**Collective Thomson scattering diagnostic at Wendelstein 7-X**

A Collective Thomson Scattering (CTS) diagnostic is installed at Wendelstein 7-X for ion temperature measurements in the plasma core. The diagnostic utilizes 140 GHz gyrotrons usually used for electron cyclotron resonance heating (ECRH) as a source of probing radiation. The CTS diagnostic uses a quasi-optical transmission line covering a distance of over 40 m. The transmission line is shared between the ECRH system and the CTS diagnostic. Here we elaborate on the design, installation, and alignment of the CTS diagnostic and present the first measurements at Wendelstein 7-X.
Core plasma ion cyclotron emission driven by fusion-born ions

Ion cyclotron emission (ICE) signals whose spectral peaks match the fundamental cyclotron frequencies of hydrogen and tritium in the plasma core, near the magnetic axis, are observed in ASDEX Upgrade deuterium plasmas. In these cases the only source of energetic (1 MeV) hydrogen and tritium ions is D–D fusion reactions between neutral beam injected deuterium ions and bulk deuterium ions. Hydrogen-matched core ICE is observed in a wide variety of ASDEX Upgrade plasmas, while tritium-matched core ICE is (so far) only observed in so-called H-mode density limit plasmas. In all cases
ICE signals are detected directly using B-dot probes, which provide information on the emission frequency, the amplitude, and, in principle, the parallel wavenumber values. These observations support the idea of using an ICE-based diagnostic to monitor the presence of fusion-born alpha particles in tritium-burning fusion plasmas on devices such as JET, ITER, CFETR, or DEMO.

**General information**

- **State:** Published
- **Organisations:** Plasma Physics and Fusion Energy, Department of Physics, Technical University of Denmark, Max Planck Institute for Plasma Physics, University of Warwick, Culham Science Centre, University of Seville
- **Number of pages:** 5
- **Publication date:** 2019
- **Peer-reviewed:** Yes

**Publication information**

- **Journal:** Nuclear Fusion
- **Volume:** 59
- **Issue number:** 1
- **Article number:** 014001
- **ISSN (Print):** 0029-5515
- **Ratings:**
  - BFI (2019): BFI-level 1
  - Web of Science (2019): Indexed yes
  - BFI (2018): BFI-level 1
  - Web of Science (2018): Indexed yes
  - BFI (2017): BFI-level 1
  - Web of Science (2017): CiteScore 2.13 SJR 0.759 SNIP 1.424
  - Web of Science (2017): Impact factor 4.057
  - Web of Science (2017): Indexed yes
  - BFI (2016): BFI-level 1
  - Web of Science (2016): CiteScore 1.62 SJR 1.284 SNIP 1.416
  - Web of Science (2016): Impact factor 3.307
  - Web of Science (2016): Indexed yes
  - BFI (2015): BFI-level 1
  - Web of Science (2015): CiteScore 1.88 SJR 1.51 SNIP 1.62
  - Web of Science (2015): Indexed yes
  - BFI (2014): BFI-level 1
  - Web of Science (2014): CiteScore 2.2 SJR 1.907 SNIP 1.667
  - Web of Science (2014): Impact factor 3.062
  - Web of Science (2014): Indexed yes
  - BFI (2013): BFI-level 1
  - Web of Science (2013): CiteScore 1.83 SJR 1.366 SNIP 1.516
  - Web of Science (2013): Impact factor 3.243
  - ISI indexed (2013): ISI indexed yes
  - Web of Science (2013): Indexed yes
  - BFI (2012): BFI-level 1
  - Web of Science (2012): CiteScore 1.81 SJR 1.441 SNIP 1.448
  - Web of Science (2012): Impact factor 2.734
  - ISI indexed (2012): ISI indexed yes
  - Web of Science (2012): Indexed yes
  - BFI (2011): BFI-level 1
  - Web of Science (2011): CiteScore 3.78 SJR 2.043 SNIP 2.433
  - Web of Science (2011): Impact factor 4.09
  - ISI indexed (2011): ISI indexed yes
  - Web of Science (2011): Indexed yes
Electron-cyclotron-resonance heating in Wendelstein 7-X: A versatile heating and current-drive method and a tool for in-depth physics studies: Paper

For stellarators, which need no or only small amounts of current drive, electron-cyclotron-resonance heating (ECRH) is a promising heating method even for the envisaged application in a fusion power plant. Wendelstein 7-X (W7-X) is equipped with a steady-state capable ECRH system, operating at 140 GHz, which corresponds to the 2nd cyclotron harmonic of the electrons at a magnetic field of 2.5 T. Ten gyrotrons are operational, and already delivered 7 MW to W7-X plasmas. Combined with pellet injection, the highest triple product (0.68 × 10^{20} \text{keV m}^{-3} \text{s}), observed up to now in stellarators, was achieved (Sunn Pedersen et al 2018 Plasma Phys. Control. Fusion 61 014035). For the first time, W7-X plasmas were sustained by 2nd harmonic O-mode heating, approaching the collisionality regime for which W7-X was optimized. Power deposition scans did not show any indication of electron temperature profile resilience. In low-density, low-power plasmas a compensation of the bootstrap current with electron-cyclotron current drive (ECCD) was demonstrated. Sufficiently strong ECCD close to the plasma centre produced periodic internal plasma-crash events, which coincide with the appearance of low order rational of the rotational transform.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Technical University of Denmark
Contributors: Wendelstein 7-X Team, Stejner, M.
Number of pages: 9
Publication date: 2019
Peer-reviewed: Yes

Publication information
Journal: Plasma Physics and Controlled Fusion
Volume: 61
Issue number: 1
Article number: 014037
ISSN (Print): 0741-3335
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.74 SJR 0.69 SNIP 1.243
Web of Science (2017): Impact factor 3.032
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1 SJR 1.433 SNIP 1.258
Web of Science (2016): Impact factor 2.392
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.1 SJR 1.314 SNIP 1.345
Web of Science (2015): Impact factor 2.404
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.61 SJR 1.542 SNIP 1.346
Web of Science (2014): Impact factor 2.186
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.54 SJR 1.2 SNIP 1.253
Web of Science (2013): Impact factor 2.386
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.63 SJR 1.453 SNIP 1.201
Web of Science (2012): Impact factor 2.369
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.69 SJR 1.496 SNIP 1.591
Web of Science (2011): Impact factor 2.731
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.468 SNIP 1.408
Web of Science (2010): Impact factor 2.466
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.589 SNIP 1.324
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.845 SNIP 1.569
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.927 SNIP 1.374
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.844 SNIP 1.556
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.756 SNIP 1.54
Alpha-particle velocity-space diagnostic in ITER

We discuss α-particle velocity-space diagnostic in ITER based on the planned collective Thomson scattering (CTS) and γ-ray spectrometry (GRS) systems as well as ASCOT simulations of the α-particle distribution function. GRS is sensitive to α-particles with energies MeV at all pitches p, and CTS for MeV and . The remaining velocity space is not observed. GRS and CTS view the plasma (almost) perpendicularly to the magnetic field. Hence we cannot determine the sign of the pitch of the α-particles and cannot distinguish co- and counter-going α-particles with the currently planned α-particle diagnostics. Therefore we can only infer the sign-insensitive 2D distribution function by velocity-space tomography for MeV. This is a serious limitation, since co- and counter-going α-particle populations are expected to have different birth rates and neoclassical transport as well as different anomalous transport due to interaction with modes such as Alfvén eigenmodes. We propose the installation of an oblique GRS system on ITER to allow us to diagnostically track such anisotropy effects and to infer the full, sign-sensitive for MeV. α-particles with MeV are diagnosed by CTS only, which does not allow velocity-space tomography on its own. Nevertheless, we show that measurements of the α-particle energy spectrum, which is an ITER measurement requirement, are now feasible for MeV using a velocity-space tomography formalism assuming isotropy in velocity space.

General information

State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Department of Applied Mathematics and Computer Science, Scientific Computing, Center for Nuclear Technologies, Radiation Physics, University of Milan - Bicocca, ITER Cadarache, Max-Planck-Institut fur Plasmaphysik, Culham Science Centre, University of California at Irvine, Aalto University, Ioffe Institute, Consiglio Nazionale delle Ricerche
Number of pages: 16
Publication date: 2018
Peer-reviewed: Yes

Publication information

Journal: Nuclear Fusion
Volume: 58
Issue number: 9
Article number: 096019
ISSN (Print): 0029-5515
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.13 SJR 0.759 SNIP 1.424
Web of Science (2017): Impact factor 4.057
Bayesian Integrated Data Analysis of Fast-Ion Measurements by Velocity-Space Tomography

Bayesian integrated data analysis combines measurements from different diagnostics to jointly measure plasma parameters of interest such as temperatures, densities, and drift velocities. Integrated data analysis of fast-ion measurements has long been hampered by the complexity of the strongly non-Maxwellian fast-ion distribution functions. This has recently been overcome by velocity-space tomography. In this method two-dimensional images of the velocity distribution functions consisting of a few hundreds or thousands of pixels are reconstructed using the available fast-ion measurements. Here we present an overview and current status of this emerging technique at the ASDEX Upgrade tokamak and the JET tokamak based on fast-ion D-alpha spectroscopy, collective Thomson scattering, gamma-ray and neutron emission spectrometry, and neutral particle analyzers. We discuss Tikhonov regularization within the Bayesian framework. The implementation for different types of diagnostics as well as the uncertainties are discussed, and we highlight the importance of integrated data analysis of all available detectors.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, University of Milan - Bicocca, Max-Planck-Institut fur Plasmaphysik, Uppsala University, Rutherford Appleton Laboratory, Culham Science Centre, Aalto University, Consiglio Nazionale delle Ricerche

Number of pages: 14
Pages: 23-36
Publication date: 2018
Peer-reviewed: Yes
Deuterium temperature, drift velocity, and density measurements in non-Maxwellian plasmas at ASDEX Upgrade

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Max-Planck-Institut fur Plasmaphysik, University of Milan - Bicocca
Number of pages: 12
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Nuclear Fusion
Volume: 58
Issue number: 3
Article number: 036017
ISSN (Print): 0029-5515
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
Molecular gas masses of gamma-ray burst host galaxies

Context. Long gamma-ray bursts (GRBs) can potentially be used as a tool to study star formation and recent gas accretion onto galaxies. However, the information about gas properties of GRB hosts is scarce. In particular, very few carbon monoxide (CO) line detections of individual GRB hosts have been reported. It has also been suggested that GRB hosts have lower molecular gas masses than expected from their star formation rates (SFRs). Aims. The objectives of this paper are to analyse molecular gas properties of the first substantial sample of GRB hosts and test whether they are deficient in molecular gas. Methods. We obtained CO(2-1) observations of seven GRB hosts with the APEX and IRAM 30 m telescopes. We analysed these data together with all other hosts with previous CO observations. From these observations we calculated the molecular gas masses of these galaxies and compared them with the expected values based on their SFRs and metallicities. Results. We obtained detections for 3 GRB hosts (980425, 080207, and 111005A) and upper limits for the remaining 4 (031203, 060505, 060814, and 100316D). In our entire sample of 12 CO-observed GRB hosts, 3 are clearly deficient in molecular gas, even taking into account their metallicity (980425, 060814, and 080517). Four others are close to the best-fit line for other star-forming galaxies on the SFR-M-H2 plot (051022, 060505, 080207, and 100316D). One host is clearly molecule rich (111005A). Finally, the data for 4 GRB hosts are not deep enough to judge whether they are molecule deficient (000418, 030329, 031203, and 090423). The median value of the molecular gas depletion time, M-H2/SFR, of GRB hosts is similar to 0.3 dex below that of other star-forming galaxies, but this result has low statistical significance. A Kolmogorov-Smirnov test performed on M-H2/SFR shows an only similar to 2 sigma difference between GRB hosts and other galaxies. This difference can partly be explained by metallicity effects, since the significance decreases to similar to 1 sigma for M-H2/SFR versus metallicity. Conclusions. We found that any molecular gas deficiency of GRB hosts has low statistical significance and that it can be attributed to their lower metallicities; and thus the sample of GRB hosts has molecular properties that are consistent with those of other galaxies, and they can be treated as representative star-forming galaxies. However, the molecular gas deficiency can be strong for GRB hosts if they exhibit higher excitations and/or a lower CO-to-H2 conversion factor than we assume, which would lead to lower molecular gas masses than we derive. Also, the concentration of atomic gas recently found close to GRB and supernova sites, indicating recent gas inflow, our results about the weak molecular deficiency imply that such an inflow does not enhance the SFRs significantly, or that atomic gas converts efficiently into the molecular phase, which fuels star formation. Only if the analysis of a larger GRB host sample reveals molecular deficiency (especially close to the GRB position) would this support the hypothesis of star formation that is directly fuelled by atomic gas.
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.8 SJR 2.265 SNIP 1.099
Web of Science (2017): Impact factor 5.565
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.68 SJR 2.234 SNIP 1.199
Web of Science (2016): Impact factor 5.014
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.5 SJR 2.545 SNIP 1.224
Web of Science (2015): Impact factor 5.185
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 2.82 SJR 2.883 SNIP 1.247
Web of Science (2014): Impact factor 4.378
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 2.01 SJR 2.747 SNIP 1.159
Web of Science (2013): Impact factor 4.479
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.14 SJR 2.903 SNIP 1.36
Web of Science (2012): Impact factor 5.084
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 3.42 SJR 2.737 SNIP 1.322
Web of Science (2011): Impact factor 4.587
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.849 SNIP 1.424
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.976 SNIP 1.438
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.907 SNIP 1.291
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.861 SNIP 1.333
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 3.646 SNIP 1.4
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 3.265 SNIP 1.338
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.862 SNIP 1.448
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.157 SNIP 1.362
Web of Science (2003): Indexed yes
Neutronics analysis of the ITER Collective Thomson Scattering system

The Collective Thomson Scattering (CTS) will be the ITER diagnostic responsible for measuring the alpha-particle velocity distribution. Using mirrors, a powerful microwave beam is directed into the plasma via an opening in the plasma-facing wall. The microwaves will scatter off fluctuations in the plasma, and the scattered signal is recorded after transmission through a series of mirrors and waveguides. Several components of the CTS system will be directly exposed to neutron radiation from the plasma which can change the properties of the components and reduce their lifetime. In this paper, a neutronics analysis is presented for the CTS system. A study on the influence of different materials on the nuclear heat loads in the launcher mirror is also presented, along with the design of a simple cooling system. All the studies were conducted using the Monte Carlo program MCNP6. The outputs, in particular the nuclear heat loads, will be used to perform the thermal analysis of the system.

General information
State: Published
Organisations: Center for Nuclear Technologies, Radiation Physics, Radioecology and Tracer Studies, Department of Physics, Plasma Physics and Fusion Energy, University of Lisbon
Number of pages: 7
Pages: 22-28
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Fusion Engineering and Design
Volume: 134
ISSN (Print): 0920-3796
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.51 SJR 0.61 SNIP 1.273
Web of Science (2017): Impact factor 1.437
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.14 SJR 0.579 SNIP 1.054
Web of Science (2016): Impact factor 1.319
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.41 SJR 0.682 SNIP 1.493
Web of Science (2015): Impact factor 1.301
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Observations of core ion cyclotron emission on ASDEX Upgrade tokamak
The B-dot probe diagnostic suite on the ASDEX Upgrade tokamak has recently been upgraded with a new 125 MHz, 14 bit resolution digitizer to study ion cyclotron emission (ICE). While classic edge emission from the low field side plasma is often observed, we also measure waves originating from the core with fast fusion protons or beam injected deuterons being a possible emission driver. Comparing the measured frequency values with ion cyclotron harmonics present in the plasma places the origin of this emission on the magnetic axis, with the fundamental hydrogen/second deuterium cyclotron harmonic matching the observed values. The actual values range from ~27 MHz at the on-axis toroidal field $B_T = -1.79$ T to ~40 MHz at $B_T = -2.62$ T. When the magnetic axis position evolves during this emission, the measured frequency values track the changes in the estimated on-axis cyclotron frequency values. Core ICE is usually a transient event lasting ~100 ms during the neutral beam startup phase. However, in some cases, core emission occurs in steady-state plasmas and lasts for longer than 1 s. These observations suggest an attractive possibility of using a non-perturbing ICE-based diagnostic to passively monitor fusion alpha particles at the location of their birth in the plasma core, in deuterium-tritium burning devices such as ITER and DEMO.
Relativistic supernova 2009bb exploded close to an atomic gas cloud

Context. The host galaxies of gamma-ray bursts (GRBs) have been claimed to have experienced a recent inflow of gas from the intergalactic medium. This is because their atomic gas distribution is not centred on their optical emission and because they are deficient in molecular gas given their high star formation rates (SFRs). Similar studies have not been conducted for host galaxies of relativistic supernovae (SNe), which may have similar progenitors.

Aims. The potential similarity of the powering mechanisms of relativistic SNe and GRBs allowed us to make a prediction that relativistic SNe are born in environments similar to those of GRBs, that is, ones which are rich in atomic gas. Here we embark on testing this hypothesis by analysing the properties of the host galaxy NGC 3278 of the relativistic SN 2009bb. This is the first time the atomic gas properties of a relativistic SN host are provided and the first time resolved 21 cm-hydrogen-line (H I) information is provided for a host of an SN of any type in the context of the SN position.

Methods. We obtained radio observations with the Australia Telescope Compact Array (ATCA) covering the H I line, and optical integral field unit spectroscopy observations with the Multi Unit Spectroscopic Explorer (MUSE) at the Very Large Telescope (VET). Moreover, we analysed archival carbon monoxide (CO) and multi-wavelength data for this galaxy.

Results. The atomic gas distribution of NGC 3278 is not centred on the optical galaxy centre, but instead around a third of atomic gas resides in the region close to the SN position. This galaxy has a few times lower atomic and molecular gas masses than predicted from its SFR. Its specific SFR (sSFR = SFR/M*) is approximately two to three times higher than the main-sequence value, placing it at the higher end of the main sequence, towards starburst galaxies. SN 2009bb exploded close to the region with the highest SFR density and the lowest age, as evident from high H alpha EW, corresponding to the age of the stellar population of similar to 5.5 Myr. Assuming this timescale was the lifetime of the progenitor star, its initial mass would have been close to similar to 36 M☉.

Conclusions. As for GRB hosts, the gas properties of NGC 3278 are consistent with a recent inflow of gas from the intergalactic medium, which explains the concentration of atomic gas close to the SN position and the enhanced SFR. Super-solar metallicity at the position of the SN (unlike for most GRBs) may mean that relativistic explosions signal a recent inflow of gas (and subsequent star formation), and their type (GRBs or SNe) is determined either (i) by the metallicity of the inflowing gas, so that metal-poor gas results in a GRB explosion and metal-rich gas (for example a minor merger with an evolved galaxy or re-accretion of expelled gas) results in a relativistic SN explosion without an accompanying GRB, or (ii) by the efficiency of gas mixing (efficient mixing for SN hosts leading to a quick disappearance of metal-poor regions), or (iii) by the type of the galaxy (more metal-rich galaxies would result in only a small fraction of star formation being fuelled by metal-poor gas).
Main-ion temperature and plasma rotation measurements based on scattering of electron cyclotron heating waves in ASDEX Upgrade: Paper

We demonstrate measurements of spectra of O-mode electron cyclotron resonance heating (ECRH) waves scattered collectively from microscopic plasma fluctuations in ASDEX Upgrade discharges with an ITER-like ECRH scenario. The measured spectra are shown to allow determination of the main ion temperature and plasma rotation velocity. This demonstrates that ECRH systems can be exploited for diagnostic purposes alongside their primary heating purpose in a reactor relevant scenario.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Max-Planck-Institut fur Plasmaphysik
Number of pages: 10
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Plasma Physics and Controlled Fusion
Volume: 59
Issue number: 7
Article number: 075009
ISSN (Print): 0741-3335
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.74 SJR 0.69 SNIP 1.243
Web of Science (2017): Impact factor 3.032
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1 SJR 1.433 SNIP 1.258
Web of Science (2016): Impact factor 2.392
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.1 SJR 1.314 SNIP 1.345
Web of Science (2015): Impact factor 2.404
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.61 SJR 1.542 SNIP 1.346
Web of Science (2014): Impact factor 2.186
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.54 SJR 1.2 SNIP 1.253
Web of Science (2013): Impact factor 2.386
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.63 SJR 1.453 SNIP 1.201
Web of Science (2012): Impact factor 2.369
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.69 SJR 1.496 SNIP 1.591
Web of Science (2011): Impact factor 2.731
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.468 SNIP 1.408
Web of Science (2010): Impact factor 2.466
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.589 SNIP 1.324
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.845 SNIP 1.569
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.927 SNIP 1.374
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.844 SNIP 1.556
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.756 SNIP 1.54
Scopus rating (2004): SJR 2.246 SNIP 1.382
Scopus rating (2003): SJR 2.135 SNIP 1.253
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.668 SNIP 1.058
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.679 SNIP 1.233
Web of Science (2001): Indexed yes
MeV-range velocity-space tomography from gamma-ray and neutron emission spectrometry measurements at JET

We demonstrate the measurement of a 2D MeV-range ion velocity distribution function by velocity-space tomography at JET. Deuterium ions were accelerated into the MeV-range by third harmonic ion cyclotron resonance heating. We made measurements with three neutron emission spectrometers and a high-resolution γ-ray spectrometer detecting the γ-rays released in two reactions. The tomographic inversion based on these five spectra is in excellent agreement with numerical simulations with the ASCOT–RFOF and the SPOT–RFOF codes. The length of the measured fast-ion tail corroborates the prediction that very few particles are accelerated above 2 MeV due to the weak wave-particle interaction at higher energies.
Observation of short time-scale spectral emissions at millimeter wavelengths with the new CTS diagnostic on the FTU tokamak: Paper

On the FTU tokamak, the collective Thomson scattering (CTS) diagnostic was renewed for investigating the possible excitation of parametric decay instabilities (PDI) by electron cyclotron (EC) or CTS probe beams in presence of magnetic islands and measure their effects on the EC power absorption. The experiments were performed launching a gyrotron...
probe beam (140 GHz, 400 kW) and observing the scattered radiation in symmetric and asymmetric directions (with respect to the equatorial plane) in different conditions of plasma density and magnetic field (with or without the EC resonance in the plasma), and with magnetic islands generated by Neon injection. The acquisition with a fast digitizer allowed observing spectral features with very high time and frequency resolution. Shots were performed at 7.2 T, with the fundamental EC resonance out of the plasma region, at 4.7 T, with the resonance on the high field side of the plasma column, and at 3.6 T, in this last case with the plasma between the first and the second EC harmonics both lying outside the plasma volume. Several types of spectral features characterized by their frequency and their fast time evolution were identified in the observed signal after a proper treatment. The paper reports the observations in the different experimental cases and the correlation of the features with the existence of MHD modes as witnessed by magnetic probes signals and with macroscopic plasma parameters.

**General information**

**State:** Published

**Organisations:** Department of Physics, Plasma Physics and Fusion Energy, Consiglio Nazionale delle Ricerche, ENEA Centro Ricerche Frascati, Swiss Federal Institute of Technology Lausanne, RAS - Institute of Applied Physics, Università degli Studi di Milano-Bicocca, Università degli Studi di Napoli Federico II


**Number of pages:** 8

**Publication date:** 2017

**Peer-reviewed:** Yes

**Publication information**

**Journal:** Nuclear Fusion

**Volume:** 57

**Issue number:** 7

**Article number:** 076004

**ISSN (Print):** 0029-5515

**Ratings:**

BFI (2019): BFI-level 1

Web of Science (2019): Indexed yes

BFI (2018): BFI-level 1

Web of Science (2018): Indexed yes

BFI (2017): BFI-level 1

Scopus rating (2017): CiteScore 2.13 SJR 0.759 SNIP 1.424

Web of Science (2017): Impact factor 4.057

Web of Science (2017): Indexed yes

BFI (2016): BFI-level 1

Scopus rating (2016): CiteScore 1.62 SJR 1.284 SNIP 1.416

Web of Science (2016): Impact factor 3.307

Web of Science (2016): Indexed yes

BFI (2015): BFI-level 1

Scopus rating (2015): CiteScore 1.88 SJR 1.51 SNIP 1.62


Web of Science (2015): Indexed yes

BFI (2014): BFI-level 1

Scopus rating (2014): CiteScore 2.2 SJR 1.907 SNIP 1.667

Web of Science (2014): Impact factor 3.062

Web of Science (2014): Indexed yes

BFI (2013): BFI-level 1

Scopus rating (2013): CiteScore 1.83 SJR 1.366 SNIP 1.516

Web of Science (2013): Impact factor 3.243

ISI indexed (2013): ISI indexed yes

Web of Science (2013): Indexed yes

BFI (2012): BFI-level 1

Scopus rating (2012): CiteScore 1.81 SJR 1.441 SNIP 1.448

Web of Science (2012): Impact factor 2.734

ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 3.78 SJR 2.043 SNIP 2.433
Web of Science (2011): Impact factor 4.09
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 2.268 SNIP 1.927
Web of Science (2010): Impact factor 3.303
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.993 SNIP 2.441
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 2.031 SNIP 1.736
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.005 SNIP 1.987
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.062 SNIP 1.937
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.885 SNIP 1.932
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.647 SNIP 1.673
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.215 SNIP 1.673
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 3.275 SNIP 1.409
Scopus rating (2001): SJR 2.159 SNIP 2.173
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 1.843 SNIP 1.104
Scopus rating (1999): SJR 1.99 SNIP 1.496
Original language: English
Keywords: Collective Thomson scattering, Parametric decay instabilities, Electron cyclotron heating, Magnetic islands
Electronic versions:
preprint0275.pdf
DOIs:
10.1088/1741-4326/aa6ce1
Source: FindIt
Source-ID: 2357683310
Research output: Research - peer-review : Journal article – Annual report year: 2017

Overview of ASDEX Upgrade results
The ASDEX Upgrade (AUG) programme is directed towards physics input to critical elements of the ITER design and the preparation of ITER operation, as well as addressing physics issues for a future DEMO design. Since 2015, AUG is equipped with a new pair of 3-strap ICRF antennas, which were designed for a reduction of tungsten release during ICRF operation. As predicted, a factor two reduction on the ICRF-induced W plasma content could be achieved by the reduction of the sheath voltage at the antenna limiters via the compensation of the image currents of the central and side straps in the antenna frame. There are two main operational scenario lines in AUG. Experiments with low collisionality, which comprise current drive, ELM mitigation/suppression and fast ion physics, are mainly done with freshly boronized walls to reduce the tungsten influx at these high edge temperature conditions. Full ELM suppression and non-inductive operation up to a plasma current of $I_p = 0.8$ MA could be obtained at low plasma density. Plasma exhaust is studied under conditions of high neutral divertor pressure and separatrix electron density, where a fresh boronization is not required. Substantial progress could be achieved for the understanding of the confinement degradation by strong D puffing and the improvement with nitrogen or carbon seeding. Inward/outward shifts of the electron density profile relative to the temperature profile effect the edge stability via the pressure profile changes and lead to improved/decreased pedestal performance. Seeding and D gas puffing are found to effect the core fueling via changes in a region of high density on the high field side (HFSHD). The integration of all above mentioned operational scenarios will be feasible and naturally obtained in a large device where the edge is more opaque for neutrals and higher plasma temperatures provide a lower
collisionality. The combination of exhaust control with pellet fueling has been successfully demonstrated. High divertor enrichment values of nitrogen $E^N_N \geq 10$ have been obtained during pellet injection, which is a prerequisite for the simultaneous achievement of good core plasma purity and high divertor radiation levels. Impurity accumulation observed in the all-metal AUG device caused by the strong neoclassical inward transport of tungsten in the pedestal is expected to be relieved by the higher neoclassical temperature screening in larger devices.
Overview of progress in European medium sized tokamaks towards an integrated plasma-edge/wall solution

Integrating the plasma core performance with an edge and scrape-off layer (SOL) that leads to tolerable heat and particle loads on the wall is a major challenge. The new European medium size tokamak task force (EU-MST) coordinates research on ASDEX Upgrade (AUG), MAST and TCV. This multi-machine approach within EU-MST, covering a wide parameter range, is instrumental to progress in the field, as ITER and DEMO core/pedestal and SOL parameters are not achievable simultaneously in present day devices. A two prong approach is adopted. On the one hand, scenarios with tolerable transient heat and particle loads, including active edge localised mode (ELM) control are developed. On the other hand, divertor solutions including advanced magnetic configurations are studied. Considerable progress has been made on both approaches, in particular in the fields of: ELM control with resonant magnetic perturbations (RMP), small ELM regimes, detachment onset and control, as well as filamentary scrape-off-layer transport. For example full ELM suppression has now been achieved on AUG at low collisionality with n=2 RMP maintaining good confinement $H_{98}(y2) ≈ 0.95$. Advances have been made with respect to detachment onset and control. Studies in advanced divertor configurations (Snowflake, Super-X and X-point target divertor) shed new light on SOL physics. Cross field filamentary transport has been characterised in a wide parameter regime on AUG, MAST and TCV progressing the theoretical and experimental understanding crucial for predicting first wall loads in ITER and DEMO. Conditions in the SOL also play a crucial role for ELM stability and access to small ELM regimes.

General information

State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Technical University of Denmark
Zoletnik, S., Zuin, M.
Wodniak, I., Wolfrum, E., Yadykin, D., Zagorski, R., Zammuto, I., Zanca, P., Zaplotnik, R., Zestanakis, P., Zhang, W.,
Thornton, A., Tolias, P., Tophøj, L. E. H., Treutterer, W., Trevisan, G., Tripsky, M., Tsironis, C., Tsui, C., Tudisco, O.,
Szepesi, T., Tál, B., Tala, T., Tamain, P., Tardini, G., Tardocchi, M., Teplukhina, A., Terranova, D., Testa, D., Theiler, C.,
Spizzo, G., Spolaore, M., Stange, T., Pedersen, M. S., Stapanov, I., Stober, J., Strand, P., Šušnjara, A., Suttrop, W.,
Sieglin, B., Silva, C., Silva, A., Silva Fuglister, M., Simpson, J. J., Snicker, A., Sommariva, C., Sozzi, C., Spagnolo, S.,
Schweinzer, J., Seidl, J., Sertoli, M., Šesnić, S., Shabbir, A., Shalpegin, A., Shanahan, B., Sharapov, S., Sheikh, U., Sias,
Scannell, R., Scheffer, M., Schneider, M., Schneider, B., Schneider, P., Schneller, M., Schrittwieser, R., Schubert, M.,
Sabot, R., Saint-Laurent, F., Salewski, M., Salmi, A., Samaddar, D., Sanchis-Sanchez, L., Santos, J., Sauter, O.,
Reux, C., Ripamonti, D., Rittich, D., Riva, G., Rodriguez-Ramos, M., Rohde, V., Rosato, J., Ryter, F., Saarelma, S.,
Rattá, G., Ratynskaia, S., Ravera, G., Rády, D., Reich, M., Reimerdes, H., Reimold, F., Reinke, M., Reiser, D., Resnik, M.,
Reim, J., Reichl, N., Ritt, M., Ritter, S., Rendl, R., Rendina, M., Reich, W., Read, P., Rebeyrolle, T., Puetz, T., Pufal, T.,
Pereira, A., Perelli Cippo, E., Pericoli Ridolfini, V., Peterka, R., Petersson, P., Petritzka, V., Piovesan, P., Piron, C., Pironti, A., Pisano, F., Pisokas, T., Pitts, R., Ploumikostas, I.,
Plyusnin, V., Pokol, G., Poljak, D., Pölöksesi, P., Popovic, Z., Pór, G., Porte, L., Potzel, S., Predebon, I., Preynas, M.,
Primc, G., Pucella, M., Puiatti, M., Püttcher, T., Rack M., Ramogida, G., Rapson, C., Rasmussen, J. J., Rasmussen, J.,
Rättä, G., Ratynskaia, S., Ravera, G., Rády, D., Reich, M., Reimerdes, H., Reimold, F., Reineke, M., Reiser, D., Resnik, M.,
Reux, C., Ripamonti, D., Rittich, D., Riva, G., Rodríguez-Ramos, M., Rohde, V., Rosato, J., Ryter, F., Saarelma, S.,
Sabot, R., Saint-Laurent, F., Salewski, M., Salmi, A., Samaddar, D., Sanchis-Sanchez, L., Santos, J., Sauter, O.,
Scannell, R., Scheffer, M., Schneider, M., Schneider, B., Schneider, P., Schneller, M., Schrittwieser, R., Schubert, M.,
Schwarz, T., Seidl, J., Sertoli, M., Šesnić, S., Shabbir, A., Shalpegin, A., Shanahan, B., Sharapov, S., Sheikh, U., Sias,
Scannell, R., Scheffer, M., Schneider, M., Schneider, B., Schneider, P., Schneller, M., Schrittwieser, R., Schubert, M.,
Schweinzer, J., Seidl, J., Sertoli, M., Šesnić, S., Shabbir, A., Shalpegin, A., Shanahan, B., Sharapov, S., Sheikh, U., Sias,
Scannell, R., Scheffer, M., Schneider, M., Schneider, B., Schneider, P., Schneller, M., Schrittwieser, R., Schubert, M.,
Schweinzer, J., Seidl, J., Sertoli, M., Šesnić, S., Shabbir, A., Shalpegin, A., Shanahan, B., Sharapov, S., Sheikh, U., Sias,
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.13 SJR 0.759 SNIP 1.424
Web of Science (2017): Impact factor 4.057
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.62 SJR 1.284 SNIP 1.416
Web of Science (2016): Impact factor 3.307
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.88 SJR 1.51 SNIP 1.62
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.2 SJR 1.907 SNIP 1.667
Web of Science (2014): Impact factor 3.062
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.83 SJR 1.366 SNIP 1.516
Web of Science (2013): Impact factor 3.243
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.81 SJR 1.441 SNIP 1.448
Web of Science (2012): Impact factor 2.734
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 3.78 SJR 2.043 SNIP 2.433
Web of Science (2011): Impact factor 4.09
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 2.268 SNIP 1.927
Web of Science (2010): Impact factor 3.303
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.993 SNIP 2.441
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 2.031 SNIP 1.736
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.005 SNIP 1.987
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.062 SNIP 1.937
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.885 SNIP 1.932
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.647 SNIP 1.673
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.215 SNIP 1.673
RAMI analysis of the ITER LFS CTS system

This paper describes an initial RAMI analysis for the ITER Low Field Side Collective Thomson Scattering system (LFS CTS) based on its preliminary architecture at system design level. The benefits and challenges involved in this analysis since an early phase of the design are discussed together with the methodology pursued. The Functional Analysis, developed both at system and sub-system level, are the major inputs for the RAMI analysis. A systematic approach has been used, and significant design assumptions have been made due to the lack of knowledge and definition inherent to preliminary design stages. This study includes the Failure Mode, Effects and Criticality Analysis and the Reliability Block Diagram of the system. The results obtained for the system Availability and Reliability are presented and discussed, and criticality charts are developed to highlight the risk levels of the failure modes, regarding to their likelihood and effects on the Availability of the ITER machine. Mitigation actions are proposed to reduce these risk levels in case of impact on the ITER operation.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, University of Lisbon
Number of pages: 6
Pages: 663-668
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Fusion Engineering and Design
Volume: 123
ISSN (Print): 0920-3796
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.51 SJR 0.61 SNIP 1.273
Web of Science (2017): Impact factor 1.437
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.14 SJR 0.579 SNIP 1.054
Web of Science (2016): Impact factor 1.319
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.41 SJR 0.682 SNIP 1.493
Web of Science (2015): Impact factor 1.301
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Recent development of collective Thomson scattering for magnetically confined fusion plasmas

Here we review recent experimental developments within the field of collective Thomson scattering with a focus on the progress made on the devices TEXTOR and ASDEX Upgrade. We discuss recently discovered possibilities and limitations of the diagnostic technique. Diagnostic applications with respect to ion measurements are demonstrated. Examples include measurements of the ion temperature, energetic ion distribution function, and the ion composition.

General information

State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Max-Planck-Institut fur Plasmaphysik
Number of pages: 7
Publication date: 2017
Peer-reviewed: Yes

Research output: Research - peer-review \ Journal article – Annual report year: 2017
Benchmark and combined velocity-space tomography of fast-ion D-alpha spectroscopy and collective Thomson scattering measurements

We demonstrate the combination of fast-ion D-alpha spectroscopy (FIDA) and collective Thomson scattering (CTS) measurements to determine a common best estimate of the fast-ion velocity distribution function by velocity-space tomography. We further demonstrate a benchmark of FIDA tomography and CTS measurements without using a numerical simulation as common reference. Combined velocity-space tomographies from FIDA and CTS measurements confirm that sawtooth crashes reduce the fast-ion phase-space densities in the plasma center and affect ions with pitches close to one more strongly than those with pitches close to zero.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Max Planck Institute for Plasma Physics
Contributors: Jacobsen, A. S., Salewski, M., Geiger, B., Korsholm, S. B., Leipold, F., Nielsen, S. K., Rasmussen, J., Pedersen, M. S., Weiland, M.
Number of pages: 5
Publication date: 2016
Peer-reviewed: Yes

Publication information
Journal: Plasma Physics and Controlled Fusion
Volume: 58
Issue number: 4
Article number: 042002
ISSN (Print): 0741-3335
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.74 SJR 0.69 SNIP 1.243
Web of Science (2017): Impact factor 3.032
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1 SJR 1.433 SNIP 1.258
Web of Science (2016): Impact factor 2.392
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.1 SJR 1.314 SNIP 1.345
Web of Science (2015): Impact factor 2.404
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.61 SJR 1.542 SNIP 1.346
Web of Science (2014): Impact factor 2.186
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.54 SJR 1.2 SNIP 1.253
Web of Science (2013): Impact factor 2.386
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.63 SJR 1.453 SNIP 1.201
Web of Science (2012): Impact factor 2.369
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Collective Thomson scattering measurements of fast-ion transport due to sawtooth crashes in ASDEX Upgrade

Sawtooth instabilities can modify heating and current-drive profiles and potentially increase fast-ion losses. Understanding how sawteeth redistribute fast ions as a function of sawtooth parameters and of fast-ion energy and pitch is hence a subject of particular interest for future fusion devices. Here we present the first collective Thomson scattering (CTS) measurements of sawtooth-induced redistribution of fast ions at ASDEX Upgrade. These also represent the first localized fast-ion measurements on the high-field side of this device. The results indicate fast-ion losses in the phase-space measurement volume of about 50% across sawtooth crashes, in good agreement with values predicted with the Kadomtsev sawtooth model implemented in TRANSP and with the sawtooth model in the EBdyna_go code. In contrast to the case of sawteeth, we observe no fast-ion redistribution in the presence of fishbone modes. We highlight how CTS measurements can discriminate between different sawtooth models, in particular when aided by multi-diagnostic velocity-space tomography, and briefly discuss our results in light of existing measurements from other fast-ion diagnostics.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, University of Seville, Max-Planck-Institut fur Plasmaphysik, FOM Dutch Institute for Fundamental Energy Research, Budapest University of Technology and Economics
Design of the Collective Thomson Scattering diagnostic for the next-generation fusion experiment ITER

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Center for Nuclear Technologies, Radiation Physics, University of Lisbon, Fusion For Energy
Publication date: 2016
Peer-reviewed: Yes
Event: Abstract from Dansk Fysisk Selskab Årsmøde 2016, Middelfart, Denmark.
Electronic versions:
Abstract_DFS2016.pdf
Source: PublicationPreSubmission
Source-ID: 127089789
Research output: Research - peer-review › Conference abstract for conference – Annual report year: 2016

Developing diagnostic systems for ITER – the next step fusion energy experiment

Fusion energy research is moving to the next stage with the well progressed construction of one of the largest research infrastructures ever – ITER. The goal of ITER is to produce 500 MW of fusion power while heating the fuel –deuterium/tritium plasma – by 50 MW. This will confirm fusion energy to be a viable energy source. Fusion energy power plants will be safe and can be operated to supply the baseload of an energy system. The fuel resources are inexhaustible, and can be derived from sea water. Fusion energy is based on the nuclear reaction fusing hydrogen isotopes into helium – like in the Sun – and thus no CO₂ is released in the energy production. The waste of the energy production is the irradiated steel of the core of the reactor, but this radioactivity will only last for about 100 years and no long-term radioactive waste storage is needed.

While the promise of safe, clean and abundant energy is the ultimate goal of fusion energy, the path towards this is challenging. A fusion plasma has a temperature of 200 mio. degrees (15 times that of the core of the Sun), and this is confined by a magnetic field generated by powerful superconducting magnets in a vacuum chamber of 1000 m³. Operating diagnostic systems in the environment of ITER is a challenge for many technologies, but due to robustness, microwave diagnostics will play an increasingly important role in burning plasma fusion energy experiments like ITER and beyond. The Collective Thomson Scattering (CTS) diagnostic to be installed at ITER is an example of such a diagnostic
with great potential in present and future experiments. The ITER CTS diagnostic will inject a 1 MW 60 GHz beam of electromagnetic radiation from a gyrotron into the ITER plasma and observe the scattering off fluctuations in the plasma – to monitor the dynamics of the fast ions generated in the fusion reactions. This will provide important physics understanding of the behavior of the fusion plasma that can be used for optimizing future fusion power plants. A research team at DTU (DTU Physics and DTU Nutech) has been tasked by Fusion for Energy (the European coordinator for supplies to ITER) to develop the ITER CTS diagnostic in collaboration with Instituto Superior Técnico in Portugal. It is a 5 year effort of more than 50 man year total effort. This presentation will outline the prospects and the status of the development of fusion energy research and the CTS diagnostic system for ITER.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Center for Nuclear Technologies, Radiation Physics
Number of pages: 1
Publication date: 2016
Peer-reviewed: Yes
URLs:
http://www.sustain.dtu.dk/

Bibliographical note
Sustain Abstract E-12

Exploiting the energy source of the stars: Fusion energy research at DTU
With increasing energy demands and a limited supply of fossil fuels, the need for efficient, clean, and sustainable energy sources grows ever more pressing. Nuclear fusion – the process from which stars like the Sun derive their energy – holds the potential to help address this challenge. To mimic this process on earth, experimental fusion devices seek to confine and heat gas to millions of degrees (creating a fusion plasma). Learning how such plasmas behave is a crucial step towards realizing fusion as a sustainable energy source. At the Plasma Physics and Fusion Energy (PPFE) section at DTU Physics, we are exploring this issue, focusing on three areas of high priority on the way towards a working fusion power plant.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy
Number of pages: 1
Publication date: 2016
Peer-reviewed: Yes
URLs:
http://www.sustain.dtu.dk/

Bibliographical note
Sustain Abstract E-10

Fast-ion energy resolution by one-step reaction gamma-ray spectrometry
The spectral broadening of γ-rays from fusion plasmas can be measured in high-resolution gamma-ray spectrometry (GRS). We derive weight functions that determine the observable velocity space and quantify the velocity-space sensitivity of one-step reaction high-resolution GRS measurements in magnetized fusion plasmas. The weight functions suggest that GRS resolves the energies of fast ions directly without the need for tomographic inversion for selected one-step reactions at moderate plasma temperatures. The D(p,γ)3He reaction allows the best direct fast-ion energy resolution. We illustrate our general formalism using reactions with and without intrinsic broadening of the γ-rays for the GRS diagnostic at JET.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, University of Milan - Bicocca, Culham Science Centre, Max Planck Institute for Plasma Physics, CNR
GRB 980425 host: [C II], [O I], and CO lines reveal recent enhancement of star formation due to atomic gas inflow

Context. Accretion of gas from the intergalactic medium is required to fuel star formation in galaxies. We have recently suggested that this process can be studied using host galaxies of gamma-ray bursts (GRBs).

Aims. Our aim is to test this possibility by studying in detail the properties of gas in the closest galaxy hosting a GRB (980425).

Methods. We obtained the first ever far-infrared (FIR) line observations of a GRB host, namely Herschel/PACS resolved [C ii] 158 μm and [O i] 63 μm spectroscopy, and an APEX/SHeFi CO(2-1) line detection and ALMA CO(1-0) observations of the GRB 980425 host.

Results. The GRB 980425 host has elevated [C ii]/FIR and [O i]/FIR ratios and higher values of star formation rates (SFR) derived from line ([C ii], [O i], Hα) than from continuum (UV, IR, radio) indicators. [C ii] emission exhibits a normal morphology, peaking at the galaxy centre, whereas [O i] is concentrated close to the GRB position and the nearby Wolf-Rayet region. The high [O i] flux indicates that there is high radiation field and high gas density at these positions, as derived from modelling of photo-dissociation regions. The [C ii]/CO luminosity ratio of the GRB 980425 host is close to the highest values found for local star-forming galaxies. Indeed, its CO-derived molecular gas mass is low given its SFR and metallicity, but the [C ii]-derived molecular gas mass is close to the expected value.

Conclusions. The [O i] and H i concentrations and the high radiation field and density close to the GRB position are consistent with the hypothesis of a very recent (at most a few tens of Myr ago) inflow of atomic gas triggering star formation. In this scenario dust has not had time to build up (explaining high line-to-continuum ratios). Such a recent enhancement of star formation activity would indeed manifest itself in high SFR\text{line}/SFR\text{continuum} ratios because the line indicators are sensitive only to recent (~ 10 Myr) activity, whereas the continuum indicators measure the SFR averaged over much longer periods (~100 Myr). Within a sample of 32 other GRB hosts, 20 exhibit SFR\text{line}/SFR\text{continuum} > 1 with a mean ratio of 1.74 ± 0.32. This is consistent with a very recent enhancement of star formation that is common among GRB hosts, so galaxies that have recently experienced inflow of gas may preferentially host stars exploding as GRBs. Therefore GRBs may be used to select a unique sample of galaxies that is suitable for the investigation of recent gas accretion.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, University of Edinburgh, European Space Agency - ESA, University of Copenhagen, Nicolaus Copernicus University in Torun, University of Lisbon, Leiden University, Observatorio Astrofisico Di Arcetri, Florence, Universiteit Gent, Instituto de Astrofisica de Andalucia, Vrije Universiteit Amsterdam, European Space Astronomy Centre and European Space Agency, Thüringer Landessternwarte Tautenburg, Centro de Astrobiología, National Institute for Astrophysics, Max-Planck-Institut fur extraterrestrische Physik, Stockholm University, Chinese Academy of Sciences
High-definition velocity-space tomography of fast-ion dynamics

Velocity-space tomography of the fast-ion distribution function in a fusion plasma is usually a photon-starved tomography method due to limited optical access and signal-to-noise ratio of fast-ion Dα (FIDA) spectroscopy as well as the strive for high-resolution images. In high-definition tomography, prior information makes up for this lack of data. We restrict the target velocity space through the measured absence of FIDA light, impose phase-space densities to be non-negative, and encode the known geometry of neutral beam injection (NBI) sources. We further use a numerical simulation as prior information to reconstruct where in velocity space the measurements and the simulation disagree. This alternative approach is demonstrated for four-view as well as for two-view FIDA measurements. The high-definition tomography tools allow us to study fast ions in sawtoothing plasmas and the formation of NBI peaks at full, half and one-third energy by time-resolved tomographic movies.

General information

State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Department of Applied Mathematics and Computer Science, Scientific Computing, Max-Planck-Institut fur Plasmaphysik, University of California at Irvine, University of Milan - Bicocca
Number of pages: 15
Publication date: 2016
Peer-reviewed: Yes

Publication information
Journal: Nuclear Fusion
Volume: 56
Issue number: 10
Article number: 106024
ISSN (Print): 0029-5515
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
High power microwave diagnostic for the fusion energy experiment ITER

Microwave diagnostics will play an increasingly important role in burning plasma fusion energy experiments like ITER and beyond. The Collective Thomson Scattering (CTS) diagnostic to be installed at ITER is an example of such a diagnostic with great potential in present and future experiments. The ITER CTS diagnostic will inject a 1 MW 60 GHz gyrotron beam into the ITER plasma and observe the scattering off fluctuations in the plasma — to monitor the dynamics of the fast ions generated in the fusion reactions.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Center for Nuclear Technologies, Radiation Physics, University of Lisbon, Eindhoven University of Technology, Fusion For Energy
Number of pages: 2
Publication date: 2016

Host publication information
Title of host publication: 2016 41st International Conference on Infrared, Millimeter, and Terahertz waves (IRMMW-THz)
Publisher: IEEE
ISBN (Print): 978-1-4673-8486-5
ISBN (Electronic): 978-1-4673-8485-8
Electronic versions: IRMMW_synopsis_Korsholm_ITER_CTS_PID4361567.pdf
DOIs: 10.1109/IRMMW-THz.2016.7758537
Source: FindIt
Source-ID: 2349436767
Research output: Research - peer-review › Article in proceedings – Annual report year: 2016

High Power Microwave Diagnostic for the Fusion Energy Experiment ITER

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Center for Nuclear Technologies, Radiation Physics, University of Lisbon, Eindhoven University of Technology, Fusion For Energy
Publication date: 2016
Peer-reviewed: Yes
Event: Poster session presented at 41st International Conference on Infrared, Millimeter and Terahertz Waves, Copenhagen, Denmark.
Electronic versions: Korsholm_IRMMWThz.pdf
Source: PublicationPreSubmission
Source-ID: 127089775
Research output: Research - peer-review › Poster – Annual report year: 2016
Inflow of atomic gas fuelling star formation
Gamma-ray burst host galaxies are deficient in molecular gas, and show anomalous metal-poor regions close to GRB positions. Using recent Australia Telescope Compact Array (ATCA) Hi observations we show that they have substantial atomic gas reservoirs. This suggests that star formation in these galaxies may be fuelled by recent inflow of metal-poor atomic gas. While this process is debated, it can happen in low-metallicity gas near the onset of star formation because gas cooling (necessary for star formation) is faster than the Hi-to-H₂ conversion.

Inversion methods for fast-ion velocity-space tomography in fusion plasmas
Velocity-space tomography has been used to infer 2D fast-ion velocity distribution functions. Here we compare the performance of five different tomographic inversion methods: truncated singular value decomposition, maximum entropy,
minimum Fisher information and zeroth and first-order Tikhonov regularization. The inversion methods are applied to fast-ion $\Delta\alpha$ measurements taken just before and just after a sawtooth crash in the ASDEX Upgrade tokamak as well as to synthetic measurements from different test distributions. We find that the methods regularizing by penalizing steep gradients or maximizing entropy perform best. We assess the uncertainty of the calculated inversions taking into account photon noise, uncertainties in the forward model as well as uncertainties introduced by the regularization which allows us to distinguish regions of high and low confidence in the tomographies. In high confidence regions, all methods agree that ions with pitch values close to zero, as well as ions with large pitch values, are ejected from the plasma center by the sawtooth crash, and that this ejection depletes the ion population with large pitch values more strongly.

**General information**

State: Published  
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Max Planck Institute for Plasma Physics, University of California at Irvine  
Number of pages: 16  
Publication date: 2016  
Peer-reviewed: Yes

**Publication information**

Journal: Plasma Physics and Controlled Fusion  
Volume: 58  
Issue number: 4  
Article number: 045016  
ISSN (Print): 0741-3335  
Ratings:  
BFI (2019): BFI-level 1  
Web of Science (2019): Indexed yes  
BFI (2018): BFI-level 1  
Web of Science (2018): Indexed yes  
BFI (2017): BFI-level 1  
Scopus rating (2017): CiteScore 1.74 SJR 0.69 SNIP 1.243  
Web of Science (2017): Impact factor 3.032  
Web of Science (2017): Indexed yes  
BFI (2016): BFI-level 1  
Scopus rating (2016): CiteScore 1 SJR 1.433 SNIP 1.258  
Web of Science (2016): Impact factor 2.392  
Web of Science (2016): Indexed yes  
BFI (2015): BFI-level 1  
Scopus rating (2015): CiteScore 1.1 SJR 1.314 SNIP 1.345  
Web of Science (2015): Impact factor 2.404  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 1  
Scopus rating (2014): CiteScore 1.61 SJR 1.542 SNIP 1.346  
Web of Science (2014): Impact factor 2.186  
Web of Science (2014): Indexed yes  
BFI (2013): BFI-level 1  
Scopus rating (2013): CiteScore 1.54 SJR 1.2 SNIP 1.253  
Web of Science (2013): Impact factor 2.386  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes  
BFI (2012): BFI-level 1  
Scopus rating (2012): CiteScore 1.63 SJR 1.453 SNIP 1.201  
Web of Science (2012): Impact factor 2.369  
ISI indexed (2012): ISI indexed yes  
Web of Science (2012): Indexed yes  
BFI (2011): BFI-level 1  
Scopus rating (2011): CiteScore 2.69 SJR 1.496 SNIP 1.591
Measuring main-ion temperatures in ASDEX upgrade using scattering of ECRH radiation

We demonstrate that collective Thomson scattering of millimeter wave electron cyclotron resonance heating radiation can be used for measurements of the main-ion temperature in the ASDEX Upgrade tokamak.

General information

State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Max-Planck-Institut fur Plasmaphysik
Number of pages: 2
Publication date: 2016

Host publication information

Title of host publication: 2016 41st International Conference on Infrared, Millimeter, and Terahertz waves
Publisher: IEEE
ISBN (Print): 978-1-4673-8486-5
ISBN (Electronic): 978-1-4673-8485-8
DOI: 10.1109/IRMMW-THz.2016.7758538
Source: FindIt
Millimeter-wave receiver design for plasma diagnostics
Scattered millimeter waves entering from the collective Thomson scattering diagnostic at ASDEX Upgrade fusion device are generally elliptically polarized. In order to convert the millimeter waves to linearly polarized waves (required for the detector), birefringent window assemblies (sapphire) have been developed to replace grooved metal mirrors. This allows a significantly more compact receiver design which is less susceptible to misalignment. The setup has been tested and implemented at ASDEX Upgrade.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Technical University of Denmark
Number of pages: 2
Publication date: 2016

Host publication information
Title of host publication: 2016 41st International Conference on Infrared, Millimeter, and Terahertz waves
Publisher: IEEE
ISBN (Print): 978-1-4673-8486-5
ISBN (Electronic): 978-1-4673-8485-8
DOI: 10.1109/IRMMW-THz.2016.7758533
Source: Findit
Source-ID: 2349436911
Research output: Research - peer-review › Article in proceedings – Annual report year: 2016

Numerical and experimental study of the redistribution of energetic and impurity ions by sawteeth in ASDEX Upgrade:
Paper
In the non-linear phase of a sawtooth, the complete reconnection of field lines around the q = 1 flux surface often occurs resulting in a radial displacement of the plasma core. A complete time-dependent electromagnetic model of this type of reconnection has been developed and implemented in the EBdyna_go code. This contribution aims at studying the behaviour of ions, both impurity and fast particles, in the pattern of reconnecting field lines during sawtoothing plasma experiments in the ASDEX Upgrade tokamak by using the newly developed numerical framework. Simulations of full reconnection with tungsten impurity that include the centrifugal force are achieved and recover the soft x-ray measurements. Based on this full-reconnection description of the sawtooth, a simple tool dedicated to estimate the duration of the reconnection is introduced. This work then studies the redistribution of fast ions during several experimentally observed sawteeth. In some cases of sawteeth at ASDEX Upgrade, full reconnection is not always observed or expected so the code gives an upper estimate of the actual experimental redistribution. The results of detailed simulations of the crashes are compared with measurements from various diagnostics such as collective Thomson scattering and fast-ion D-alpha (FIDA) spectroscopy, including FIDA tomography. A convincing qualitative agreement is found in different parts of velocity space.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, FOM Dutch Institute for Fundamental Energy Research , Max Planck Institute for Plasma Physics
Number of pages: 12
Publication date: 2016
Peer-reviewed: Yes

Publication information
Journal: Nuclear Fusion
Volume: 56
Issue number: 11
Article number: 112012
ISSN (Print): 0029-5515
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.13 SJR 0.759 SNIP 1.424
Web of Science (2017): Impact factor 4.057
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.62 SJR 1.284 SNIP 1.416
Web of Science (2016): Impact factor 3.307
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.88 SJR 1.51 SNIP 1.62
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.2 SJR 1.907 SNIP 1.667
Web of Science (2014): Impact factor 3.062
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.83 SJR 1.366 SNIP 1.516
Web of Science (2013): Impact factor 3.243
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.81 SJR 1.441 SNIP 1.448
Web of Science (2012): Impact factor 2.734
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 3.78 SJR 2.043 SNIP 2.433
Web of Science (2011): Impact factor 4.09
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 2.268 SNIP 1.927
Web of Science (2010): Impact factor 3.303
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.993 SNIP 2.441
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 2.031 SNIP 1.736
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.005 SNIP 1.987
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.062 SNIP 1.937
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.885 SNIP 1.932
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.647 SNIP 1.673
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.215 SNIP 1.673
Simulator of GAlyaxy Millimetre/submillimetre Emission (SIGAME): CO emission from massive z=2 main-sequence galaxies

We present sigame (Simulator of GAlyaxy Millimetre/submillimetre Emission), a new numerical code designed to simulate the $^{12}$CO rotational line spectrum of galaxies. Using sub-grid physics recipes to post-process the outputs of smoothed particle hydrodynamics (SPH) simulations, a molecular gas phase is condensed out of the hot and partly ionized SPH gas. The gas is subjected to far-UV radiation fields and cosmic ray ionization rates which are set to scale with the local star formation rate volume density. Level populations and radiative transport of the CO lines are solved with the 3D radiative transfer code lime. We have applied sigame to cosmological SPH simulations of three disc galaxies at z = 2 with stellar masses in the range $\sim 0.5–2 \times 10^{11} M_\odot$ and star formation rates $\sim 40–140 M_\odot$ yr$^{-1}$. Global CO luminosities and line ratios are in agreement with observations of disc galaxies at z = 2 up to and including J = 3–2 but falling short of the few existing J = 5–4 observations. The central 5kpc regions of our galaxies have CO 3 – 2/1 – 0 and 7 – 6/1 – 0 brightness temperature ratios of $\sim 0.55–0.65$ and $\sim 0.02–0.08$, respectively, while further out in the disc the ratios drop to more quiescent values of $\sim 0.05$ and $<0.01$. Global CO-to-$H_2$ conversion ($\alpha_{CO}$) factors are $\sim 1.5 M_\odot pc^{-2} (K km s^{-1})^{-1}$, i.e. $\sim 2–3$ times below the typically adopted values for disc galaxies, and $\alpha_{CO}$ increases with radius, in agreement with observations of nearby galaxies. Adopting a top-heavy Giant Molecular Cloud (GMC) mass spectrum does not significantly change the results. Steepening the GMC density profiles leads to higher global line ratios for $J_{up} \geq 3$ and CO-to-$H_2$ conversion factors $\sim 3.6 M_\odot pc^{-2} (K km s^{-1})^{-1}$. 

General information
State: Published
Organisations: IT Service, Department of Physics, Plasma Physics and Fusion Energy, University of Copenhagen, University College London
Pages: 3306-3333
Publication date: 2016
Peer-reviewed: Yes

Publication information
Journal: Monthly Notices of the Royal Astronomical Society
Volume: 457
Issue number: 3
ISSN (Print): 0035-8711
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.54 SJR 2.346 SNIP 0.904
Web of Science (2017): Impact factor 5.194
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.09 SJR 2.388 SNIP 1.134
Web of Science (2016): Impact factor 4.961
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4 SJR 2.701 SNIP 1.165
Web of Science (2015): Impact factor 4.952
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.79 SJR 3.23 SNIP 1.322
Web of Science (2014): Impact factor 5.107
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 5.1 SJR 3.155 SNIP 1.23
Web of Science (2013): Impact factor 5.226
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 4.89 SJR 3.283 SNIP 1.392
Web of Science (2012): Impact factor 5.521
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 4.63 SJR 2.964 SNIP 1.35
Web of Science (2011): Impact factor 4.9
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 3.18 SNIP 1.339
Web of Science (2010): Impact factor 4.888
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.662 SNIP 1.512
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 3.6 SNIP 1.287
Scopus rating (2007): SJR 3.399 SNIP 1.287
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 4.769 SNIP 1.326
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 4.434 SNIP 1.229
Scopus rating (2004): SJR 4.385 SNIP 1.384
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 3.104 SNIP 1.35
Scopus rating (2002): SJR 2.491 SNIP 1.325
Scopus rating (2001): SJR 2.251 SNIP 1.042
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 2.989 SNIP 1.102
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 3.144 SNIP 1.122

Original language: English
Keywords: radiative transfer, methods: numerical, ISM: clouds, ISM: lines and bands, galaxies: high-redshift, galaxies: ISM
Three-wave interaction during electron cyclotron resonance heating and current drive

Non-linear wave-wave interactions in fusion plasmas, such as the parametric decay instability (PDI) of gyrotron radiation, can potentially hamper the use of microwave diagnostics. Here we report on anomalous scattering in the ASDEX Upgrade tokamak during electron cyclotron resonance heating experiments. The observations can be linked to parametric decay of the gyrotron radiation at the second harmonic upper hybrid resonance layer.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Technical University of Denmark, Max-Planck-Institut für Plasmaphysik
Number of pages: 2
Publication date: 2016

Host publication information
Title of host publication: 2016 41st International Conference on Infrared, Millimeter, and Terahertz waves
Publisher: IEEE
ISBN (Print): 978-1-4673-8486-5
ISBN (Electronic): 978-1-4673-8485-8
( International Conference on Infrared, Millimeter and Terahertz Waves).
DOIs: 10.1109/IRMMW-THz.2016.7758400
Source: FindIt
Source-ID: 2349437031
Research output: Research - peer-review › Article in proceedings – Annual report year: 2016

Velocity-space tomography of fusion plasmas by collective Thomson scattering of gyrotron radiation

We propose a diagnostic capable of measuring 2D fast-ion velocity distribution functions in the MeV-range in magnetized fusion plasmas. Today velocity-space tomography based on fast-ion spectroscopy is regularly used to measure for ion energies below 100 keV. Unfortunately, the signal-to-noise ratio becomes fairly low for MeV-range ions. Ions at any energy can be detected well by collective Thomson scattering of mm-wave radiation from a high-power gyrotron. We demonstrate how collective Thomson scattering can be used to measure in the MeV-range in reactor relevant plasmas such as in the tokamaks ITER or DEMO.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Max Planck Institute for Plasma Physics, Max Planck Institute
Number of pages: 2
Publication date: 2016

Host publication information
Title of host publication: 2016 41st International Conference on Infrared, Millimeter, and Terahertz waves (IRMMW-THz)
Publisher: IEEE
ISBN (Print): 978-1-4673-8486-5
ISBN (Electronic): 978-1-4673-8485-8
( International Conference on Infrared, Millimeter and Terahertz Waves).
DOIs: 10.1109/IRMMW-THz.2016.7758534
Bulk Ion Heating with ICRF Waves in Tokamaks

Heating with ICRF waves is a well-established method on present-day tokamaks and one of the heating systems foreseen for ITER. However, further work is still needed to test and optimize its performance in fusion devices with metallic high-Z plasma facing components (PFCs) in preparation of ITER and DEMO operation. This is of particular importance for the bulk ion heating capabilities of ICRF waves. Efficient bulk ion heating with the standard ITER ICRF scheme, i.e. the second harmonic heating of tritium with or without $^3$He minority, was demonstrated in experiments carried out in deuterium-tritium plasmas on JET and TFTR and is confirmed by ICRF modelling. This paper focuses on recent experiments with $^3$He minority heating for bulk ion heating on the ASDEX Upgrade (AUG) tokamak with ITER-relevant all-tungsten PFCs. An increase of 80% in the central ion temperature $T_i$ from 3 to 5.5 keV was achieved when 3 MW of ICRF power tuned to the central $^3$He ion cyclotron resonance was added to 4.5 MW of deuterium NBI. The radial gradient of the $T_i$ profile reached locally values up to about 50 keV/m and the normalized logarithmic ion temperature gradients $R/LT_i$ of about 20, which are unusually large for AUG plasmas. The large changes in the $T_i$ profiles were accompanied by significant changes in measured plasma toroidal rotation, plasma impurity profiles and MHD activity, which indicate concomitant changes in plasma properties with the application of ICRF waves. When the $^3$He concentration was increased above the optimum range for bulk ion heating, a weaker peaking of the ion temperature profile was observed, in line with theoretical expectations.
Consistency between real and synthetic fast-ion measurements at ASDEX Upgrade

Internally consistent characterization of the properties of the fast-ion distribution from multiple diagnostics is a prerequisite for obtaining a full understanding of fast-ion behavior in tokamak plasmas. Here we benchmark several absolutely-calibrated core fast-ion diagnostics at ASDEX Upgrade by comparing fast-ion measurements from collective Thomson scattering, fast-ion spectroscopy, and neutron rate detectors with numerical predictions from the TRANSP/NUBEAM transport code. We also study the sensitivity of the theoretical predictions to uncertainties in the plasma kinetic profiles. We find that theory and measurements generally agree within these uncertainties for all three diagnostics during heating phases with either one or two neutral beam injection sources. This suggests that the measurements can be described by the same model assuming classical slowing down of fast ions. Since the three diagnostics in the adopted configurations probe partially overlapping regions in fast-ion velocity space, this is also consistent with good internal agreement among the measurements themselves. Hence, our results support the feasibility of combining multiple diagnostics at ASDEX Upgrade to reconstruct the fast-ion distribution function in 2D velocity space.
Web of Science (2017): Impact factor 3.032
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1 SJR 1.433 SNIP 1.258
Web of Science (2016): Impact factor 2.392
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.1 SJR 1.314 SNIP 1.345
Web of Science (2015): Impact factor 2.404
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.61 SJR 1.542 SNIP 1.346
Web of Science (2014): Impact factor 2.186
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.54 SJR 1.2 SJR 1.253
Web of Science (2013): Impact factor 2.386
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.63 SJR 1.453 SNIP 1.201
Web of Science (2012): Impact factor 2.369
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.69 SJR 1.496 SNIP 1.591
Web of Science (2011): Impact factor 2.731
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.468 SNIP 1.408
Web of Science (2010): Impact factor 2.466
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.589 SNIP 1.324
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.845 SNIP 1.569
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.927 SNIP 1.374
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.844 SNIP 1.556
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.756 SNIP 1.54
Scopus rating (2004): SJR 2.246 SNIP 1.382
Scopus rating (2003): SJR 2.135 SNIP 1.253
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.668 SNIP 1.058
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.679 SNIP 1.233
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 1.974 SNIP 1.097
Scopus rating (1999): SJR 2.001 SNIP 1.471
Determining fast-ion velocity-space distribution functions using velocity-space tomography

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Max Planck Institute for Plasma Physics, University of California at Irvine, Uppsala University
Number of pages: 4
Publication date: 2015

Host publication information
Title of host publication: Proceedings of the 42nd European Physical Society Conference on Plasma Physics
Publisher: European Physical Society
Source: PublicationPreSubmission
Source-ID: 112051297
Research output: Research - peer-review › Article in proceedings – Annual report year: 2015

Doppler tomography in fusion plasmas and astrophysics
Doppler tomography is a well-known method in astrophysics to image the accretion flow, often in the shape of thin discs, in compact binary stars. As accretion discs rotate, all emitted line radiation is Doppler-shifted. In fast-ion Dα (FIDA) spectroscopy measurements in magnetically confined plasma, the Dα-photons are likewise Doppler-shifted ultimately due to gyration of the fast ions. In either case, spectra of Doppler-shifted line emission are sensitive to the velocity distribution of the emitters. Astrophysical Doppler tomography has lead to images of accretion discs of binaries revealing bright spots, spiral structures and flow patterns. Fusion plasma Doppler tomography has led to an image of the fast-ion velocity distribution function in the tokamak ASDEX Upgrade. This image matched numerical simulations very well. Here we discuss achievements of the Doppler tomography approach, its promise and limits, analogies and differences in astrophysical and fusion plasma Doppler tomography and what can be learned by comparison of these applications.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Max Planck Institute, University of California, University of Warwick
Number of pages: 10
Pages: 014021
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: Plasma Physics and Controlled Fusion
Volume: 57
Issue number: 1
ISSN (Print): 0741-3335
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.74 SJR 0.69 SNIP 1.243
Web of Science (2017): Impact factor 3.032
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1 SJR 1.433 SNIP 1.258
Web of Science (2016): Impact factor 2.392
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.1 SJR 1.314 SNIP 1.345
Web of Science (2015): Impact factor 2.404
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.61 SJR 1.542 SNIP 1.346
Web of Science (2014): Impact factor 2.186
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.54 SJR 1.2 SNIP 1.253
Web of Science (2013): Impact factor 2.386
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.63 SJR 1.453 SNIP 1.201
Web of Science (2012): Impact factor 2.369
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.69 SJR 1.496 SNIP 1.591
Web of Science (2011): Impact factor 2.731
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.468 SNIP 1.408
Web of Science (2010): Impact factor 2.466
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.589 SNIP 1.324
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.845 SNIP 1.569
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.927 SNIP 1.374
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.844 SNIP 1.556
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.756 SNIP 1.54
Scopus rating (2004): SJR 2.246 SNIP 1.382
Scopus rating (2003): SJR 2.135 SNIP 1.253
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.668 SNIP 1.058
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.679 SNIP 1.233
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 1.974 SNIP 1.097
Scopus rating (1999): SJR 2.001 SNIP 1.471

Original language: English

Keywords: Tomography, Fast ions, Accretion discs, Spectroscopy, Fast ion D-alpha spectroscopy, Tomamak

Electronic versions:
First operations with the new Collective Thomson Scattering diagnostic on the Frascati Tokamak Upgrade device

Anomalous emissions were found over the last few years in spectra of Collective Thomson Scattering (CTS) diagnostics in tokamak devices such as TEXTOR, ASDEX and FTU, in addition to real CTS signals. The signal frequency, down-shifted with respect to the probing one, suggested a possible origin in Parametric Decay Instability (PDI) processes correlated with the presence of magnetic islands and occurring for pumping wave power levels well below the threshold predicted by conventional models. A threshold below or close to the Electron Cyclotron Resonance Heating (ECRH) power levels could limit, under certain circumstances, the use of the ECRH in fusion devices. An accurate characterization of the conditions for the occurrence of this phenomenon and of its consequences is thus of primary importance. Exploiting the front-steering configuration available with the real-time launcher, the implementation of a new CTS setup now allows studying these anomalous emission phenomena in FTU under conditions of density and wave injection geometry that are more similar to those envisaged for CTS in ITER. The upgrades of the diagnostic are presented as well as a few preliminary spectra detected with the new system during the very first operations in 2014.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Consiglio Nazionale delle Ricerche, EURATOM-ENEA sulla Fusione, Swiss Federal Institute of Technology Lausanne
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: Journal of Instrumentation
Volume: 10
Issue number: 10
Article number: P10007
ISSN (Print): 1748-0221
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.23 SJR 0.642 SNIP 1.04
Web of Science (2017): Impact factor 1.258
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.22 SJR 0.903 SNIP 1.164
Web of Science (2016): Impact factor 1.22
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.96 SJR 0.833 SNIP 0.966
Web of Science (2015): Impact factor 1.31
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.08 SJR 0.683 SNIP 1.062
Web of Science (2014): Impact factor 1.399
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.23 SJR 0.791 SNIP 1.089
Massive stars formed in atomic hydrogen reservoirs: H i observations of gamma-ray burst host galaxies

Long gamma-ray bursts (GRBs), among the most energetic events in the Universe, are explosions of massive and short-lived stars, so they pinpoint locations of recent star formation. However, several GRB host galaxies have recently been found to be deficient in molecular gas (H_2), believed to be the fuel of star formation. Moreover, optical spectroscopy of GRB afterglows implies that the molecular phase constitutes only a small fraction of the gas along the GRB line of sight. Here we report the first ever 21 cm line observations of GRB host galaxies, using the Australia Telescope Compact Array, implying high levels of atomic hydrogen (HI), which suggests that the connection between atomic gas and star formation is stronger than previously thought. In this case, it is possible that star formation is directly fuelled by atomic gas (or that the H_1-to-H_2 conversion is very efficient, which rapidly exhaust molecular gas), as has been theoretically shown to be possible. This can happen in low-metallicity gas near the onset of star formation because cooling of gas (necessary for star formation) is faster than the H_1-to-H_2 conversion. Indeed, large atomic gas reservoirs, together with low molecular gas masses, stellar, and dust masses are consistent with GRB hosts being preferentially galaxies which have very recently started a star formation episode after accreting metal-poor gas from the intergalactic medium. This provides a natural route for forming GRBs in low-metallicity environments. The gas inflow scenario is also consistent with the existence of the companion HI object with no optical counterpart ~19 kpc from the GRB 060505 host, and with the fact that the HI centroids of the GRB 980425 and 060505 hosts do not coincide with optical centres of these galaxies, but are located close to the GRB positions.

Bibliographical note
The present work has been carried out under an EUROfusion Enabling Research project. A shorter version of this contribution is due to be published in PoS at: 1st EPS conference on Plasma Diagnostics.

Source: Findit
Source-ID: 276235954
Research output: Research - peer-review › Conference article – Annual report year: 2015

Massive stars formed in atomic hydrogen reservoirs: H i observations of gamma-ray burst host galaxies

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, University of Edinburgh, Universiteit Gent, University of Copenhagen, University of California at Santa Cruz, University of Leicester, Australia Telescope National Facility, University of Sydney, Max-Planck-Institut fur extraterrestrische Physik, European Space Astronomy Centre and European Space Agency, ASI Science Data Center, National Institute for Astrophysics, Thüringer Landessternwarte Tautenburg, University Paris Diderot - Paris 7, University of Calabria, Stockholm University, Leiden University, Aix Marseille Universite
Measurements of the fast-ion distribution function at ASDEX upgrade by collective Thomson scattering (CTS) using active and passive views

Collective Thomson scattering (CTS) can provide measurements of the confined fast-ion distribution function resolved in space, time and 1D velocity space. On ASDEX Upgrade, the measured spectra include an additional signal which previously has hampered data interpretation. A new set-up using two independent heterodyne receiver systems enables subtraction of the additional part from the total spectrum, revealing the resulting CTS spectrum. Here we present CTS measurements from the plasma centre obtained in L-mode and H-mode plasmas with and without neutral beam injection (NBI). For the first time, the measured spectra agree quantitatively with the synthetic spectra in periods with and without NBI heating. For the discharges investigated, the central velocity distribution of neutral beam ions can be described by classical slowing down. These results will have a major impact on ITER physics exploration, since CTS is presently the only diagnostic to measure the confined alpha particles produced by the fusion reactions.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Max Planck Institute for Plasma Physics, FOM Dutch Institute for Fundamental Energy Research
Number of pages: 9
Pages: 035009
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: Plasma Physics and Controlled Fusion
Volume: 57
Issue number: 3
ISSN (Print): 0741-3335
Ratings:

BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.74 SJR 0.69 SNIP 1.243
Web of Science (2017): Impact factor 3.032
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1 SJR 1.433 SNIP 1.258
Web of Science (2016): Impact factor 2.392
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.1 SJR 1.314 SNIP 1.345
Web of Science (2015): Impact factor 2.404
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.61 SJR 1.542 SNIP 1.346
Web of Science (2014): Impact factor 2.186
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.54 SJR 1.2 SNIP 1.253
Web of Science (2013): Impact factor 2.386
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.63 SJR 1.453 SNIP 1.201
Web of Science (2012): Impact factor 2.369
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.69 SJR 1.496 SNIP 1.591
Web of Science (2011): Impact factor 2.731
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.468 SNIP 1.408
Web of Science (2010): Impact factor 2.466
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.589 SNIP 1.324
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.845 SNIP 1.569
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.927 SNIP 1.374
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.844 SNIP 1.556
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.756 SNIP 1.54
Scopus rating (2004): SJR 2.246 SNIP 1.382
Overview of the JET results
Since the installation of an ITER-like wall, the JET programme has focused on the consolidation of ITER design choices and the preparation for ITER operation, with a specific emphasis given to the bulk tungsten melt experiment, which has been crucial for the final decision on the material choice for the day-one tungsten divertor in ITER. Integrated scenarios have been progressed with the re-establishment of long-pulse, high-confinement H-modes by optimizing the magnetic configuration and the use of ICRH to avoid tungsten impurity accumulation. Stationary discharges with detached divertor conditions and small edge localized modes have been demonstrated by nitrogen seeding. The differences in confinement and pedestal behaviour before and after the ITER-like wall installation have been better characterized towards the development of high fusion yield scenarios in DT. Post-mortem analyses of the plasma-facing components have confirmed the previously reported low fuel retention obtained by gas balance and shown that the pattern of deposition within the divertor has changed significantly with respect to the JET carbon wall campaigns due to the absence of thermally activated chemical erosion of beryllium in contrast to carbon. Transport to remote areas is almost absent and two orders of magnitude less material is found in the divertor.
Plasma rotation and ion temperature measurements by collective Thomson scattering at ASDEX Upgrade

We present the first deuterium ion temperature and rotation measurements by collective Thomson scattering at ASDEX Upgrade. The results are in general agreement with boron-based charge exchange recombination spectroscopy measurements and consistent with neoclassical simulations for the plasma scenario studied here. This demonstration opens the prospect for direct non-perturbative measurements of the properties of the main ion species in the plasma core with applications in plasma transport and confinement studies.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Max-Planck-Institut fur Plasmaphysik
Number of pages: 1
Pages: 062001
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: Plasma Physics and Controlled Fusion
Volume: 57
Issue number: 6
ISSN (Print): 0741-3335
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.74 SJR 0.69 SNIP 1.243
Web of Science (2017): Impact factor 3.032
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1 SJR 1.433 SNIP 1.258
Web of Science (2016): Impact factor 2.392
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.1 SJR 1.314 SNIP 1.345
Web of Science (2015): Impact factor 2.404
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.61 SJR 1.542 SNIP 1.346
Web of Science (2014): Impact factor 2.186
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.54 SJR 1.2 SNIP 1.253
Web of Science (2013): Impact factor 2.386
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.63 SJR 1.453 SNIP 1.201
Web of Science (2012): Impact factor 2.369
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Recent ASDEX Upgrade research in support of ITER and DEMO

Recent experiments on the ASDEX Upgrade tokamak aim at improving the physics base for ITER and DEMO to aid the machine design and prepare efficient operation. Type I edge localized mode (ELM) mitigation using resonant magnetic perturbations (RMPs) has been shown at low pedestal collisionality. In contrast to the previous high $v^*$ regime, suppression only occurs in a narrow RMP spectral window, indicating a resonant process, and a concomitant confinement drop is observed due to a reduction of pedestal top density and electron temperature. Strong evidence is found for the ion heat flux to be the decisive element for the L–H power threshold. A physics based scaling of the density at which the minimum $PLH$ occurs indicates that ITER could take advantage of it to initiate H-mode at lower density than that of the final $Q = 10$ operational point. Core density fluctuation measurements resolved in radius and wave number show that an increase of $R/Lte$ introduced by off-axis electron cyclotron resonance heating (ECRH) mainly increases the large scale fluctuations. The radial variation of the fluctuation level is in agreement with simulations using the GENE code. Fast particles are shown to undergo classical slowing down in the absence of large scale magnetohydrodynamic (MHD) events and for low heating power, but show signs of anomalous radial redistribution at large heating power, consistent with a broadened off-axis neutral beam current drive current profile under these conditions. Neoclassical tearing mode (NTM) suppression experiments using electron cyclotron current drive (ECCD) with feedback controlled deposition have allowed to test several control strategies for ITER, including automated control of (3,2) and (2,1) NTMs during a single discharge. Disruption mitigation studies using massive gas injection (MGI) can show an increased fuelling efficiency with high field side injection, but a saturation of the fuelling efficiency is observed at high injected mass as needed for runaway electron suppression. Large locked modes can significantly decrease the fuelling efficiency and increase the asymmetry of radiated power during MGI mitigation. Concerning power exhaust, the partially detached ITER divertor scenario has been demonstrated at $P_{sep}/R = 10$ MW m$^{-1}$ in ASDEX Upgrade, with a peak time averaged target load around 5 MW m$^{-2}$, well consistent with the component limits for ITER. Developing this towards DEMO, full detachment was achieved at
$P_{\text{sep/R}} = 7 \text{ MW m}^{-1}$ and stationary discharges with core radiation fraction of the order of DEMO requirements (70\% instead of the 30\% needed for ITER) were demonstrated. Finally, it remains difficult to establish the standard ITER $Q = 10$ scenario at low $q_{95} = 3$ in the all-tungsten (all-W) ASDEX Upgrade due to the observed poor confinement at low $\beta_N$. This is mainly due to a degraded pedestal performance and hence investigations at shifting the operational point to higher $\beta_N$ by lowering the current have been started. At higher $q_{95}$, pedestal performance can be recovered by seeding $N_2$ as well as $CD_4$, which is interpreted as improved pedestal stability due to the decrease of bootstrap current with increasing Zeff. Concerning advanced scenarios, the upgrade of ECRH power has allowed experiments with central ctr-ECCD to modify the q-profile in improved H-mode scenarios, showing an increase in confinement at still good MHD stability with flat elevated q-profiles at values between 1.5 and 2.
Star formation suppression in compact group galaxies: a new path to quenching?

We present CO(1-0) maps of 12 warm H-2-selected Hickson Compact Groups (HCGs), covering 14 individually imaged warm H2 bright galaxies, with the Combined Array for Research in Millimeter Astronomy. We found a variety of molecular gas distributions within the HCGs, including regularly rotating disks, bars, rings, tidal tails, and possibly nuclear outflows, though the molecular gas morphologies are more consistent with spirals and earlytype galaxies than mergers and interacting systems. Our CO-imaged HCG galaxies, when plotted on the Kennicutt-Schmidt relation, shows star formation (SF) suppression of $<S > = 10 \pm 5$, distributed bimodally, with five objects exhibiting suppressions of S greater than or similar to 10 and depletion timescales greater than or similar to 10 Gyr. This SF inefficiency is also seen in the efficiency per freefall time of Krumholz et al. We investigate the gas-to-dust ratios of these galaxies to determine if an incorrect $^{12}$CO-M(H$_2$) conversion caused the apparent suppression and find that HCGs have normal gas-to-dust ratios. It is likely that the cause of the apparent suppression in these objects is associated with shocks injecting turbulence into the molecular gas, supported by the fact that the required turbulent injection luminosity is consistent with the bright H$_2$ luminosity reported by Cluver et al. Galaxies with high SF suppression (S greater than or similar to 10) also appear to be those in the most advanced stages of transition across both optical and infrared color space. This supports the idea that at least some galaxies in HCGs are transitioning objects, where a disruption of the existing molecular gas in the system suppresses SF by inhibiting the molecular gas from collapsing and forming stars efficiently. These observations, combined with recent work on poststarburst galaxies with molecular reservoirs, indicates that galaxies do not need to expel their molecular reservoirs prior to quenching SF and transitioning from blue spirals to red early-type galaxies. This may imply that SF
quenching can occur without the need to starve a galaxy of cold gas first.
Velocity-space observation regions of high-resolution two-step reaction gamma-ray spectroscopy

High-resolution γ-ray spectroscopy (GRS) measurements resolve spectral shapes of Dopplerbroadened γ-rays. We calculate weight functions describing velocity-space sensitivities of any two-step reaction GRS measurements in magnetized plasmas using the resonant nuclear reaction $^{9}$Be$(\alpha,n\gamma)^{12}$C as an example. The energy-dependent cross sections of this reaction suggest that GRS is sensitive to alpha particles above about 1.7 MeV and highly sensitive to alpha particles at the resonance energies of the reaction. Here we demonstrate that high-resolution two-step reaction GRS measurements are not only selective in energy but also in pitch angle. They can be highly sensitive in particular pitch angle ranges and completely insensitive in others. Moreover, GRS weight functions allow rapid calculation of γ-ray energy spectra from fast-ion distribution functions, additionally revealing how many photons any given alpha-particle velocity-space region contributes to the measurements in each γ-ray energy bin.

General information

State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, University of Milan - Bicocca, Culham Science Centre, Max Planck Institute for Plasma Physics, Consiglio Nazionale delle Ricerche
Number of pages: 15
Pages: 093029
Publication date: 2015
Peer-reviewed: Yes

Publication information

Journal: Nuclear Fusion
Volume: 55
Issue number: 9
ISSN (Print): 0029-5515
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.13 SJR 0.759 SNIP 1.424
Web of Science (2017): Impact factor 4.057
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Velocity-space sensitivity of neutron spectrometry measurements

Neutron emission spectrometry (NES) measures the energies of neutrons produced in fusion reactions. Here we present velocity-space weight functions for NES and neutron yield measurements. Weight functions show the sensitivity as well as the accessible regions in velocity space for a given range of the neutron energy spectrum. Combined with a calculated fast-ion distribution function, they determine the part of the distribution function producing detectable neutrons in a given neutron energy range. Furthermore, we construct a forward model based on weight functions capable of rapidly calculating neutron energy spectra. This forward model can be inverted and could thereby be used to directly measure the fast-ion phase-space distribution functions, possibly in combination with other fast-ion diagnostics. The presented methods and results can be applied to neutron energy spectra measured by any kind of neutron spectrometer and to any neutron yield measurement.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Uppsala University
Number of pages: 13
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: Nuclear Fusion
Volume: 55
Article number: 053013
ISSN (Print): 0029-5515
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.13 SJR 0.759 SNIP 1.424
Web of Science (2017): Impact factor 4.057
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.62 SJR 1.284 SNIP 1.416
Web of Science (2016): Impact factor 3.307
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.88 SJR 1.51 SNIP 1.62
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.2 SJR 1.907 SNIP 1.667
Web of Science (2014): Impact factor 3.062
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.83 SJR 1.366 SNIP 1.516
Web of Science (2013): Impact factor 3.243
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Improved Collective Thomson Scattering measurements of fast ions at ASDEX Upgrade

Understanding the behaviour of the confined fast ions is important in both current and future fusion experiments. These ions play a key role in heating the plasma and will be crucial for achieving conditions for burning plasma in next-step fusion devices. Microwave-based Collective Thomson Scattering (CTS) is well suited for reactor conditions and offers such an opportunity by providing measurements of the confined fast-ion distribution function resolved in space, time and 1D velocity space. We currently operate a CTS system at ASDEX Upgrade using a gyrotron which generates probing radiation at 105 GHz. A new setup using two independent receiver systems has enabled improved subtraction of the background signal, and hence the first accurate characterization of fast-ion properties. Here we review this new dual-receiver CTS setup and present results on fast-ion measurements based on the improved background characterization. These results have been obtained both with and without NBI heating, and with the measurement volume located close to the centre of the plasma. The measurements agree quantitatively with predictions of numerical simulations. Hence, CTS studies of fast-ion dynamics at ASDEX Upgrade are now feasible. The new background subtraction technique could be important for the design of CTS systems in other fusion experiments.
Measurement of a 2D fast-ion velocity distribution function by tomographic inversion of fast-ion D-alpha spectra

We present the first measurement of a local fast-ion 2D velocity distribution function $f(v_{\parallel}, v_{\perp})$. To this end, we heated a plasma in ASDEX Upgrade by neutral beam injection and measured spectra of fast-ion D$\alpha$ (FIDA) light from the plasma centre in three views simultaneously. The measured spectra agree very well with synthetic spectra calculated from a TRANSPI/NUBEAM simulation. Based on the measured FIDA spectra alone, we infer $f(v_{\parallel}, v_{\perp})$ by tomographic inversion. Salient features of our measurement of $f(v_{\parallel}, v_{\perp})$ agree reasonably well with the simulation: the measured as well as the simulated $f(v_{\parallel}, v_{\perp})$ are lopsided towards negative velocities parallel to the magnetic field, and they have similar shapes. Further, the peaks in the simulation of $f(v_{\parallel}, v_{\perp})$ at full and half injection energies of the neutral beam also appear in the measurement at similar velocity-space locations. We expect that we can measure spectra in up to seven views simultaneously in the next ASDEX Upgrade campaign which would further improve measurements of $f(v_{\parallel}, v_{\perp})$ by tomographic inversion.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Max Planck Institute, University of Seville, University of California
Pages: 023005
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: Nuclear Fusion
Volume: 54
Issue number: 2
ISSN (Print): 0029-5515
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.13 SJR 0.759 SNIP 1.424
Web of Science (2017): Impact factor 4.057
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.62 SJR 1.284 SNIP 1.416
Web of Science (2016): Impact factor 3.307
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.88 SJR 1.51 SNIP 1.62
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.2 SJR 1.907 SNIP 1.667
Web of Science (2014): Impact factor 3.062
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.83 SJR 1.366 SNIP 1.516
Web of Science (2013): Impact factor 3.243
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.81 SJR 1.441 SNIP 1.448
On velocity-space sensitivity of fast-ion D-alpha spectroscopy
The velocity-space observation regions and sensitivities in fast-ion Dα (FIDA) spectroscopy measurements are often described by so-called weight functions. Here we derive expressions for FIDA weight functions accounting for the Doppler shift, Stark splitting, and the charge-exchange reaction and electron transition probabilities. Our approach yields an efficient way to calculate correctly scaled FIDA weight functions and implies simple analytic expressions for their boundaries that separate the triangular observable regions in (v‖, v⊥)-space from the unobservable regions. These boundaries are determined by the Doppler shift and Stark splitting and could until now only be found by numeric simulation.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Max Planck Institute, University of California at Irvine
Resolving the bulk ion region of millimeter-wave collective Thomson scattering spectra at ASDEX Upgrade

Collective Thomson scattering (CTS) measurements provide information about the composition and velocity distribution of confined ion populations in fusion plasmas. The bulk ion part of the CTS spectrum is dominated by scattering off fluctuations driven by the motion of thermalized ion populations. It thus contains information about the ion temperature, rotation velocity, and plasma composition. To resolve the bulk ion region and access this information, we installed a fast acquisition system capable of sampling rates up to 12.5 GS/s in the CTS system at ASDEX Upgrade. CTS spectra with frequency resolution in the range of 1 MHz are then obtained through direct digitization and Fourier analysis of the CTS signal. We here describe the design, calibration, and operation of the fast receiver system and give examples of measured bulk ion CTS spectra showing the effects of changing ion temperature, rotation velocity, and plasma composition.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Max Planck Institute
Number of pages: 12
Pages: 093504
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: Review of Scientific Instruments
Volume: 85
Issue number: 9
ISSN (Print): 0034-6748
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.32 SJR 0.585 SNIP 0.858
Web of Science (2017): Impact factor 1.428
Spatially-resolved dust properties of the GRB 980425 host galaxy

Gamma-ray bursts (GRBs) have been proposed as a tool to study star formation in the Universe, so it is crucial to investigate whether their host galaxies and immediate environments are in any way special compared with other star-forming galaxies. Here we present spatially resolved maps of dust emission of the host galaxy of the closest known GRB 980425 at $z=0.0085$ using our new high-resolution observations from Herschel, APEX, ALMA and ATCA. We modeled the spectral energy distributions of the host and of the star-forming region displaying the Wolf-Rayet signatures in the spectrum (WR region), located 800 pc away from the GRB position. The host is characterised by low dust content and high fraction of UV-visible star-formation, similar to other dwarf galaxies. Such galaxies are abundant in the local universe, so it is not surprising to find a GRB in one of them, assuming the correspondence between the GRB rate and star-formation. The WR region contributes substantially to the host emission at the far-infrared, millimeter and radio wavelengths and we propose this to be a consequence of its high gas density. If dense environments are also found close to the positions of other GRBs, then the ISM density should also be considered as an important factor influencing whether a given stellar population can produce a GRB, in a similar way as metallicity.
Strong far-infrared cooling lines, peculiar CO kinematics, and possible star-formation suppression in Hickson compact group 57

We present [C II] and [O I] observations from Herschel and CO(1-0) maps from the Combined Array for Research in Millimeter Astronomy (CARMA) of the Hickson compact group HCG 57, focusing on the galaxies HCG 57a and HCG 57d. HCG 57a has been previously shown to contain enhanced quantities of warm molecular hydrogen consistent with shock or turbulent heating. Our observations show that HCG 57d has strong [C II] emission compared to L-FIR and weak CO(1-0), while in HCG 57a, both the [C II] and CO(1-0) are strong. HCG 57a lies at the upper end of the normal distribution of the [C II]/CO and [C II]/FIR ratios, and its far-infrared (FIR) cooling supports a low-density, warm, diffuse gas that falls close to the boundary of acceptable models of a photon-dominated region. However, the power radiated in the [C II] and warm H$_2$ emissions have similar magnitudes, as seen in other shock-dominated systems and predicted by recent models. We suggest that shock heating of the [C II] is a viable alternative to photoelectric heating in violently disturbed, diffuse gas. The existence of shocks is also consistent with the peculiar CO kinematics in the galaxy, indicating that highly noncircular motions are present. These kinematically disturbed CO regions also show evidence of suppressed star formation, falling a factor of 10-30 below normal galaxies on the Kennicutt-Schmidt relation. We suggest that the peculiar properties of both galaxies are consistent with a highly dissipative, off-center collisional encounter between HCG 57d and 57a, creating ring-like morphologies in both systems. Highly dissipative gas-on-gas collisions may be more common in dense groups because of the likelihood of repeated multiple encounters. The possibility of shock-induced star-formation suppression may explain why a subset of these HCG galaxies has been found previously to fall in the mid-infrared green valley.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, California Institute of Technology, Universidad De Granada. Universidad Nacional Autonoma de Mexico, Universite Paris-Sud, University of Crete, Australian National University, Stockholm University, Instituto de Astrofísica de Andalucía, University of Massachusetts, University of Cape Town
Pages: 1-16
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: Astrophysical Journal
Volume: 795
Issue number: 2
ISSN (Print): 0004-637X
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.41
Web of Science (2017): Impact factor 8.561
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.26
Web of Science (2016): Impact factor 8.955
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.8
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.57
Strong scattering of mm-waves in tokamaks

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, FOM Dutch Institute for Fundamental Energy Research, Max Planck Institute
Number of pages: 2
Publication date: 2014

Host publication information
Title of host publication: Proceedings of the 9th International Workshop “Strong Microwaves and Terahertz Waves: Sources and Applications”
Towards fusion energy as a sustainable energy source: Activities at DTU Physics

Nuclear fusion – the process from which the Sun derives its energy – holds the potential to become a clean, safe, highly efficient, and virtually inexhaustible energy source for the future. To mimic this process on earth, experimental fusion devices seek to heat gas to millions of degrees (creating a fusion plasma) and to confine it within magnetic fields. Learning how such plasmas behave and can be controlled is a crucial step towards realizing fusion as a sustainable energy source. At the Plasma Physics and Fusion Energy (PPFE) section at DTU Physics, we are exploring these issues, focusing on areas of high priority on the way towards a working fusion power plant. On the theoretical front, we are simulating plasma turbulence and transport of heat and particles in fusion plasmas (Fig. 1a). These issues play a key role in determining how the plasma behaves globally and how well it remains confined in the magnetic field of the fusion device. Understanding this is important for optimizing plasma performance and for controlling the heat load onto the walls of the confining vessel. Experimentally, we operate equipment to measure key plasma properties in experimental fusion devices such as ASDEX Upgrade in Germany (Fig. 1b+c). Using a technique called collective Thomson scattering (CTS), we can infer the plasma composition and the dynamics of energetic ions in the plasma. Control of these parameters is vital for achieving a high fusion yield in future power plants. We are also designing CTS equipment for the next-step fusion device ITER (Fig. 1d), in which plasma temperatures will exceed 200 million C. This machine is currently being built in France in a large international effort to experimentally demonstrate fusion as a viable energy source and pave the way for the first fusion power plant.
How to compute velocity-space tomographies using several fast-ion diagnostics

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Max Planck Institute, University of Seville, University of California
Number of pages: 4
Publication date: 2013

Host publication information
Title of host publication: Europhysics conference abstracts
Volume: 37D
ISBN (Print): 2-914771-84-3
Electronic versions:

Bibliographical note
Authors: JET-EFDA Contributors
Source: PublicationPreSubmission
Source-ID: 97133975
Research output: Research - peer-review › Journal article – Annual report year: 2014

How to compute velocity-space tomographies using several fast-ion diagnostics

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Max Planck Institute, University of Seville, University of California
Number of pages: 4
Publication date: 2013

Host publication information
Title of host publication: Europhysics conference abstracts
Volume: 37D
ISBN (Print): 2-914771-84-3
Electronic versions:

Bibliographical note
Authors: JET-EFDA Contributors
Source: PublicationPreSubmission
Source-ID: 97133975
Research output: Research - peer-review › Journal article – Annual report year: 2014
Measuring the total and baryonic mass profiles of the very massive CASSOWARY 31 strong lens: A fossil system at $z = 0.77$

We investigate the total and baryonic mass distributions in deflector number 31 (CSWA 31) of the Cambridge And Sloan Survey Of Wide ARcs in the skY (CASSOWARY). We confirm spectroscopically a four-image lensing system at redshift $z = 1.4870$ with Very Large Telescope/X-shooter observations. The lensed images are distributed around a bright early-type galaxy at redshift $0.683$, surrounded by several smaller galaxies at similar photometric redshifts. We use available optical and X-ray data to constrain the deflector total, stellar and hot gas mass through, respectively, strong lensing, stellar population analysis and plasma modelling. We derive a total mass projected within the Einstein radius $R_{\text{Ein}} = 70$ kpc of $(40 \pm 1) \times 10^{12} M_{\odot}$, and a central logarithmic slope of $-1.7 \pm 0.2$ for the total mass density. Despite a very high stellar mass and velocity dispersion of the central galaxy of $(3 \pm 1) \times 10^{12} M_{\odot}$ and $(450 \pm 80)$ km s$^{-1}$, respectively, the cumulative stellar-to-total mass profile of the deflector implies a remarkably low stellar mass fraction of $20$ per cent ($3-6$ per cent) in projection within the central galaxy effective radius $R_{\text{e}} = 25$ kpc ($R = 100$ kpc). We also find that the CSWA 31 deflector has properties suggesting it to be among the most distant and massive fossil systems studied so far. The unusually strong central dark matter dominance and the possible fossil nature of this system render it an interesting target for detailed tests of cosmological models and structure formation scenarios.

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, University of Copenhagen
Contributors: Grillo, C., Christensen, L., Gallazzi, A., Rasmussen, J.
Pages: 2604-2612
Publication date: 2013
Peer-reviewed: Yes

Publication information
Volume: 433
Issue number: 3
ISSN (Print): 0035-8711
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.54 SJR 2.346 SNIP 0.904
Web of Science (2017): Impact factor 5.194
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.09 SJR 2.388 SNIP 1.134
Web of Science (2016): Impact factor 4.961
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4 SJR 2.701 SNIP 1.165
Web of Science (2015): Impact factor 4.952
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.79 SJR 3.23 SNIP 1.322
Web of Science (2014): Impact factor 5.107
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 5.1 SJR 3.155 SNIP 1.23
Web of Science (2013): Impact factor 5.226
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 4.89 SJR 3.283 SNIP 1.392
Web of Science (2012): Impact factor 5.521
ISI indexed (2012): ISI indexed yes
Velocity-space tomography of the fast-ion distribution function

Fast ions play an important role in heating the plasma in a magnetic confinement fusion device. Fast-ion Dα (FIDA) spectroscopy diagnoses fast ions in small measurement volumes. Spectra measured by a FIDA diagnostic can be related to the 2D fast-ion velocity distribution function. A single FIDA view probes certain regions in velocity-space, determined by the geometry of the set-up. Exploiting this, the fast-ion distribution function can be inferred using a velocity-space tomography method. This poster contains a tomography calculated from measured spectra from three different FIDA views at ASDEX Upgrade. The quality of the tomography improves with the number of FIDA views simultaneously measuring the same volume. To investigate the potential benefits of including additional views (up to 18), tomographies are inferred from synthetic spectra calculated from a simulated distribution function. The number of experimentally available views can be increased by combining different types of diagnostics in a joint velocity-space tomography. Using this, up to 7 views are available at ASDEX Upgrade from 2014.

General information

State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Max Planck Institute, University of Seville, University of California at Irvine
Publication date: 2013
Peer-reviewed: Yes
Velocity-space tomography using many-view CTS or FIDA systems

General information
State: Published
Organisations: Department of Physics, Plasma Physics and Fusion Energy, Max Planck Institute, University of Seville, University of California
Number of pages: 4
Pages: 1358-1361
Publication date: 2013

Host publication information
Title of host publication: Europhysics conference abstracts
Volume: 37D
ISBN (Print): 2-914771-84-3
Electronic versions:
Velocity-space tomography using many-view CTS or FIDA systems.pdf
URLs:

Bibliographical note
P5.130
Source: dtu
Source-ID: u::8872
Research output: Research - peer-review › Article in proceedings – Annual report year: 2013

Projects:

On Three-Wave interactions in Wendelstein 7X
Tancetti, A., PhD Student, Department of Physics
Nielsen, S. K., Main Supervisor, Department of Physics
Rasmussen, J., Supervisor, Department of Physics
01/09/2018 → 31/08/2021
Project: PhD

Activities:

Monitoring the state of a nuclear fusion plasma - the role of energetic ions
Period: 30 Jan 2018
Jesper Rasmussen (Speaker)
Department of Physics
Plasma Physics and Fusion Energy

Description
Rydberg Seminar at Univ. of Lund, Sweden

Related external organisation
**Energetic particles in burning plasmas**  
**Period:** 26 Sep 2017 → 28 Sep 2017  
Jesper Rasmussen (Lecturer)  
Department of Physics  
Plasma Physics and Fusion Energy  
**Description**  
PhD lectures given at the 8th Sino-Danish Autumn School on Fusion Plasma Physics and Technology, Beijing, China

**Related event**

**8th Sino-Danish Autumn School on Fusion Plasma Physics and Technology**  
26/09/2017 → 28/09/2017  
Beijing, China  
Activity: Talks and presentations › Guest lectures, external teaching and course activities at other universities

---

**Velocity space tomography: Methods and results**  
**Period:** 16 Jun 2017  
Jesper Rasmussen (Speaker)  
Department of Physics  
Plasma Physics and Fusion Energy

**Related event**

**2nd Joint Nordic Fusion Energy Seminar**  
15/06/2017 → 16/06/2017  
Activity: Talks and presentations › Conference presentations

---

**The DTU fusor – Fusion power at your fingertips**  
**Period:** 22 May 2017  
Jesper Rasmussen (Speaker)  
Department of Physics  
Plasma Physics and Fusion Energy

**Related event**

**Danish Physical Society Annual Meeting 2017**  
22/05/2017 → 23/05/2017  
Activity: Talks and presentations › Conference presentations

---

**Diagnosing fusion-born alpha particles in ITER (and DEMO?)**  
**Period:** 26 Sep 2016 → 30 Sep 2016  
Jesper Rasmussen (Lecturer)  
Department of Physics  
Plasma Physics and Fusion Energy  
**Description**  
PhD lectures given at the 7th Sino-Danish Autumn School on Fusion Plasma Physics and Technology, Hefei, China

**Related event**

**7th Sino-Danish Autumn School on Fusion Plasma Physics and Technology**  
26/09/2016 → 30/09/2016
Hefei, China
Activity: Talks and presentations › Guest lectures, external teaching and course activities at other universities

Hot enough for you? Monitoring the health of a nuclear fusion plasma
Period: 6 Jun 2016 → 7 Jun 2016
Jesper Rasmussen (Speaker)
Department of Physics
Plasma Physics and Fusion Energy

Description
Contributed talk, Danish Physical Society Annual Meeting 2016, Middelfart, Denmark. Awarded "Best Talk" at the meeting.

Related external organisation
Unknown external organisation
Activity: Talks and presentations › Conference presentations

Fast ion properties in fusion plasmas: Theory and measurements
Period: 14 Sep 2015 → 18 Sep 2015
Jesper Rasmussen (Lecturer)
Department of Physics
Plasma Physics and Fusion Energy

Description
PhD lectures given at the 6th Sino-Danish Autumn School on Fusion Plasma Physics and Technology, Hefei, China

Related event
6th Sino-Danish Autumn School on Fusion Plasma Physics and Technology
14/09/2015 → 18/09/2015
Hefei, China
Activity: Talks and presentations › Guest lectures, external teaching and course activities at other universities

Investigating fast-ion transport due to sawtooth crashes using Collective Thomson Scattering
Period: 31 Aug 2015 → 4 Sep 2015
Jesper Rasmussen (Speaker)
Department of Physics
Plasma Physics and Fusion Energy

Description
Contributed talk, 14th IAEA Technical Meeting on Energetic Particles in Magnetic Confinement Systems, Vienna, Austria

Related external organisation
Unknown external organisation
Activity: Talks and presentations › Conference presentations

Fusionsenergi - efterligning af stjernernes energikilde
Period: 29 Jul 2015
Jesper Rasmussen (Lecturer)
Department of Physics
Plasma Physics and Fusion Energy

Description
Public lecture presented to high-school students at the UNF Fysik Camp 2015
**Fast ion properties in fusion plasmas: Theory and measurements**
Period: 15 Sep 2014 → 19 Sep 2014
Jesper Rasmussen (Lecturer)
Department of Physics
Plasma Physics and Fusion Energy

**Description**
PhD lectures given at the 5th Sino-Danish Autumn School on Fusion Plasma Physics and Technology, Hefei, China

**Related event**
5th Sino-Danish Autumn School on Fusion Plasma Physics and Technology
15/09/2014 → 19/09/2014
Hefei, China
Activity: Talks and presentations › Guest lectures, external teaching and course activities at other universities

**Prizes:**

**Best talk at DFS 2016**
Jesper Rasmussen (Recipient)
Department of Physics, Plasma Physics and Fusion Energy

**Description**
Award for "Best talk" (DKK 2500) at the Annual Meeting of the Danish Physical Society 2016

**Details**
Awarded date: 7 Jun 2016
Degree of recognition: National
Granting Organisations: Danish Physical Society
Prize: Prizes, scholarships, distinctions