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Annotated Bibliographry
of EDGE2D Use

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Annotated Bibliography of EDGE2D Use

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Updated on June 17, 2005 to include the papers published from the 2004 PSI conference, the papers to be published at the 2005 EPS conference, and some papers previously missed which A. Loarte pointed out to us. Figure 1 was not updated, and remains valid only to Nov. 19, 2004.

INTRODUCTION

This annotated bibliography is intended to help EDGE2D users, and particularly new users, find existing published literature that has used EDGE2D. Our idea is that a person can find existing studies which may relate to his intended use, as well as gain ideas about other possible applications by scanning the attached tables.

To create the bibliography, we started with the basic 94A-Simonini reference (see Table I) and studied both the papers it referenced and the publications which cited 94A-Simonini. Then, we looked at the references in these papers, and also did a citation search for each paper that had used EDGE2D. This revealed more papers which had used EDGE2D, and so we then read them, looked at their references and at publications that had cited them. This pattern was repeated until new papers that had used EDGE2D were no longer found. Probably some papers that used EDGE2D have not been listed here. These papers may have been published in journals which are not quoted in the Science Citation Index, or may have miss-spelled the first author's name and so cannot be found under the correct listing, or may not have referenced a previous EDGE2D code paper (04-Erents is an example of a paper that does not actually reference the code). Another set of papers that might have been missed are short papers where the authors were constrained for space and might not have listed a full set of references. Some EPS conference papers may fall into that category.

The literature search was time consuming, but at the end, I (JDS) feel that I have read nearly every paper that has used EDGE2D, and that process gives me a perspective on the code. Basically, EDGE2D has been extensively used with about 79 published papers which have been cited a total of about 530 times (up to November 19, 2004) (see figure 1). Calculations have been published for about 40 different JET shots (Table II) where the shot number could be identified since it was quoted. However, in some publications, the discharge has not been identified by the shot number, so probably many more JET shots have been analyzed. As well, calculations for C-MOD, DIII-D, AUG, and ITER have been published.

Many times the code results have featured in Review papers, but those are not listed here, preferring to list the primary reference where the original work was performed. The sole exception is 97A-Loarte, a review article that is also the only place that several figures have appeared in the literature. The papers were not listed where an EDGE2D run was performed in support of the work, but the description of the results was so brief and anecdotal, that I (JDS) felt an EDGE2D user could gain little from reading the article. 98-Gill is an example of an inadequate description of the code use and results, but was included here, because the use was unique, and therefore potentially interesting to some user.

The papers (Table I) were assembled into a yearly grouping including the first 4 authors, a topic classification, and a brief description of any interesting information about the code use, and the number of times that paper has been cited. Please understand that the comments are not a critical evaluation of the papers, but rather a scoping of the EDGE2D use, including any features which I (JDS) found unusual. Readers should read any papers carefully, since I (JDS) do think some statements were questionable in some papers. At the other end of the spectrum, some papers seem like very good science and were enjoyable to read; I (JDS) recommend such papers as 97B-Loarte, and 03-Lonnroth to anyone who is reading this bibliography.

Table II lists some of the main parameters that the publications used, whenever they were documented in the paper. You can see that a wide range of transport coefficients, pinch velocities, and chemical sputtering coefficients have been used. Moreover, the values have drifted over the years, presumably as the fashions change.

Table III groups the publications according to topic, since we suspect that EDGE2D users will be most interested in finding other papers which have previously dealt with the same topic. The classification is our own, and is arbitrary. Some papers appear in more than one topic, when appropriate.

The wide variety of uses that have been made of the code is impressive and we used 10 classifications.

Table IV assembles a brief description of the major code changes that were accomplished in every year. We do not know the actual code version used in each publication. Our intention is that Table IV allows the reader to consider which features were used in the code runs in a particular publication. I (GC) think that is the best that we can do in this regard.

Finally, a histogram of the publications and citation frequency is shown in figure 1. About 3 years elapsed between the major code development; (say 1994), and extensive applications, (say 1997). Another roughly 3 year time delay appears when the Joint undertaking gave way to the EFDA organization in 2000, and simultaneously, most of the (then) main EDGE2D users left JET. The publication rate using EDGE2D declined for about 2-3 years. Apparently it also took about 3 years for a new batch of users (including JDS) to become familiar with the virtues of EDGE2D.

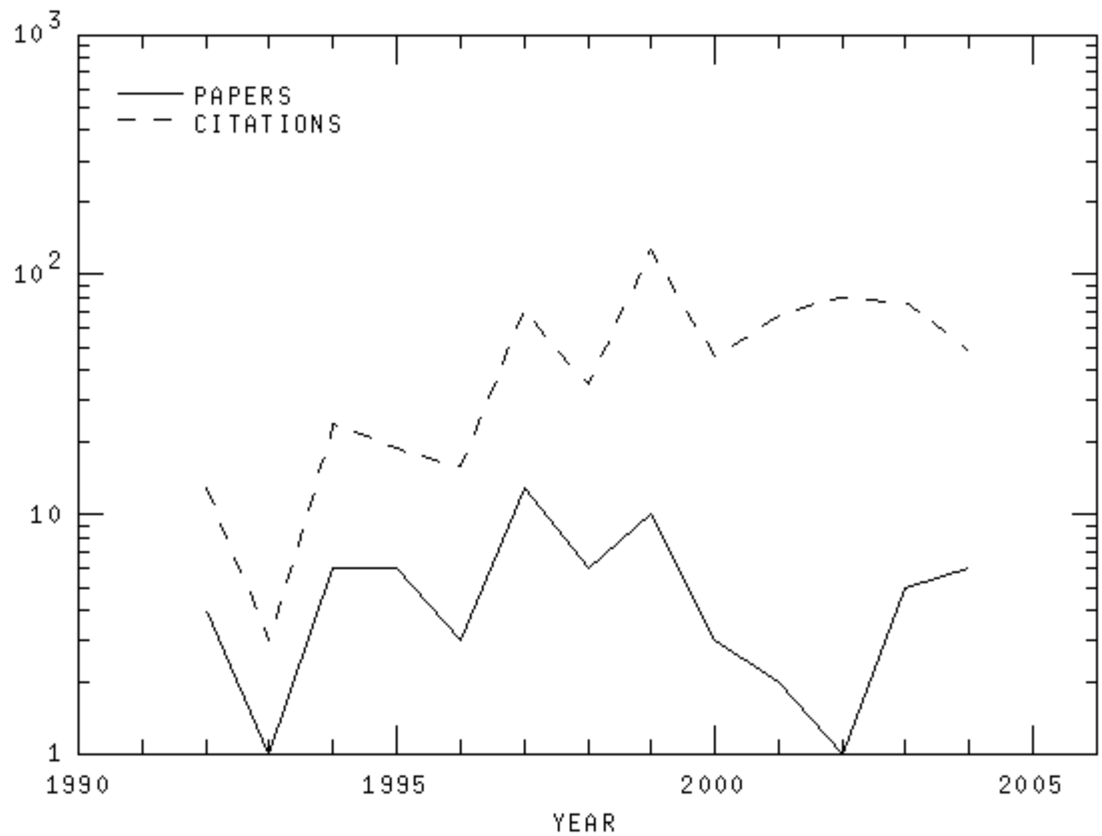

Figure 1: the number of publications/year using EDGE2D (solid line), and the number of citations/year of any paper which used EDGE2D (dashed). This indicates that the code has found considerable use with considerable impact upon fusion research.

ACKNOWLEDGEMENT

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<u>Table I: List of Publications which used EDGE2D</u>

1992

92-Radford: "The Application of Moment Equations to Scrape Off Layer Plasmas"

G.J. Radford,

Contrib. Plasma Phys. **<u>32</u>**, 297 (1992)

CODE DEVELOPMENT – describes the coupling of impurity and ion fluxes in EDGE2D, although the examples are from EDGE1D. (17 citations)

92-Simonini: "Modeling Impurity Control at JET"

R.Simonini, A. Taroni, M. Keilhacker, G. Radford, *et al*,

J. Nucl. Mater. **<u>196-198</u>**, 369 (1992)

CODE DEVELOPMENT – Compares EDGE1D and EDGE2D simulations of Ohmic 24721. (22 citations)

92-Taroni: "The Multi-Fluid Codes EDGE1D and EDGE2D: Models and Results"

A. Taroni, G. Corrigan, G. Radford, R. Simonini, *et al*,

Contrib. Plasma Phys. **<u>32</u>**, 438 (1992)

CODE DEVELOPMENT – used orthogonal grid. (10 citations)

92-Vlases: "Divertor Physics at JET: Experimental Results and Modeling"

G.C. Vlases and JET Team,

Proc. Conf on Plasma Phys and Contr. Nuclear Fusion Research, (Wurzburg IAEA 1992)

CODE VALIDATION, also **DIVERTOR DESIGN –** (5 citations)

1993

93-Simonini: "2D Modeling of the JET Divertor"
R. Simonini, G. Corrigan, J. Spence, A. Taroni, *et al*,
EPS part II, p 771 (1993)
DIVERTOR DESIGN – proposed MkII design. Matched EDGE2D runs to experimental mid-plane decay lengths. (1 citation).

1994

94-Harbour: "The Control of Convection by Fuelling and Pumping in the JET Pumped Divertor"
P.J. Harbour, P. Andrew, D. Campbell, S. Clement, *et al*,
Proc. 21st EPS Conf. Pl. Phys. And Contr. Fus. Part II, p. 746 (1999)
SOL FLOWS – Mk I L-Mode 29817 was used to calculate the source induced SOL flow and relate to JET puff and pump experiments. (1 citation)

94-Horton: "Modelling and measurements of JET Divertor Plasmas"
L.D. Horton and JET Team,
Plasma Phys. and Contr. Fus. Research, Vol 1, 541 (IAEA, 1994)
DETACHED PLASMAS – EDGE2D used with no impurities and out used in conjunction with DIVIMP. Modelled 30829, 30831, and 31504. (7 citations).

94A-Simonini: "Models and Numerics in the Multi-Fluid 2D Edge plasma Code EDGE2D/U"
R. Simonini, G. Corrigan, G. Radford, J. Spence, A. Taroni
Contrib. Plasma. Phys. **<u>34</u>**, 368 (1994)
PRIMARY REFERENCE TO EDGE2D – called U to indicate the application of non-orthogonal grids. (45 citations)

94B-Simonini: "A Numerical Study of Plasma Detachment Conditions in JET Divertor Plasmas"
R. Simonini, G. Corrigan, G. Radofrd, J. Spence, et al,
Proc. 21st EPS Conf. Pl. Phys. and Contr. Fus. Part II, p.694 (1999)
DETACHED PLASMAS – Neon was puffed into an Mk IIGB prototype divertor design. (1 citation)

94-Taroni: A Study of the performance of JET Devertor Configurations with Consistent treatment of Impurities"

A. Taroni, G. Corrigan, R. Simonini, J. Spence, *et al*,
Contrib. Plasma Phys. **34**, 448 (1994)

DIVERTOR DESIGN – no flux limiter was used since JET data (quoting 92-Vlases) do not indicate it is appropriate? (11 citations)

94-Weber: "numerical Simulation of Hydrogen Atomic Losses in a Divertor Plasma"

S. Weber, R. Simonini, and A. Taroni,
Contrib. Plasma Phys. **34**, 374 (1994)

CODE DEVELOPMENT – called EDGE2D/N and designed to understand the role of charge exchange in dissipating power and momentum. (4 citations).

1995

95-Davies: "The Behaviour of Divertor and Scrape-Off Layer parameters in JET"

S.J. Davies, S.K. Erents, H.Y. Guo, A. Loarte, *et al*,
Proc. 22nd EPS Conf. Pl. Phys. and Contr. Fus. Vol. III, p. 257 (Bournemouth, 1995)

SOL TRANSPORT – developed an analytic derivation of SOL transport coefficients and compared to EDGE2D from 95B-LOARTE, finding that EDGE2D was about an order of magnitude higher.

95A-Loarte: "Comparison between measured Scrape-off layer Plasma Parameters and 2D Model calculations for JET X-point Discharges"

A. Loarte, A. Chankin, S. Clement, G. Corrigan, *et al*,
J. Nucl. Mater. **220-222**, 606 (1995)

SOL TRANSPORT – studied 24165, 24175, 24171, 25720, and 25710. If fluxes are driven by gradients in real space then the derived coefficients are about twice the values when the fluxes were driven by gradients in magnetic flux co-ordinates. (6 citations).

95B-Loarte: "The influence of Divertor Geometry on JET Discharges"
A. Loarte, D. J. Cambell, S. Clement, S.J. Davies, *et al*,
Proc. 22nd EPS Conf. On Pl. Phys. and Contr. Fus. Vol III, p. 305 (Bournemouth, 1995)
DIVERTOR DESIGN – compared vertical with horizontal targets, using Mark I 31504 and 31496. (4 citations).

95-Matthews: "Highly radiating and detached Plasmas on Carbon and Beryllium Targets"
G.F. Matthews and JET Team,
Pl. Phys. and Control. Fusion **37**, A227 (1995)
DETACHED PLASMAS – $Y_{CHEM} = 0$ but mocked up chemical sputtering by externally injecting carbon. (27 citations).

95-McCormick: "Recycling, Divertor parameters and SOL Transport for High Performance Discharges in the NEW JET"
K. McCormick, J.K. Ehrenberg, A. Loarte, R. Monk, *et al***,**
Proc. 22nd EPS Conf. On Pl. Phys. and Contr. Fus. Vol. **19C**, part I, p. 313 (Bournemouth, 1995)
HYDROGENIC PROCESSES: Identifies little recycling changes in different divertor configurations

95-Monk: "Determination of JET scrape-off layer transport coefficients using an interpretative 'onion-skin' plasma model"
R.D. Monk, L.D. Horton, A. Loarte, G. F. Matthews, *et al*,
J. Nucl. Mater. **220-222**, 612 (1995)
CODE VALIDATION – same EDGE2D runs as in 95A-Loarte but table 2 shows a comparison with DIVIMP. (10 citations).

95A-Taroni: "A Study with the EDGE2D code of the power exhaust problem in ITER relevant divertor plasmas"

A. Taroni, G. Corrigan, R. Simonini, J. Spence, *et al*,

J. Nucl. Mater. **220-222**, 1086 (1995)

DETACHED PLASMAS – Mark I divertor calculations compare horizontal and vertical targets, but no actual ITER simulations. (22 citations)

95B-Taroni: "Multifluid Modelling of Radiative and Detached Edge Plasmas and Comparison with Experimental Results"

A. Taroni, G. Corrigan, L.D. Horton, A. Loarte, *et al*,

Proc. 22nd EPS Conf. Pl Phys. and Contr. Fus. Vol IV, p. 297 (Bournemouth, 1995)

DETACHED PLASMAS – pinch was required to improve agreement with j_{sat} at outer target for 31627 and 30829. (5 citations).

1996

96-Radford: "The Particle and heat Drift Fluxes and their Implementation into the EDGE2D transport Code"

G.J. Radofrd, A.V. Chankin, G. Corrigan, R. Simonini, *et al*,

Contrib. Plasma Phys. **36**, 187 (1996)

CODE DEVELOPMENT – note discussion of divergence free components. (13 citations).

96-Simonini: A predictive Study of the JET Mark II gas Box Divertor"

R. Simonini, G. Corrigan, G. Radford, J. Spence, et al,

Proc. 23th Eur. Conf. on Pl. Phys. and Contr. Fus. Vol II, p. 823 (Kiev, 1997)

DIVERTOR DESIGN – evaluation Z_{eff} for N seeded plasmas with possible septum designs for the Mk II GB divertor. (5 citations).

96-Taroni: "Energy and particle transport Modelling with a Time dependent Combined Core and EDGE Transport Code"

A. Taroni and JET Team,

Fusion Energy II, 477 (1996) (IAEA Conference)

CODE DEVELOPMENT also **INTEGRATED MODELLING** – matched H_α signals for Mark I Hot Ion H-Mode 32919 for EDGE2D to provide neutral deuterium influx to core transport model. (3 citations).

1997

97-Garcia-Cortes: "Turbulence Studies in the JET Scrape-off layer Plasmas"

I. Garcia-Cortes, M. Endler, A. Loarte, S.J. Davies, *et al*,

Proc. 24th Eur. Conf. on Pl. Phys. and Contr. Fus. Part I, p. 109 (Bertchetsgaden, 1997)

SOL TRANSPORT – Used EDGE2D to relate the transport coefficients to the diffusive particle fluxes measured by probes and concluded that a pinch velocity of 7.5 m/s was needed. (0 citations).

97-Ingesson: "Radiation distribution and neutral particle loss in JET MkI and MkIIA divertors"

L.C. Ingesson, R. Reichle, G.C. Fehmers, H. Guo, *et al*,

Proc. 24th Eur. Conf. on Pl. Phys. and Contr. Fus. Part I, p. 113 (Bertchetsgaden, 1997)

HYDROGENIC PROCESSES – (12 citations)

97A-Loarte: "Understanding the edge physics of divertor experiments by comparison of 2D edge Code Calculations and experimental measurements"

A. Loarte,

J. Nucl. Mater. **241-243**, 118 (1997)

SOL TRANSPORT, also **CODE VALIDATION**, also, **DETACHED PLASMAS**, also **SOL FLOWS** – a review paper documenting the range of transport coefficients used to fit different plasma types. Some data have not been otherwise published. Figure 7 has a comparison of EDGE2D and UEDGE. Figures 8 and 9 show inner and outer detachment. Figure 14 shows EDGE2D calculations of C-MOD. (25 citations).

97B-Loarte: "Multimachine Simulations of Divertor Pumping and its dependency on Target geometry and Plasma Conditions"

A. Loarte, J.K. Ehrenberg, L.D. Horton, B. Lipschultz, *et al*,

Proc. 24th Eur. Conf. on Pl. Phys. and Contr. Fus. Vol III, p. 1049 (Bertchetsgaden, 1997)

HYDROGENIC PROCESSES – contrasts direct scattering of neutrals into pumping slots (DIII-D) with multiple scattering (JET and C-MOD). (5 citations).

97-Maggi: "Measurement and analysis of radiated power components in the JET MkI divertor using VUV spectroscopy"

C.F. Maggi, J.D. Elder, W. Fundamenski, R. Giannella, *et al*,

J. Nucl. Mater. **241-243**, 414 (1997)

IMPURITIES – EDGE2D was used to provide the background plasma for DIVIMP calculated spectral signals. (10 citations)

97-Matthews: "Scaling Radiative Plasmas to ITER"

G.F. Matthews, S. Allen, N. Asakura, J. Goetz, *et al*,

J. Nucl. Mater. **241-243**, 450 (1997)

IMPURITIES – relationship between Z_{eff} and radiated power calculated for JET and ITER. (33 citations).

97-McCormick: "Deduction of SOL Transport Coefficients Using 2D Modelling for Hot Ion ELM-free H-Modes in JET"

G.K. McCormick, A. Chankin, S. Clements, S. Davies, *et al*,
J. Nucl. Mater. **241-243**, 444 (1997)

SOL TRANSPORT – related D without pinch to D with pinch. Studied sensitivity to recycling, grid width, wall material, and thermal transport barrier. (5 citations).

97-Monk: "The Effect of Divertor Closure on Detachment in JET"

R.D. Monk, A. Loarte, S.J. Davies, J.K. Ehrenberg, *et al*,
Proc. 24th Eur. Conf. on Pl. Phys. and Contr. Fus. Part I, p. 117 (Bertchetsgaden, 1997)

DETACHED PLASMAS – compared degree of detachment for density scans in Mk I, Mk II, and Mk IIA. (5 citations).

97-Radford: "Fluid Modelling with Drift Fluxes of magnetic Field Reversal Experiments in JET"

G.J. Radford, A.V. Chankin, G. Corrigan, R. Simonini, *et al*,
Proc. 24th Eur. Conf. on Pl. Phys. and Contr. Fus. Part I, p. 125 (Bertchetsgaden, 1997)

SOL FLOWS – high recycling L-Mode modelled with forward and reversed field. (4 citations)

97-Reichle: "Low Energy Neutral particle Fluxes in the JET Divertor"

R. Reichle, J.K. Ehrenberg, N.A.C. Gottardi, L.D. Horton, *et al*,
J. Nucl. Mater. **241-243**, 456 (1997)

HYDROGENIC PROCESSES – studied Mk I 31504 near detachment. (7 citations).

97-Simonini: "An Interpretive/predictive Study of the JET Mark II Divertors for ELMy H-modes in JET"

R. Simonini, G. Corrigan, M.Fichtmuller, R. Monk, et al,
EPS Conf. Contr. Fus. And Pl. Phys. part 1, p. 13 (Bertchetsgaden, 1997)

DIVERTOR DESIGN – used Mk IIA 37937, and 37940 vertical and horizontal target Hot Ion H-Modes to validate models of the Mk IIGB divertor design and included an evaluation of the effect of Septum removal. (5 citations).

97-Stangeby: “Code-code Comparison of DIVIMP’s ‘onion-skin-model’ and the EDGE2D fluid code”

P.C. Stangeby, J.D. Elder, W. Fundamenski, A. Loarte, *et al*,
J. Nucl. Mater. **241-243**, 358 (1997)

CODE VALIDATION – studied low and high recycling JET cases and a detached C-MOD case. (13 citations).

97-Vlases: “Lightly-or non-seeded, partially detached ITER Divertor Operation”

G. Vlases, G. Corrigan, and A. Taroni,
J. Nucl. Mater. **241-243**, 310 (1997)

IMPURITIES – 200 MW into ITER SOL with N_2 seeding. (3 citations).

1998

98A-Fichtmuller: “Multi-Species Developments in the EDGE2D Code”

M. Fichtmuller, G. Corrigan, G. Radford, R. Simonini, *et al*,
Contrib. Plasma Phys. **38**, 284 (1998)

CODE DEVELOPMENT – describes reduced charge state and illustrates with He puffing in Mark I 33994. (2 citations).

98B-Fichtmuller: “Core-edge Coupling and the Effect of the edge on overall plasma performance”

M. Fichtmuller, G. Corrigan, L. Lauro Taroni, R. Simonini, *et al*,
Czech. J. Phys. 48, 25 Suppl. 2 (1998)

INTEGRATED MODELLING – used EDGE2D to calculate effects of C sputtering, He exhaust, He puffing, and individual ELMs on core, by coupling to JETTO. This paper is more readily available as JET report – JET-P(98) 69. (5 citations)

98-Gill: “Particle and Energy Flows following giant Edge localized Modes in JET”

R.D. Gill, B. Alper, S. Arshad, A.D. Cheetam, *et al*,
Nucl. Fus. **38**, 1461 (1998)

HYDROGENIC PROCESSES – anecdotal description of EDGE2D use to check the plausibility that x-ray flashed were caused by energetic neutrals originating from wall materials. (7 citations).

98-Lauro Taroni: "Time Dependent Modelling of Impurity transport in the JET core and Divertor Plasma"

L.Lauro Taroni, G. Corrigan, R. Simonini, J. Spence, *et al*,
Contrib. Plasma, Phys. **38**, 242 (1998)

CODE DEVELOPMENT, also **IMPURITIES** – JETTO-SANCO coupled to EDGE2D and illustrated with Ne puffing into an L-Mode 37306. (0 citations).

98-Radford: "The Development of Simplified heat Flux Limiters"

G.J. Radford, G. Corrigan, M. Fichtmuller, and J. Spence,
Contrib. Plasma Phys. **38**, 183 (1998)

CODE DEVELOPMENT – electron heat flux limiter negligible but ion heat flux limiter reduced thermal force by 30%. (0 citations).

98-Taroni: "Modelling of JET H-Mode Plasmas with Type I ELMs"

A. Taroni, G. Corrigan, J. Lingertat, V. Parail, *et al*,
Contrib. Plasma Phys. **38**, 37 (1998)

INTEGRATED MODELLING, also **ELMS** – ELM model is incorporated into JETTO, but the examples are from combined JETTO/EDGE2D/NIMBUS. (5 citations)

1999

99-Fichtmuller: "Simulation of Helium Exhaust in JET and ITER"

M. Fichtmuller, G. Corrigan, L. Lauro Taroni, R. Simonini, *et al*,
J. Nucl. Mater. **266-269**, 330 (1999)

INTEGRATED MODELLING, also **IMPURITIES** – C friction pulled He out of the divertor. Simulated JET ELMY H-Modes 33994 from Mark I and 44338 from Mark II, as well as 1997 ITER with 200 MW into SOL. (1 citation).

99A-Guo: "The Role of recycling and Impurity Production in JET Hot Ion H-Modes"

H.Y. Guo, B. Balet, G. Conway, G. Corrigan, *et al*,
J. Nucl. Mater. **266-269**, 825 (1999)

HYDROGENIC PROCESSES, also **IMPURITIES**– effects due to target temperature change between Mark I and Mark II. Looked at 38093, 38356, and 33643. (4 citations).

99B-Guo: "Influence of Divertor Geometry on Neutral Compression, Impurity Enrichment and particle Exhaust on JET"

H.Y. Guo, I. Coffey, G. Corrigan, M. Groth, *et al*,
Proc. 26th EPS Conf. Pl. Phys. and Contr. Fus. (1999)

IMPURITIES- Neon and Helium enrichment calculated in Mk IIGB L-Mode. (0 citations)

99A-Maggi: The Isotope Effect on the L-Mode density Limit in JET hydrogen, deuterium, and tritium divertor plasmas"

C.F. Maggi, R.D. Monk, L.D. Horton, K. Borrass, *et al*,
Nucl. Fus. **39**, 979 (1999)

HYDROGENIC PROCESSES – isotope affected the neutral mean free path for ionization in the SOL. (3 citations).

99B-Maggi: "Modelling of deuterium emission in high density divertor plasmas in JET"

C.F. Maggi, L.D. Horton, G. Corrigan, H.J. Jackel, *et al*,
J. Nucl. Mater. **266-269**, 867 (1999)

HYDROGENIC PROCESSES – H_α calculations including opacity corrections. (4 citations).

99A-Matthews: "Studies in JET divertors of varied geometry II: Impurity seeded plasmas"

G.F. Matthews, B. Balet, J.G. Cordey, S.J. Davies, *et al*,
Nucl. Fus. **39**, 19 (1999)

IMPURITIES – (28 citations).

99B-Matthews: "Trace tritium and the H-Mode Density Limit"
G.F. Matthews, K-D. Zastrow, P. Andrew, B. Balet, *et al*,
J. Nucl. Mater. **266-269**, 1134 (1999)
HYDROGENIC PROCESSES – EDGE2D used to calculate the deuterium ionization inside the separatrix for 42529. (5 citations).

99-Saibene: "The Influence of Isotope mass, edge magnetic Shear, and Input Power on High Density ELMy H-Modes in JET"
G. Saibene, L.D. Horton, R. Sartori, B. Balet, *et al*,
Nucl. Fus. **39**, 1133 (1999)
INTEGRATED MODELLING, also **HYDROGENIC PROCESSES** – EDGE2D provided the edge influxes for 39609 and 39611, and the isotope effects were calculated for the neutrals crossing the separatrix. (68 citations).

99-Stamp: "Experimental determination of the Contribution of chemical Sputtering on Core carbon Concentrations"
M.F. Stamp, D. Elder, H.Y. Guo, M. von Hellermann, *et al*,
J. Nucl. Mater. **266-269**, 685 (1999)
IMPURITIES – similar EDGE2D runs as 00-Guo, but here the relation to the experimental data of 4000 is explained. The transport coefficients and carbon chemical sputtering yield are slightly different than 00-Guo. (8 citations).

99-Taroni: "Integrated Core-Edge Modelling of Energy Confinement Degradation and Particle Content Saturation in JET ELMy H-Modes"
A. Taroni, G. Corrigan, M. Fichtmueller, D.J. Heading, *et al*,
Proc. 26th EPS Conf. Pl. Phys. and Contr. Fus. Part II, (1999)
INTEGRATED MODELLING, also **ELMS** – used the JETTO edge transport coefficients for the EDGE2D SOL values. Same shot numbers as 99-Saibene, but neither paper discusses the relation to the other paper. (3 citations)

2000

00-Chankin: "Modelling of SOL flows and target asymmetries in JET field reversal experiments with EDGE2D code"

A.V. Chankin, J.P. Coad, G. Corrigan, S. J. Davies, *et al*,
Contrib. Plasma Phys. **40**, 288 (2000)

SOL FLOWS – models used the classical drifts. (6 citations).

00-Guo: "Effects of divertor geometry and Chemical Sputtering on Impurity Behaviour and Plasma Performance in JET"

H.Y. Guo, G.F. Matthews, I. Coffey, S.K. Erents, *et al*,
Nucl. Fus. **40**, 379 (2000)

IMPURITIES – effects of closure on recycling and intrinsic impurities for Mark I, Mark IIA, and Mark IIGB. Modelled 40000, and 40346. Calculated the effects of target temperature changes between 300 and 400 ºC. (8 citations).

00-Maggi: "The Effect of charge exchange with neutral deuterium on carbon emission in JET divertor plasmas"

C.F. Maggi, L.D. Horton, and H.P. Summers,
Plasma Phys. and Contr. Fus. **42**, 669 (2000)

HYDROGENIC PROCESSES – density scan of EDGE2D runs to simulate the time evolution of 34859, an Ohmic density limit discharge. (7 citations).

2001

01-Fundamenski: "Analysis of SOL behavior in JET Mk IIGB using an advanced onion-skin solver (OSM2)"

W. Fundamenski, S.K. Erents, G.F. Matthews, A.V. Chankin, *et al*,
J. Nucl. Mater. **290-293**, 593 (2001)

CODE VALIDATION – (10 citations).

01-Chankin: "Interpretation of SOL flows and target asymmetries in JET using EDGE2D code calculations"

A.V. Chankin, G. Corrigan, S.K. Erents, G.F. Matthews, *et al*,
J. Nucl. Mater. **290-293**, 518 (2001)

SOL FLOWS – includes classical drifts and seems to find the correct magnitude of SOL flow difference (fig. 6) between forward and reverse fields. Similar calculations as for 00-Chankin, but with transport coefficients reduced in ½ and less power into the SOL to avoid unspecified "kinetic effects". (11 citations).

2002

02-Matthews: "The effect of CD_4 puffing on the peripheral scrape-off layer in JET"

G.F. Matthews, S.K. Erents, W. Fundamenski, *et al*,
Pl. Phys. Contr. Fus. **44**, 689 (2002)

IMPURITIES –modeled the SOL density perturbation. (2 citations).

2003

03-Lonnroth: "Integrated predictive Modelling of the Effect of neutral gas Puffing in ELMy H-Mode Plasmas"

J-S. Lonnroth, V.V. Parail, G. Corrigan, D. Heading, *et al*,
Pl. Phys. Contr. Fus. **45**, 1689 (2003)

INTEGRATED MODELING also **ELMS** – EDGE2D calculated the fuelling efficiency for a density scan feeding the fluxes to JETTO and iteratively allowing MHD calculations to assess the effects of magnetic shear and MHD on the ELM behavior. (7 citations).

03A-Matthews: "The Effect of ion orbit losses on JET edge plasma simulations"

G.F. Matthews, G. Corrigan, S.K. Erents, W. Fundamenski, *et al*,
J. Nucl. Mater. **313-316**, 986 (2003)

INTEGRATED MODELING – EDGE2D provided the input for ASCOT (kinetic code) for 50401 and 50402. Claimed EDGE2D accounts for only ½ of actual P_{SOL}, but this result was not described in the quoted references. (2 citations).

03B-Matthews: "Ion Optics Evaluation of the plasma ion mass spectrometer (PIMS) designed for the JET tokamak"

G.F. Matthews, W. Schustereder, N. Cant, S.K. Erents, *et al*,
Int. J. of Mass Spectr. **223**, 45 (2003)

HYDROGENIC PROCESSES – I have only seen the abstract, but apparently EDGE2D was used to provide signal estimates in evaluating a detector design. (1 citation)

03-Parail: "Integrated Predictive Modeling of JET H-Mode Plasma with Type I and Type III ELMs"

V. Parail, G. Bateman, M. Becoulet, G. Corrigan, *et al*,
Plasma Phys. Rep. **29**, 539 (2003)

INTEGRATED MODELING, and also **ELMS** – modeled ELMy H-Modes scanning gas puffing and triangularity in 53186, 53298, 53299, and 52739. Overlap with 03-Lonngroth is difficult to judge. (2 citations).

03-Strachan: "JET Carbon Screening experiments using methane gas puffing and its relation to intrinsic carbon impurities"

J.D. Strachan, W. Fundamenski, M. Charlet, G. Corrigan, *et al*,
Nucl. Fus. **43**, 922 (2003)

IMPURITIES – EDGE2D looked at divertor fuelling efficiency for carbon. (2 citations).

2004

04-Erents: "A comparison of experimental measurements and code results to determine flows in the JET SOL"

S.K. Erents, R.A. Pitts, W. Fundamenski, J.P. Gunn, *et al*,
Plasma Phys. and Contr. Fus. **46**, 1757 (2004)

SOL FLOWS – Models forward and reversed field flows similar to 01-Chankin, but with roughly 3X smaller resulting flows.

04-Fundamenski: Boundary plasma energy transport in JET ELMy H-Modes"

W. Fundamenski, S. Sipila, and JET-EFDA contributors,
Nuclear Fusion **44**, 20 (2004)

HYDROGENIC PROCESSES – 50 simulations of 50415, varying input parameters to form a regression data base.

04-Kallenbach: "EDGE2D Modelling of edge profiles in JET diagnostic optimized configuration"

A. Kallenbach, Y. Andres, M. Beurskens, G. Corrigen, *et al*,
Pl. Phys. Contr. Fus. **46**, 431 (2004)

ELMS – step-like edge transport coefficients with a particle pinch following ansatz developed to explain AUG SOL parameters.

04-Rapp "Reduction of Divertor heat load in JET ELMy H-Modes using impurity seeding techniques"

J. Rapp, P. Monier-Garbet, G.F. matthews, R. Sartori, *et al*,
Nucl. Fus. **44**, 312 (2004)

IMPURITIES – modelled Mk IIGB radiative dissipation of ELM energy using 53318. Step transport coefficients similar to 04-Kallenbach with coefficients increased during the ELMs.

04A-Strachan: "Diverted Tokamak Carbon Screening: scaling with machine size and consequences for core contamination"

J.D. Strachan, G. Corrigan, A. Kallenbach, G.F. Matthews, *et al*,
Nucl. Fus. **44**, 772 (2004)

IMPURITIES – AUG and ITER modeling as well as 49706 of carbon screening and sources.

04B-Strachan: "EDGE2D Simulations of JET ^{13}C Migration Experiments"
J.D. Strachan, J.P. Coad, G. Corrigan, G.F. Matthews, *et al*,
Proc 31st EPS Conf. Pl. Phys. Control. Fusion (London, 2004)
IMPURITIES - modelled migration of carbon injected at top or at outer strike point.

2005

05-Belo: "Numerical simulation of impurity screening in the SOL of JET plasma by localised Deuterium gas puffing"
P. Belo, V. Parail, G. Corrigan, J. Hogan, *et al*,
Proc. 32nd EPS Conf. Pl. Phys. Control. Fusion (Tarragona, 2005)
IMPURITIES – Neon fuelling from various locations, with carbon impurities due to sputtering. Density scans to detachment.

05-Bonnin: "B2-Eirene (SOLPS) Modelling of JET SOL plasma flow"
X. Bonnin, R.A. Pitts, D. Coster, and S. K. Erents
Proc. 32nd EPS Conf. Pl. Phys. Control. Fusion (Tarragona, 2005)
CODE VALIDATION – compared SOLPS results to the EDGE2D results from 04-Erents.

05-Coster: "Benchmarking Tokamak Edge Modelling"
D.P. Coster, X. Bonnin, G. Corrigan, G.S. Kirnev, *et al*,
J. Nucl. Mater. **337-339,** 366 (2005)
CODE VALIDATION – benchmarking with SOLPS found little difference so long as the same physics is used, but commonly EDGE2D is run without flux limiters in contrast to SOLPS.

05-Fundamenski: "Effect of B X ∇B Direction on SOL Energy Transport in JET"
W. Fundamenski, P. Andrew, K. Erents, A. Huber, *et al*,
J. Nucl. Mater. **337-339**, 305 (2005)
SOL TRANSPORT – modelled in-out power asymmetry in forward and reversed field.

05A-Huber: "The Effect of Field Reversal on the JET Mk IIGB-SRP divertor performance in L-Mode Density Limit Discharges"

A. Huber, J. Rapp, P. Andrew, P. Coad, *et al*,

J. Nucl. Mater. **337-339**, 241 (2005)

DETACHED PLASMAS – Simulates in-out asymmetry in target power and CIII emission includes drifts.

05B-Huber: "Modelling JET Divertor Physics wit the EDGE2D Code"

A. Huber, P. Andrew, P. Coad, G. Corrigan, *et al*,

Proc. 32nd EPS Conf. Pl. Phys. Control. Fusion (Tarragona, 2005)

HYDROGENIC PROCESSES – Calculates hydrogen spectral light and spatial distribution for forward and reversed field cases. Compares the EDGE2D calculations to edge density measurements from Li beam, edge LIDAR, and core LIDAR.

05-Kirnev: "EDGE2D Code Simulations of SOL Flows and in-out Divertor Asymmetries in JET"

G.S. Kirnev, G. Corrigan, D. Coster, S.K. Erents, *et al*,

J. Nucl. Mater. **337-339**, 271 (2005)

SOL FLOW – combines effects due to ballooning-like poloidal variations and radial convection to replicate observed JET SOL flows.

05-Lonnroth: "Analysis of ELM heat pulse propagation in the JET scrape-off layer with an integrated fluid-kinetic approach"

J.S. Lonnroth, G. Corrigan, W. Fundamenski, V. Parail, et al,

Proc. 32nd EPS Conf. Pl. Phys. Control. Fusion (Tarragona, 2005)

INTEGRATED MODELLING and also **ELMS** – very low ELM enhanced transport in the outer SOL regions used to match experiment, and also concluded a time varying flux limiter applies.

05-Pitts: "Edge and Divertor Physics with Reversed Toroidal Field in JET"

R.A. Pitts, P. Andrew, X. Bonnin, A.V. Chankin, *et al*,

J. Nucl. Mater. **337-339**, 146 (2005)

SOL FLOW – compares mechanisms used in EDGE2D to describe SOL flows and the relation the JET experiments.

05-Pospieszczyk: "Molecular Deuterium Sources in Outer Divertor of JET"

A.Pospieszczyk, S. Brezinsek, G. Sergienko, P.T. Greenland, *et al*,

J. Nucl. Mater. **337-339**, 500 (2005)

HYDROGENIC PROCESSES – Molecules make up a significant contribution to the fuelling in the divertor (70-95%).

05-Strachan: "Methane Screening Experiments in JET Reverse Field Experiments"

J.D. Strachan, B. Alper, G. Corrigan, S.K. Erents, *et al*,

J. Nucl. Mater. **337-339**, 25 (2005)

SOL FLOW, also **IMPURITIES** – modeled 49705 and 59598

Table IIA- List of EDGE2D parameters used in publications. The shot numbers are all for JET, χ_e/χ_i indicates the electron/ion heat conductivities, and one value indicates the paper assumed equality. D/D_Z are the ion and impurity diffusion coefficients; a single value indicates the ion value.

Ref.	Shot	χ_e/χ_i (m^2/s)	D/D_Z (m^2/s)	V (m/s)	Y_{CHEM}	Comments
92-Simonini	24721					
92-Vlases		0.5	0.1			
93-Simonini		2.0	0.1			
94-Harbour	29817	1.5	0.2			Mk I L-Mode
94-Horton	30829 30831 31504			6		
94-Taroni		2.0	0.1			Coefficients 5X larger in divertor
95A-Loarte	24165	0.5	0.1			Ohmic in H_2
	24175	0.5	0.2			L-Mode in H_2
	24171	0.25	0.05			H-Mode in H_2
	25720	.7	0.05			L-Mode in D_2
	25710	0.5	0.05			L-Mode in D_2
95B-Loarte	31504	1.3	0.12			Also 31496
95-Matthews		1.5	1	15	0	Carbon injection to mimic Chemical Sputtering
95-McCormick	26087	0.8/1.5	0.3	-9		Hot-Ion H-Mode, compared to 32823, 32919, 33643
95A-Taroni			1	15		Equivalent
			0.12	0		
95-B-Taroni	30829 31627	1.5	1	15		
96-Taroni	32919					
97-Garcia-Cortes			0.15	7.5		Matched EDGE2D fluxes to probe measured fluxes
97A-Loarte		0.5-2	0.1-0.3	0		Ohmic
		1-5	0.1-0.5	0		L-Mode
		0.1-0.5	0.05-0.2	0		H-Mode
	C-MOD	2.5	0.4	0		N seeding
97B-Loarte		0.3-1.5	0.02-0.1			JET density and power scans
	DIII-D	2.5	0.2			2MW L-Mode at $n_{SEP}=10^{19}\ m^{-3}$
	DIII-D	0.1	0.02			5MW H-Mode at $n_{SEP}=2\ 10^{19}\ m^{-3}$
	C-MOD	0.5	0.05			0.8MW at $n_{SEP} = 4\ 10^{19}\ m^{-3}$
97-McCormick	32919	0.5-3**/1	0.03-.15**	0		Equivalent
			0.1	15-45**		
97-Monk		1.5	0.1		0.02	Density scans, 2MW, Simulates Mk I, IIA, IIAP
97-Radford	31608 31485	0.75-3.0	0.2-1.0	2.4-15		
97-Simonini	37940 37937	0.2/0.4	0.1	4.5	1*Mech	$n_{SEP}=10^{19}\ m^{-3}$
97-Stangeby		1	0.1	0		
	C-MOD	0.3	0.7	0		
97-Vlases	ITER	1	0.5	0		
98A-Fichtmuller	33994					He puffing
98B-Fichtmuller			1			
98-Lauro Taroni	37306		1.0	0		

Table IVB- Continued list of EDGE2D parameters used in publications

Ref.	Shot	X_e/ X_i (m^2/s)	D/ D_Z (m^2/s)	V (m/s)	Y_{CHEM}	Comments
99-Fichtmuller	33994	0.2/0.4	0.1	9.5	0.03	Mk I
	44338	0.2/0.4	0.1	9.5	0.03	Mk II
99A-Guo	38093 33643 38356	0.2/0.4	0.1	6	.5*Haasz	
99B-Guo		0.5	0.2		0.5*Mech	n_{SEP} = 0.3-1.5 10^{19} m^{-3}, flux space
99A-Maggi		1.5	0.1	0	.02	H/D/T
99B-Maggi		1.5	0.1	0		
99A-Matthews		2.5	0.4	0		Partially detached
		0.2	0.05	0		Inter-ELM
99B-Matthews	42529					
99-Saibene	39609 39611					ELMs
99-Stamp	40000	0.2/0.4	0.1	4.5	0.3*Haasz	
99-Taroni	39609 39611	Determined by JETTO		5	0.04	
00-Chankin		1	0.2- 0.1	6-3		
00-Guo	40000 40346	0.5	0.2		0.5*Haasz	Mk-I, Mk-IIA, Mk-IIGB, 300°C/400°C targets
00-Maggi	34859	1.5	0.1/0.1		1*Haasz	
01-Chankin		0.5	0.1	3 – 0.5		Constant in magnetic flux space, n_{SEP}=1.2 10^{19}
01-Fundamenski		1	0.15			Ohmic
02-Matthews		0.5	0.2			
03-Parail	53186 53299 52739 53298					
04-Erents	56725	= 2D	0.5-1.5**		Haasz	
04-Fundamenski	50415	= D	0.1-1	0		
04-Kallenbach		Step-like coefficients			0.5*Haasz	
04-Rapp	53318					Time evolving ELMs
04A-Strachan	49705	0.75	0.5/0.5	0	0.5*Haasz	Also, AUG 16300, ITER
Belo		.35	.25			
05-Coster	50401	.7	.5			Comparison to SOLPS
05A-Huber, 05B-Huber		1	0.5	0	Haasz	Includes drifts
05-Kirnev		0.5	0.5/0.5	10		PSOL=1-4.5 MW
05-Strachan	49706 59598	0.75	0.5/0.5	0	0.5*Haasz	Momentum source

Chemical sputtering: A.A. Haasz, and J.W. Davis, J. Nucl. Mater. **232**, 219 (1996) or B.V. Mech, et al, PSI (1996) ; ** indicates the coefficient was spatially varying

Table III – EDGE2D publications grouped by topic, using the notation from Table I. Within each heading, there is still a wide variety of topics covered.

TOPIC	PUBLICATIONS
CODE DEVELOPMENT	92-Radford, 92-Simonini, 92-Taroni, 94A-Simonini, 94-Weber, 96-Radford, 96-Taroni, 98A-Fichtmuller, 98-Lauro Taroni, 98-Radford
CODE VALIDATION	92-Vlases, 95-Monk, 97A-Loarte, 97-Stangeby, 01-Fundamenski, 05-Coster, 05-Bonnin
DIVERTOR DESIGN	92-Vlases, 93-Simonini, 94-Taroni, 95B-Loarte, 96-Simonini, 97-Simonini
DETACHED PLASMAS	94-Horton, 94B-Simonini, 95-Mathews, 95A-Taroni, 95B-Taroni, 97A-Loarte, 97-Monk, 05A-Huber
SOL TRANSPORT	95-Davies, 95A-Loarte, 97-Garcia-Cortes, 97A-Loarte, 97-McCormick, 05-Fundamenski
INTEGRATED MODELING	96-Taroni, 98B-Fichtmuller, 98-Taroni, 99-Fichtmuller, 99-Saibene, 99-Taroni, 03-Lonnroth, 03A-Matthews, 03-Parail, 05-Lonnroth
HYDROGENIC PROCESSES	95-McCormick, 97-Ingesson, 97B-Loarte, 97-Reichle, 98-Gill, 99-Guo, 99A-Maggi, 99B-Maggi, 99B-Matthews, 99-Saibene, 00-Maggi, 05-Pospieszczyk , 05B-Huber
IMPURITIES	97-Maggi, 97-Matthews, 97-Vlases, 98-Lauro Taroni, 99-Guo, 99A-Matthews, 99-Stamp, 00-Guo, 02-Matthews, 03-Strachan, 04-Rapp, 04A-Strachan, 04B-Strachan, 05-Strachan, 05-Belo
SOL FLOWS	94-Harbour, 97-Loarte, 97-Radford, 00-Chankin, 01-Chankin, 04-Erents, 05-Kirnev, 05-Pitts, 05-Strachan
ELMS	98-Taroni, 99-Taroni, 03-Lonnroth, 03-Parail, 04-Kallenbach, 05-Lonnroth

Table IV – EDGE2D major code changes by year

YEAR	CODE CHANGES
1993	- Implementation for non-orthogonal computational grids - Improvements to numerics: splitting techniques for impurity atomic processes, linearization of momentum sources. - Implementation of hydrogenic inventory controls. - Updating of physical sputtering models - Updating molecular processes
1994	- Implementation of impurity inventory controls and external puffing options. - Improvements to numerics: charge exchange source linearization's, exponential boundary conditions. - Implementation of elastic collisions. - Implementation of conservation checks and macro-zone output. - Inclusion of ADAS for ionisation/recombination processes. - Inclusion of Janev CX cross sections. - Creation of new post-processor for data visualisation and calculation of synthetic diagnostics
1995	- Coupled to 1.5 D core transport code JETTO for integrated modeling of pure hydrogenic plasmas. - Inclusion of drifts. - Inclusion of 21 moment model for parallel transport coefficients in trace impurity approximation. - Chemical sputtering for Carbon. - Time depdendent Nimbus.
1996	- Implementation of Reduced Charge State. - Implementation of 21 moment model for parallel transport with arbitrary impurity density. - Implementation of more than one impurity species. - Time dependent options for integrated core-edge modelling.

Table IV – Continuation of EDGE2D major code changes by year

YEAR	CODE CHANGES
1997	- Couple EDGE2D/JETTO to 1-D impurity core transport code SANCO for integrated modelling of impure plasmas (when used in this mode the EDGE2D/JETTO/SANCO combination was referred as COCONUT). - ELM modelling options.
1998	- Improved treatment of momentum sources due to neutrals. - Numerics : new solver option based on Krylov methods - New chemical sputtering models (Haasz 97, Roth 98)
1999	- Controls for time dependent evolution of particle inventory.
2001	- More options for prescribed radial transport coefficients including radially dependent and parametric forms. - Options for prescribed external sources. - Creation of workstation version of the catalogue, graphical post-processing facilities and calculation of synthetic diagnostics.
2002	- Model based parametric forms for radial transport coefficients.
2003	- Introduction of simple heat flux limiter options - Introduction of optional poloidal dependencies in prescribed power input and perpendicular transport models.
2004	- Additional GradB and curvature force related drift terms added. - Spatially dependent ELMS transport model.

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