

CONTENTS

Preface	v
SPECIAL INVITED PRESENTATIONS	1
ECE: The Story so Far <i>A. Costley</i>	3
Planning, Construction and Operation Experience of the ASDEX Upgrade ECRH System <i>F. Leuterer, AUG-ECRH Team</i>	22
Electron Cyclotron Maser Emission from Astrophysical and Space Plasmas <i>D.B. Melrose</i>	32
CHAPTER 1: ELECTRON CYCLOTRON HEATING	43
Summary of ECRH Experiments <i>J. Lohr</i>	44
ECRH and ECCD in Next-Generation Fusion Devices <i>H. Zohm</i>	47
Plasma Initiation and Startup Studies in the DIII-D Tokamak with Second Harmonic Electron Cyclotron Assist <i>G.L. Jackson, M.E. Austin, J.S. deGrassie, A.W. Hyatt, J. Lohr, T.C. Luce, R. Prater, W.P. West</i>	57
EBW Assisted Plasma Current Startup in MAST <i>V. Shevchenko, A. Saveliev</i>	68
Real Time Control of the Sawtooth Period on Tore Supra Using Variable ECCD Injection Angles <i>M. Lennholm, L.-G. Eriksson, F. Turco, F. Bouquey, C. Darbos, R. Dumont, G. Giruzzi, R. Lambert, R. Magne, D. Molina, P. Moreau, F. Rimini, J.-L. Ségui, S. Song, E. Traisnel</i>	74

Experiment and Modelling of ITB Phenomena with ECCD on Tore Supra	81
<i>F. Turco, G. Giruzzi, J.-F. Artaud, G. Huysmans, F. Imbeaux, P. Maget, D. Mazon, J.-L. Ségui</i>	
Stabilization of Neoclassical Tearing Modes in Tokamaks by Electron Cyclotron Current Drive	87
<i>R.J. La Haye</i>	
Utilization on Electron Bernstein Wave Heating and Current Drive for Tokamak Startup and Advanced Operations	96
<i>H. Tanaka, T. Maekawa, M. Uchida, S. Nishi, H. Igami, S. Kubo, T. Shimosuma, Y. Yoshimura, H. Takahashi, J. Miyazawa, T. Mutoh, A. Komori, T. Yoshinaga, S. Inagaki, K. Nagasaki, T. Notake, LHD Experimental Group</i>	
ECRH Experiments on Tearing Mode Physics at TEXTOR	104
<i>E. Westerhof, G.W. Spakman, M.R. de Baar, I.G.J. Classen, A.J.H. Donné, G.M.D. Hogeweij, R.J.E. Jaspers, D. de Lazzari, F.C. Schüller, C. Domier, N.C. Luhmann Jr, A. Krämer-Flecken, Y. Liang, A. Lazaros, H.K. Park, TEXTOR Team</i>	
Recent ECCD Experiments in the TJ-II Stellarator	112
<i>A. Fernández, A. Cappa, J.M. Fontdecaba, F. Castejón, K. Nagasaki</i>	
Electron Bernstein Wave Heating Experiment on the Madison Symmetric Torus	118
<i>J.K. Anderson, W.A. Cox, C.B. Forest</i>	
ECRH as a Tool for Disruption Control on FTU	124
<i>G. Granucci, S. Nowak, B. Esposito, P. Smeulders, L. Gabellieri, J.R. Martin-Solis</i>	
ECCD Experiments in Stellarator/Heliotron	130
<i>K. Nagasaki, G. Motojima, A. Fernandez, A. Cappa, J.-M. Fontdecaba, Y. Yoshimura, T. Notake, S. Kubo, T. Shimosuma, H. Igami, K. Ida, M. Yoshinuma, T. Kobuchi, TJ-II Team, CHS Team, LHD Team</i>	

Space Structure Analysis of the Large Scale $m/n=1/1$ Plasma Oscillations by Means of X- and O-ECE Under ECH at T-10 Tokamak	136
<i>V.I. Poznyak, V.V. Piterisky, G.N. Ploskirev, E.G. Ploskirev, O. Valensia</i>	
Electron Cyclotron Resonance Heating Assisted Plasma Startup in the Tore Supra Tokamak	143
<i>J. Bucalossi, P. Hertout, M. Lennholm, F. Saint-Laurent, F. Bouquay, C. Darbos, and E. Traisnel</i>	
Experiments With Electron Bernstein Waves at the WEGA Stellarator	149
<i>H.P. Laqua, D. Andruczyk, S. Marsen, M. Otte, Y.Y. Podoba, G.B. Warr, J. Preinhealter, J. Urban</i>	
CHAPTER 2: ELECTRON CYCLOTRON EMISSION	155
Electron Bernstein Wave Emission Studies on the TJ-II Stellarator	157
<i>J.B.O. Caughman, A. Fernández, A. Cappa, F. Castejón, D.A. Rasmussen, J.B. Wilgen</i>	
First Results of the TEXTOR Line of Sight ECE System for ECRH Feedback	163
<i>J.W. Oosterbeek, A. Bürger, J.A. Hoekzema, E. Westerhof, M. de Baar, M.A. Van Den Berg, W.A. Bongers, M.F. Graswinckel, B.A. Hennen, O.G. Kruijt, B. Lamers, D.J. Thoen, B.C.E. Vaessen, P.M. Wortman, R. Heidinger, S.B. Korsholm, F. Leipold, S.K. Nielsen, TEXTOR Team</i>	
ITER ECE: Plans and Challenges	170
<i>M.E. Austin, P.E. Phillips, W.L. Rowan, J. Beno, H-P Liu, A. Ouroua, R.F. Ellis, R.W. Harvey, A.E. Hubbard, G. Taylor, D.W. Johnson</i>	
Measurements of Electron Temperature and Density Fluctuations and Comparison to Gyrokinetic Simulations	178
<i>A.E. White, L. Schmitz, W.A. Peebles, T.A. Carter, E.J. Doyle, T.L. Rhodes, G. Wang, G.R. McKee, M.W. Shafer, C. Holland, G.R. Tynan, M.E. Austin, K.H. Burrell, J. Candy, J.C. DeBoo, R. Prater, G.M. Staebler, R.E. Waltz, M.A. Makowski</i>	

A Spinning Mirror for Fast Angular Scans of EBW Emission <i>F. Volpe, J. Storrs, V. Shevchenko</i>	184
Results and Prospects for Oblique ECE Measurements <i>C. Sozzi, D. Farina, L. Figini, S. Gavarravaglia, G. Grossetti, S. Nowak, P. Platania, A. Simonetto, E. de la Luna, J. Fessey, M. Zerbini, JET-EFDA Contributors</i>	190
Recent Results on the Discrepancy Between Electron Temperature Measurements in High Temperature Plasmas in JET <i>E. de la Luna, D. Farina, L. Figini, G. Grossetti, S. Nowak, C. Sozzi, M. Beurskens, O. Ford, T. Johnson, JET-EFDA Contributors</i>	200
Absolute Calibration of ECE Diagnostic: A Full Review <i>M. Zerbini, C. Sozzi, A. Simonetto</i>	208
Comparison of Inboard and Outboard Electron Temperature Measurements During Type I ELM Regimes in JET Using ECE Diagnostics <i>L. Barrera, E. de la Luna, F. Castejón, L. Figinni, D. Farina, JET-EFDA Contributors</i>	214
Correlation ECE Diagnostic on Tore Supra to Study MHD Instabilities Related to Fast Particle Dynamics <i>D. Elbèze, J.L. Ségui, A. Macor, D. Molina, M. Goniche, V.S. Udintsev</i>	220
Investigation of EBW Thermal Emission and Mode Conversion Physics in H-mode Plasmas on NSTX <i>S.J. Diem, G. Taylor, P.C. Efthimion, H.W. Kugel, B.P. Leblanc, C.K. Phillips, J.B. Caughman, J.B. Wilgen, R.W. Harvey, J. Preinhaelter, J. Urban, S.A. Sabbagh</i>	226
Electron Bernstein Wave Emission Studies on the TJ-II Stellarator <i>J.B.O. Caughman, D.A. Rasmussen, J.B. Wilgen, A. Fernández, A. Cappa, F. Castejón</i>	232
Upgrades and Real Time NTM Control Application of the ECE Radiometer on ASDEX Upgrade <i>N.K. Hicks, W. Suttrop, K. Behler, L. Giannone, A. Manini, M. Maraschek, G. Raupp, M. Reich, A.C.C. Sips, J. Stober, W. Treutterer, ASDEX Upgrade Team</i>	238

Advanced Views in Far Infrared Spectroscopy Applications for ECE Measurements	245
<i>M. Zerbini, E. Franconi</i>	
Status and Plans for the TEXTOR ECE Imaging System	250
<i>C.W. Domier, P. Zhang, X. Kong, B. Tobias, N.C. Luhmann, Jr, R. Jaspers, M.J. Van de Pol, A.J.H. Donné, H.K. Park</i>	
Application of X- and O-ECE for Electron Distribution Function Analysis under OH and ECH in T-10 Tokamak Plasma	256
<i>V.I. Poznyak, V.V. Piterisky, G.N. Ploskirev, E.G. Ploskirev</i>	
Evaluation of ECE Spectra in a Tokamak with Torus Geometry and Application to Electron Temperature Measurement	263
<i>M. Sato, A. Isayama</i>	
New Advances of the Plasma Visualization System for KSTAR	270
<i>T. Liang, Z. Shen, X. Kong, C.W. Domier, N.C. Luhmann, Jr, H.K. Park</i>	
CHAPTER 3: ELECTRON CYCLOTRON THEORY	277
Summary of the Theory Presentations at EC-15	279
<i>N.B. Marushchenko</i>	
A New Method for Modeling Microwave Beams in Toroidal Plasmas	283
<i>A.N. Saveliev</i>	
Summary of EBW Theoretical Calculations in the TJ-II Stellarator	289
<i>A. Cappa, F. Castejón, D.Lopez-Bruna, A. Fernández, M. Tereshchenko, E. Holzhauer, A. Kohn, S.S. Palov</i>	
Current Drive Calculations with an Advanced Adjoint Approach	295
<i>N.B. Marushchenko, C.D. Beidler, H. Maassberg</i>	
General Linear RF-Current Drive Calculation in Toroidal Plasma	301
<i>A.P. Smirnov, R.W. Harvey, R. Prater</i>	
Integrated Modelling of ITER Hybrid Scenarios with ECCD	307
<i>G. Giruzzi, J.F. Artaud, V. Basiuk, J. Garcia, F. Imbeaux, M. Schneider</i>	

Importance of the ECH/ECCD System to Sustain an Internal Transport Barrier in ITER	313
<i>J. Garcia, G. Giruzzi, J.F. Artaud, V. Basiuk, J. Decker, F. Imbeaux, Y. Peysson, M. Schneider</i>	
Relativistic Propagation and Damping of Electron Cyclotron Waves in Toroidal Plasmas	319
<i>A.K. Ram, J. Decker</i>	
Linear Coupling of Electron Cyclotron Waves in Magnetized Plasmas: Beyond the Range of One-Dimensional Theory	325
<i>A. Shalashov</i>	
Effect of Particle Transport on the Measured Electron Cyclotron Current Drive Profile	336
<i>C.C. Petty, J. Lohr, T.C. Luce, R. Prater, R.W. Harvey, A.P. Smirnov, M.E. Austin, M.A. Makowski</i>	
Recent Progress in Electron Cyclotron Radiative Transport Modelling of Fusion Plasmas in View of ITER and DEMO Applications	345
<i>F. Albajar, M. Bornatici, F. Engelmann</i>	
Electron Cyclotron Over Dense Plasma Heating Modeling with Full Wave Code in Spherical Tokamaks	355
<i>V. Vdovin</i>	
Benchmarking of Codes for Calculating Local Net EC Power Losses in Fusion Plasmas	363
<i>F. Albajar, M. Bornatici, F. Engelmann, A.B. Kukushkin</i>	
Predictions of Electron Cyclotron Current Drive and Heating in ITER	369
<i>R.V. Budny, C.E. Kessel, K. Indireskumar</i>	
Kinetic Effects and Outward Particle Flux Induced by ECRH in the TJ-II Stellarator	376
<i>F. Castejón, S. Eguilior, E. de la Luna, M.A. Ochando, F. Medina, D. López-Bruna, I. Calvo, A. Melnikov, L.G. Eliseev, L. Krupnik</i>	
Quasi-Optical Calculations of ECRH Power Deposition	383
<i>A.A. Balakin, M.A. Balakina, E. Westerhof</i>	

Modeling of EBW Heating in the HSX Stellarator <i>K.M. Likin</i>	391
Electron Cyclotron Current Drive in ITER <i>D. Farina, G. Ramponi</i>	397
Linear Estimation of Electron Bernstein Current Drive <i>J.M. García-Regaña, F. Castejón</i>	403
CHAPTER 4: TECHNOLOGY/GYROTRONS	409
Summary of Technology for Electron Cyclotron Heating and Current Drive <i>K. Sakamoto</i>	410
Review of the European Programme for the Development of the Gyrotron for ITER <i>F. Albajar, T. Bonicelli, G. Saibene, S. Alberti, D. Fasel, T. Goodman, J.-P. Hogge, I. Pagonakis, L. Porte, M.Q. Tran, K. Avramides, J. Vomvoridis, R. Claesen, M. Santinelli, O. Dumbrajs, G. Gantenbein, S. Kern, S. Illy, J. Jin, B. Piosczyk, T. Rzesnicki, M. Thumm, M. Henderson, S. Cirant, G. Latsas, I. Tigelis</i>	415
Progress in Increasing Gyrotron Output Power Beyond 1 MW <i>K. Felch, M. Blank, P. Borchard, P. Cahalan, S. Cauffman, H. Jory</i>	422
The 10 MW, CW, ECRH-plant for W7-X: Status and High Power Performance <i>V. Erckmann, H. Braune, H.P. Laqua, N.B. Marushchenko, G. Michel, Y. Turkin, M. Weissgerber, G. Gantenbein, M. Thumm, P. Brand, W. Kasperek, C. Lechte, W7-XS ECRH Teams</i>	427
On the Way to a Multi-Frequency ECRH System for ASDEX Upgrade <i>J. Stober, Th. Franke, G. Grünwald, F. Leuterer, A. Manini, F. Monaco, M. Münich, R. Neu, H. Schutz, D. Wagner, H. Zohm, G. Gantenbein, R. Heidinger, A. Meier, M. Thumm, W. Kasperek, C. Lechte, A.V. Chirkov, G.G. Denisov, A.Litvak, S.A. Malugin, V.E. Myasnikov, V.O. Nichiporenko, L.G. Popov, E.A. Solyanova, E.M. Tai, F. Meo, P. Woskov</i>	433

Calculation of the RF Propagation for the ITER Equatorial ECH/ECCD Launcher	440
<i>K. Kajiwara, K. Takahashi, N. Kobayashi, A. Kasugai, K. Sakamoto</i>	
ECH System on the DIII-D Tokamak	446
<i>I.A. Gorelov, J. Lohr, M. Cengher, D. Ponce</i>	
High-Power Test of a Fast Switch and Combiner for Millimetre Wave Beams	452
<i>V. Erckmann, W. Kasperek, M. Petelin, D. Shchegolkov, ECRH Groups</i>	
A Revised ITER EC System Baseline Design Proposal	458
<i>M.A. Henderson, B. Beckett, C. Darbos, N. Kobayashi, G. Saibene, F. Albajar, T. Bonicelli, S. Alberti, R. Chavan, D. Fasel, T.P. Goodman, I.Gr. Pagonakis, O. Sauter, S. Cirant, D. Farina, G. Ramponi, R. Heidinger, B. Piosczyk, M. Thumm, S.L. Rao, K. Kajiwara, K. Sakamoto, K. Takahashi, G. Denisov, T. Bigelow, D. Rasmussen</i>	
Progress on the ITER Upper Launcher Millimeter Wave Design and Testing	465
<i>A. Collazos, V.S. Udintsev, R. Chavan, F. Felici, F. Dolizy, M.A. Henderson, H. Shidara</i>	
Hybrid Transmission Lines for ECRH in the HSX Stellarator	471
<i>J.W. Radder, K.M. Likin, F.S.B. Anderson, D.T. Anderson</i>	
A Four-Frequency Mode Converter with Small Output Angle Variation for a Step-Tunable Gyrotron	477
<i>S. Liao, R.J. Vernon, J. Neilson</i>	
Measurements of the ECH Power and of the Transmission Line Losses on DIII-D	483
<i>M. Cengher, J. Lohr, I.A. Gorelov, W.H. Grosnickle, D. Ponce, P. Johnson</i>	
Effect of the Shielding Block Structure on Beam Propagation for the ITER ECRH&CD Upper Launcher	490
<i>P. Platania, C. Sozzi, M.A. Henderson</i>	

Commissioning of 84 GHz KSTAR ECH Transmission Line System <i>Y.S. Bae, W.-S. Han, H.-L. Yang, S. Park, J.-H. Jeong, W. Namkung, M.-H. Cho</i>	496
Design Aspects and RF Characterization of ITER-RF-CVD-Diamond Windows <i>T.A. Scherer, R. Heidinger, A. Meier, K. Sakamoto, K. Takahashi, K. Kajiwara, M. Henderson, R. Chavan</i>	502
Modeling Results for Proposed NSTX 28 GHz ECH/EBWH System <i>G. Taylor, S.J. Diem, R.A. Ellis, E. Fredd, N. Greenough, J.C. Hosea, T.S. Bigelow, J.B. Caughman, D.A. Rasmussen, P. Ryan, J.B. Wilgen, R.W. Harvey, A.P. Smirnov, J. Preinhaelter, J. Urban, A.K. Ram</i>	509
First Experimental Results from the EU 2 MW Coaxial Cavity ITER Gyrotron Prototype <i>T.P. Goodman, S. Alberti, E. Droz, D. Fasel, J.P. Hogge, S. Jawla, L. Porte, U. Siravo, M.Q. Tran, F. Albajar, T. Bonicelli, P. Benin, S. Bethuys, C. Lievin, S. Cirant, O. Dumbrajs, G. Gantenbein, S. Illy, J. Jin, S. Kern, B. Piosczyk, T. Rzesnicki, M. Thumm</i>	515
Status of Experiments on the EU 2 MW Coaxial Cavity ITER Gyrotron Pre-Prototype at FZK <i>S. Kern, J. Flamm, G. Gantenbein, S. Illy, J. Jin, B. Piosczyk, O. Prinz, T. Rzesnicki, M. Thumm, O. Dumbrajs</i>	523
The 140 GHz 1 MW Gyrotron — Status and Recent Results <i>G. Gantenbein, G. Dammertz, S. Illy, S. Kern, W. Leonhardt, B. Piosczyk, M. Schmid, M. Thumm, H. Braune, V. Erckmann, H.P. Laqua, G. Michel, W. Kasperek, C. Lechte, F. Legrand, C. Lievin, O. Prinz</i>	529
Electromagnetic and Structural Analyses of the ECRH UPP in ITER <i>D. Strauss, R. Heidinger, P. Späh, A. Vaccaro, G. Hailfinger</i>	535
Progress on Design and Testing of Corrugated Waveguide Components Suitable for ITER ECH and CD Transmission Lines <i>R.A. Olstad, R.W. Callis, J.L. Doane, H.J. Grunloh, C.P. Moeller</i>	542

High Efficiency 170 GHz Gyrotron and mm Wave Technology in JAEA	548
<i>K. Sakamoto, K. Kajiwara, A. Kasugai, K. Takahashi, N. Kobayashi</i>	
List of Participants	553
Author Index	557