25th IAEA Fusion Energy Conference
Saint Petersburg, Russian Federation
2014-10-18

SUMMARY
Theory

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TH Statistics

✦ Type of presentation (presented papers)

Overview	1
Oral	17+2 (Rapporteured)
Poster	127+1 (Post deadline)
Total	148

✦ Topics		Oral/OV	Poster
Confinement	53	7	46
Stability	39	4	35
Wave-plasma interactions+	34	3	31
Plasma-material interactions+	22	6	16

Outline

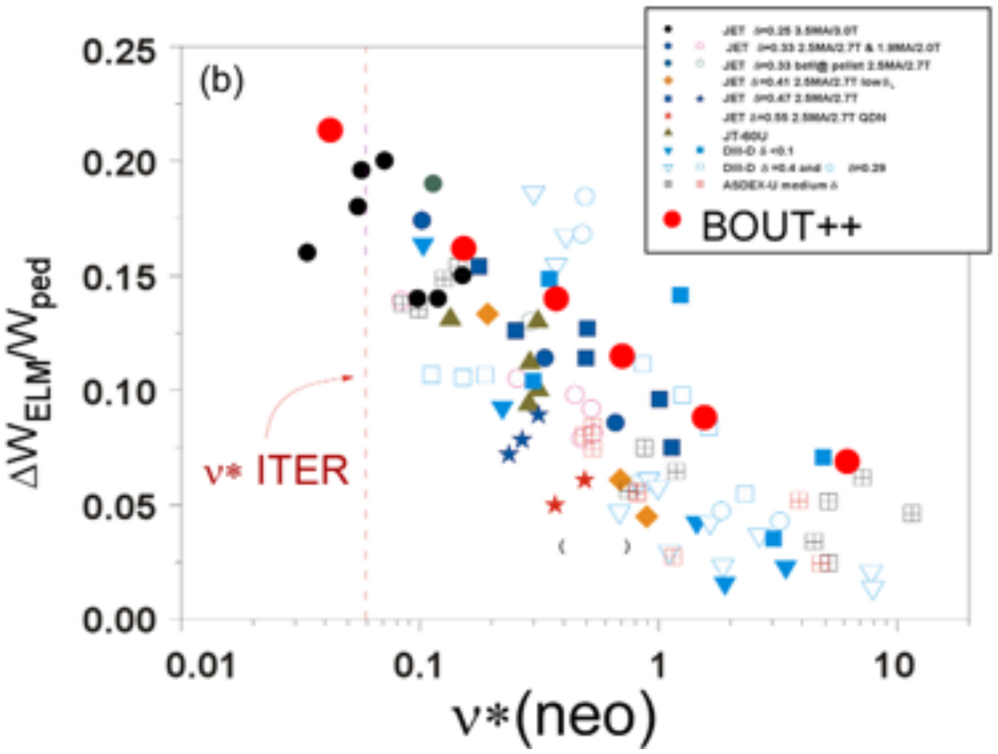
- ITER related issues
  - ELM physics and SOL transport
  - Disruption physics and runaway electrons
- Confinement
- Stability
- Energetic particles
- Heating and current drive
- Integrated modelling

ELM Physics

- **ELM Dynamics and Energy Loss Scaling**

TH/3-1Ra Xu

  - **Collisionality scaling of ELM energy loss**
    - BOUT++ results consistent with ITPA multi-tokamak DB



- **Particle and Heat Flux during ELM Bursts on EAST and DI**

TH/P2-45 Xia

  - **BOUT++ 6 field 2 fluid module**

- **Gyrokinetic Analysis of ASDEX-Upgrade Inter-ELM Profile Evolution**

PD/P5-4 Hatch

  - **GENE: rapid evolution of density and temperature profile**

- **Dynamical ELM model based on multi-scale interaction between low-n MHD ballooning mode and ETG turbulence**
  - **Self-consistent theory of hyper resistivity**

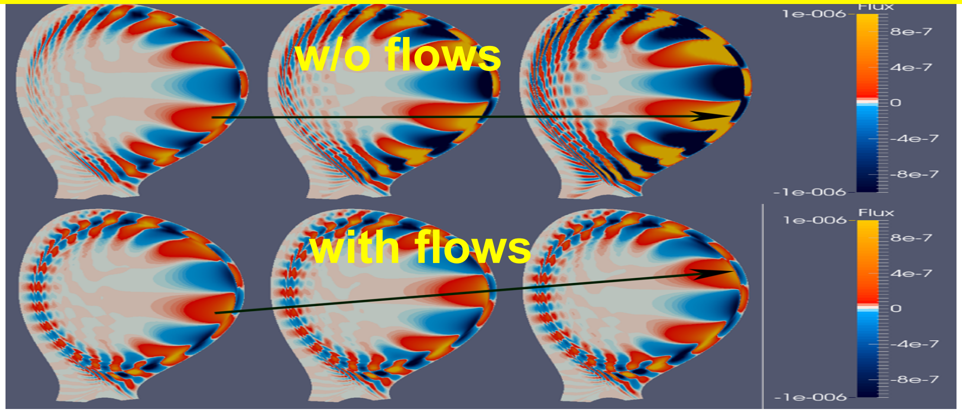
TH/P1-15 Singh

Nonlinear MHD modelling of ELMs

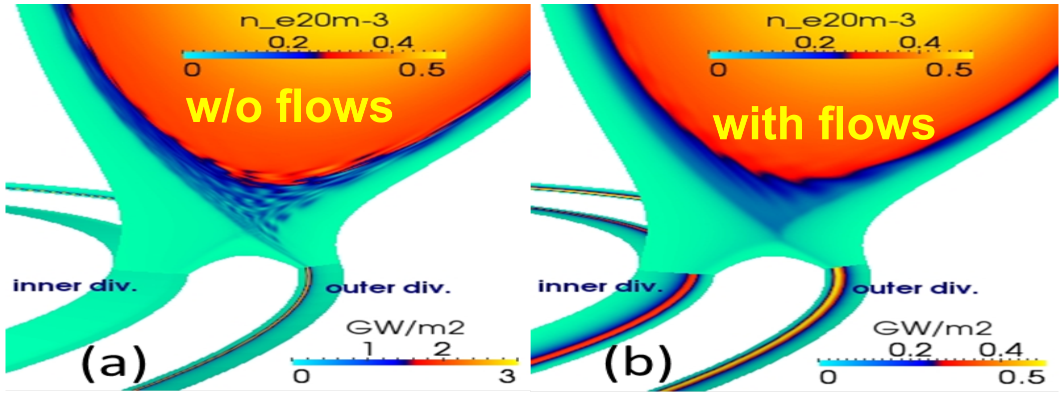
- **Nonlinear modelling of ELM and their interaction with RMP in rotating plasmas (JOREK with flow)**

TH/6-1Rb Becoulet

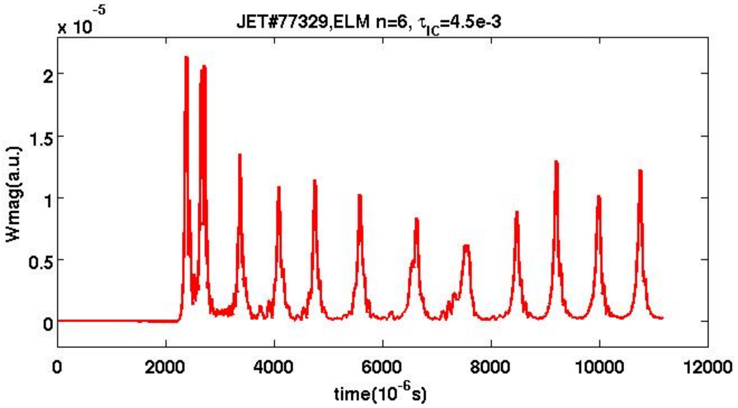
ELM precursor rotation in **ExB** (=el.dia) direction



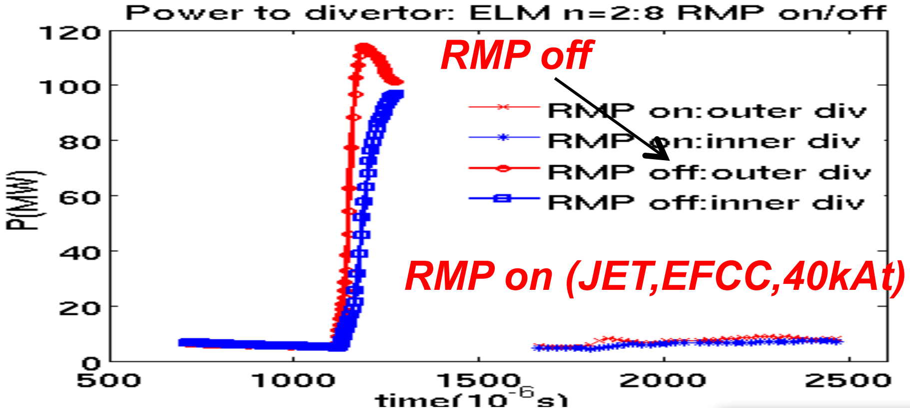
Divertor heat flux during an ELM : in/out symmetry

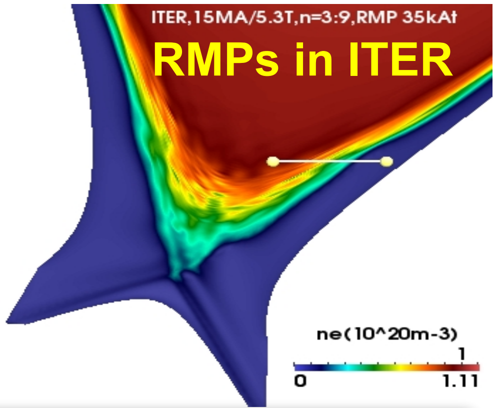


Multi-cycles ELMs with diamagnetic stabilization



Non-linear drive of edge MHD turbulence by RMPs => mitigated ELMs =>Divertor heat flux is reduced by ~10



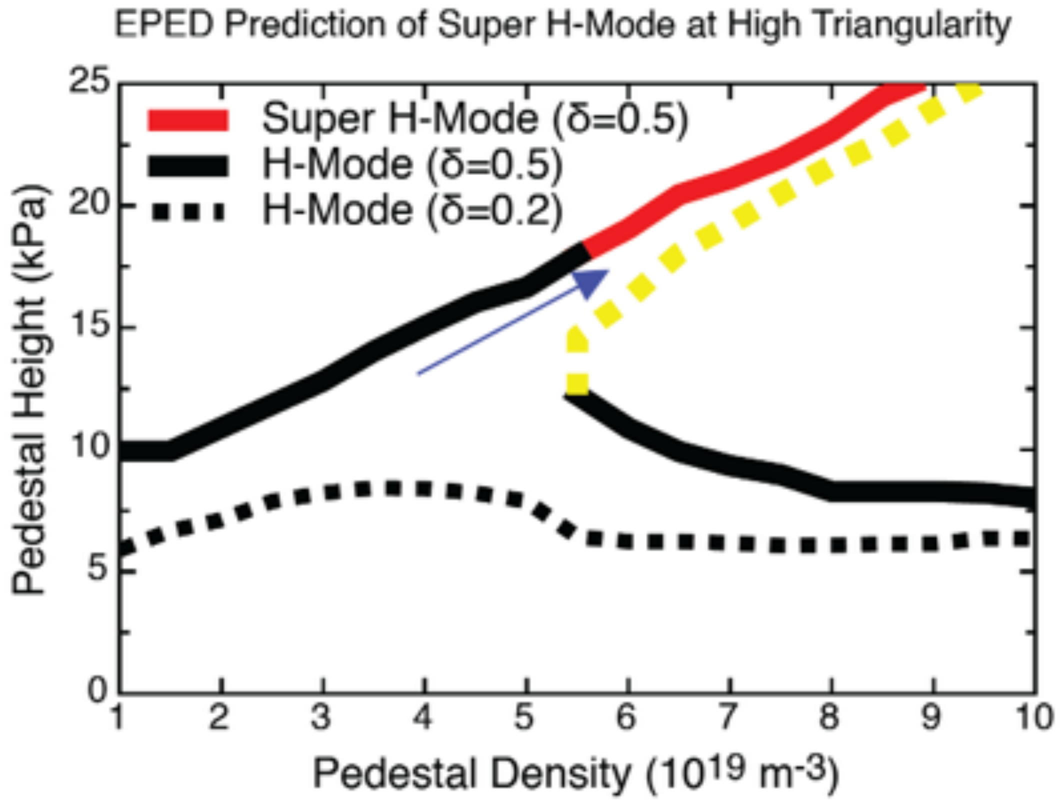


- **Nonlinear MHD simulation for ITER**
  - **ELM control**
    - pellet pacing, QH-mode
  - **SOL MHD stability**

TH/6-1Ra Huijsmans

ELM Mitigation

- ✦ Prediction and observation of “Super H-mode” TH/2-2 Snyder
  - High triangularity and high density



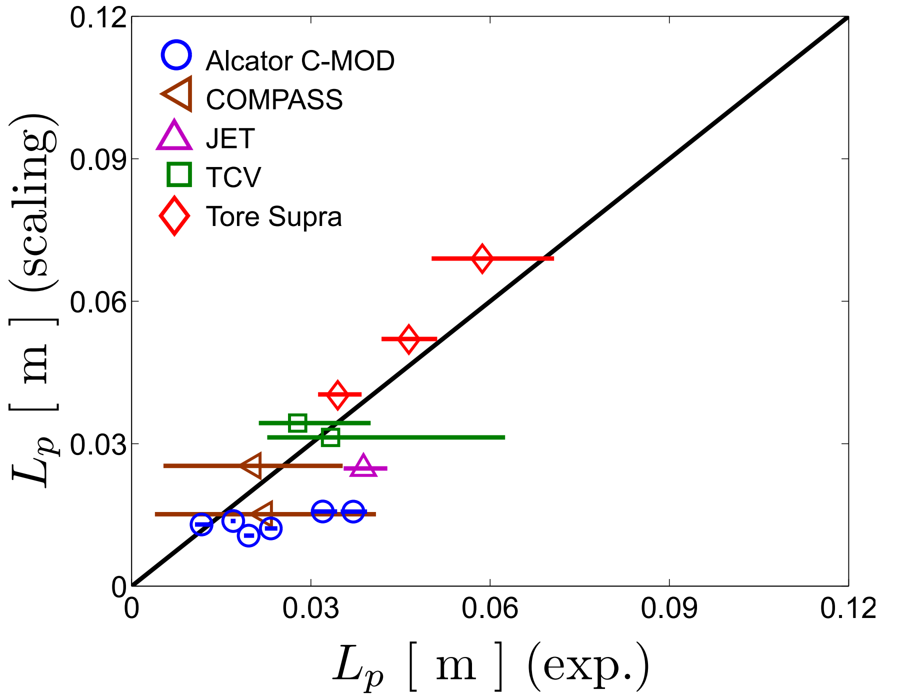
- ✦ ELM mitigation by RPM TH/P6-1 Cahyna
  - JOREK simulation and a simple analytic model
- ✦ ELM control by SMBI and Pellet Injection TH/P2-9 Rhee
  - Type-I ELM is reproduced in the sandpile model
- ✦ ELM pacing with periodic plasma column displacement
  - ELM trigger by vertical and radila jog TH/P2-2 Aydemir

SOL Physics

- **Gyrokinetic study of divertor heat-load width λ_q** TH/2-3 Chang
  - **XGC1: gyrokinetic PIC code**
    - In the present-day tokamak, λ_q is proportional to $1/I_p$
    - In ITER, this neoclassical estimate may fail due to blob size
- **Scaling of the SOL width in limited tokamak plasmas**
  - **GBS: drift-reduced Braginskii equations** TH/3-2 Ricci
  - **Scaling of SOL width**

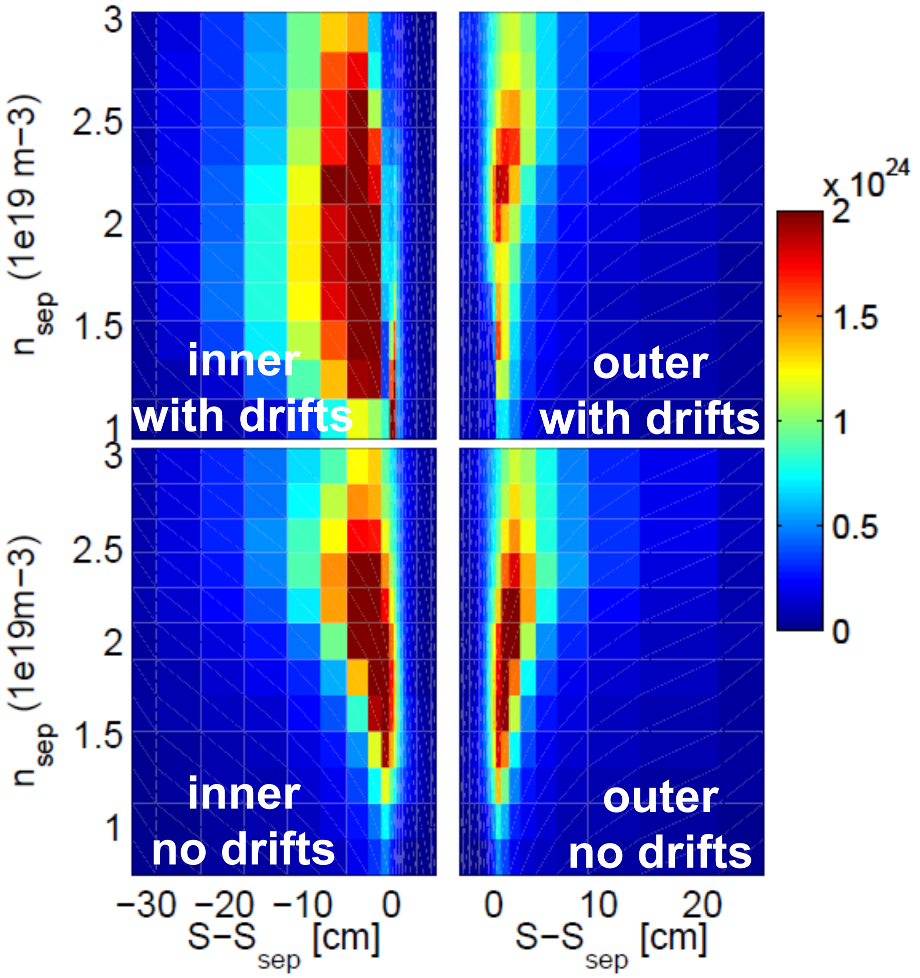
$$L_p \simeq 7.22 \times 10^{-8} q^{8/7} R^{5/7} B_\phi^{-4/7} T_{e,\mathrm{LCFS}}^{-2/7} n_{e,\mathrm{LCFS}}^{2/7} \left(1 + \frac{T_{i,\mathrm{LCFS}}}{T_{e,\mathrm{LCFS}}}\right)^{1/7}$$

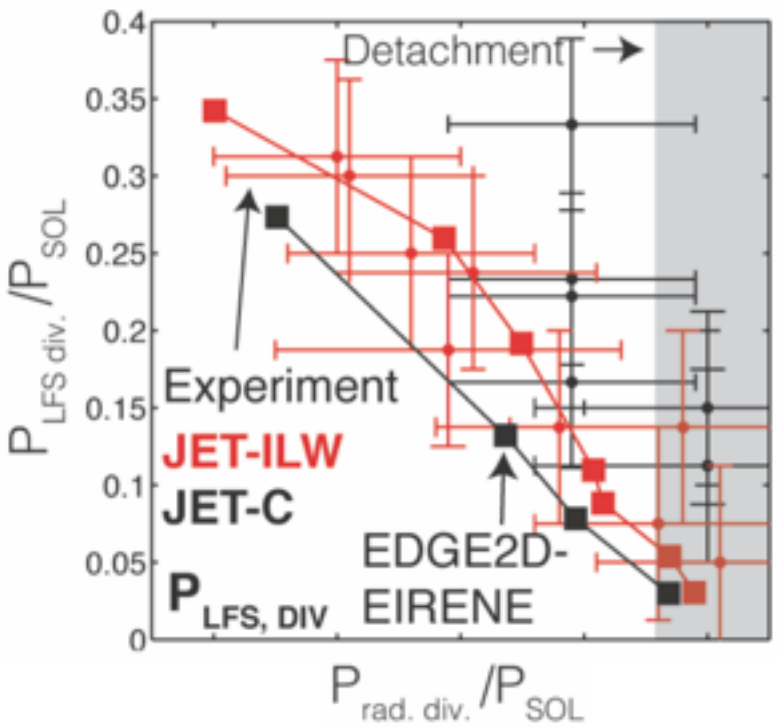
  - **Agreement with multi-machine DB**



SOL Physics with Fluid Model

- ✦ **SOL simulations with Drifts**
  - – **SOLPS5.0** TH/3-3 Aho-Mantia
    - Drift leads to asymmetric particle and power fluxes
    - ASDEX-U, JET-ILW
- ✦ **Numerical modeling for divertor design** TH/P5-50 Bufferand
  - – **SOLEDGE2D**
    - Tore Supra - WEST
- ✦ **Detachment assisted by nitrogen**
  - – **EDGE2D** TH/P5-34 Järvinen
    - N_2 seeded H-mode plasmas in JET-C and JET-ILW
    - LFS detachment when 1/2 of the SOL power is radiated in the divertor



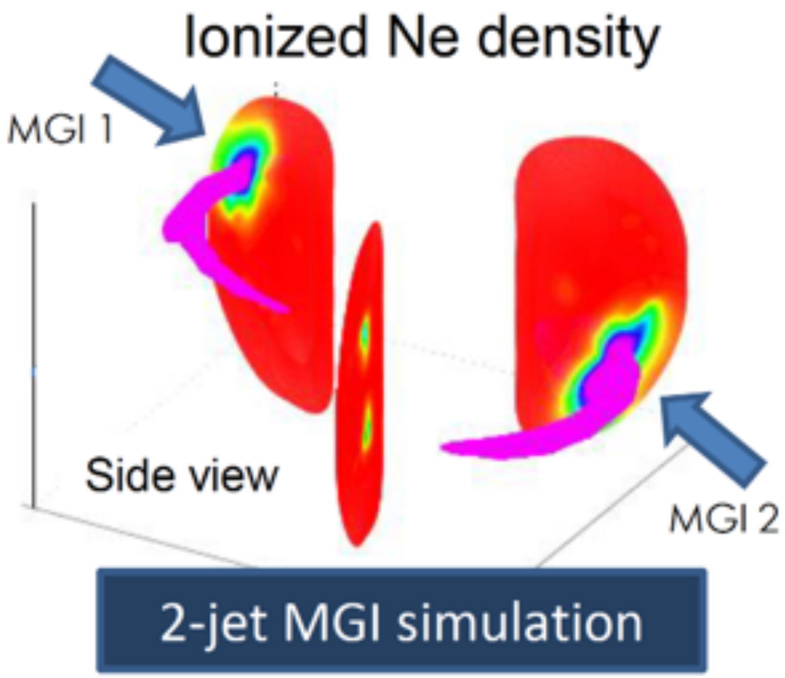


Disruption Mitigation

- **2-Jet Massive Gas Injection on DIII-D**

TH/4-1 Izzo

  - **NIMROD predicts**
    - Relative location of 2 gas jets with respect to field line pitch affects toroidal radiation asymmetry
    - No unacceptably high peaking factors for DIII-D or ITER



2-jet MGI simulation

- **Integrated Modelling of ITER Disruption Mitigation**

TH/P3-31 Konovalov

  - **DINA-ASTRA-ZIMPUR simulation confirms**
    - Mitigated disruption scenarios in ITER
    - The use of Ne is preferable to Ar providing longer current quench time

TH/P3-35 Leonov

  - **ASTRA-ZIMPUR simulations demonstrated that**
    - radiating impurity dynamics plays the dominant role in the pre thermal quench stage in MGI scenarios

Runaway Electrons

- ✦ **Kinetic modelling of runaway electrons (RE) and their mitigation in ITER**

  TH/P3-38 Aleynikov

  - **Self-consistent modelling**
    - 2D Fokker-Planck equation
    - Toroidal electric field evolution in 1D transport code
    - Scattering on high-Z nuclei, collisional friction force, synchrotron radiation, and knock-on source term
    - Ar gas densities required for successful RE mitigations are within the limitation of envisioned ITER DMS
- ✦ **Formation and termination of RE in disruptions and implications for ITER**

  TH/P3-43 Martín

  - **0D modelling of RE with Ar and Ne injection**
- ✦ **Monte-Carlo simulation on energy-dependence of RE loss induced by low-n MHD instabilities**

  TH/P5-13 Matsuyama

    - Near the stochastic threshold, drift resonance characterises the energy dependence of the RE orbit

Nonlinear GK simulation codes

- GLOBAL f(continuum)

GYSELA	EU	ES, momentum transport	TH/P4-4 Sarazin
GKNET	JP	ES, intermittent burst	TH/P5-8 Imadera

- Flux tube/surface f(continuum)

GKV	JP	EM, Helical	TH/1-1 Maeyama
GENE	EU	EM, RFP/Helical	OV/5-1 Terry
GYRO	US	ES	EX/2-3 Ernst
GS2	US	ES	EX/2-3 Ernst

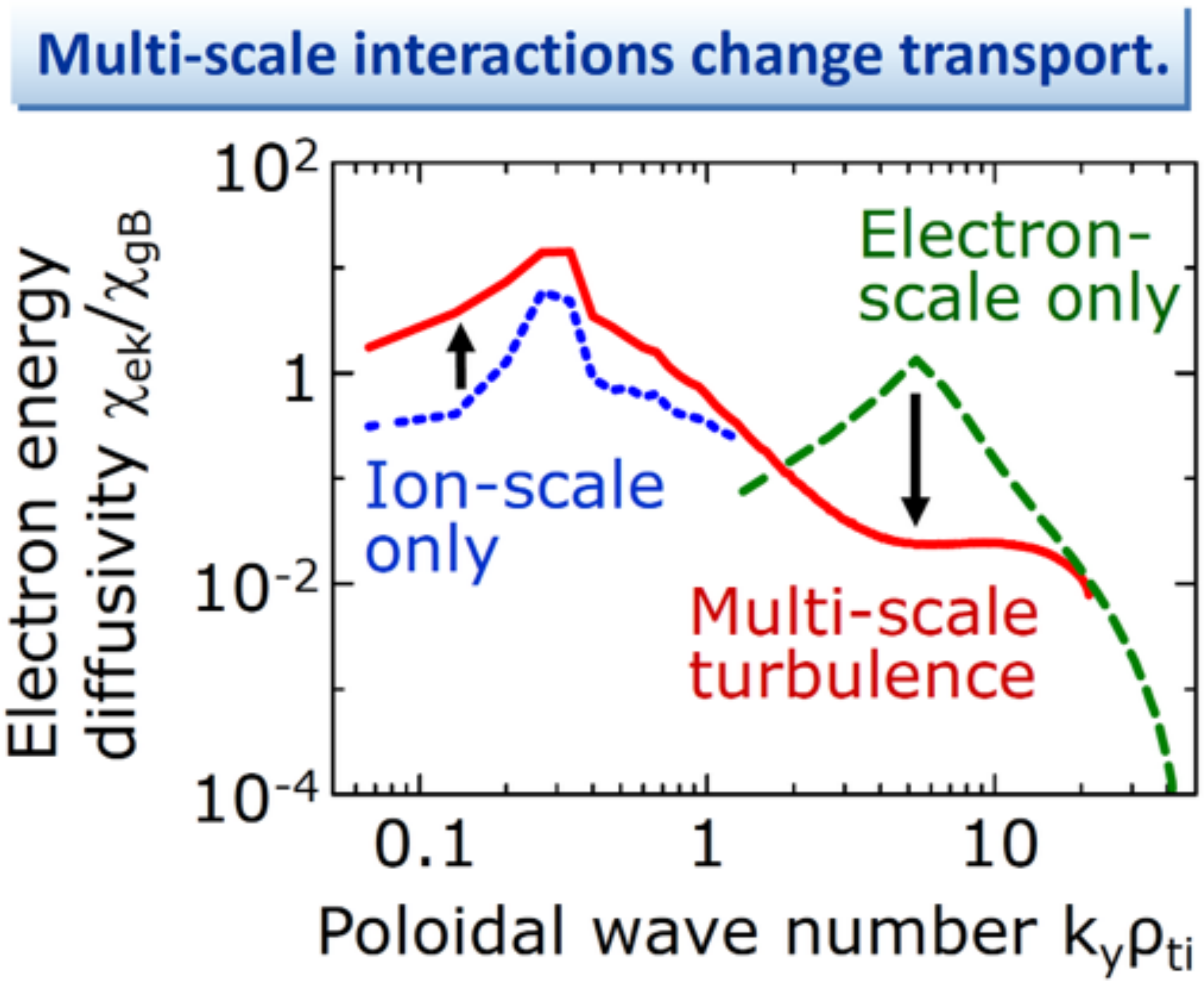
- Particle-in-cell

GTC	US	EM, Alfvén Eigenmode	TH/7-2 Lin
XGC1	US	EM, X-point transport	TH/2-3 Parker
ELMFIRE	EU	EM, full-f	TH/P5–6 Kiviniemi

Turbulent Transport (Tokamak)

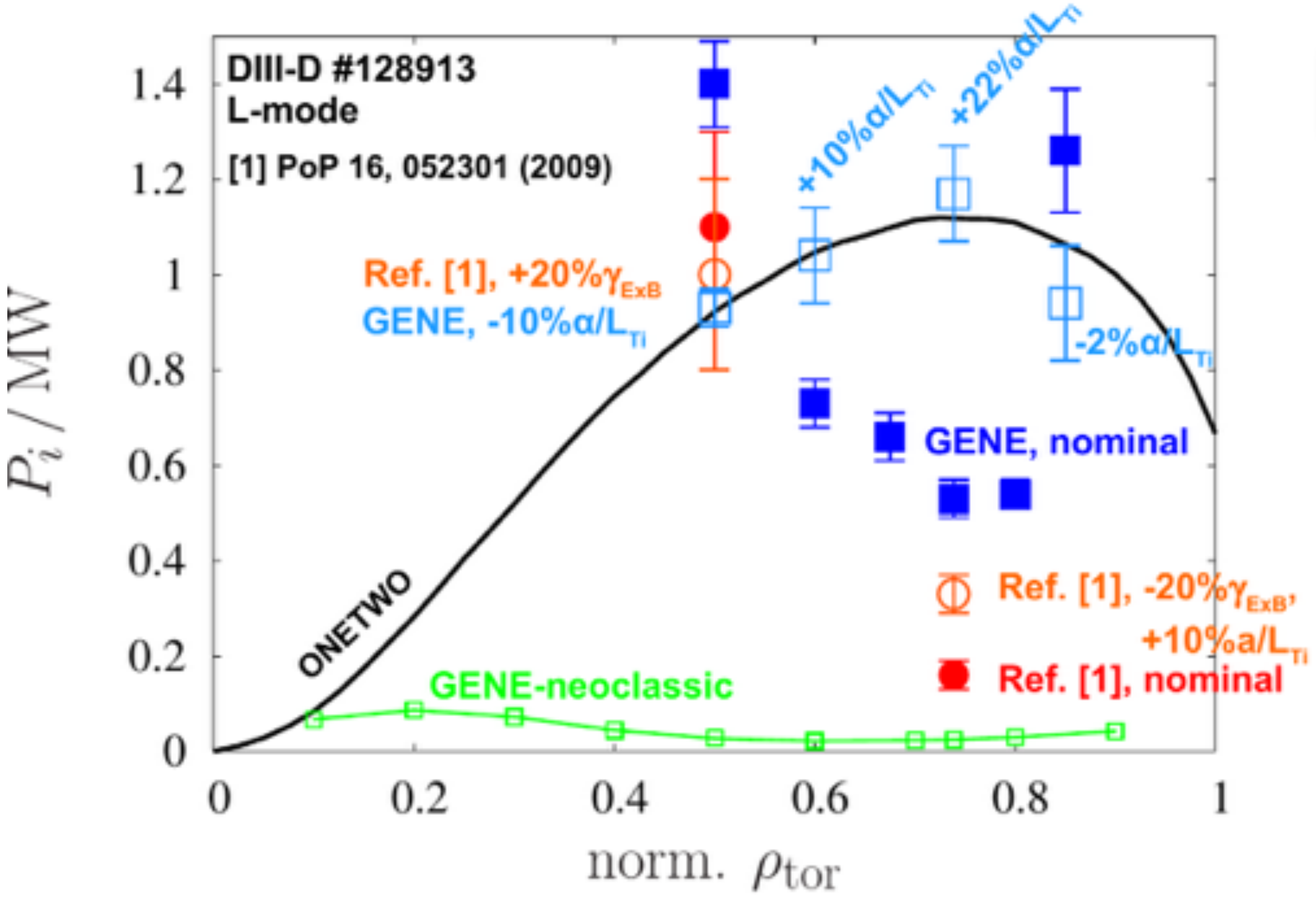
TH/1-1 Maeyama

- ✦ Multi-scale ITG/TEM/ETG Turbulence
- ✦ Simulations with Real Mass Ratio and β value
  - Shearing of ITG/TEMs suppresses ETG/Streamers
  - ETG/Streamers enhance ion-scale transport via ZF damping
  - GKV:



Turbulent Transport (Tokamak)

- **“Transport shortfall”**
  - **Discrepancy of ion heat transport in outer core L-mode discharge of DIII-D** [Holland PoP 2009]



TH/P2-7 Jenko

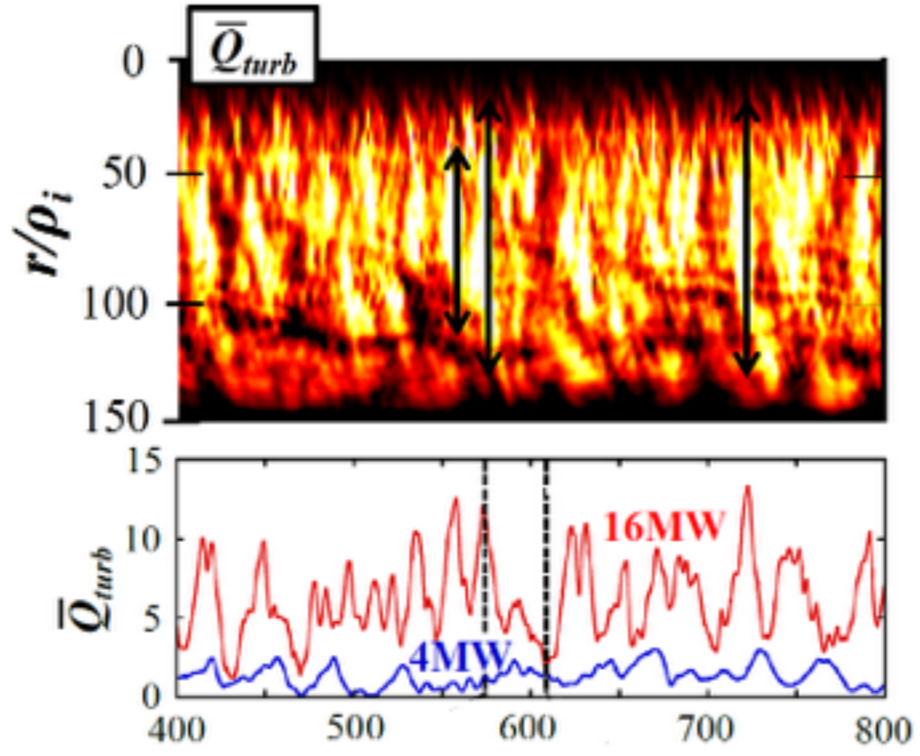
Görler et al., submitted to Phys. Plasmas

- **No shortfall**
  - **GENE: within the error bars of the density profile**
  - **XGC1: with full edge model**

TH/P2-7 Jenko

TH/2-3 Parker

Turbulent Transport (Tokamak)



- ✦ **Global profile relaxation by intermittent bursts with long correlation lengths by Imadera**

TH/P5-8 Imadera

- ✦ **Understanding of momentum transport**
  - **by GYSELA and NEMORB**

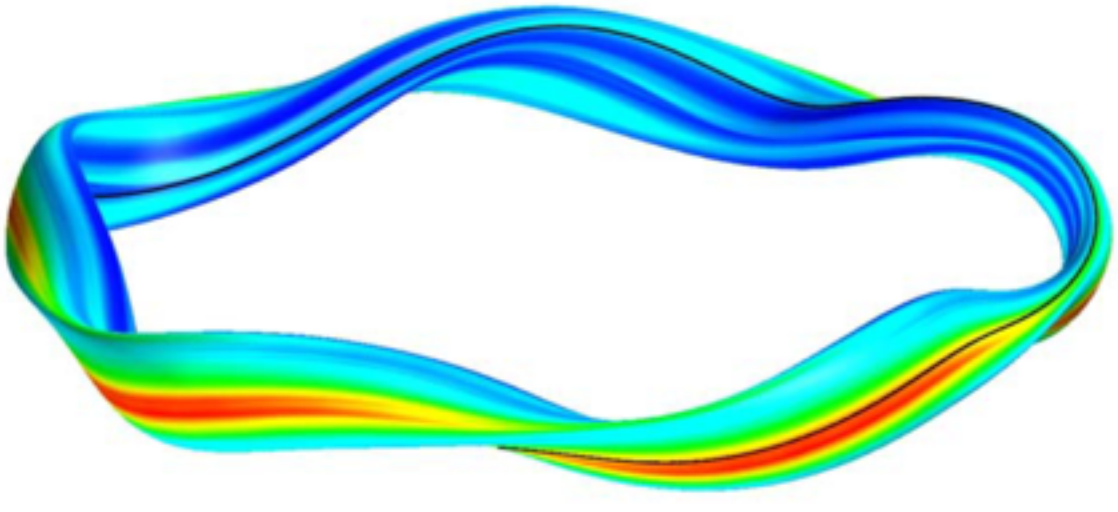
TH/P4-4 Sarazin

- ✦ **Comparison with tokamak experiments**
  - **Extension of GTC to real geometry of EAST** TH/P2-44 Xiao
  - **JET discharges with carbon wall** TH/P5-37 Moradi
  - **ITG-TEM simulation for JT-60U by GKV** TH/P7-38 Nakata

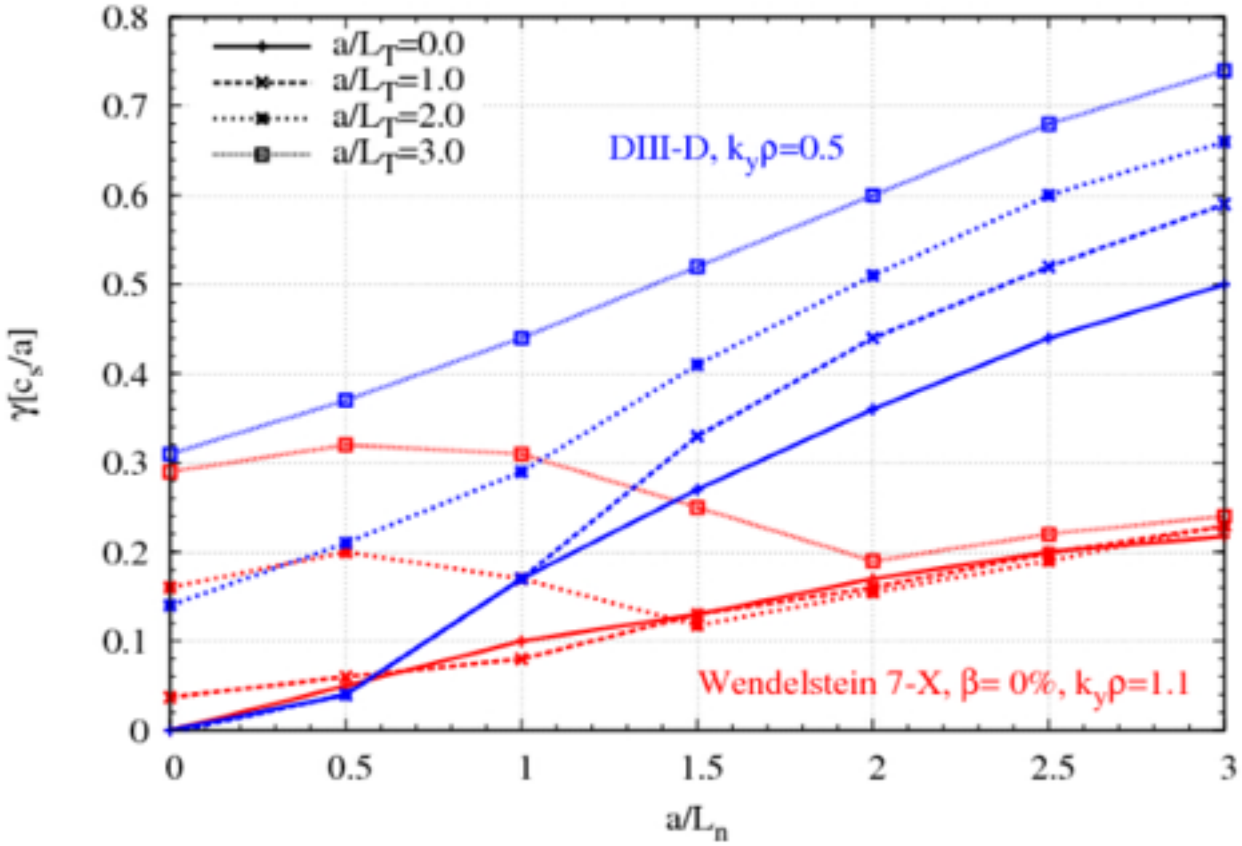
Turbulent Transport (Helical)

TH/1-2 Helander

- ✦ **Advances in stellarator gyrokinetics**
  - **EUTERPE (Linear, EM, PIC, Global)**
  - **GENE (Nonlinear, EM, Continuum, Flux surface)**
- ✦ **Less turbulence and transport when density gradient is large**
  - **since trapped-electron modes are more stable in stellarators where trapping regions have good magnetic curvature**



Nonlinear potential fluctuations in ITG tubulence in W7-X (GENE)



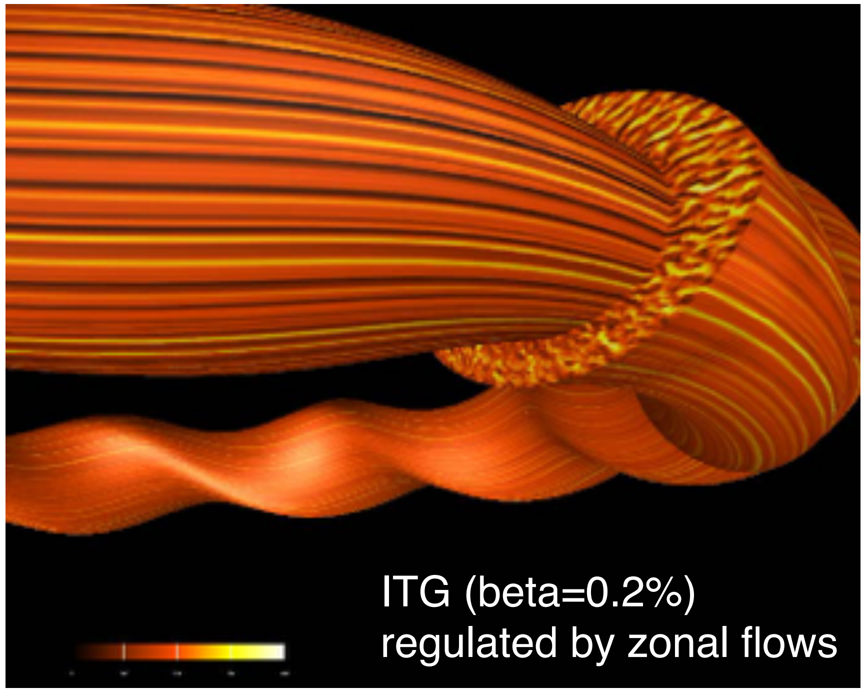
Growth rates of fastest growing modes vs density and temperature gradient in W7-X and DIII-D (GENE)

Turbulent Transport (Helical)

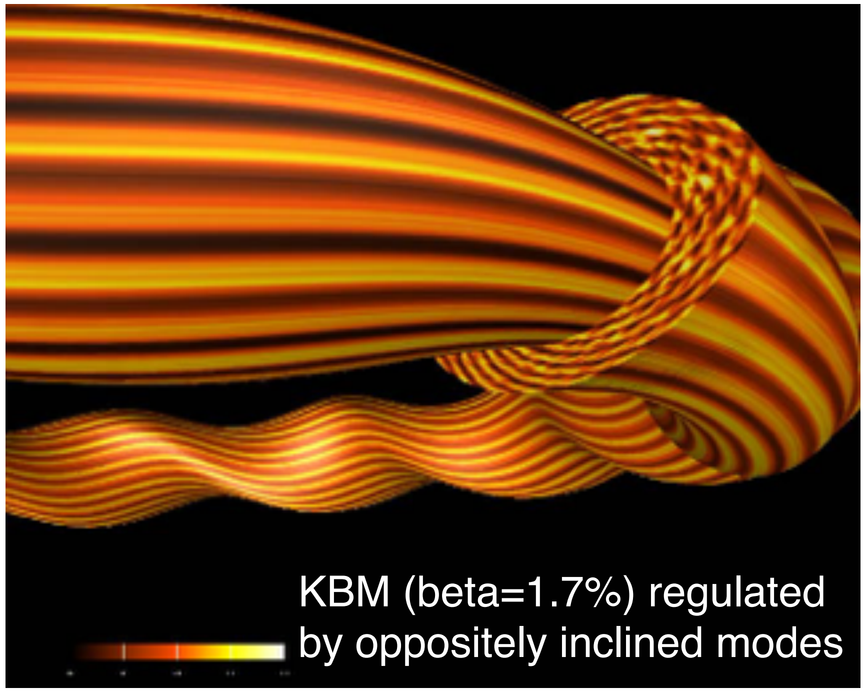
- **Electromagnetic Gyrokinetic Analysis of Turbulent Transport in Finite-Beta LHD Plasmas by GKV**

  TH/P6-40 Ishizawa

  - **Coupling between oppositely inclined convection cells leads to the saturation of KBM**
  - **Transport due to KBM turbulence is much less than ITG**



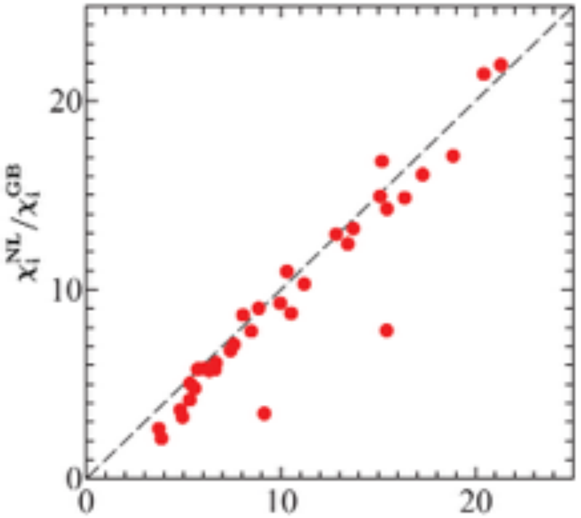
ITG (beta=0.2%)
regulated by zonal flows



KBM (beta=1.7%) regulated
by oppositely inclined modes

- **Derivation of Reduced transport model**

$$\frac{\chi_{\mathrm{i}}^{\mathrm{model}}}{\chi_{\mathrm{i}}^{\mathrm{GB}}} = \frac{A_1 \left(\sum_k \tilde{\gamma}_k / \tilde{k}_y^2 \right)^{\alpha}}{A_2 + \tilde{\tau}_{\mathrm{ZF}} / \left(\sum_k \tilde{\gamma}_k / \tilde{k}_y^2 \right)^{1/2}}$$



TH/P7-9 Nunami

Microturbulence at Finite β

OV/5-1 Terry

- Girokinetic simulation of microturbulence saturation at finite β
- Microturbulence at finite β subject to new effects
  - Stable tearing parity fluctuations excited by ITG => electron heat transport
  - Magnetic fluctuations can disable zonal flows => much higher transport
  - New instabilities arise
    - microtearing
    - kinetic ballooning mode
  - Shorter magnetic scale lengths push these effects to higher gradients, beta
- Saturation of microturbulence at finite β involves complex feedback loops, especially with zonal flows and magnetic fluctuations (both stable and unstable)

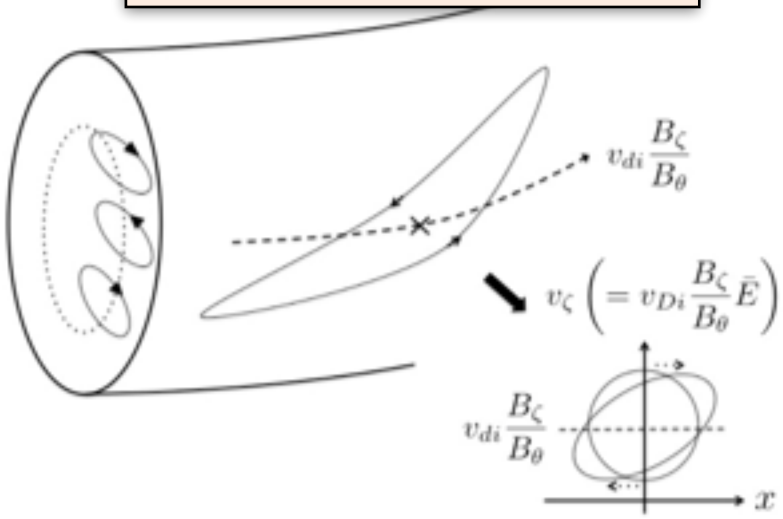
Fluid Turbulent Transport in Tokamak

- Nonlocal transport from edge to core TH/P2-12 Miyato
  - Global Reduced MHD simulation
  - Two-dimensional transport with spiral structure
  - ITG turbulence, Zonal flow, GAM oscillation
- Simulations and validations of transport TH/P7-30 Wang
  - During fueling by SMBI, GP, and PI on HL=2A tokamak
  - BOUT++ with neutral and plasma transport
  - Qualitative agreement with experimental measurements
- Numerical diagnostics of non-diffusive transport process
  - using Turbulent Diagnostic Simulator TH/P5-14 Kasuya
  - Hysteresis in the gradient-flux relation
  - Turbulence spreading, and role of the global mode
- Influence of boundary conditions TH/P2-11 Pastukhov
  - on turbulent transport and energy confinement time
  - in tokamaks with additional heating
- Feedback of NTM on DW-ZF turbulence TH/P2-52 Leconte

Turbulence Physics

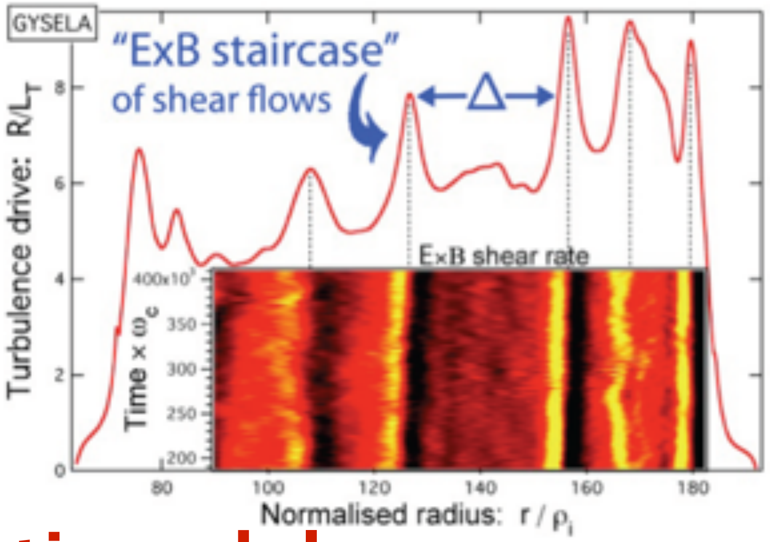
- **Turbulence driven by trapped ions**
  - **clusters of resonant trapped ions (granulations)**
  - **poloidal flows converted into toroidal flows**

TH/P2-14 Kosuga



- **New theory of mixing scale selection**
  - **What determines Avalanche Scale?**
  - **Formation of staircase**
    - co-existence of heat avalanches and ExB sheared flows
    - finite time delay allows heat flux waves; jamming happens

TH/P7-7 Diamond



- **Turbulent elasticity and the physics of time delay**

TH/P4-16 Guo

- **Effects of magnetic shear and toroidal rotation shear on turbulence spreading**

TH/P6-10 Yi

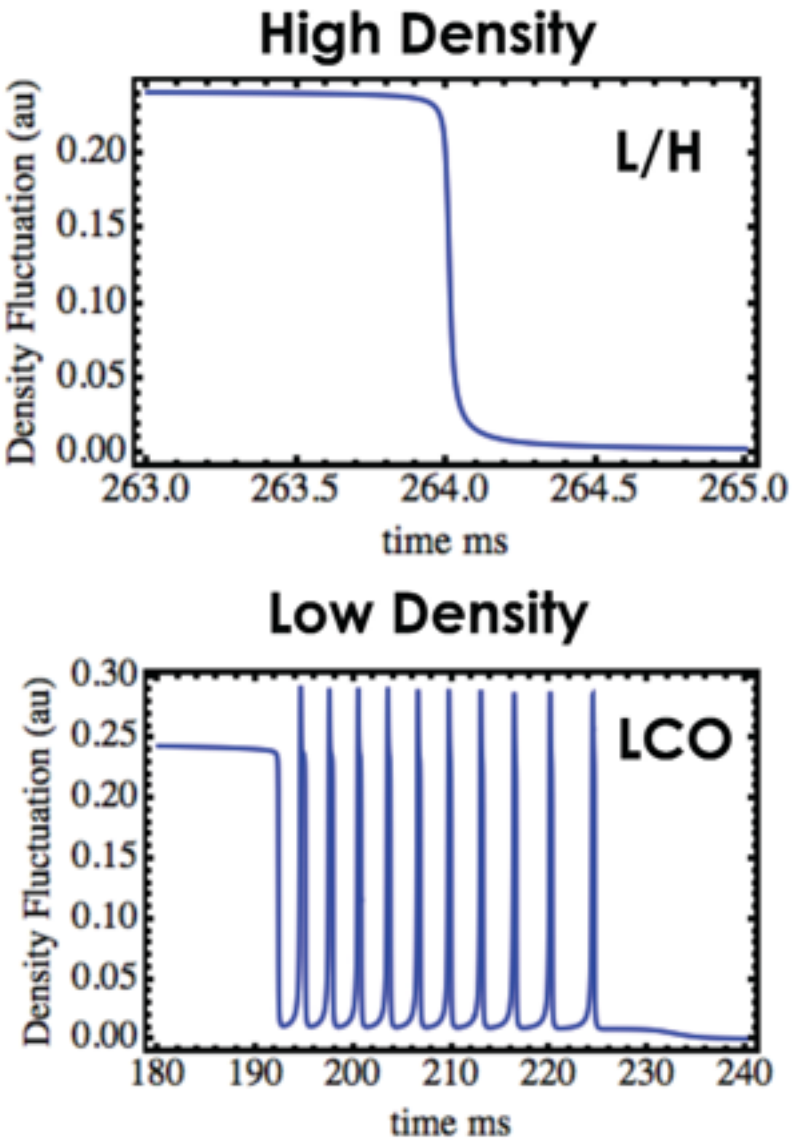
GAM Physics

- Nonlinear excitation of kinetic GAM TH/P6-16 QIU
  - by drift waves (DW) in nonuniform plasmas
  - General equation describing parametric excitation of GAM by DW turbulence
  - Nonlinear saturation of DW due to GAM excitation
- Evolution and system dependent properties of Zonal Flows (ZFs) and GAMs TH/P7-2 Hallatschek
  - in tokamaks and planet atmosphere
  - Two fluid and gyrokinetic simulations
  - Deterministic time evolution for large enough systems
- Gyrokinetic parameter scan of GAM TH/P5-6 Kiviniemi
  - close to L-H transition
  - Full-f ELMFIRE simulation
  - Good agreement with analytic theory for GAM
- Frequency and damping rates of GAM TH/P2-5 Gao
  - in collisional plasmas; importance of energy conservation

L/H Transition

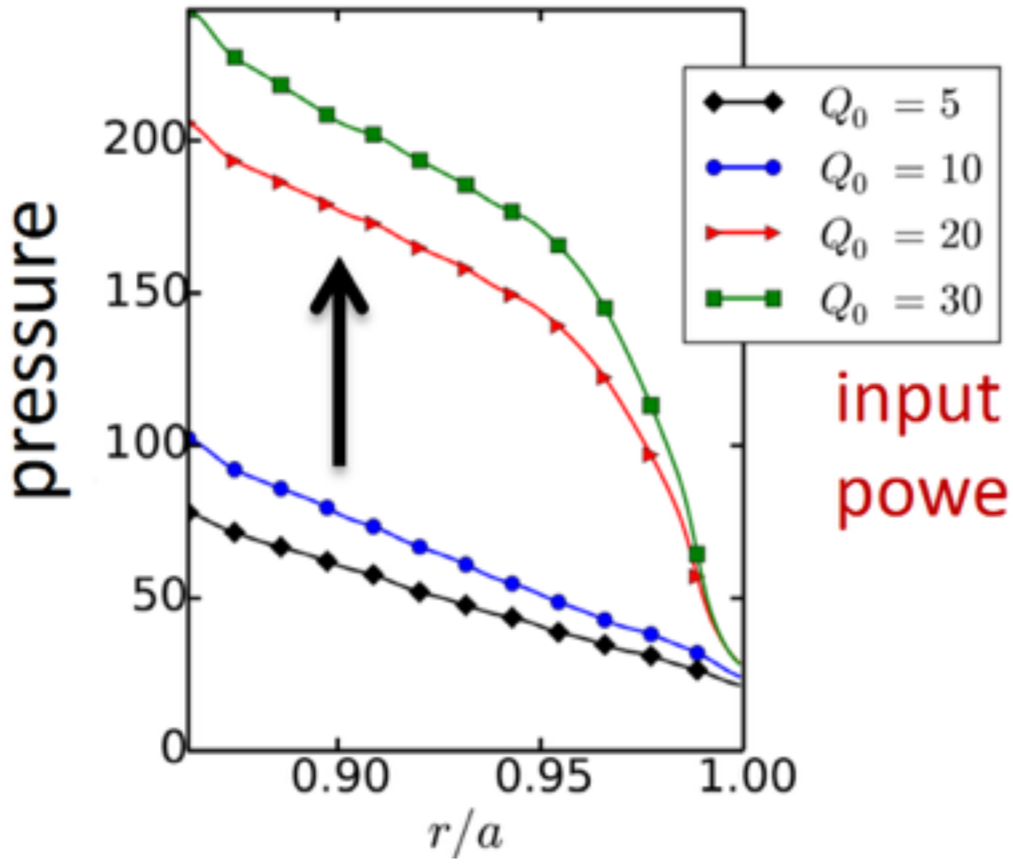
- **L/H transition and limit cycle oscillation**
  - from mean field transport equations
  - including both toroidal and parallel momentum transport

TH/P5-12 Staebler



- **L/H transition dynamics**
  - in fluid turbulence (EMEDGE3D)
  - with neoclassical force balance
  - transition above a power threshold

TH/P7-5 Chôné



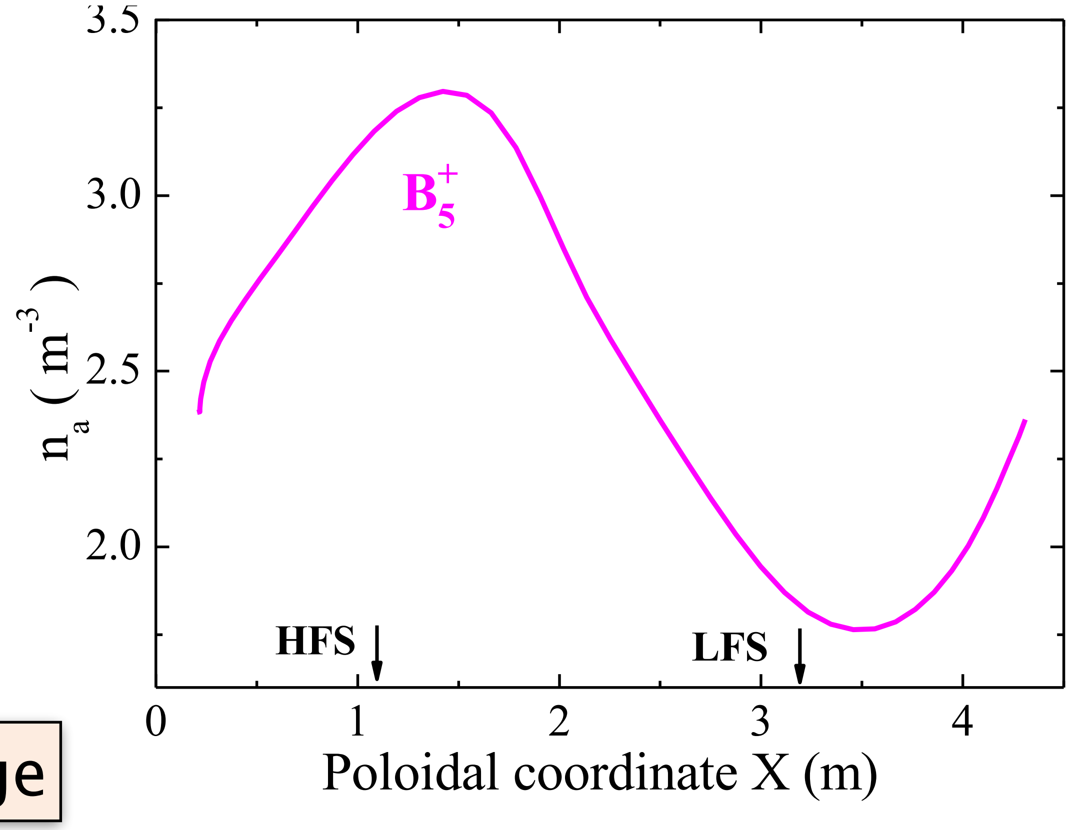
input power

L/H Transition, Barrier formation

- **3D nonlinear simulation study of the L/H transition criterion** TH/8-1 Park
  - ETB formation triggered by turbulence-driven flow
- **Power threshold scaling of L/H transition** TH/P1-9 Malkov
  - Extension of 1D model of Miki & Diamond
  - Separation of electron ion heat fluxes
  - Increase of power threshold for high density
- **Modeling of transition between L and H** TH/P3-24 Koechl
  - including W behaviour in ITER scenario
  - Limits for density ramp rate with respect to auxiliary heating power for L/H transition have been established
- **Analysis of ITB and ETB formation** TH/P6-8 Onjun
  - in tokamak plasma using bifurcation concept
- **Analysis of radial electric field formation** TH/P6-24 Lee
  - by asymmetry of NBI on KSTAR and NSTX
  - based on the gyro-center shift

Edge Physics

- **Understanding of impurity poloidal distribution** TH/2-1 Rozhansky
  - in edge pedestal by B2SOLPS5.2 transport code
  - Strong poloidal asymmetry of B^{+5} ions was obtained in accordance with experiment
  - neoclassical effects and poloidal ExB drifts in plasma with strong gradients



- **Rotation instability of neoclassical plasma near magnetic separatrix** TH/P6-2 Daybelge

Transport issues

- **Thermodynamical approach**
  - **Thermal equilibrium and density limit in tokamak reactor** TH/P5-4 Morozov
  - **Interpretation of the tokamak self-consistent pressure profile** TH/P4-6 Dyabilin
    - Energy confinement scaling close to ITER98(y,2)

- **Current drive by electron temperature gradient turbulence in tokamak pedestal region** TH/P1-3 Tiwari
- **Bayesian derivation of equilibrium distribution function for tokamak scenario** TH/P7-6 Troia
- **Open theoretical issues and solutions** TH/P7-10 Coppi
  - **Quasi coherent mode, magnetic reconnection paradox, spontaneous rotation**
- **Qualifying self-organization** TH/P1-7 Rajkovic
  - **in magnecally confined plasmas**

Advanced Divertor

- ✦ Divertor design and analysis of HL-2M

  TH/3-1Rb Zheng

  - Standard, snowflake, tripod
  - Tripod: long divertor leg and large low-B_p area
- ✦ X-divertors in ITER, current machines and DEMO

  TH/P3-34 Kotschenreuther

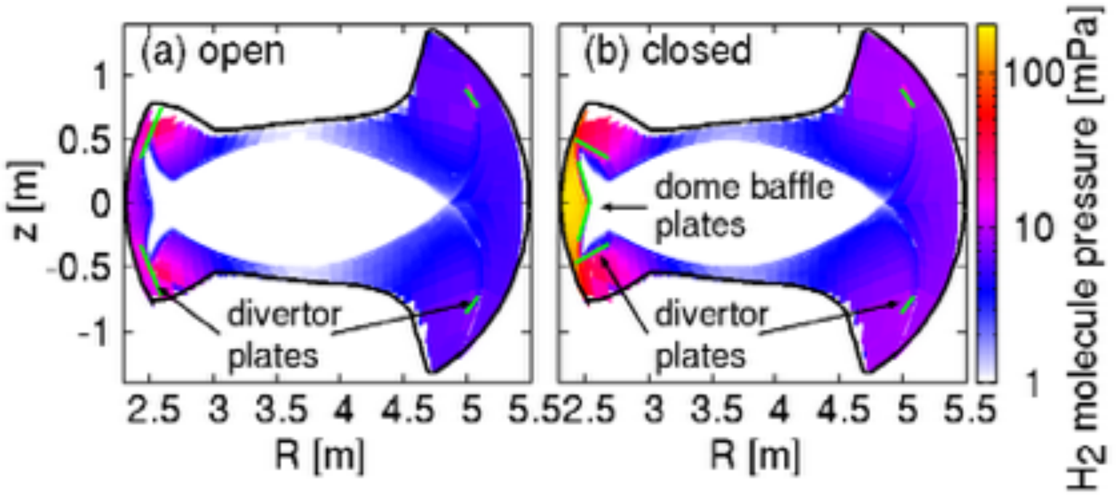
  - X-divertor magnetic configuration can be created on ITER without hardware changes
- ✦ Modeling divertor concepts for spherical tokamaks: NSTX-U and ST-FNSF

  TH/P6-50 Mwier

  - snowflake divertor: effective heat flux mitigation
  - divertor with vertical target and super-snowflake for ST-FNSF
- ✦ Analysis of open and closed LHD divertor

  TH/P6-39 Kawamura

  - Neutral gas compression under the dome



Plasma Material Interaction

- **Modelling of melt damage of W armour**

  TH/P3-40 Bazylev
  - 3D MEMOS code
  - Validation exercise against JET-ILW
- **Influence of W divertor on the performance of ITER H-mode plasmas**

  TH/P3-29 Dux
  - A very large fraction (>99.99%) of the sputtered W is immediately re-deposited
- **Kinetic simulation model of neoclassical high-Z impurity transport**

  TH/P7-8 Homma
  - Outward temperature screening effect and inward pinch
- **Influence of the divertor plate material on the plasma performance of DEMO**

  TH/P4-17 Stanik
  - COREDIV code
  - Fusion factor Q is quite similar for W and Mo plates, whereas it is slightly reduced for Ni target

Low-n MHD Modes

- Nonlinear and toroidal mode coupling effects on m=1, n=1 instabilities

  TH/P1-13 Sugiyama
  - Compressional MHD gives good fit to experimental 1/1 modes, sawtooth crashes, and edge instabilities
- Nonlinear 3D XTOR simulation of internal macro-instabilities

  TH/P5-3 Lütjens
  - including two-fluid and kinetic effects
- Resistive instabilities with full toroidal geometry and coupling using DCON

  TH/P1-5 Park
  - Resistive DCON was developed with resonant Galerkin method and show good convergence property and numerical stability
- FLR effects on low-n MHD mode at H-mode pedestal with plasma rotation

  TH/P7-4 Zheng
  - FLR effects can stabilize the modes with n >= 3
- Global GK sim. of EM instabilities in Tokamak

  TH/P4-11 Holod

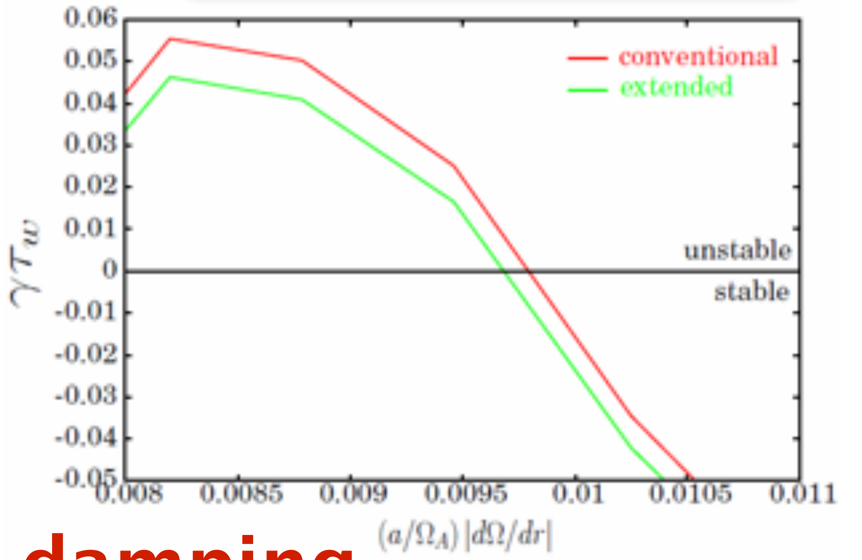
MHD Modes and Flow

- **MHD instability in rotating tokamak plasmas**
  - excited by interplay between RWM and stable MHD modes

TH/P2-15 Aiba

- **Extension of kinetic-MHD model to include toroidal rotation shear effects**
  - RWM growth rate vs rotation shear at q=2
  - Kinetic-MHD model enhances the stabilizing effect of flow shear

TH/P6-12 Shiraishi



- **RMP filed do not produce significant flow damping**
  - Strong screening of resonant harmonics due to resistive plasma response

TH/P3-44 Liu

- **Finite toroidal flow generated by resistive wall tearing modes**
  - Initially unstable tearing mode can be stabilized by the self-generated toroidal flow

TH/P5-9 Har

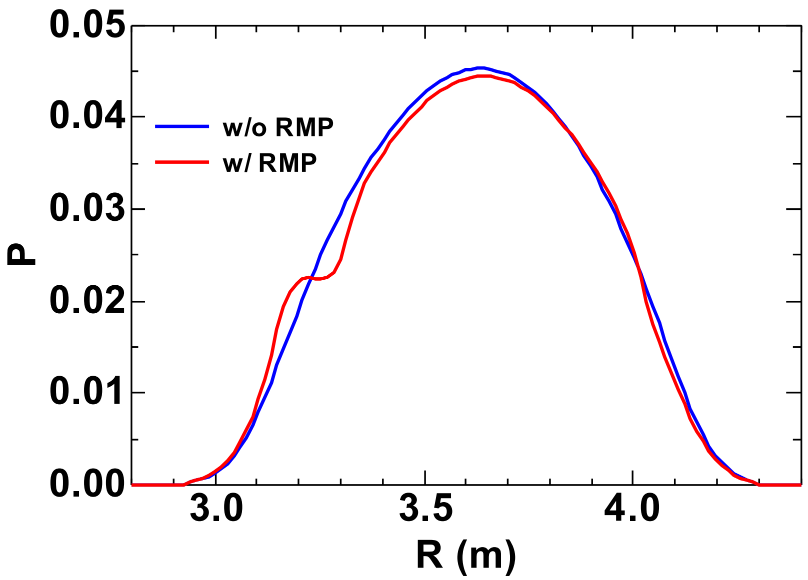
- **Tokamak toroidal rotation caused by disruptions and ELMs**
  - AVDE disruptions and ELMS can drive v_φ

TH/P2-16 Strauss

MHD Modes in Helical Plasmas

- ✦ **3D MHD analysis of heliotron plasma with RMP** TH/6-2 Ichiguchi
  - – **Pressure driven modes in heliotron equilibria with RMP**

► An m=1/n=1 magnetic island is generated.
Equilibrium pressure profile is locally flat at the O-point.

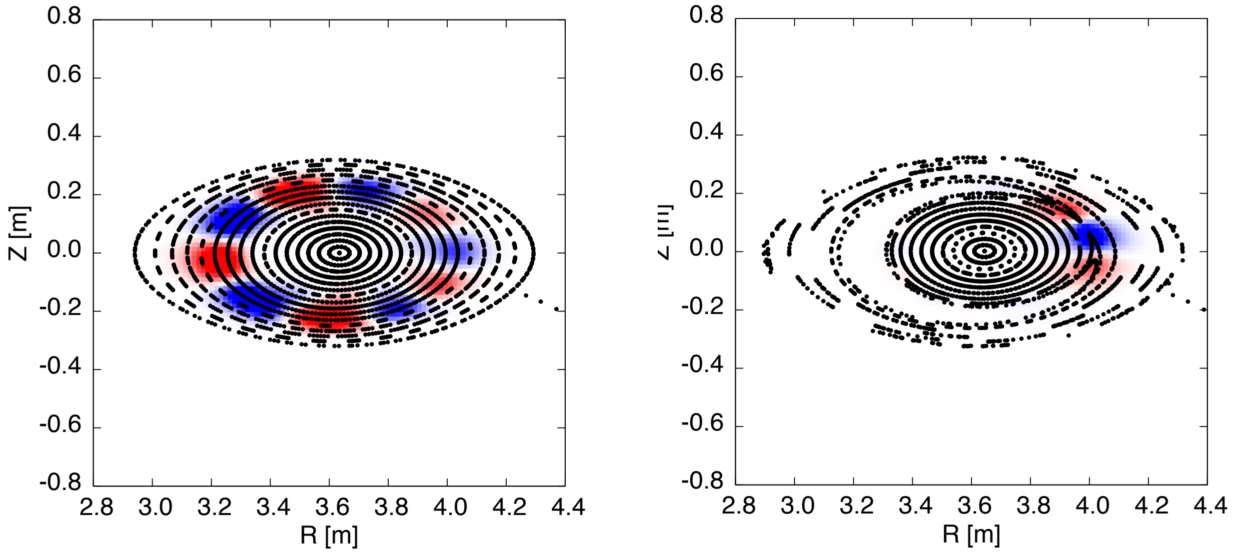


Equilibrium pressure profile on Z=0 plane.

► Different mode structures are obtained.

Without RMP :
A typical interchange mode

With RMP :
A ballooning type mode localized at the X-point



Puncture plots of field lines and mode pattern of perturbed plasma pressure in the linear phase (red and blue patterns).

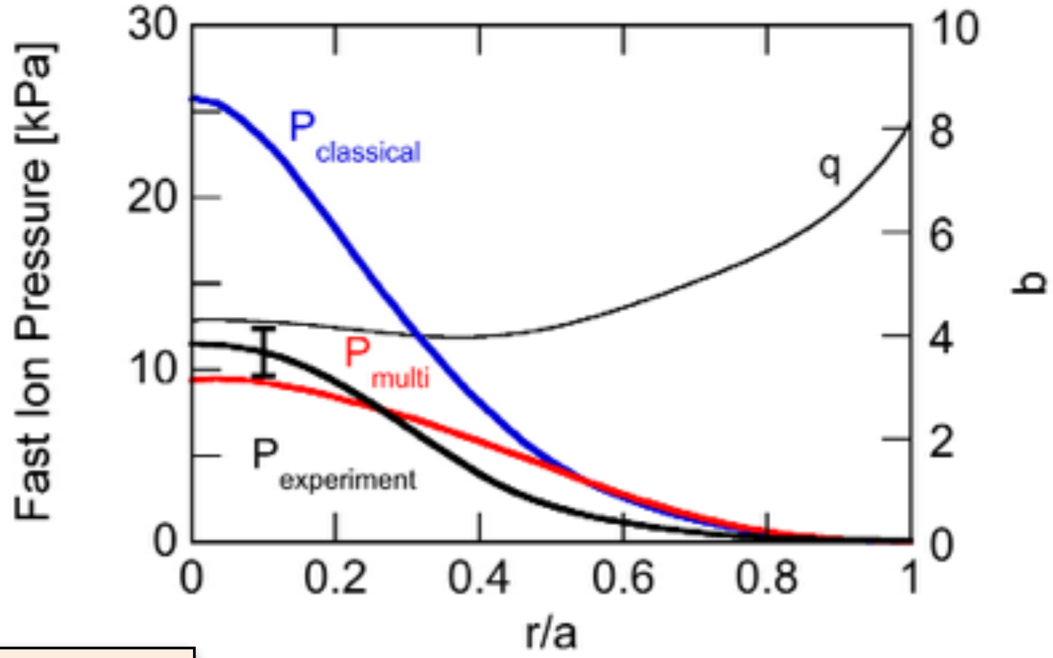
- ✦ **Two-fluid and gyro-viscous effects on the pressure-driven modes in heliotron plasma** TH/P5-17 Miura
  - – **Two-fluid effect can deteriorate pressure profile**
  - – **Gyro-viscosity effect does not explain mild saturation**

MHD Issues, Mirror Configuration

- A Cross-Benchmarking and Validation Initiative TH/P4-7 Reiman
  - **for tokamak 3D equilibrium calculations**
    - Tokamak: IPEC, MARS-F
    - Time-dependent MHD: M3D-C1, M3D, NIMROD
    - Stellarator: VMEC, NSTAB, PIES, HINT, SPEC
- Energy principle for fast RWM in tokamaks TH/P7-14 Putovitov
- Theoretical studies of RWM for RFP plasmas TH/P5-10 Guo
  - **Comparison with tokamaks**
  - **RWM and FLEM driven by energetic particles**
  - **FLEM: non-resonant fishbone like external kink mode**
- Effects of flow shear on tearing mode stability TH/P4-15 Chandra
  - **Reduced MHD code CUTIE**
- Flute instability with ExB shear flow in an open system
  - **Rayleigh-Taylor and K-H instabilities** TH/P1-17 Katanuma
- Plasma behavior in the localized non-axisymmetric B region of the GAMMA 10 tandem mirror TH/P1-31 Islam

Alfvén Eigenmodes

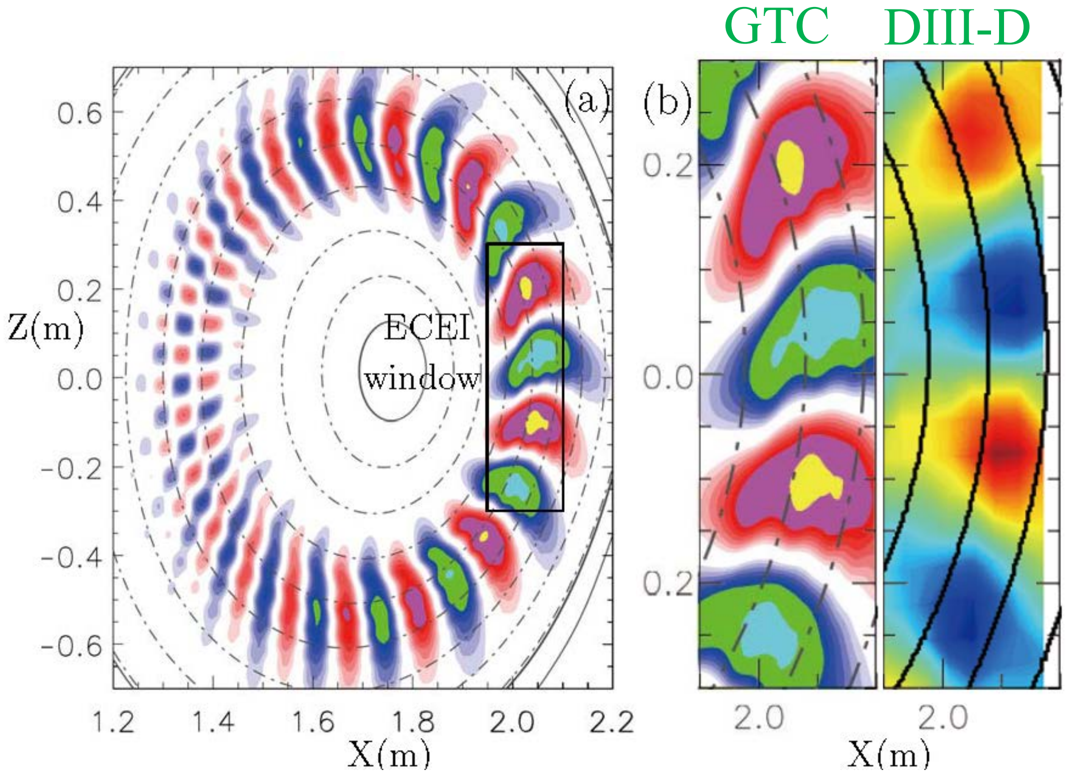
- ✦ Multi-phase simulation of Alfvén eigenmodes (AE) and fast ion distribution in DIII-D experiments TH/7-1 Todo
  - – **Classical and hybrid simulation by MEGA**
  - – **Successfully reproduced**
    - Saturation amplitude of AE
    - Fast ion pressure profile
    - Amplitude and phase of δTe



- ✦ Nonlinear dynamics of AE TH/P6-14 Zhu
  - – **Frequency chirping of TAE**
  - – **Nonlinear excitation of GAM by TAE**
  - – **Frequency down sweeping of RSAE**
- ✦ Cyclic bursts of chirping modes observed in N-NB-driven JT-60U plasmas TH/P7-39 Bierwage
  - – **MEGA with realistic geometry and fast ion source**
- ✦ Global gyrokinetic PIC simulation of AE TH/P4-49 Mishchenko

AE, Zonal Flow, Transport

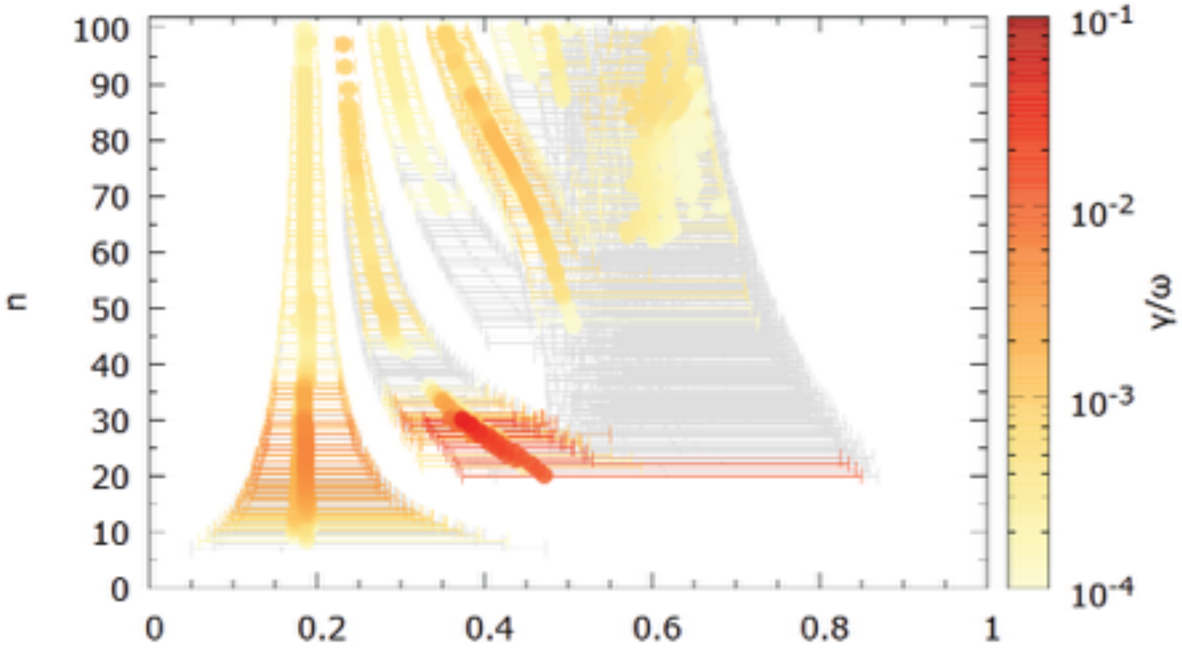
- ✦ **Saturation of TAE caused by zonal flow generation** TH/7-2 Lin
  - GTC simulation of TAE in DIII-D



- ✦ **Predictive models for fast ion relaxation in burning plasmas**
  - Critical gradient model based on linear stability theory of AE excited by AE TH/P1-2 Gorelenkov
- ✦ **Chirping AEs drive convective and diffusive transport**
  - Electrostatic self-trapping TH/P7-15 Lesur
- ✦ **Energetic particle driven geodesic acoustic mode (EGAM)**
  - New kind of EGAM observed in LHD TH/P1-12 Wang

AE and EP in ITER

- **Systematic scan of AE for ITER 15MA scenario** TH/P3-25 Rodrigues
  - **MISHKA + CASTOR-K**
  - **n=20 ~ 30 are most unstable**



- **AE for ITER 9 MA steady-state**
  - **KINX** TH/P3-39 Isaev
- **Nonlinear fast particle transport for ITER 15MA scenario**
  - **HAGIS + LIGKA** TH/P2-6 Schneller
- **AE transport predicts only mid-core re-distribution of ITER Alpha** TH/P3-42 Bass
  - **GYRO**
- **Alpha-particle confinement study in ITER** TH/P3-37 Afanasyev
  - **by NPA measurements of knock-on ion tails**
  - **Energy dependence and absolute intensity of knock-on ion fluxes depend on the fast ion confinement time**

Energetic particle confinement

- ✦ ITER energetic particle (EP) confinement

  TH/P3-30 Suonio
  - in the presence of ELM control coils and EU TBMs
  - ASCOT including recent 3D wall, feromagnetic components, ELM control coils, and EU TBMs
  - No threat to first wall from NBI ions and α-particles
- ✦ Equilibrium and fast particle confinement

  TH/P7-13 Cooper
  - in 3D tokamaks with toroidal rotation
  - Helical core deformations with characteristics of saturated ideal MHD internal kink modes: Snakes
- ✦ 3D plasma response to external magnetic perturbation on fast ion confinement in JT-60SA plasmas

  TH/P7-37 Suzuki
  - Fast ion loss is sensitive to the magnetic topology
- ✦ NBI and HHFW Fast Ion Temporal Dynamics Modeling

  TH/P6-49 Harvey
  - with CQL3D-Hybrid-FOW
  - in NSTX discharges
  - FIDA, NPA, and dn/dt signals are in reasonable with Exp.

Energetic Particle Physics

- Stabilization of core microturbulence by fast ions TH/5-2 Garcia
  - Pressure gradients are strong stabilizing for ITG turbulence: GENE + MISHKA
  - Fast ions are more efficient than thermal particles
- Energetic particle driven n=1 MHD instabilities in tokamaks with weakly reversed shear TH/P7-1 Brennan
  - NIMROD simulation suggests particles can be destabilizing the mode observed in DIII-D hybrid cases
- Fishbone modes with dual NBI heating TH/P2-13 He
- Redistribution of energetic particles TH/P1-8 Farngo
  - due to internal kink modes
- Transport theory for energetic alpha particles TH/P1-11 Shaing
  - extended to finite aspect ratio tokamaks with broken toroidal symmetry
- Fast particle driven ion cyclotron emission (ICE) in tokamaks and ICE diagnostic in ITER TH/P3-28 McClements

ICRF Waves

- **Fast wave heating and power losses in SOL**

  TH/P4-14 Bertelli

  - **Full wave analysis: AORSA**
    - NSTX: large SOL losses near the antenna and the LCFS
    - NSTX-U: wider evanescent region and lower SOL losses

- **Verification of the ICRH antenna design for W7-X**
  - **Antenna code: TOPICA**

  TH/P6-60 Ongena

- **Self-Consistent modeling of RF Sheaths**

  TH/P6-9 Colas

  - **SSWICH-SW code**
    - ICRF slow wave propagation and DC SOL plasma biasing
    - Nonlinear RF and DC sheath BCs at plasma-wall interface
    - Qualitative agreement with Tore Supra observations

- **Theoretical analysis of the ICRH antenna's impedance matchin for ELMy plasmas on EAST**

  TH/P3-13 Gong

LHRF Waves

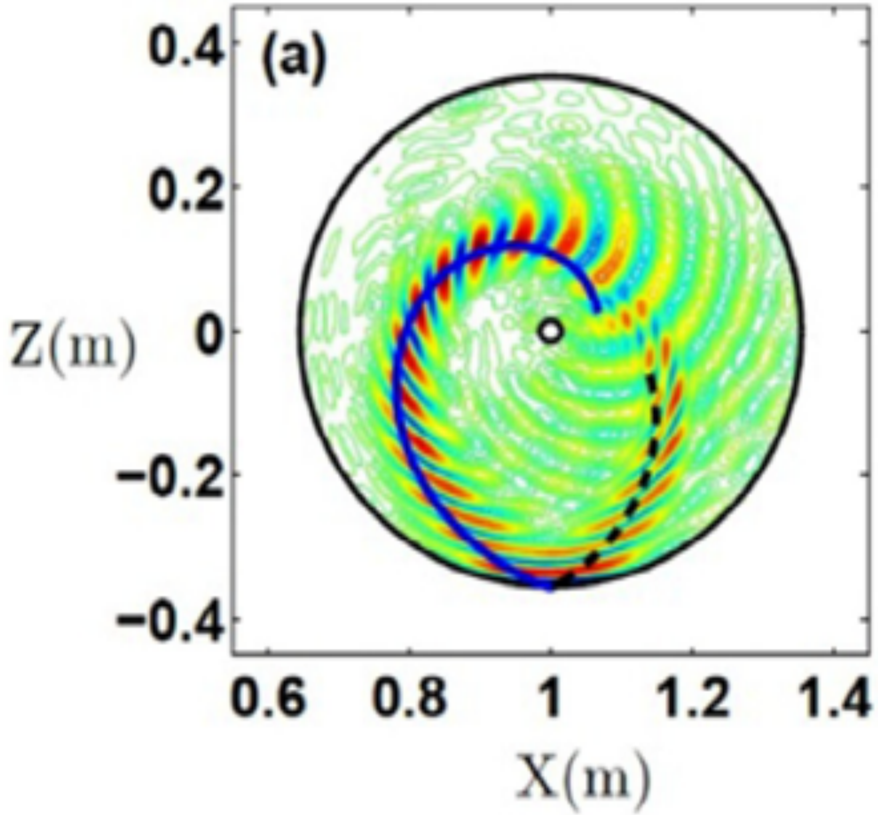
- **Off-axis current drive by fast waves in LHRF**
  - **ITER, FNSF-AT, DEMO**
    - 3D full wave code: PSTELION, STELEC2
  - **DIII-D**
    - Ray-tracing code: GENRAY

TH/P3-36 Vdovin

TH/P2-38 Pinsker

- **Particle simulation of RF waves**
  - **Particle simulation model**
    - Ion: fully kinetic
    - Electron: Drift kinetic
  - **Linear LH wave propagation**
    - Landau damping
    - Slow-fast mode conversion
  - **Nonlinear LH wave trapping of electrons**

TH/P2-10 Kuley



EC Waves and CHI

- ✦ **Anomalous absorption of EC waves**

TH/4-2 PoPov

  - – **Low-threshold parametric decay instabilities**
    - 3D trapping of the upper-hybrid or electron Bernstein waves in the drift-wave eddy

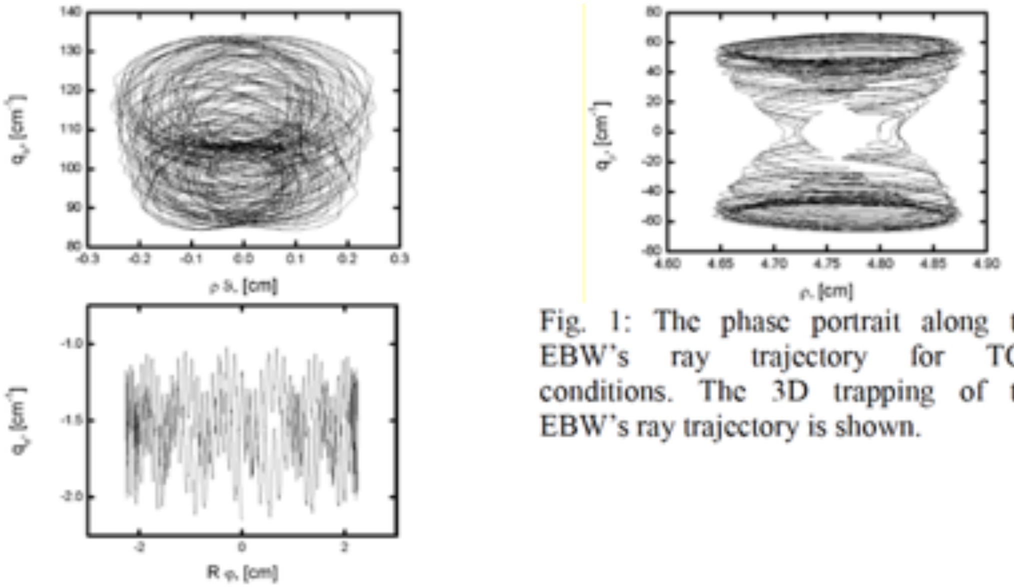


Fig. 1: The phase portrait along the EBW's ray trajectory for TCV conditions. The 3D trapping of the EBW's ray trajectory is shown.

- ✦ **Effect of multi-pass absorption of EC waves**

TH/P3-32 Minashin

  - – **Absorption of EC waves at initial stage of discharge**
  - – **Based on the approach of EC radiation transport**

- ✦ **Noninductive plasma start-up by Coaxial Helicity Injection**
  - – **TSC simulation predicts 0.4 MA in NSTX-U**

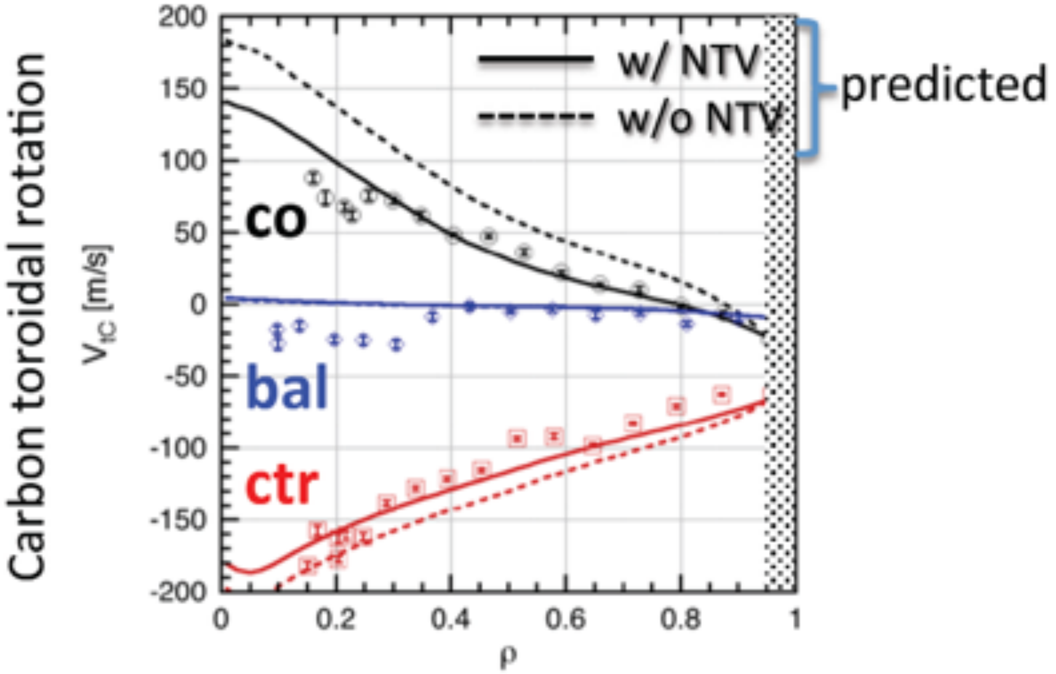
TH/P6-55 Raman

  - – **NIMROD simulation provides a more complete picture**

Integrated Modelling of Toroidal Plasmas

- ✦ Integrated modeling of toroidal rotation for JT-60U analysis
  - TOPICS + VMEC + FORTEC3D
  - Neoclassical toroidal viscosity (NTV) improves the reproducibility of toroidal rotation

TH/5-1 Honda



- ✦ Integrated modeling of core-SOL-divertor
  - Globus-M ASTRA + B2SOLPS
  - ITER ASTRA/JETTO + COREDIV

TH/P1-35 Senichenkov

TH/P3-45 Zagórski

- ✦ Integrated heat transport simulation
  - High-Ti plasma of LHD
- ✦ Kinetic integrated modeling of burning start-up phase tokamaks

TH/P6-38 Murakami

TH/P6-04 Fukuyama

Integrated Modelling Framework

- **OMFIT**

TH/P6-11 Meneghini

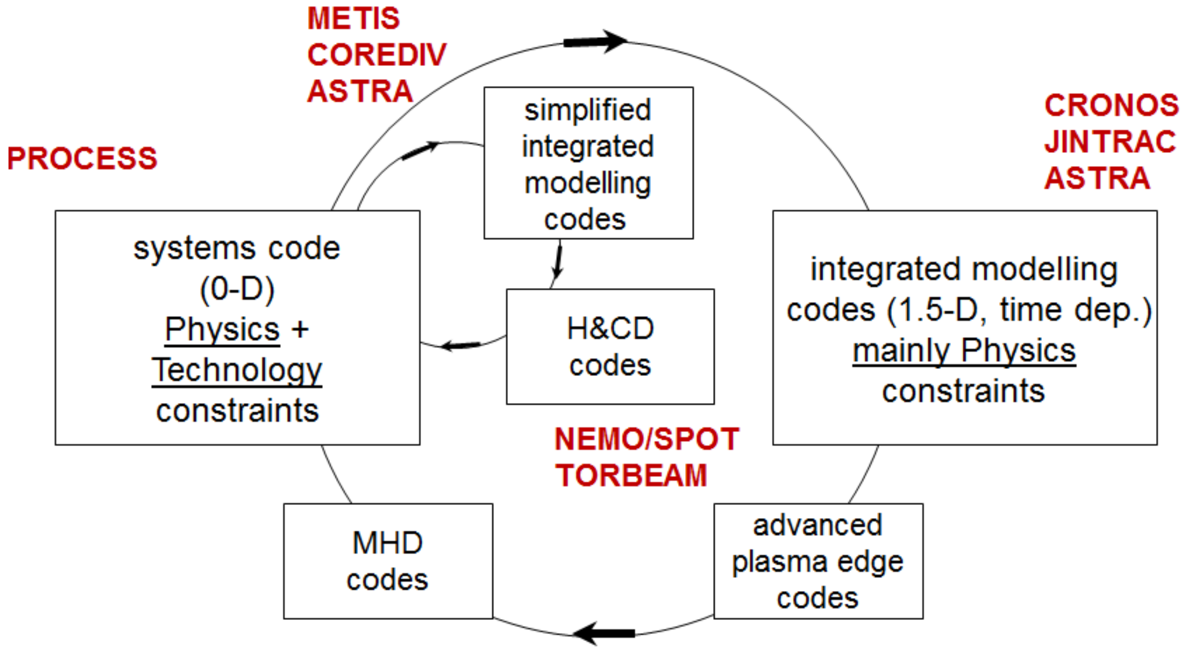
  - **Comprehensive integrated modeling framework**
  - **New physics studies**
    - Transport modeling based on Neural Networks
- **IMAS**

TH/P3-41 Imbeaux

  - **ITER Integrated Modelling & Analysis Suite**
    - Standardised, machine-generic data model
- **Modelling of DEMO scenario**

TH/P1-14 Giruzzi

  - **Three levels of analysis**
    - 0D PROCESS
    - Simplified IM (steady) METIS/COREDIV/ASTRA
    - Full IM (time dependent) CRONOS/JINTRAC/ASTRA



DEMO concept optimized by iterations

Final Remarks

- Since FEC2012 meeting, remarkable progress has been made in many areas in theory, modelling, and simulation of magnetic fusion plasmas.
- Increase of available computational resources has enable us to challenge new subjects in simulation research.
- The collaboration between experiment and theory has become an indispensable part of research activities. Now the collaboration between fusion technology, such as DEMO design, and theory is growing. This tendency will continue.
- I hope further progress in next two years, and also hope that long standing issues, such as density limit, are clearly solved at least in theoretical points of view.