

Status and plans for Joint Experiment EP-8

Validation of Neutral Beam Current Drive and projections to ITER

M. Podestà – NSTX-U, USA

D. Testa – TCV, Lausanne CH

C. Hopf, B. Geiger – ASDEX-U, GE

D. Keeling – MAST, UK

C. Collins, L. Bardoczi, W. Heidbrink – DIII-D, USA

A. Cappa – JT-II, Spain

20th ITPA Topical Group on Energetic Particles

ITER HQ, Cadarache - France

September 23-25, 2018

Goals of JEX EP-8

- Assess NB-CD efficiency vs. NBI parameters
 - Include conditions for which EP behavior departs from ‘classical’
- Develop/validate modeling tools to predict NB-CD in future devices (ITER and DEMO)
 - Include tools to account for ‘non-classical’ effects
 - Consider enhanced EP transport by instabilities, microturbulence

Progress in last ~6 months: extending modeling tools to low-f instabilities

• NSTX/NSTX-U

- Analysis of sawtoothing plasmas continues *[Kim, IAEA-TCM-EP 2017]*
 - Goal: improve sawtooth model in TRANSP *[Liu, IAEA-TCM-EP 2017]*
- Started dedicated activity on NTM, fishbone, kink modeling
 - Goal: develop “self-contained” module for TRANSP *[Podestà US TTF 2018]*
- Progress in development, benchmark of Quasi-Linear model RBQ1D

• DIII-D

- Progress in diagnostics (see M. VanZeeland’s talk)
- Recent experiment on “AE mitigation in high- q_{\min} discharges”
 - Goal: explore mitigation/suppression techniques
 - Assess predictive capabilities of reduced EP transport models (US JRT 2018)
 - Analysis started
- Progress in validating “kick model” for NTMs *[Heidbrink, IAEA-EP 2017]*
 - Goal: develop self-contained module for TRANSP *[Heidbrink, US TTF 2018]*
[Bardoczi, US TTF 2018]

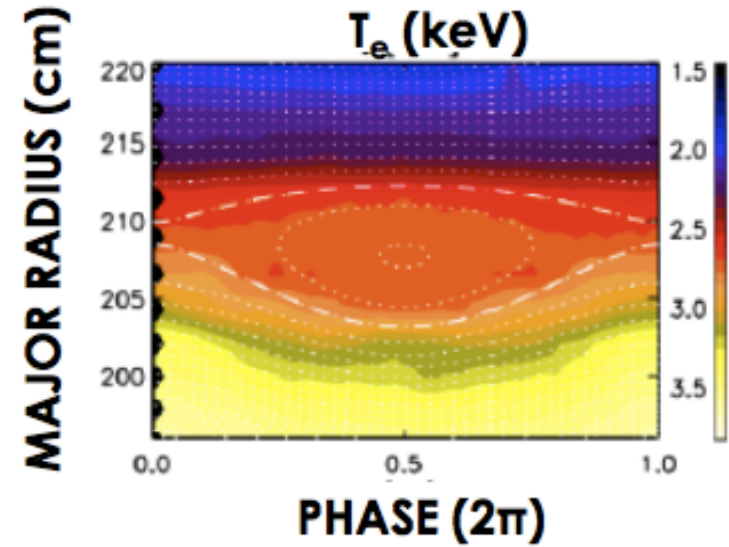
Progress in last ~6 months: New experiments, analysis ongoing

- ASDEX-U/TCV (MST1 programme)
 - High- q_{\min} scenarios with high NI fraction on AUG
 - Preliminary results: good agreement between measured & simulated MSE, Vloop
 - Neoclassical, in spite of strong MHD activity,
 - However: enhanced EP transport required to match neutrons, W_{mhd} , FIDA
 - Results in disagreement for MSE, current!
 - *See B. Geiger's presentation*
- MAST-U: plans unchanged from previous meeting
 - Experimental programme coordinated within EU-MST1
 - *Fast Ions and Current Drive* studies are prominent part of it

Progress in last ~6 months: Experimental data available, modeling tools needed

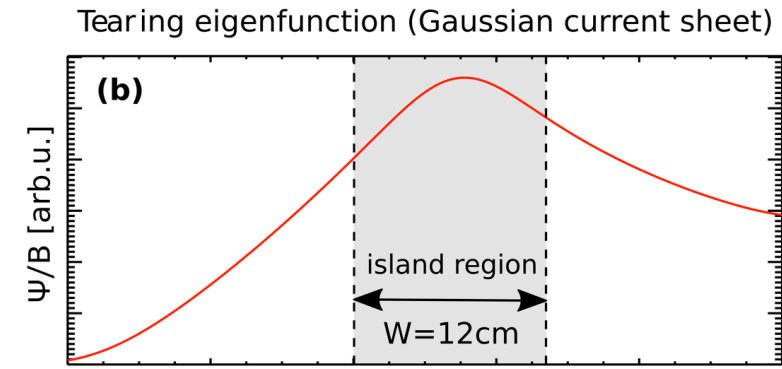
- JT-II
 - Database on NBCD available from past years
 - No new experiments in last ~year (fixing technical issues)
 - Analysis of experimental data starting
 - *Main issue: lack of modeling tools!*
 - Need to improve maturity of modeling tools for NBCD to same level as those available for axi-symmetric configurations

Coordinated NSTX-U/DIII-D effort has started to understand & model EP transport by NTMs

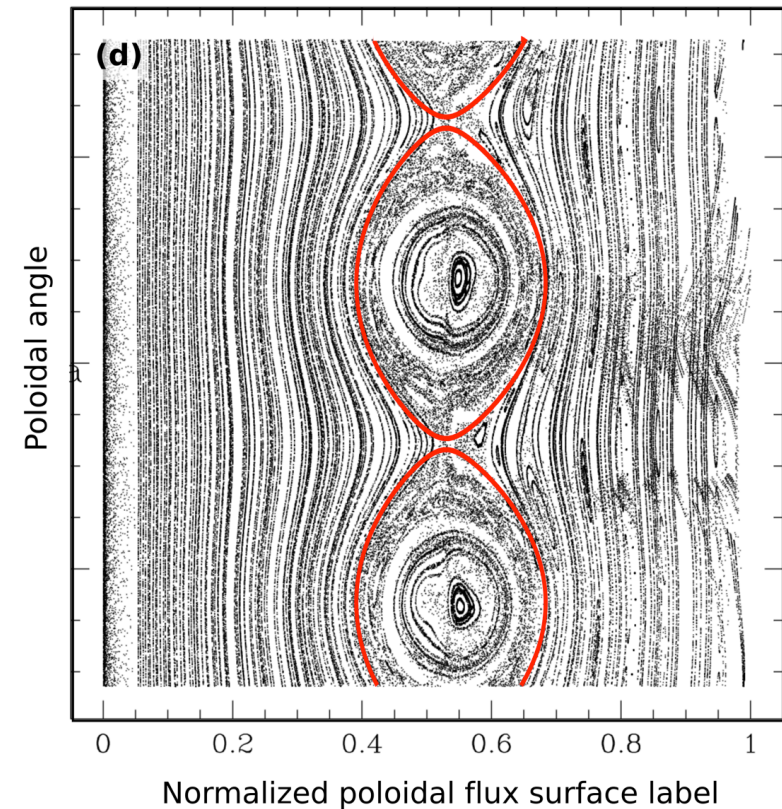
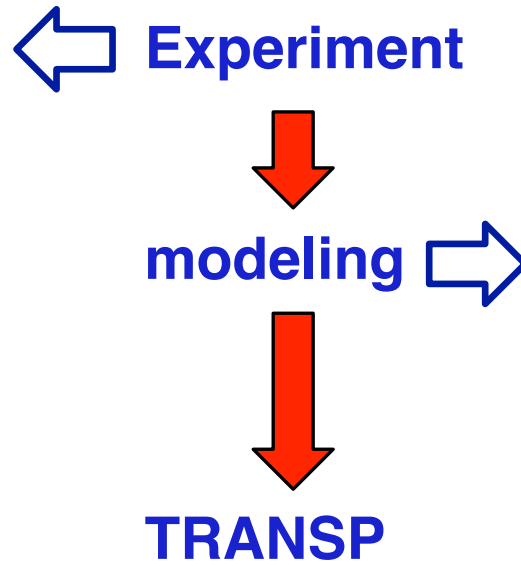
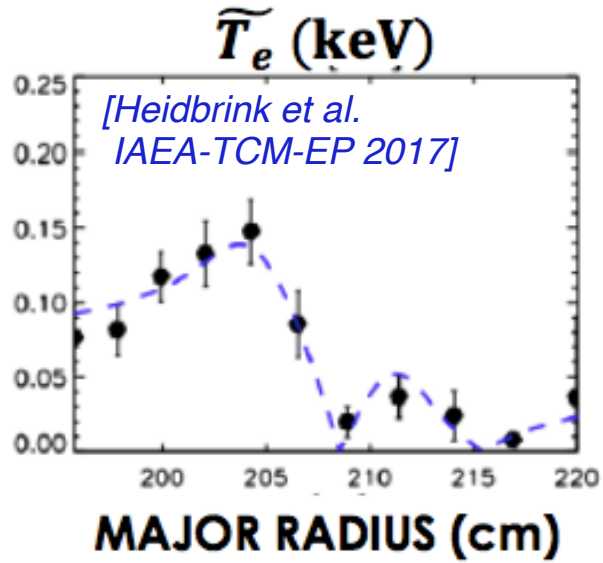


Ongoing validation of "kick model" with NTMs (L. Bardoczi, DIII-D)

Goal:
predictive model for EP transport by NTMs



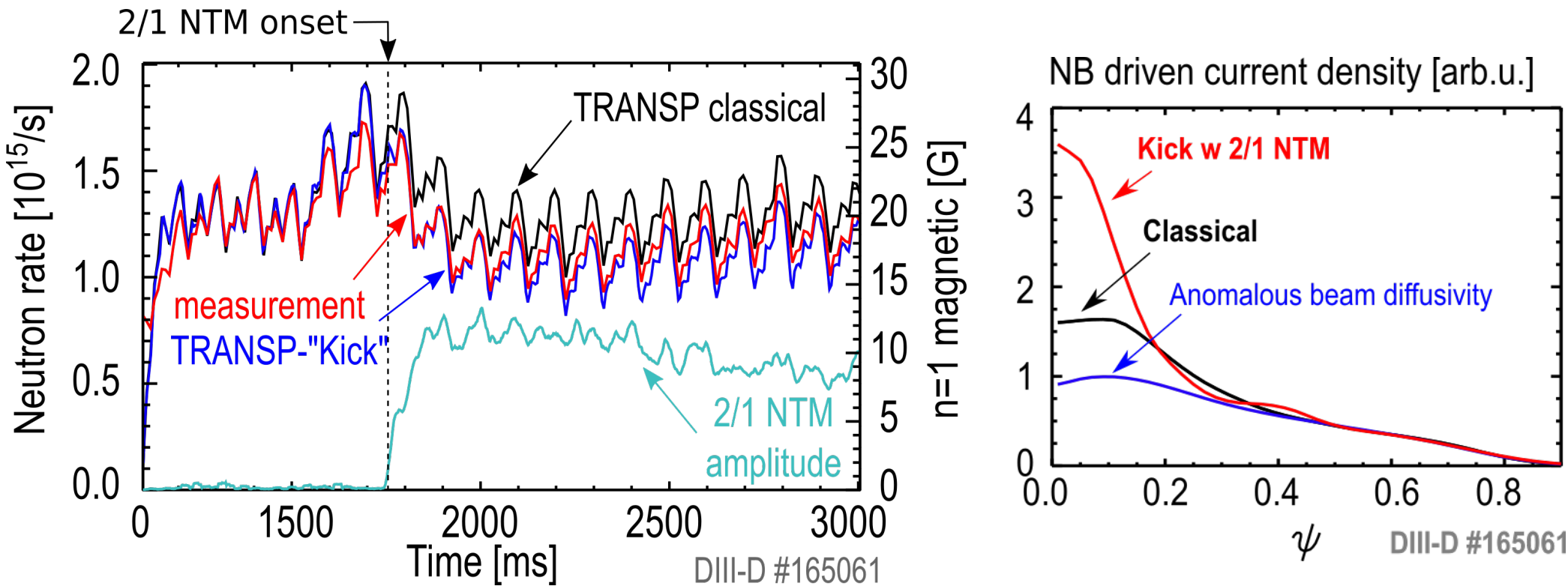
Poincare plot of thermal electrons (ORBIT) & separatrix of imposed island structure (analytic)



Leverage work by Poli & Fredrickson to include NTM stability model in TRANSP

Example: interpretive TRANSP analysis, *no free parameters*

- NTM island width from measurements
- Reproduce neutron rate, stored energy



- NB current redistribution depends on NTM spectrum
 - e.g. core peaking vs broadening predicted for 2/1 vs 3/2 NTMs

(L. Bardoczi, DIII-D – US TTF 2018)

Plans

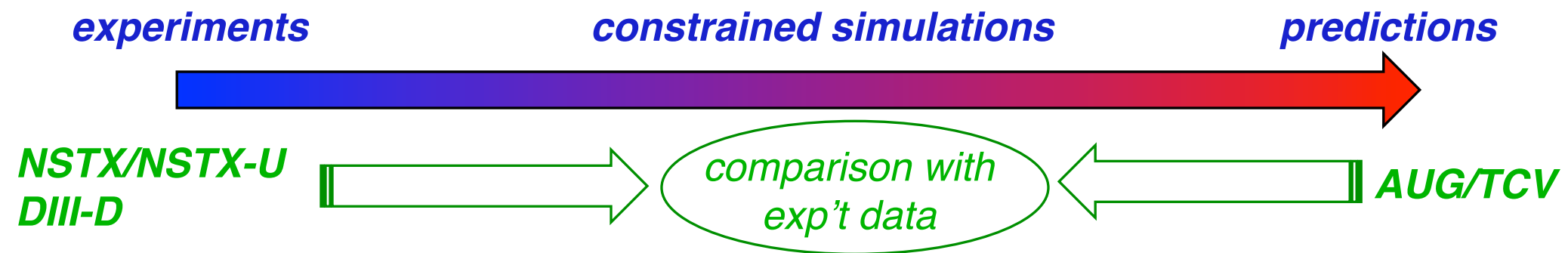
- Applying new modeling tools for EP transport by low-f instabilities
 - Assess resulting NBCD degradation
 - Assess synergy between low-f modes and AEs
- Working to make modeling tools (*kick model*) available to broader community
- Assessment of predictive capabilities would benefit from coordination with ITPA IOS
 - Joint meeting in the near future (1day overlap)?
- *Need quantitative NBCD modeling tools for non-axisymmetric configurations!*

Backup slides

Continuous progress in NB-CD database and analysis tools

- NSTX/NSTX-U/DIII-D
 - Database on NB-CD expanded
 - Focusing on identification of “critical parameters” for reliable, quantitative CD predictions
- ASDEX-Upgrade, TCV
 - Progress in experiments with MSE, FIDA data with NBI
 - Analyzing discharges with high non-inductive current fraction, look for effects of instabilities on NB-CD performance

> *Converging to similar methodology:*



Open issue: relax constraints in TRANSP simulation degrades prediction accuracy

- > Remove additional constraints in TRANSP simulations, check agreement with “reference” run
- Unconstrained V_{surf} leads to similar NB-driven current profile, but “large” discrepancy in predicted q-profile
 - *Ongoing work: assess role of computed resistivity [F. M. Poli, D. Kim]*

D3D#159243, t=800.0ms

