ITPA – Topical Group on MHD Stability

Ted Strait

Presented at the
15th Workshop on MHD Stability Control
Madison, Wisconsin

November 17, 2010
The ITPA Operates under the Auspices of the ITER-IO

Purpose: provide a framework for coordinated physics research activities

- Develop the physics basis for ITER operation
- Integrate the expertise of the international fusion community into ITER
- Provide a pathway to exploit the capabilities of existing fusion facilities in support of ITER
- Create a common international research program organized around scientific issues

Advisory role with respect to the ITER-IO

[excerpts from the ITPA charter]
Scope of the MHD Topical Group

- **MHD instabilities and active control**
  - Sawteeth, NTMs, RWMs

- **Disruptions and disruption mitigation**
  - Disruption database, disruption characterization
  - Prediction, avoidance, and mitigation of disruptions

- **Plasma magnetic control**
  - Control of plasma current, position and shape
  - Control and reduction of error fields

- **Diagnostic issues related to the above**
MHD Stability Topical Group

• Leaders
  A. Sen (chair)
  E. Strait (deputy)
  Y. Gribov (deputy)

• US members
  E. Strait (coordinator)  S. Jardin
  R. Granetz (deputy)    S. Sabbagh
  J. Harris              F. Waelbroeck
  V. Izzo                J. Wesley
Post-IAEA Topical Group Meeting

- **Seoul National University, October 18-20, 2010**
  - Approximately 40 participants
  - Included joint sessions with topical groups on
    - Energetic Particles
    - Divertor-SOL
    - Pedestal

- **The agenda included sessions on**
  - ITER needs (by Y. Gribov and M. Sugihara)
  - Small number of contributed talks
  - Activities of joint experiments and working groups
# Joint Experiments

<table>
<thead>
<tr>
<th>MDC-1</th>
<th>Disruption mitigation by massive gas jets</th>
<th>M. Lehnen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Optimal disruption mitigation schemes to avoid large local heat loads, halo currents, and runaway avalanche generation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MDC-2</th>
<th>Joint experiments on resistive wall mode physics</th>
<th>S. Sabbagh ('11)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Benchmark and validate kinetic RWM stability models</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MDC-4</th>
<th>NTM physics - aspect ratio comparison</th>
<th>M. Maraschek</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Analysis of MAST↔AUG and DIII-D↔NSTX data sets</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Expected to close in 2011</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MDC-5</th>
<th>Sawtooth control methods for NTM suppression</th>
<th>I. Chapman</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Improve NTM $\beta$-limits by controlling fast ion-stabilized sawteeth</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MDC-8</th>
<th>Current drive prevention/stabilisation of NTMs</th>
<th>R. La Haye</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Develop real-time control including benefits of ECCD modulation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Provide multi-machine data on power requirements for extrapolation to ITER</td>
<td></td>
</tr>
</tbody>
</table>
Joint Experiments

**Primary contact**

**MDC-12  Non-resonant magnetic braking**  T. Hender
- Comparison of magnetic braking from externally applied $n=2$ or $3$ fields
- Experiment closed (2010), analysis continuing

**MDC-14  Rotation effects on NTMs**  R. Buttery
- Error field sensitivity of medium $\beta_N$ low rotation plasmas
- Resolve other governing physics for the $2/1$ NTM $\beta_N$ limit

**MDC-15  Disruption database development**  J. Wesley
- Halo currents: complete the entry of multi-machine data
- Shutdowns by massive gas injection: define variables, begin data entry

**MDC-16  Runaway electron generation, confinement, loss**  R. Granetz
- Develop and improve radial and vertical position control of the RE beam
- Explore dissipation of the RE beam by injection of impurity gas or pellets
- Continue investigation of runaway suppression by 3-D fields

**MDC-17  Active disruption avoidance**  M. Maraschek
- Direct ECH heating of magnetic islands: joint scaling of power required
Working Groups Address Short-term Issues for ITER

• Response to requests from ITER-IO for recommendations on specific issues

• Short time scale (1-2 years)

• Recommendations to be based on modeling, analysis of existing data
  – New experiments not envisioned due to short deadlines
Working Groups — Ongoing

WG-1 Waveforms of current in error field correction coils A. Garofalo
- For design of the coil power supplies and analysis of ac losses in these superconducting coil
- Preliminary report June 2010

WG-2 Guideline for optimization of distribution of ferritic inserts M. Schaffer
- Trade-off between TF ripple and low n error fields caused by ferromagnetic inserts of irregular sectors
- Report Dec. 2010

WG-3 Power requirements for ECRH & ICRF control of sawteeth I. Chapman
- Sawtooth stabilization by fast ions, destabilization by local H&CD, sawtooth period to avoid triggering NTMs
WG-4  Diagnostic requirements for MHD stability control  J. Lister
- For control or avoidance of vertical instability, RWM, error fields, NTM, sawtooth, ELM, AE, disruption
- Draft report in preparation

WG-5  Halo currents caused by disruptions  V. Riccardo
- Halo current fraction and toroidal peaking, halo current width, rotation of halo current asymmetry

WG-6  Sideways forces on vacuum vessel and magnets caused by disruptions  T. Hender
- Assessment of models and measurements for horizontal forces on vacuum vessel, PFC, and magnets
New Working Groups for 2011 – Being Defined

**WG-7** Resistive wall mode feedback control
- Assess capability of ITER ELM coils to stabilize RWMs

**WG-8** Radiation asymmetry during MGI
- Recommendation on the minimum number of ports for MGI

**WG-9** Criteria for error field correction
- Limits on low n error fields for avoidance of locked modes (at low and high $\beta_N$) for resonant and non-resonant magnetic fields
Please Participate!

• Help needed with joint experiments, working groups, and other activities

• You do not need to be an “official” member to attend meetings and participate in other ways

• Next MHD group meetings (tentatively):
  March 1-4, 2011 - Gandhinagar, India
  October 2011 - Padova, Italy

• Web sites
  http://itpa.ipp.mpg.de/ (old)
  http://www.iter.org/org/team/fst/itpa/ (new)