*Overview of Recent Activities of the ITPA Topical Group on "Steady State Operations and Energetic Particles"**

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Chair, U.S. SSO&EP Topical Group

*** Originally called "Energetic Particles, Heating and Steady State Operation"**

Who?

- **U.S. membership**:
  - *International participants:*
    - C.K.Phillips - Leadeer (PPPL), R. Prater - Co-Leader (GA),
    - P. Bonoli (MIT), C. Forest (U.W.-Madison), W. Heidbrink (UC-Irvine)
  - *Additional U.S. group members:*

    D. Batchelor (ORNL), B. Breizman (IFS), D. Darrow (PPPL),
    N. Gorelenkov (PPPL), T. Luce (GA), R. Nazikian (PPPL),
    P. Politzer (GA), D. Swain(ORNL),J.R. Wilson (PPPL), M. Zarnstorff (PPPL)

- **International SSO&EP Group chaired by C. Gormezano (EU) and S. Ide (Japan)**
  - 5 participants each from EU, Russian Federation, Japan, and U.S.

- ***Attendance at meetings has been open to interested parties - your participation is welcome!***

What and Where?

- ***What*** : ***focus international collaborations in the area of steady-state operation and energetic particle behaviour for burning plasmas***

- **Where**:
  - First meeting in Naka, Japan in February 2002
  - Second meeting in Cadarache, France in October 2002
  - Upcoming meetings:
    - St. Petersburg, Russia in July 2003
      - emphasis on steady-state scenarios; current drive modeling
    - San Diego (General Atomics) in October 2003
      - emphasis on energetic particles and optimization of ECCH system
      - in conjunction with 8th IAEA Technical Meeting on "Energetic Particles in Magnetic Confinement Systems."

Focus of group is on steady-state scenarios for ITER and Burning Plasmas

Group serves to focus international collaborations in the area of steady-state operation and energetic particle behaviour for burning plasmas by:

- encouraging international collaboration on experiments, code developments and modelling activities;
- identifying and formulating Research Priorities for Physics R&D;
- evaluating and documenting the scientific progress and providing an annual written report to the ITPA Coordinating Committee;
- promoting publications and presentations.

Scope includes:

- validate the heating and current drive systems foreseen for ITER;
- active control tools needed for current and plasma control (pellets as well if needed)

[*but general control systems foreseen for an ITER discharge are in TG MHD*]

Three candidate schemes for steady-state operations have been identified

- Hybrid scenarios with very long high fusion yield pulses:
  - high beta, high confinement, high bootstrap, steady current profile but not full current drive.

- Steady state scenario for ITER:
  - high confinement, high beta, f_{BS}=50%, full current drive with well-aligned currents.

- Real advanced scenario:
  - high confinement, high beta, f_{BS}=80% and full current drive with well-aligned currents.

High Priority Research Objectives: 2003

- Multi-machine assessment of candidate steady state and hybrid scenarios;
- Install steady state scenario development data base;
- Explore and develop plasmas with very high bootstrap content;
- H&CD code benchmarking on FWCD, NBCD, LHCD and ECCD;
- Start assessment of reversed shear operational space;
- Modelling of EP collective modes and experiments including quantitative measurements.
- Assess effects on EP of proposed q-profiles for steady state and hybrid scenarios.

Medium Priority Objectives: 2003 and beyond

- Coordinated modelling of ITER scenarios (continuous updates as appropriate);
- Identify an approach to estimate uncertainties in projecting H/CD systems to Burning Plasmas (Develop self-consistent integrated modelling capability for H/CD systems)
- Evaluate ITERH/CD systems in terms of relevance to standard operating scenarios and global Steady-State requirements
- Continue the assessment of ECCD and LHCD system both for NTM stabilization and current profile control
- Need to understand RF-driven rotation
- Assess energetic particles and H/CD diagnostics requested for ITER.
- Continue analysis of ripple induced losses in deeply reversed magnetic shear scenarios;
- Develop global non-perturbative gyro-kinetic models for linear stability of MHD collective effects.

Some ongoing studies by the SSO & EP Group

- P. Bonoli and E, Barbato (FT-U / EU) are coordinating lower hybrid code benchmarking activities.
- T. Luce is providing candidate steady-state and hybrid discharges from DIII-D and is supporting ECCD studies.
- RF SciDAC group is simulating proposed ITER ICRH heating and FWCD scenarios using advanced modeling codes (D. Batchelor, P. Bonoli, F. Jaeger, C.K. Phillips).
- D. Swain has been coordinating the writing of a white paper on the ICRF system for ITER.
- P. Bonoli and C. Forest have been developing a white paper on lower hybrid current drive for ITER.
- C. Gormezano has been coordinating efforts to develop predictive simulation studies using existing transport models and “benchmarked” current drive codes.

Summary

- SSO & EP group has begun internationally coordinated studies of steady state scenarios and supporting heating, current drive and energetic particle physics for burning plasmas, such as ITER
- The group meets twice per year
- Your input and participation is welcome