

# Report from Integrated Scenarios Breakout Session

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*Thanks for contributions from all  
speakers and attendees.*

# Scope of breakout group

- **“Integrated scenarios” group focused on cross-cutting issues, both experiments and modelling**
  - ELMy H-mode, Hybrid, Steady-State operating modes
  - **Heating/CD/Momentum/particle sources.**
  - Core transport, pedestal and divertor compatibility issues.
  - Scenario modelling capabilities and issues
  - **Control - joint session**

# Progress since Snowmass

- Great deal of progress on many fronts, presented by Tim Luce on Wed, and in breakout session.
- Some examples/highlights:
  - Hybrid scenario now obtained and documented on many devices worldwide. Long, steady discharges with  $\beta_N \leq \beta_{N, \text{no wall}}$ ,  $f_{NI} \sim 50\%$
  - 100% non-inductive current with  $\beta_N \geq \beta_{N, \text{no wall}}$ ,  $f_{BS} \sim 65\%$ .
  - Broad ITBs with  $\beta_N \sim 4$ .
  - High performance integrated scenarios beginning on STs.
  - RF physics models much improved via SciDAC initiatives, compared with wave measurements.
  - Community recognition of need for comprehensive modelling effort; FSP launched.
  - Integrated core-pedestal transport modelling beginning.

# ISSUES for Successful BP in ITER

- MANY issues were identified in each subject area and scenario. Several will be covered by other breakout sessions. Focus here on ones not covered elsewhere, or which seem critical to success of ITER scenarios.

## **Heating and Current Drive sources:**

- Are proposed 'day 1' heating and CD sources sufficient?
- Will each source deliver what is expected (eg, ICRF antenna coupling, load tolerance? Gyrotron, NNBI performance?)
- Is Lower Hybrid Current drive needed for ITER scenarios? What are system parameters, including launcher coupling?
- Want FLEXIBILITY in sources to deal with unknowns.

# ISSUES for Successful BP in ITER(2)

“your issues are our issues” - all topical areas impact int. scenarios

- **Many cross-cutting issues are common to ALL scenarios, including baseline Q=10 H-mode.**
- **Particular concern about pedestal/ELM parameters, compatibility with both core confinement and divertor power loading.**
- **ITER regime will be different from most present expts**
  - Low torque/rotation,  $T_i \sim T_e$ , higher  $n/n_{GW}$ , low neutral penetration.
- **Fuelling and particle transport** require further attention for both density profile control and impurity control (eg for radiative divertor).
- **Integrated simulation tools** will be needed for prediction and control.

# Issues for Advanced Scenarios

- Are there limitations for advanced scenarios posed by ITER startup/current ramp evolution? (starting on outer limiter, long L-mode phase...) *Time-critical in case design changes are required.*
- Reaching full long-pulse/ fluence potential will require upgrades to external systems. (heat rejection, cryoplant)
- Hybrid Scenario:
  - Physics of confinement improvement, MHD effect on  $j(r)$  not fully understood, therefore projection to ITER uncertain.
- Steady-State non-inductive:
  - Maintaining self-consistent pressure and non-inductive current profiles in high- $\beta$  self-heated regime: Challenge to modelling and expts.
  - Divertor heat load solution needed.
  - Want experimental demonstrations of stationary, more integrated scenarios (eg, radiative divertor, NTM control,  $q$  control) and over broader, ITER-relevant parameter range.

# BPO Structure to address issues

- Consensus that there **should** be a separate wave-particle topical group in BPO, including RF, NBI. (as in strawman)
  - Would coordinate with ITPA SSO and existing RF groups (eg, RF SciDAC, RF topical conference).
  - Would address the identified H&CD source issues.
- Feel there should also be a standing Topical group on Integrated Scenarios (difference from strawman)
  - Likely to be long term effort, not amenable only to short-term tasks.
  - **A topical group is needed to prioritize, coordinate US efforts to resolve the identified scenario issues, and decide on more specific task groups.**
  - Close contact with other topical groups, esp. Operations and Control.
  - Coordinate with ITPA SSO, Transport and CDBM groups, others, and with US integrated modelling activities, eg PTRANSP, FSP

# Possible BPO TASK groups

Possible near-term activities which could form the basis of future BPO Task groups to address issues were discussed, including:

- **Critical assessment of the heating and current drive mix on ITER (ICRF, NBI, EC, LH) and impact on achievable scenarios.**
  - Task requires further definition by topical group.
- **Limitations to startup flexibility for advanced scenarios**
  - Free-boundary evolution simulations to examine q-profile, L-H transition, additional heating, impurities,...impact on establishing desired plasma profiles/regime.
- **Integrated modeling of ITER fuelling (pellets+gas) and particle transport to assess density profiles, controllability.**
  - Coordinate with ITER, ITPA activities.