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NSTX Boundary Physics Topical Science Group Summary

College W&M
Colorado Sch Mines
Columbia U
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General Atomics
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LLNL
Lodestar
MIT
Nova Photonics
New York U
Old Dominion U
ORNL
PPPL
PSI
Princeton U
SNL
Think Tank, Inc.
UC Davis
UC Irvine
UCLA
UCSD
U Colorado
U Maryland
U Rochester
U Washington
U Wisconsin

V. A. Soukhanovskii, TSG Leader

Lawrence Livermore National Laboratory, Livermore, CA

R. Maingi, TSG Deputy

Oak Ridge National Laboratory, Oak Ridge, TN

D. P. Stotler, Theory & Modeling

Princeton Plasma Physics Laboratory, Princeton, NJ

Culham Sci Ctr
U St. Andrews
York U
Chubu U
Fukui U
Hiroshima U
Hyogo U
Kyoto U
Kyushu U
Kyushu Tokai U
NIFS
Niigata U
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JAEA
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ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep
U Quebec

FY 2009 NSTX Midrun assessment meeting

17 June 2009

Princeton, NJ

Boundary Physics TSG priorities are defined by

- **DOE and NSTX Milestones**
  - **FY 2009 DOE Joint Research Target (JRT, formerly JOULE) milestone:** Conduct experiments on major fusion facilities to develop understanding of **particle control and hydrogenic fuel retention** in tokamaks.
  - **FY 2010 DOE Joint Research Target (JRT, formerly JOULE) milestone:** Conduct experiments on major fusion facilities to improve understanding of the **heat transport in the tokamak scrape-off layer** (SOL) plasma, strengthening the basis for projecting divertor conditions in ITER.
  - **FY 2010 Research Milestone R(10-3):** Assess H-mode **pedestal characteristics and ELM stability** as a function of collisionality and lithium conditioning.
- **ITPA participation, ITER needs**
- **ST development path needs**

Three Boundary Physics TSG priorities have been defined for FY 2009 run

- Assess hydrogenic species **retention**, and characterize **pumping** of hydrogenic species by lithium coated plasma facing components (FY 2009 Joule milestone)

- Determine the relationship of **ELM properties** to discharge boundary shape, lithium conditioning, and 3D resonant magnetic perturbations (RMPs), and compare **stability of pedestal/ELMs** with model calculations (R10-3)

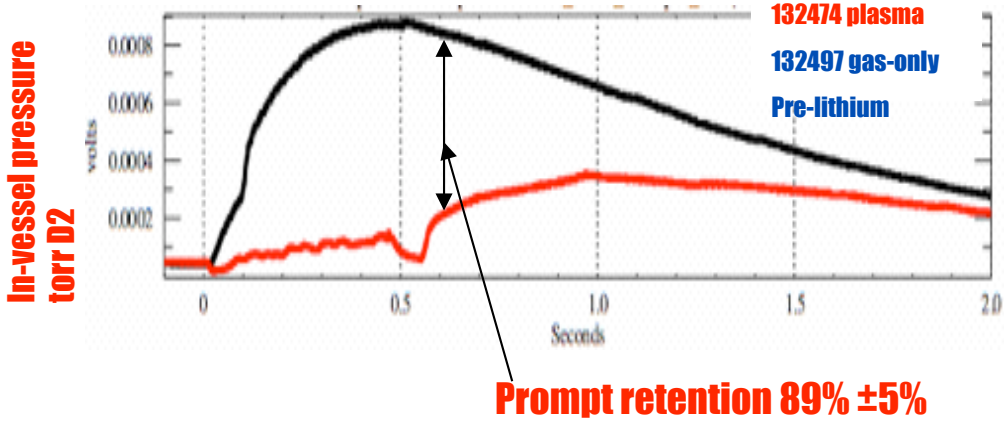
- Compare divertor heat flux widths to midplane density and temperature widths and edge turbulence characteristics, and determine the scaling of SOL and divertor heat transport (FY 2010 Joule milestone)

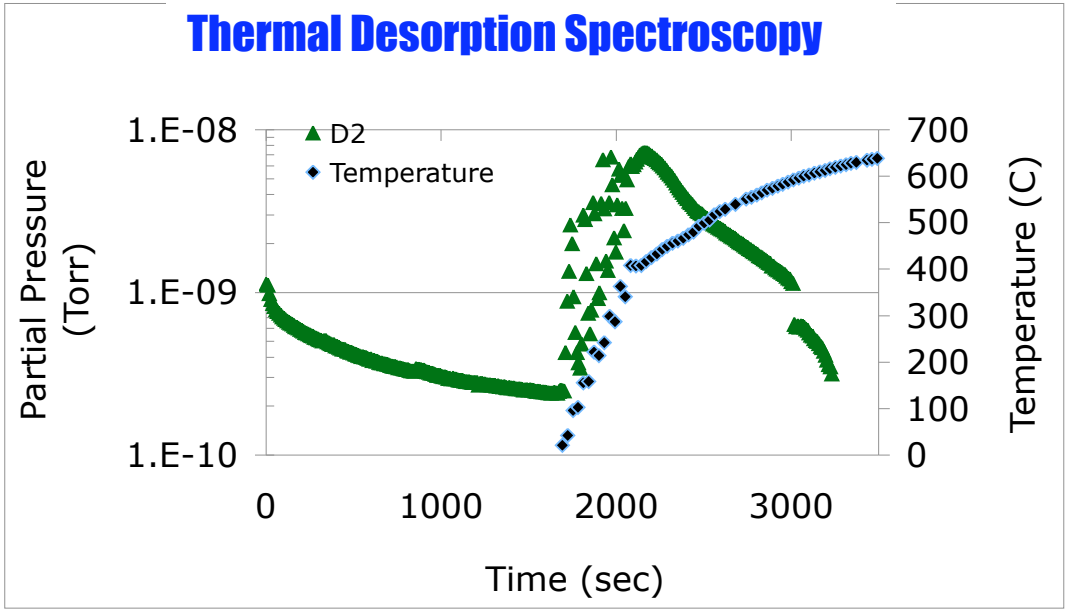
Summary of completed experiments

- XP 911 - C. H. Skinner, FY 2009 Retention and pumping milestone
- XP 923 - R. Maingi, FY 2010 SOL thermal transport milestone
- XP 912 - V. A. Soukhanovskii, Pedestal fueling comparison with SGI and gas
- B. Nelson, Divertor biasing with CHI

XP 911, Lithium pumping and retention, by C. H. Skinner *et al.*

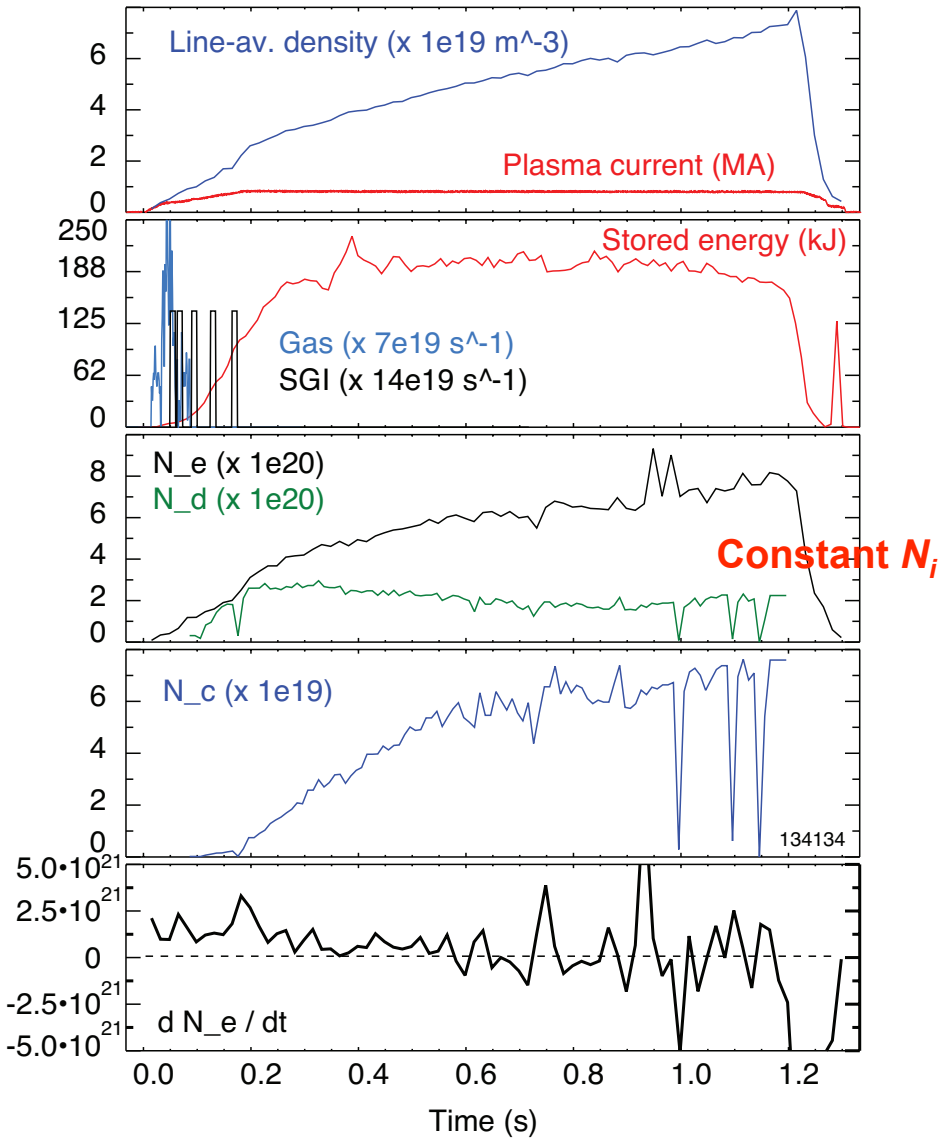
- Gas balance measurements showed high (>90%) prompt retention, that decreased due to post-shot outgassing.
- As part of a collaboration with Purdue University ATJ graphite, Si and Pd samples were exposed to the plasmas by a sample probe at Bay J.
- After exposure, thermal desorption spectroscopy was performed on an ATJ sample. Background thermal desorption from samples unexposed to NSTX plasmas was also measured.
- Twelve samples have been shipped to Purdue University for further surface analysis





XP 912, Pedestal fueling comparison by SGI and LFS gas, by V. A. Soukhanovskii *et al.*

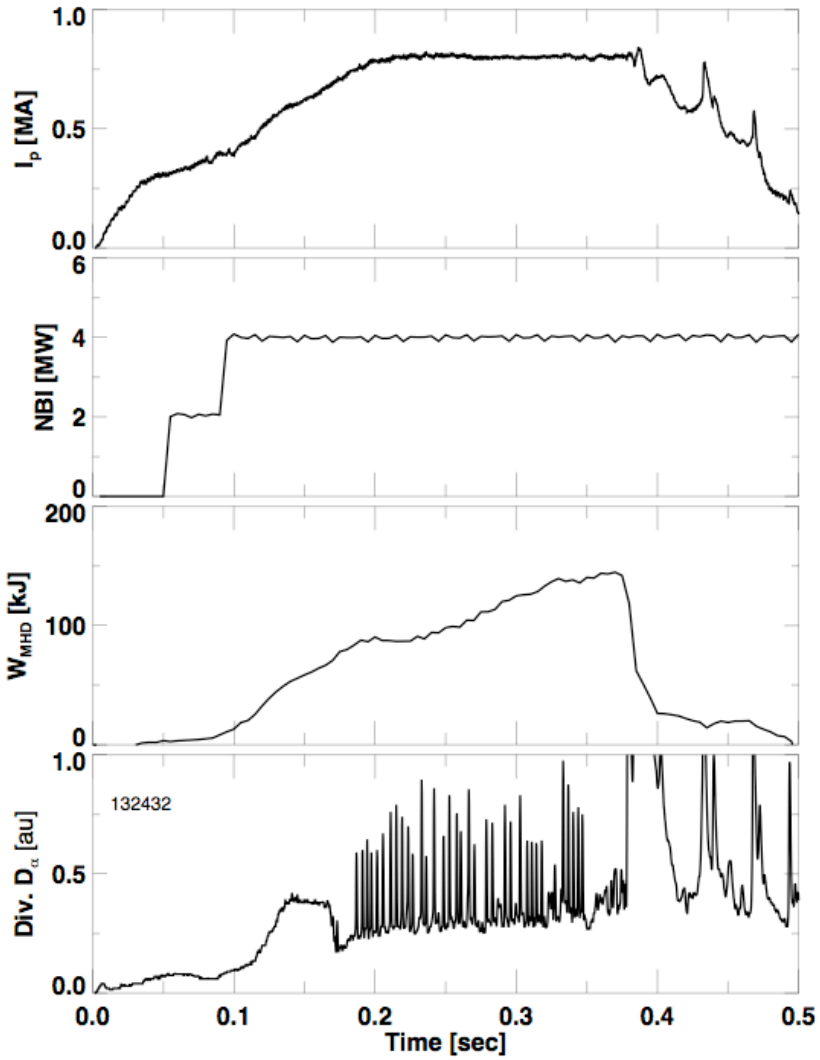
- Obtained n_e-matched discharges with CS+LFS and CS+SGI fueling
  - Needed 1.3-2 x rate of LFS gas injector to maintain same density
- Obtained good n_e and T_e profiles (at outer gap ~ 10 cm) to compare SGI and LFS fueling
  - Will analyze pedestal height and width in collaboration with ORNL
- Developed shoulder and SGI long pulse fueling scenarios
- Developed SGI-only fueling scenario with ion density control
  - N_i constant, while N_e is rising due to carbon; LITER at 9 mg/min

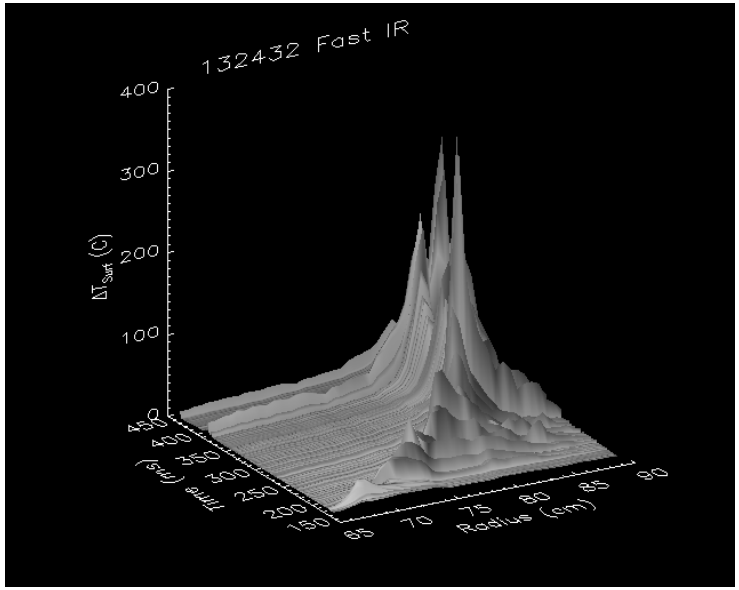


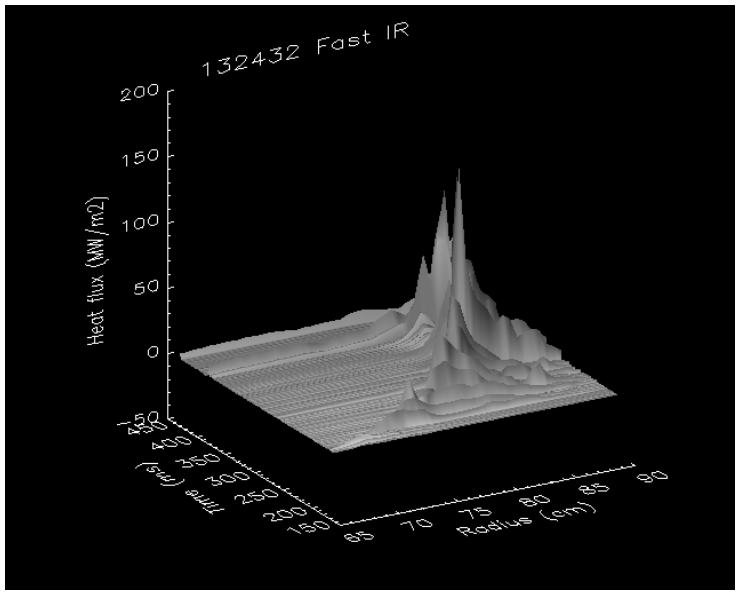
XP 923, Thermal SOL transport studies, by R. Maingi *et al.*

- Goal: obtain heat flux and turbulence data for comparison with C-Mod, DIII-D
  - Simulation with fluid and turbulence codes planned
- I_p scan: 0.6–0.8 MA in 0.05 MA steps; P_{NBI} scan: 2–6 MW in 1 MW steps
- Abbreviated P_{NBI} and I_p scans in high δ shape discharges
- Note: running this XP early in year pre-lithium was tough, due to machine conditions. Limits:
  - Fast IR camera only looking at low δ (ok later)
  - Only 8 channels of new bolometer
  - Likely require more data next year, analysis pending

XP 923 obtained an initial data set for FY 2010 JRT







Fast camera data – J.-W. Ahn (ORNL)

Boundary Physics TSG FY 2009 summary

- **Experiments completed to date**
  - C. H. Skinner, FY 2009 Retention and pumping milestone
  - R. Maingi, FY 2010 SOL thermal transport milestone
  - V. A. Soukhanovskii, Pedestal fueling comparison with SGI and gas
  - B. Nelson, Divertor biasing with CHI

- **Revised prioritized list of remaining experiments**

Top equal priority

- J. Canik, Magnetically triggered ELMs in Li-conditioned discharges (1 day)
- A. Sontag, ELM stability dependence on triangularity (1 day)
- S. J. Zweben, Ultra-high-speed GPI measurements of the L-H transition (0.3 day)

Second tier

1. V. A. Soukhanovskii, Snowflake divertor (1 day)
2. C. H. Skinner, Dust transport and modeling (0.5 day)
3. V. A. Soukhanovskii, Radiative divertor with impurity injection (1 day)
4. C. H. Skinner, Dust mobilization from ITER-scale castellation gap (1 day)

Boundary Physics TSG strongly supports the reversed B_t campaign proposal

- Unique opportunity for BP TSG to study pedestal and ELM stability, SOL and divertor heat and particle transport in LSN discharges with **B x grad B** up
  - Extensive diagnostic coverage of lower divertor

Two experiments proposed:

1. Operational space of L- and H-mode discharges, and L-H threshold at reversed B_t (1 day)
2. SOL and divertor transport and turbulence ("Edge characterization") with reversed B_t (2 days)
   - Include scans of P_{NBI}, I_p, n_e (n_i) in low and high κ, δ configurations
   - Focus on SOL / divertor measurements for transport and turbulence
   - Divertor detachment with D_2 puffing
   - Large database of **B x grad B** case from previous years for comparison
   - Modeling with UEDGE, SOLPS, and BOUT codes for interpretation