NSTX Physics Projections and Analysis

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NSTX Research Forum

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Outline

NSTX

- Design modification - Addition of PF5 coil
- Projections of operating parameters
- Physics Analysis Responsibilities
  - Data acquisition/management/access and tools
  - Theory
  - Remote collaboration

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Boundary Shape Effects

NSTX

- Off-axis “dimple in outer boundary due to proximity of PF4 to plasma
- Boundary deformation resulted in a ~20% reduction in -limit for high- , high-bootstrap optimized profiles

- Studied plasmas with larger separations between OFS and PF coil
  - Move plasma boundary in up to 15 cm
  - Move PF coil out
- Settled on configuration with new PF ~ 20 cm farther out than PF4
  - High- (40%), high-bootstrap (f_{bs}~0.75) target recovered
- Moved original PF vertically
  - Additional PF coil allows greater shape flexibility

Parameterized Shape Case Stable to Edge Ballooning

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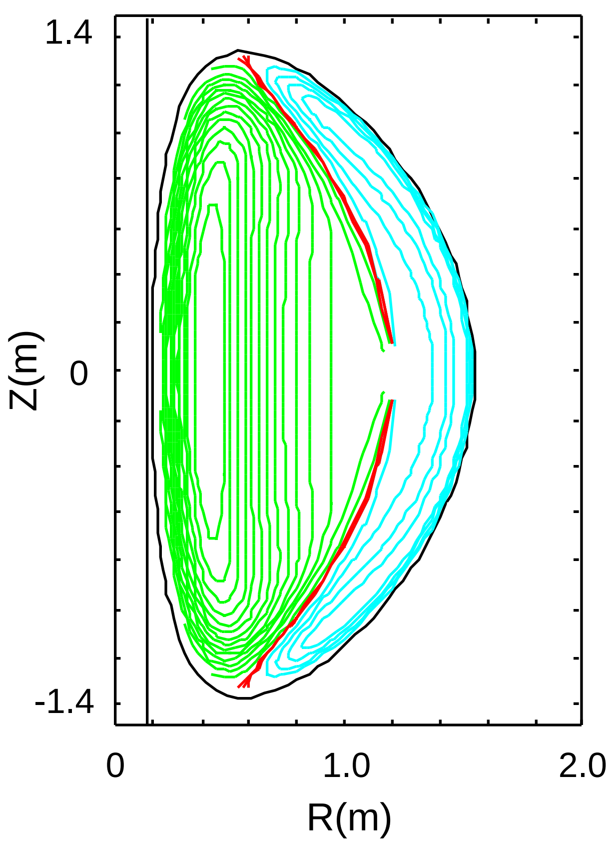
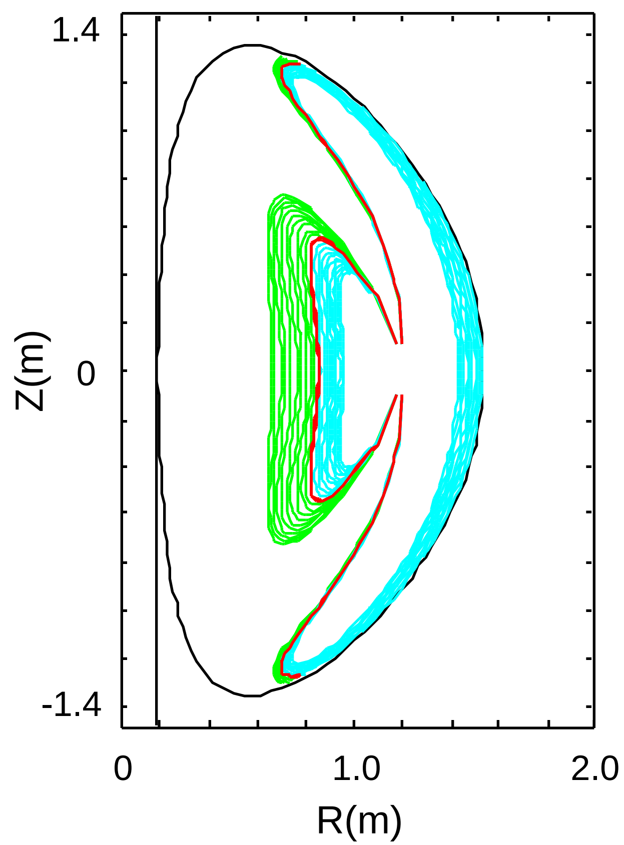
|S| > 0 in regions of large | p k | > 0 on bad curvature side

Small | p k | in regions where |S| 0

Local shear S (Stabilizing)



Local   p k (Destabilizing)



Red = 0
Light blue > 0
Green < 0

J. Manickam (PPPL)

Dimple creates regions of low local shear near edge

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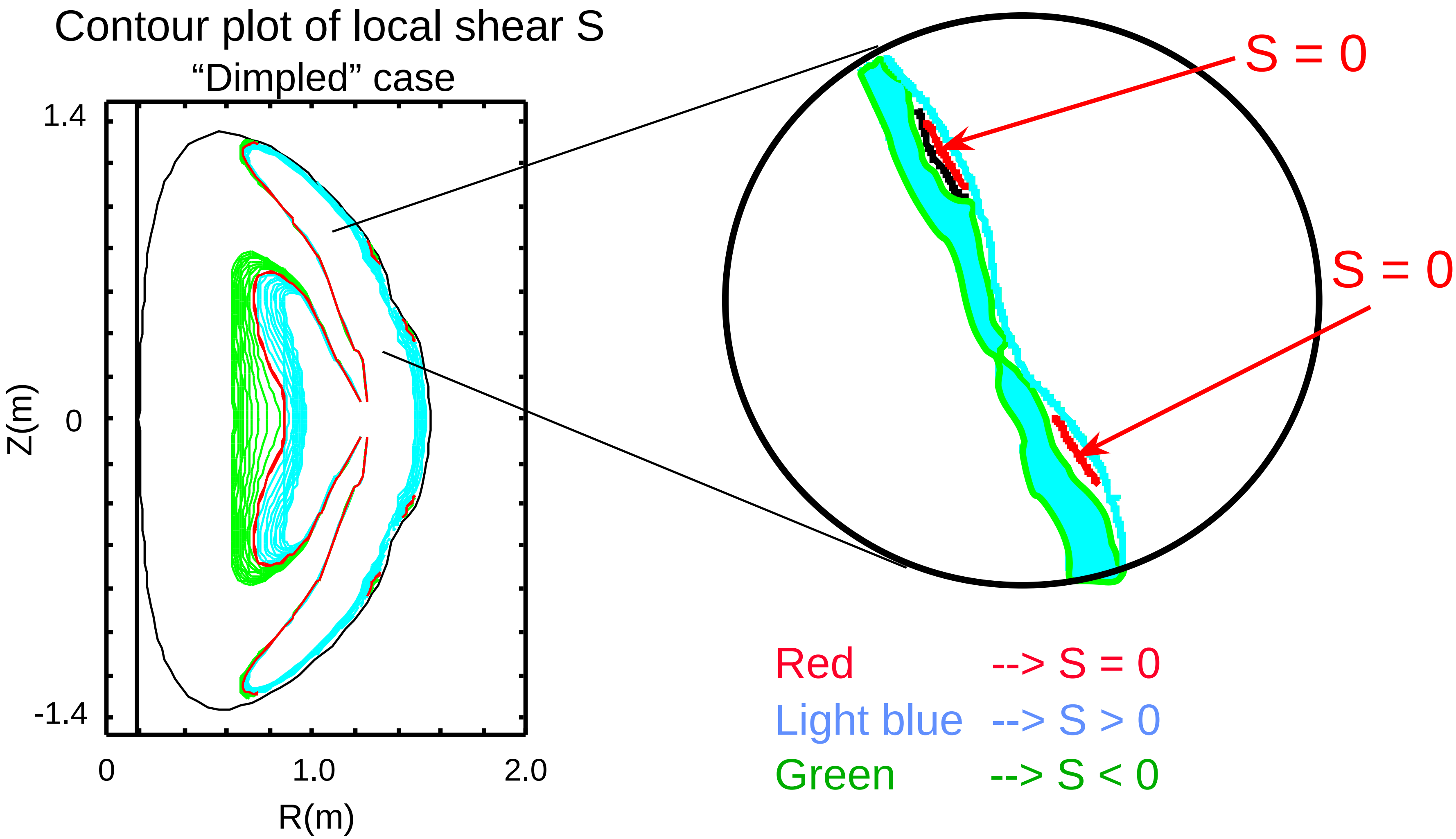

Red --> S = 0
Light blue --> S > 0
Green --> S < 0

J. Manickam (PPPL)

Large p k and low S trigger local high-n instability

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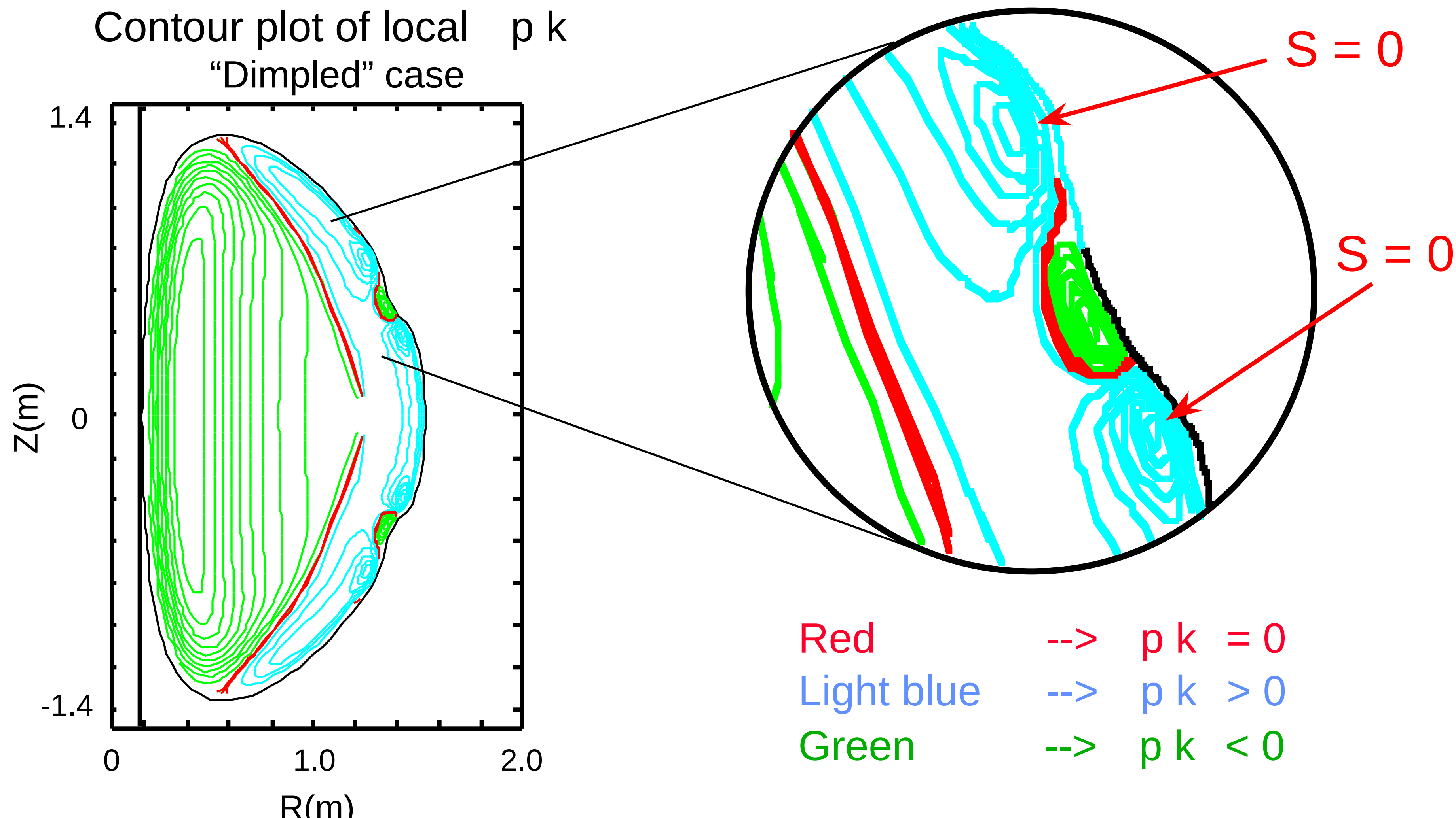
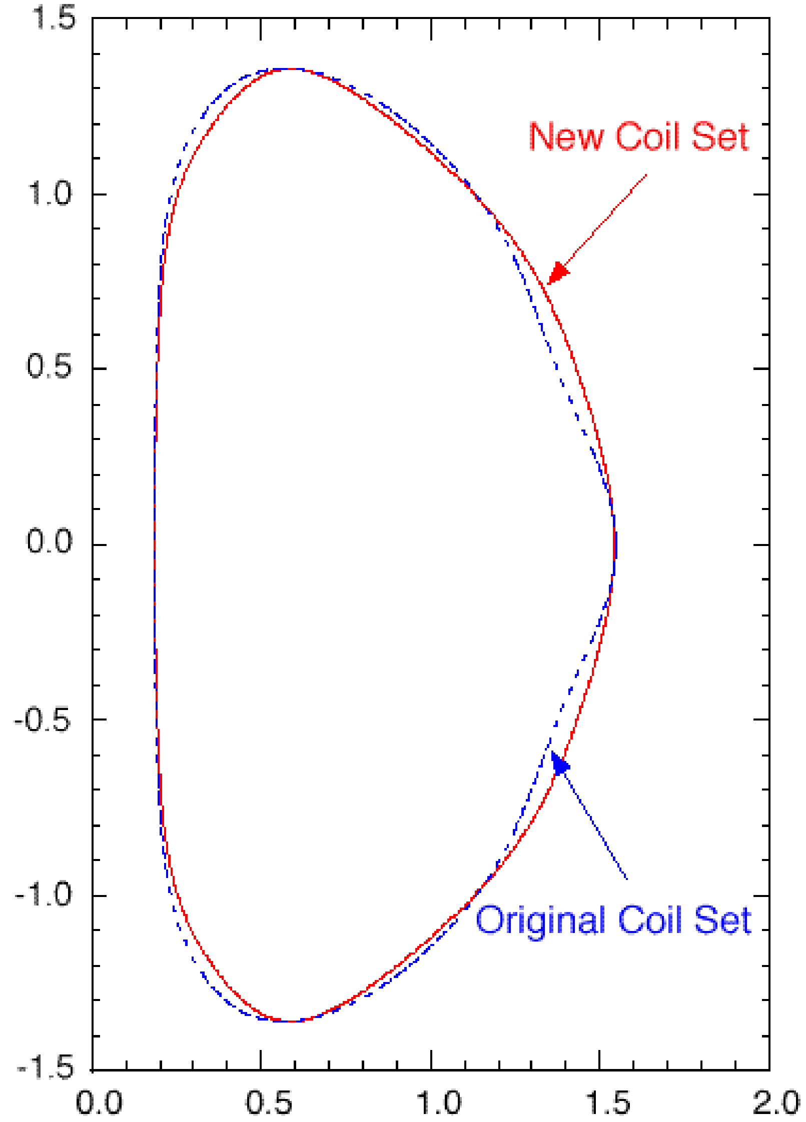


J. Manickam (PPPL)

Comparison of Outer Boundary Shapes with Old and New Coil Sets

No dimple with new coil set



n=1 Kink Mode Limits β

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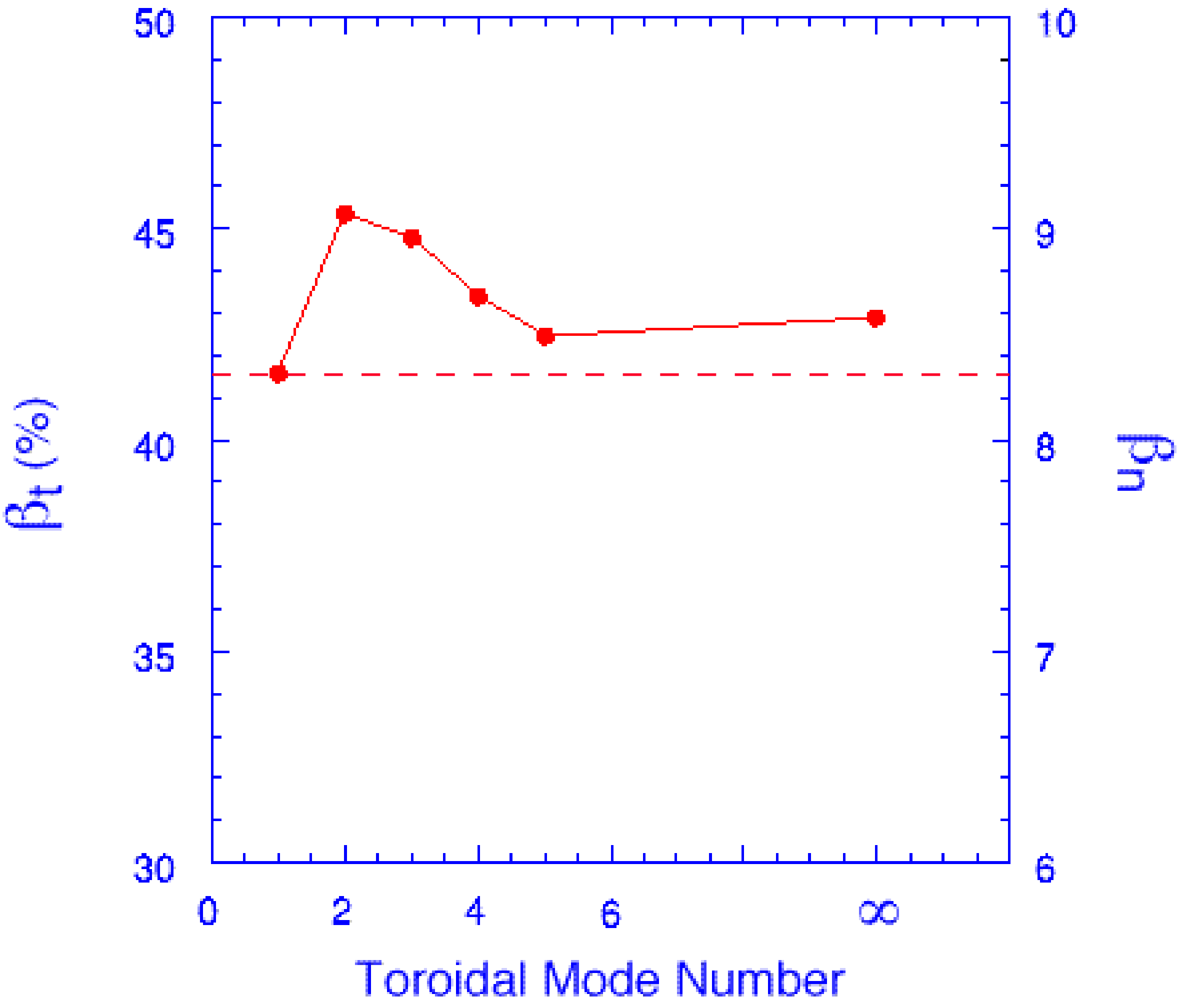

Enhanced Shape Flexibility with Additional PF coil

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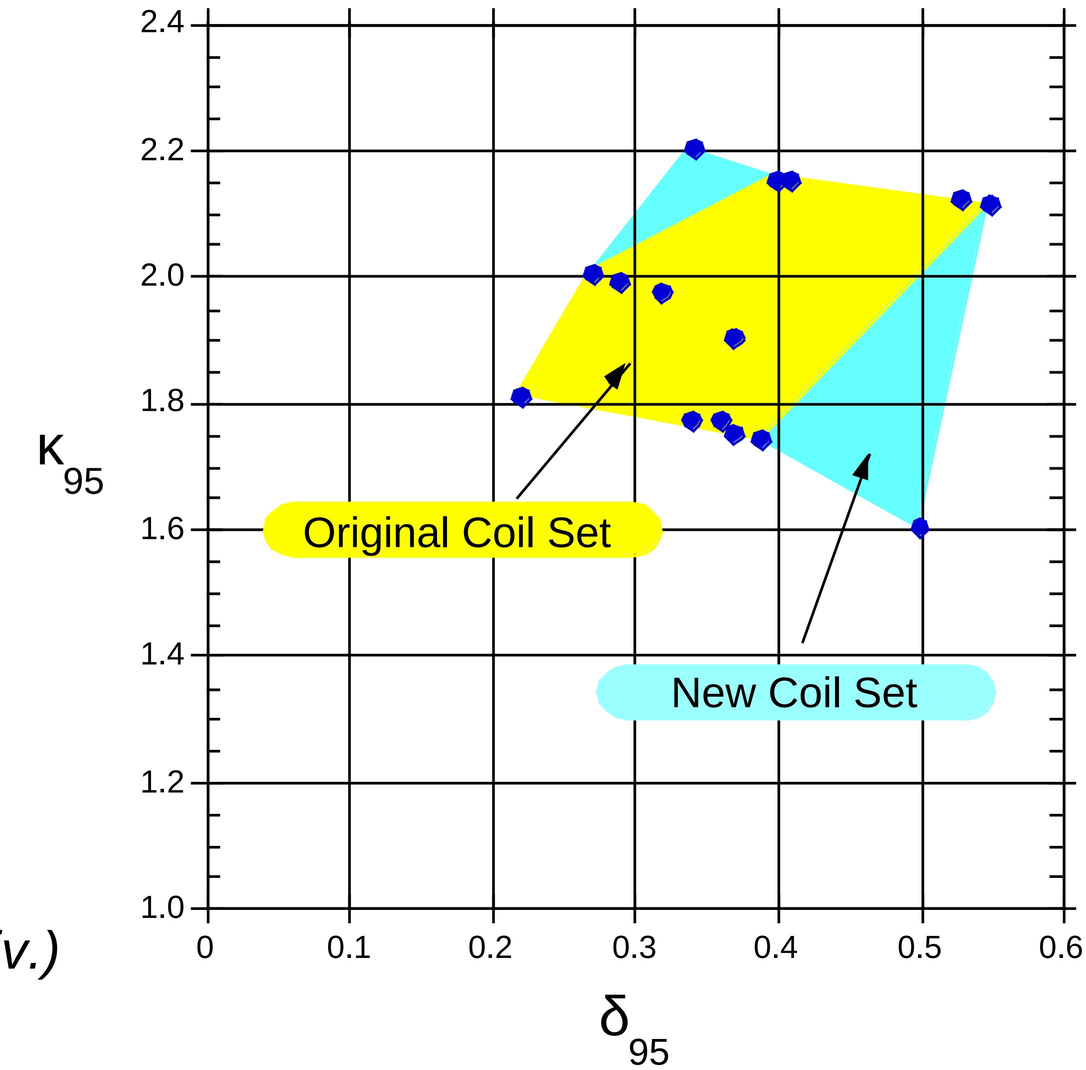
Double Null Equilibria

l_i =0.2-1.0 β_t=0-45%

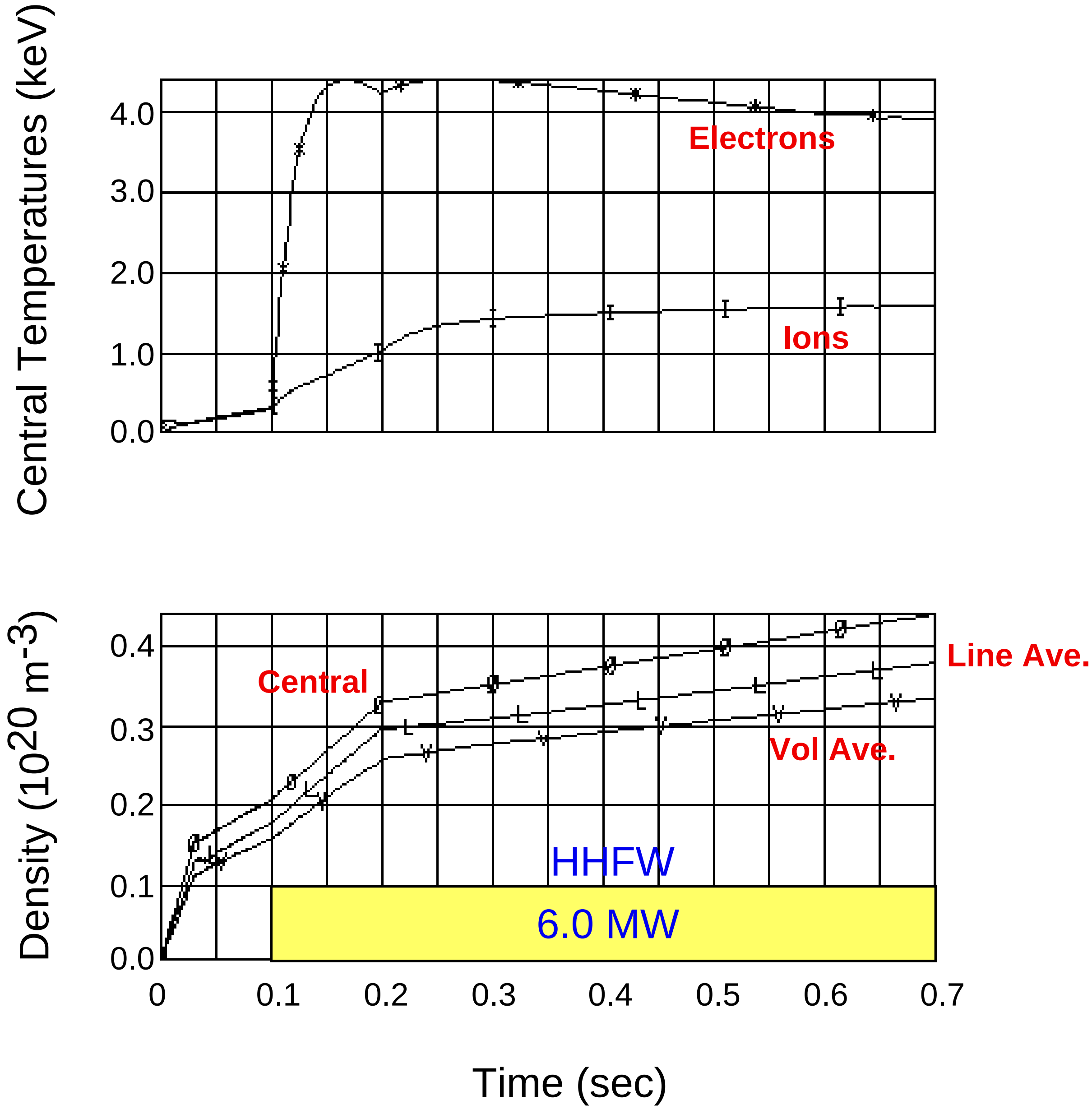


(F. Paoletti, Columbia Univ.)

TSC Simulations

- 1.25 LGC

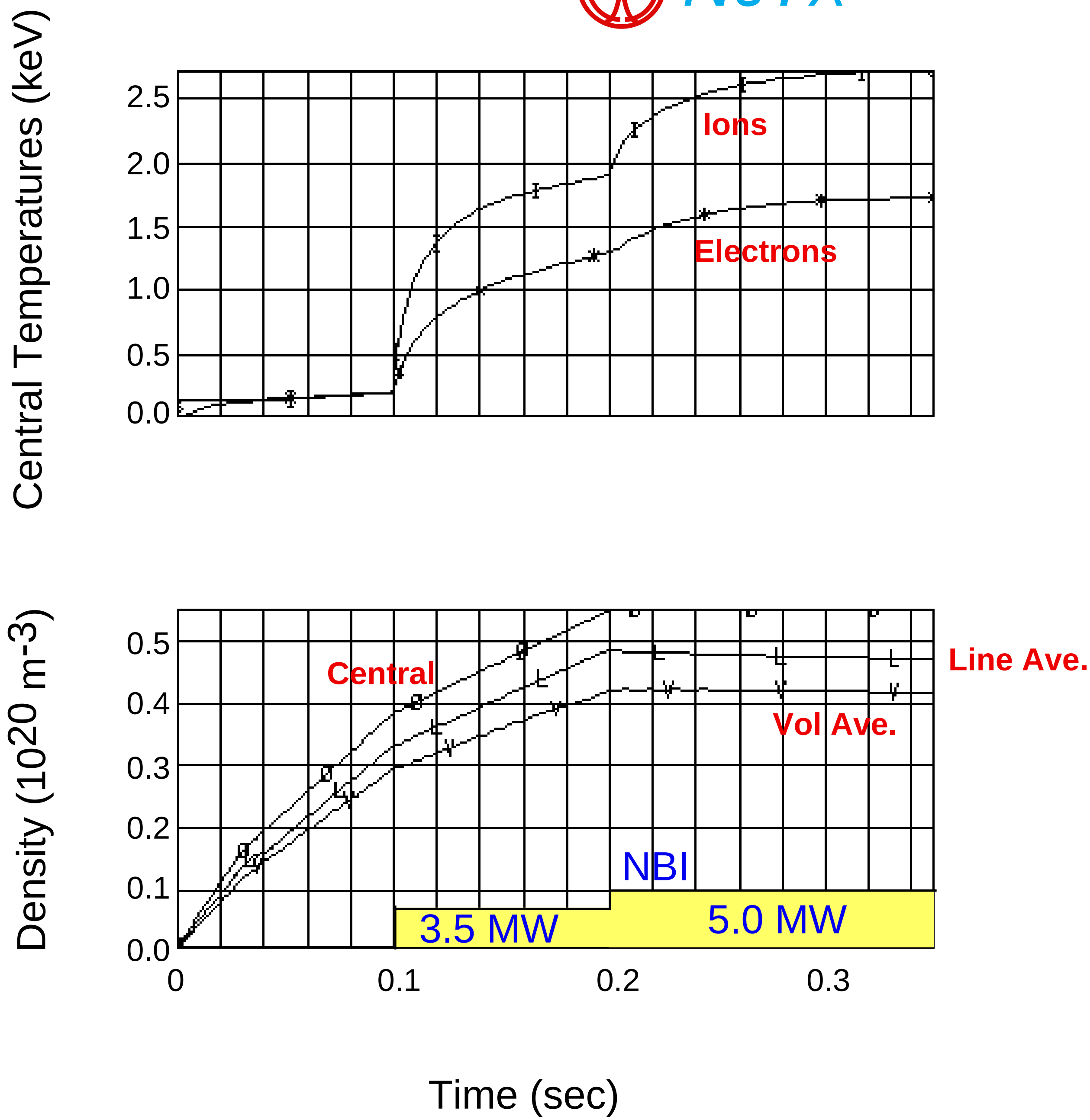
- HHFW Heating Only



TSC Simulations

- 1.25 LGC

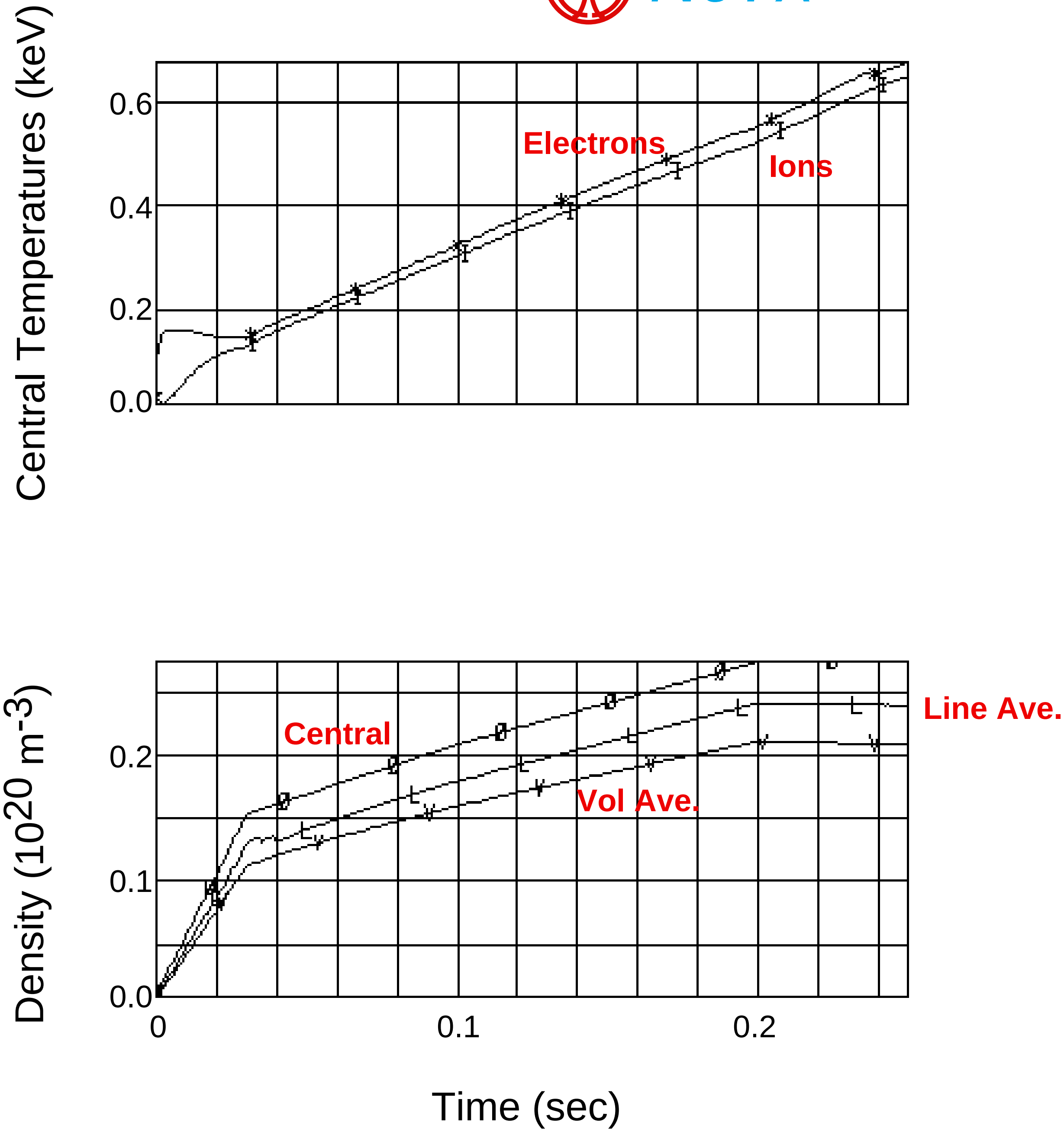
- NB Heating
  Only



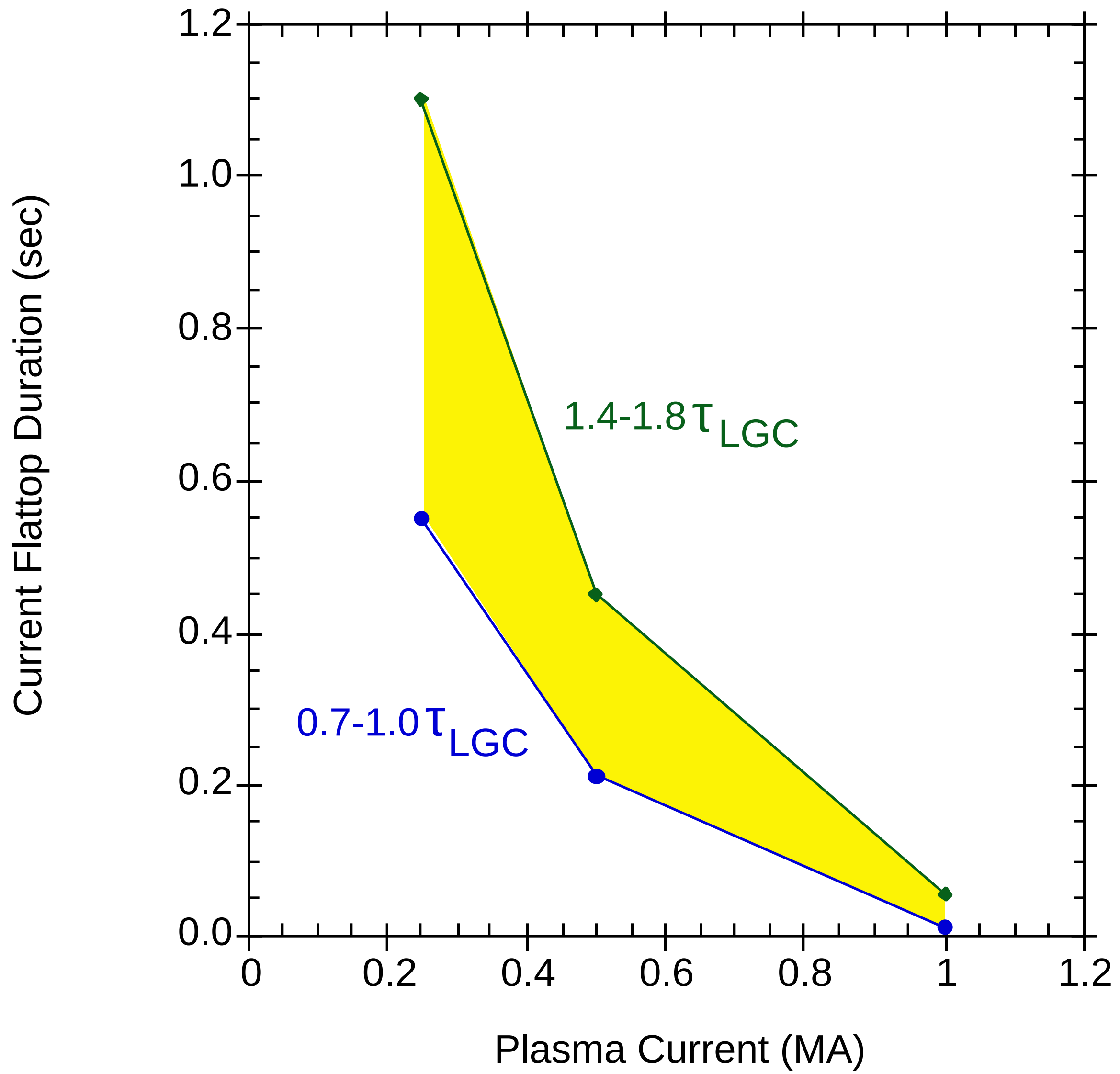
TSC Simulations

- 1.25 LGC

- OH Heating Only



Current Flattop Duration - OH Heating Only

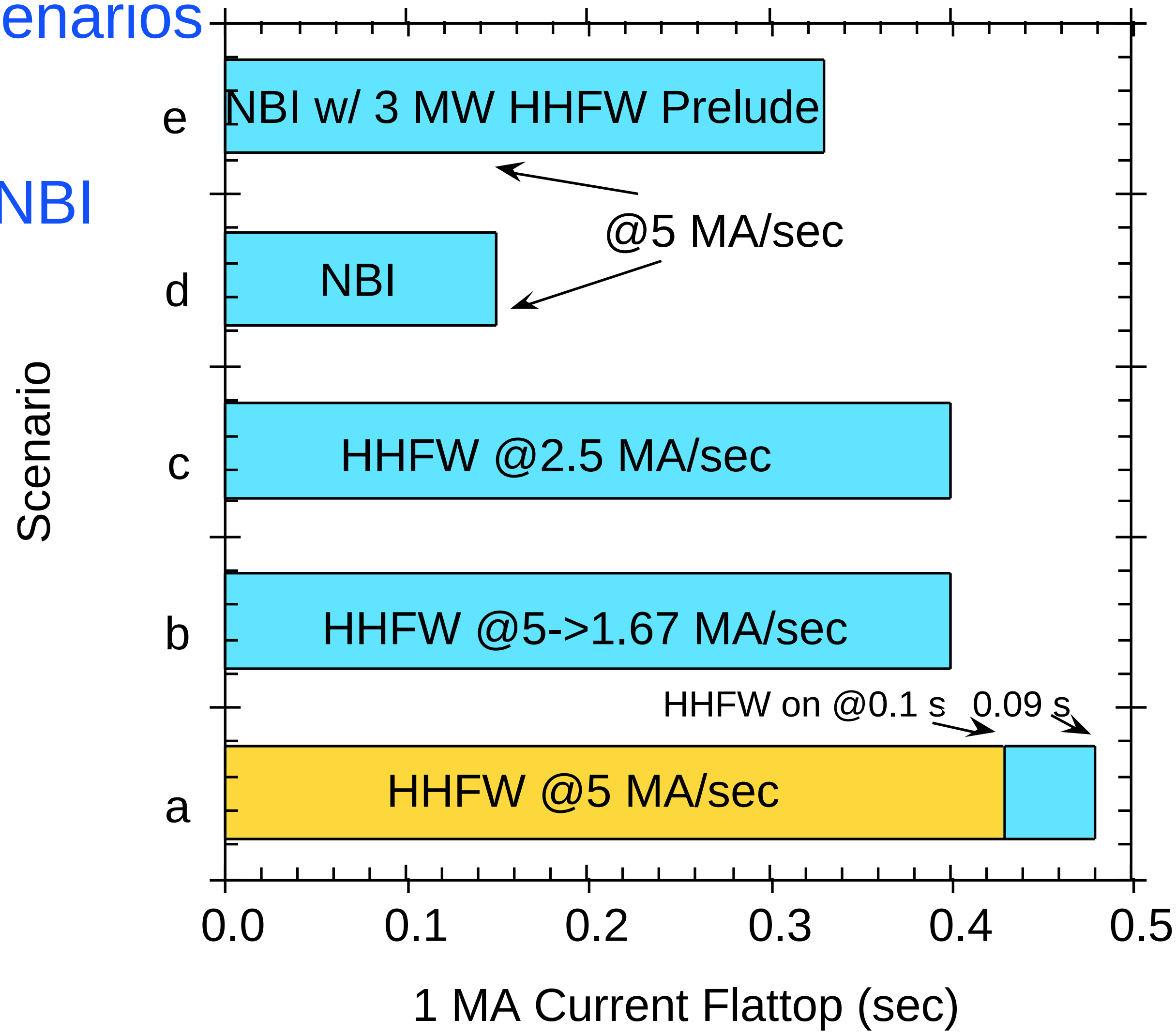


Current Flattop Duration

NSTX

Inductive Discharge Scenarios

6 MW HHFW, 5 MW NBI



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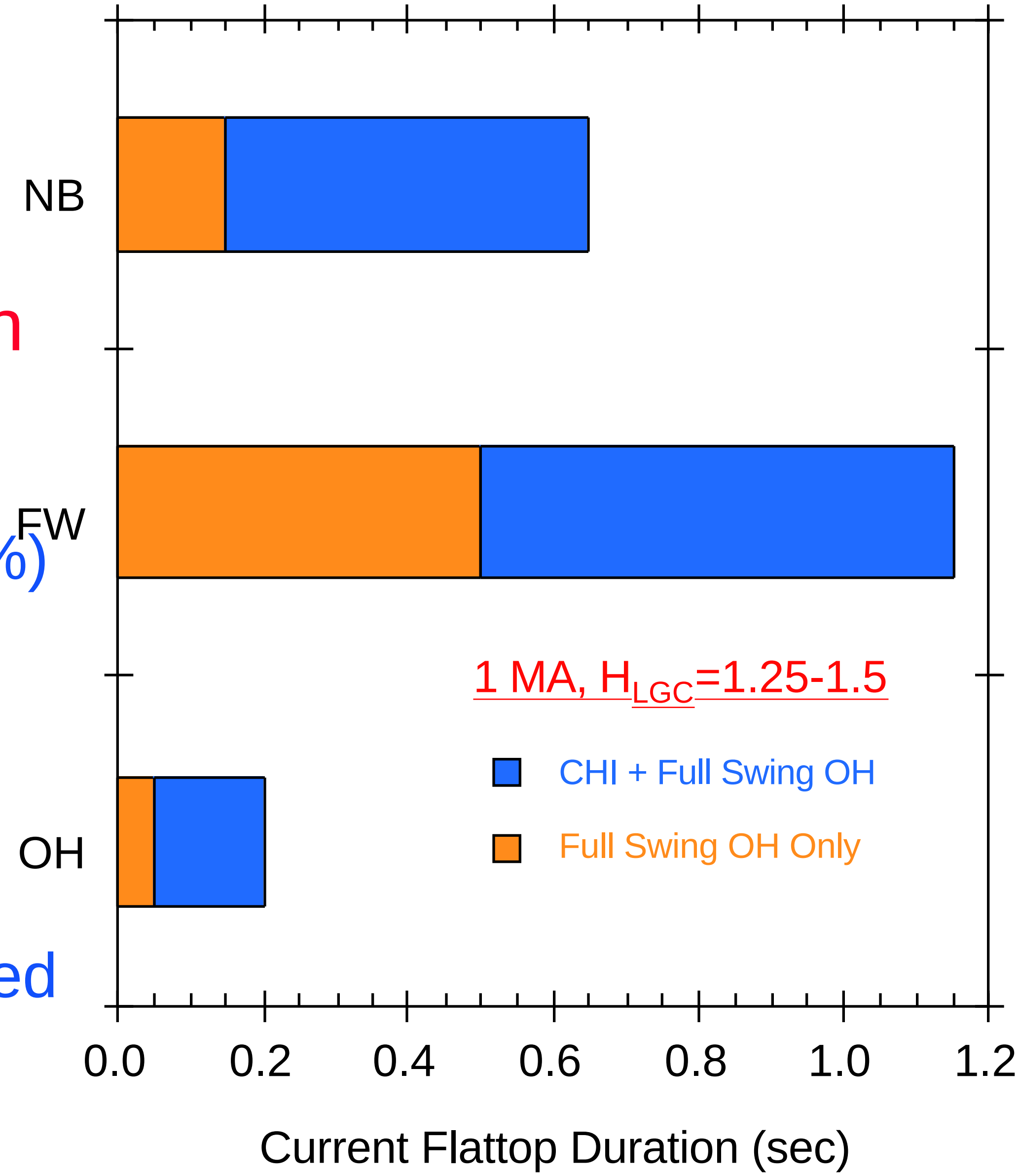
0.5 MA CHI target greatly extends 1 MA current flattop duration

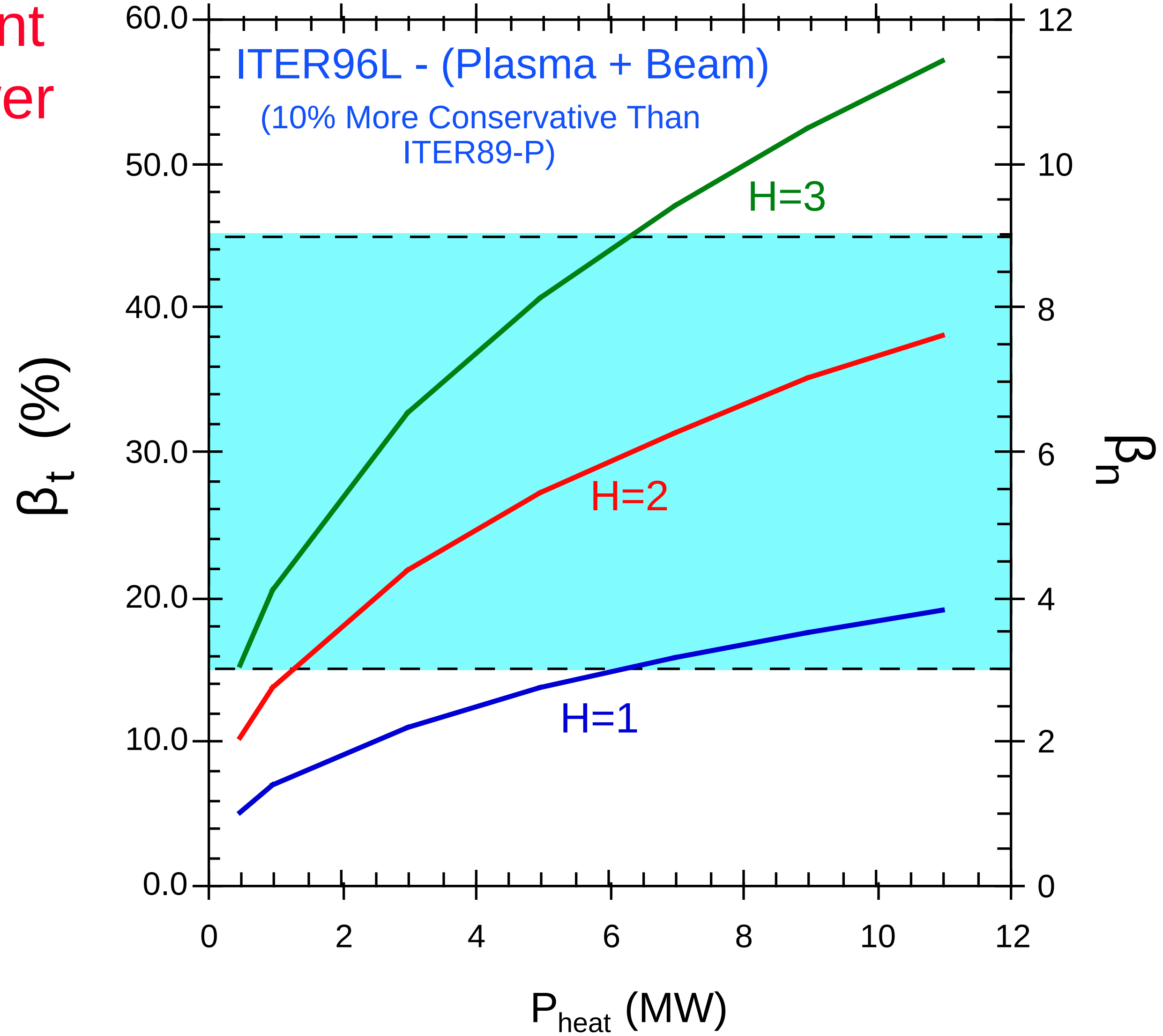
First Regime Plasmas
(q_0~1, $\beta \leq$ 25%)

Bootstrap CD Included

HHFW, NB-CD Not Included



Enhanced Confinement and/or Additional Power Necessary to Achieve Target of 40% β_t



Phases of an Experiment

- XP development/approval/scheduling -
  Run Coordinator

- XP execution -
  Experimental Research Operations

- Analysis/results/publication -
  Physics Analysis

Physics Analysis Responsibilities

NSTX

- Support of data analysis in control room and off-line
  - Data acquisition & management tools
  - Modelling (e.g., TRANSP, EFIT, RF, NBI,...)
  - Data validation using analysis tools
  - Data access policy
- Scenario development
  - Support of XP preparation (short-term)
  - Discharge optimization (long-term)
- Theory Integration

Physics Analysis Responsibilities (cont'd)

NSTX

- Remote collaboration (facilitate data analysis and communication for entire research team)
- Plasma control system development
- Interface with Computer Division to ensure proper support for data acquisition & analysis
- Work closely with RC and TF leaders to ensure
  - Data acquisition and analysis can support XPs and project goals
  - Timeliness of results
- Coordinate Physics meetings
- Coordinate dissemination of results through publications and conferences
  - Publication policy

Data Acquisition/Management

- NSTX has adopted the MDS+ system (Traverser, Scope)
- Data display tools are IDL based (FAS, Review+)
- Database management through MS-SQL
  - Accessible through IDL/MDS+
  - Porting LOCUS and MINGL utilities
  - Start with MIT LOGBOOK for comments
- Mixed VMS/UNIX now; evolving towards UNIX
- Active collaboration with MIT and GA for software development and sharing

Other Analysis Tools

- EFIT for equilibrium reconstruction
  - Future real-time control algorithm based on real-time EFIT
- TRANSP for transport analysis
  - Between-shots and “off-line”
  - HHFW ray tracing for heating and current drive profiles (also important for equilibrium reconstruction)
  - Guiding center approximation for NBI may be problematic at high-q_0
- TSC for predictive simulations

Data Access Policy Draft

It will be the responsibility of the diagnostics physicists to produce calibrated and validated observables in a timely fashion. This means reducing the measured raw signals to a form that can be used for analysis in support of the ongoing experiment or subsequently, and then validated and released by the responsible diagnostic physicist for such use. This data will hereafter be referred to as “validated reduced data”.

Validated reduced data will be available to the entire NSTX physics group for high-level physics analysis. There will be no restrictions on any individual or group of individuals from performing high-level physics analysis that uses validated reduced data, regardless of who performed the original measurements. The high-level analysis can be either between-shots (in support of the on-going experiment) or “off-line”.

The results of the high-level analysis, when validated, will be available to the entire group.

Data Publication Policy Draft

It is expected that the responsible physicist will write up as first author the first results from his/her efforts. “Efforts” includes diagnostic measurements, subsystems, experiments, analysis, etc. In later papers, if he/she is actively involved in the analysis of the data, he/she would be in the first alphabetical group of authors (after the first author). In general, authorship priorities are

1) first author - person who leads the effort in the experiment or the analysis, and who writes the paper

2) first alphabetical group of authors (after first author) - persons who have actively contributed to the work through experiment, analysis, writing, etc.

3) second alphabetical group of authors - other persons who have contributed to the work through data, operations, analysis, etc.

When publication rights on authorship priorities are in contention and cannot be resolved at the Divisional level, the decision will be made by the User’s Group using prevailing professional standards.

Theory Tasks (J. Manickam)

- Generally a low level of support (fractions of FTE) this FY
- Gyro-fluid, gyro-kinetic modelling with rotation effects
- TAE modes and expected fast ion losses
- RF and bootstrap modelling for non-inductive startup
- Resistive and neoclassical tearing modes (NIMROD)
- Coupling of equilibrium and stability codes
- Fast equilibrium reconstruction

Remote Collaboration (S. Sabbagh)

NSTX

- Facilitate collaboration from remote desktop or meeting room
- Operations
  - Common data management system (MDS+/IDL)
  - Control room cameras/interactive audio*
  - On-site contact for remote diagnosticians
  - “Persistent space” for communications*
- Physics/Operations meetings
  - Interactive audio/hi-res slide projection over WEB*
  - “Tape delayed” broadcasts of meetings over the WEB*
- Outstanding issues
  - Remote control of diagnostics

* proposed