Particle balance assessment in NSTX: strategy and tools.

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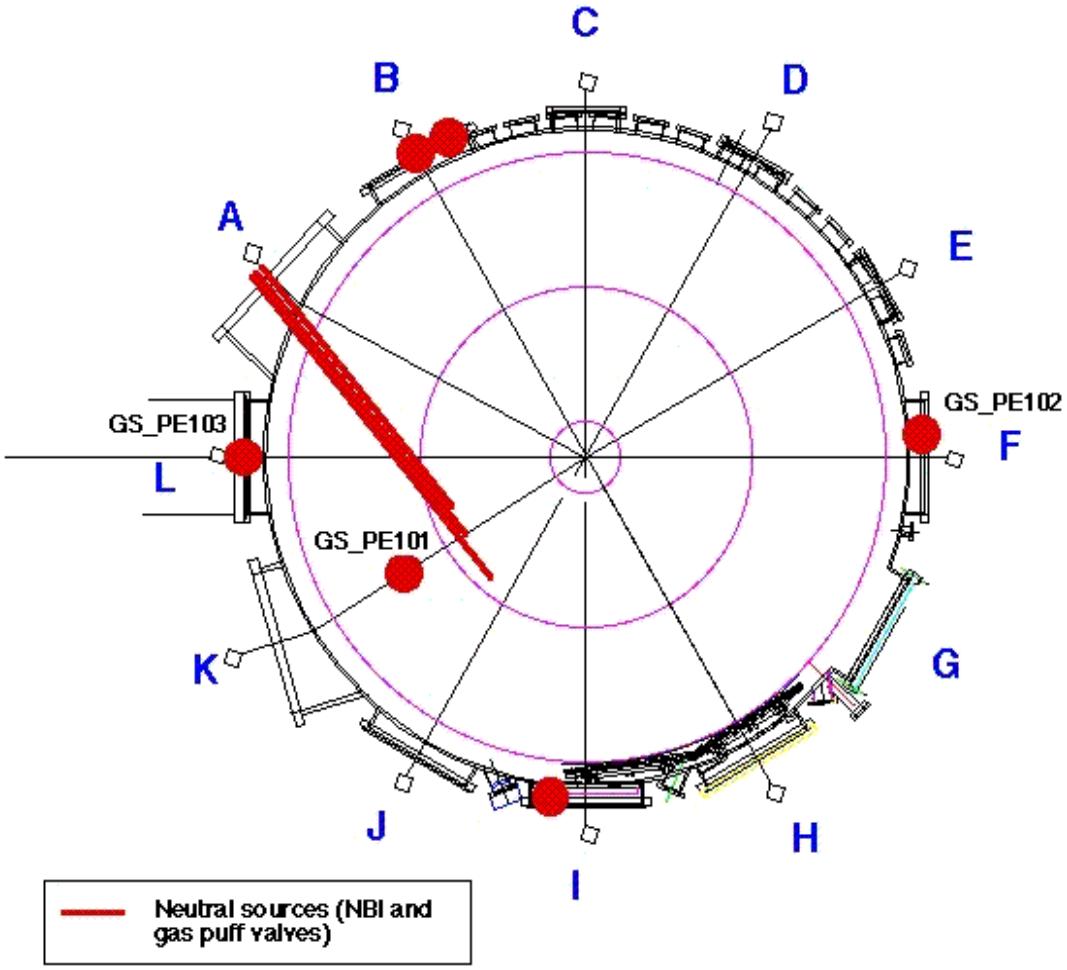
Strategy for particle balance assessment

Plasma operations	Confinement and Transport	Boundary physics

Particle balance

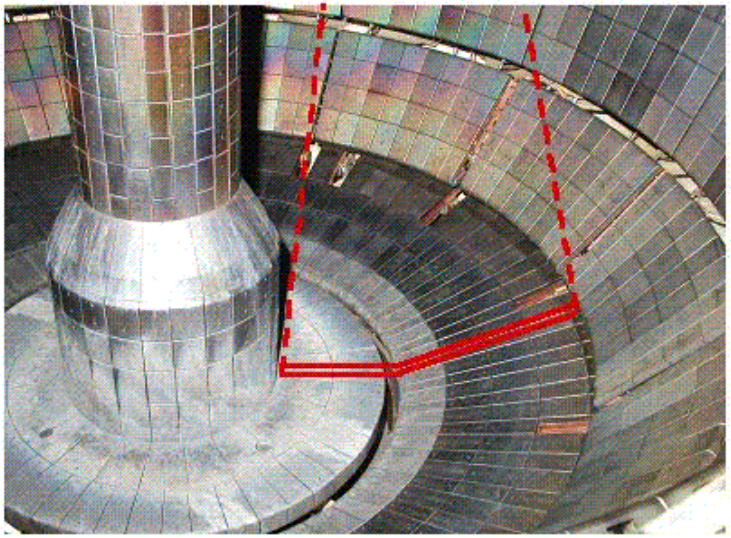
- Understand particle sources, sinks, total inventory
- Determine efficiencies of fuel and exhaust sources
- Determine density limits and scaling laws
- Determine particle confinement and scaling laws

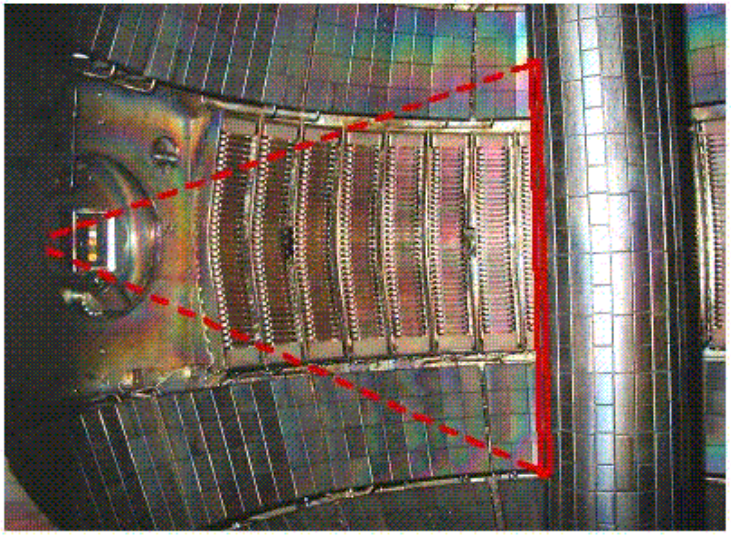
Particle sources, sinks and diagnostics

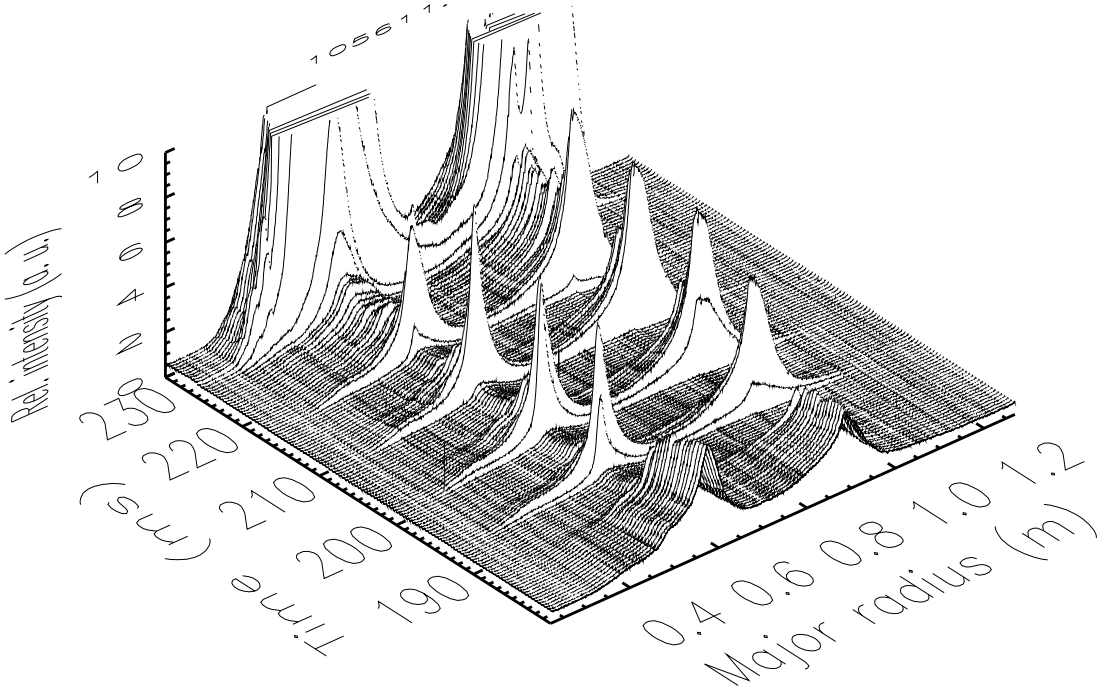


- Plasma configurations: inner wall limited (IWL), diverted (LSN, DND)
- Fuel gases: D2, He
  Puffed mostly from midplane Bay F valve at R < 150 torr l /s
- Other gasses (He, Ne, Ar) puffed from Bay B, Bay I valves
- Vessel volume: 28.7 m^3,
  plasma volume 10 - 11 m^3
- Heating: OH (1 MW),
  HHFW (6 MW), NBI (5 MW)
- Wall conditioning: He GDC,
  TMB and plasma boronization
- Extensive profile diagnostics (MPTS, FiReTiP, UCLA MMWR, NPA, spectroscopy)

Spectrally filtered 1-D 4.8 kHz CCD arrays (ORNL - PPPL)

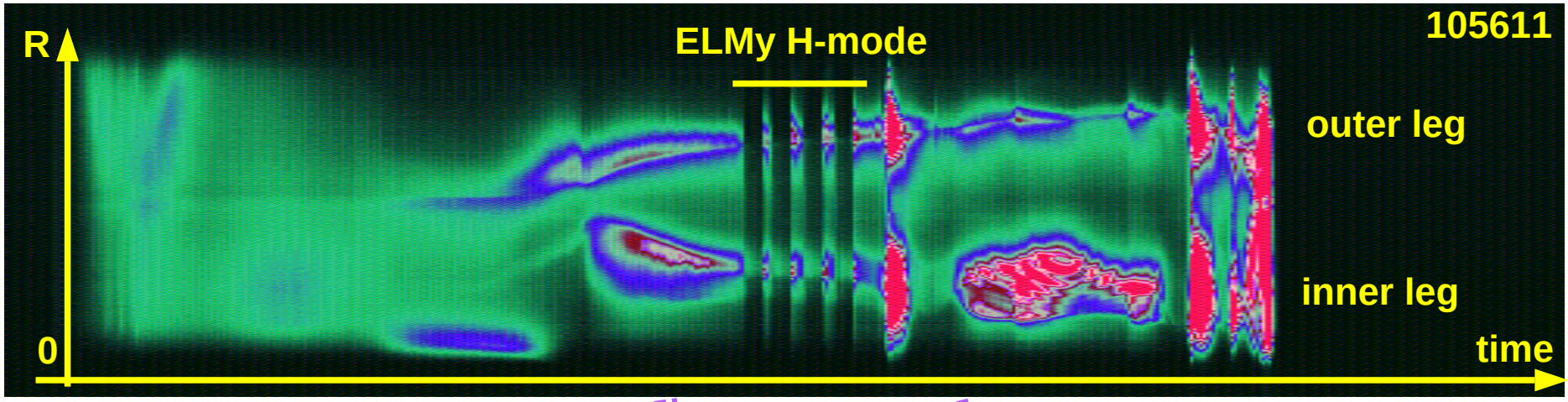


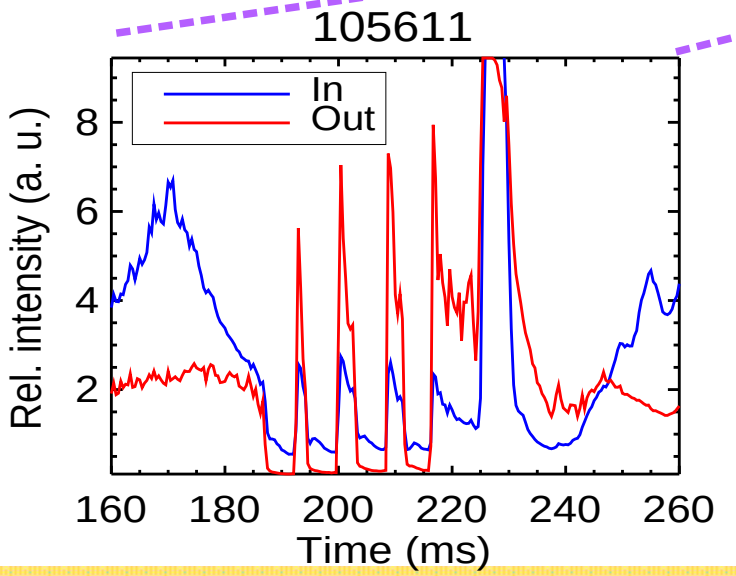




- Data obtained with C III and D_α filters (2001)
- In-vessel spatial calibration done (08/2001)
- Photometric calibration being done (09/2001)

D_α brightness profiles of divertor and center stack

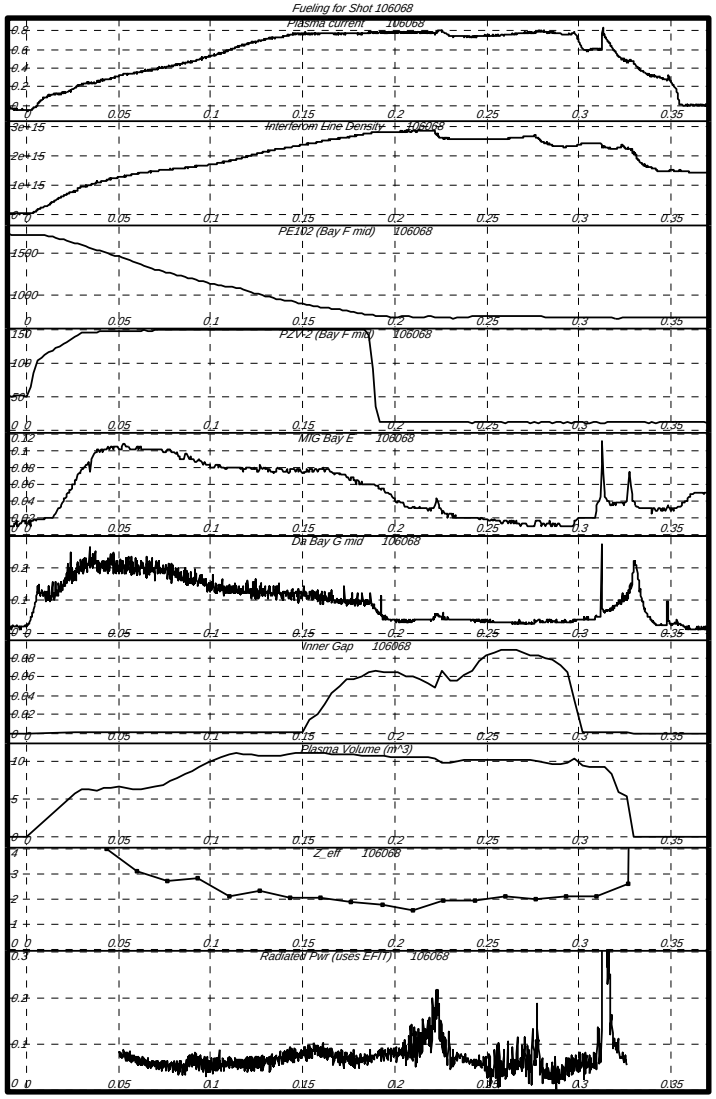




Applications:

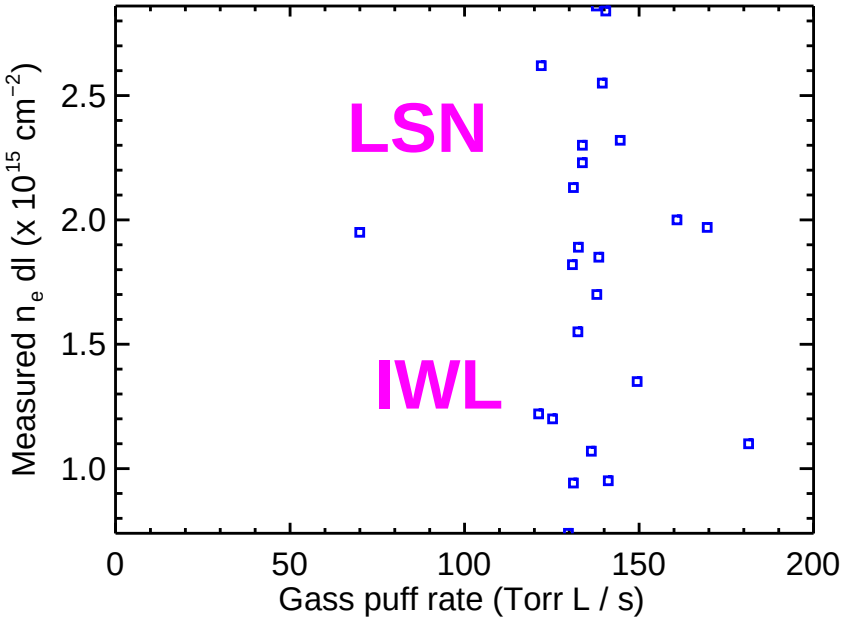
- High res. D_α and C III brightness profiles
- Edge events (ELMs, high n/m modes, IREs)
- Plasma configuration (diverted, partially diverted, limited plasmas)

Gas puffing is not very efficient

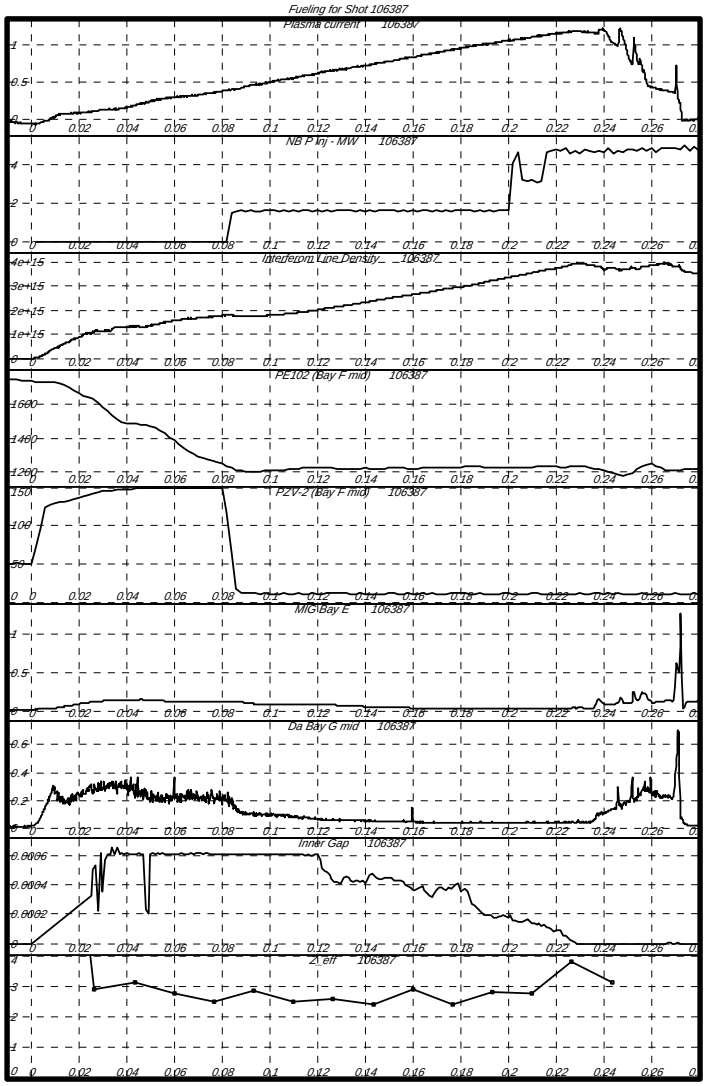


Ohmic IWL and LSN 0.8 MA fiducial shots

$$\overline{n_e} \lesssim (0.1 - 0.9) \times n_{Gr}$$



NBI provides efficient core fueling



NBI fueling rate R < 10 Torr l / s

Modeling

Numerical modeling (R. Maingi, C. Bush (ORNL), M. Rensink (LLNL), D. Stotler, S. Kaye, V. Soukhanovskii (PPPL))

- Input: Measured heat flux profiles, D_α , C III profiles, plasma profiles
- DEGAS2: Monte-Carlo 2D neutral code - neutral sources and transport
- UEDGE: 2D multifluid code - transport, recycling, fueling efficiency
- TRANSP: particle balance, fueling efficiency, confinement

Analytical modeling

- Input: plasma profiles, Zeff, fueling rates, exhaust rates
- Determine recycling from global particle balance of all sources and sinks, plasma neutrality and Zeff.
- Determine fueling efficiency, confinement time

Future plans

- **New experiments**

  - Gas puffing XP (He, Ne, Ar, ..?) - study rad. limits, fueling, transport
  - Particle balance in D2 and He plasmas - study fueling laws, particle confinement scaling laws

- **New fueling techniques**

  - Consider center stack gas puff fueling (very efficient at MAST)
  - Thermal molecular beam fueling (idea to be presented at 2002 NSTX Research Forum)

- **Diagnostic improvements**

  - Two additional spectrally filtered cameras (ORNL)
  - IR cameras
  - Fast scanning probe (UCSD)
  - Additional HAIFA channels