Kinetic Documentation on NSTX

Local Measurements Progress (Revised)

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NSTX PAC Meeting

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Princeton, NJ, USA

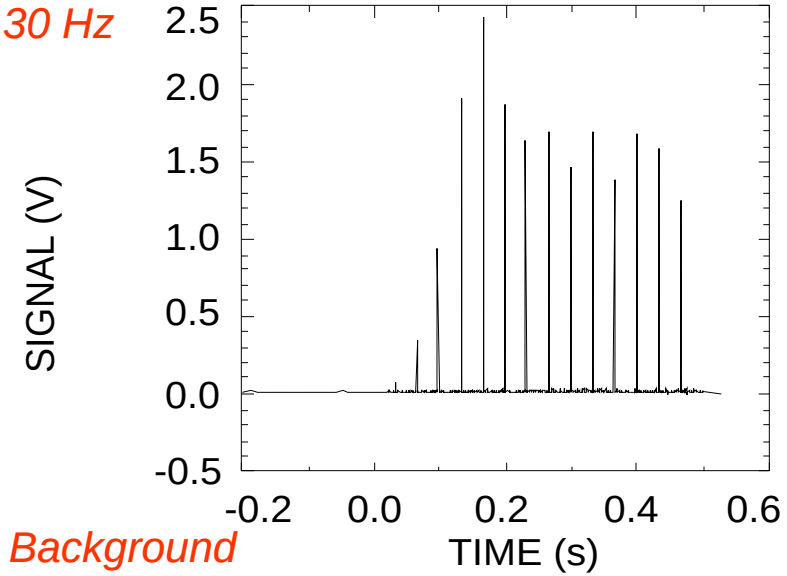
Kinetic Profile Documentation

- Thomson scattering, $n_e(R,t)$, $T_e(R,t)$, *PPPL*
- Charge-exchange recombination spectroscopy, $T_i(R,t)$, $v_{tor}(R,t)$, *PPPL*
- Edge reflectometer, edge $n_e(R)$, *UCLA*
- Ultra-soft x-rays cameras, *JHU*
- Bolometer array, $P_{rad}(R,t)$, *PPPL*
- Edge reflectometer, SOL $n_e(R)$ in front of HHFW antenna, *ORNL*

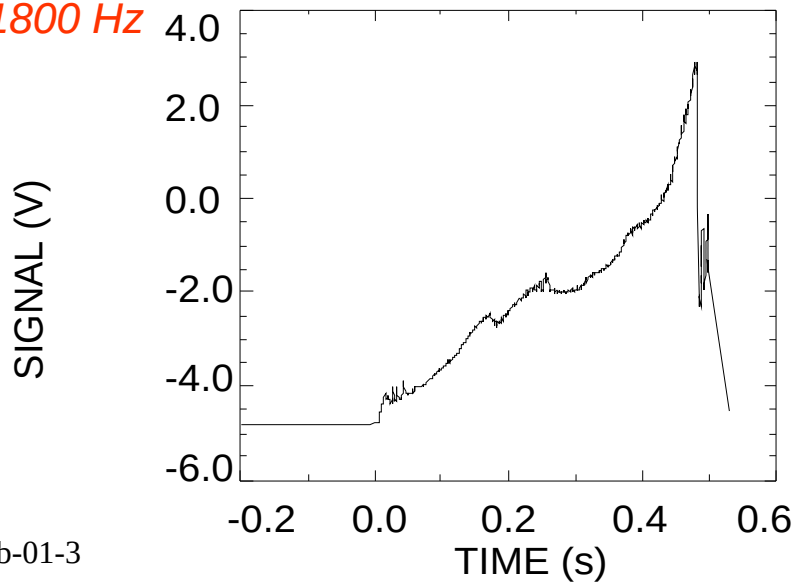
Multi-point Thomson Scattering

- 30 Hz laser
- 10 spatial channels
- Measures TS scattered light
- and plasma background radiation
- Routine operation
- Calibrated from first principles
  - Rayleigh data used for $n_e(R,t)$ and $n_e l$ scaling.
- Small statistical error bars
- Upgrades FY02-FY03

Laser-Scattered Light, 30 Hz



Plasma Background Light, ≤1800 Hz

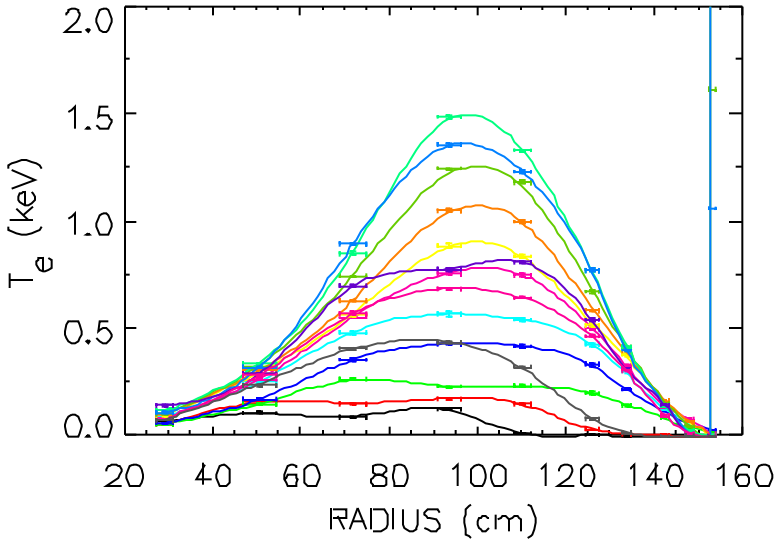


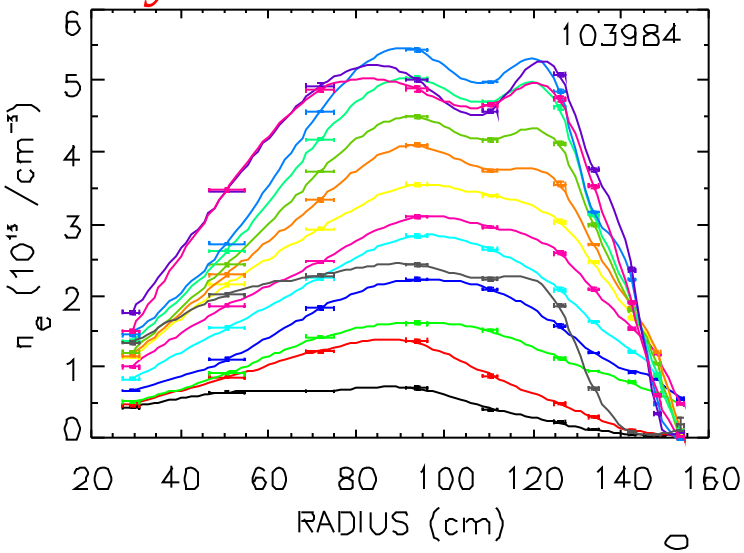
Multi-point Thomson Scattering

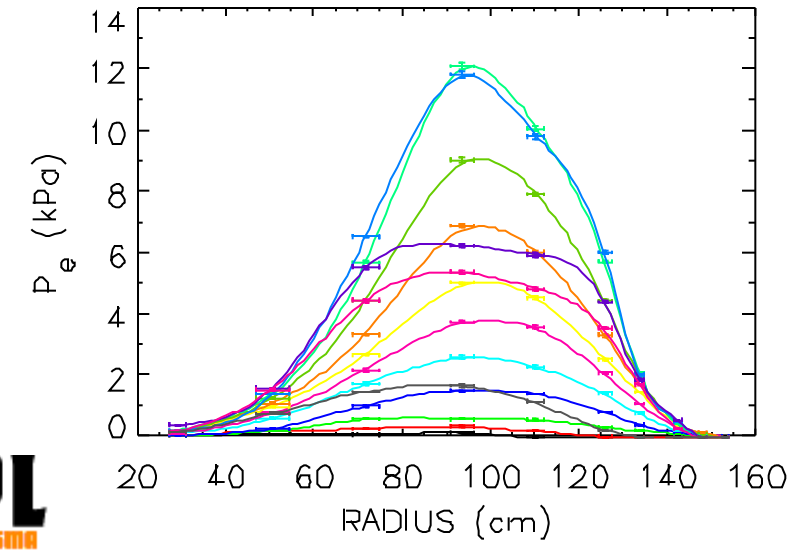
NSTX

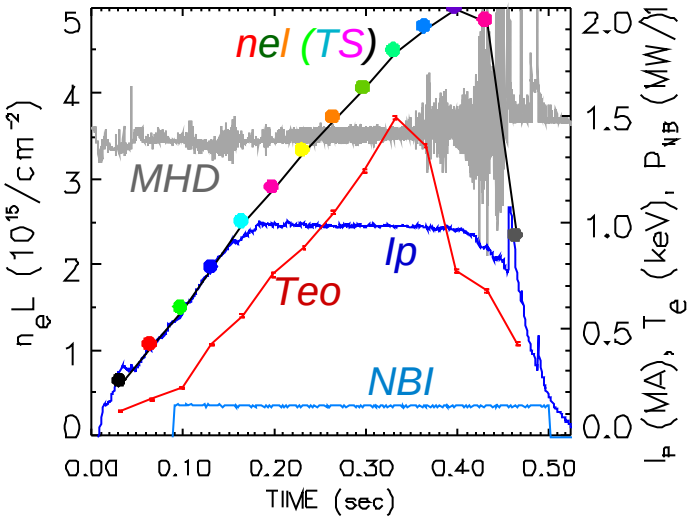
Between-shot data analysis

Control- room display





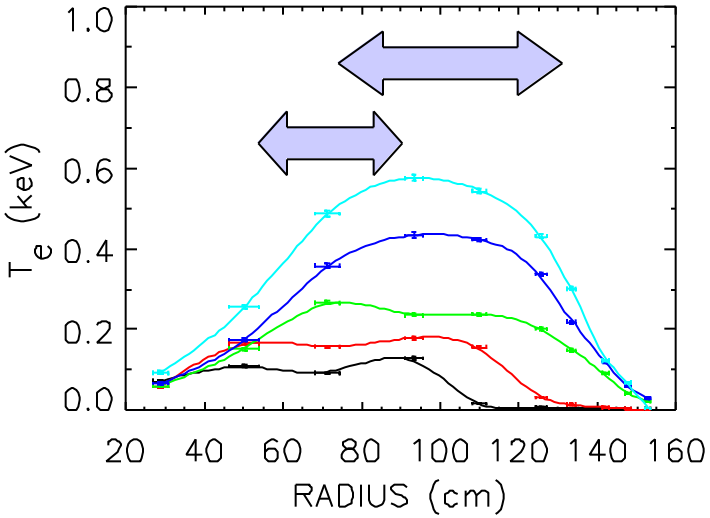


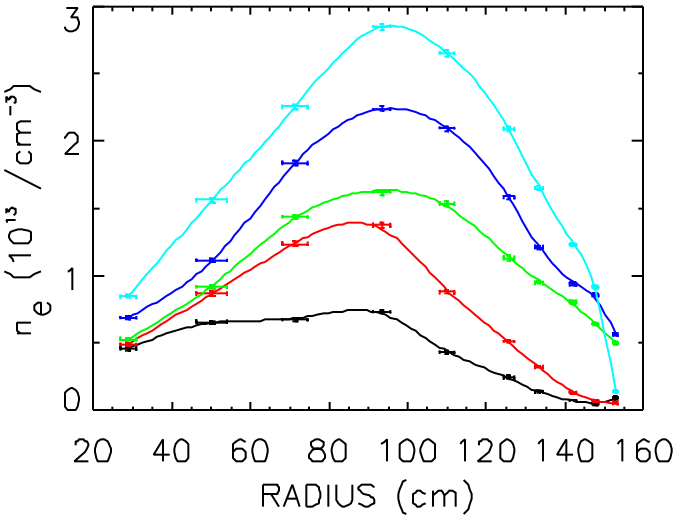


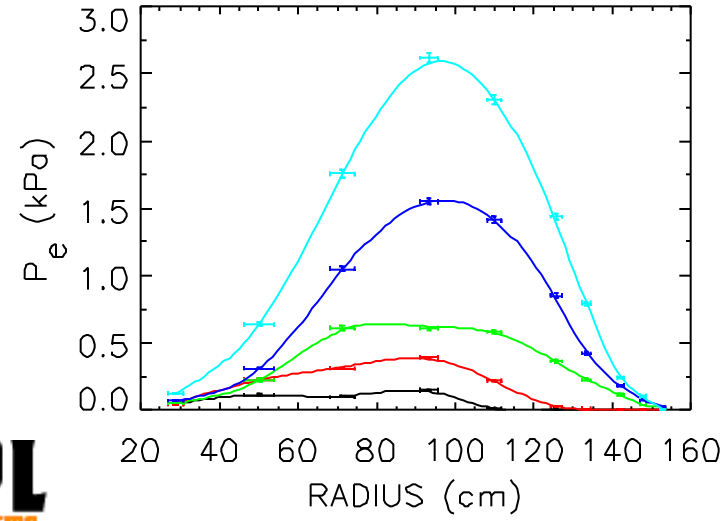
PPPL PRINCETON PLASMA PHYSICS LABORATORY

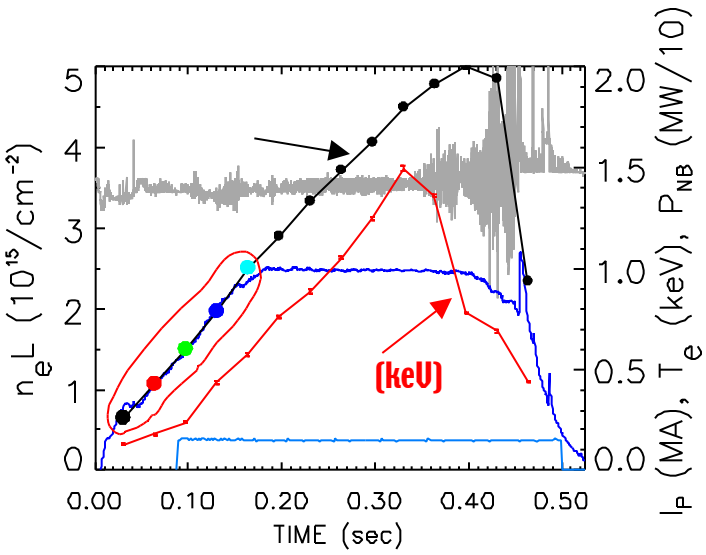
MPTS: *Ip* Ramp-up and NBI Start

103984





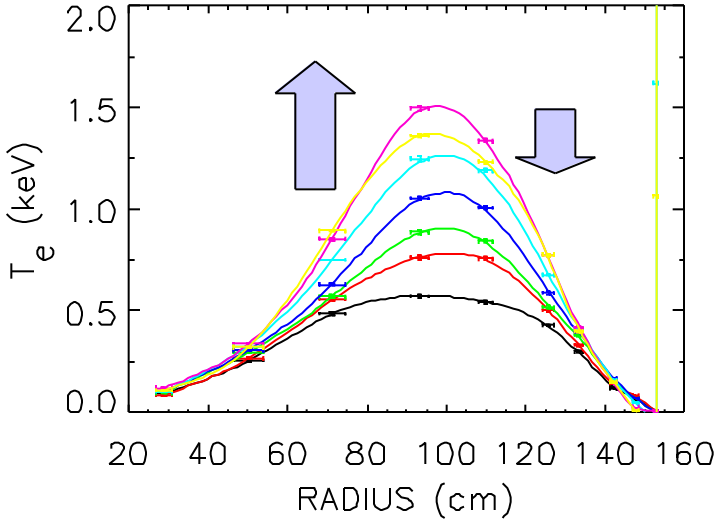


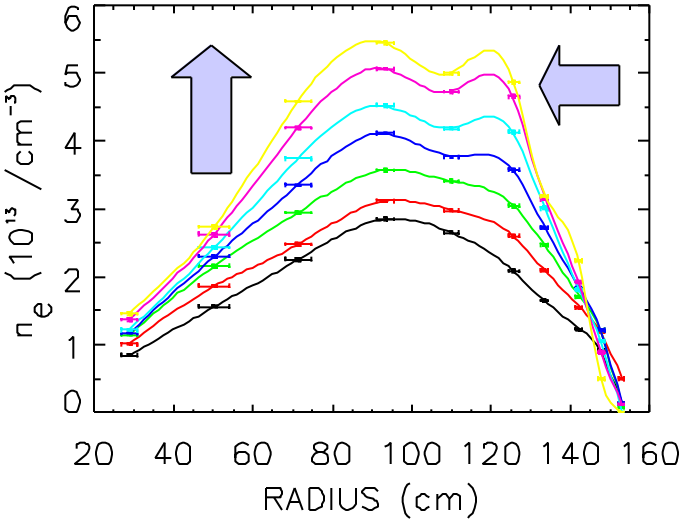


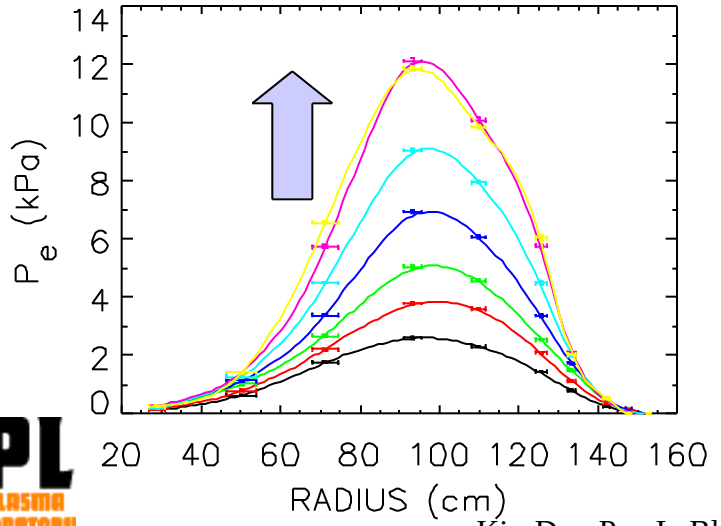
PPPL PRINCETON PLASMA PHYSICS LABORATORY

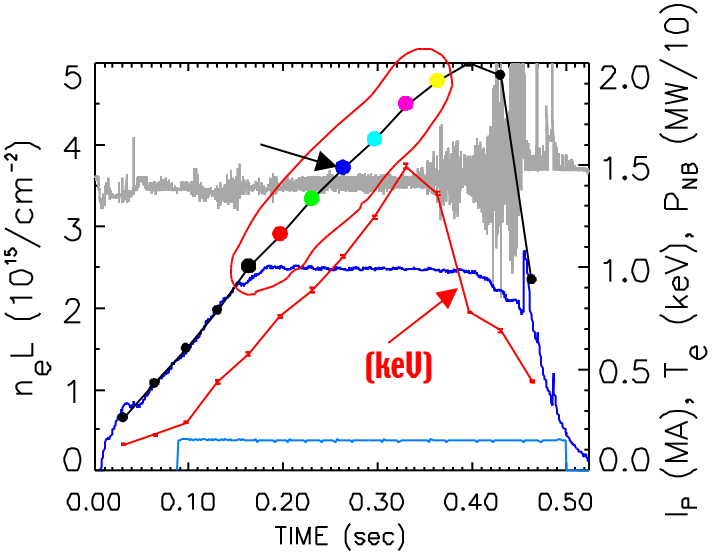
MPTS: Flat Top and MHD Growth

103984

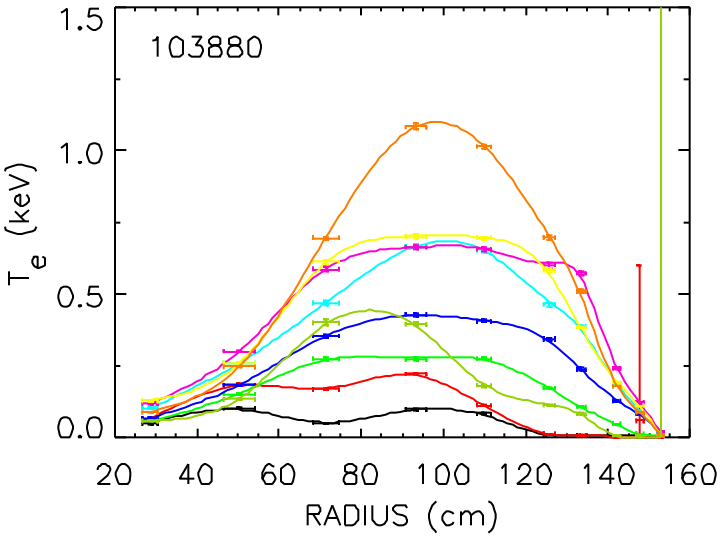


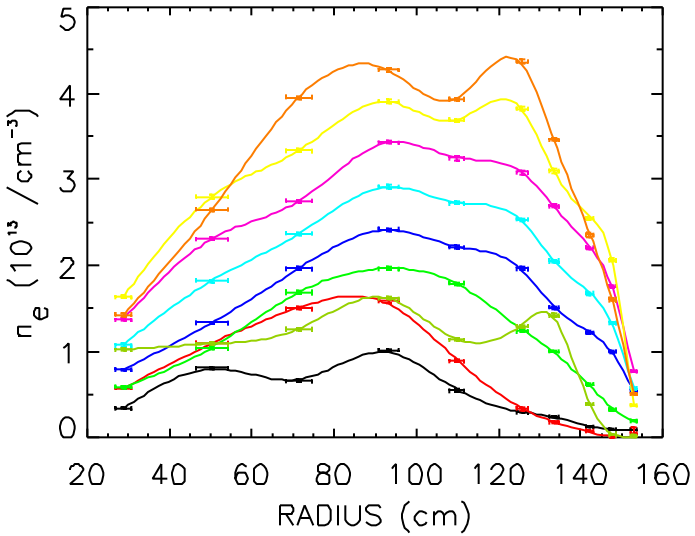


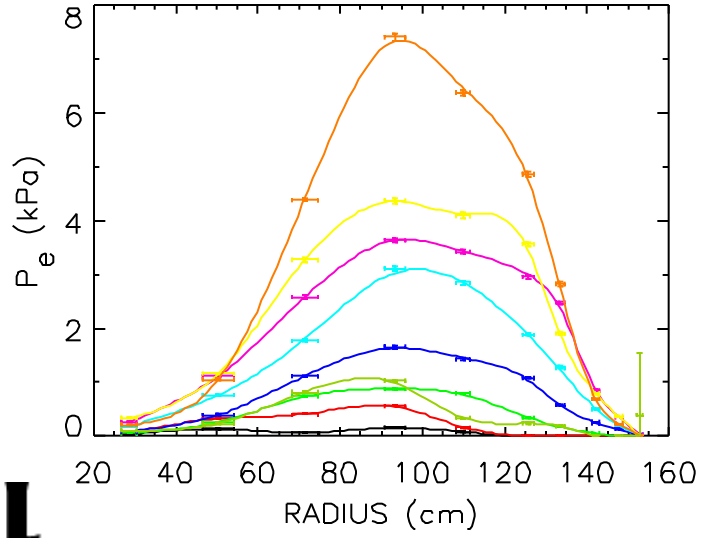


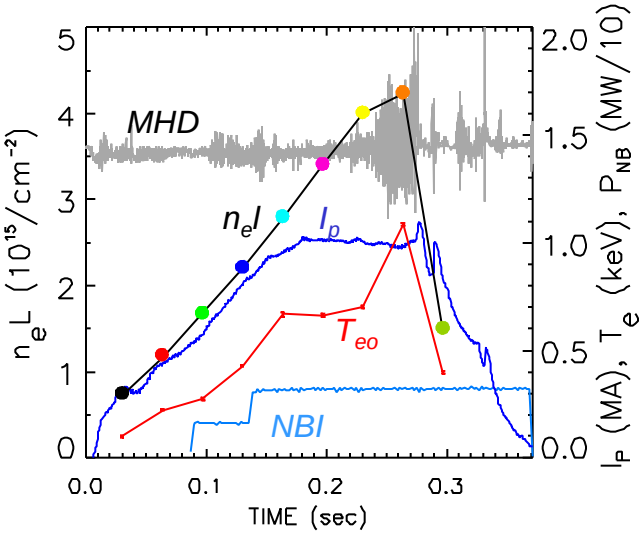


MPTS: Late T_e Increase

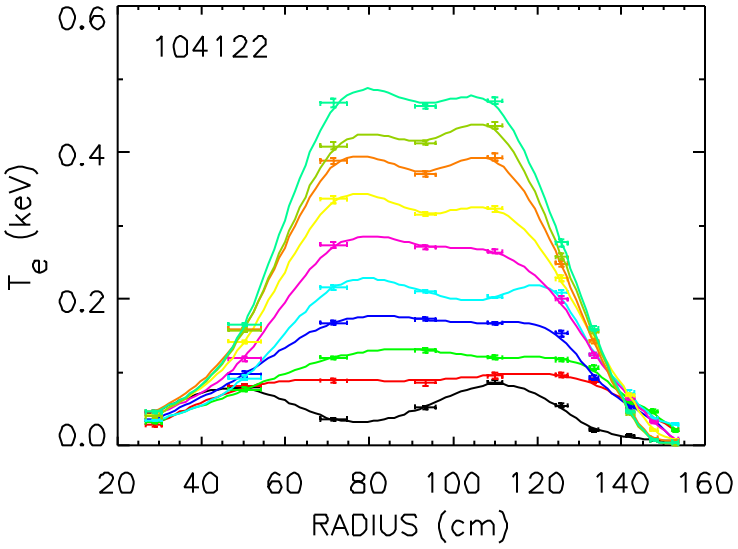


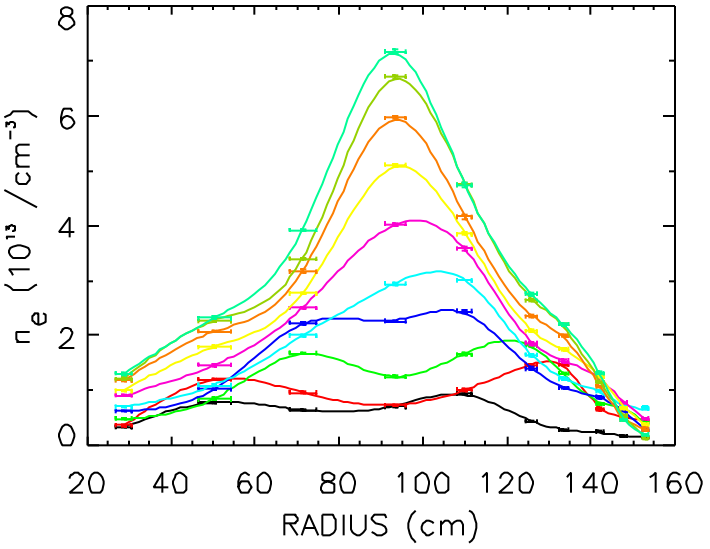


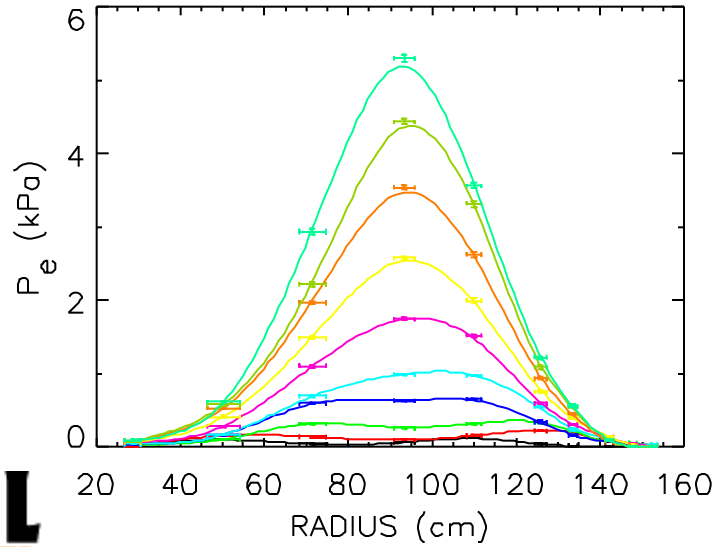


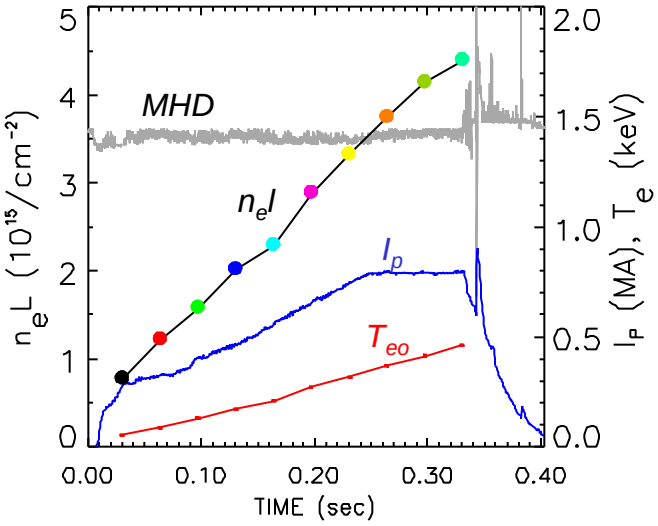


MPTS: Ohmic, MHD Quiescent

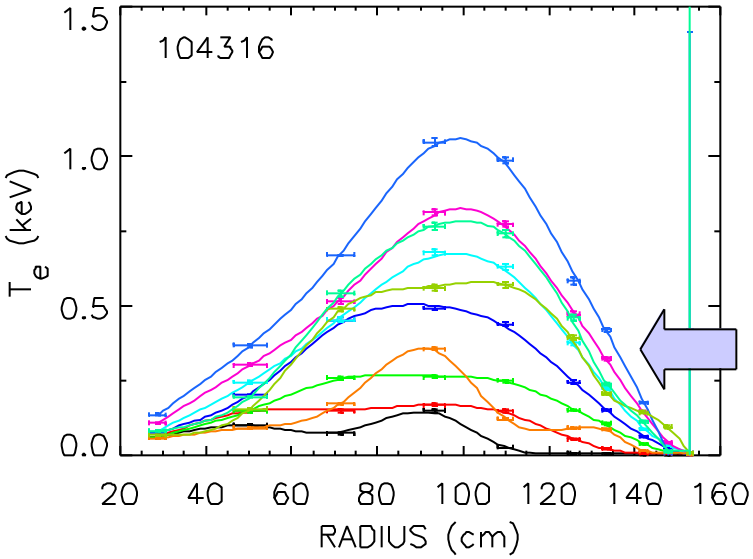


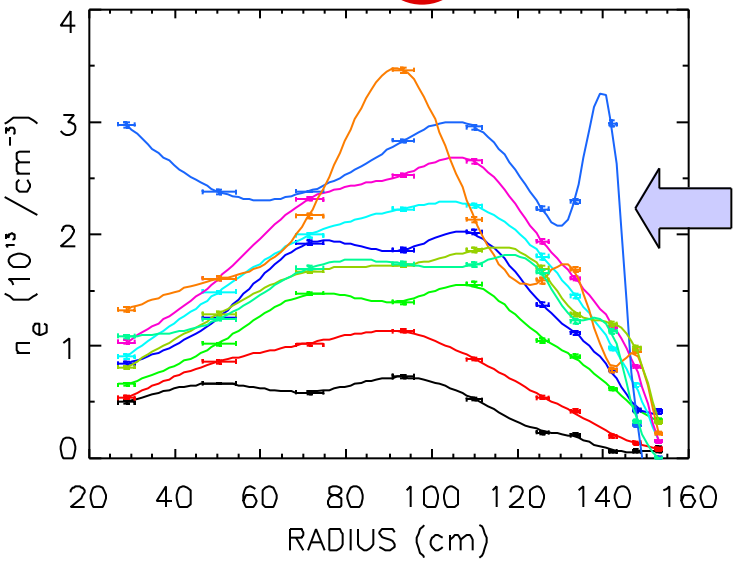


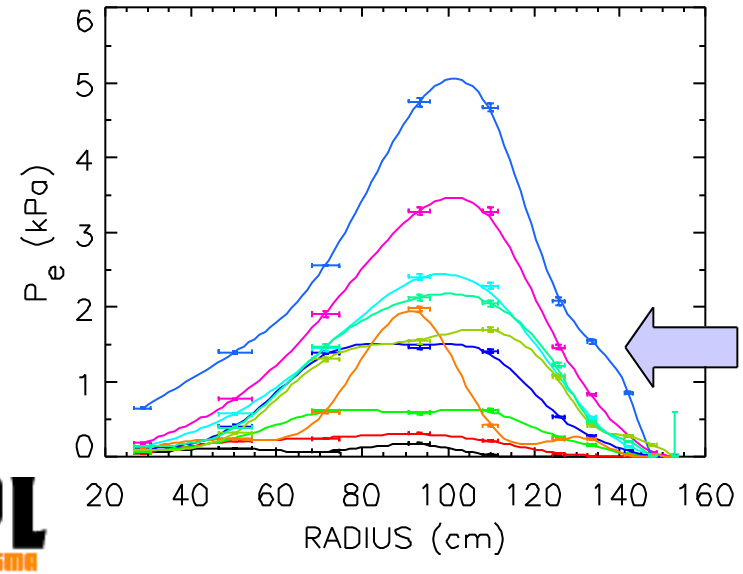


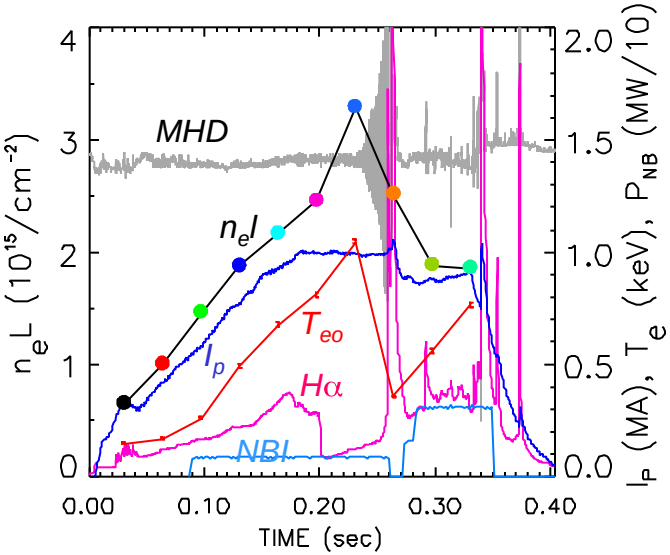


MPTS: H Mode

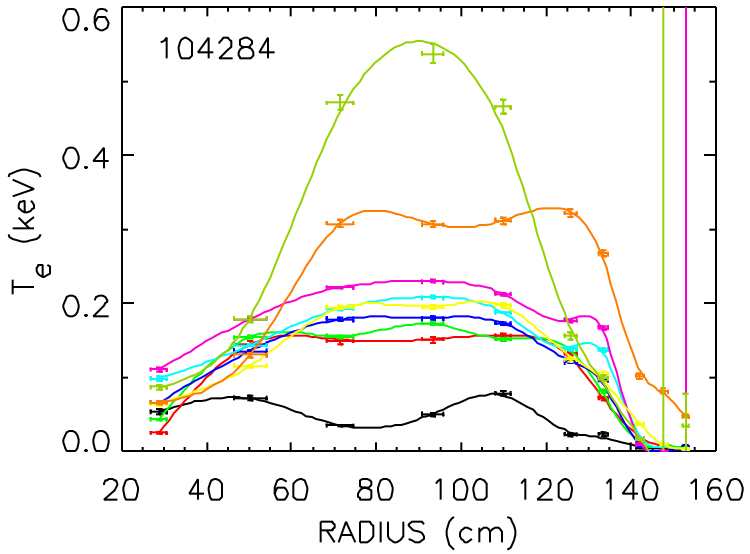

104316
T_e (keV)
RADIUS (cm)

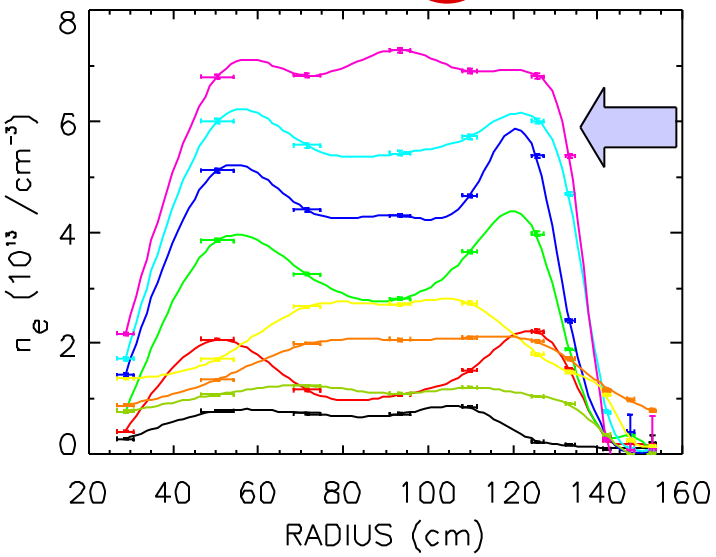

n_e (10^{13} /cm^{-3})
RADIUS (cm)

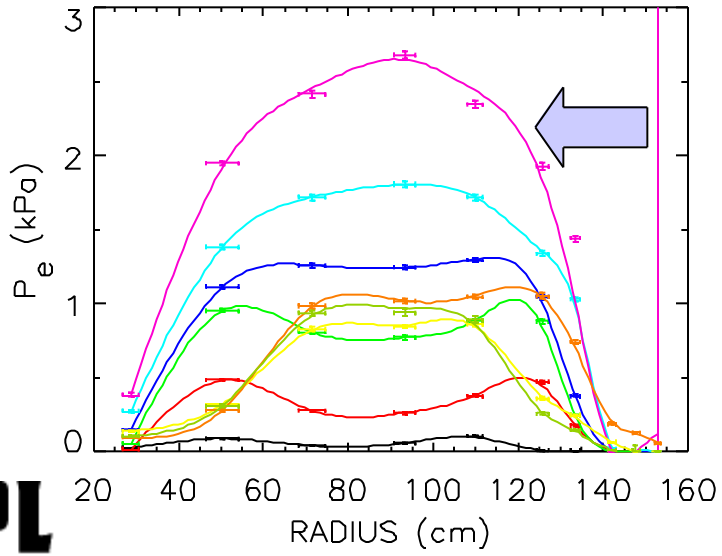

P_e (kPa)
RADIUS (cm)

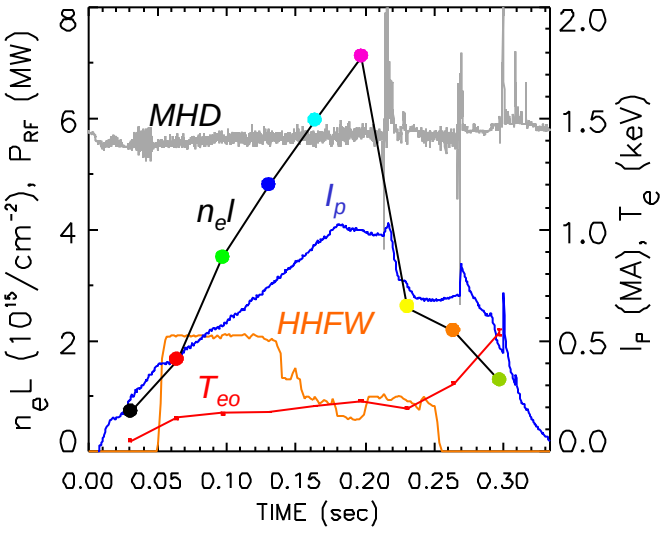

MHD
$n_e l$
T_{eo}
I_p
Hα
NBI
$n_e L$ (10^{15}/cm^{-2})
I_P (MA), T_e (keV), P_{NB} (MW/10)
TIME (sec)

MPTS: Early HHFW Application



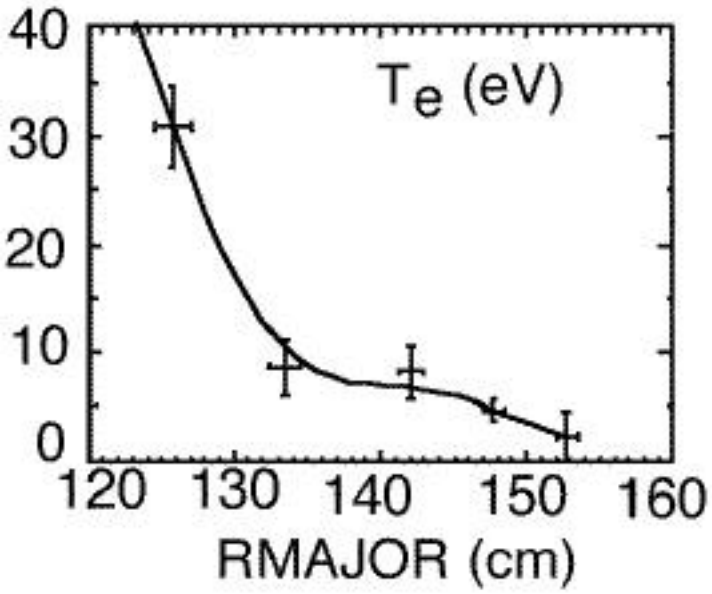


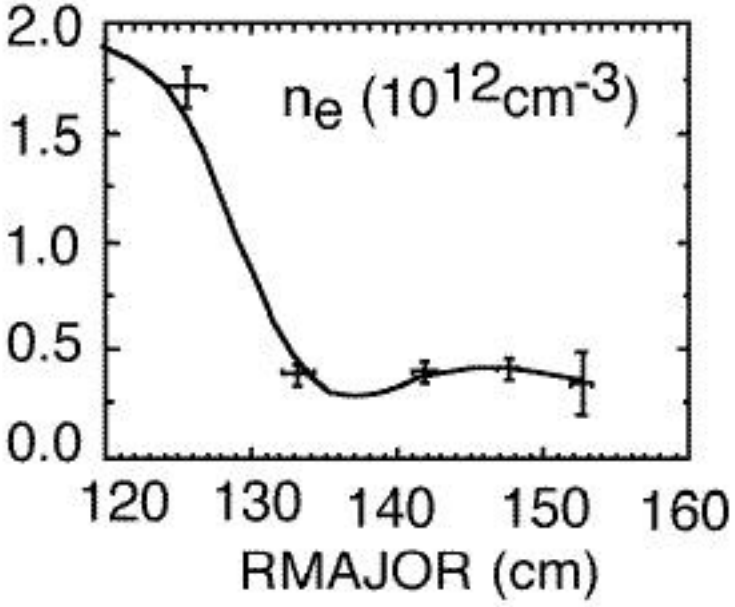




Good Edge Measurement Capability

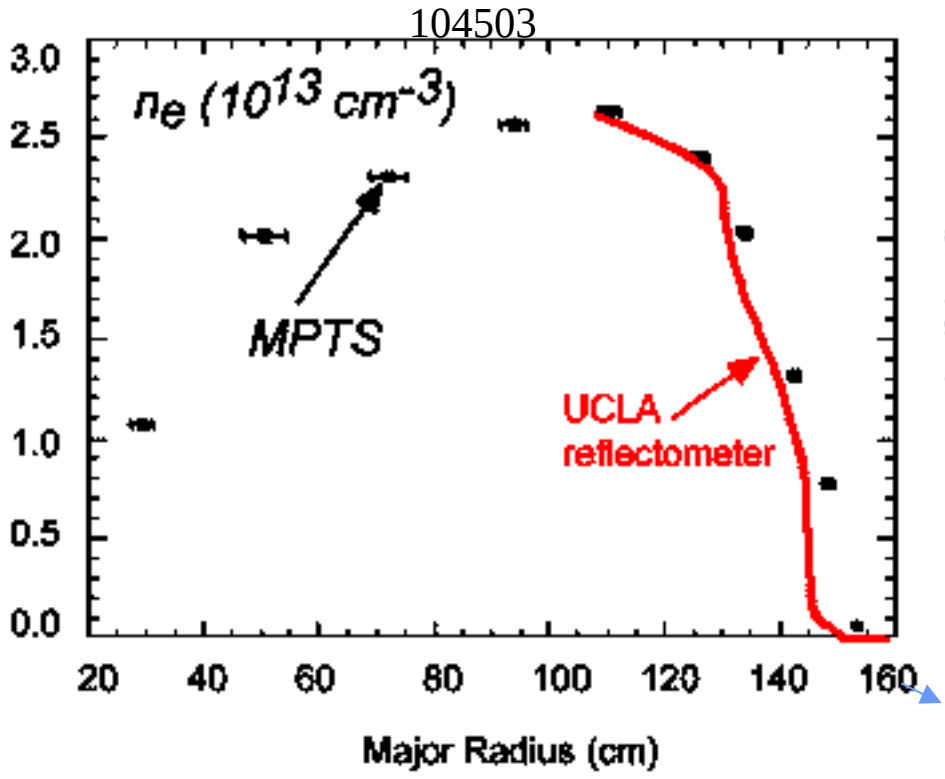
103764, $t = 0.030$ second

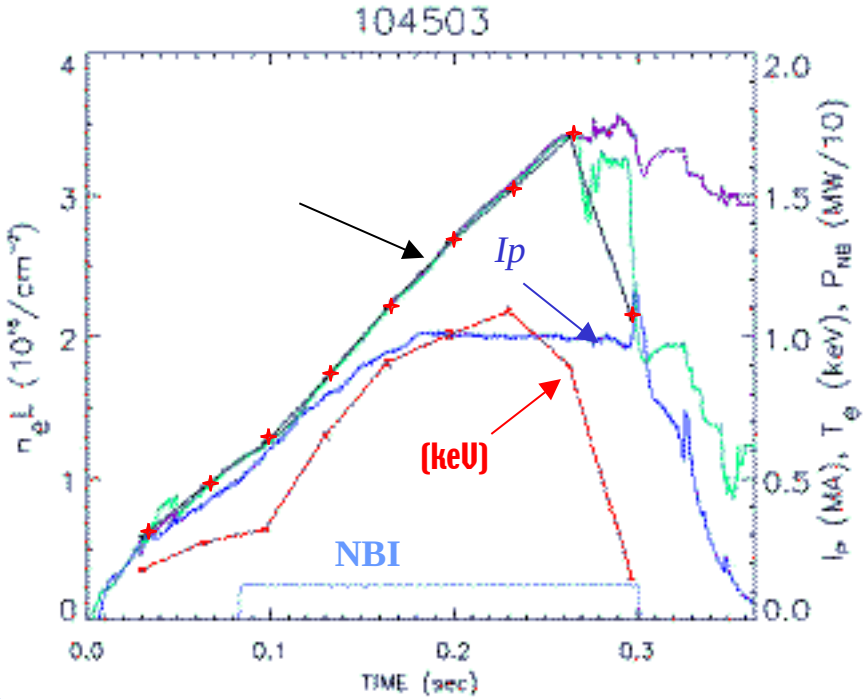




Diagnostic Crosscheck for $n_e(R)$

- Good match between TS, edge reflectometer and micro-wave interferometer

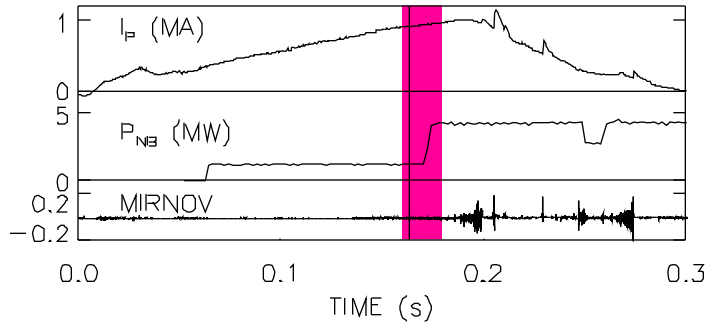


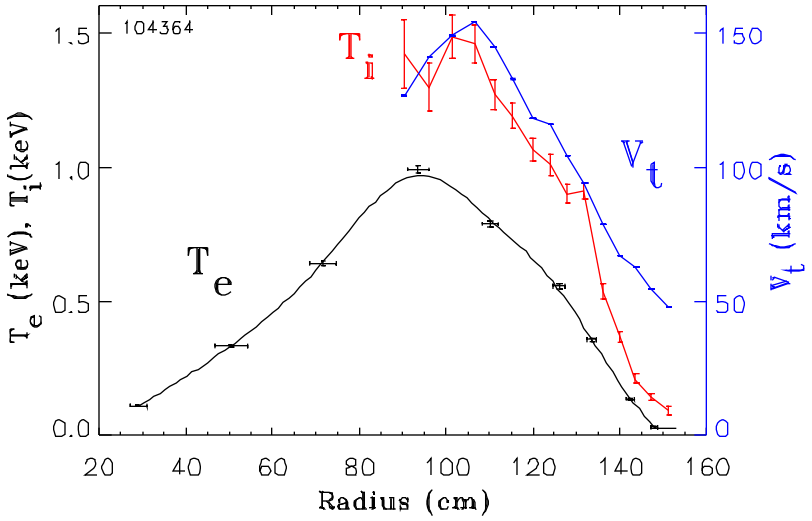


S. Kubota, T. Peebles, UCLA

Charge Exchange Recombination Spectroscopy

- Preliminary CHERS data
- Interim system
- 17 spatial channels
- C VI, n=8-7, 5290 Å
- Present analysis done at NBI power step-up points.

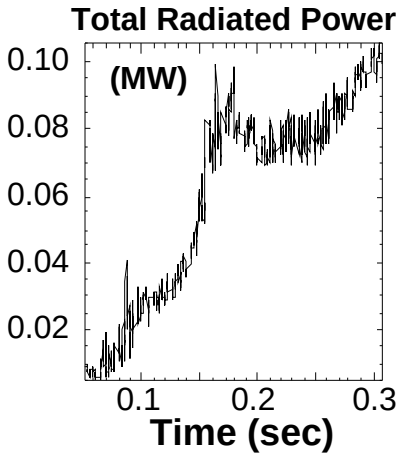


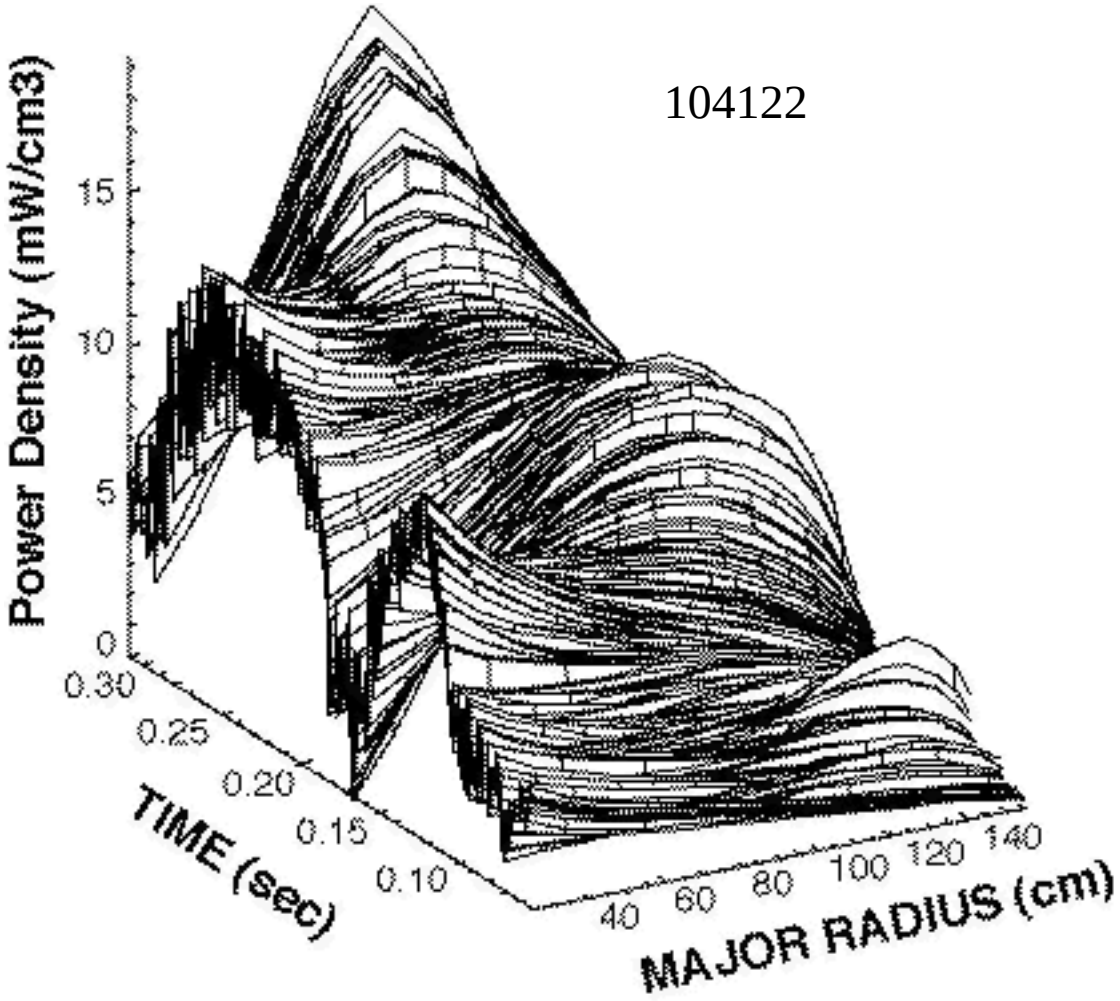


R. Bell

Bolometer Array

- $P_{rad}(R,T)$ measurement
- 16-channel array

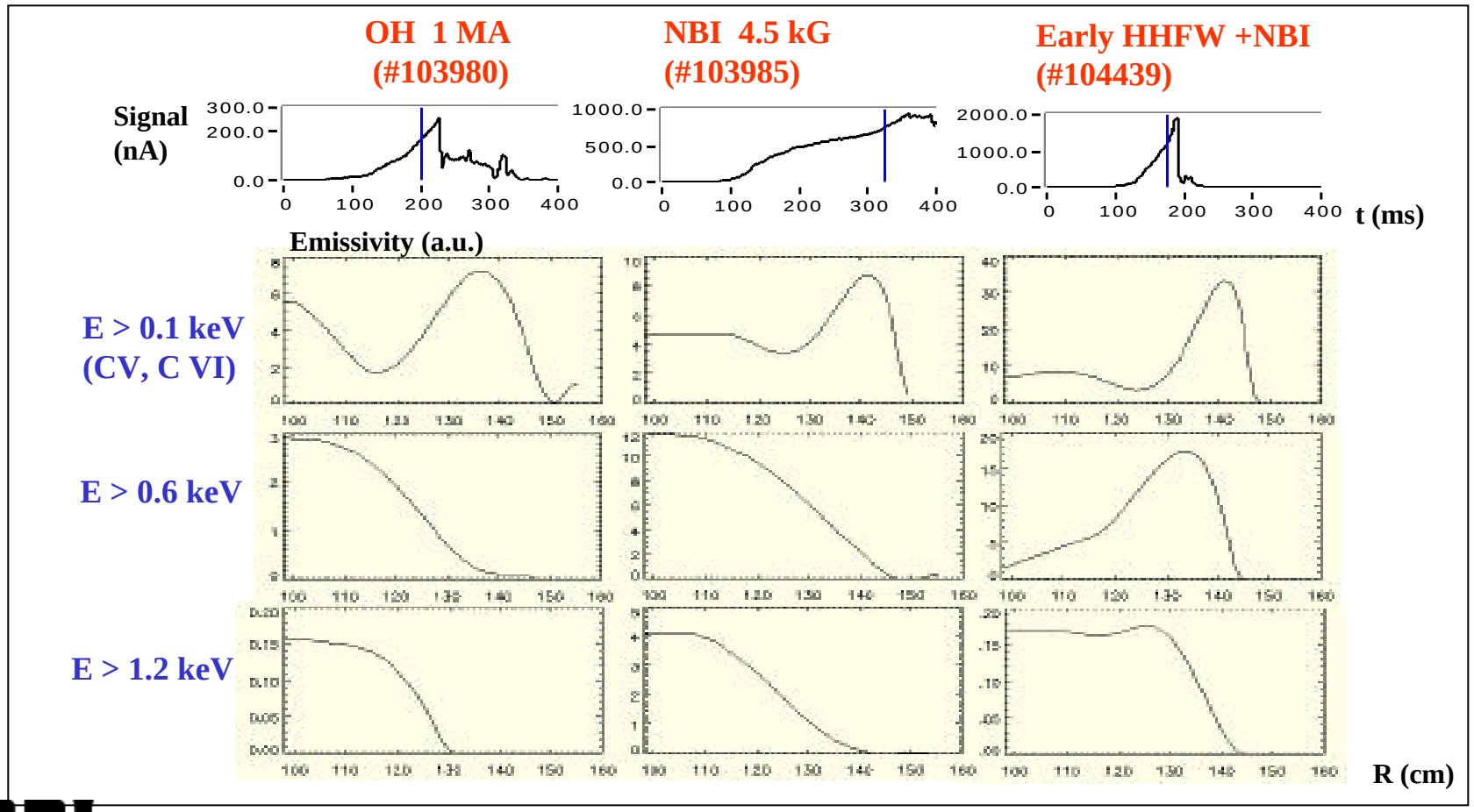




S. Paul

USXR Profiles in Three Energy Ranges

- OH and NBI profiles qualitatively similar,
- Striking difference in core profiles with HHFW



$Z_{eff}(r)$ estimate from USXR arrays and GRITS spectrometer and MPTS

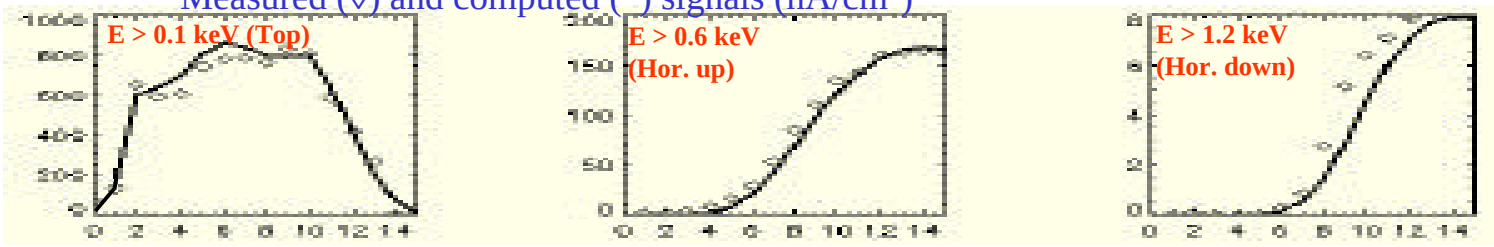
GRITS spectrum (photons/cm^2/sr/s)

103980

t = 0.197 s

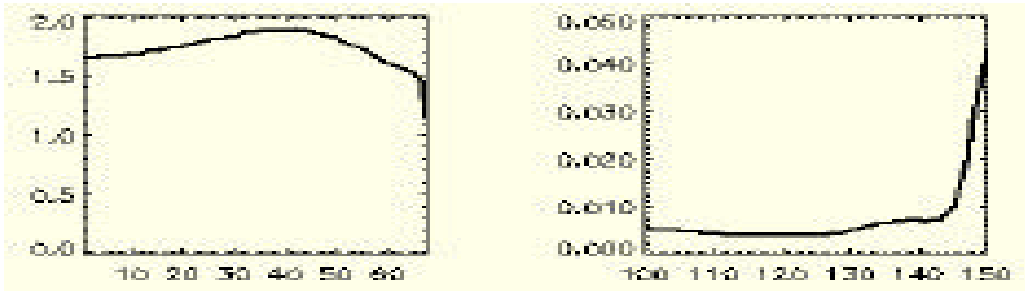
λ (angstrom)

Measured (◊) and computed (-) signals (nA/cm^3)



Chord#

Z_{eff}



P_{rad}(W/cm^3)

r(cm) R (cm)

- **USXR profiles matched in three spectral ranges**
- **MIST + EFIT + MPTS + GRITS spectrometer data**
- **Typical post-boronization impurity concentrations :**

  C ≈ 1-1.5 %, O ≈ 0.1-0.3%, F ≈ 0.03-0.1 %, negligible metals

  Z_{eff} 1.6 ÷ 2, flat or slightly hollow profiles

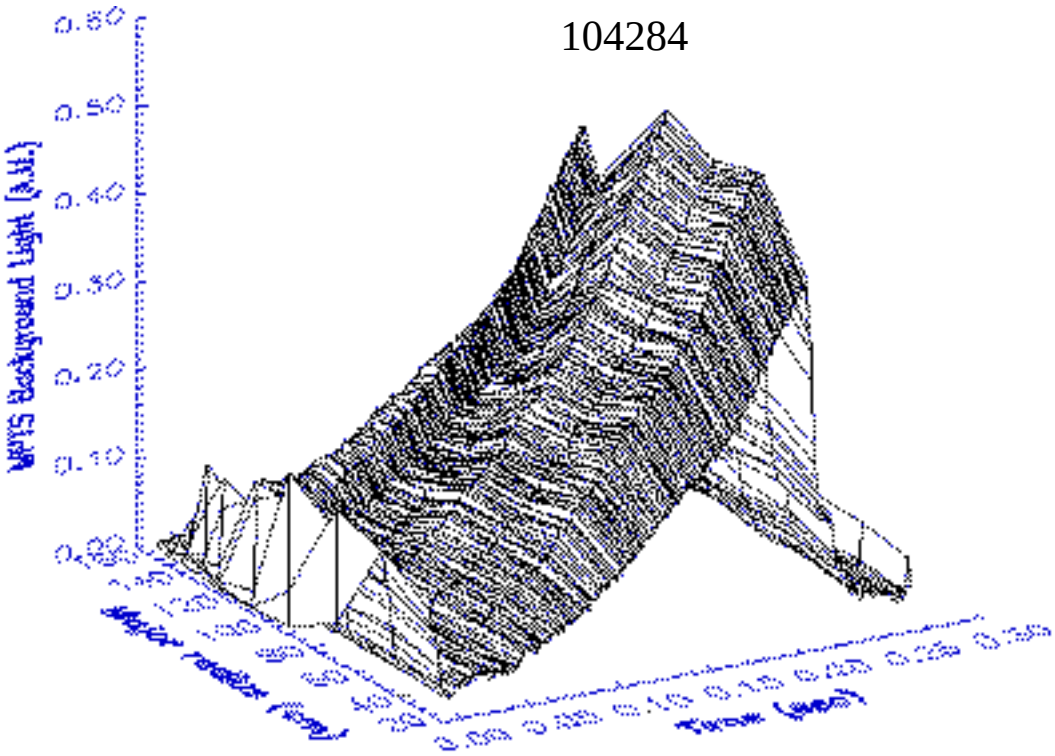
D. Stutman

$Z_{eff}(R,T)$ from MPTS Background Light?

- Consider using MPTS background light data to obtain local emissivity $\varepsilon(R,t)$.
- Application to $Z_{eff}(R,T)$ determination.

$$Z_{eff} = \frac{\varepsilon T^{\frac{1}{2}} \lambda^2 e^{\frac{hc}{T_e \lambda}}}{g_{ff} n_e^2}$$

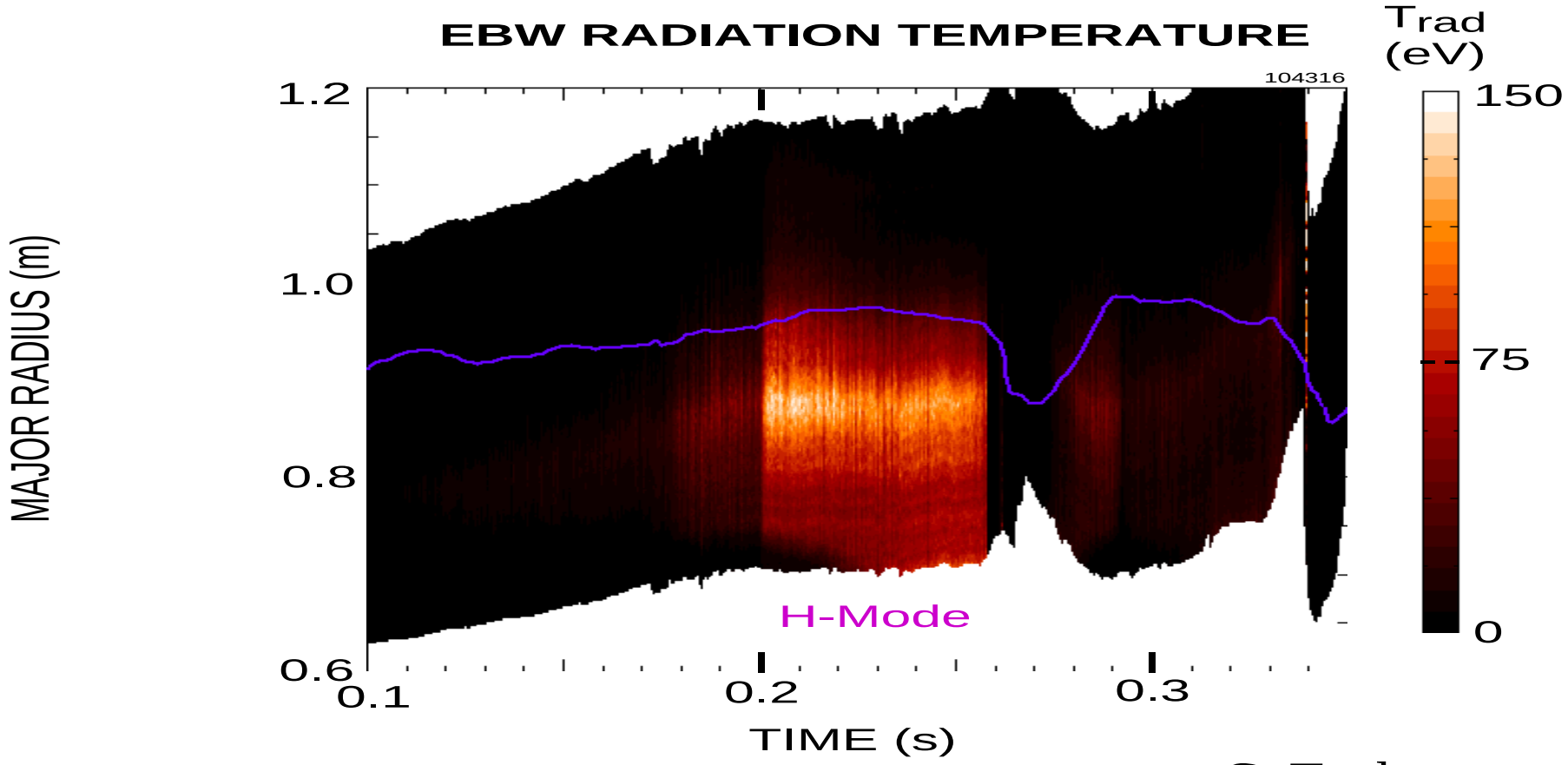
- Work in progress
  - Feasibility yet to be established.



Future Plan

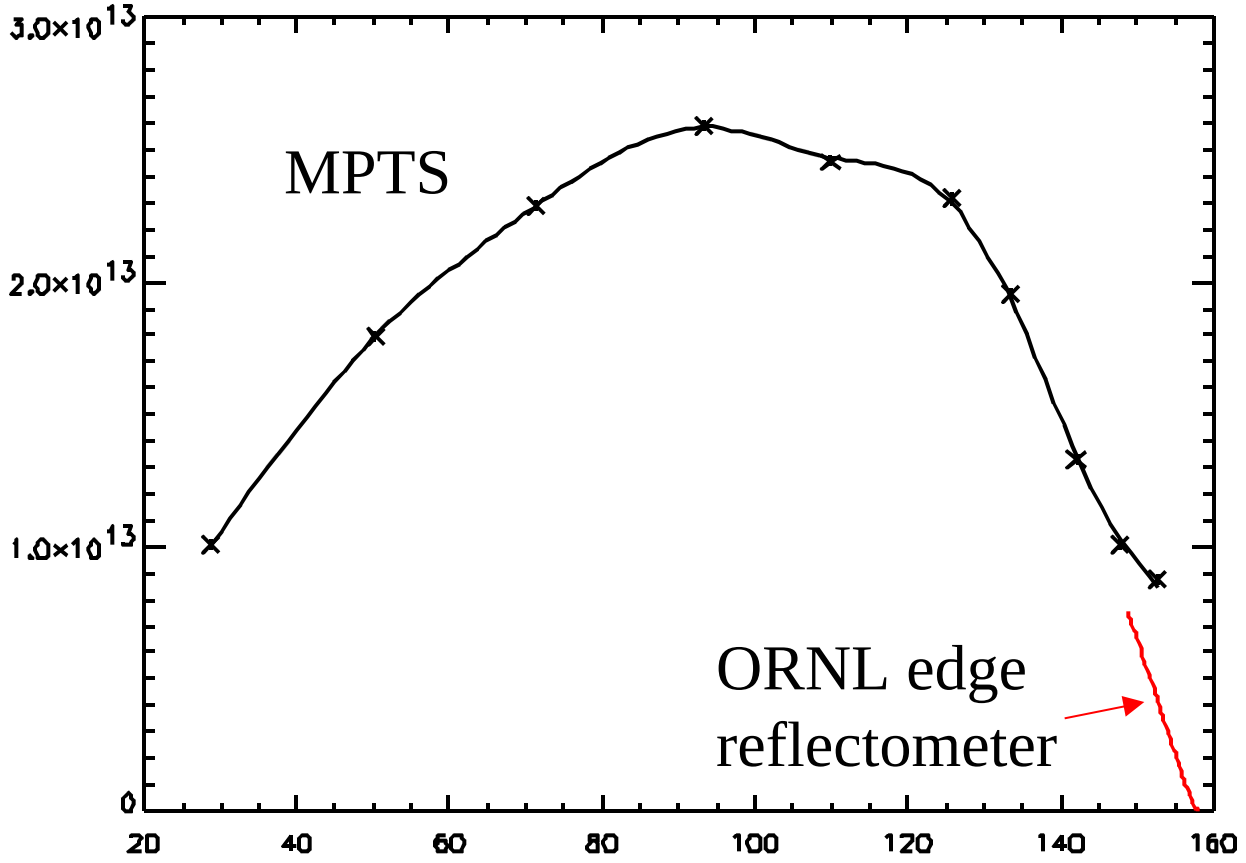
- MPTS Upgrades
  - 60 Hz, 20 spatial channels, FY01
  - 90 Hz, 30 spatial channels, FY02
  - 90 Hz, 35-40 channels, FY03
- FIR-TIP (Far-infrared interferometer and polarimeter)
  - 2 chords in FY01
  - 7 chords in FY02
- CHERS
  - 75 spatial channels, FY02
- MSE
  - 2 spatial channels in FY01
  - 10 spatial channels in FY02
  - LIF-MSE: 10 spatial channels in FY03
- VB array
  - 30 chords in FY02
- Fast scanning edge probe in FY02
- Poloidal CHERS in FY03?

EBW Emission Intensity Increases during H Mode



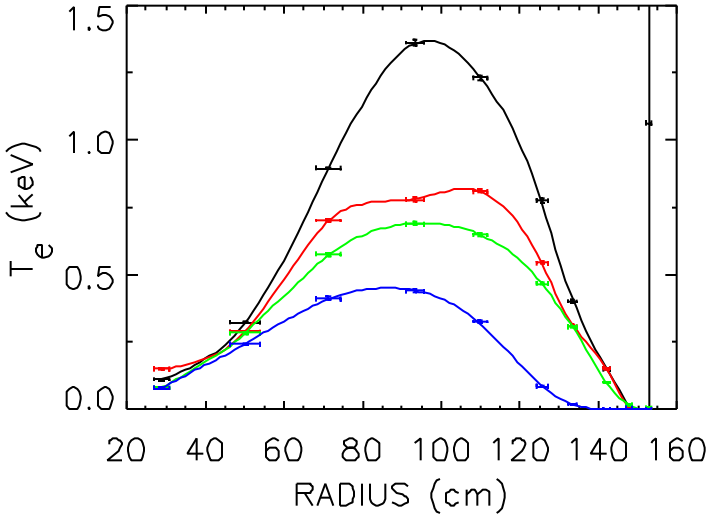
G. Taylor

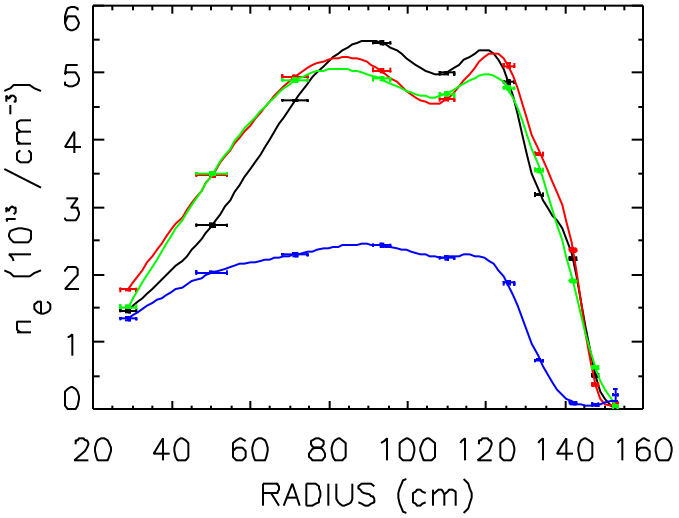
Density Profile during HHFW

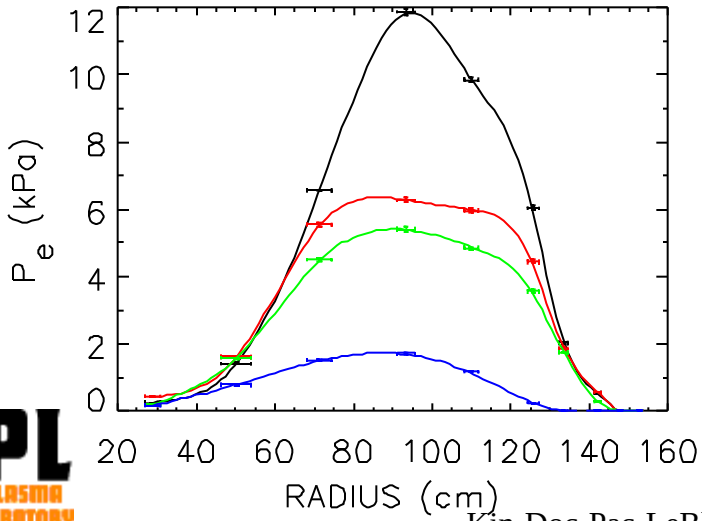


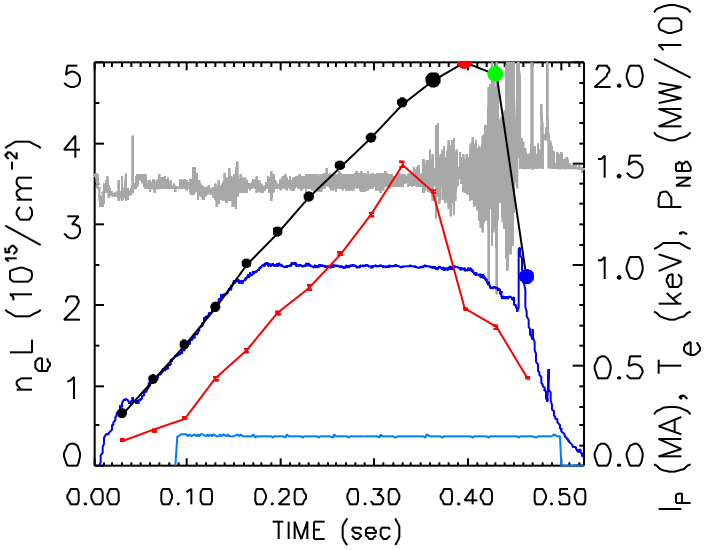
J. Wilgen

MPTS: Strong MHD and Termination



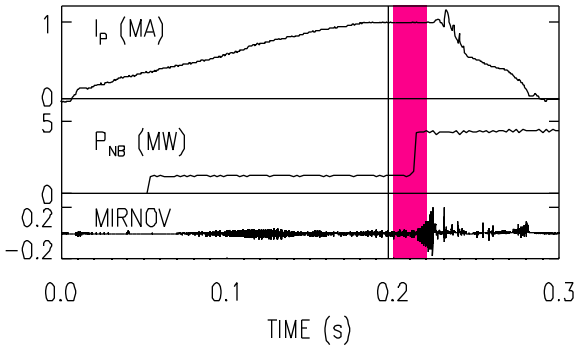


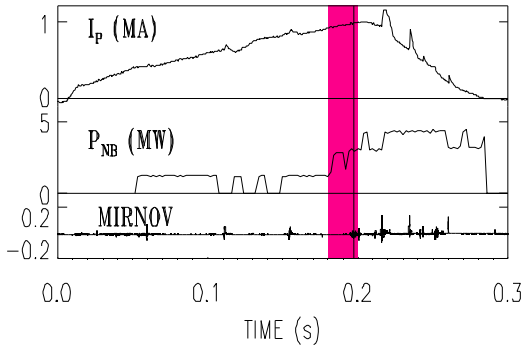


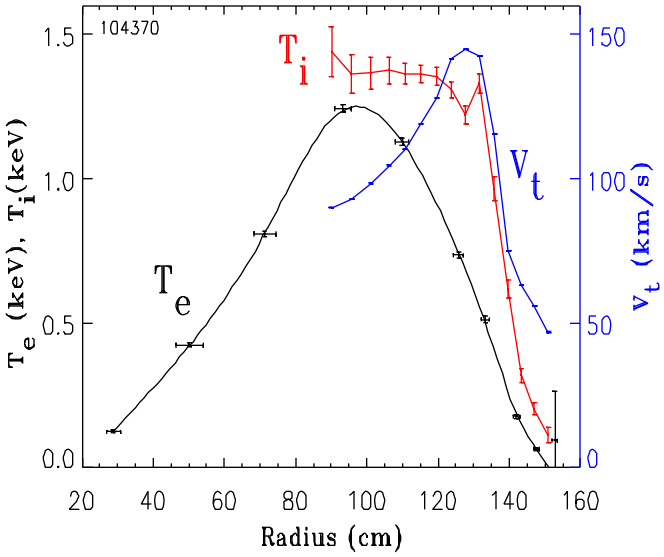


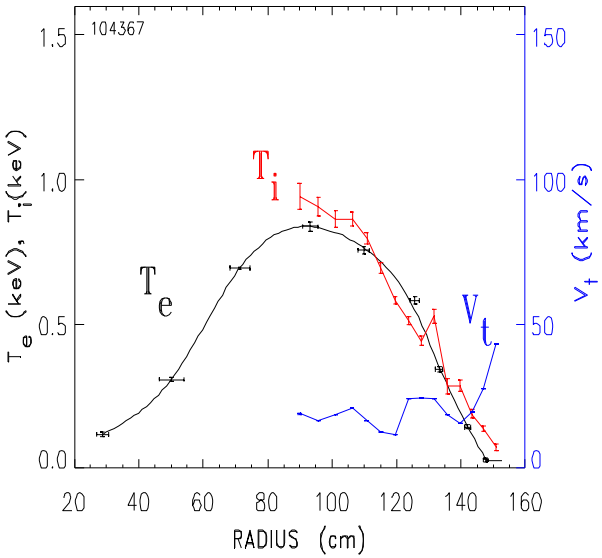
PPPL PRINCETON PLASMA PHYSICS LABORATORY

More CHERS Data









R. Bell