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NPA Measurement of the Anisotropic NB Energetic Ion Distribution and Beam Ion Profile on NSTX: XP-417

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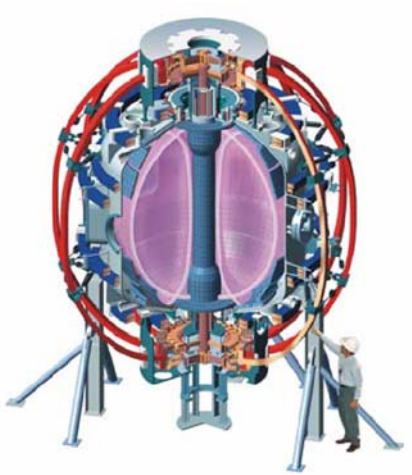

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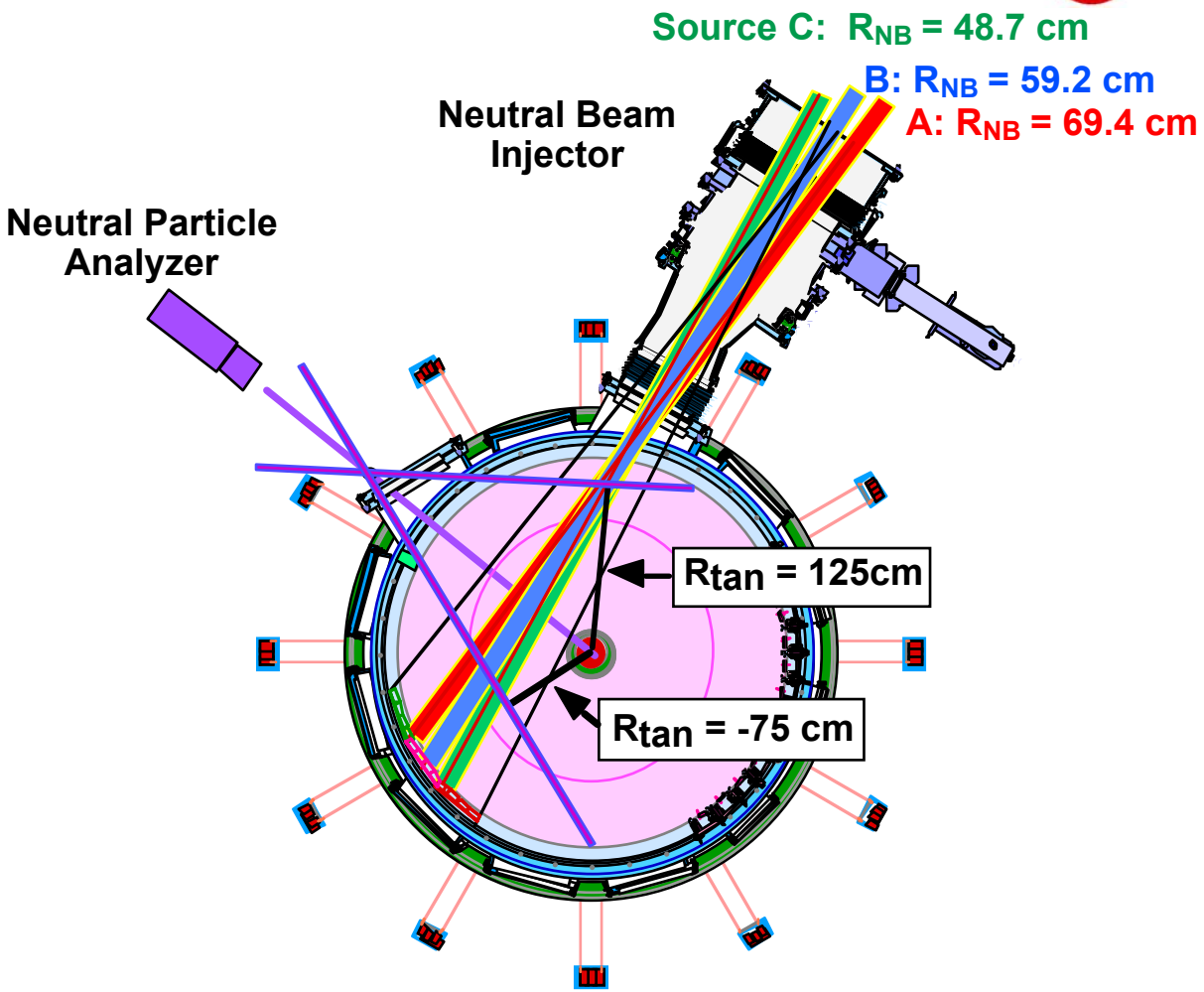
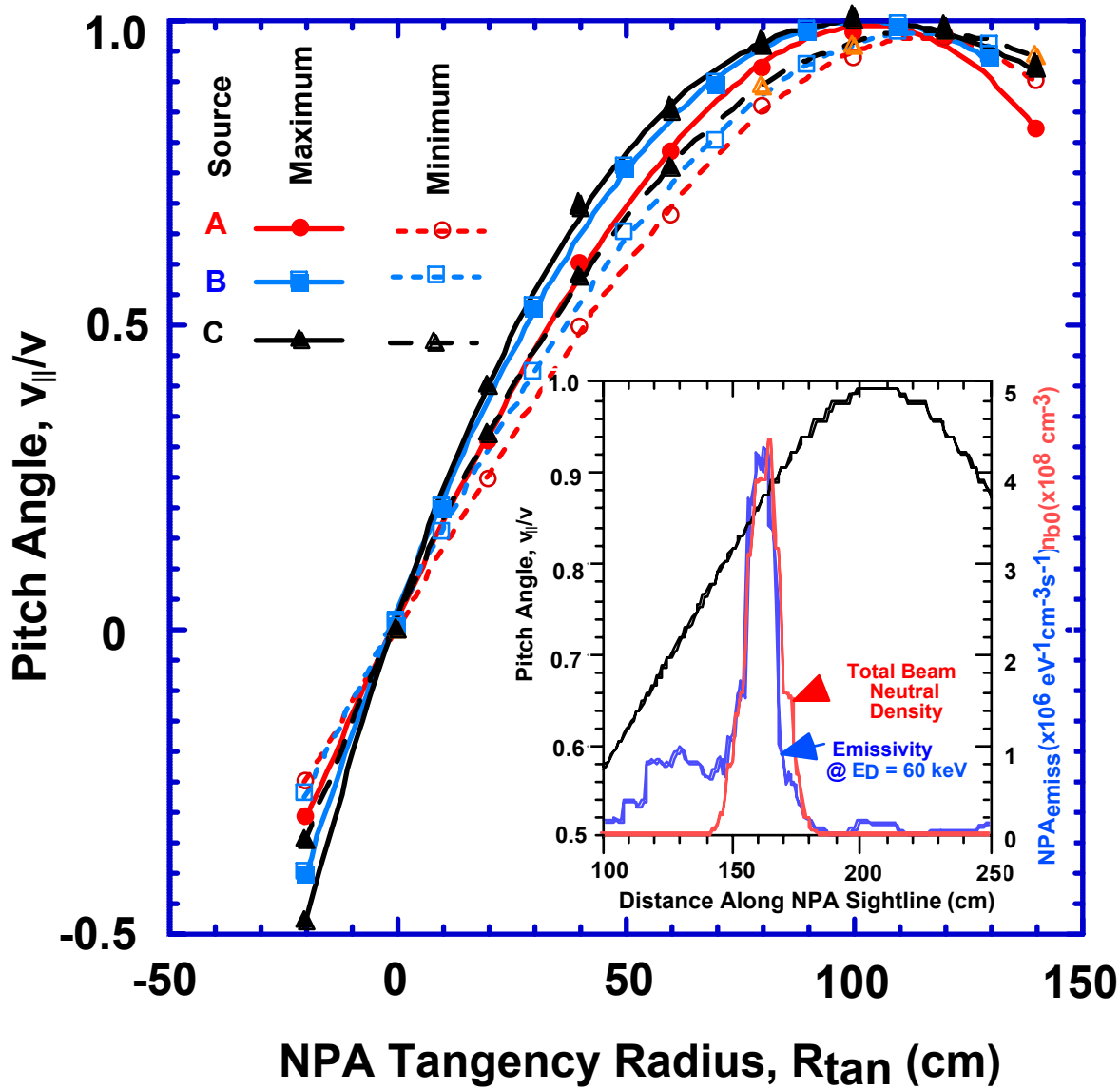
The Neutral Particle Analyzer (NPA) on NSTX Scans Horizontally Over a Wide Range of Tangency Angles on a Shot-to-Shot Basis



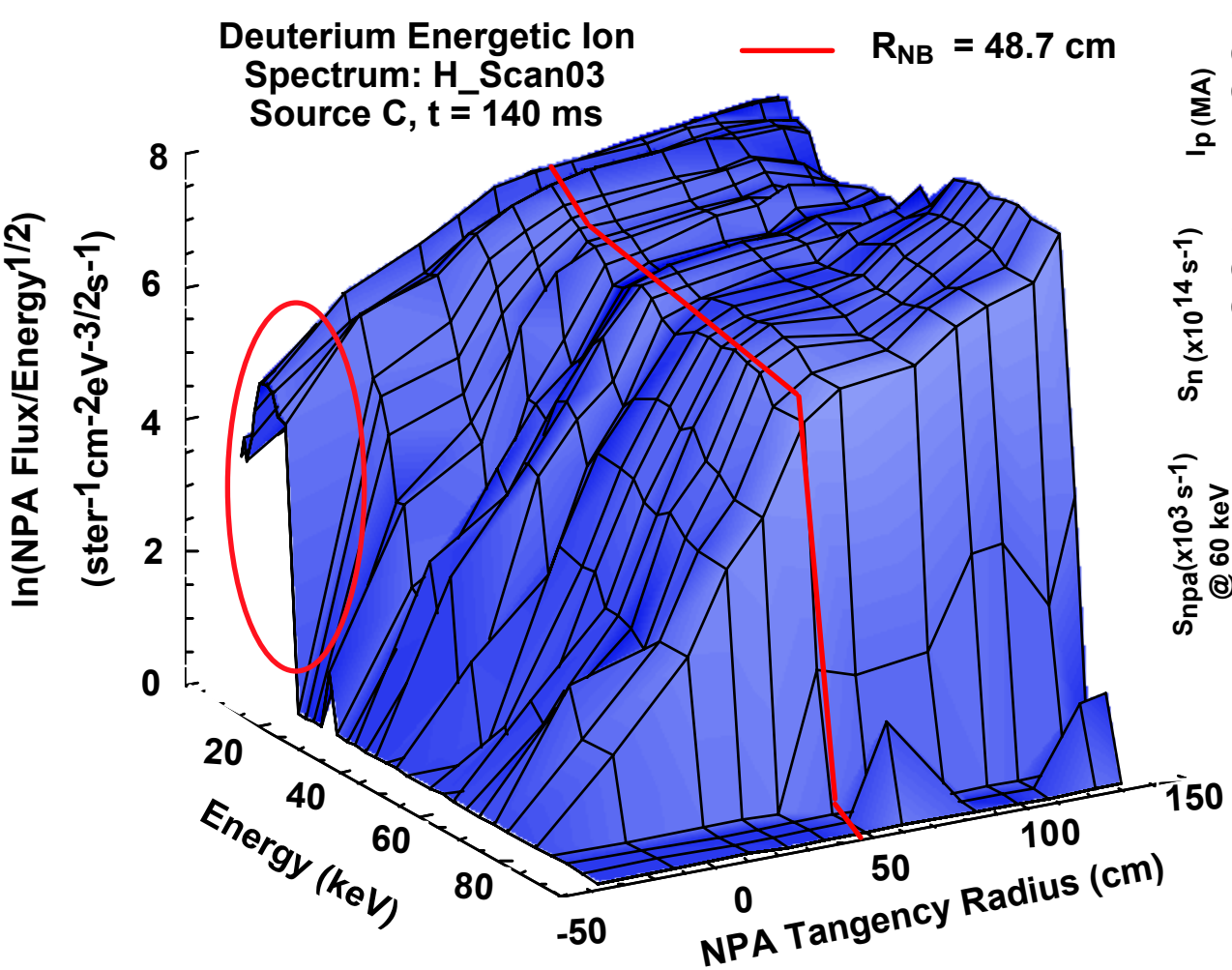
- Covers Thermal (0.1 - 20 keV) and Energetic Ion (≤ 150 keV) Ranges

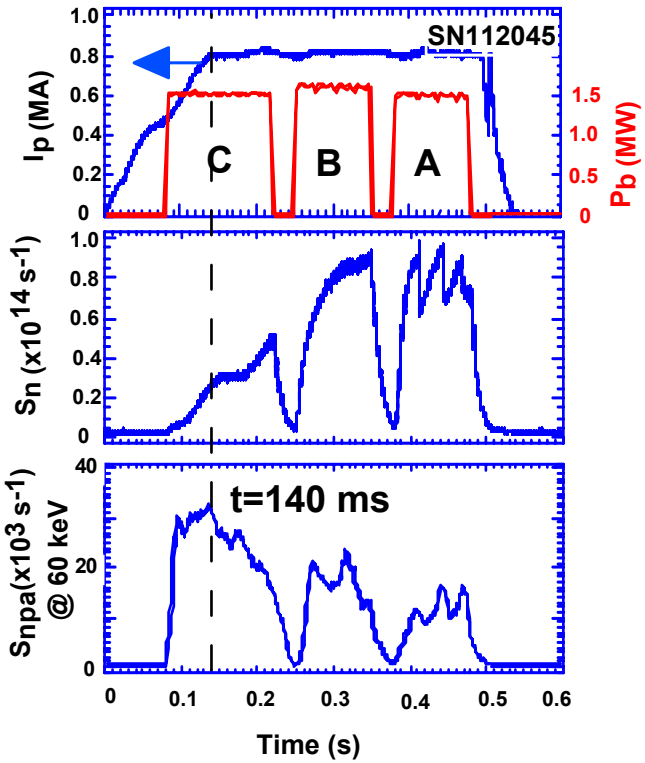
NPA Measurements are Spatially Localized by Beam Injected Neutrals



- The beam injected neutrals spatially localize the NPA signal insert).
- Approximately 2/3 of the line-integrated flux originates in the NB region.
- This spatial localization constrains the range of pitch angles viewed by the NPA (main panel).
- Spatial localization weakens with increasing NB penetration distance (due to attenuation of the beam neutrals).

Slowing Down and Pitch Angle Scattering of NB Ions in NSTX Plasmas is Consistent with Classical Behavior

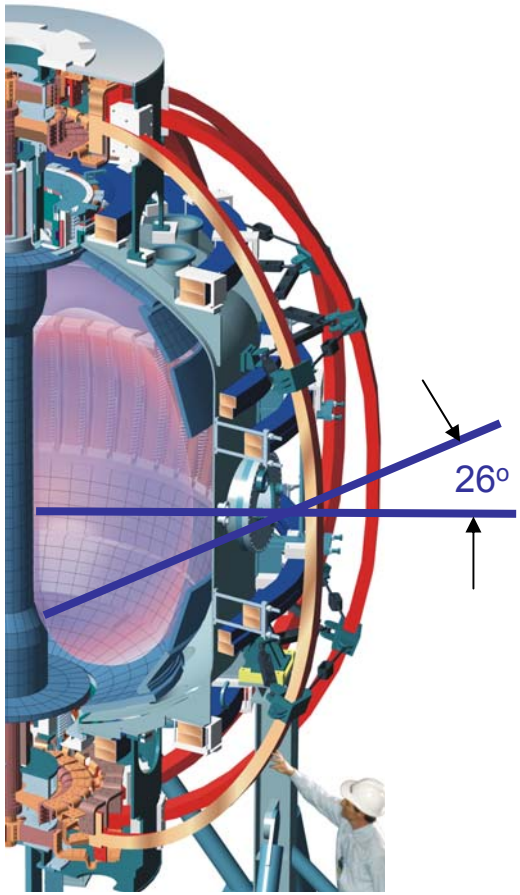


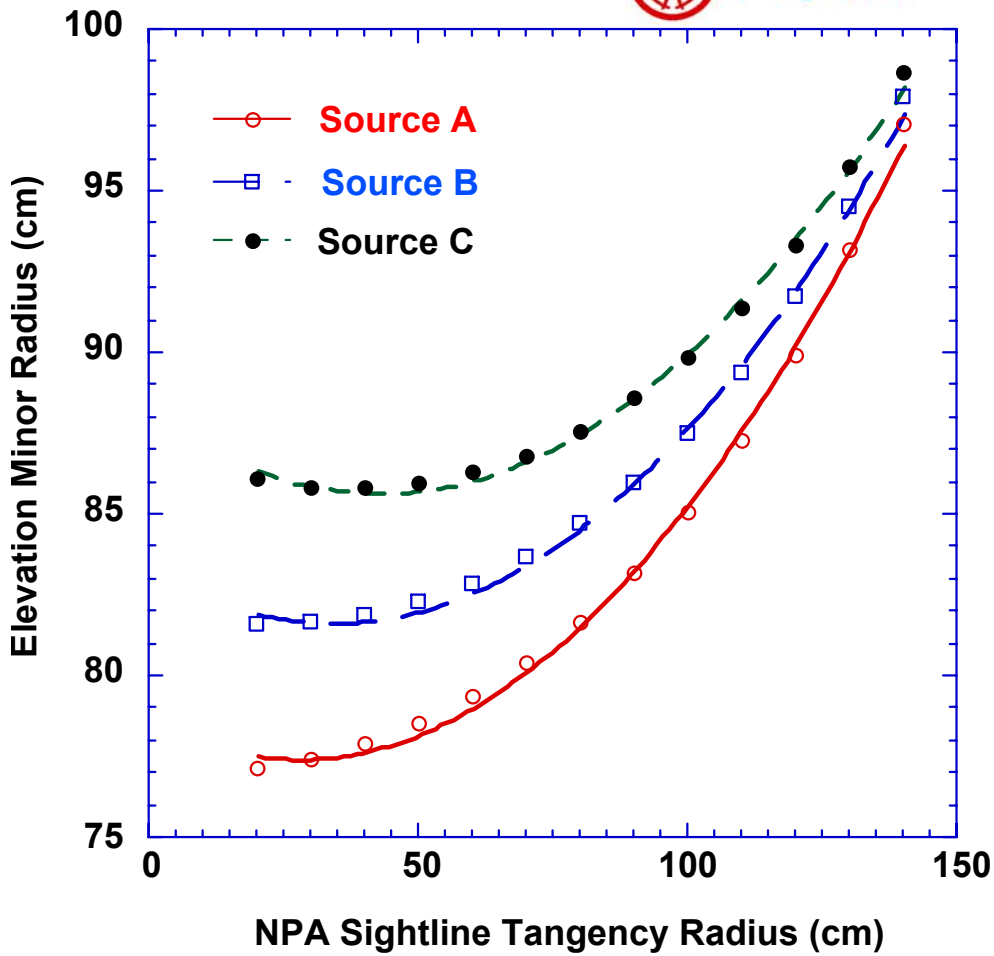


Spectrum at 60 ms after start of NBI

- E_{perp} distribution for $E \leq E_{crit}$ (~15 keV) fills in over ~ 60 ms (classical time: ~ 50 ms)

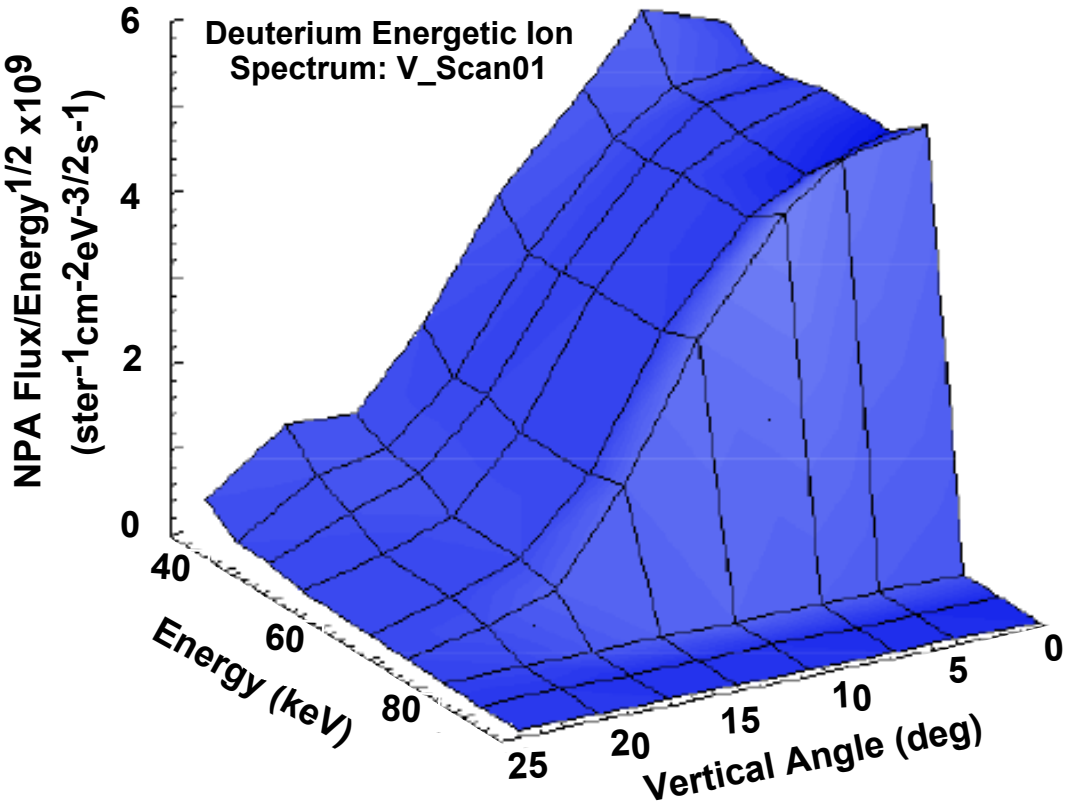
The NSTX NPA Can Scan 26° Vertically Downward





The elevation minor radius at the intersection of the NPA sightline with a given neutral beam line depends on the NPA midplane tangency radius.

NPA Vertical Scan Reveals the Beam Neutral Footprint

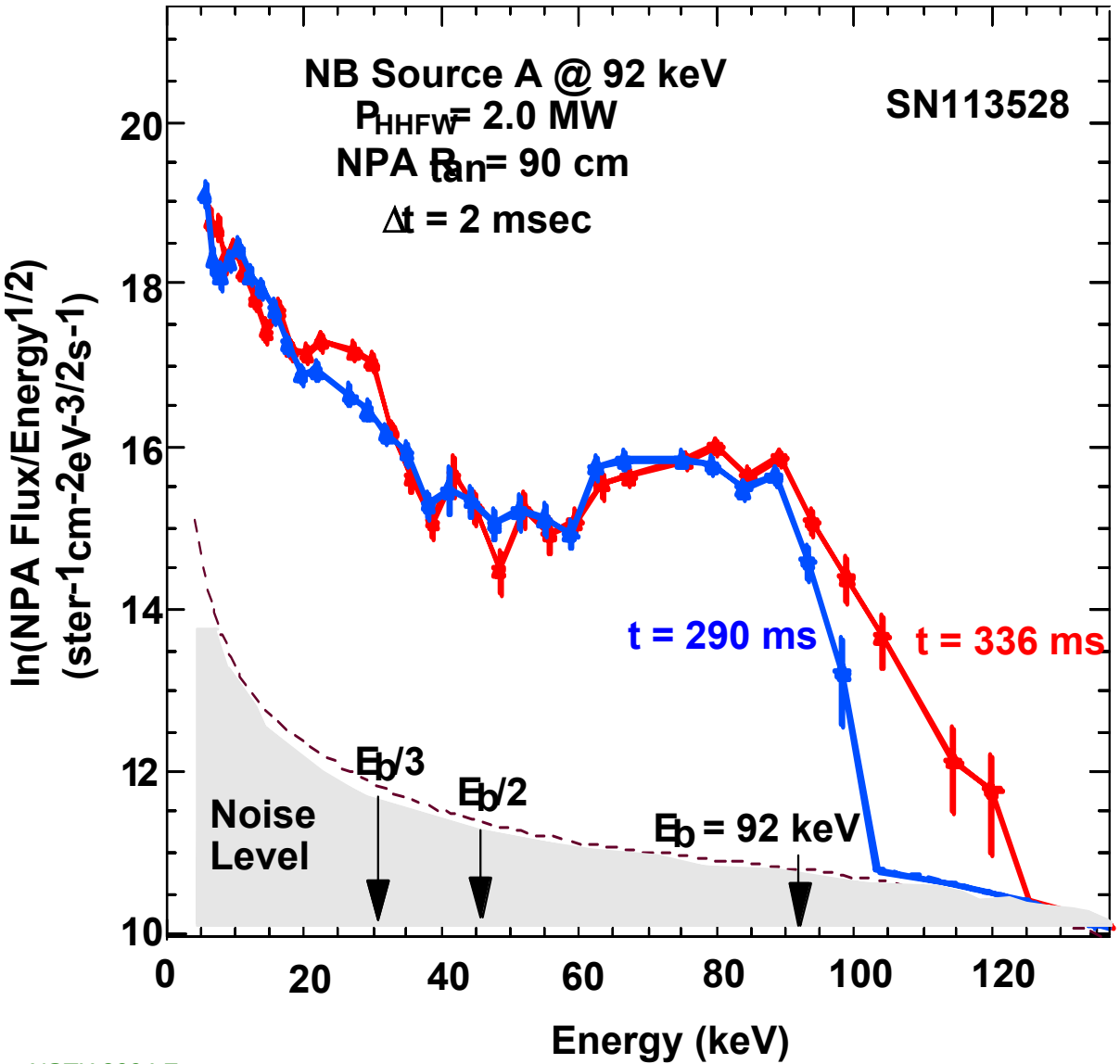


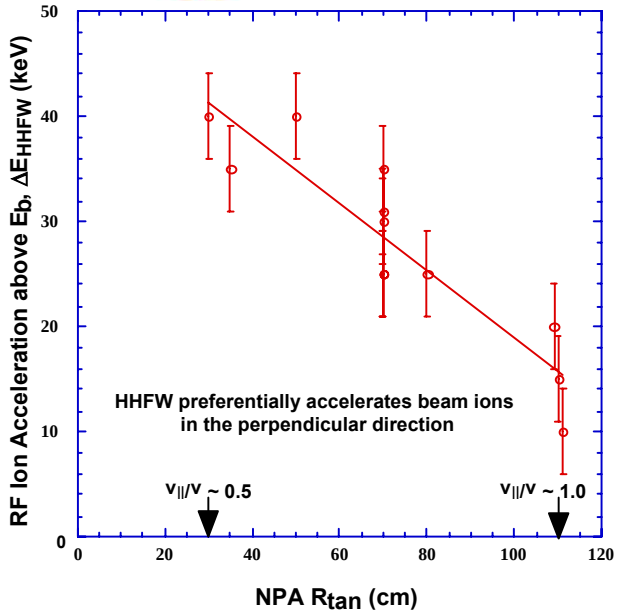
Shown is the NPA measurement of the NB elevation profile versus beam energy and vertical scan angle obtained at R_{tan} = 80 cm revealing the spatial distribution of the injected neutral beam Source A below the mid-plane.

Extensive Sets of Data Were Obtained on Additional Ion Behavior Topics

- Ion temperature measurements in Ohmic and NB-heated discharges:
  - vertical NPA scan for elevation $T_i(r)$
- Ion Redistribution and/or loss of thermal and energetic ions due to reconnection events and sawteeth:
  - ion acceleration due to reconnection events
- Extension of measurements on MHD-induced energetic ion loss behavior:
  - scaling with NB injection energy
  - spatial (field pitch) localization of ion loss
- Energetic ion tail production during HHFW launch in NB heated discharges:
  - support of XP-449, "Suppression of Frequency Chirping by HHFW Heating of Beam Ions"

Suppression of Frequency Chirping by HHFW Heating of Beam Ions: XP-449





- Comparable RF acceleration of neutral beam ions observed at E_b ~ 65 keV and E_b ~ 90 keV for all NB sources.
- The energetic ion tails form in < 15 ms for P_{HHFW} ~ 2 MW.
- Tail decay time ~ 12 ms.