Initial Neutral Particle Analyzer Measurements of Energetic Ion Distributions in NSTX

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NSTX Results Review

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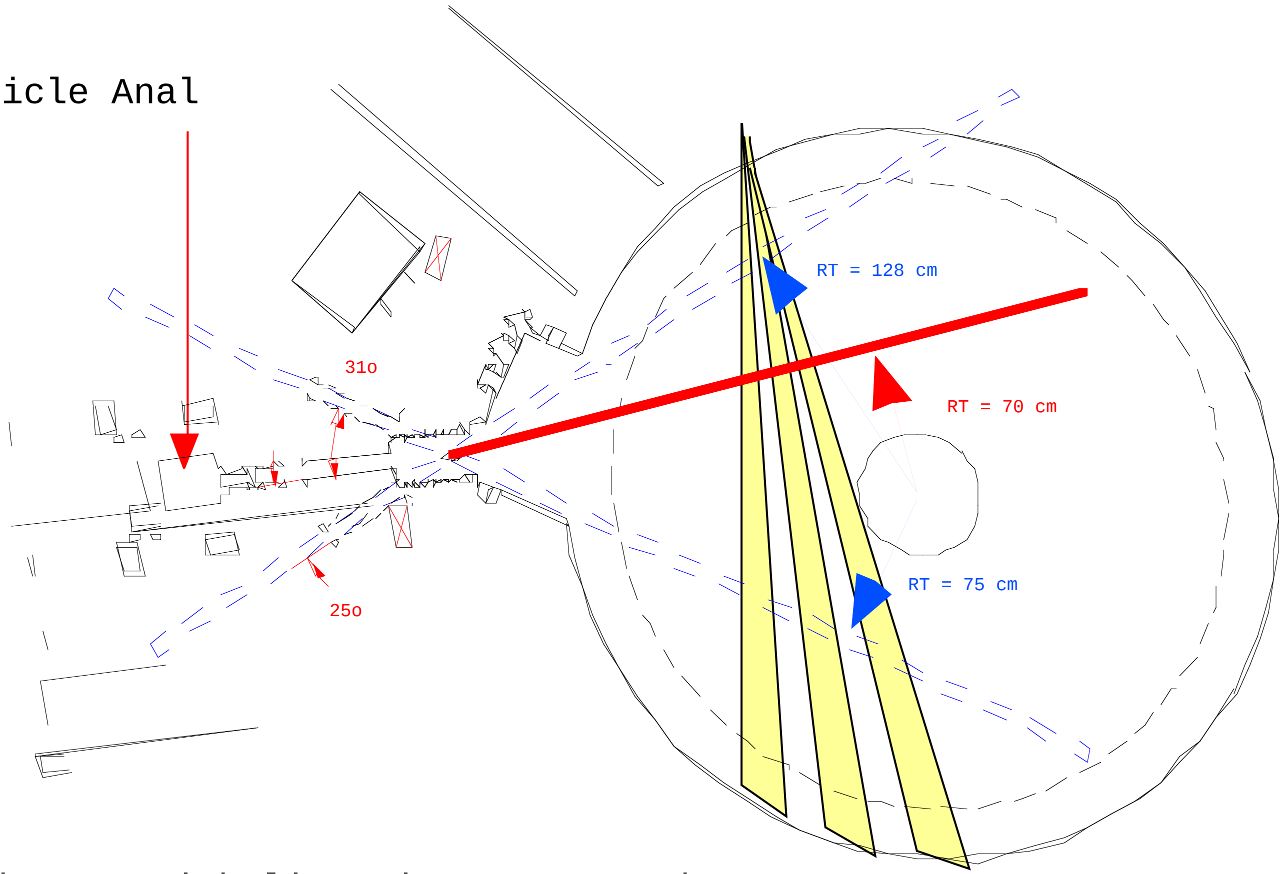
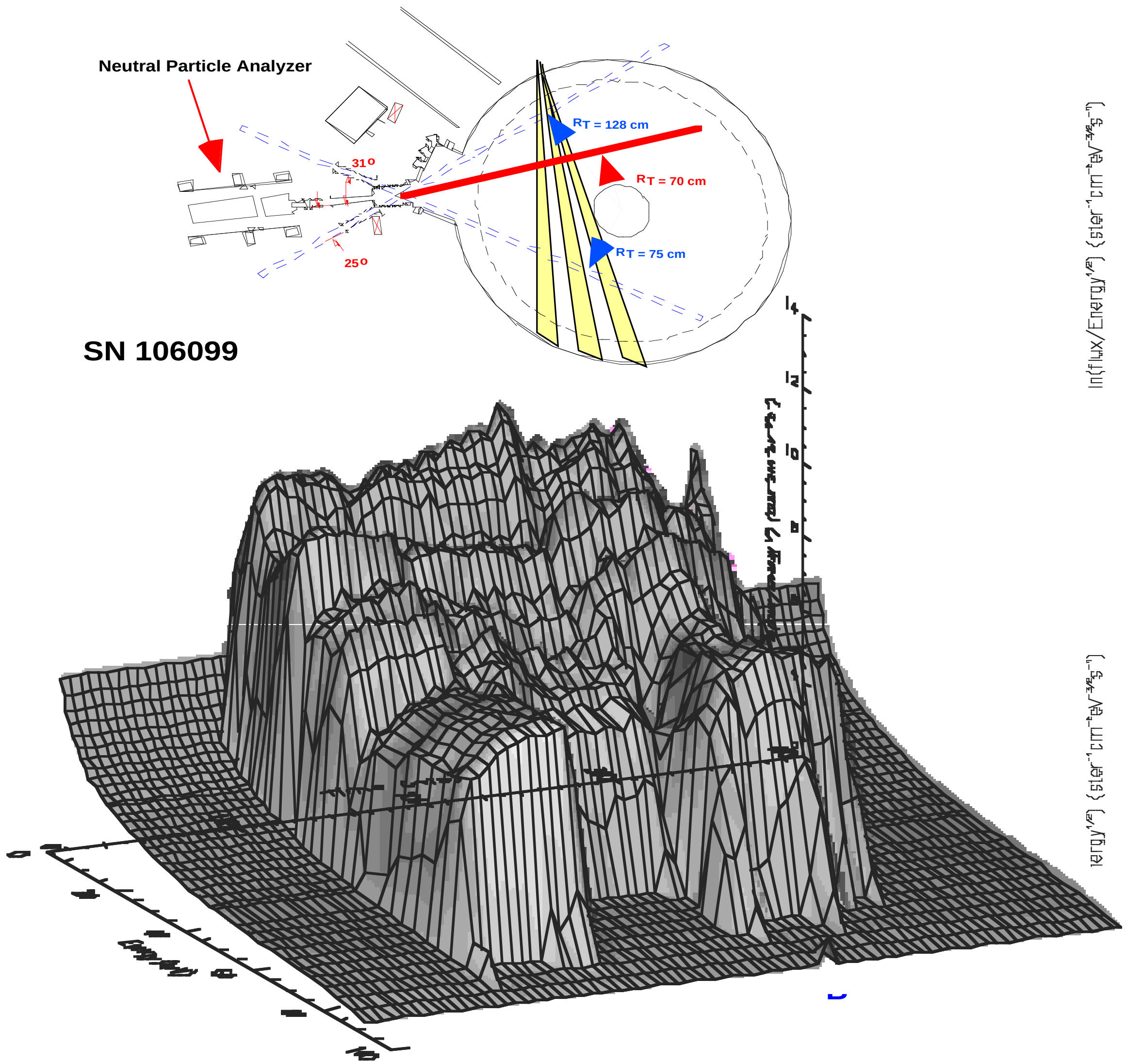
NPA Sightline Scanned from R_{tan} = 92 cm (co-D^+) to R_{tan} = - 15 cm (ctr-D^+)

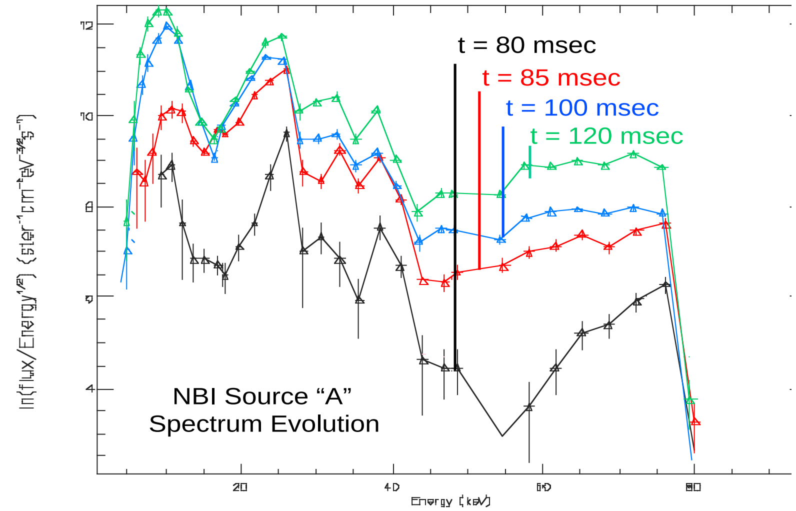
Neutral Particle Anal

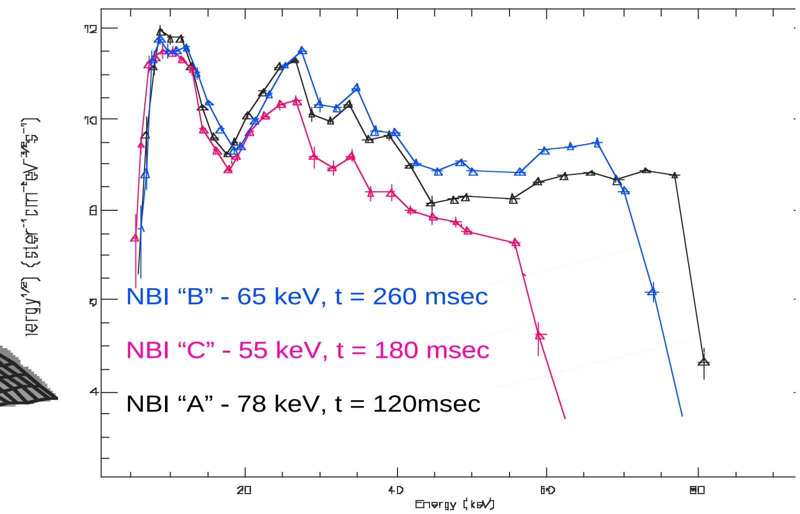


- The NPA sightline views across th
  injection paths

NPA Measurements of Deuterium Neutral Beam Ion Spectra in NSTX

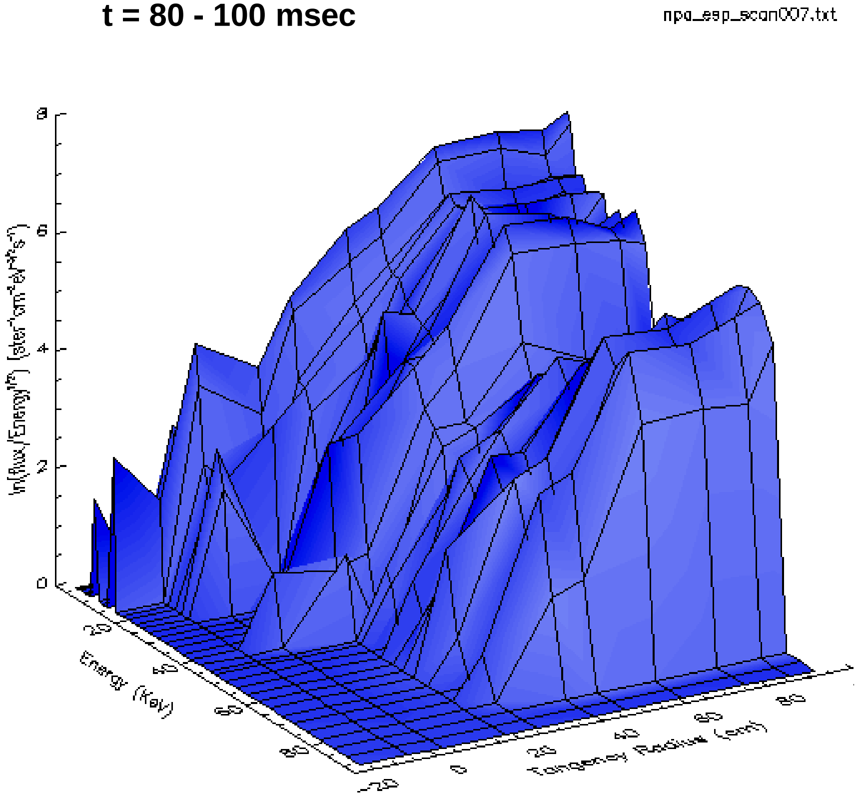




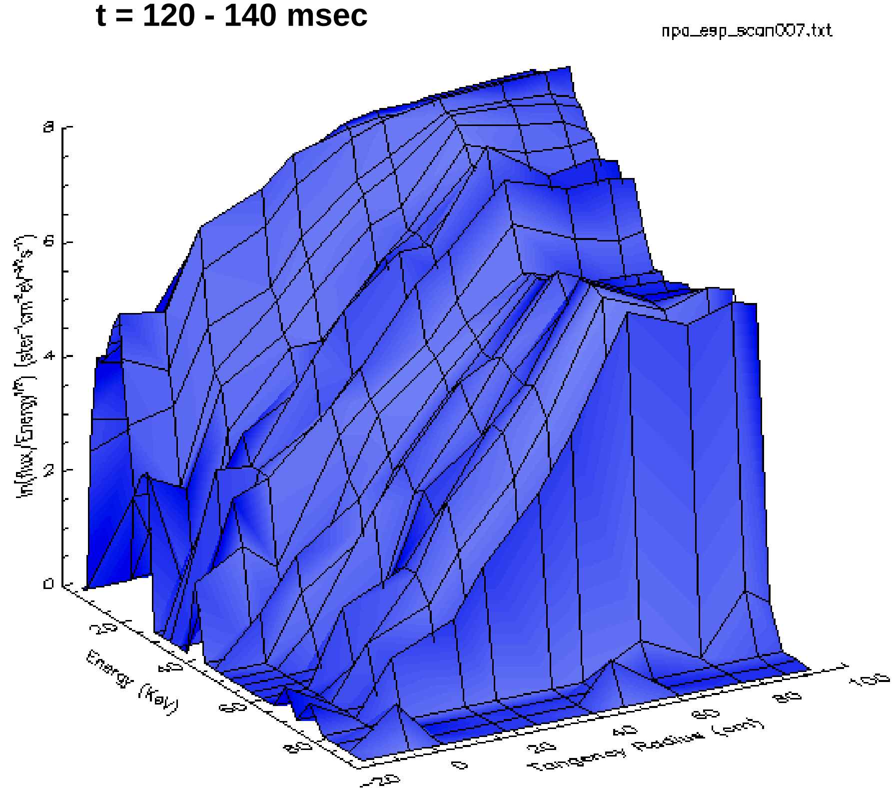


NB Energetic Ion Distribution: Horizontal Scan Data

t = 80 - 100 msec



t = 120 - 140 msec



Source B @ 80 keV, t_{inj} = 80 msec

NPA R_{tan} scan from -20 cm to 92 cm

NB Energetic Ion Distribution: Initial Scan Results

- $E_\perp$ fill at $R_{tan} \leq 20$ cm

NB Source	A	B	C
Δt (msec)	60	60	40
Flux Level	1	1	2

- τ_{slow} < $\tau_{scattering}$

  15-25 msec   40- 60 msec

- Energetic ion spectrum depletes with:

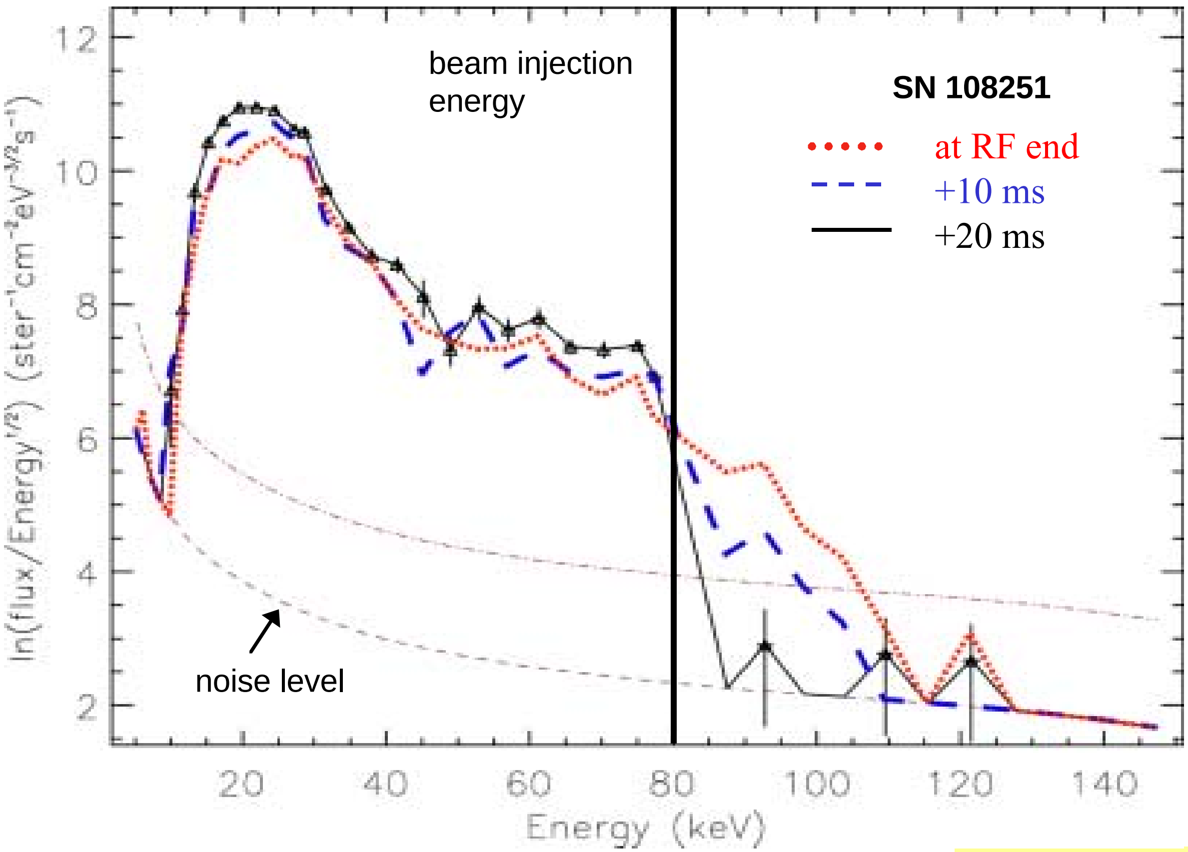
  - increasing n_e
  - decreasing outer gap
  - H mode

All effects decrease beam penetration

NPA Shows Fast Ion Tail Build-up and 'Classical' Decay After HHFW Turn-off

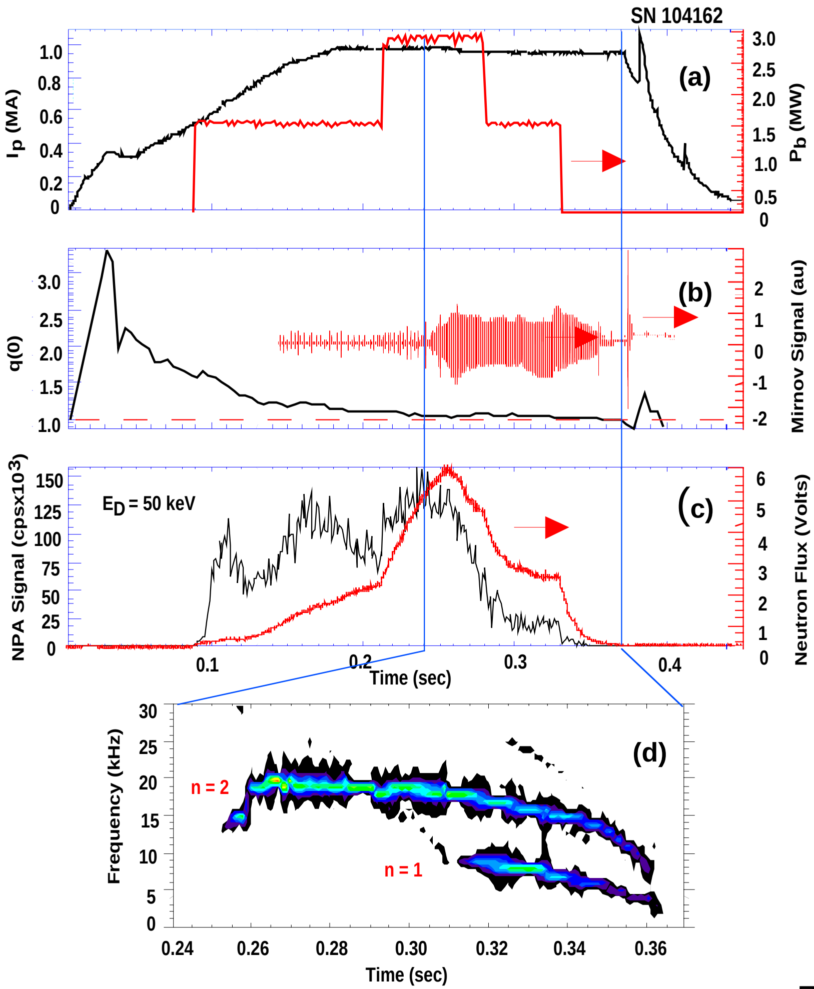
- HHFW turns off at t=200ms
- NBI Source A on throughout

- HHFW+NBI fast ion interactions at $\omega/\Omega_D \approx 9$
- D^+ tail extends to 140keV
- Tail saturates in time during HHFW



Effect of MHD on NPA Measurements in the "<u>Fast ion</u>" Energy Range (E_D ~ 5 - 85 keV)

- **Peak NB power of 3 MW is injected during I_p - 1 MA flat top - panel (a)**
- **A large n=2 mode grows @ 0.26 sec followed by n=1 @ 0.32 sec - panels (b) and (d)**
- **Neutron rollover and fast ion loss occurs at start of n=2 activity - panel (c)**
- **MHD activity produces both fast ion loss and thermal ion loss (not shown)**



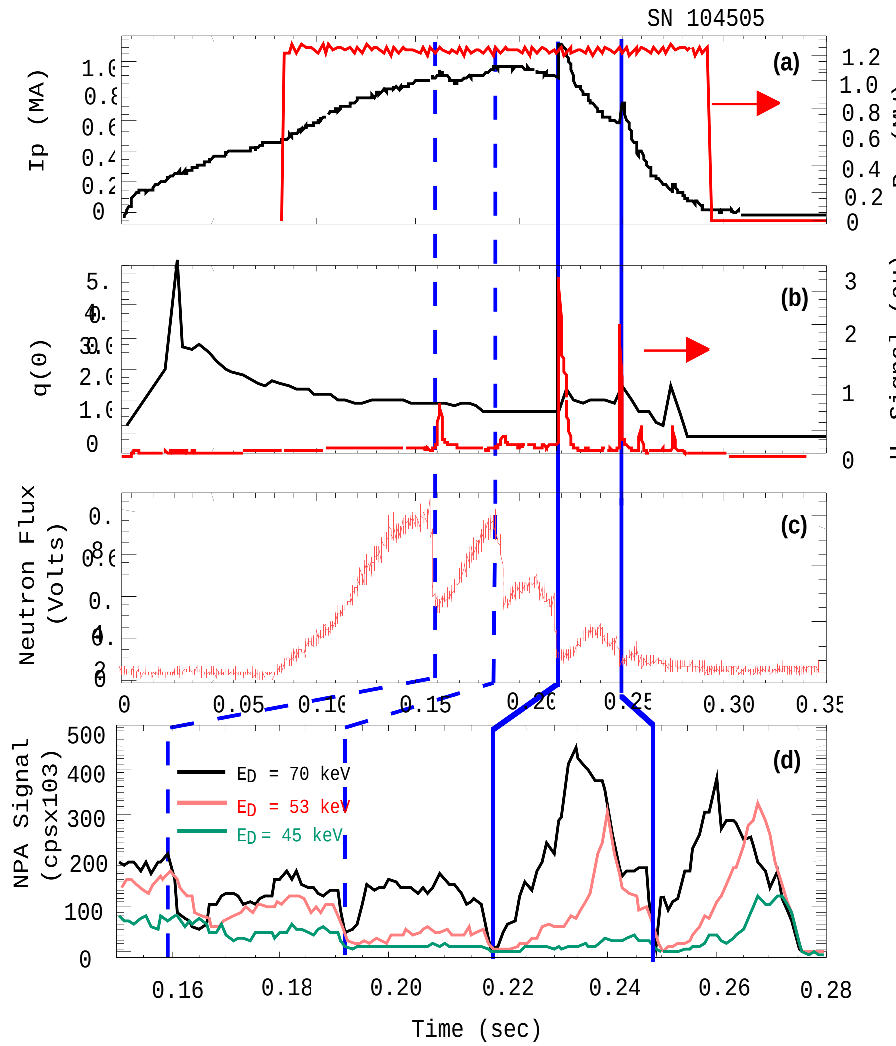
NPA Measurements in the "Fast ion" Energy Range (E_D ~ 5 - 85 keV) during IRE Events

- Shown are two large reconnection events (solid vertical lines) preceded by two small IREs (dashed lines). IREs occur when q(0)≤ 1 - panel (b)

- Neutron yield crashes due to IREs - panel (c), then recovers as NBI continues

- NPA fast ion spectrum is promptly depleted during IREs without the redistribution signature seen in the thermal energy range - panel (d)

- After IREs, NBI continues and the fast ion spectrum rebuilds. The NPA signal becomes larger during I_p rampdown due to increasing CX neutral target density



Summary

- The Neutral Particle Analyzer on NSTX has provided measurements of the evolution of the D^+ NB energetic ion distribution (E ~ 5 - 95 keV)
- Horizontal scan capability is producing quality fast ion energy distribution vs R_{tan} measurements. TRANSP simulation of NPA results will be available soon.
- An energetic ion tail up to ~ 140 keV is formed on the $E \leq 80$ keV D^+ NB ion distribution in the presence of HHFW injection. Tail formation observed for R_{tan} = 40 - 70 cm.
- MHD activity causes gradual loss energetic ion distributions: R_{tan} effects being analyzed
- IRE activity causes prompt loss of energetic ions: observed at all R_{tan}