

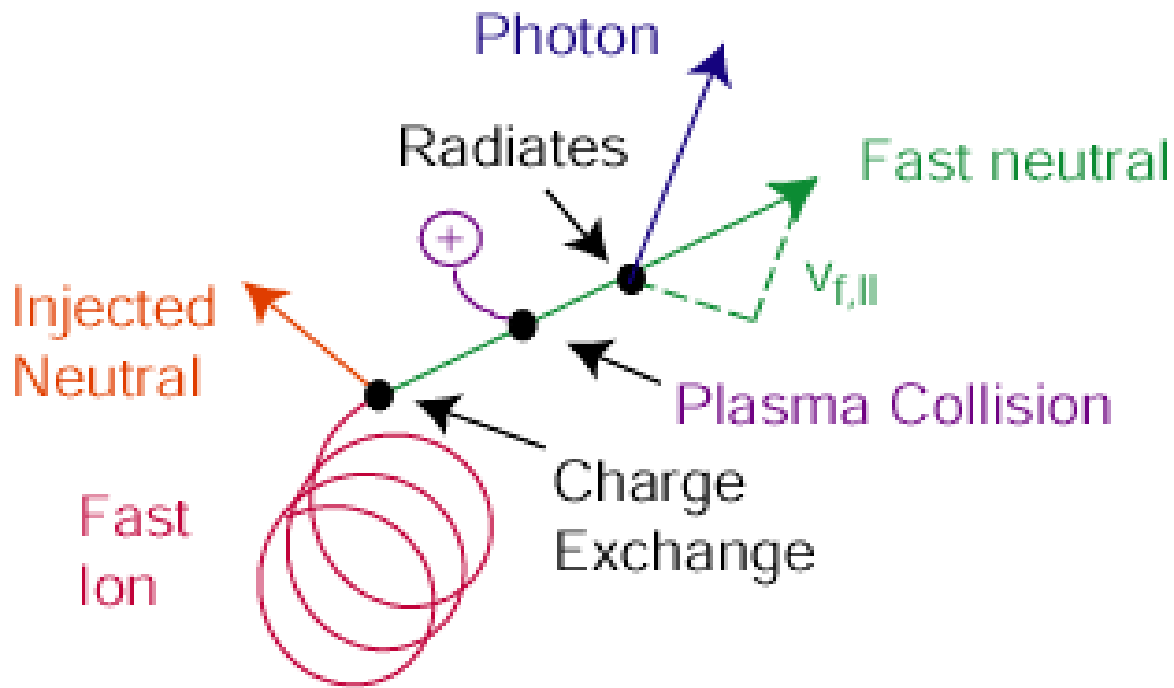
NSTX fast-ion D_α (FIDA) Diagnostics

UC Irvine - PPPL

M.Podestà

- Investigate fast ion dynamics
 - Interaction with instabilities (mostly AEs)
 - Loss/redistribution associated with fast ion driven modes
- Measurements should span the entire radius
 - Prototype is measuring at one radial position
- Sub-millisecond time-scales

Principles of the FIDA diagnostics



- A type of Charge Exchange Recombination Spectroscopy
- Exploit large Doppler shift (measure wings of D_{α} line)

Principles of the FIDA diagnostics

Photon

On DIII-D :

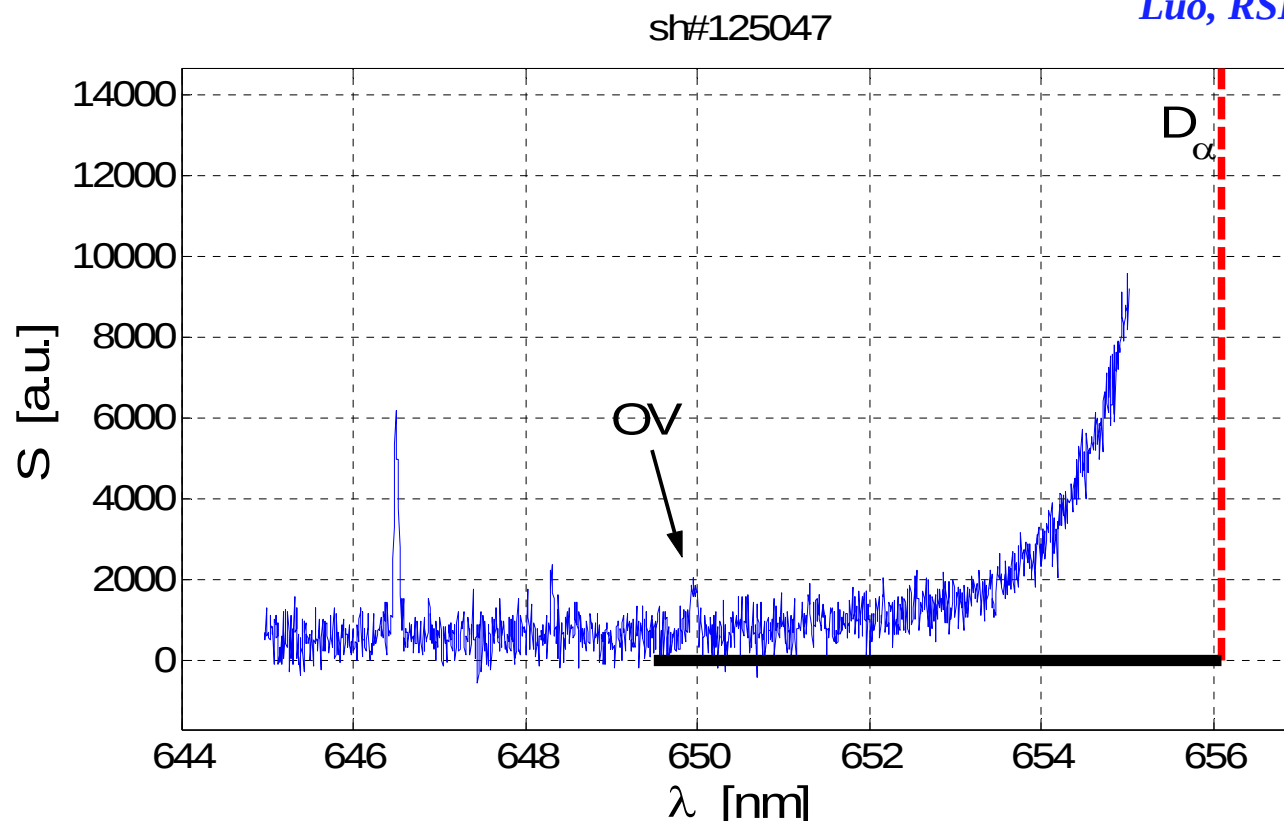
- Achieved resolution :

~ 5 cm, ~ 10 keV, 1 ms

- Background subtraction usually dominates uncertainty

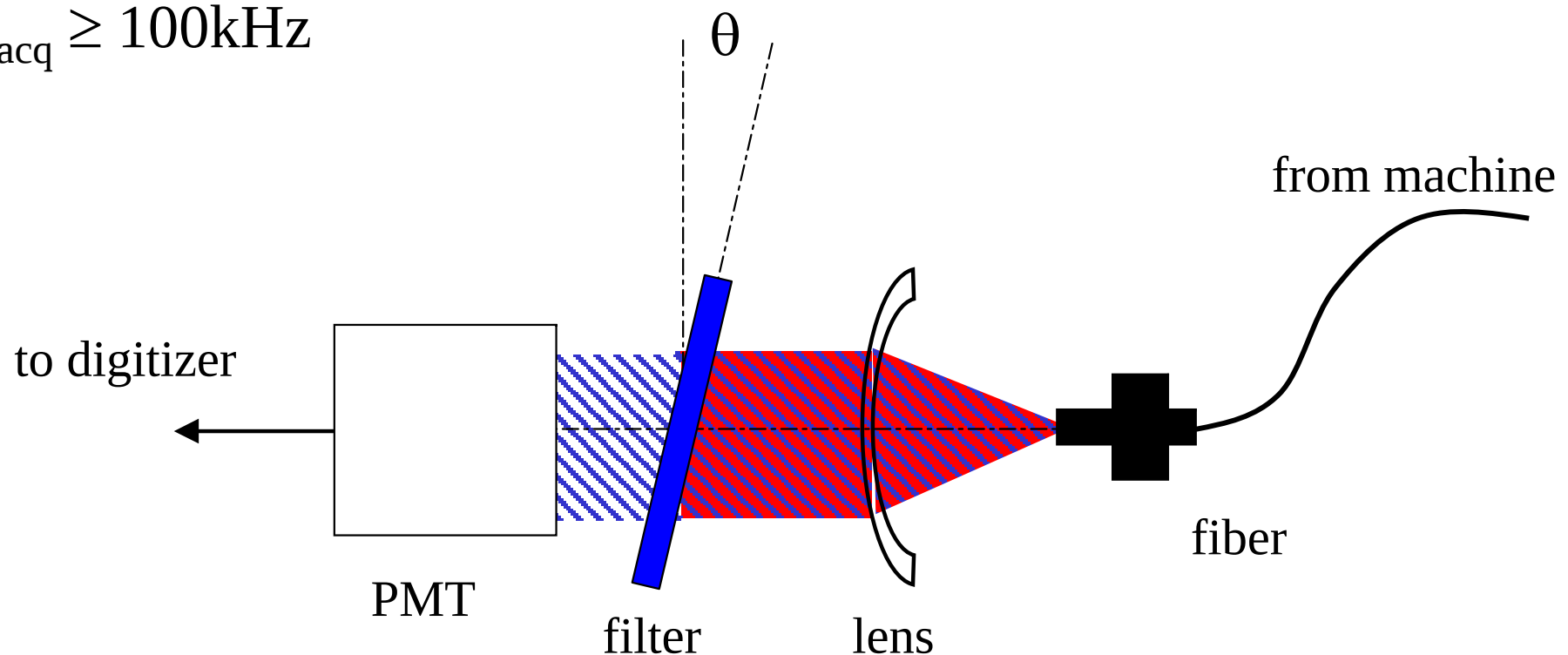
Heidbrink, PPCF 46 (2004) 1855

Luo, RSI (2006)



NSTX - FIDA prototype

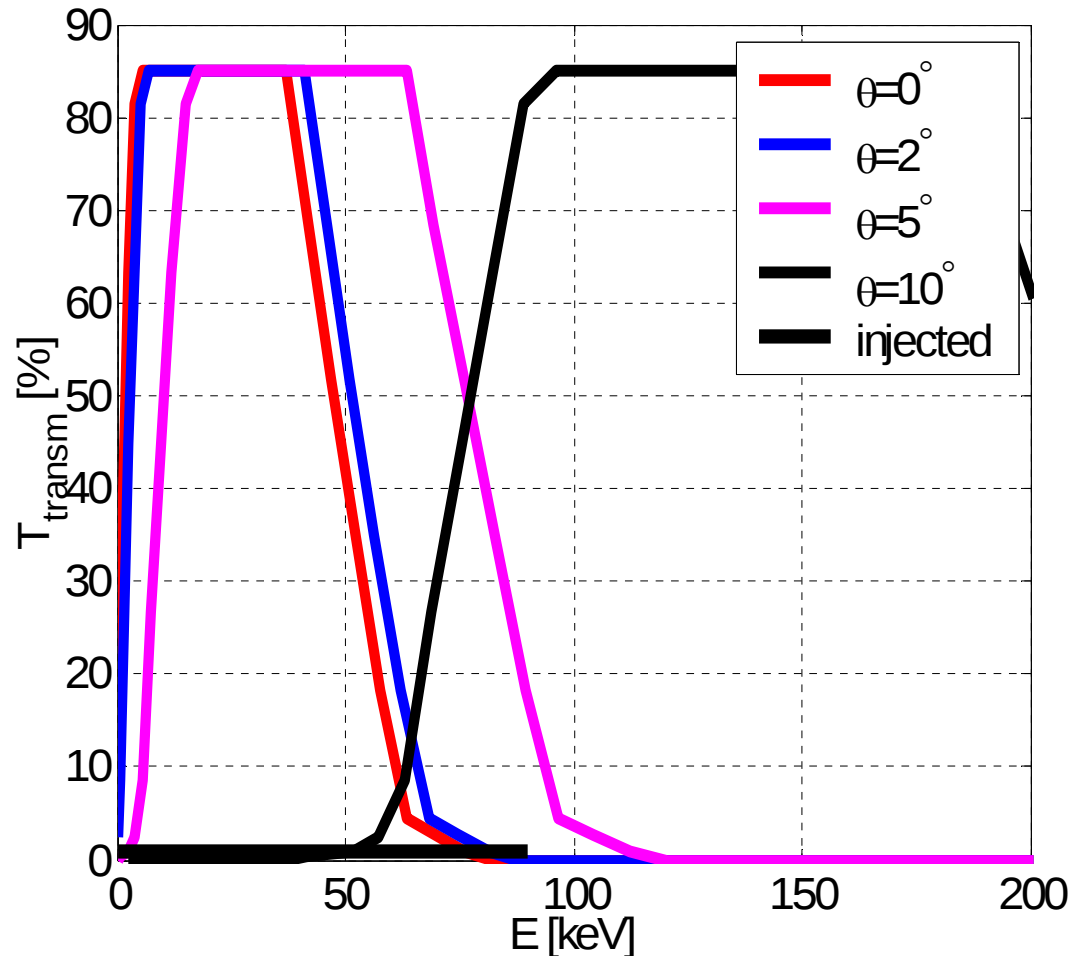
- One “channel” looking at $R=120$ cm or $R=100$ cm
- Two vertical views intercepting/missing the beam for direct background subtraction
 - *Active* and *Background* views
- $f_{\text{acq}} \geq 100\text{kHz}$



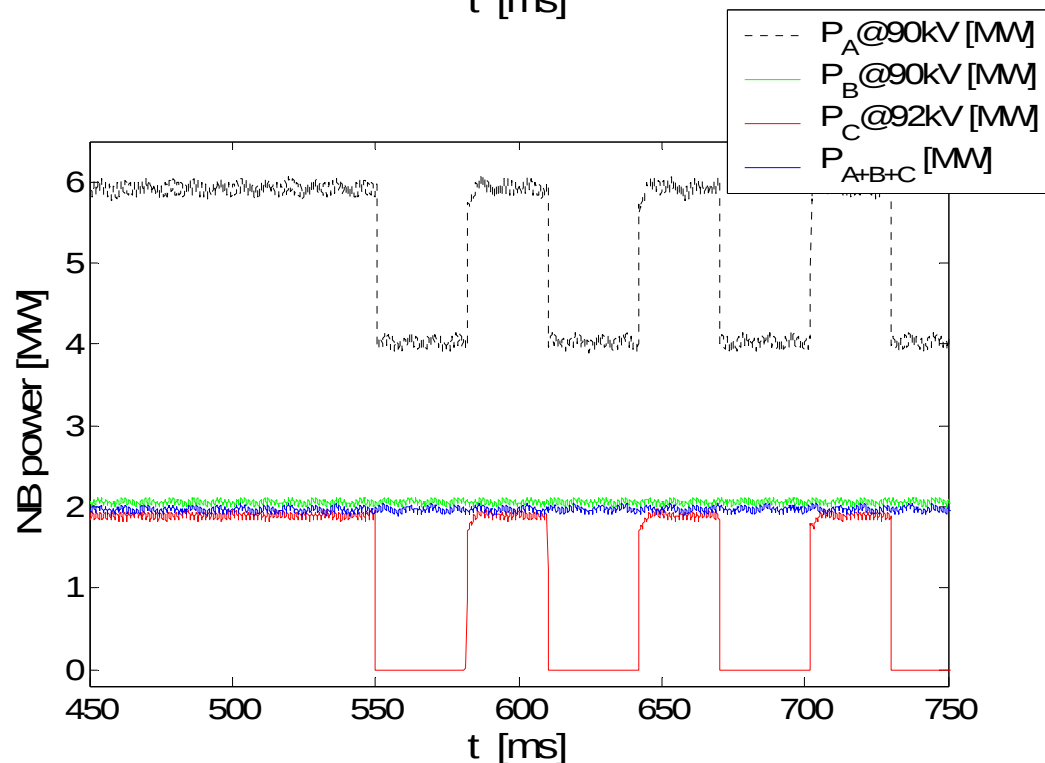
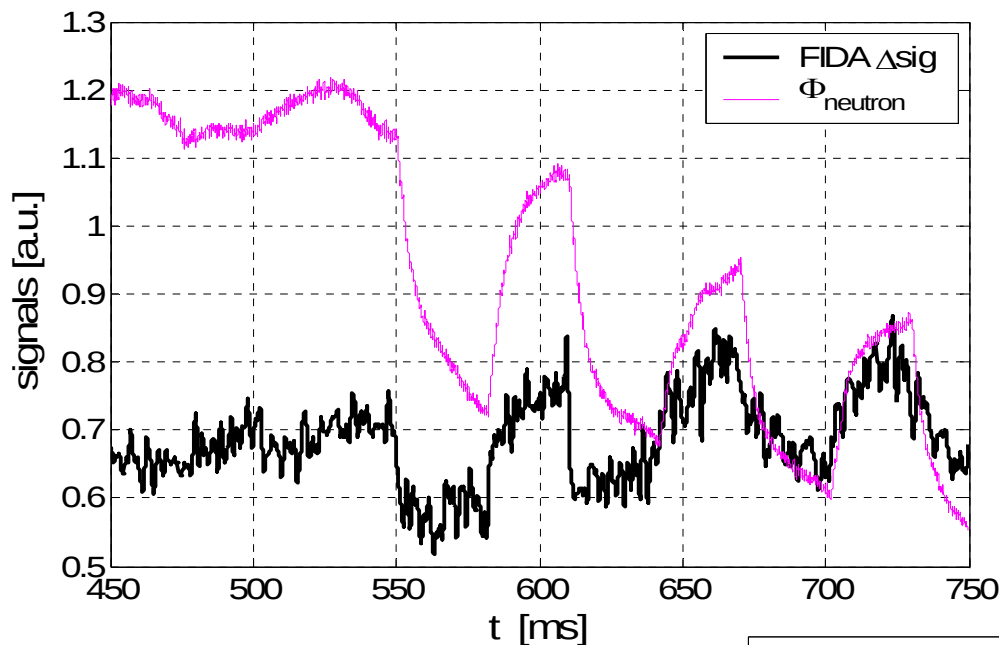
- Data available from sh#124324 on

NSTX - FIDA prototype

- Pass-band filter: measure only the blue wing of the D_α spectrum
 - Select energy range through θ
 - Allows qualitative spectral analysis



Examples from 2007 Run /1



- Clear response to beam modulation
 - Consistent with neutron flux (determined by beam-plasma reaction)
- Compatibly with expectations:

$$\Delta\text{sig}(t) \propto n_{\text{inj}} n_{\text{fast ions}}$$

Prompt response
to “diagnostic”
beam

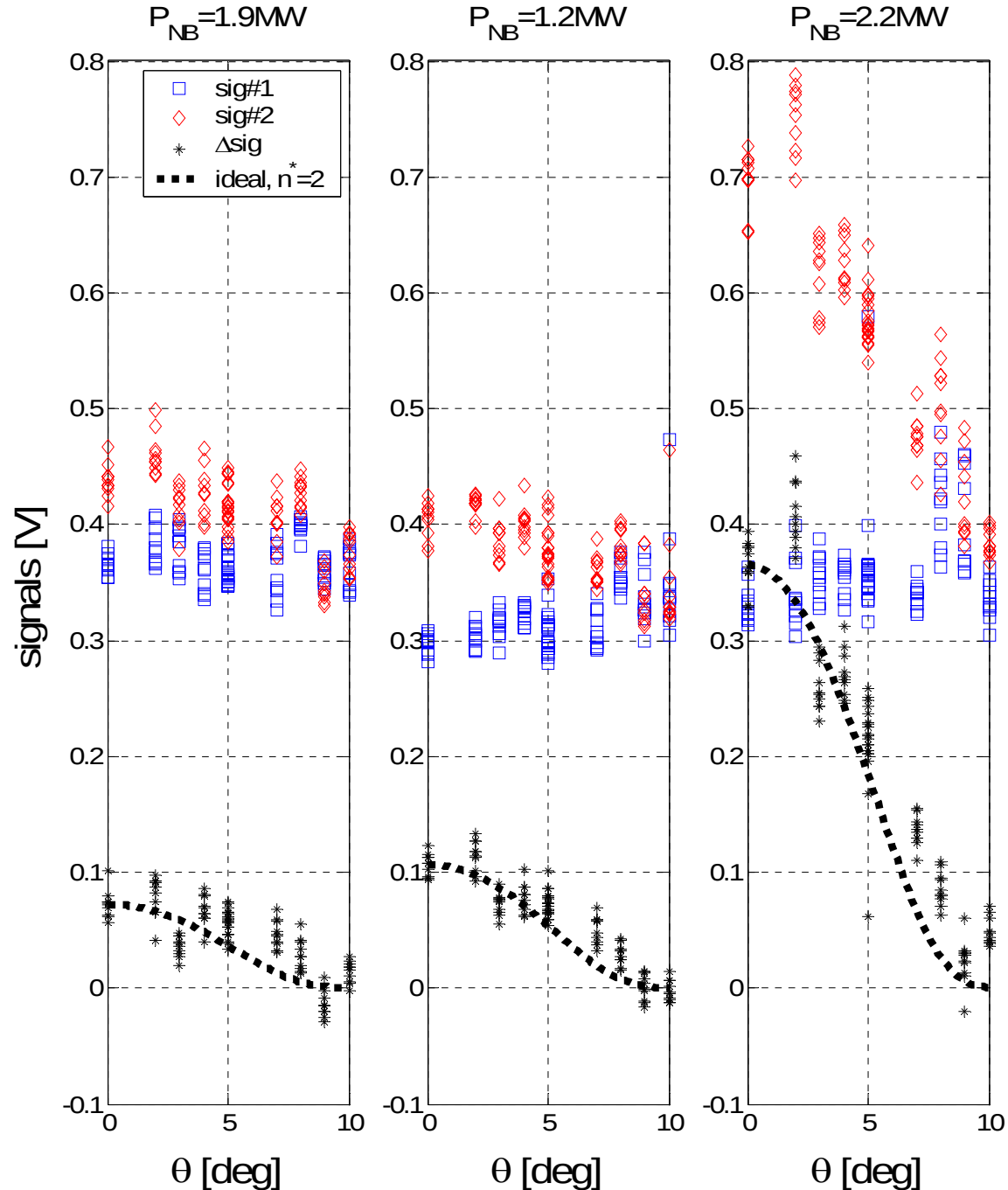
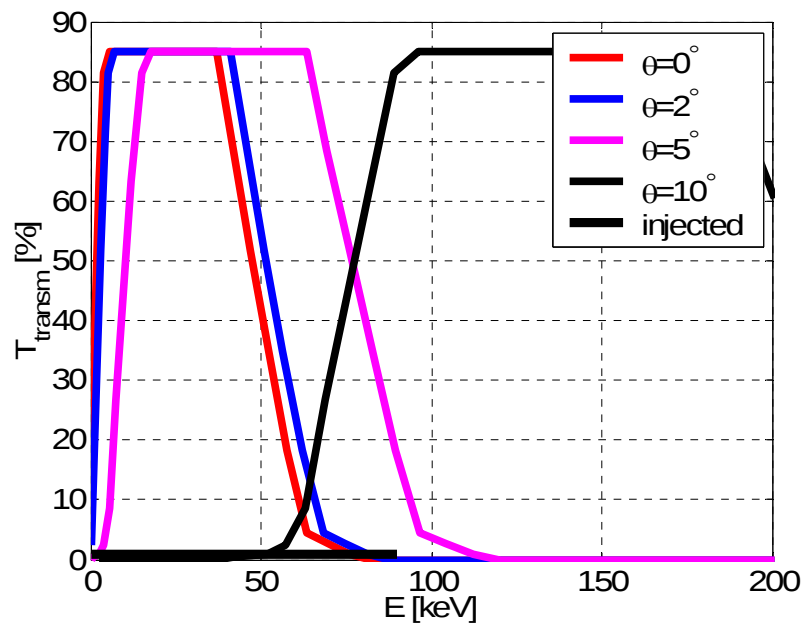
Response on
slowing-down
time scale

Example:

R=120cm

XP 737 - sh#124814,124819,124821,124822

Examples from 2007 Run /2



Rough spectral analysis:

- Scan θ
- Results are “reasonable”
 - Need to characterize the filter response
 - Need to know the spectrum
- Data available for XP 705, XP 721, XP 737

Next steps...

- 2007 Run

- More quantitative analysis: unfold $n_{\text{fast ions}}(t)$ from raw signals

$$\Delta \text{sig}(t) \propto n_{\text{inj}} n_{\text{fast ions}}$$

- **Cross-check with other diagnostics** (neutron rate, NPA, S FLIP, ...)
- Response to beam modulation
- Modeling (e.g. neutral beam deposition profile)
- Spectral response
- **Data already available for many XPs**

- 2008 Run

- Set up FIDA diagnostics; optimize spatial, temporal and spectral resolution
- Two instruments:
 - Band-pass filter + high sampling rate ($\Leftarrow$ prototype)
 - Spectrometer, multiple radial views (follow DIII-D concept)

Raw signals

shot#124705

