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NSTX-U

XMP 110: FIDA/SSNPA Checkout Preliminary Results on Beam Ion Confinement

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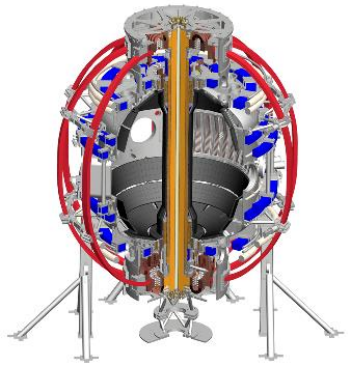
PPPL



Motivation and Run Plan of XMP-110

Motivation

- Check the accuracy of FIDA background subtraction
  (beam modulation vs. passive view)
- Compare the diagnostic response in phase space
  (v-FIDA vs. t-FIDA, r-ssNPA vs. t-ssNPA)
- Initial assessment of beam ion confinement especially NB line #2
  → prepare for XP1522 “Beam ion confinement of 2nd NBI line”

Run plan

I. Short (~20ms) beam blips from NB line #1 and #2 @65keV/1MW

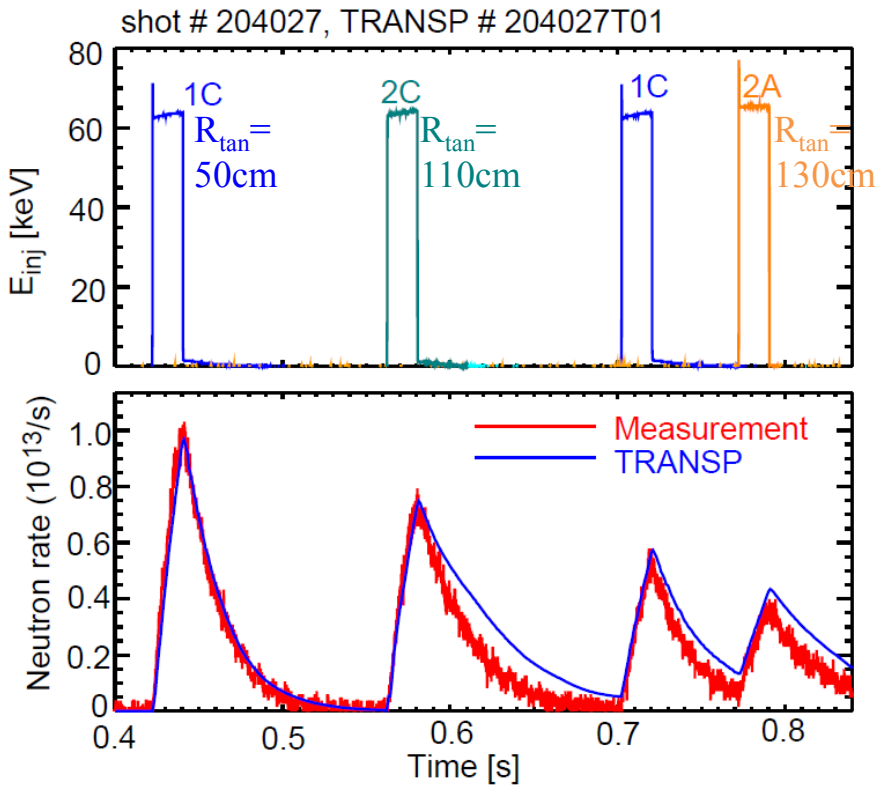
II. Relatively long (100ms>fast ion slowing down time) pulses @65keV/1MW

III. Perform step (1) and (2) again when beams are available at 90keV/2MW

Plasma conditions

L-mode plasma, B_t=0.65T, I_p~0.7MA, relatively low density (<3x10^{13}cm^{-3})

Preliminary Result I: Fast-Ion Behavior is Consistent with Classical Slowing-Down Theory



- Neutrons are mainly generated by beam-plasma reactions

$$S_n \sim n_f n_d < \sigma v >$$

- Rise rate $\propto \frac{dn_f}{dt} n_d < \sigma v >$

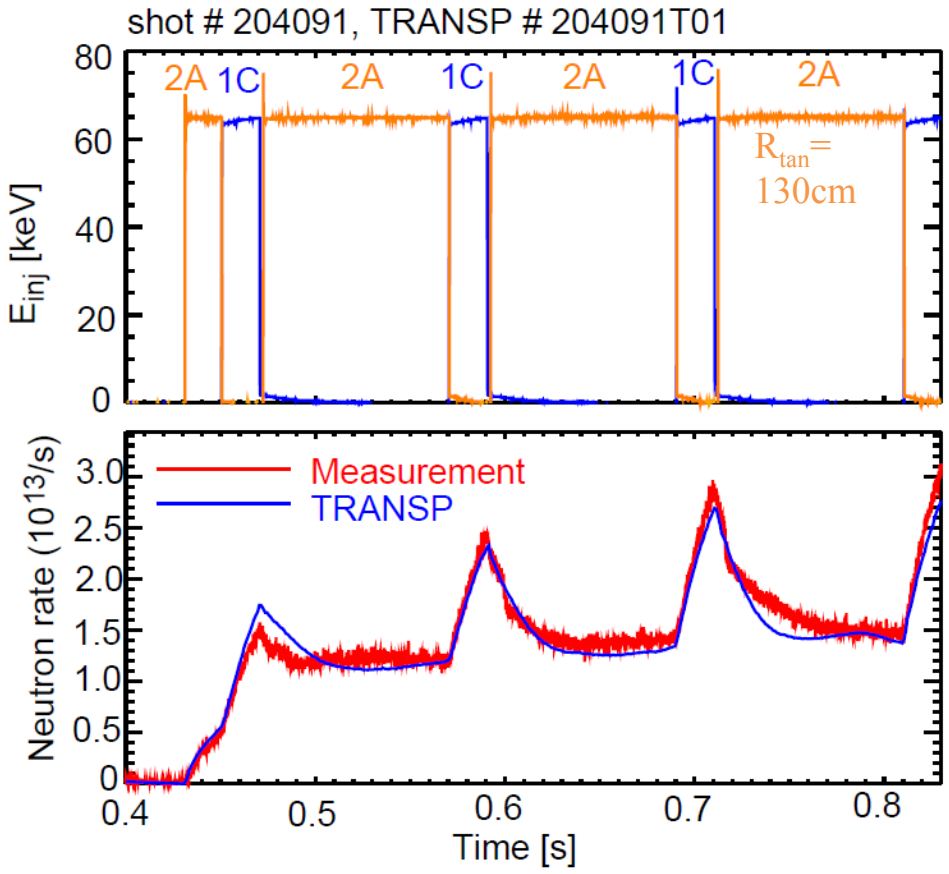
is a measure of prompt confinement

- Decay rate $\propto \nu_e \propto n_e / T_e^{3/2}$

The magnitude, rise and decay rates of neutron signal reasonably agree with the TRANSP prediction that assumes fast ions behave classically.

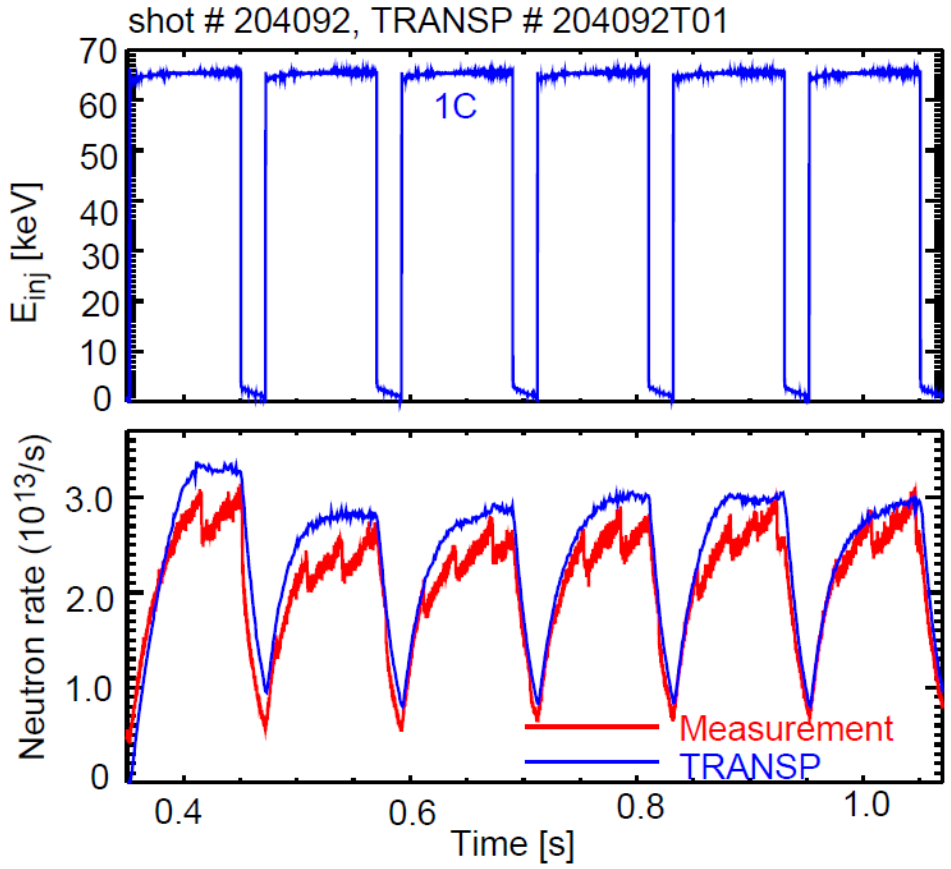
- Rise rate agrees well → fast ion generation & prompt confinement are as expected
- Decay rate agrees for most cases (except 2C) → fast ions are generally well confined

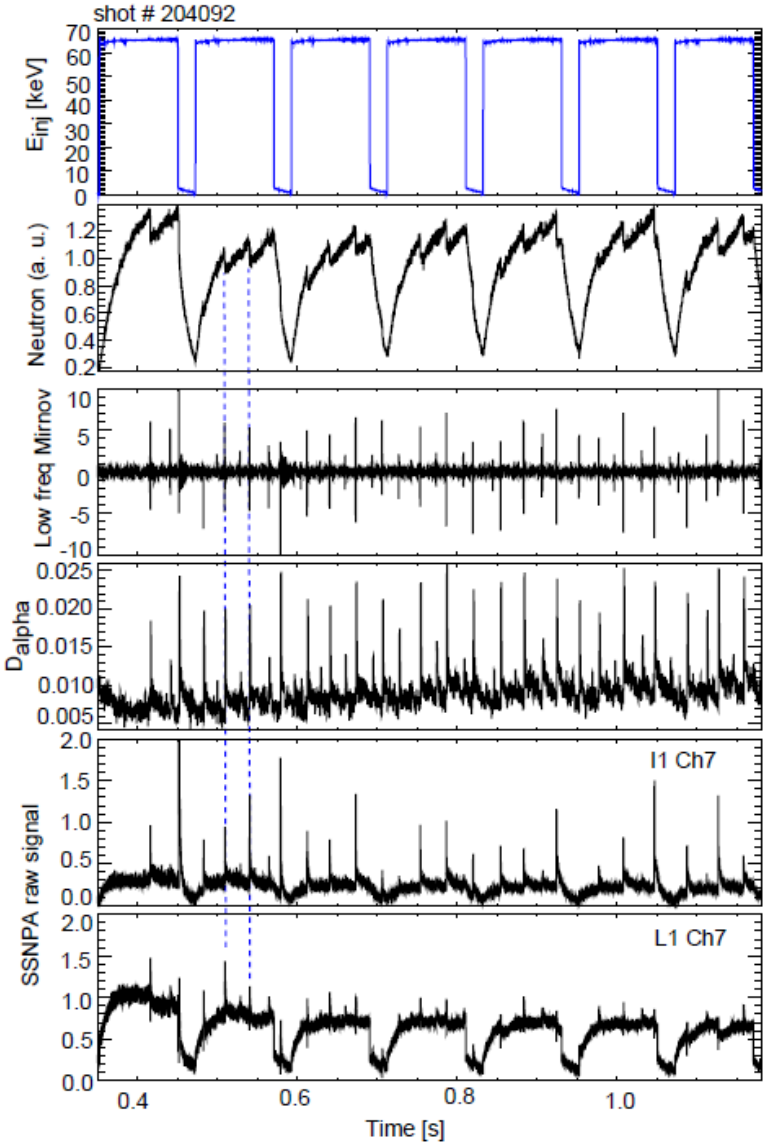
Preliminary Result I: Fast-Ion Behavior is Consistent with Classical Slowing-Down Theory (Cont'd)



- 100ms pulses of 2A (R_{tan}=130cm) followed by 20ms pulses of 1C (R_{tan}=50cm)
- Very weak MHDs
- Neutron rate agrees well with TRANSP prediction
- Neutron rate during 1C (R_{tan}=50cm) pulses is larger than at 2A (R_{tan}=130cm). Mainly because a large fraction of 2A power is lost as shine-through due to low density.

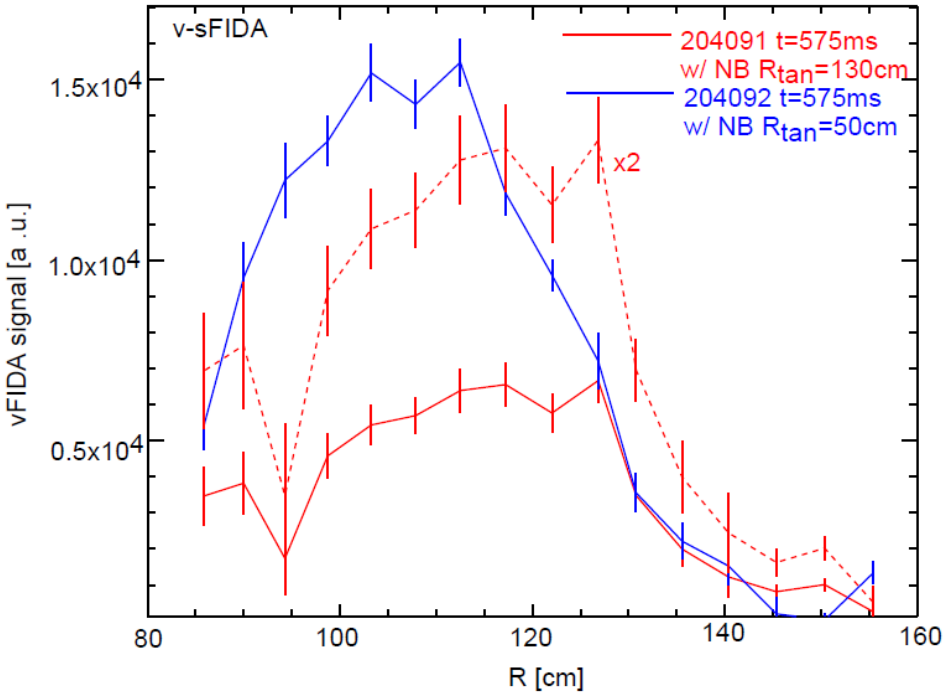
Preliminary Result II: Sawteeth Caused Fast Ion Loss

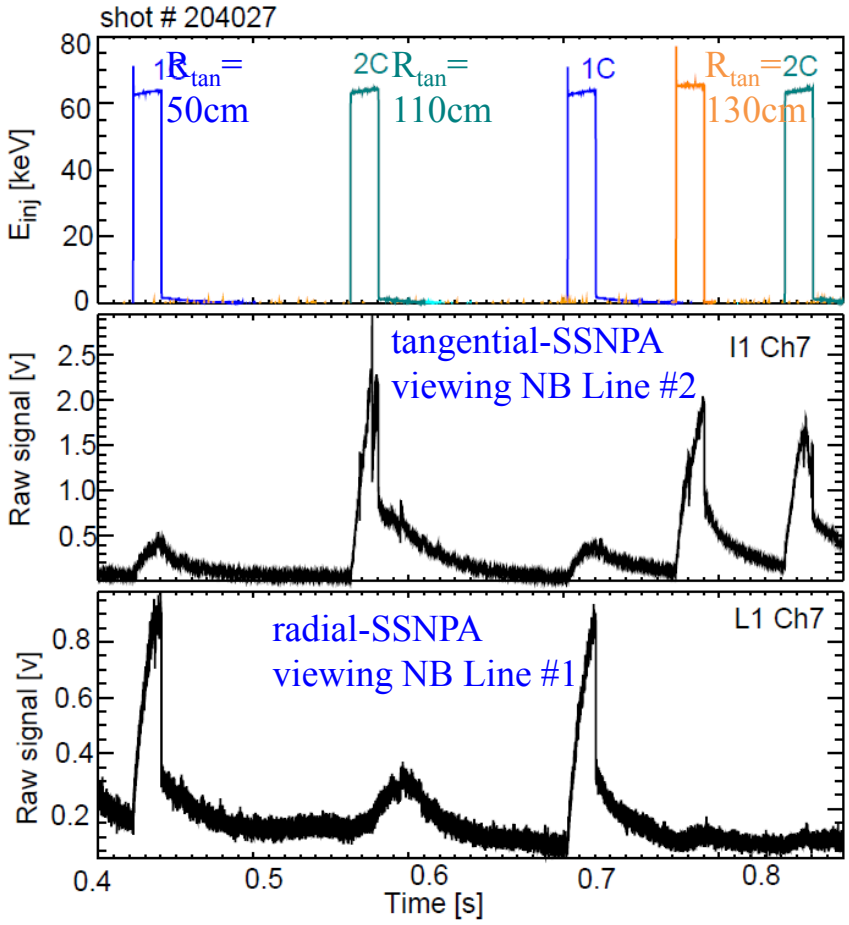




- 100ms pulses of 1C (R_{tan}=50cm)
- Bursts are observed Mirnov, D_{alpha}, SSNPA signals during sawtooth crashes.

Preliminary Result III: Reasonable Data Obtained on FIDA and SSNPA Diagnostics





- vFIDA and SSNPA diagnostics response to NB line #1 and line #2, as expected
- Active & passive responses are clearly seen on SSNPA arrays

Summary

- Beam blip experiment and comparison with TRANSP suggest that the behavior of fast ions from NB line #1 and #2 is likely consistent with classical slowing-down theory.
- Sawteeth induced fast ion loss has been observed on neutron rate and SSNPA signals.
- Reasonable data are obtained on vFIDA and SSNPA diagnostics.
- More accurate TRANSP modelling and more quantitative comparison of neutron rate and FIDA signals between experiments and modelling will be performed when MSE and CHERS diagnostics are available.

Backup Slides

FIDA and SSNPA Sightlines