NSTX-U

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XMP: FIDA/ssNPA/sFLIP Checkout

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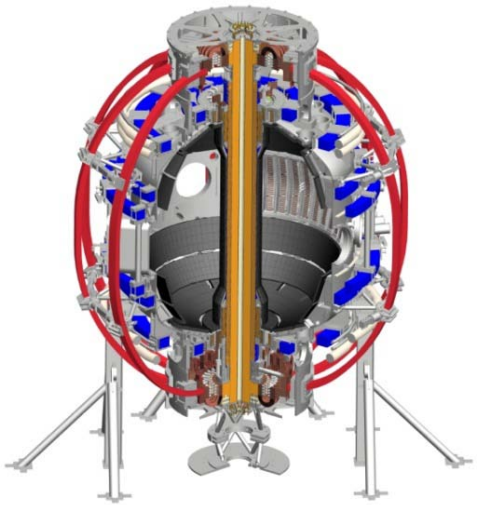
EP Group Review
NSTX-U Control Room Annex
June 11, 2015



XMP Goal: Check and Optimize FIDA/ssNPA/sFLIP

Motivation:

- FIDA, ssNPA and sFLIP are critical diagnostics for beam ion confinement and transport.
- t-FIDA and ssNPA are new/upgraded diagnostics.

Main goals:

- Check the accuracy of background subtraction (FIDA: beam modulation vs. passive views)
- Compare the response in phase space (v-FIDA vs. t-FIDA, r-ssNPA vs. t-ssNPA)
- Optimize the filter angle of f-FIDA systems
- Test s-FLIP diagnostic

Secondary goals:

- Assess FIDA and ssNPA response for different neutral beam sources
- Obtain one quiescent shot for TRANSP/FIDAsim simulations.

Allocation: 1 day (strongly prefer two half days)

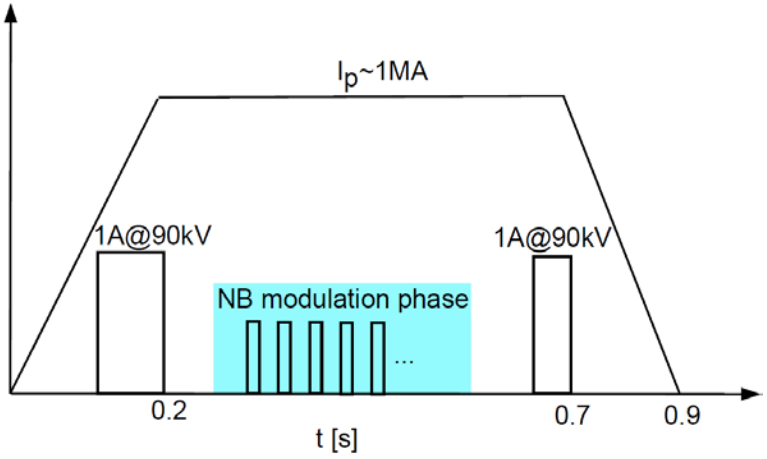
Overall Run Plan (1.0 Day)

Baseline conditions

- NSTX like plasma, L-mode, quiescent
- **B_t=0.5T**, I_p~1MA, relatively low density (3-4x10^{13} cm^{-3})

Template discharge

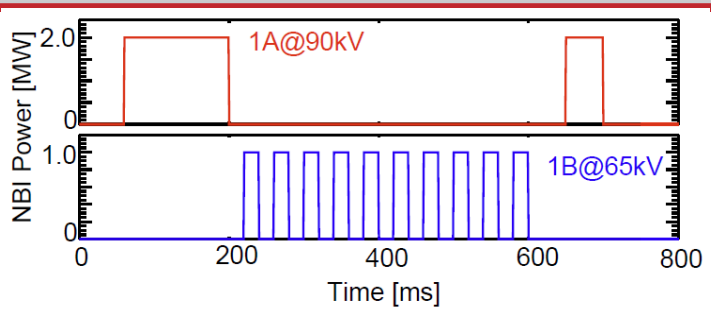
- Source 1A @90kV to provide MSE and CHERS measurements.
- Many different beam modulation patterns in "NB modulation phase"



Part A(½ day): **1A@90kV**, **others@65kV** [10+2 optional shots]

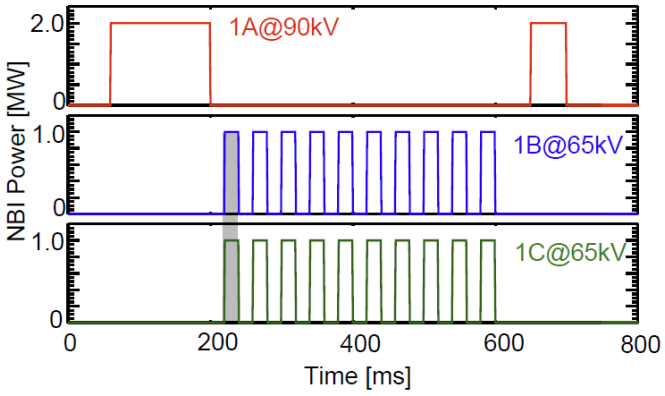
Part B(½ day): **1A/1C/2A@90kV**, **others@65kV** [7?+3+2 optional shots]

Shot Plan of Part A - the First ½ Day

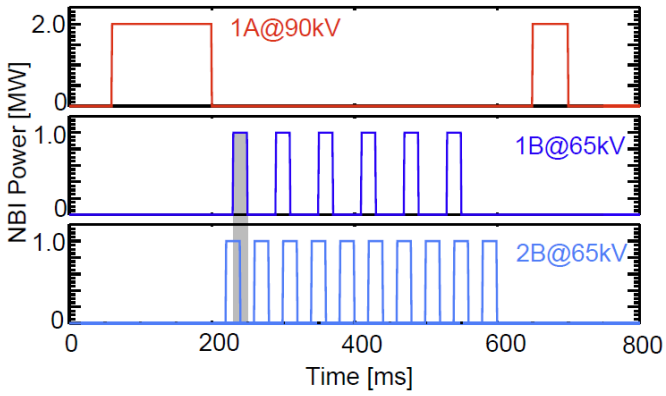


- Step 1: **baseline development** [~4 shots?]
  - L-mode, quiescent B_t=0.5T, I_p~1MA
  - Uncertain how long it will take
  - Hope to get some extra dedicate development time with other TSGs

    Note: 3 XPs from T&T and 1XP from PS TSG are also interested in quiescent L mode
  - Two main techniques: (i) center-stack limited configuration (ii) lower E_{inj}
- Step 2: FIDA/ssNPA **background/passive signals** [2 shots]



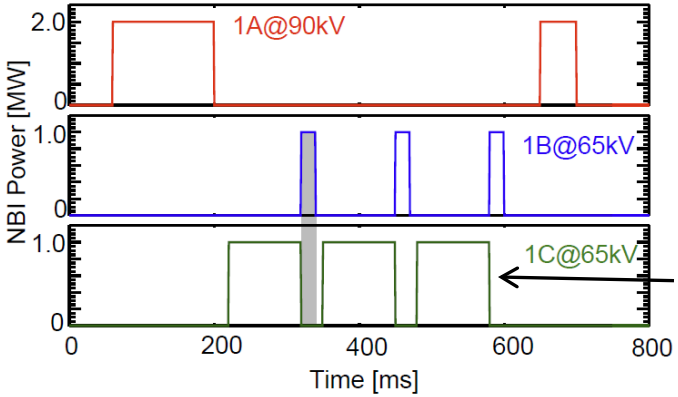
20ms on, 20ms off (either 1 or 2 beams) for V-FIDA, t-FIDA, r-ssNPA



for t-ssNPA

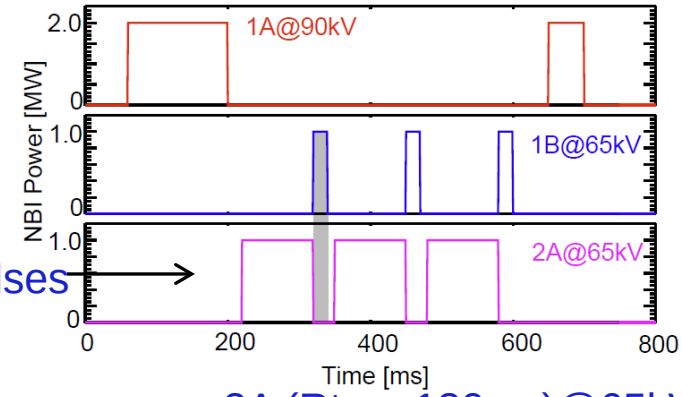
Shot Plan of Part A (Cont'd)

- Step 3: **diagnostic response in phase space** [~2 shots]



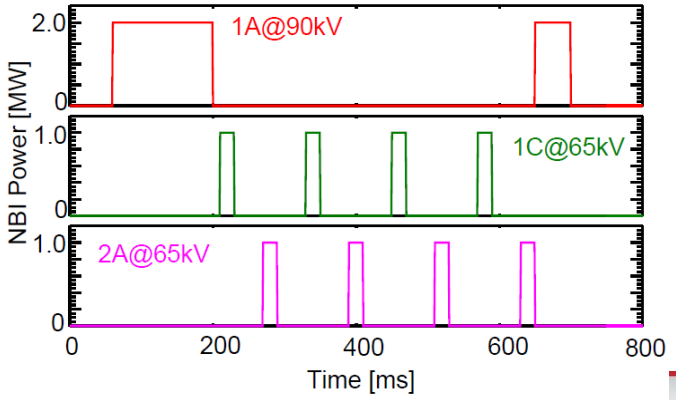
1C(Rtan=50cm)@65kV

90ms pulses



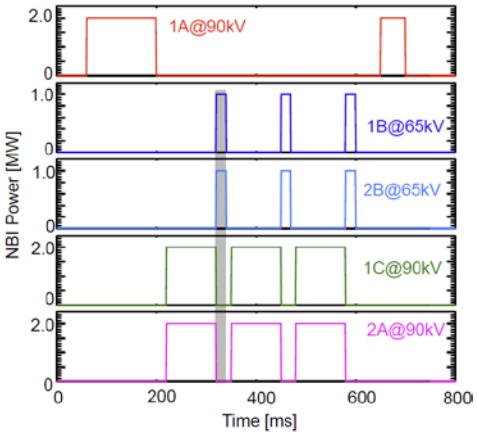
2A (Rtan=130cm)@65kV

- Step 4: **isolated beam blips** (20ms on, 50ms off) for TRANSP and FIDAsim simulations [1 shot]
- Step 5: response to different neutral beam source [2 optional shots]
- Step 6: **s-FLIP checkout** [1 shot]
  (**I_p=0.7MA**, instead of 1.0MA)

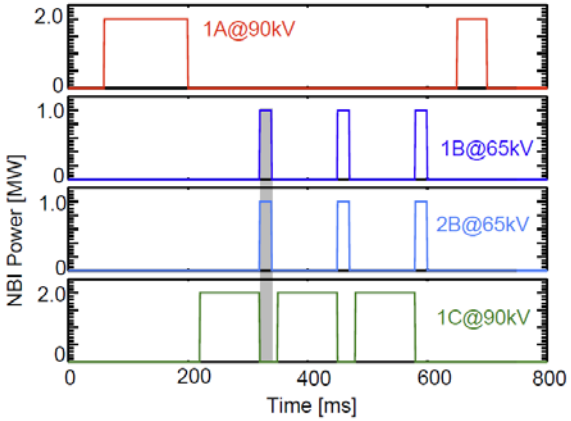


Shot Plan of Part B - the Second ½ Day

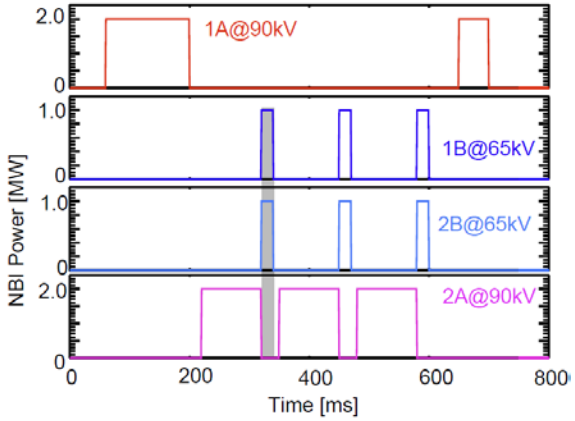
- Step 1**: scan of the filter angle of f-FIDA** systems [7?]
  - Filter angle determines which portion of fast-ion spectrum will be collected by PMT. [0^0,2^0,4^0,6^0,-2^0,-4^0,$-^06$]
  - This may be completed in piggyback mode if there are many (>7) repeat shots w/ NBI in other XMPs.



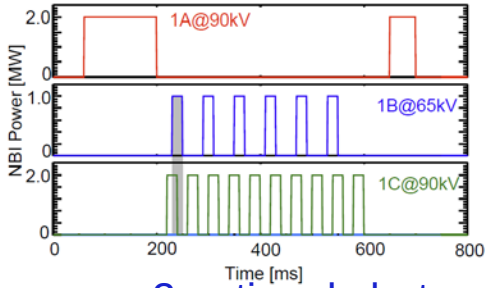
- Step 2: **diagnostic response in phase space** [2+2 optional]



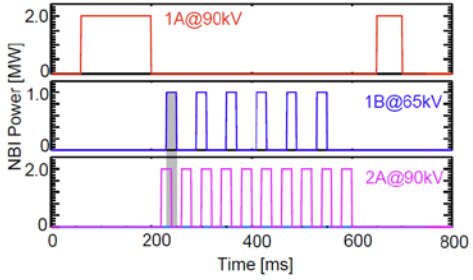
1C (Rtan=50cm)@90kV



2A (Rtan=130cm)@ 90kV



2 optional shots



- Step 3: **s-FLIP checkout** with **I_p=0.7MA** [1 shot]
  - similar to step 6 in part A, change E_{inj} to 90kV

Machine, Beam and Diagnostic Requirements

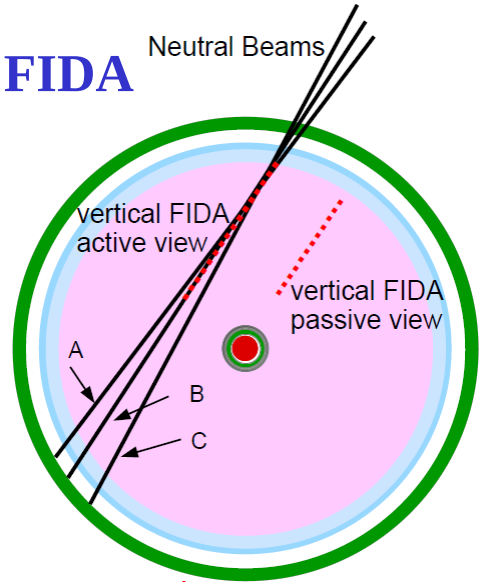
- Require reproducible L mode plasmas with minimal MHDs
- Need 1A/1C/2A operational at 65kV/90kV, 1B/1C/2A/2B/2C operational at 65kV. (2C@65kV is needed only in one optional shot).
- The machine needs relatively clean to avoid impurity contamination on FIDA spectra.
- Diagnostic needs: Mirnov coils, plasma profile diagnostics (MPTS, CHERS, MSE) and fast ion diagnostics (FIDA, SSNPA, sFLIP, neutron).
- Prefer this XMP at least a week later than the CHERS checkout XMP, at least a week earlier than the main XP1522.

In case not all beam sources are available, a backup plan is provided in the written XMP form. The minimum requirement is three NB sources, i.e. 1A, 1C (or 1B), and 2A (or 2B).

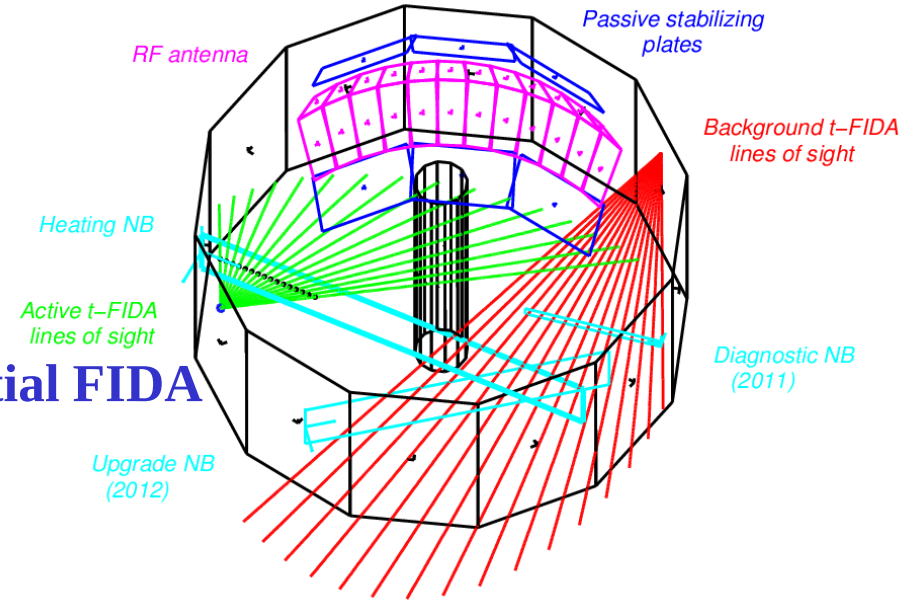
Backup Slides

Vertical and Tangential FIDA on NSTX-U

Vertical FIDA

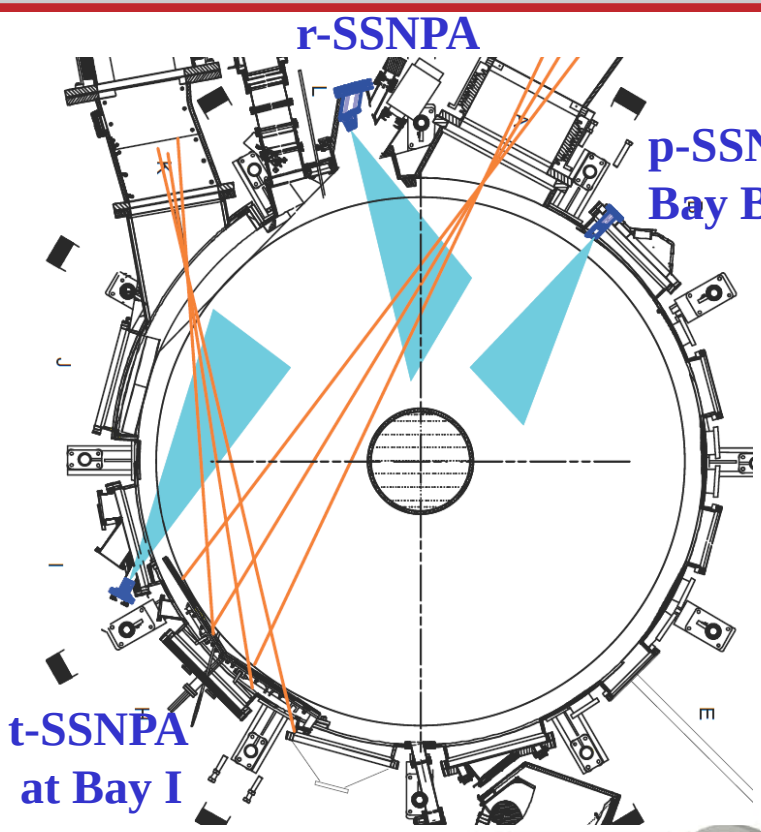


Tangential FIDA



- Each FIDA system consists of
- **spectrometer-FIDA**, full D_a spectrum, 16 ch, R=0.85-1.55m, 100Hz, ~5cm, ~10keV
  →measure fast ion (F. I.) profile
- **band-pass filter-FIDA**, 3 ch at R=1.0, 1.2, 1.4m, 50kHz, energy integrated signal
  → measure fast ion transport associated with instabilities

Upgraded SSNPA System Aims at Measuring Fast-Ion Distribution with Fast Time Resolution and Coarse Energy Information



- 3 subsystems with Si photodiode arrays

(i) **r-SSNPA**: **trapped F.I.** in the core

(ii) **t-SSNPA**: **passing F.I.** in the mid-radius

→ Separate the response of passing & trapped F.I.

(iii) **p-SSNPA**: **passive signal** near the edge

- **r-SSNPA & t-SSNPA: 16 ch, ~5cm, 120 kHz bandwidth, [>25, >45, >65] keV**

→ fast ion profile, transport associated with instabilities