U.S. DEPARTMENT OF ENERGY | Office of Science

NSTX-U

Fast-ion Active Beam Diagnostics

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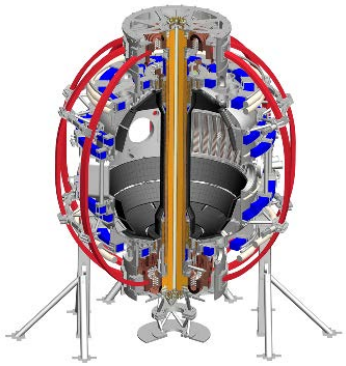
Collaboration Plans
5/17/2016

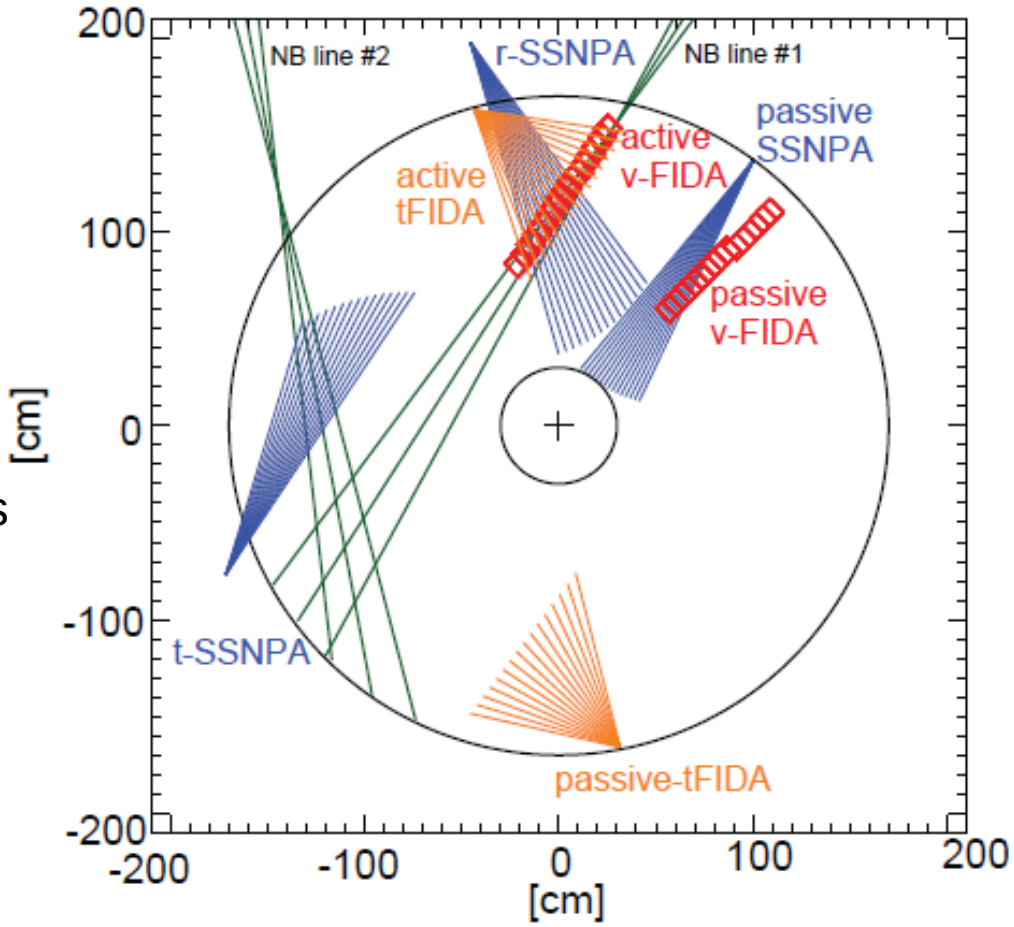
UCIrvine
University of California, Irvine

PPPL



FIDA & NPA Diagnostics are operational

- Podestà installed the vertical fast-ion D-alpha (v-FIDA) diagnostic that worked on NSTX
- Bortolon installed the tangential FIDA diagnostic on NSTX in 2011
- Deyong Liu installed new solid-state neutral particle analyzer (SSNPA) arrays for NSTX-U
- All diagnostics have “active” views of injected neutrals and “passive” views that miss heating beams



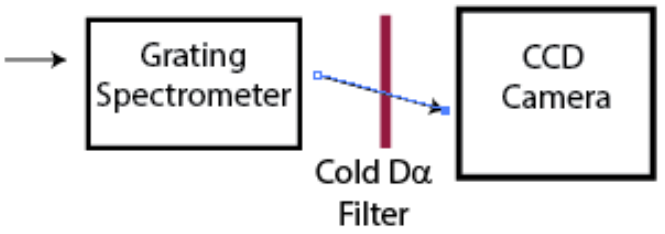
t-FIDA and v-FIDA are instrumented like NSTX

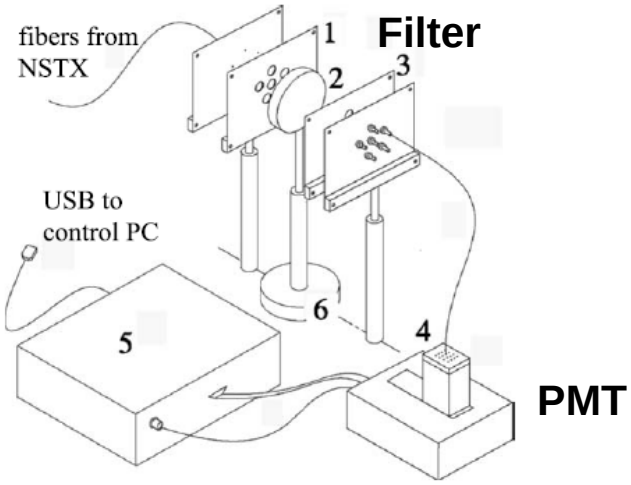
Spectroscopic system

- 16 channels for both active & passive views (32 total)
- Full spectrum (cold D-alpha line attenuated)
- 5 & 10 ms integration times (t-FIDA & v-FIDA, respectively)

PMT (f-FIDA) system

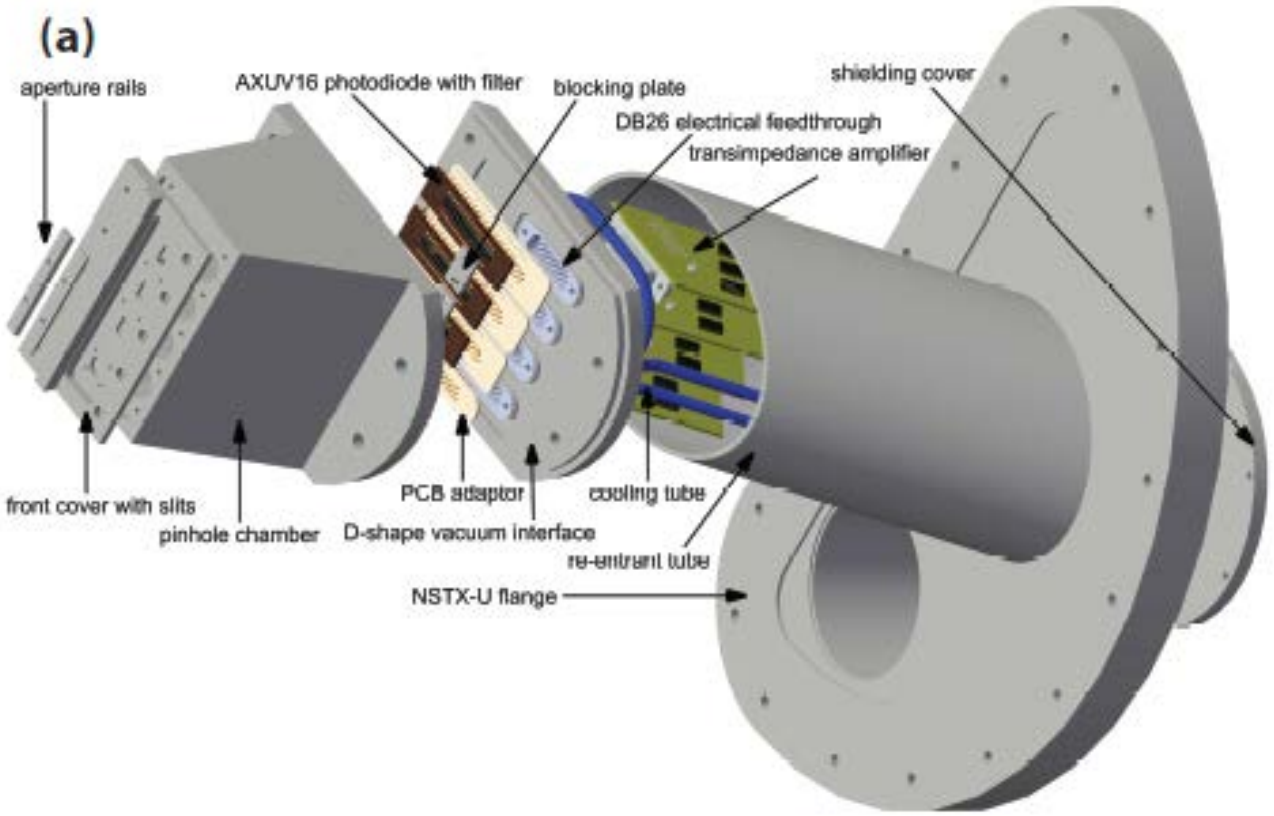
- 3 channels for both active & passive views
- Bandpass filter integrates blue-shifted light
- Detects ~ 100 kHz fluctuations



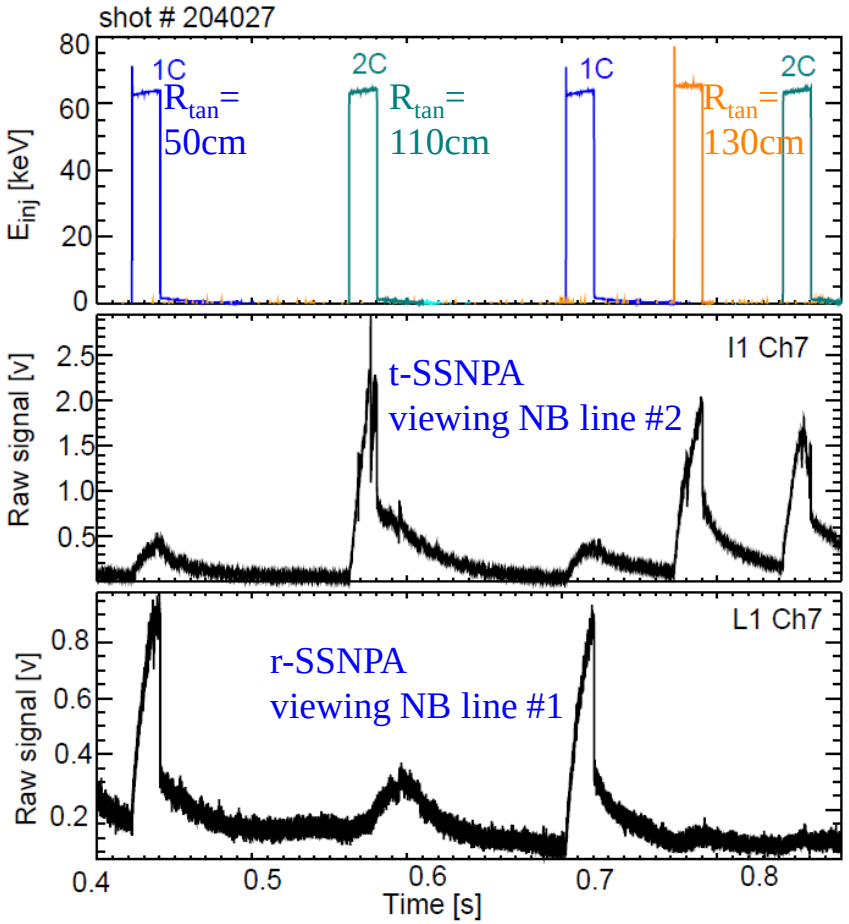


The SSNPA diagnostic uses arrays of detectors operated in current mode

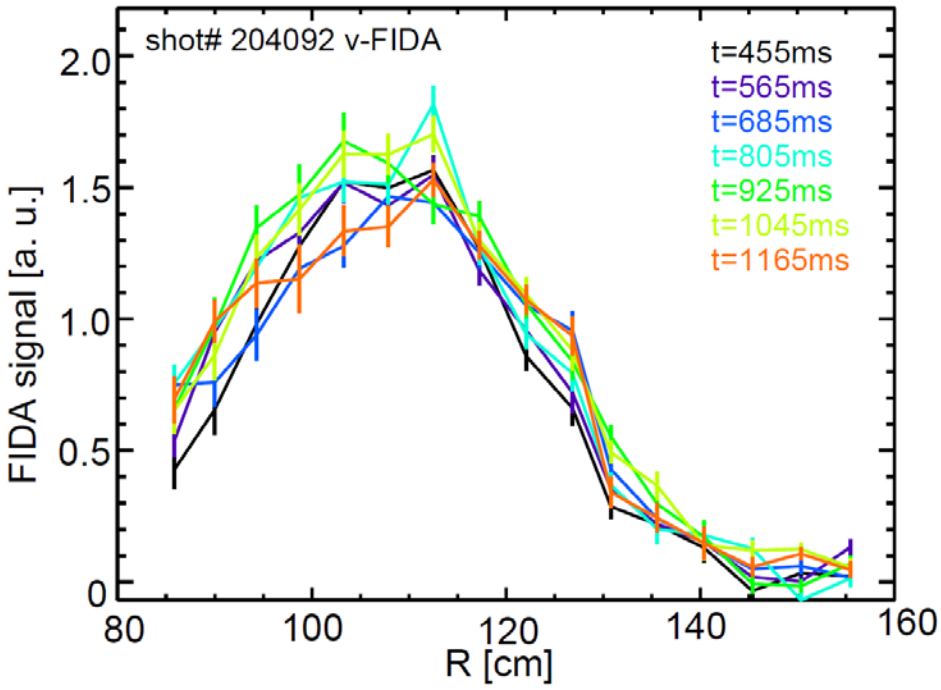
- Three 16-channel arrays in Bay I and Bay J, one 16-channel array at Bay B
- Arrays have W filters of varying thickness for crude energy resolution
- Current mode for ~ 100 kHz frequency resolution



Fast-ion Signals are observed on all FIDA and SSNPA Diagnostics

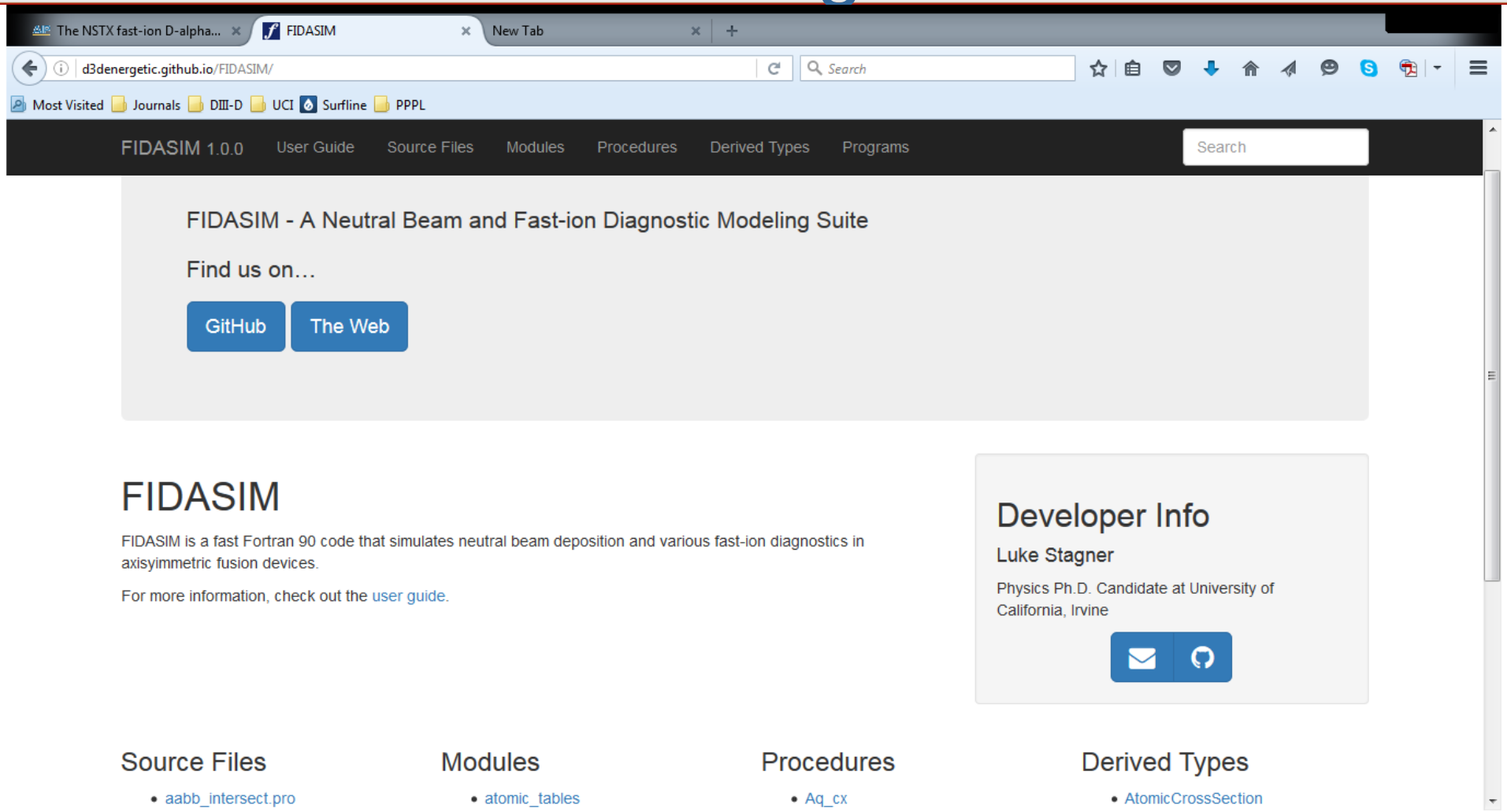


V-FIDA



- SSNPA and FIDA respond to NB line #1 and line #2, as expected
- Active & passive response are clearly observed
- Still have unresolved background issues for every system!

FIDASIM for forward modeling of FIDA & NPA signals

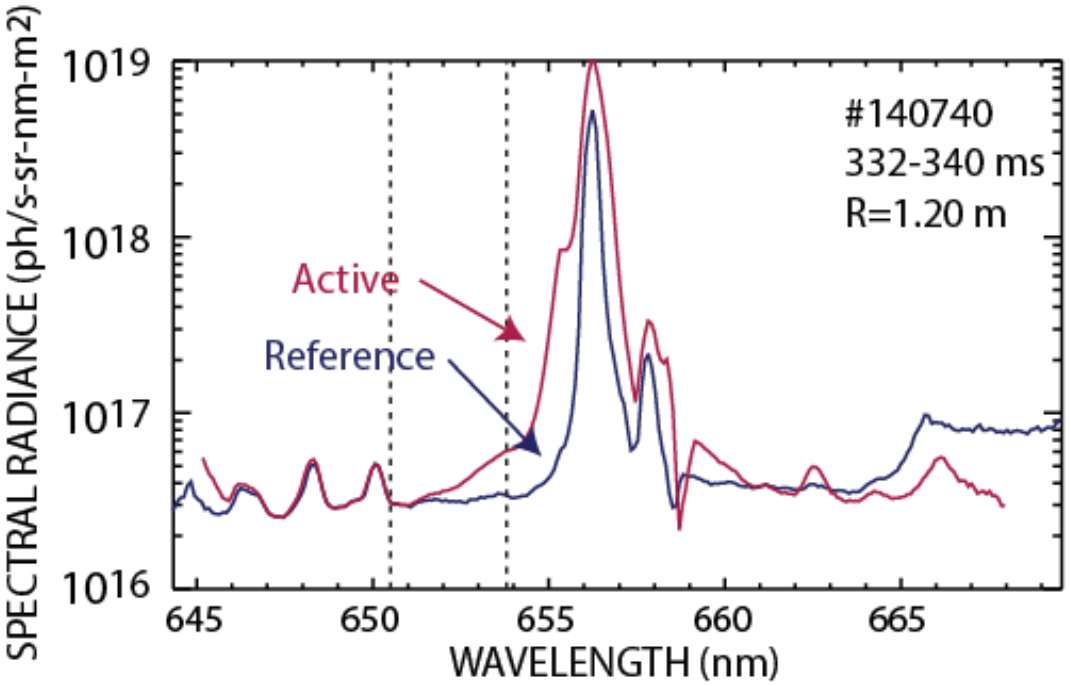


Upgrades are envisioned

1. Operate existing FIDA & SSNPA diagnostics 2016
2. FIDA vertical view test 2016
3. Infer distribution function from the data (Stagner's PhD thesis) 2017
4. Single-channel pulse-counting SSNPA 2017
5. Multichannel pulse-counting SSNPA 2018
6. FIDA upgrade 2018

Test vertical view from lower port (2016)

- Red-shifted spectra often unusable
- Would a view that avoids the divertor give better data?
- Borrow P-CHERS fibers at end of run to test alternative sightlines

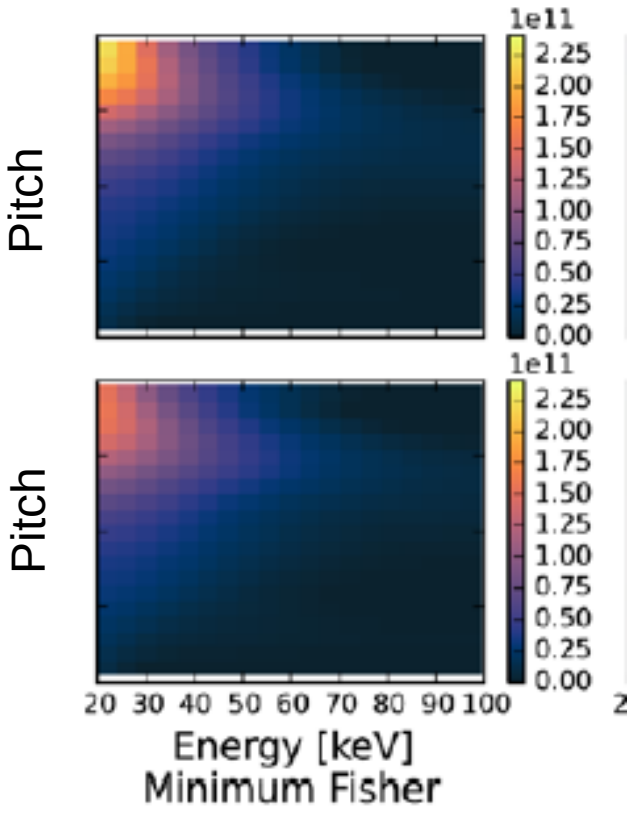


NF **56** (2016) 056005

Infer distribution function (2017)

- In collaboration with the Technical University of Denmark, techniques for velocity-space inversion are already available.
- Stagner's thesis will incorporate spatial information
- Apply to best NSTX-U cases in 2017

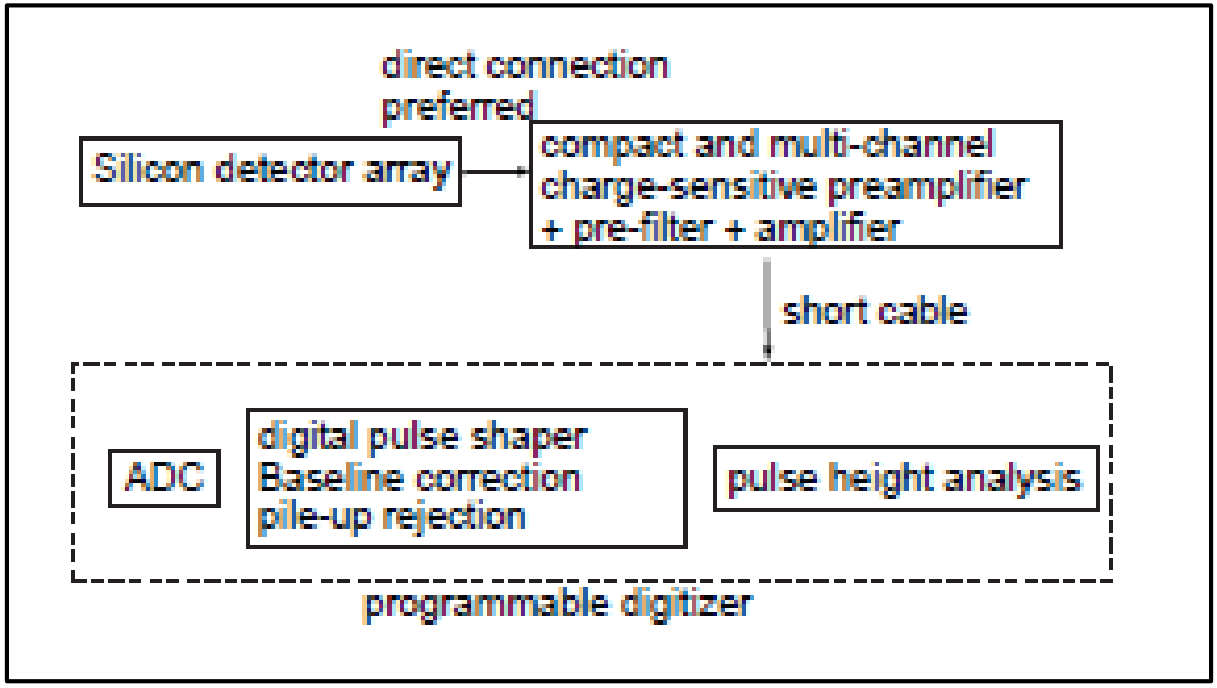
Before/After a Sawtooth



PPCF **58** (2016) 045016

Pulse-counting SSNPA

- Detects fast-ion acceleration by HHFW above injection energy
- Reduce flux to avoid pulse pileup
- Need good S:N to convert pulse heights to energy spectra
- Demonstrate feasibility with a single channel in 2017
- Multiple spatial channels in 2018

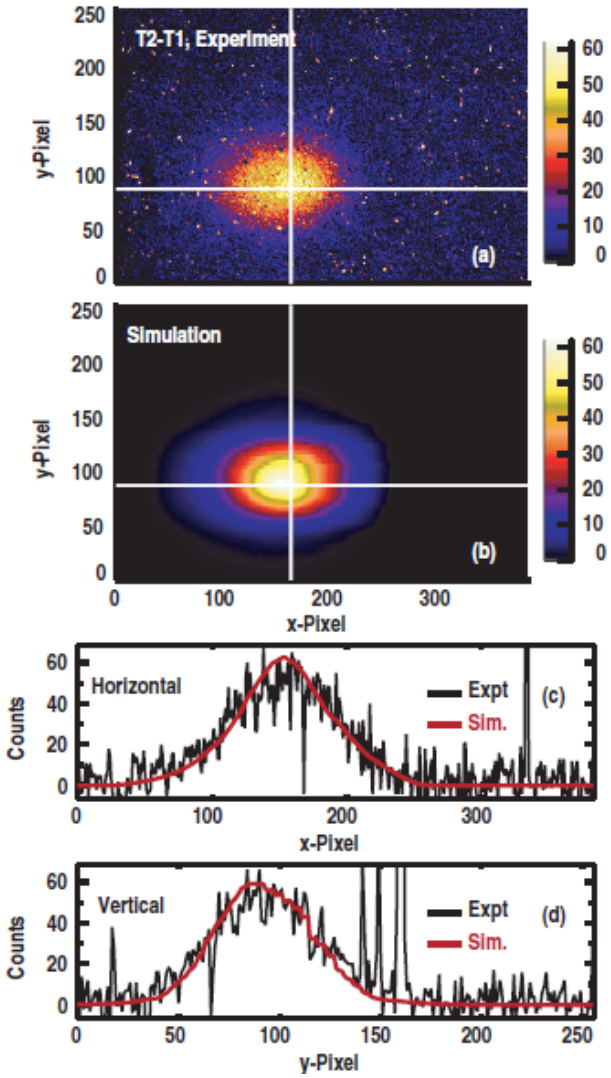


FIDA Upgrade (2018)

Funds will be available for one upgrade:

- Spectral system with ~ 1 ms temporal resolution
- 2D imaging with no spectral resolution
- Additional sightlines for improved velocity-space resolution

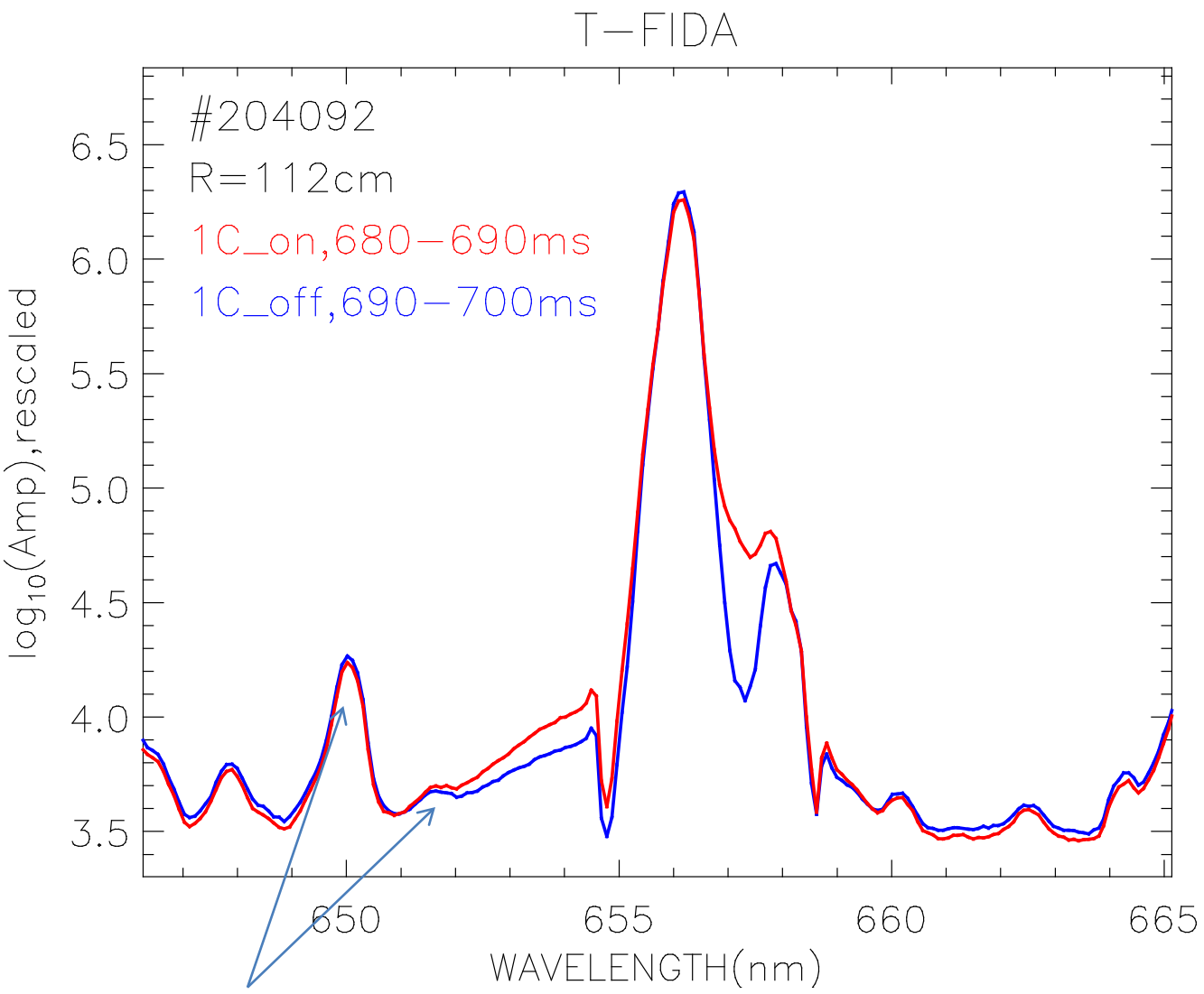
The selected upgrade will be based on NSTX-U results



PPCF **51** (2009) 055001

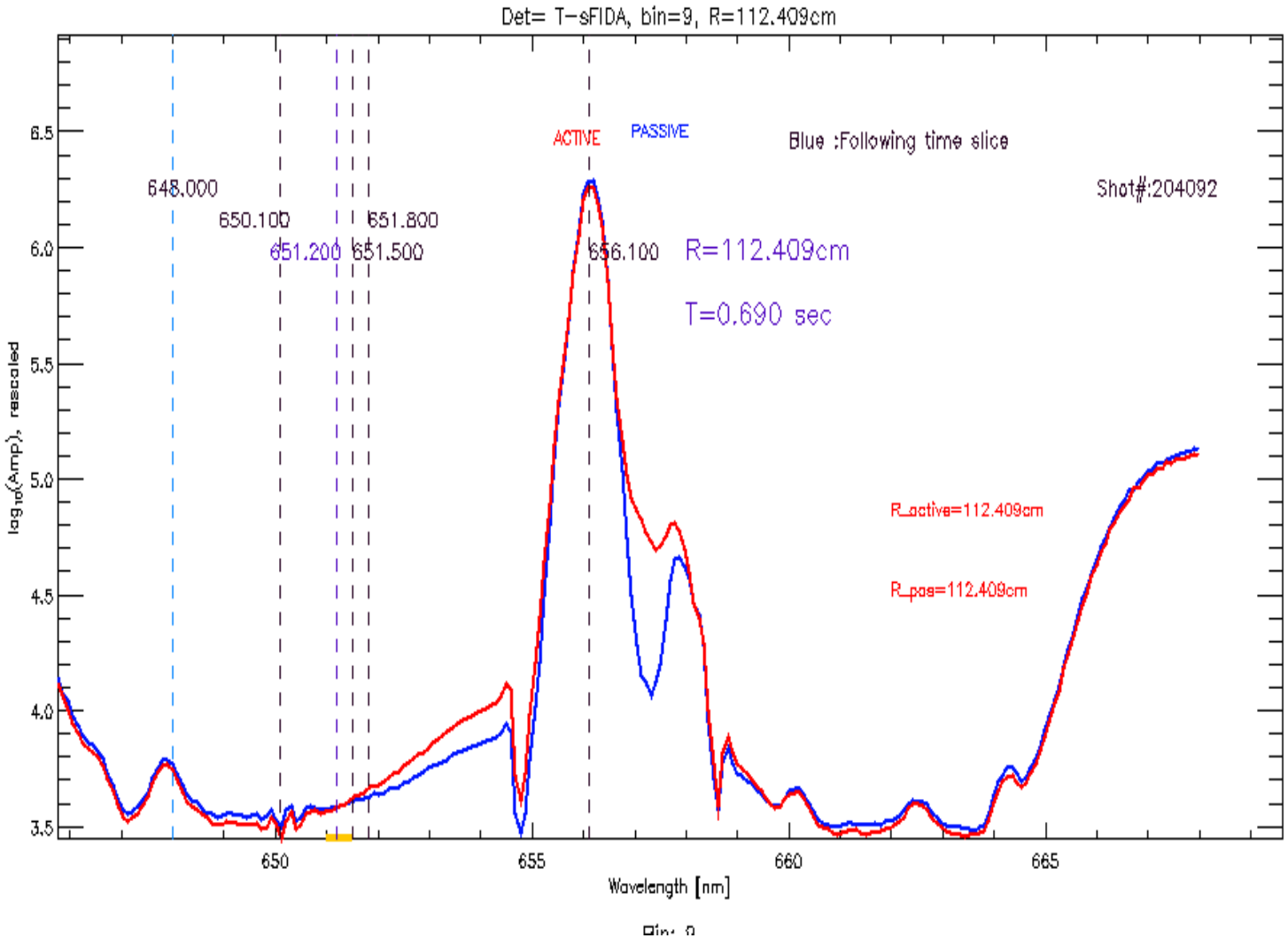
t-FIDA Backups

An example of T-FIDA spectra

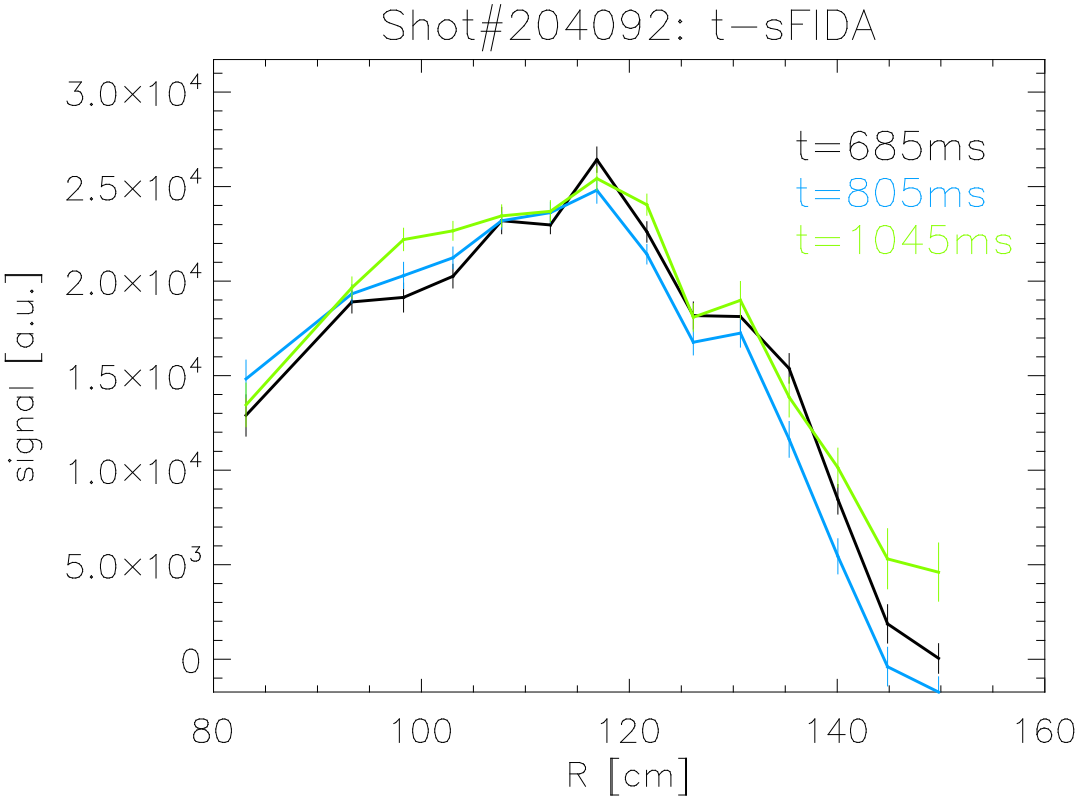


Impurities; In order to get T-FIDA signal, we need to remove impurities lines

The spectrum after removing impurities lines



Net signal profile along major radius



- Signal intensity increase at edge at time 1045ms, this may be because of sawtooth
- As shown in slide 7. During this shot, the data for other modulation time slices is shown is back up slid.