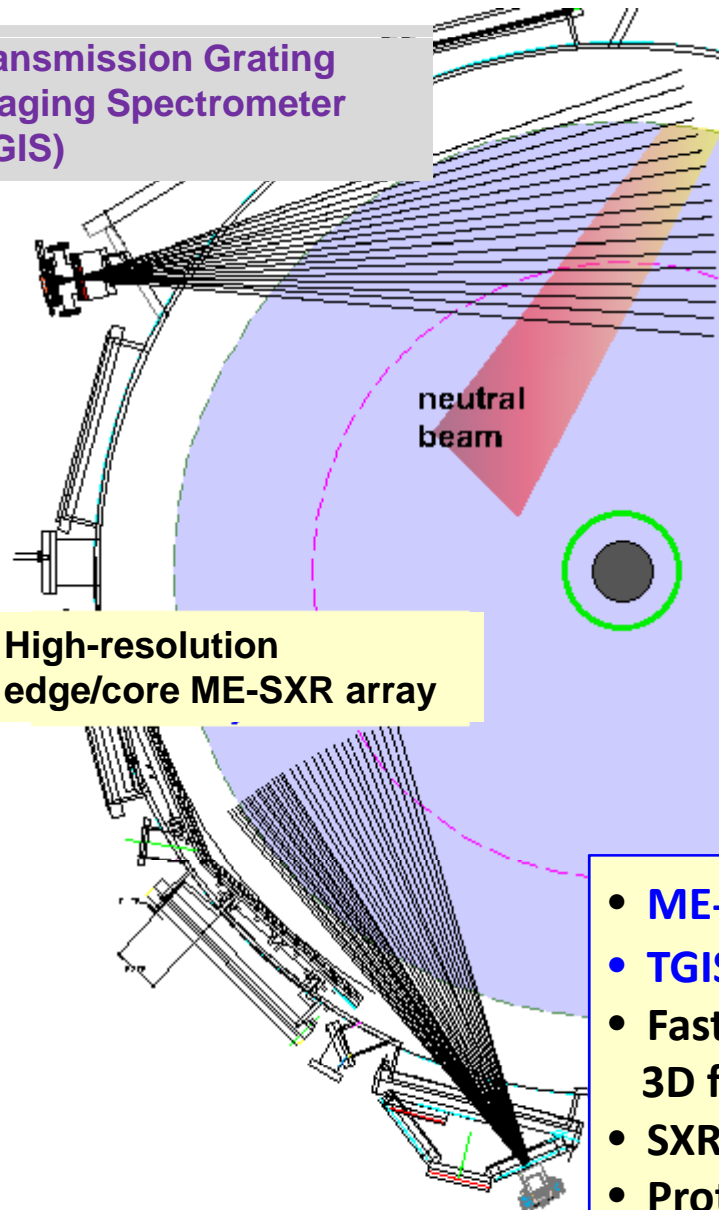


Diagnostic results from prototype  
ME-SXR array and  
Transmission Grating spectrometer

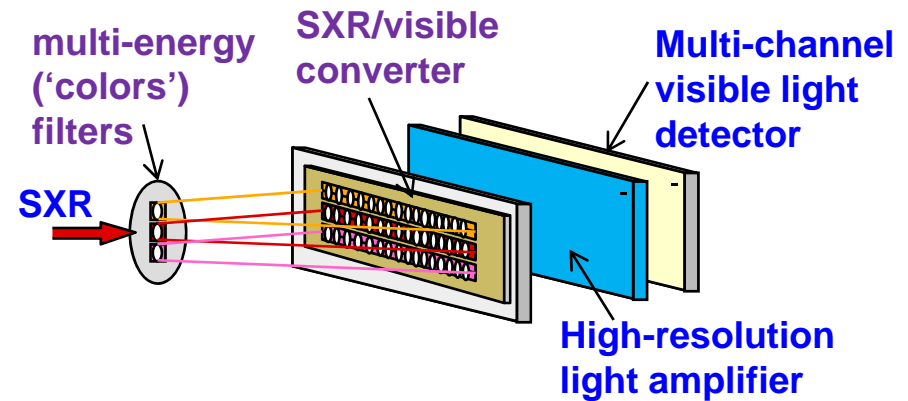
D. Stutman, L. Delgado, K. Tritz, and M. Finkenthal  
*Johns Hopkins University*

# GOAL: High resolution multi-energy SXR system for NSTX edge and core

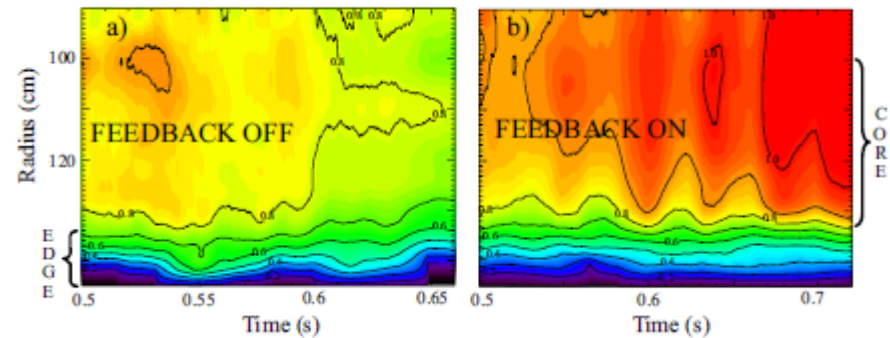
Transmission Grating Imaging Spectrometer (TGIS)



High-resolution edge/core ME-SXR array



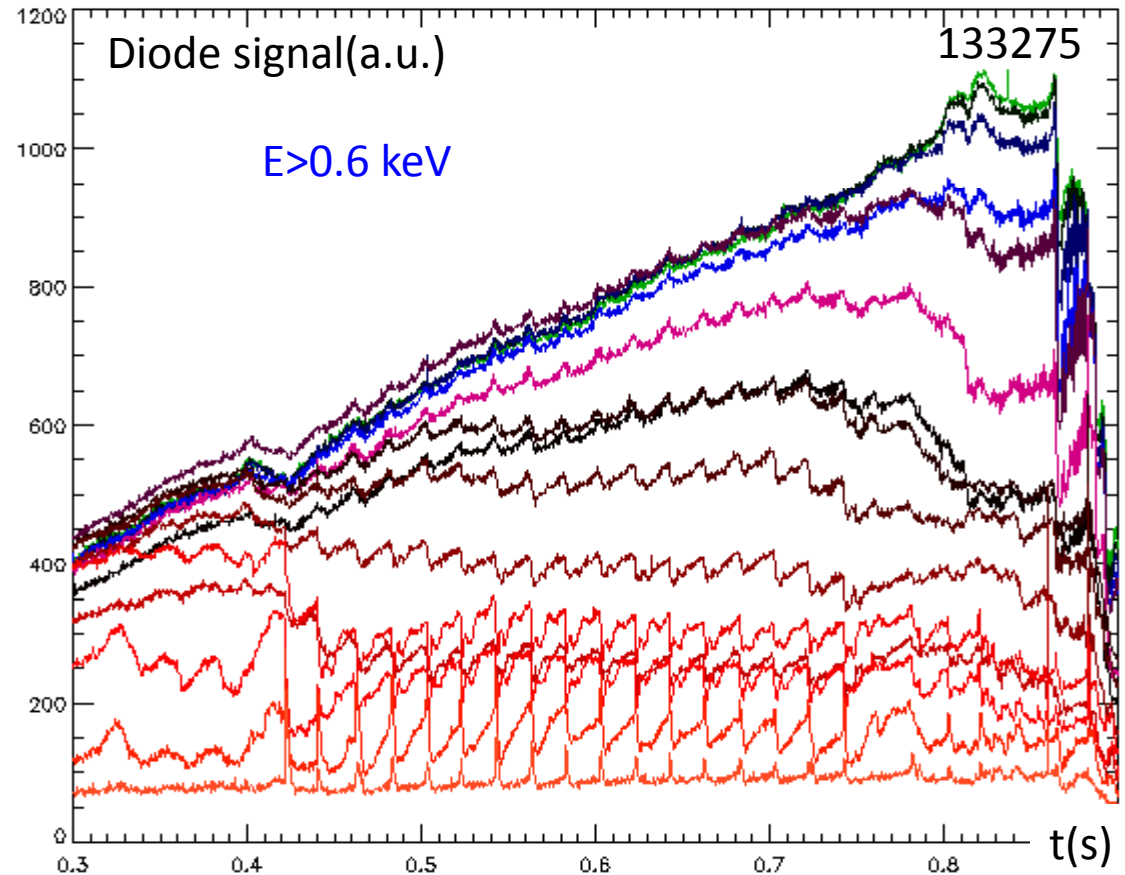
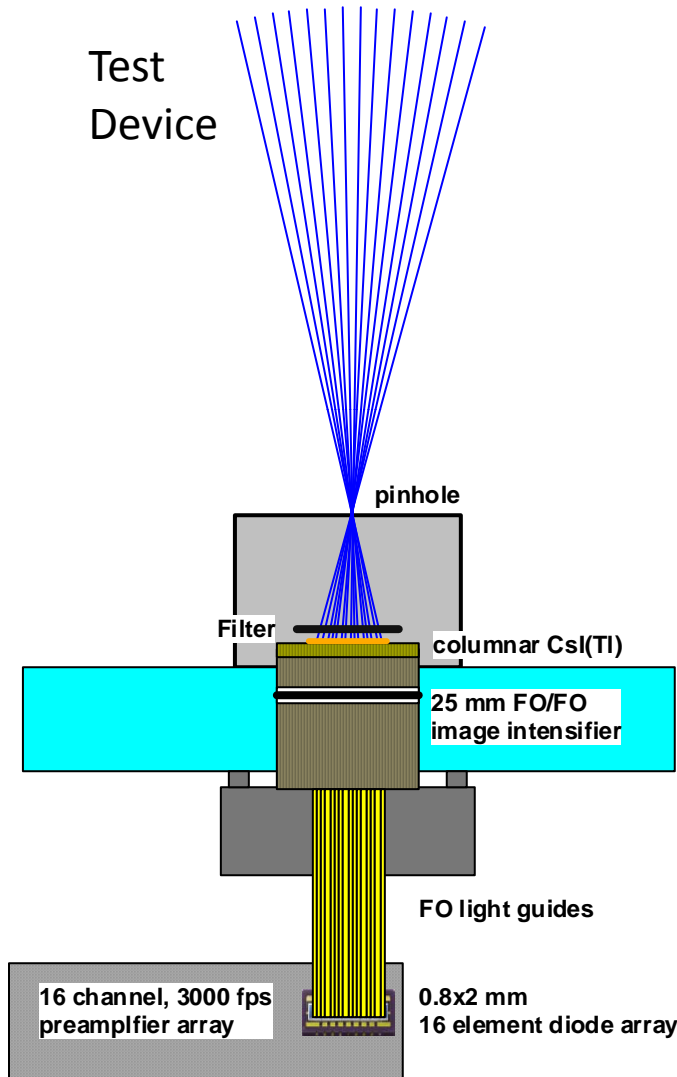
ME-SXR  $T_e$  *Delgado et al*



- ME-SXR array: 1 cm / 1ms / 10 eV-10 keV (6 'colors')
- TGIS: 4 cm / 50 ms / 10-500 Å (beam CX)
- Fast  $T_e$ ,  $n_e$ ,  $n_z$ , edge/core transport dynamics, disruptions, 3D field effects, non-thermal EDF
- SXR control in tokamaks and stellarators
- Prototype devices tested this run

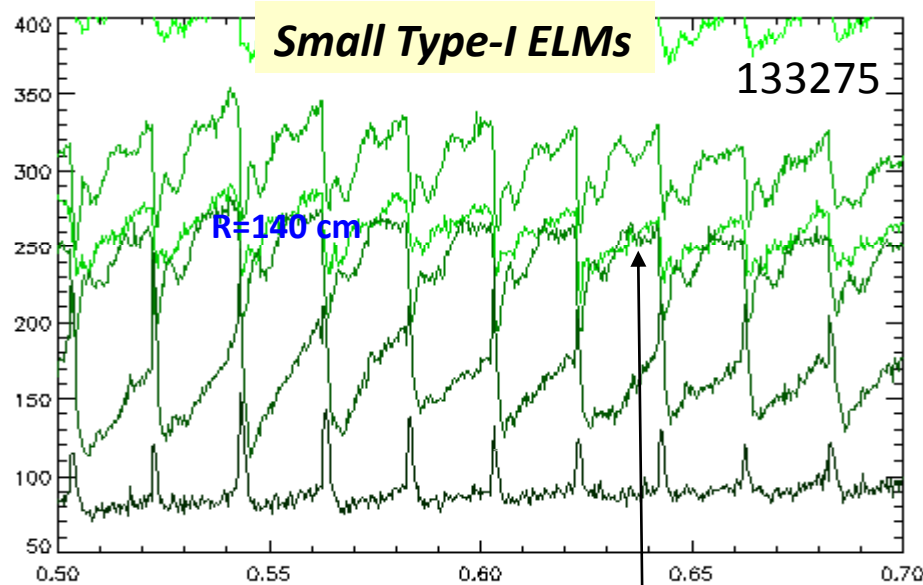
# Prototype image intensifier based SXR array (1-color)

## Photodiode readout (3 KHz)

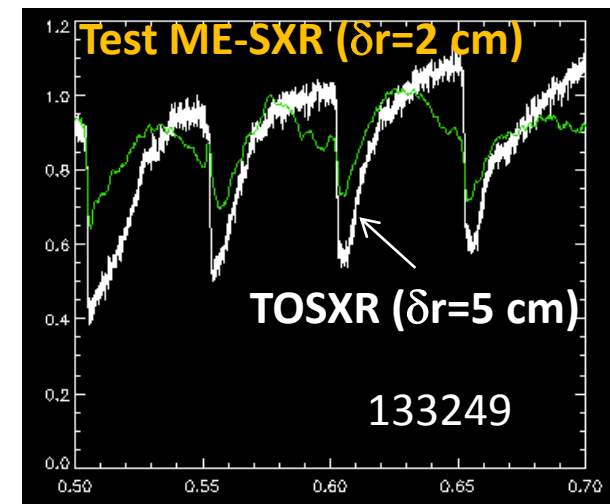
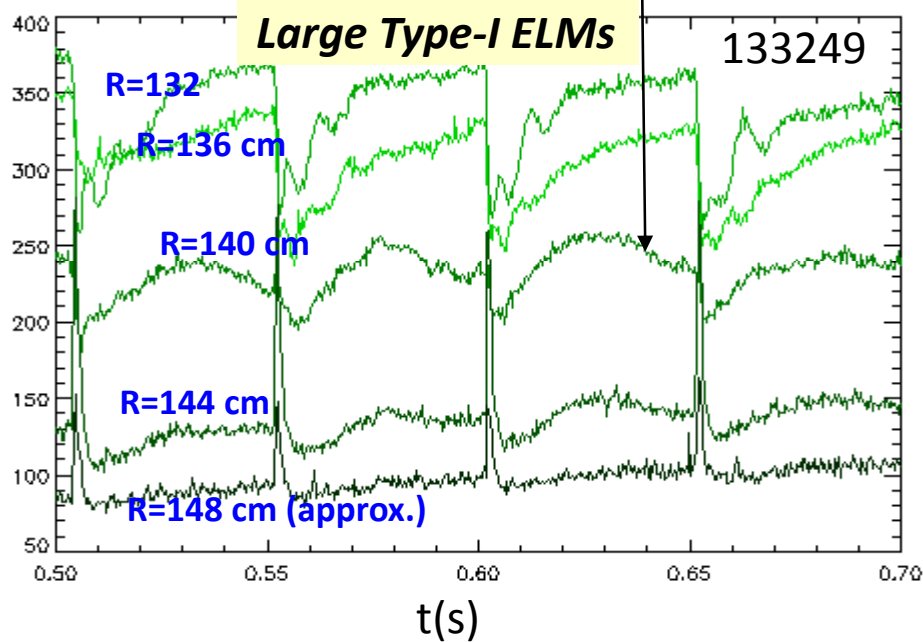


- No neutron noise, no SPA pick-up, good SNR
- 2 cm resolution for test device, 1 cm accessible
- Good long term solution with optimal components (non-linear intensifier, poor preamp in these tests)

# High spatial resolution pays off

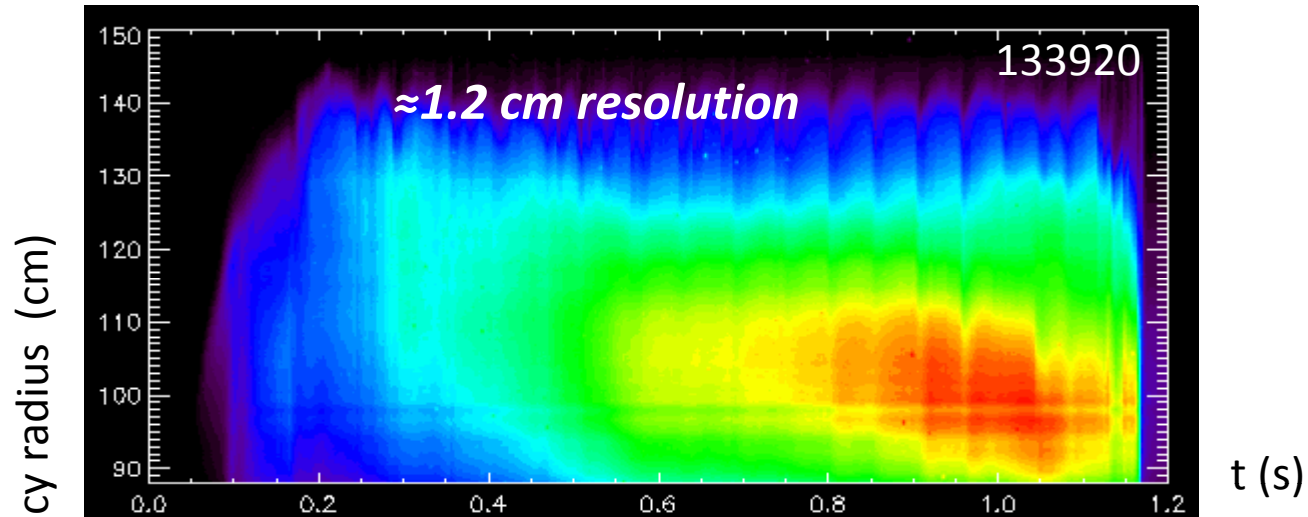


- Different edge confinement dynamics
- Transport (particle?electrons?) degrades at pedestal top (R=140 cm) before large ELM
- 'Pinpoint' impurity injection for edge transport dynamics between ELMs (ITER)

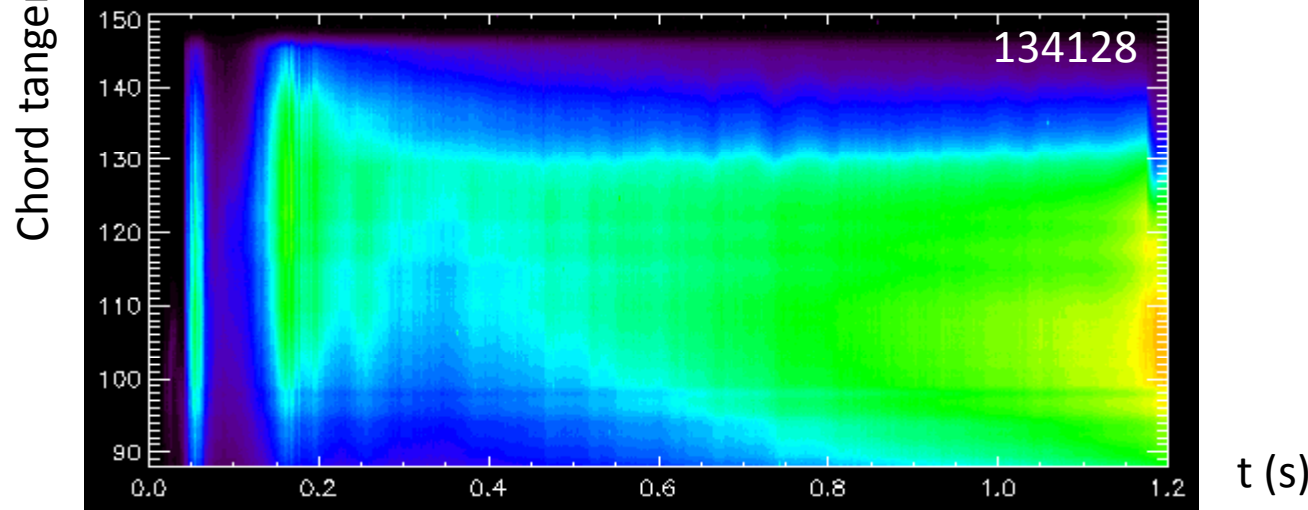


## Fast camera readout (with L. Roquemore)

$E > 0.6$  keV  
300 fps

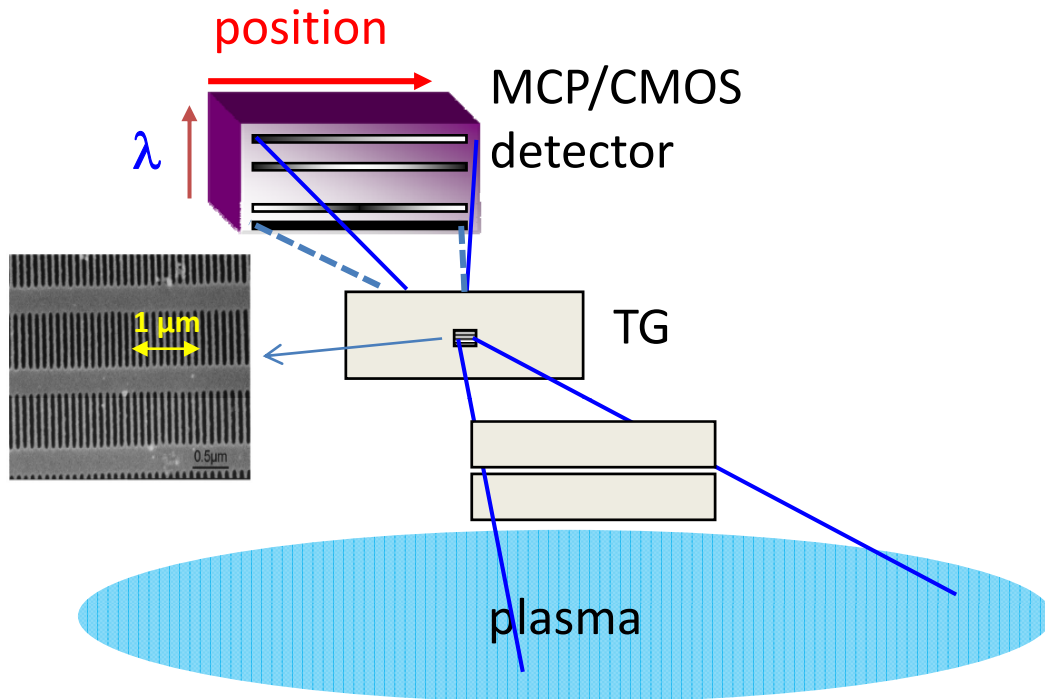


$E > 0.3$  keV  
2000 fps



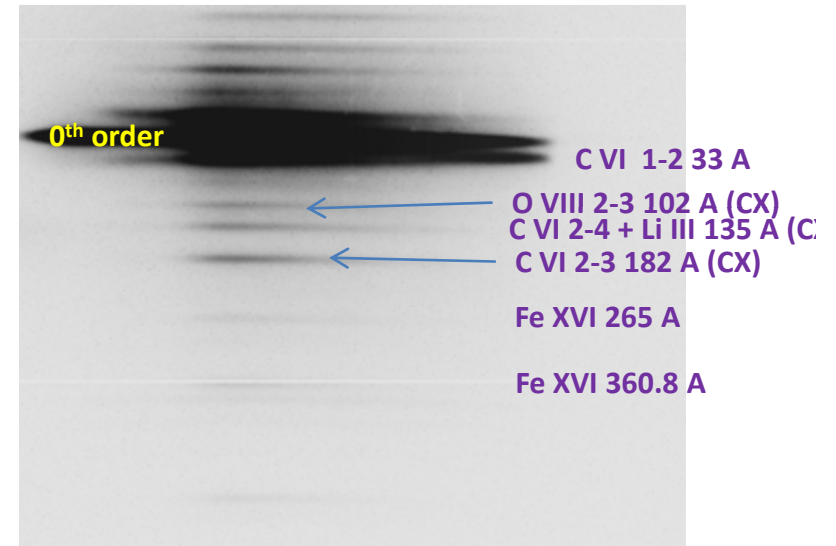
- Continuous coverage with highest spatial resolution at  $\sim 300$ -1000 fps
- Planned readout for first operational stage of NSTX edge-core array (next run)
- Diode solution also under test (20-ch. edge bolometer array as lowest 'color')

# Prototype Transmission Grating Imaging Spectrometer (TGIS)

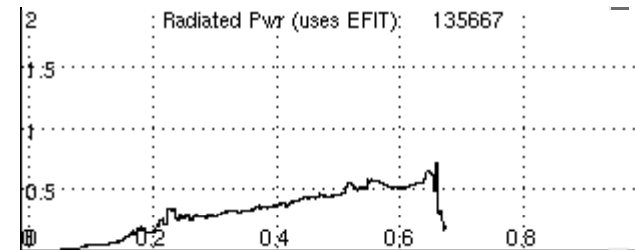
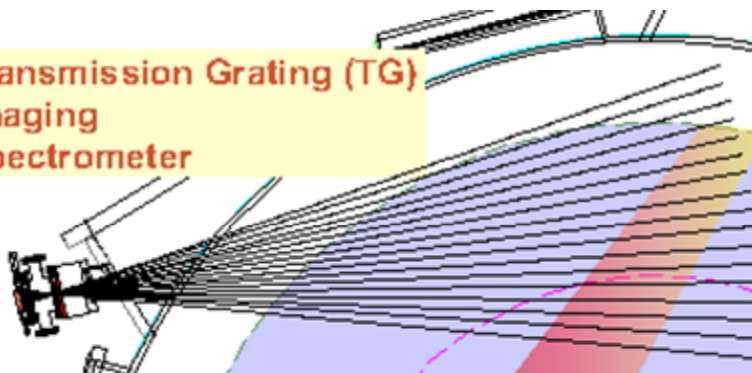


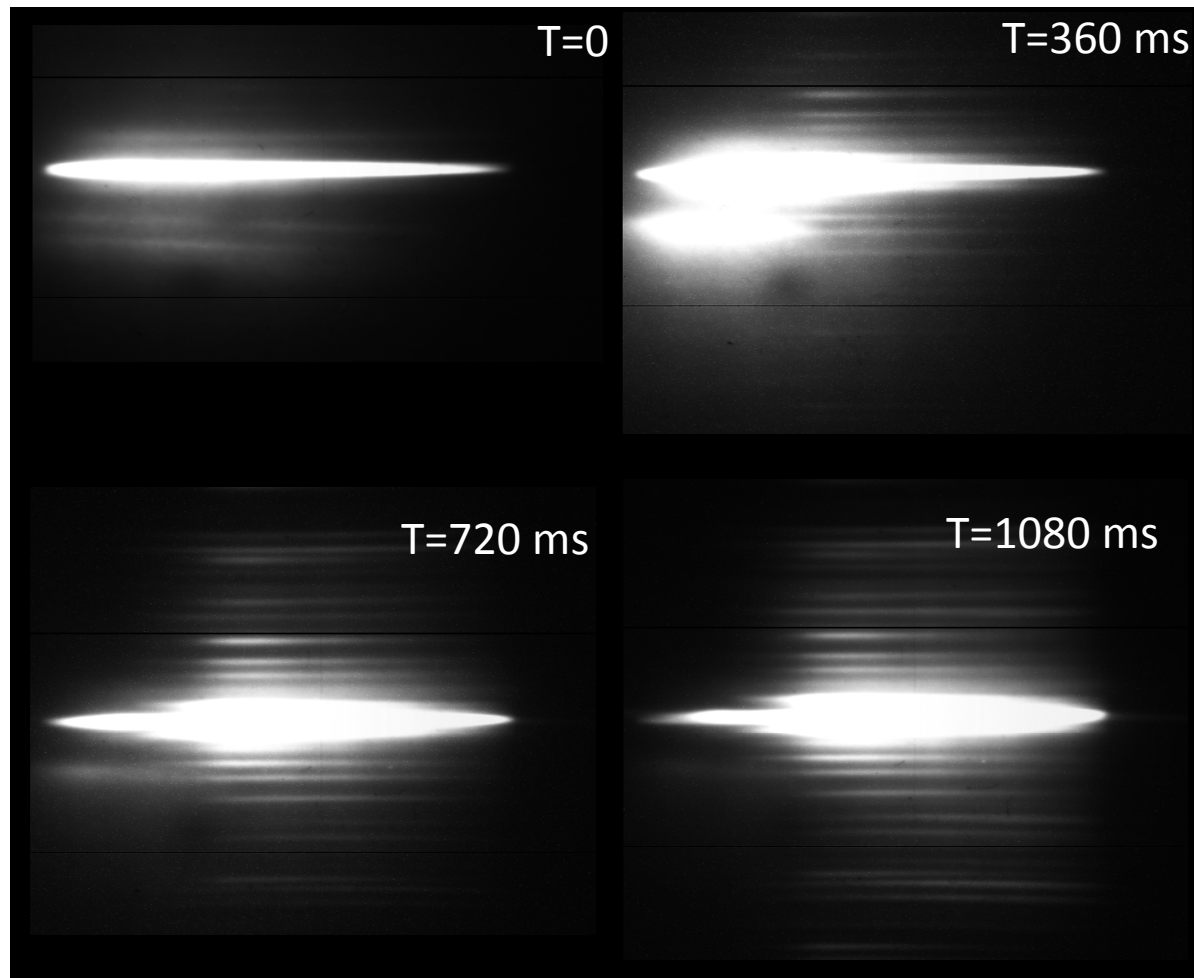
Low  $P_{\text{rad}}$  shot

edge beam emission inboard



Transmission Grating (TG)  
Imaging  
Spectrometer



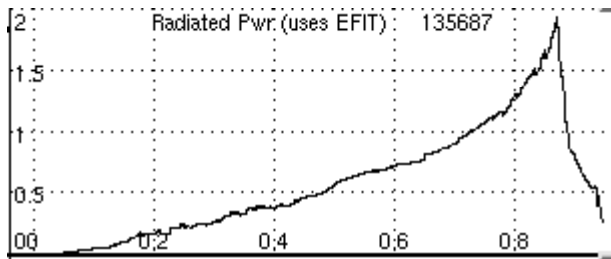
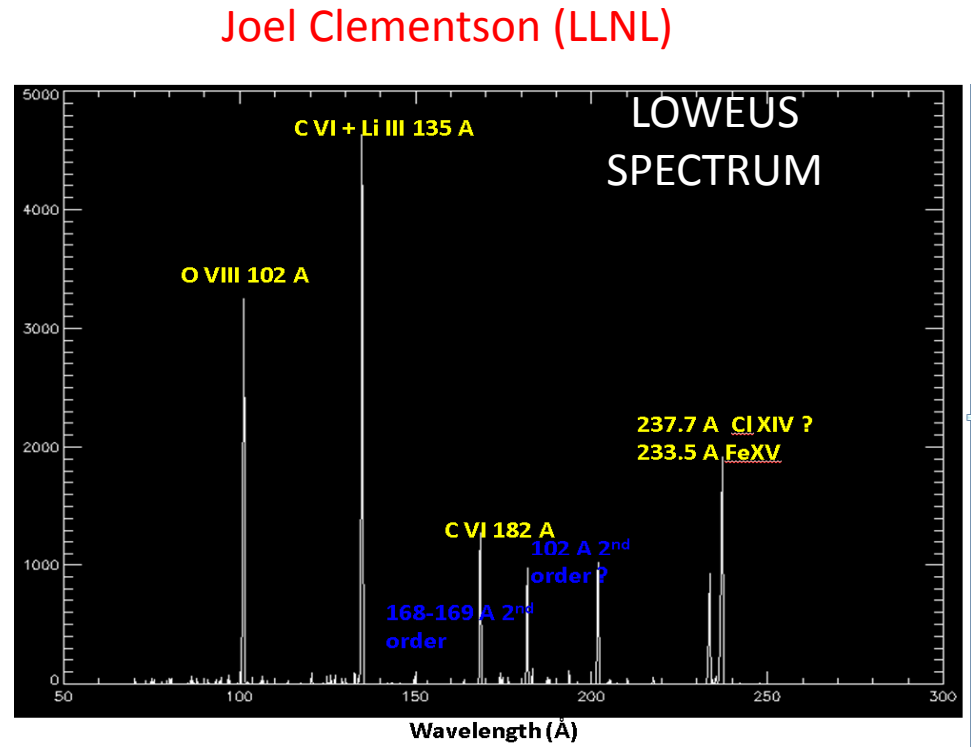
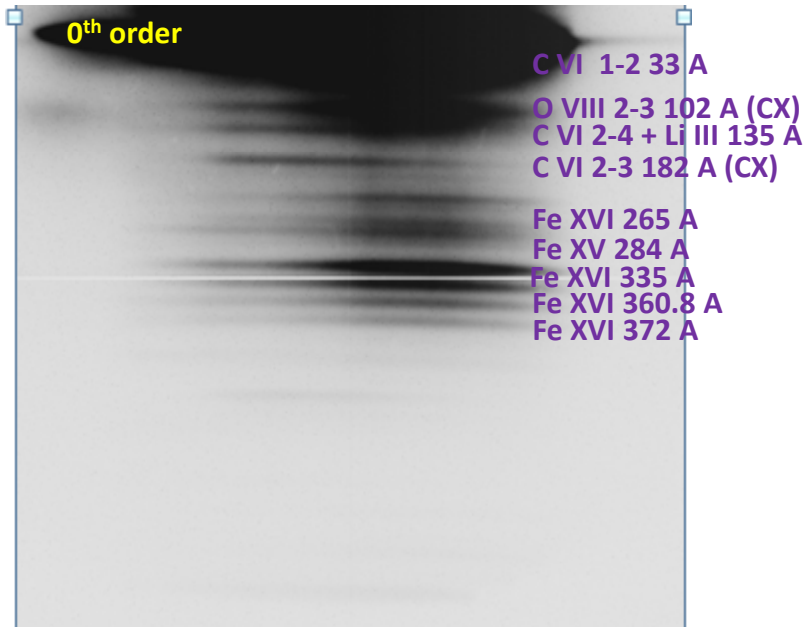


- Multi-frame capability (360 ms)
- Upgradeable to 50 ms
- Space-resolved impurity fractions for ME-SXR modeling



# High $P_{\text{rad}}$ shots dominated by C, O and Fe radiation

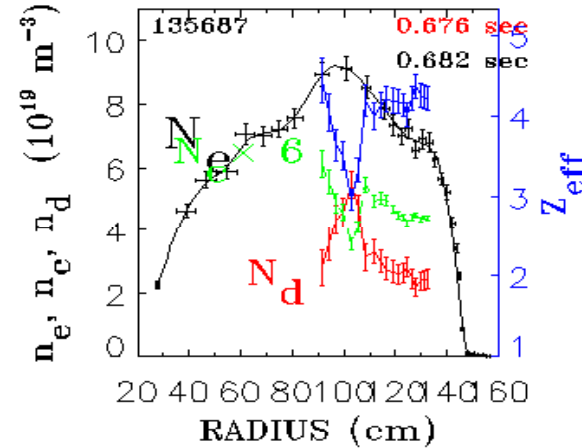
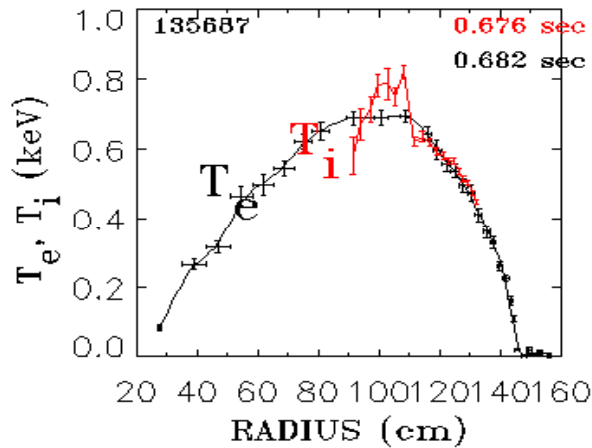
## High $P_{\text{rad}}$ shot



- Mg-like to Ne-like Fe consistent with  $\langle T_e \rangle \approx 0.7$  keV
- Comparable intensity of O VI 102 Å and C VI 182 Å



# TGIS, LOWEUS indicate oxygen is major plasma impurity this run



n=2-3 CX  
excitation rates

O/C CX rate  $\approx 2.3$

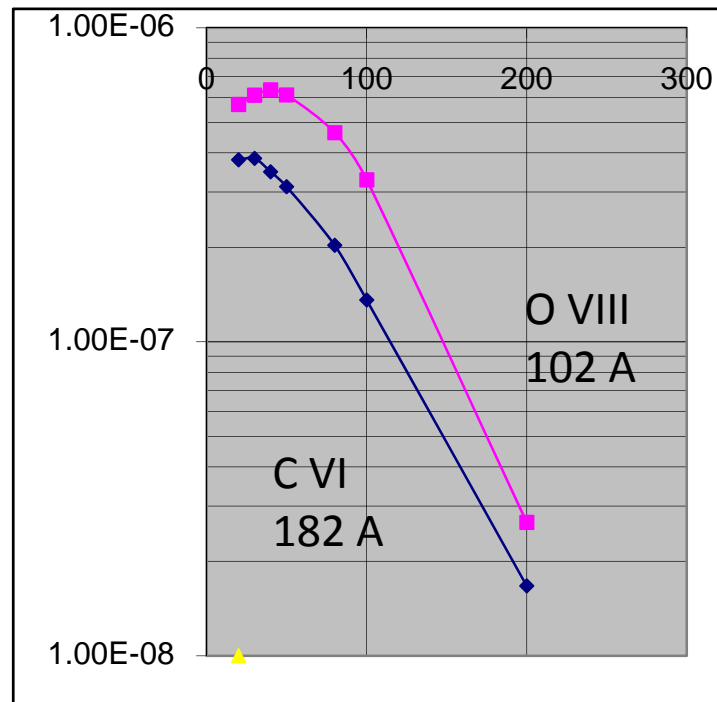
102 Å  $\approx$  182 Å



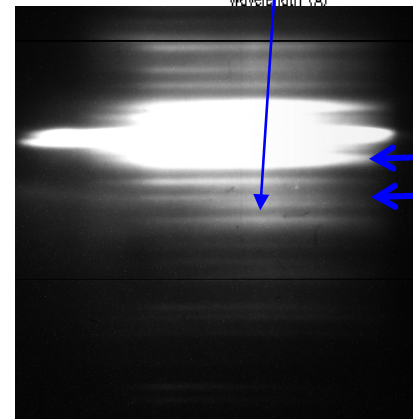
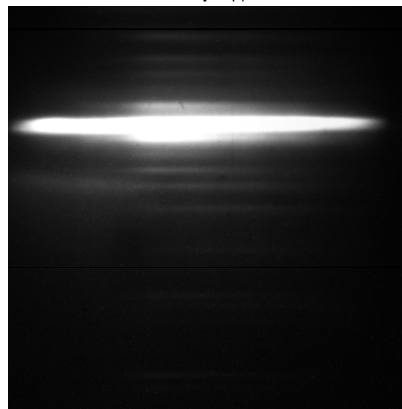
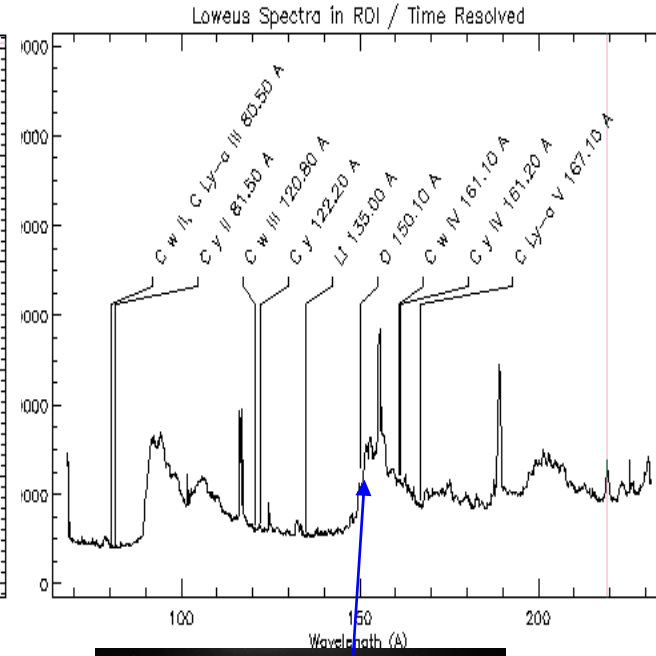
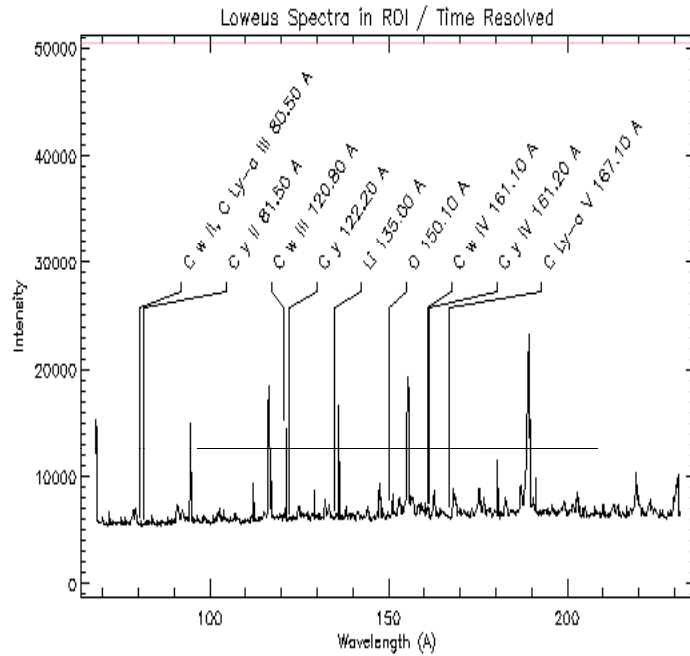
$f_{\text{Oxygen}} \approx 40\% f_{\text{Carbon}}$

$\Rightarrow$  *little D left*

Beam voltage kV



# TGIS shows injected tungsten reaches the NSTX core



# Summary

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- **Multiple components of high resolution ME-SXR system for NSTX tested successfully**
- **Interesting transport results expected from new edge-core system**
- **Two toroidally displaced ME-SXR arrays for RWM and disruptions ; a must for pedestal studies also?**
- **Oxygen seems to have a strong presence in Li conditioned plasmas**

R=132 cm

