

Dual-energy SXR tomography
system for plasma equilibrium,
MHD and transport studies on NCSX

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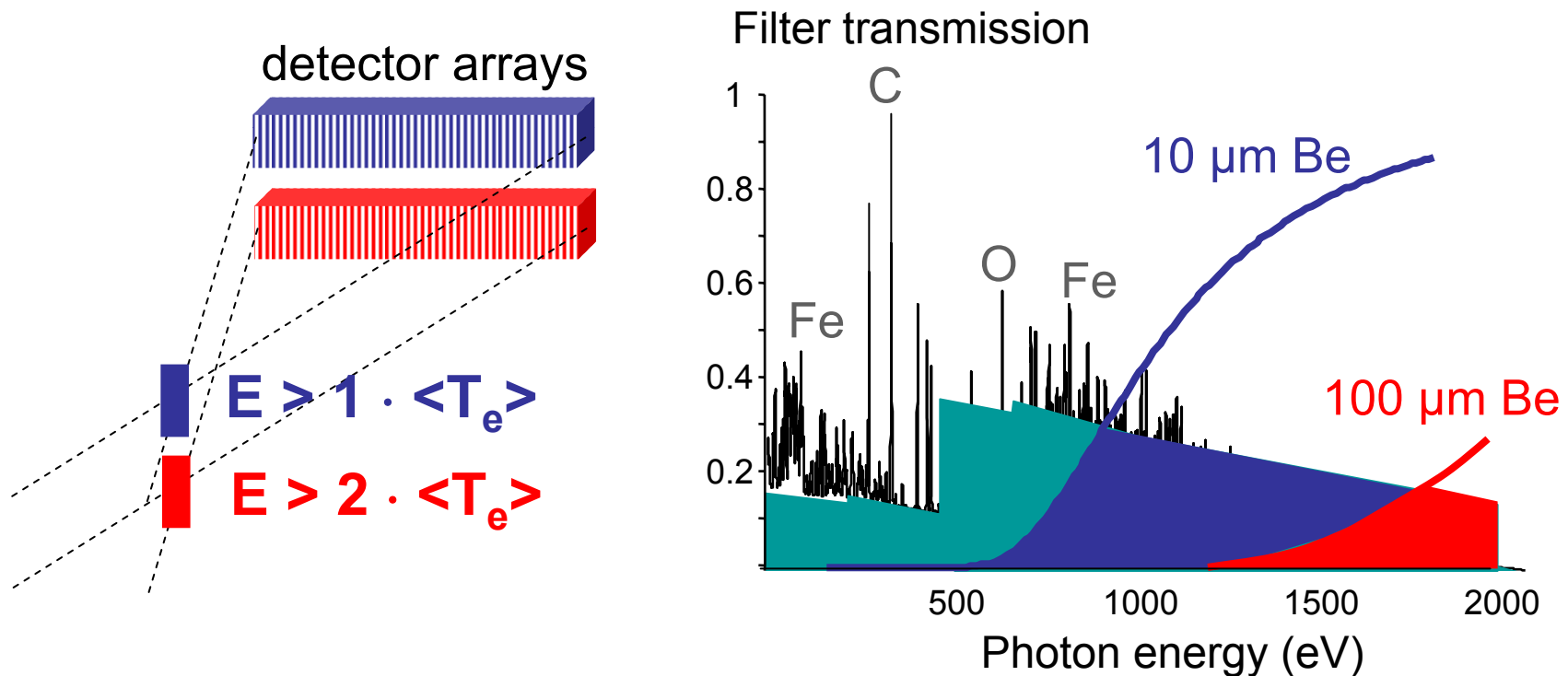
Motivation

- Proposed JHU research at NCSX :
 - MHD and equilibrium measurements
 - Impurity and electron transport (stellarator-ST comparison)
 - Plasma control using SXR

- Tool: **Dual-energy SXR tomography system**
 - T_e iso-surfaces for equilibrium reconstruction
 - 2-D T_e (n_e , n_z) perturbations (MHD mode, island, injection)
 - Real-time T_e for feedback control

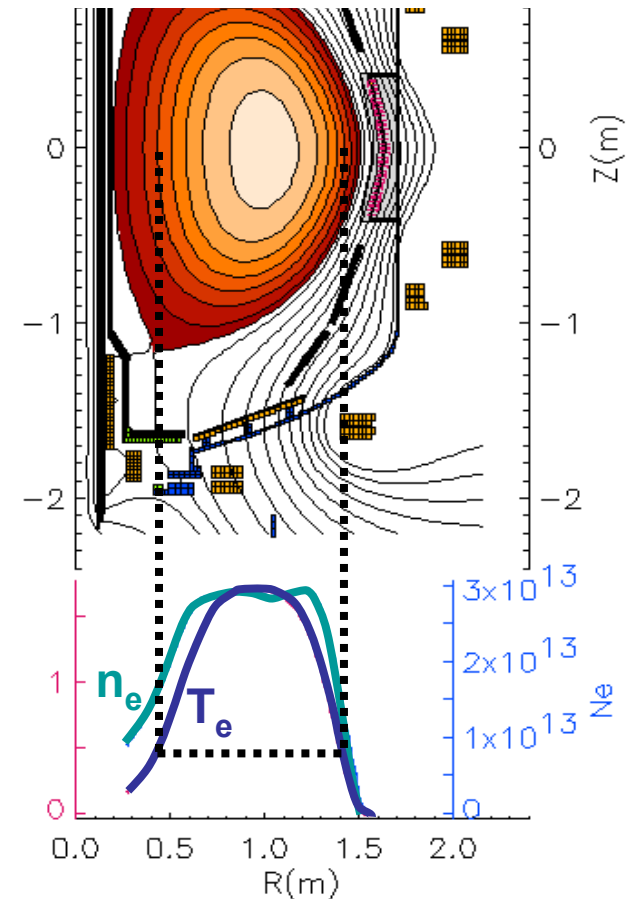
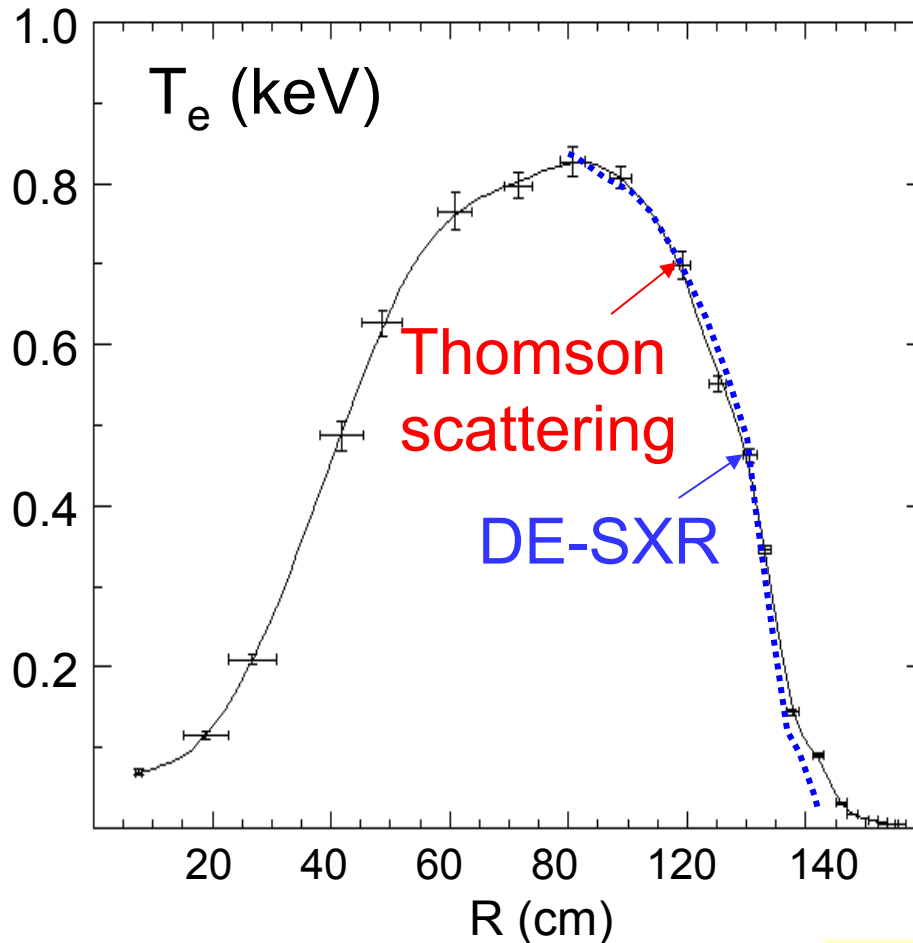
- Stems from multi-energy SXR diagnostic developed at NSTX

Dual-energy SXR diagnostic (DE-SXR)



- Plasma simultaneously imaged in two energy ranges
- SXR profiles modeled using *ab-initio* atomic data (HULLAC, CHIANTI)

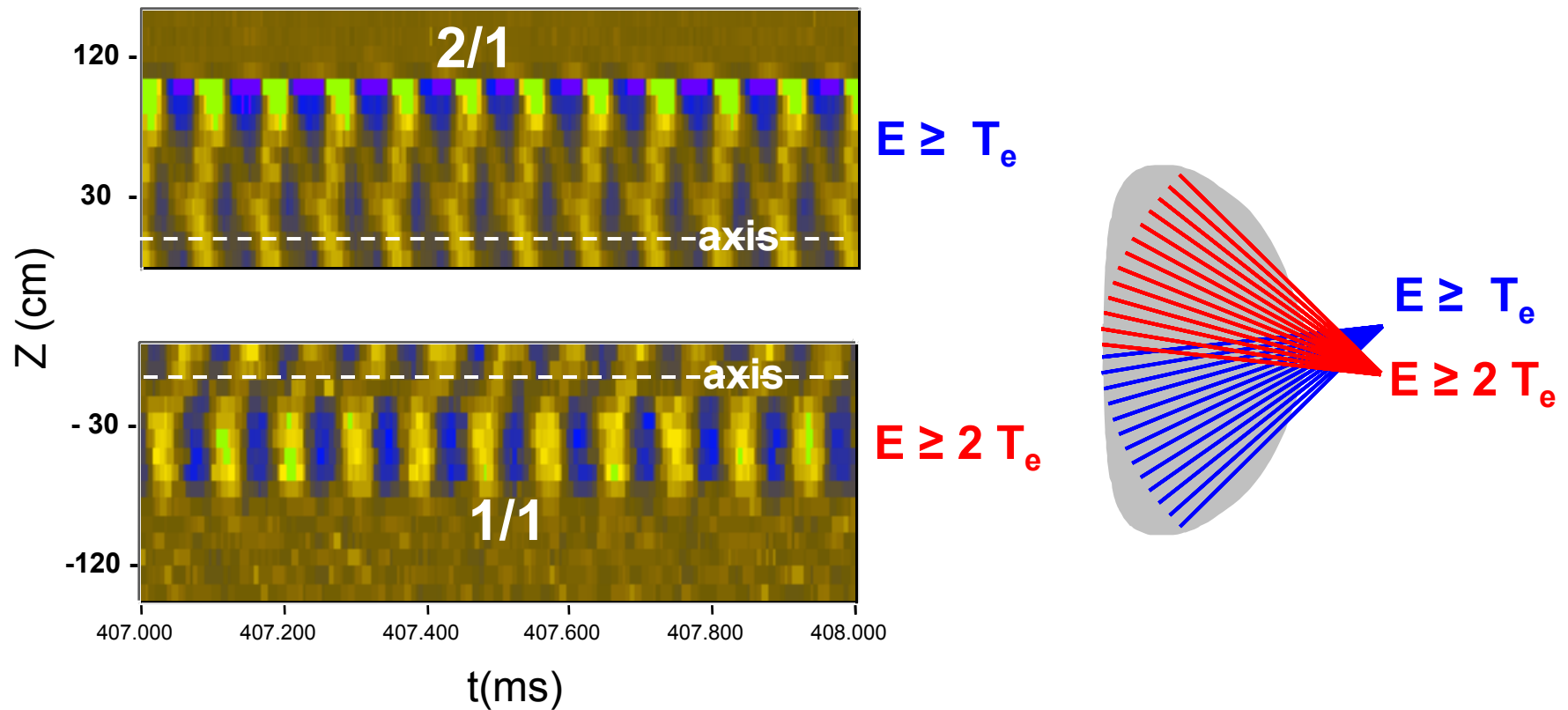
Fast T_e profiles in sub-keV plasma



- $T_e(r,t)$ by normalizing SXR to Thomson at t_0

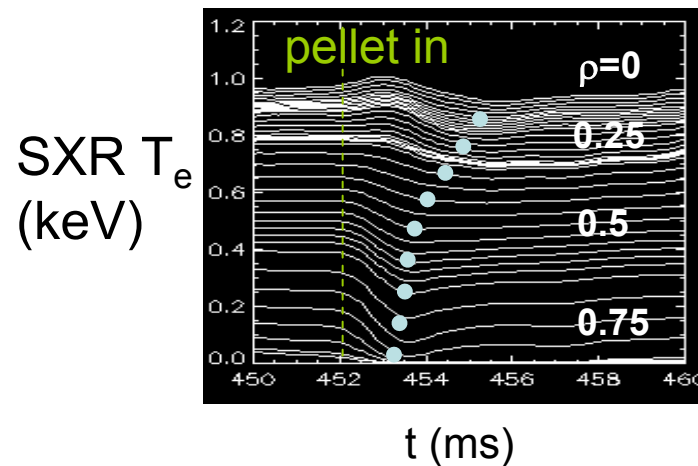
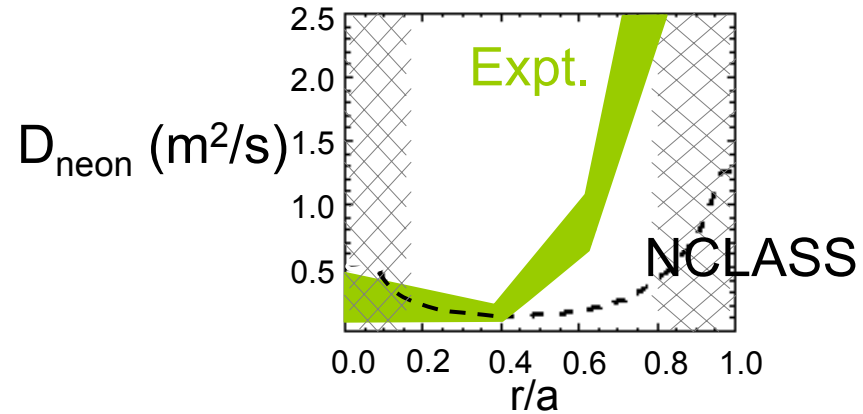
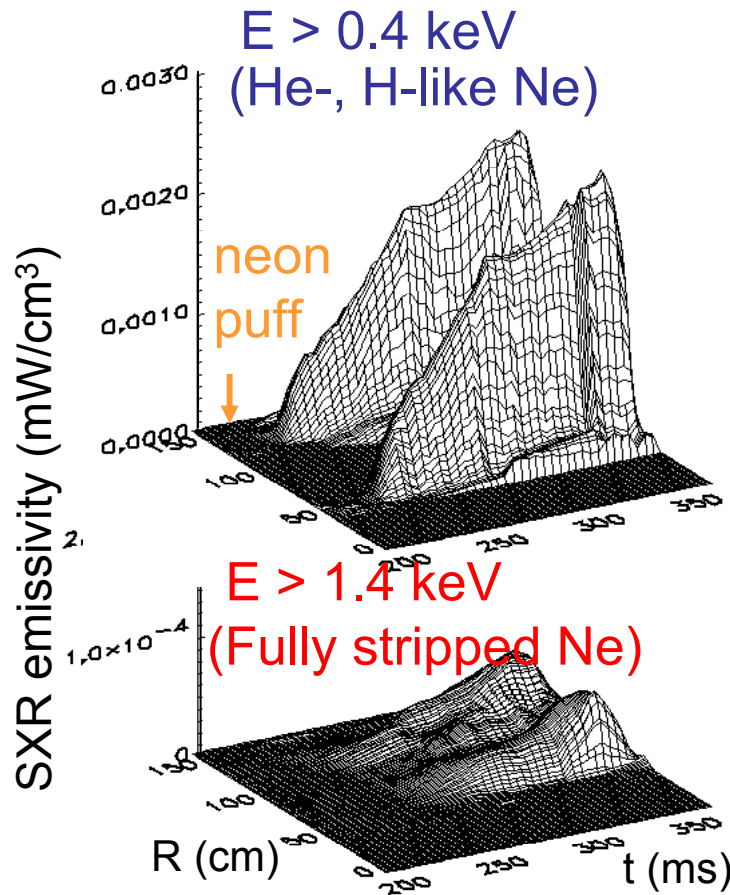
- T_e maps well on flux surfaces
- T_e iso-surfaces for equilibrium reconstruction on NCSX

Simultaneous edge and core MHD



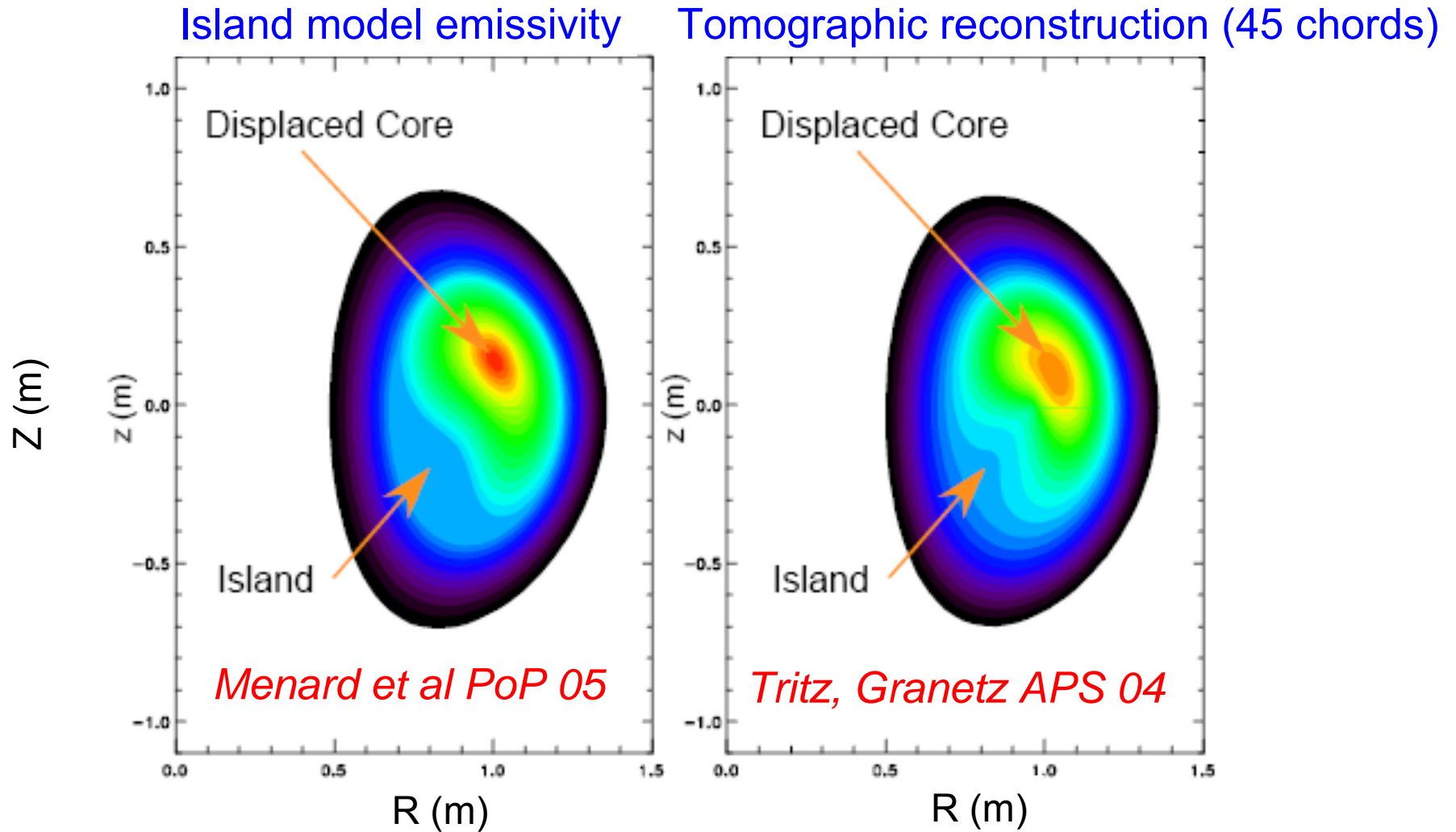
- DE-SXR 'decouples' core and edge modes
- Mode δT_e (δn_e , δn_z) also possible (Stutman *et al PoP 06*)

Impurity and electron transport



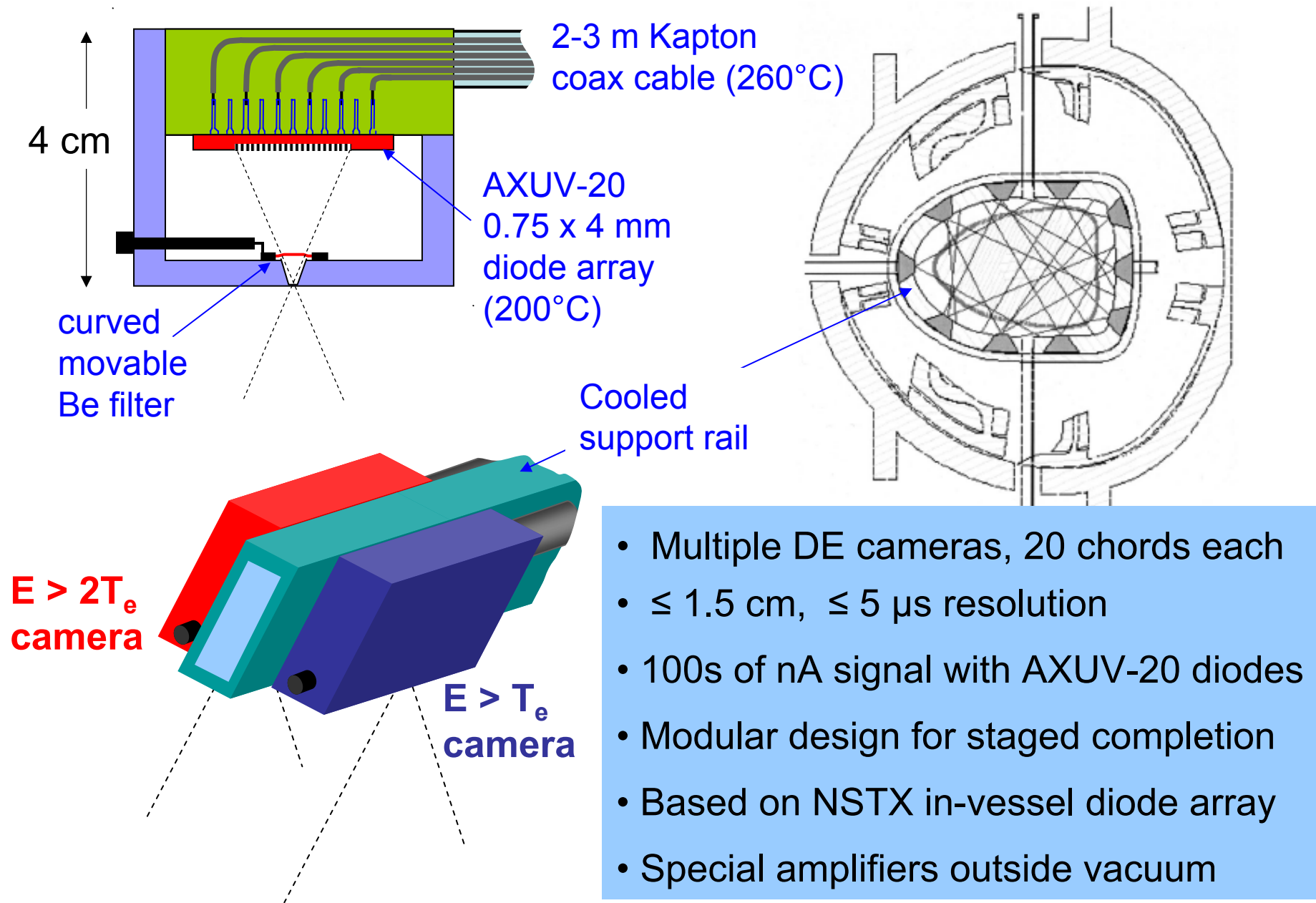
- DE-SXR discriminates edge and core charge states
- T_e perturbation diagnostic *in lieu* of ECE

Tomography using AXUV diode detectors



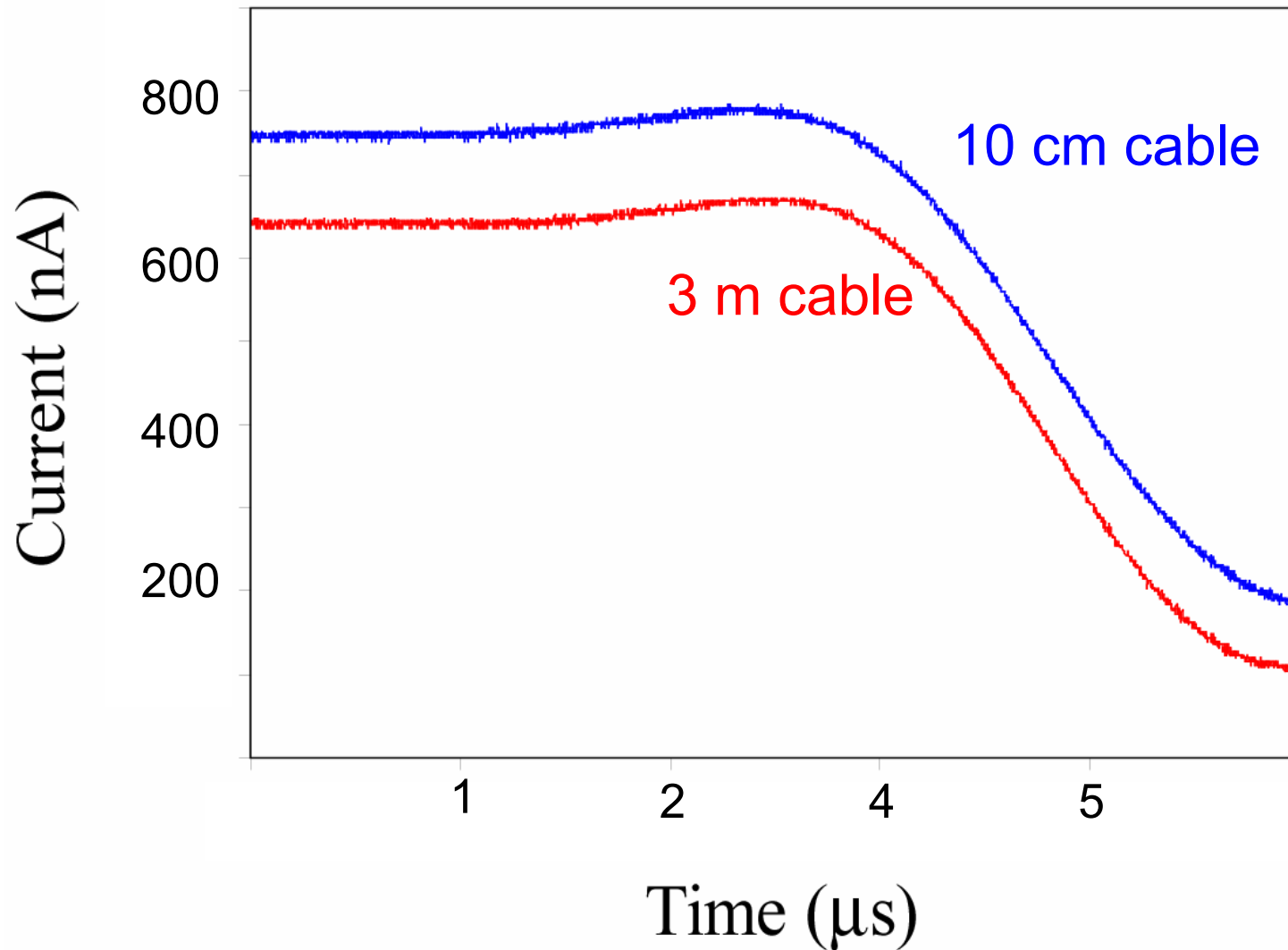
- Uniform AXUV response + algorithm optimization -> tomography with relatively sparse coverage

Proposed NCSX DE-SXR system



Special amplifiers enable using long cables

10^7 V/A transimpedance gain, 2 x 5 mm AXUV-16 diode, RG-58



Summary

- *Dual energy SXR tomography system* proposed for:
 - T_e iso-surfaces for equilibrium reconstruction
 - tomography of MHD T_e , n_e , n_z perturbations
 - perturbative particle and electron transport
 - plasma control using SXR T_e
- Compact, economical and tested solution using AXUV arrays
- Modular design for phased implementation (possibly from 2009)
- *Multi-chordal transmission grating spectrometer* (10-300 Å)
for improved accuracy in DE-SXR modeling