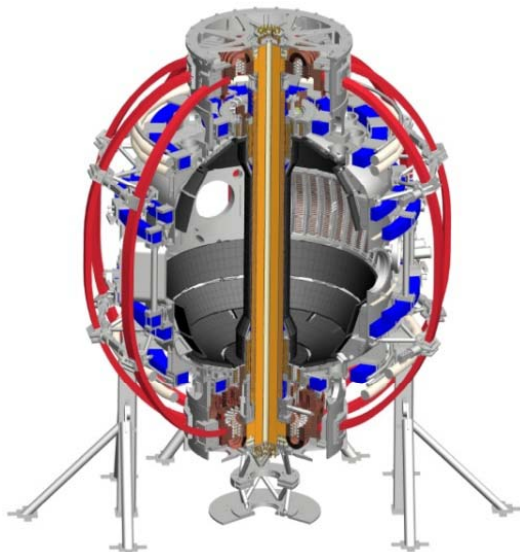


NSTX-U Collaboration Status and Plans for: Johns Hopkins University

Coll of Wm & Mary
 Columbia U
 CompX
 General Atomics
 FIU
 INL
 Johns Hopkins U
 LANL
 LLNL
 Lodestar
 MIT
 Lehigh U
 Nova Photonics
 ORNL
 PPPL
 Princeton U
 Purdue U
 SNL
 Think Tank, Inc.
 UC Davis
 UC Irvine
 UCLA
 UCSD
 U Colorado
 U Illinois
 U Maryland
 U Rochester
 U Tennessee
 U Tulsa
 U Washington
 U Wisconsin
 X Science LLC

Dan Stutman,
Kevin Tritz, Jorge Munoz Burgos (Aug. 2014)

NSTX-U Collaborator Research Plan Meetings
PPPL – LSB B318
April / May 2014



Culham Sci Ctr
 York U
 Chubu U
 Fukui U
 Hiroshima U
 Hyogo U
 Kyoto U
 Kyushu U
 Kyushu Tokai U
 NIFS
 Niigata U
 U Tokyo
 JAEA
 Inst for Nucl Res, Kiev
 Ioffe Inst
 TRINITI
 Chonbuk Natl U
 NFRI
 KAIST
 POSTECH
 Seoul Natl U
 ASIPP
 CIEMAT
 FOM Inst DIFFER
 ENEA, Frascati
 CEA, Cadarache
 IPP, Jülich
 IPP, Garching
 ASCR, Czech Rep

FY14 status in preparation for FY15 operations (1)

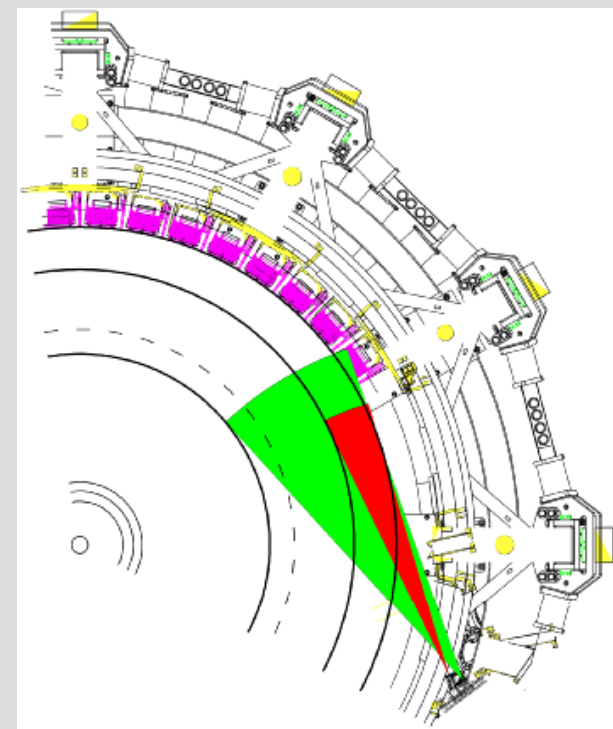
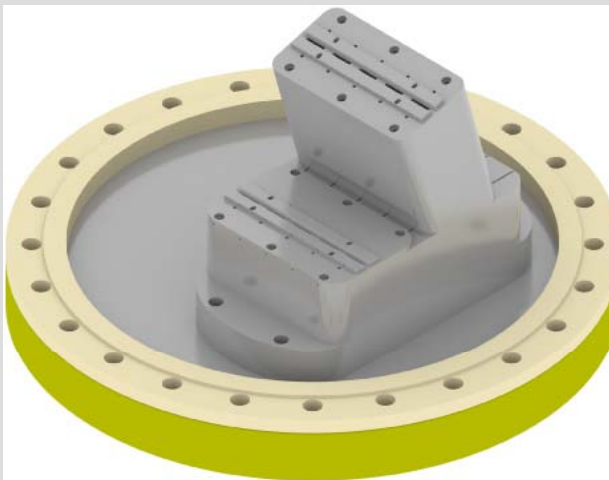
- New Core/Edge ME-SXR arrays (2x100 channels)
 - Detectors, port electronics, DAQ components ready
 - Mechanical and port integration design ready for FDR review
 - Installation end of this summer
 - Spatial calibrations after FY15 run (not needed with new NN analysis)
- Transmission Grating Imaging Spectrometer (TGIS)
 - Fast detector upgrade (from 400 to 20 ms)
 - Tested and calibrated in the lab
 - Installation before FY15 physics run

NSTX-U ME-SXR system

core Δr : 3 cm
edge Δr : 1 cm

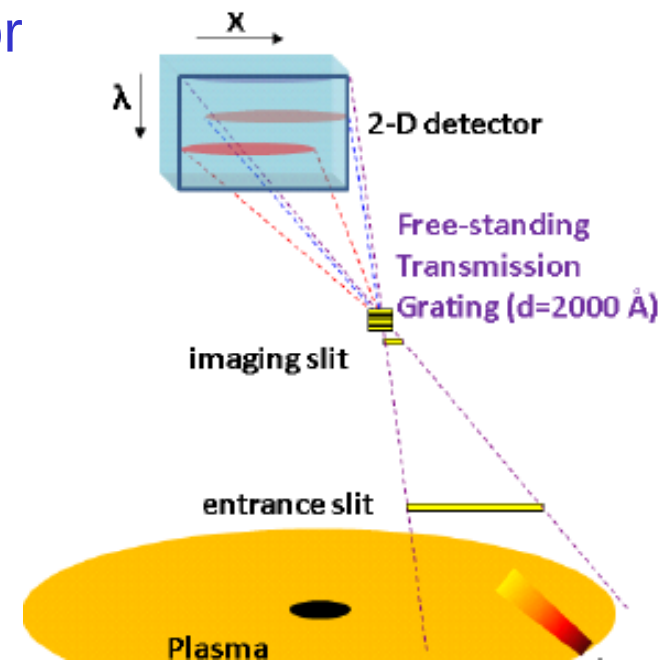
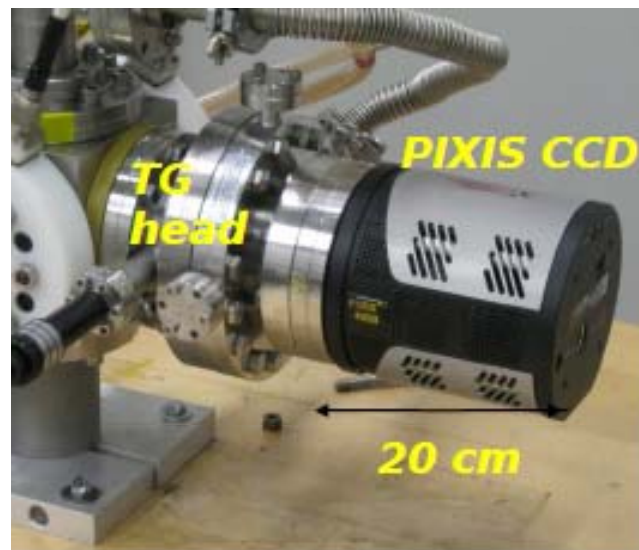
Speed: 10 kHz

10 energy bands



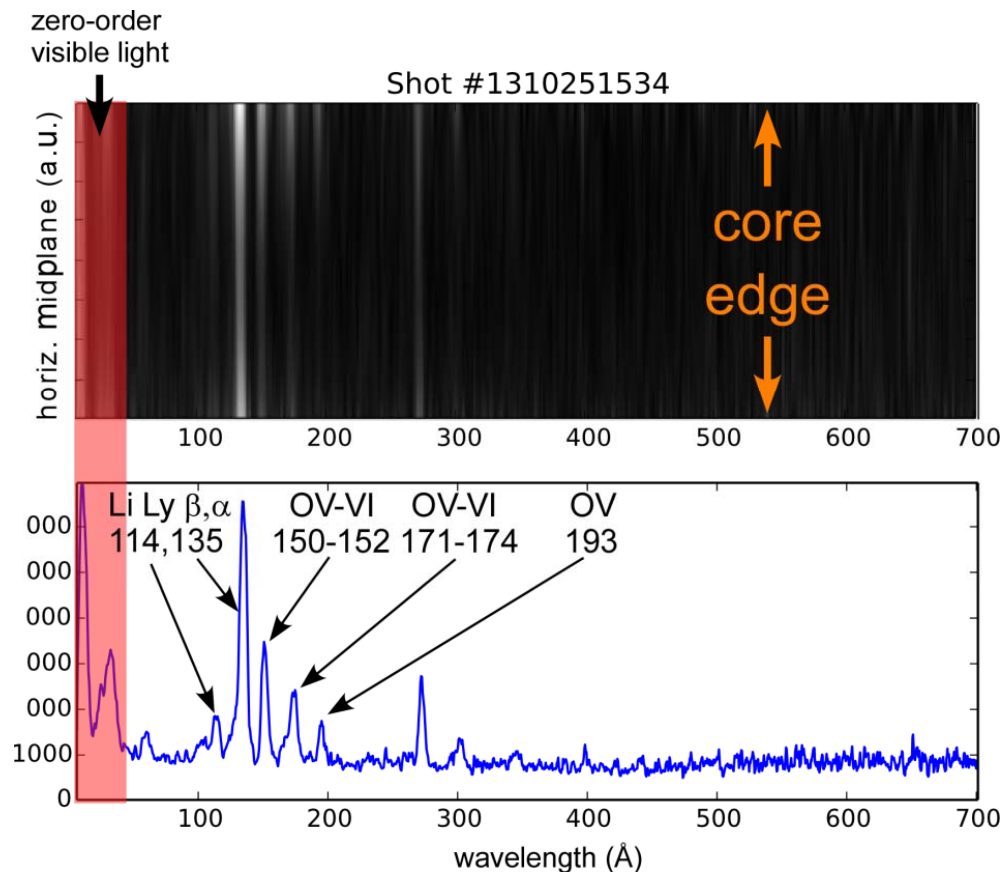
FY14 status in preparation for FY15 operations (2)

- Poloidal USXR arrays operational
 - Sharing D-tacq DAQ system with ME-SXR
- Partnering with LLNL to implement impurity LBO system
- TG Imaging Radiometer (TGIR) successfully tested on LTX
 - Developed under Advanced Diagnostics program
 - Ready for further testing on NSTX upper divertor

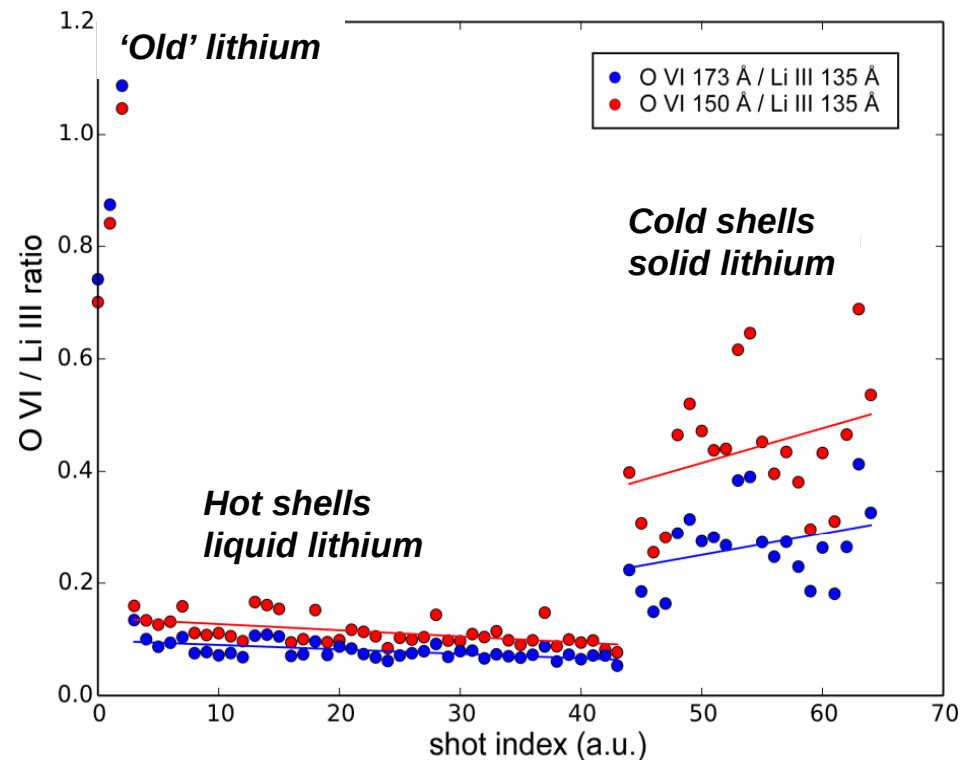


TGIR on LTX reveals effects of solid/liquid lithium PFC on oxygen impurity

TGIR space resolved XUV spectrum



O VI / Li III Ratio

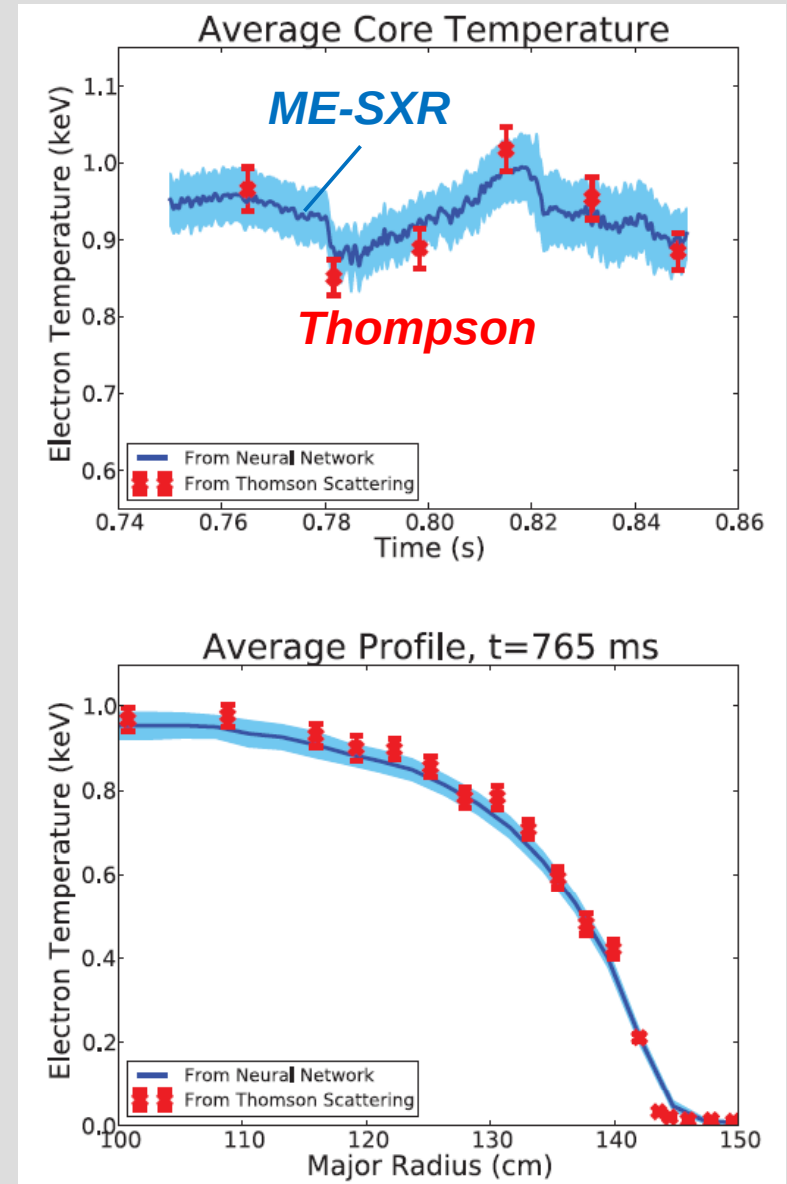


K. Tritz et al, in preparation

Research Plans for FY2015 and FY2016 (1)

- Provide routine fast ME-SXR T_e profiles
 - 10 kHz $T_e(r)$ diagnostic [1]
 - Neural network analysis:
ME-SXR + MPTS + TGIS
- Rebase NSTX ME-SXR edge and core transport results
 - Impurity transport using Neon gas puffs [2-4]
 - Perturbative electron transport using ELMs [5]
 - GAE intermittent electron transport using new fast T_e capability [6]

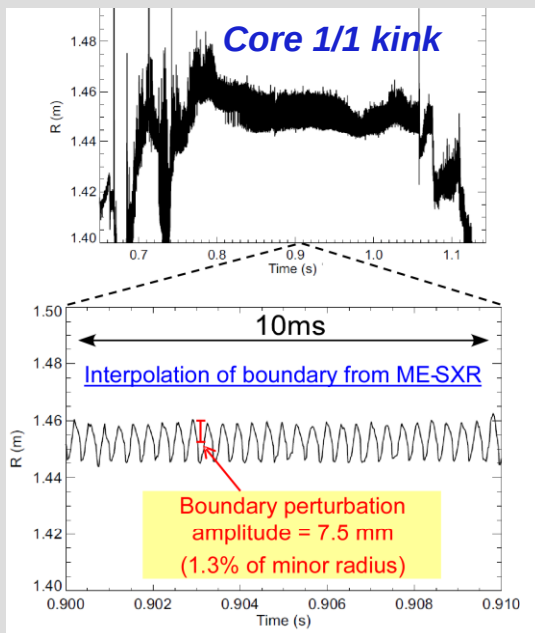
D. Clayton et al PPCF 2014



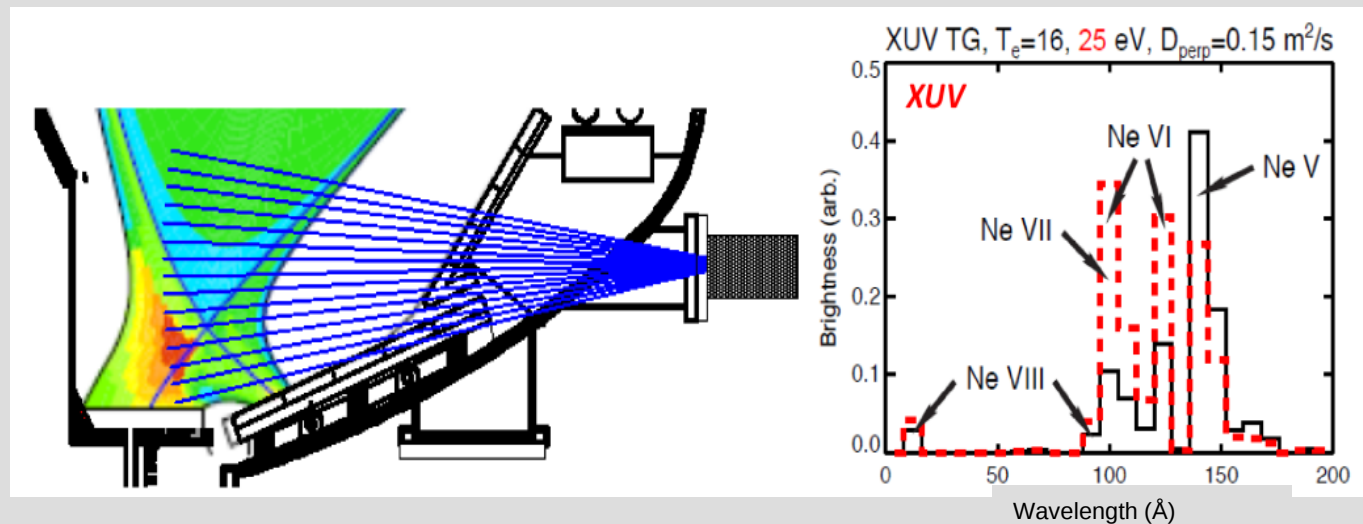
Research Plans for FY2015 and FY2016 (2)

- ME-SXR with repetitive LBO for multi-channel transport
 - Evaluate neural networks for transport analysis (STRAHL/TRANSP)
- ME-SXR boundary diagnostic
 - MHD radial displacements [7], ELM and RWM dynamics [8]
- Computational study of TGIR based divertor T_e and impurity diagnostic using neural networks

ME-SXR boundary displacement



Divertor TGIR concept



Ideas to enhance participation in NSTX-U research/program by U.S. Universities, early-career researchers, and students

- Stabilize funding to prevent loss of personnel and to enable engaging graduate students in research

Highest-priority incremental measurement capability

(For diagnostic solicitation grantees funded for 2012-2015)

- Additional D-Tacq DAQ system to enable simultaneous operation of core/edge ME-SXR and poloidal USXR arrays
 - At present we can run only 2 of 3 systems simultaneously
- XUV CCD detector for core TGIS spectrometer
 - Eliminate complex differential pumping system
 - Significantly improve measurement linearity and SNR
 - Enable synchrotron absolute calibration

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- 2) “Multi-energy Soft-x-ray Technique for Impurity Transport Measurements in the Fusion Plasma Edge” D.J. Clayton, K. Tritz, D. Stutman, M. Finkenthal, S.M. Kaye, D. Kumar, B.P. LeBlanc, S. Paul, S.A. Sabbagh, *Plasma Phys. Contr. Fus.*, **54**, 105022 (2012)
- 3) “Impurity Transport Experiments and Effects on MHD in the National Spherical Torus Experiment (NSTX)” L. Delgado-Aparicio, D. Stutman, K. Tritz, F. Volpe, K.L. Wong, R.E. Bell, M. Finkenthal, E. Fredrickson, S.P. Gerhardt, S.M. Kaye, B.P. LeBlanc, J.E. Menard, S. Paul, L. Roquemore, *Nucl. Fus.*, **51**, 083047 (2011)
- 4) “Impurity transport measurements in beam heated low-confinement mode discharges in the National Spherical Torus Experiment” D. Stutman, M. Finkenthal, R.E. Bell, S.M. Kaye, B.P. LeBlanc, J.E. Menard, E.J. Synakowski, D.S. Darrow, V. Soukhanovskii, C. Bourdelle, *Phys. Plasmas*, **10**, 4387 (2003)
- 5) “Relationship between edge localized mode severity and electron transport in the National Spherical Torus Experiment” K. Tritz, S.M. Kaye, R. Maingi, S.A. Sabbagh, D. Stutman, R.E. Bell, L. Delgado-Aparicio, C.W. Somier, M. Finkenthal, B.P. LeBlanc, W. Lee, N.C. Luhmann, E. Mazzucato, H. Park, D.R. Smith, *Phys. Plasmas*, **15**, 056119 (2008)
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- 7) “Three dimensional distortions of the tokamak plasma boundary: I. Boundary displacements in the presence of saturated MHD instabilities” I.T. Chapman, D. Brunetti, P. Buratti, W.A. Cooper, J.P. Graves, J.R. Harrison, J. Holgate, S. Jardin, S.A. Sabbagh, K. Tritz, *submitted Nucl. Fus.* (2014)
- 8) “Soft X-ray Measurements of Resistive wall mode Behavior in NSTX” L. Delgado-Aparicio, D. Stutman, S.A. Sabbagh, R.E. Bell, J.W. Berkery, K. Tritz, S.P. Gerhardt, B.P. LeBlanc, M. Finkenthal, J.P. Levesque, K.C. Lee, J.E. Menard, S. Paul, L. Roquemore, *Plasma Phys. Contr. Fus.*, **53**, 035005 (2011)