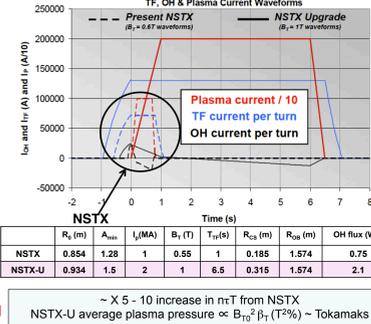
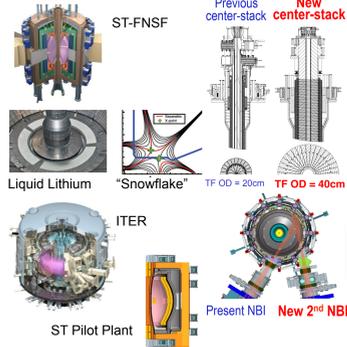


NSTX Upgrade Mission Elements

- Advance ST as candidate for Fusion Nuclear Science Facility (FNSF)
- Develop solutions for the plasma-material interface challenge
- Explore unique ST parameter regimes to advance predictive capability - for ITER and beyond
- Develop ST as fusion energy system

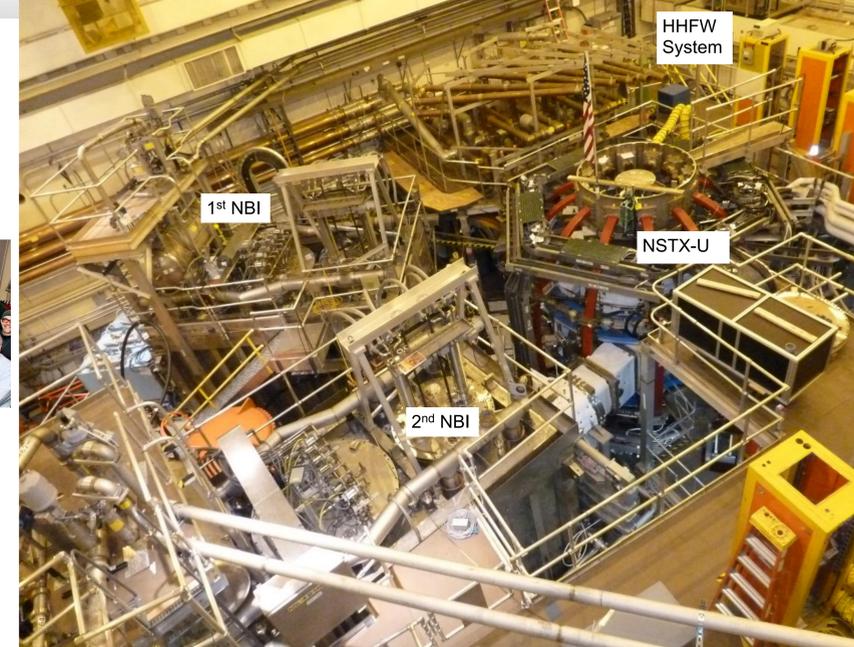


NSTX Upgrade Project Progress Overview

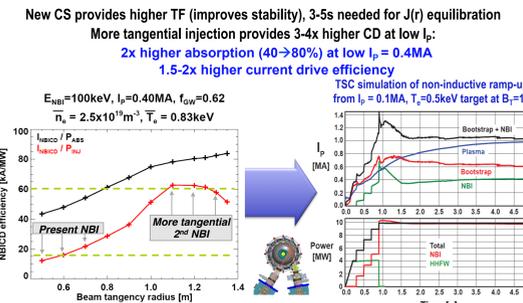
- New Center Stack Project Scope**
- Inner TF bundle
 - TF Flex bus
 - OH coil
 - Inner PF coils
- 2nd NBI Project Scope**
- Decontaminate TFTR beamline
 - Refurbish for reuse
 - Relocate pump duct, 22 racks and numerous diagnostics to make room in the NSTX Test Cell
 - Install new port on vacuum vessel to accommodate NB2
 - Move NB2 to the NSTX Test Cell
 - Install power, water, cryo and controls
- Structure**
- Enhance outer TF supports
 - Enhance PF supports
 - Reinforce umbrella structure
 - New umbrella lids
- Ancillary Sys**
- Power systems
 - I&C, Services, Coil protection



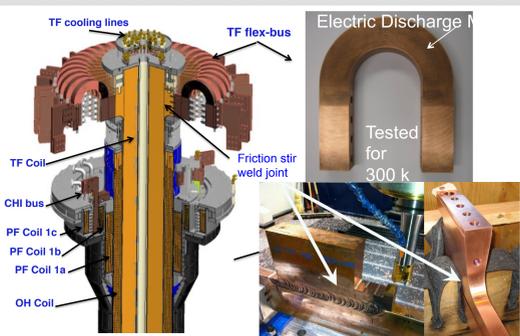
Recent Aerial View of the NSTX-U Test Cell



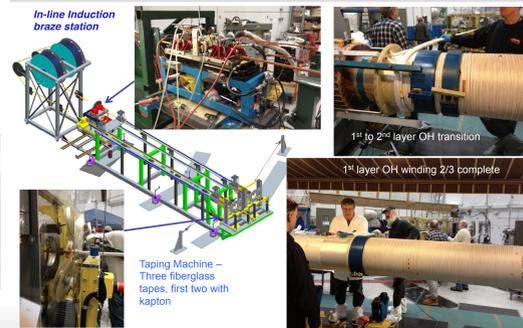
Non-inductive ramp-up from ~0.4MA to ~1MA projected to be possible with new centerstack (CS) + more tangential 2nd NBI



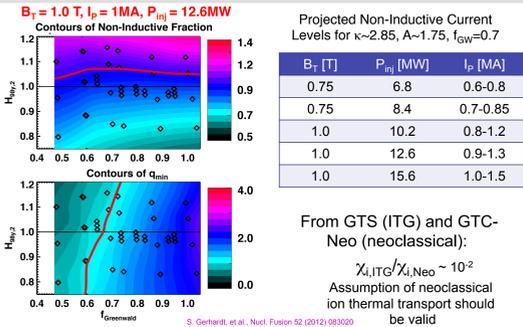
Improved Center-Stack Design to Handle Increased Forces Identical 36 TF Bars and Innovative Flex-Bus Design



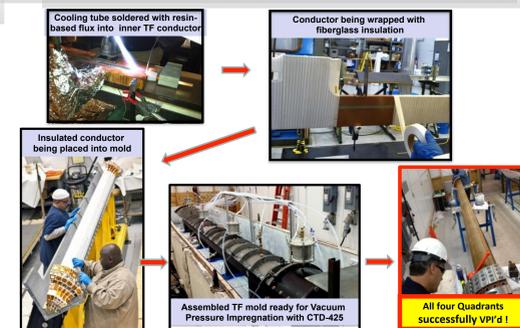
OH Winding Operation Went Well! OH Conductor Induction Braze & Taping Machine



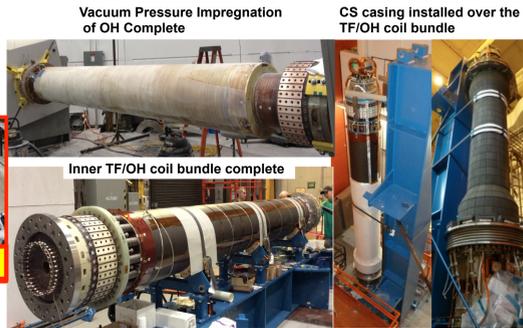
100% non-inductive operating points projected for a range of toroidal fields, densities, and confinement levels



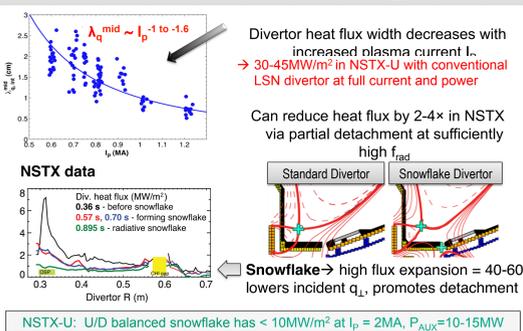
Center Stack Fabrication & Assembly Complete Innovative manufacturing techniques completed



Center-stack Components Fabricated Center-stack assembly complete



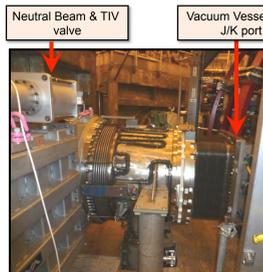
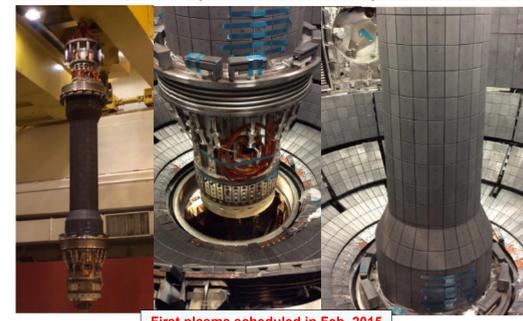
NSTX-U will investigate detachment and high-flux-expansion "snowflake" divertor for heat flux mitigation



Center-stack TF bundle fabrication steps TF bundle and casing are complete



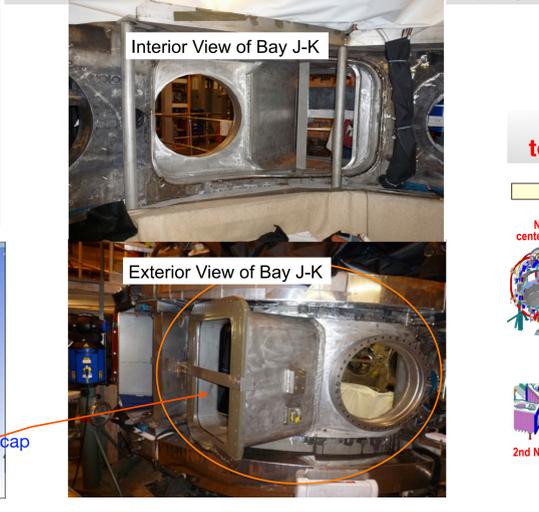
New Center-Stack Installed In NSTX-U (October 24, 2014)



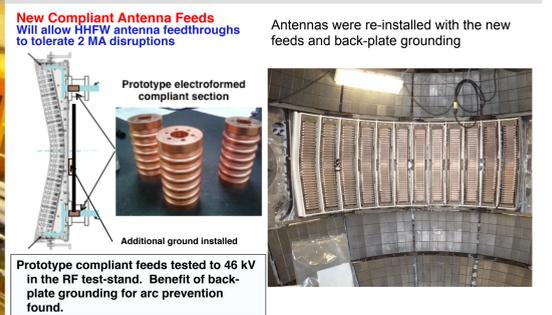
NSTX-U diagnostics to be installed during first 2 years Half of NSTX-U Diagnostics Are Led by Collaborators

- MHD/Magnetics/Reconstruction**
 - Magnetics for equilibrium reconstruction
 - Gas-puff imaging (500kHz)
 - Langmuir probe array
 - High-n and high-frequency Mirnov arrays
 - Locked-mode detectors
 - PWM sensors
- Profile Diagnostics**
 - MPTS (42 ch, 60 Hz)
 - T-CHERS: $T_e(r), V_e(r), n_e(r), n_i(r), \nu_e(r)$ (51 ch)
 - P-CHERS: $V_e(r)$ (71 ch)
 - MSE-CIF (18 ch)
 - MSE-LF (20 ch)
 - ME-SXR (40 ch)
- Turbulence/Modes Diagnostics**
 - Pooidal FIR high-k scattering
 - Beam Emission Spectroscopy (48 ch)
 - Microwave Reflectometer
 - Microwave Polarimeter
 - Ultra-soft x-ray arrays - multi-color
- Energetic Particle Diagnostics**
 - Fast Ion D₊ profile measurement (perp + tang)
 - Solid-State neutral particle analyzer
 - Fast lost-ion probe (energy/pitch angle resolving)
 - Neutron measurements
- Edge Divertor Physics**
 - Gas-puff imaging (500kHz)
 - Langmuir probe array
 - Edge Rotation Diagnostics (T_e, V_e, ν_e)
 - 1-2 CCD H_α cameras (divertor, midplane)
 - 2-D divertor fast visible camera
 - Metal foil divertor bolometer
 - AXUV-based Divertor Bolometer
 - IR cameras (60x42) (3)
 - Fast IR camera (two color)
 - Tile temperature thermocouple array
 - Divertor fast eroding thermocouple
 - Dust detector
 - Edge Deposition Monitors
 - Scrape-off layer reflectometer
 - Edge neutral pressure gauges
 - Material Analysis and Particle Probe
 - Divertor UV Spectrometer
- Plasma Monitoring**
 - FIRETIP interferometer
 - Fast visible cameras
 - Visible bremsstrahlung radiometer
 - Visible and UV survey spectrometers
 - VUV transmission grating spectrometer
 - Visible filterscopes (hydrogen & impurity lines)
 - Wall coupon analysis

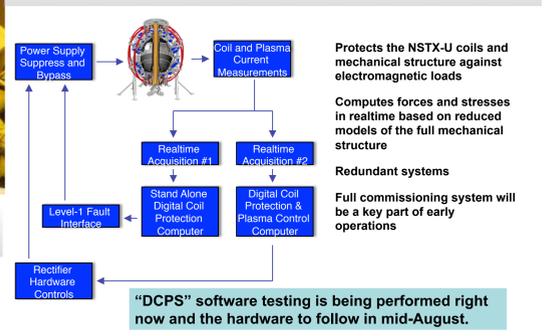
Highly Tangential 2nd NBI Enabled by JK-Cap Outer Wall Radii Moved Outward to Avoid Beam Clipping



HHFW System for Electron Heating and Current Ramp-up Improved Antennas were installed on NSTX-U



New Digital System Provides Comprehensive Coil Protection

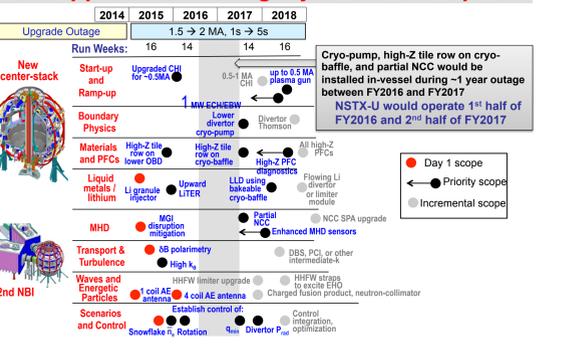


Formulating Strategy Toward Full NSTX-U Parameters After CD-4, the plasma operation could enter quickly into new regimes

	NSTX (Max.)	Year 1 NSTX-U Operations (2015)	Year 2 NSTX-U Operations (2016)	Year 3 NSTX-U Operations (2017)	Ultimate Goal
I_p [MA]	1.2	-1.6	2.0	2.0	2.0
B_T [T]	0.55	-0.8	1.0	1.0	1.0
Allowed TF $\dot{\Gamma}$ [MA ²]	7.3	80	120	160	160
I_p Flat-Top at max. allowed $\dot{\Gamma}$, I_p , and B_T [s]	-0.4	-3.5	-3	5	5

- 1st year goal: operating points with forces up to 1/2 the way between NSTX and NSTX-U, 1/2 the design-point heating of any coil
 - Will permit up to ~5 second operation at $B_T=0.65$
- 2nd year goal: Full field and current, but still limiting the coil heating
 - Will revisit year 2 parameters once year 1 data has been accumulated
- 3rd year goal: Full capability

Facility and Diagnostic Enhancements to support the exciting 5 year research plan



First plasma scheduled in Feb. 2015