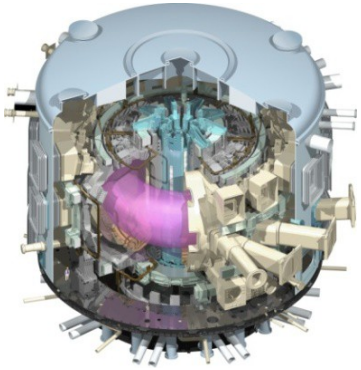
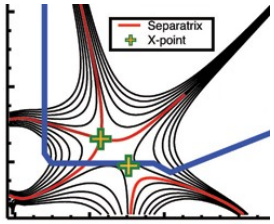
NSTX-U Mission Elements:

- Explore unique ST parameter regimes to advance predictive capability - for ITER and beyond
- Develop solutions for plasma-material interface (PMI)
- Advance ST as Fusion Nuclear Science Facility and Pilot Plant

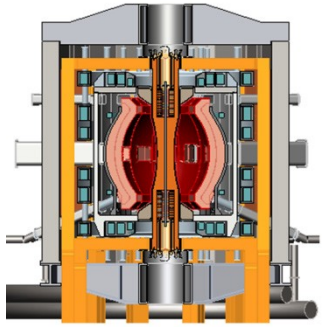


ITER

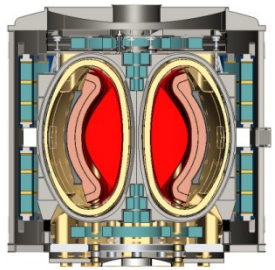
Liquid metals / Lithium



Snowflake/X

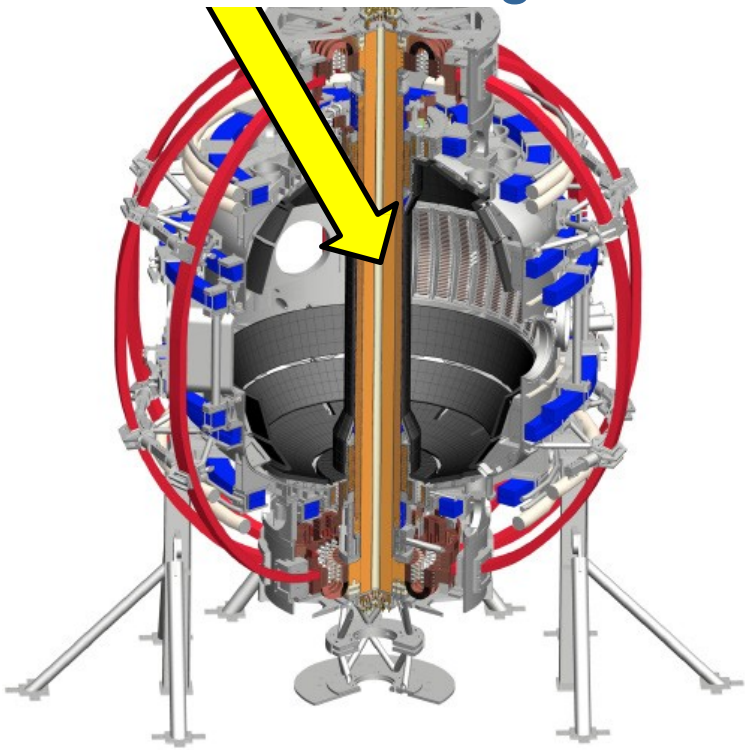


ST-FNSF / Pilot-Plant

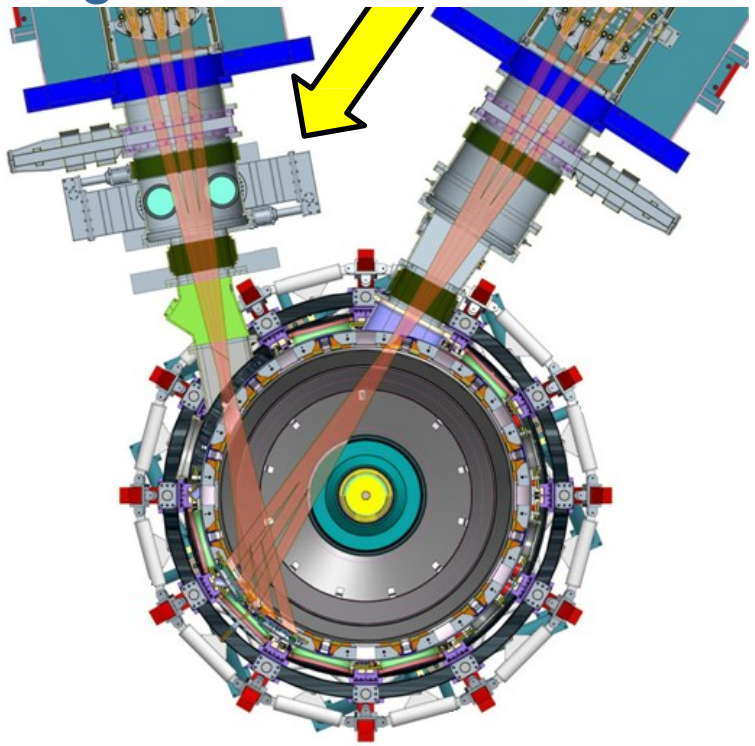


NSTX-U will access new physics with 2 major new tools:

1. New Central Magnet



2. Tangential 2nd Neutral Beam



<u>Higher T_i low collisionality at high β</u>

→ Unique regime, study new transport and stability physics

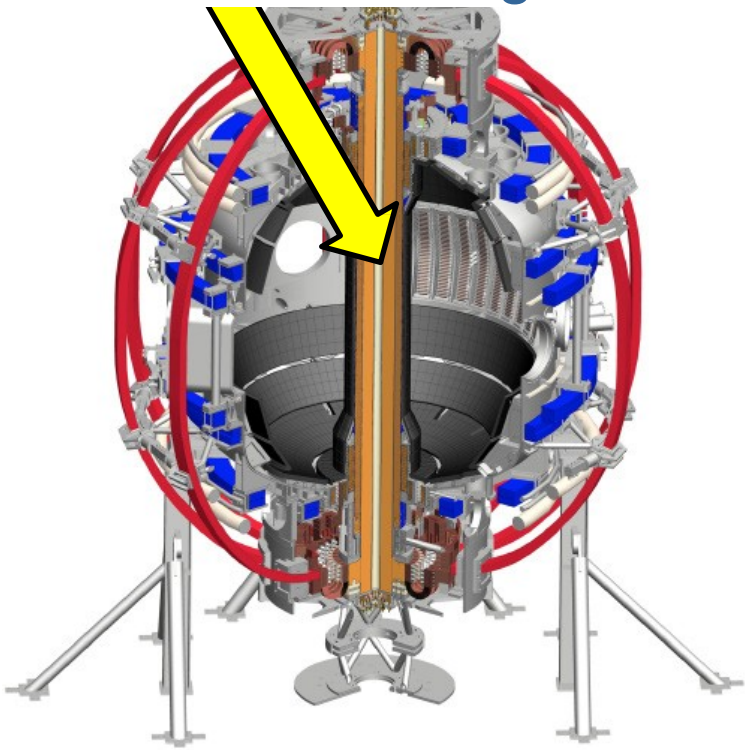
<u>Full non-inductive current drive</u>

→ Not demonstrated in ST at high-β_T

Essential for any future steady-state ST

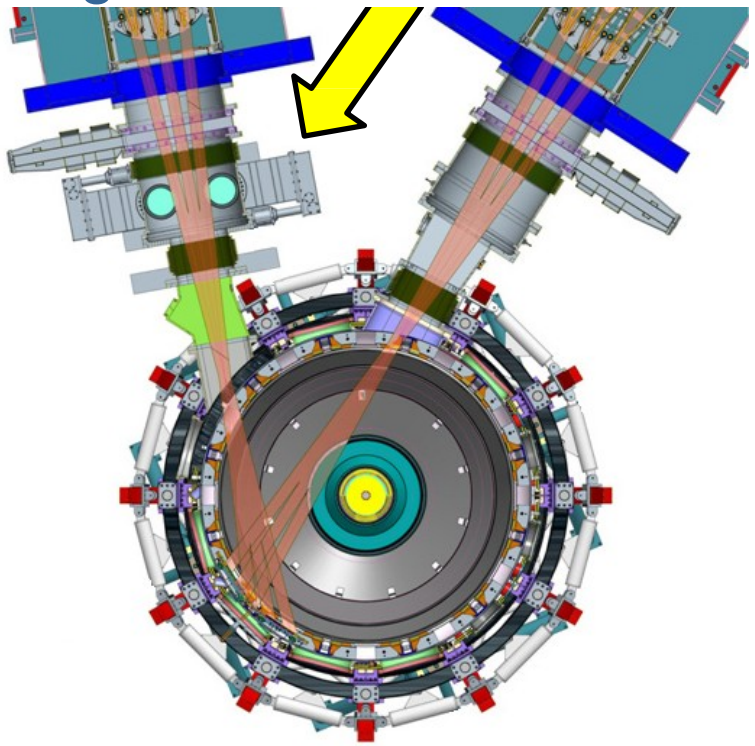
NSTX-U will have major boost in performance

1. New Central Magnet



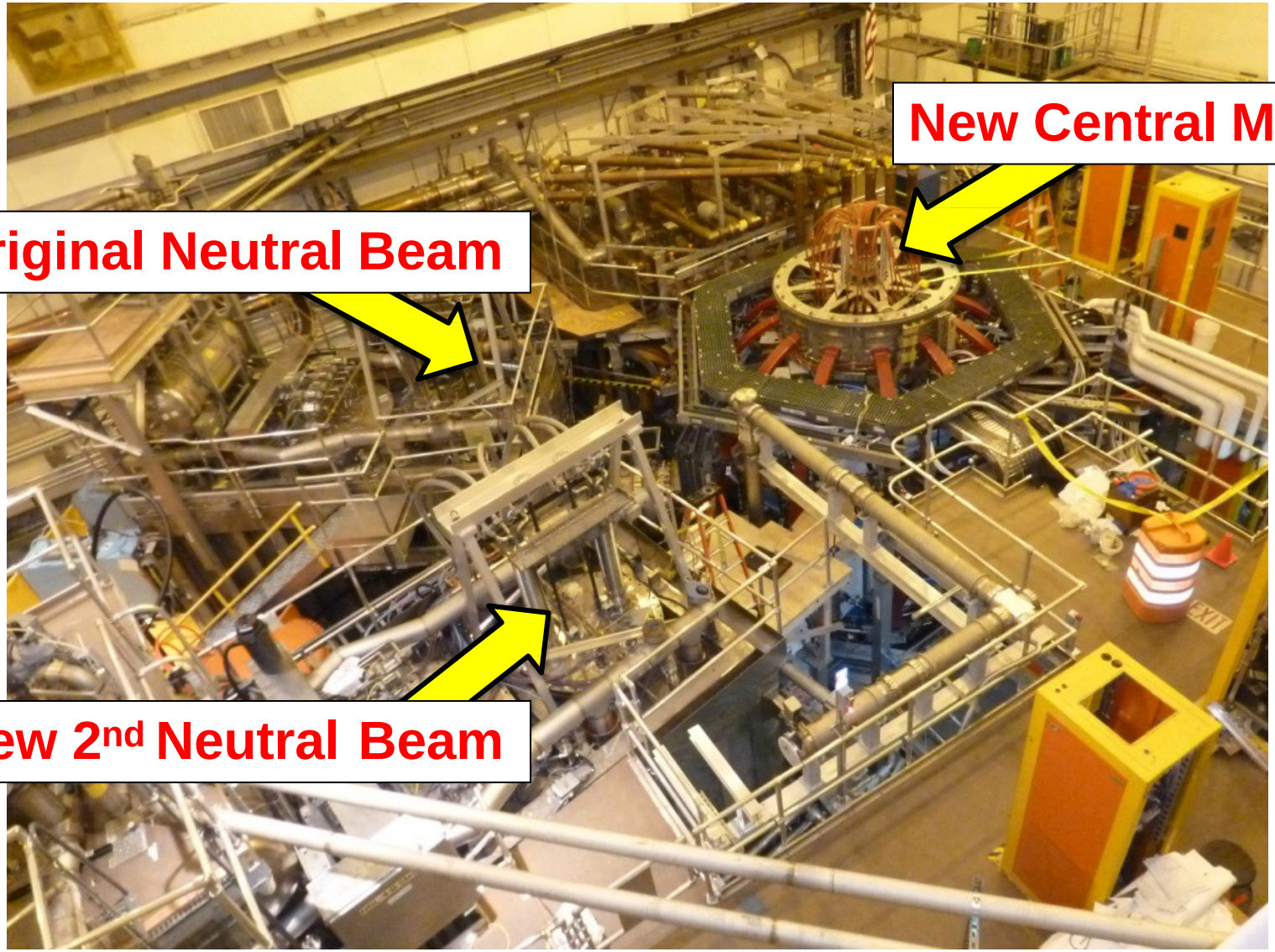
- 2× toroidal field (0.5 → 1T)
- 2× plasma current (1 → 2MA)
- 5× longer pulse (1 → 5s)

2. Tangential 2nd Neutral Beam



- 2× heating power (5 → 10MW)
  - Tangential NBI → 2× current drive efficiency
- 4× divertor heat flux (→ ITER levels)
- Up to 10× higher $nT\tau_E$ (~MJ plasmas)

Completed NSTX Upgrade Project



Design studies show ST potentially attractive as Fusion Nuclear Science Facility (FNSF) or Pilot Plant

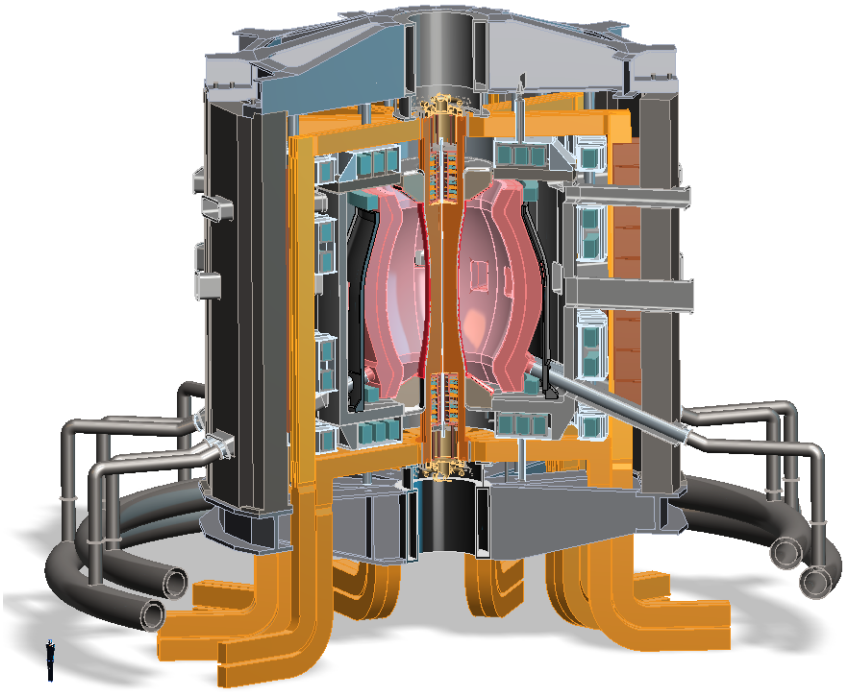
FNSF: Provide neutron fluence for material/component R&D + T self-sufficiency

Pilot Plant: Electrical self-sufficiency: $Q_{eng} = P_{elec} / P_{consumed} \geq 1$ + FNSF mission

FNSF with copper TF coils

A=1.7, R_0 = 1.7m, κ_x = 2.7

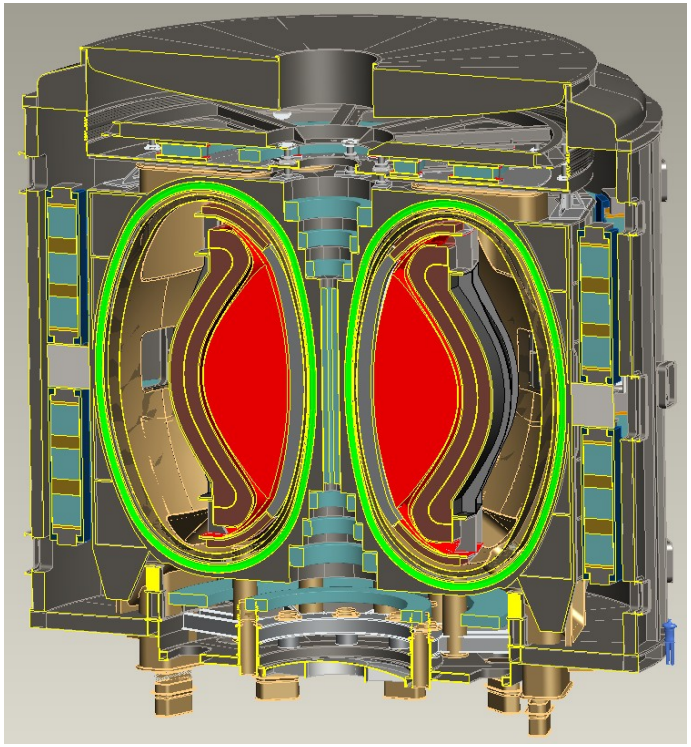
Fluence = 6MWy/m², TBR ~ 1



FNSF / Pilot Plant with HTS TF coils

A=2, R_0 = 3m, κ_x = 2.5

6MWy/m², TBR ~ 1, Q_{eng} ~ 1



NSTX-U = National Spherical Torus eXperiment - Upgrade

Highly collaborative research program

Domestic (33)

College of William and Mary
Columbia University
CompX
Florida International Univ.
General Atomics
Idaho National Laboratory
Johns Hopkins University
Lawrence Livermore Nat. Lab.
Lehigh University
Lodestar Research Corporation
Los Alamos National Laboratory
Massachusetts Institute of Tech.
Nova Photonics, Inc
Oak Ridge National Laboratory
Old Dominion University
Princeton Plasma Physics Lab
Princeton University
Purdue University
Sandia National Laboratory
Tech-X Corporation
U. of California - Davis
U. of California - Irvine
U. of California - Los Angeles
U. of California - San Diego
U. of California - Space Sci. Lab.
University of Colorado
University of Illinois
University of Maryland
University of Rochester
University of Tennessee
University of Texas
University of Washington
University of Wisconsin

~400 team members

~350 data users

55 institutions

22 US Universities

April 2016

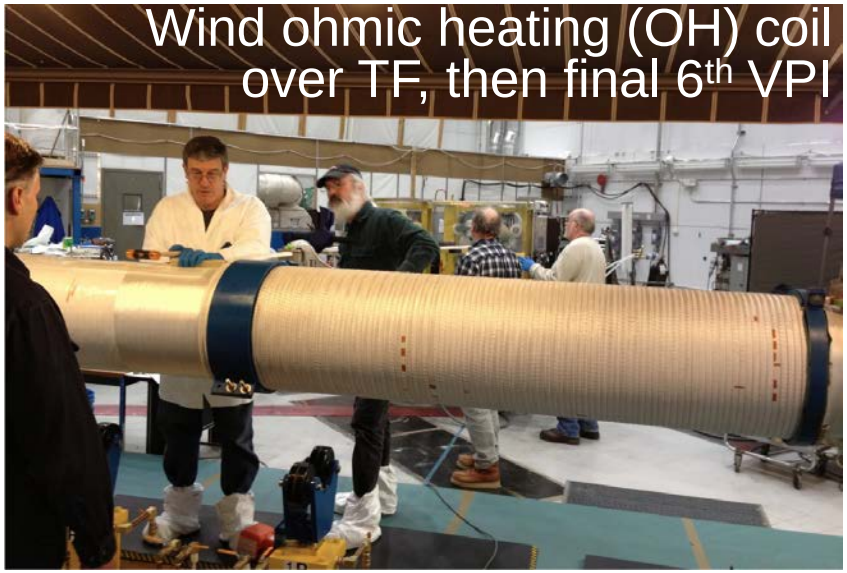
International (22)

ASIPP
CCFE
FOM Institute DIFFER
Hiroshima University
Inst. for Nuclear Research
IPP-Czech Republic
Ioffe Physical-Tech. Inst.
JAEA
KAIST
Kyoto University
Kyushu University
NFRI
NIFS
Niigata University
Seoul National University
Tokamak Energy, LTD
TRINITI
UNIST
University of Costa Rica
University of Hyogo
University of Tokyo
University of York

Central magnet construction was complex, multi-stage, multi-year effort

Built 4 toroidal field (TF) quadrants

4 vacuum pressure impregnations (VPI)

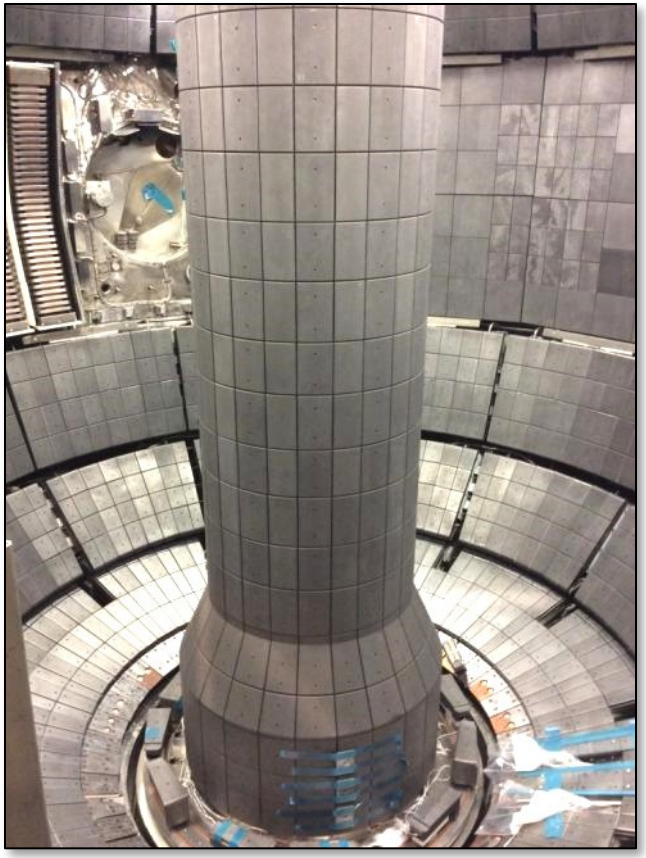


Fabrication and installation of central magnet ultimately successful

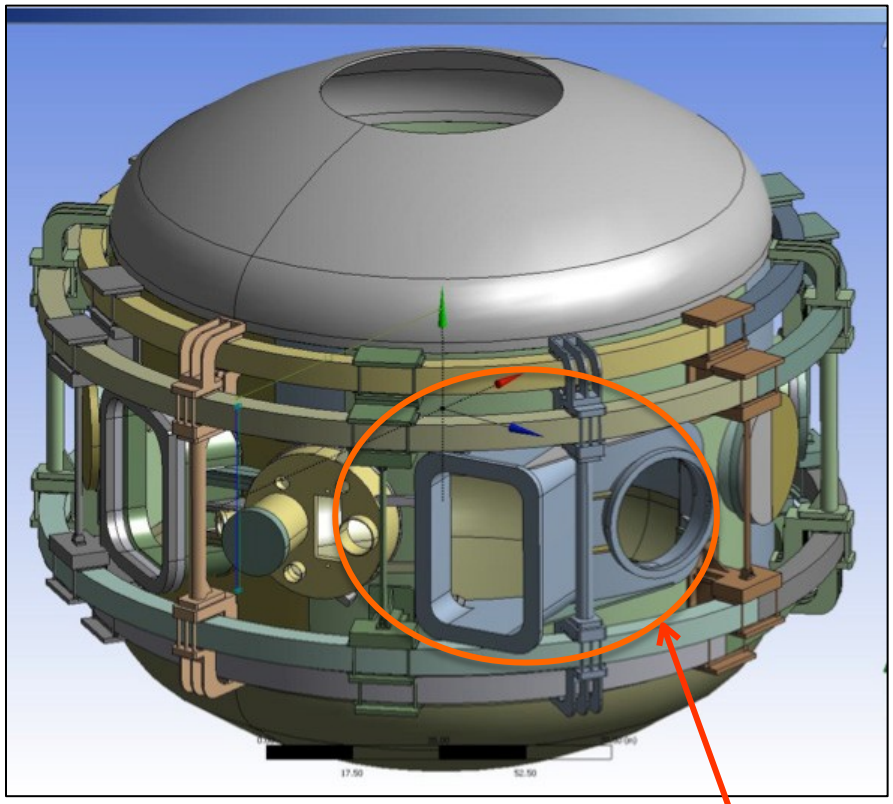
Over shield wall

Over the machine

Inside NSTX-U!



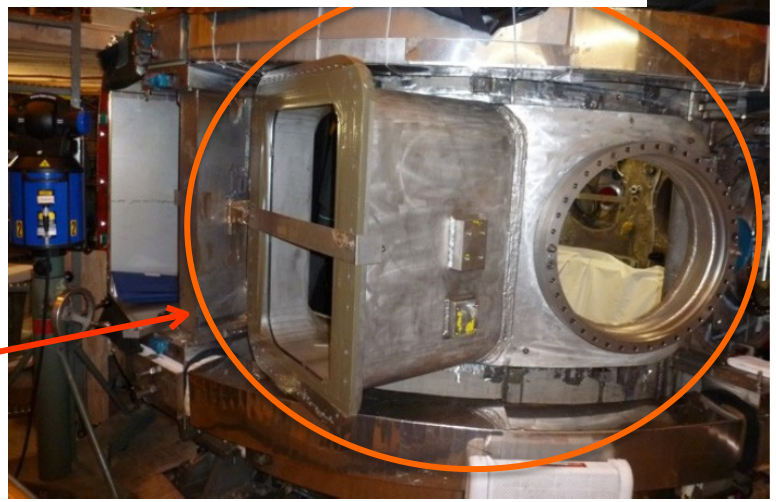
Tangential neutral beam required major vacuum vessel modifications



JK cap

Interior View of Bay J-K

Exterior View of Bay J-K



2nd beam (from TFTR DT campaign) required T decontamination, NSTX test-cell re-arrangement

Beam Box being lifted over NSTX

Beam Box placed in its final location and aligned

Beam Box being populated with components