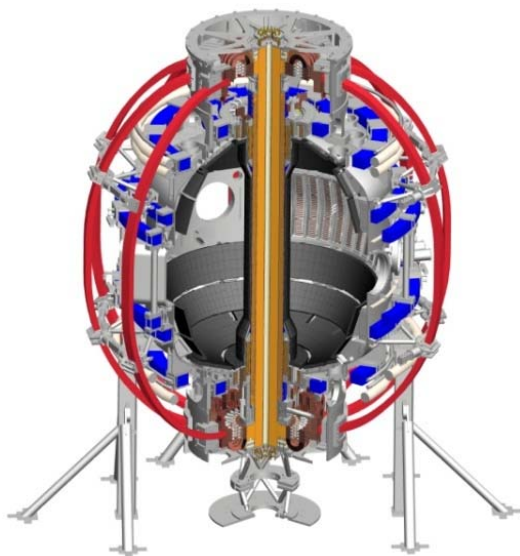


# Non-axisymmetric Control Coil (NCC) design and analysis plan for NSTX-U

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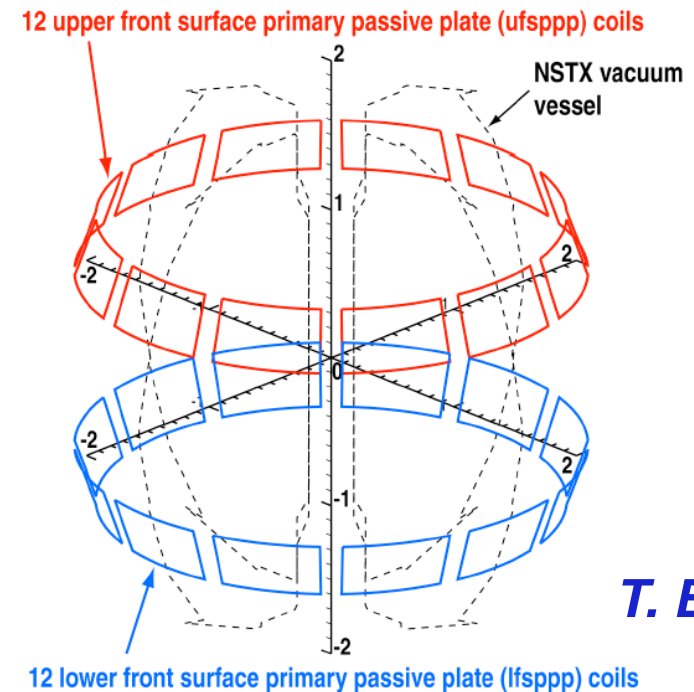
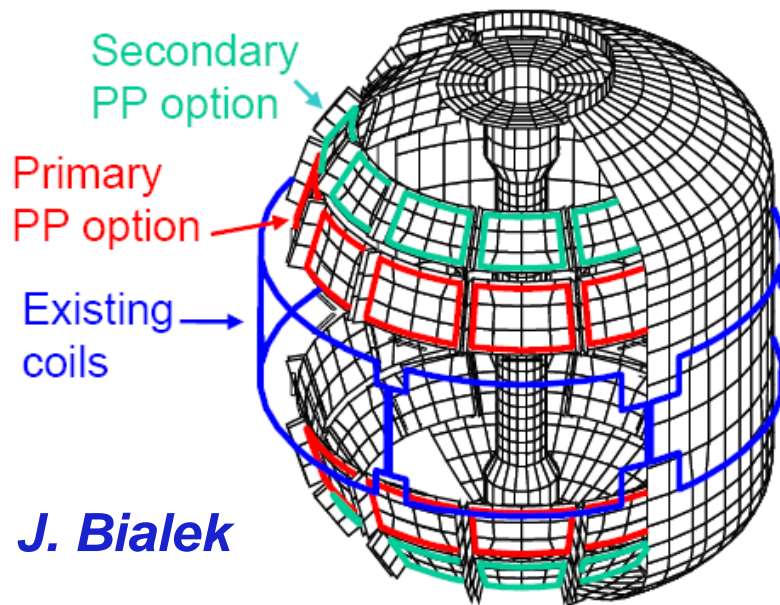
**B318, PPPL  
July 19, 2012**



*Culham Sci Ctr  
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Kyoto U  
Kyushu U  
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CIEMAT  
FOM Inst DIFFER  
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CEA, Cadarache  
IPP, Jülich  
IPP, Garching  
ASCR, Czech Rep*

# Motivation

- Opportunity for Non-axisymmetric Control Coil (NCC) may exist in NSTX-U in 3<sup>rd</sup> or 4<sup>th</sup> year operation
- It is important to motivate NCC by piling up physics analyses and justifying utilities in NSTX-U 5yr-plan documents
- We need coils, targets, and analysis plan



# Agenda

- Coil option and analyses, previously done for NSTX (S. Sabbagh)

- Discussion:

- Coil option (Primary and secondary, or new?)
- NSTX-U targets (A couple of cases from Stefan?)
- Analysis plan (and time frame?)

- 3.3.3.1. Non-axisymmetric Control Coil (NCC) to achieve:

*Tentative outlines in 5-yr plan documents*

- 3.3.3.1.1. Rotation control, and thereby RWM kinetic stabilization, error field correction, tearing mode stabilization
    - 3.3.3.1.2. RWM active control for significant multi-mode spectrum
    - 3.3.3.1.3. ELM control and stabilization
    - 3.3.3.1.4. Prediction for ITER 3D coil capabilities
    - 3.3.3.1.5. Simultaneous control for rotation, RWM, error field, TM, ELM
    - 3.3.3.1.6. IPEC, NTV, VALEN-3D, RWMSC codes will be actively used for 3D physics studies with NCCs

# Coil option

- Primary and secondary option?
  - Coil geometries are available (S. Sabbagh)
  - Will give the richest spectrum with existing 6 RWM/EF coils for tokamaks, and be tested first in high performance ST
    - 12-12 off-midplane internal coils + 6 midplane internal-like coils
    - MAST has 6-12 off-midplane coils + 4 external coils
    - Clean and rotating  $n=1-3$  is possible
    - Rotating  $n=4$  is possible (with higher  $n$  harmonics)
    - Standing  $n=5-6$  is possible
- Other options?
  - Possible to consider other technically valid options?
  - Possible for analysis in short-time frame?

# NSTX-U target plasmas

- How many targets in analysis?
  - Many targets are available (S. Gerhardt)
- High performance targets?
  - High non-inductive current fraction?
    - Important for plasma response
  - With a couple of NBI combinations?
    - Important for NTV, rotation, fast ions
    - Produce rotation and fast-ion profiles and do RWM kinetic calculations?
- High current and field?
  - $I_p=1-2\text{MA}$ ,  $B_T=0.5-1.0\text{T}$ ?
    - Important for coil currents, vacuum Chirikov calculations, etc

# Analysis plan

- Level of details : Possible utility? Or Sophisticated metric?
- Analysis:
  - RWM active control (J. Bialek)
    - VALEN3D, done for NSTX, most certain
  - Error Field Correction (J.-K. Park)
    - IPEC, clear, but weak impacts expected
  - NTV and rotation control (J.-K. Park, K. Kim)
    - NTV, torque is clear, but rotation profile is difficult to predict
  - RWM kinetic stabilization (J. Berkery)
    - MISK, secondary, rotation profile is needed
  - ELM control and stabilization (?)
    - TRIP3D (or VAC3D) done for NSTX, clear, but only for necessary condition
  - Simultaneous control (?)
    - $n=1+3$  correction + RWM active control + rotation control
  - Prediction for ITER 3D coil capabilities (?)
  - Other analysis (?)