Physics design of cryo-pumps for NSTX-U

September 18, 2011 – J. Menard

Some proposed design constraints:

- Pump(s) on outboard divertor
  - Insufficient space on inboard
- Minimize reduction of vacuum chamber volume
- Retain position of passive plates + plate supports
  - Minimizes impact on stability, system cost, schedule
- Modification of divertor plates allowed
- Addition of baffle plates allowed
  - Length, position, angle, shape should be optimized
- Design to pump range of divertor configurations:
 - Standard divertor, high flux expansion (snowflake), …

Example cryos on DIII-D, NSTX geometry

- DIII-D low and high-δ bottom cryos and baffles

- NSTX divertor, passive plates, and supports
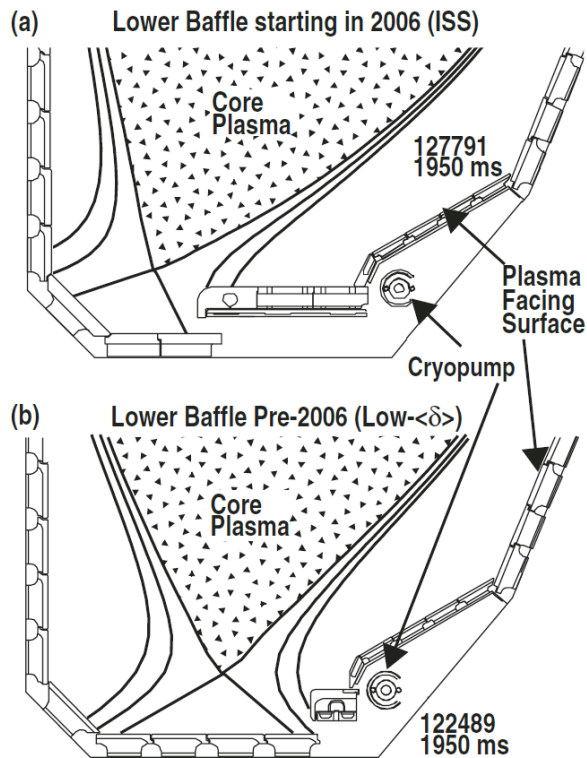
Figure 2. An elevation-view of the lower divertor region of the DIII-D vacuum vessel showing, both, the current ISS baffling (a) and the pre-2006 low-$\langle\delta\rangle$ baffling (b). EFIT equilibria of a typical RMP discharge for each configuration is superimposed to highlight changes to plasma divertor operations.
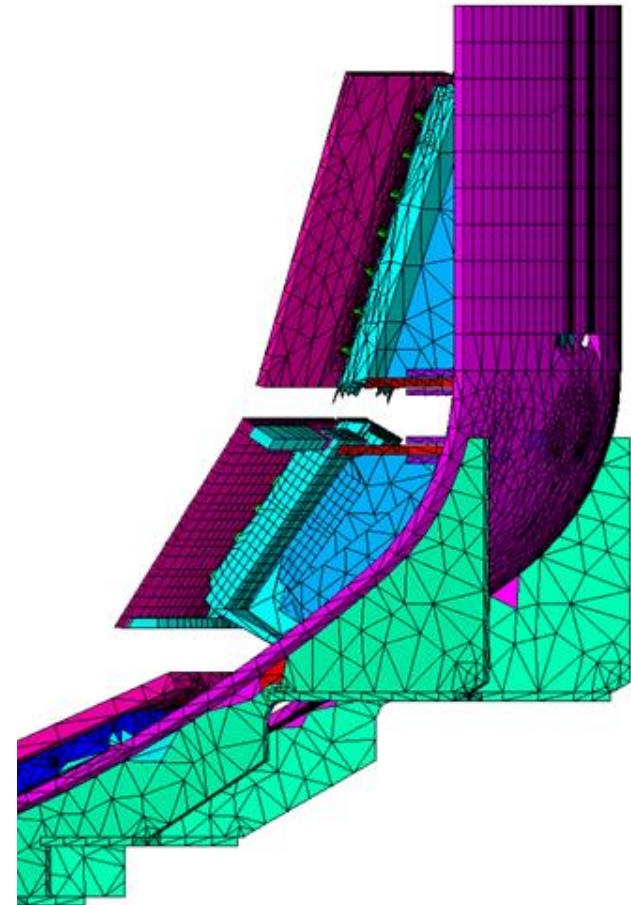
Some example NSTX OBD cryo options:

- Minimal change to divertor, close chamber volume at bottom of secondary plates

- Shorten divertor plates, minimal changes/attachments to passive plates, close plenum at baffle OD

- Largest chamber volume, large cryo radius and area, no direct line-of-sight to cryo-pump

- Need more/better ideas!

A

B

C

Cryo-pump
Baffle plate
Gas seal, chamber boundary
Shortened divertor plate

3
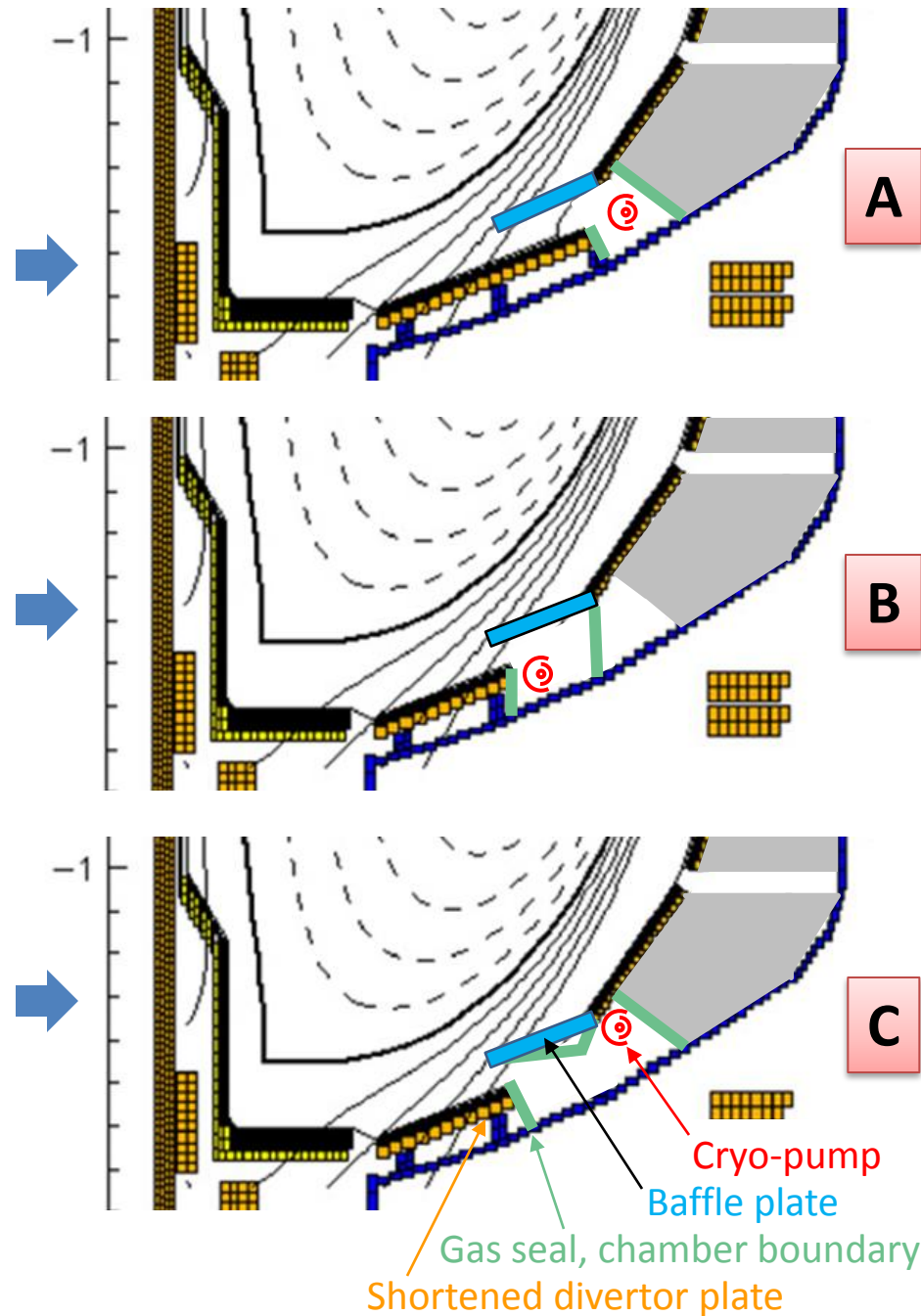
Scope, team, and deliverables

- Scope and team:
    a. Lead/oversee physics design – Rajesh M., Jon M.
    b. ID shapes and scenarios to be assessed for pumping – Stefan G., Vlad S., all
    c. Generate/ID free-boundary NSTX-U equilibria – Stefan G., Jon M.
    d. NSTX divertor particle flux data for NSTX-U design – Mike J. + others
    e. Pumping modeling – John C., LLNL, Daren S.
    f. Iterate once or twice, choose best pumping chamber configuration - all

- Deliverables from PAC-29 presentation (for PAC-31):
    1. Higher heating power: P_{NBI}=10 MW (maybe even higher?)
    2. D, χ consistent with I_P = 2 MA, B_T = 1 T operation
        - Present values from 1.2 MA, 0.55 T, 6 MW case
    3. Up/down symmetric double-null calculation
        - Only lower divertor considered presently
    4. Compatibility with power exhaust and snowflake
    5. Actual NSTX-U PFC geometry and space constraints
    6. Iterate for compatibility with core scenario calculations

- Deadline: mid-January 2012