FIR and mm-Wave Density Monitoring, Feedback Control and Fluctuation Diagnostics for NSTX

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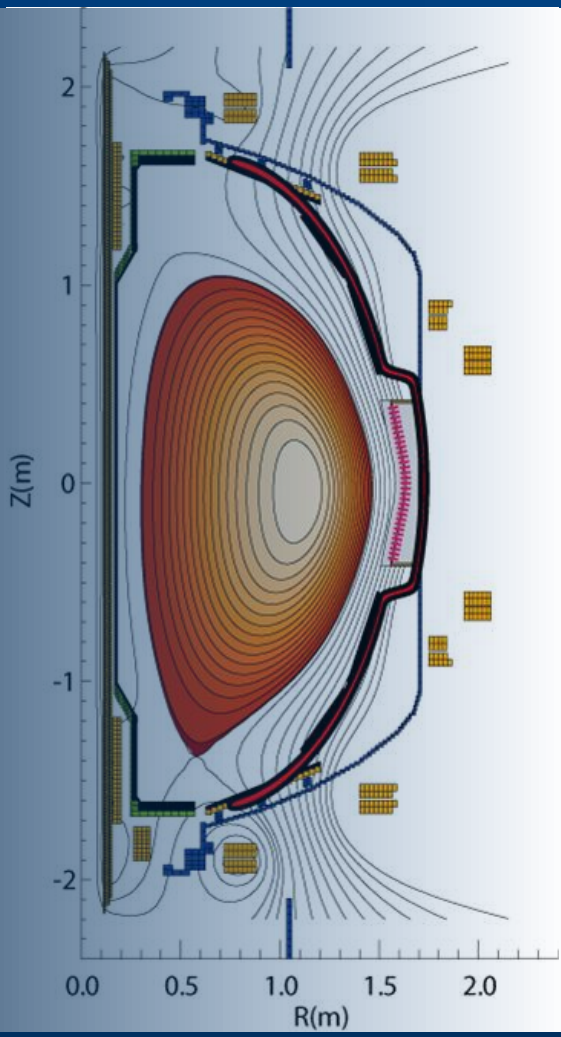
July 26th, 2012

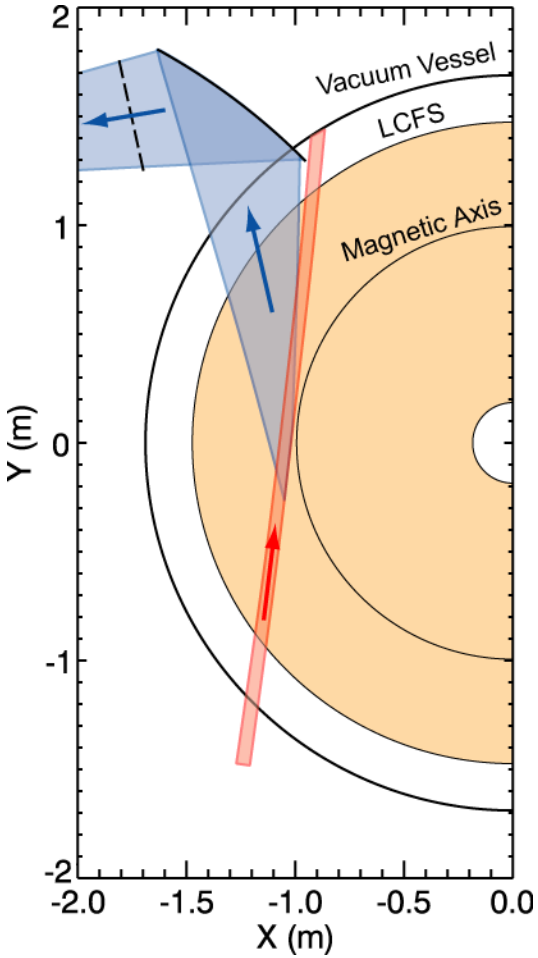


PPPL

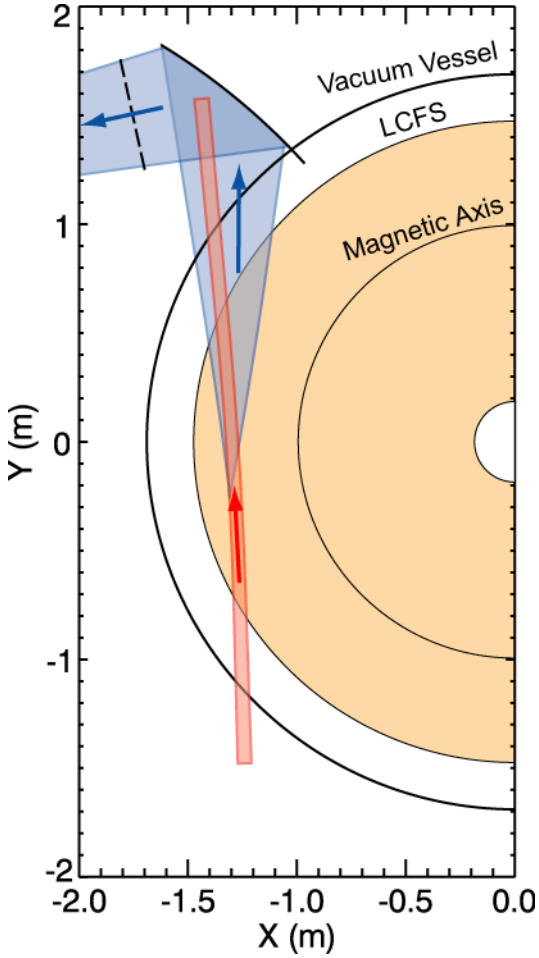
D.M.R.C
Davis MM-Wave Research Center

High-K Scattering System

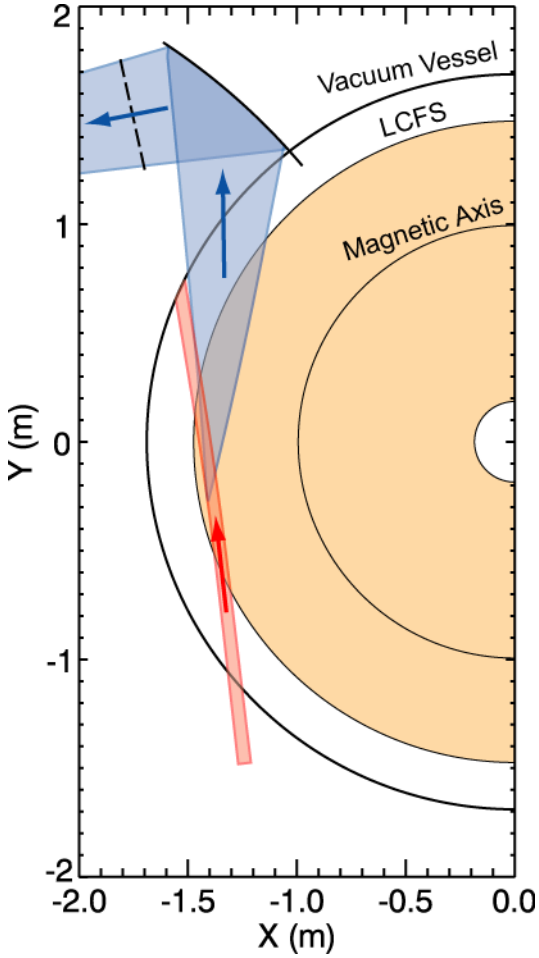
Inboard ρ = 0.05
$k_\perp \rho_e$ up to 0.7



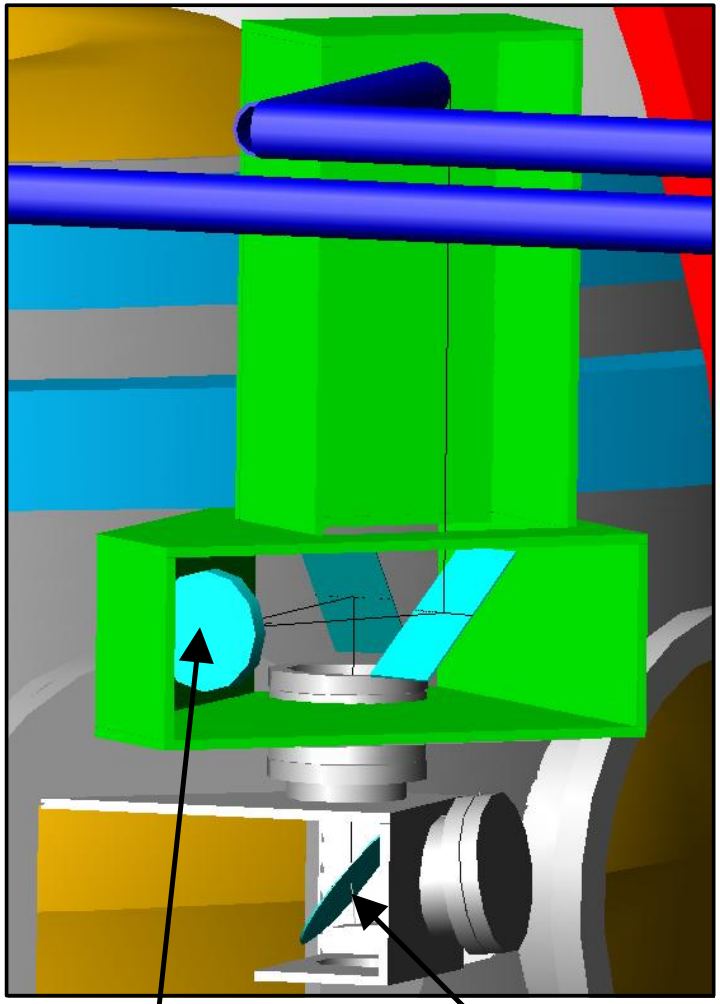
Intermediate ρ = 0.4
$k_\perp \rho_e$ up to 0.4

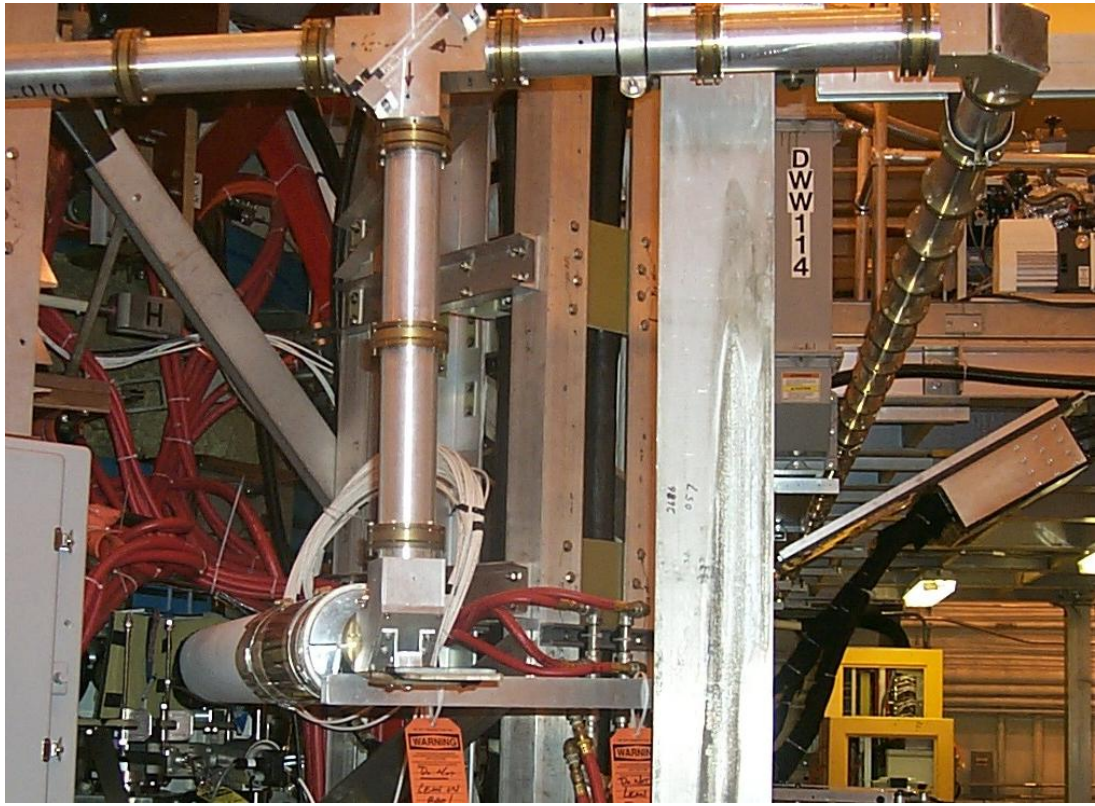


Outboard ρ = 0.75
$k_\perp \rho_e$ up to 0.4

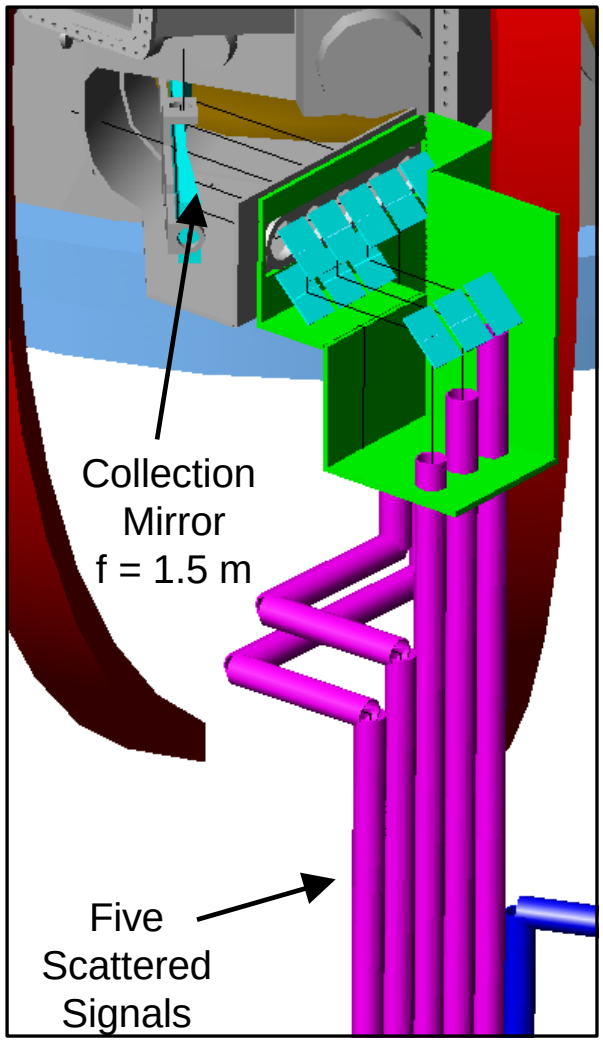


High-K Scattering System: Launcher

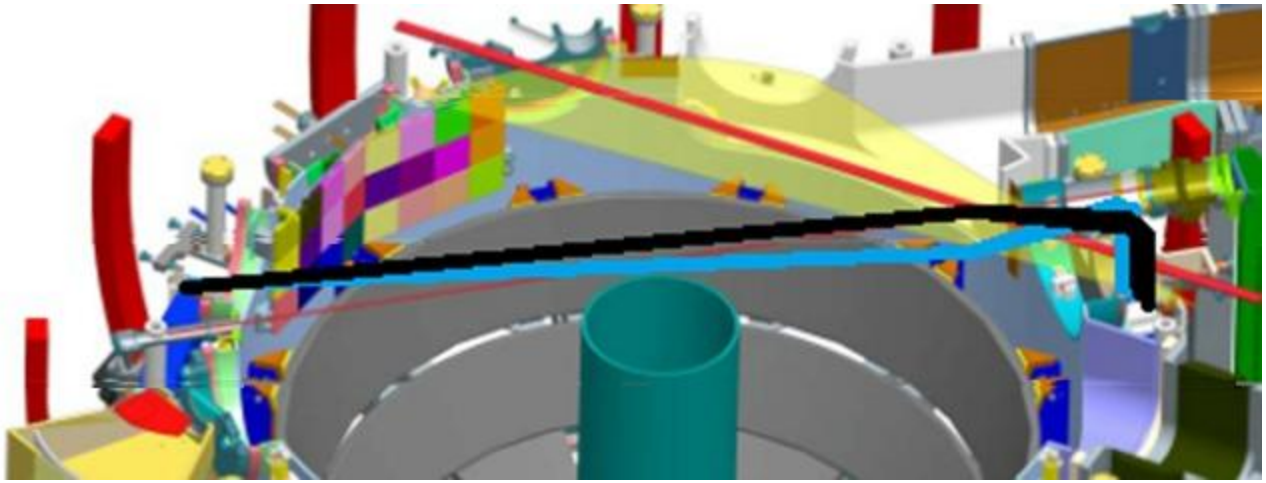


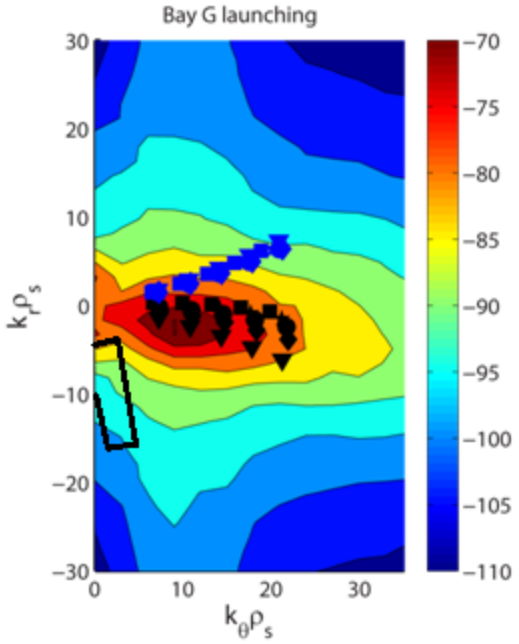


High-K Scattering System: Receiver

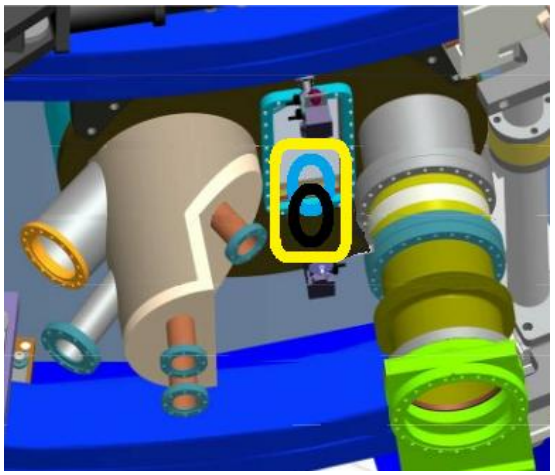


600 GHz Poloidal Scattering System

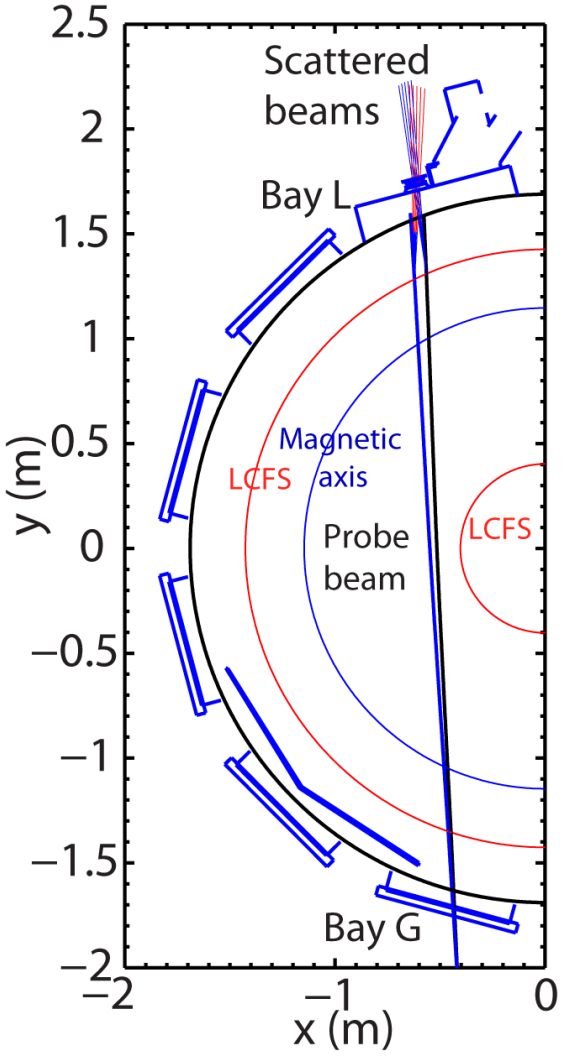




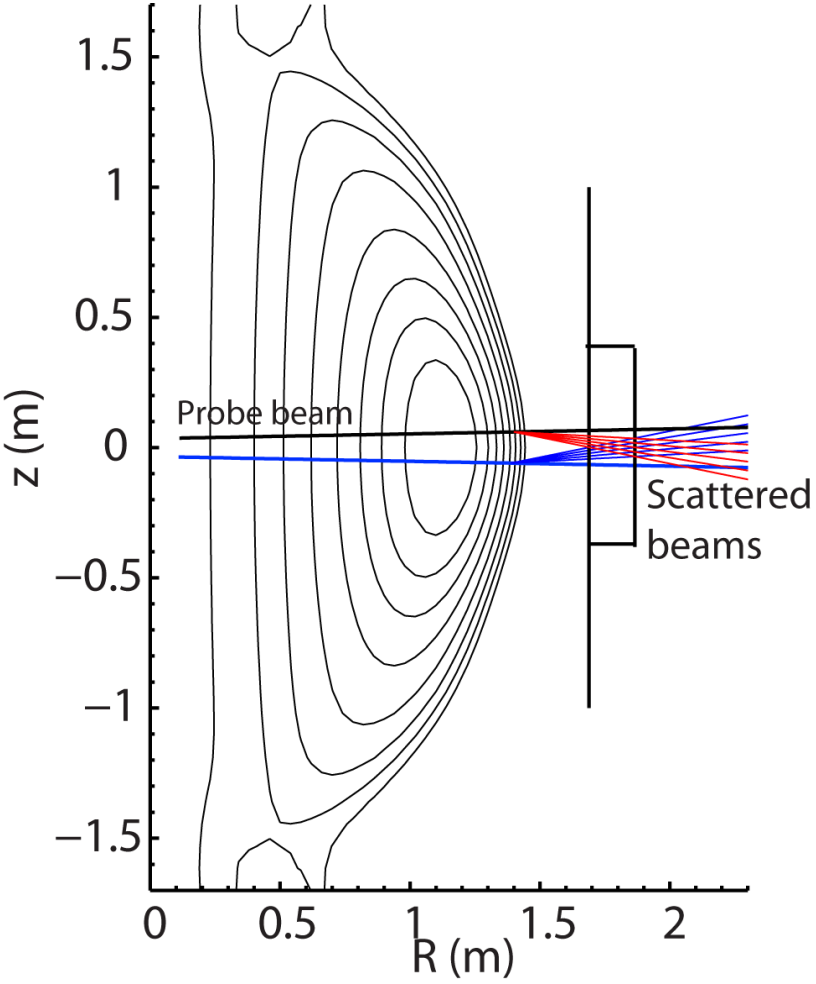
- Replace 280 GHz high-k toroidal scattering system with a ~600 GHz poloidal scattering system
- CO_2 laser pumped FIR laser to provide ~100 mW of probe power at 600 GHz
- Probe beam launched from Bay G
- Scattered beams are collected through collection mirror at Bay L



Poloidal Scattering Geometries

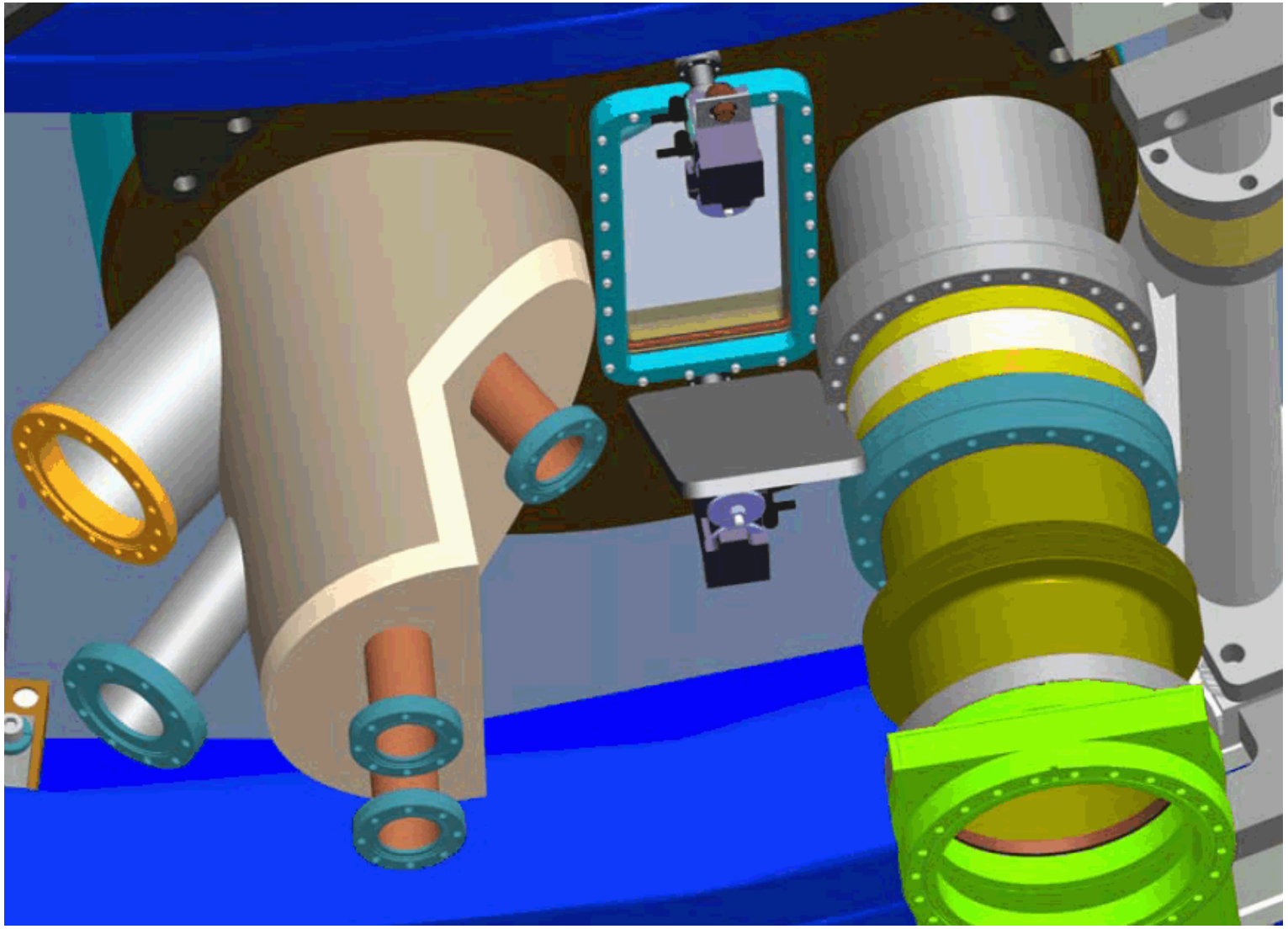


Top View



Side View

New Bay L Port Cover



Poloidal Scattering System Goals

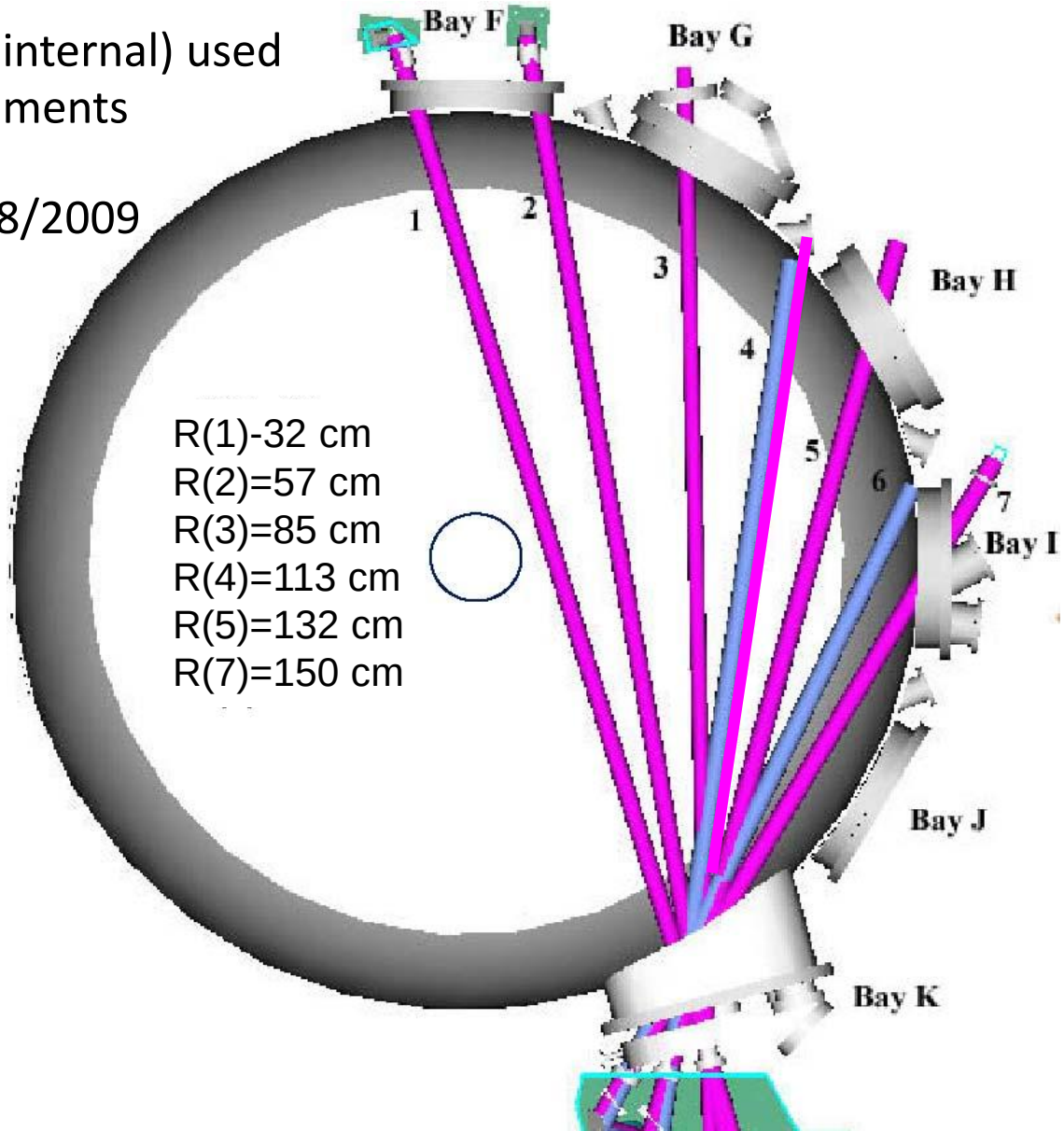
- Upgrade Goals
  - Relocate entrant/exit ports

Entrance	Beam dump/detector
Bay G (preferably midplane port)	Bay L

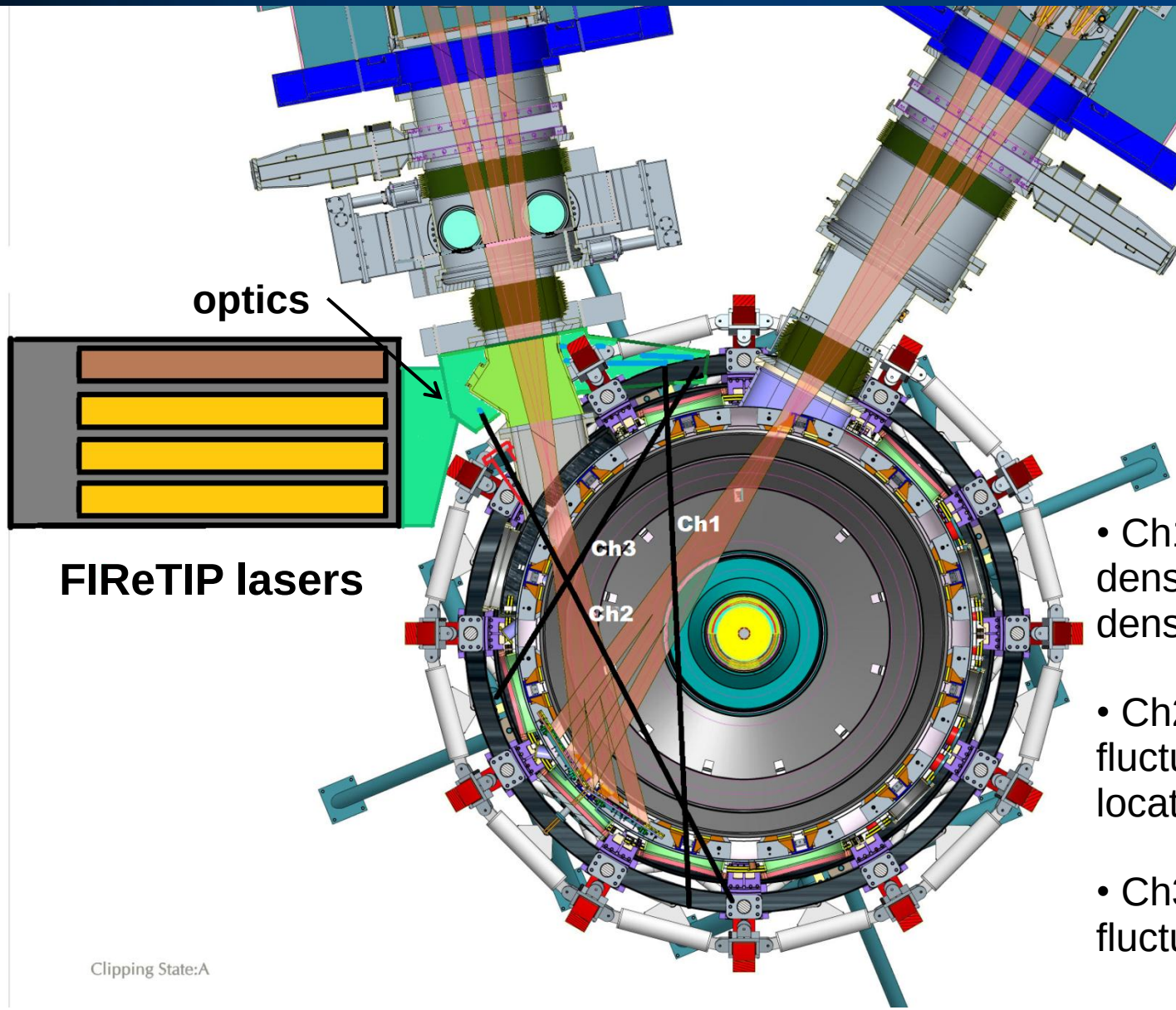
  - Increase probe beam frequency from 280 to 600 GHz for improved high-k resolution
  - Increase beam power for better SNR
  - Replace solid state 280 GHz LO with higher power FIR laser at 600 GHz
  - Steerable beam trajectory to sample poloidal and radial density fluctuations
- Increased radial and poloidal wave number coverage
- Greater spatial coverage
  - Design a 5 to 8 channel receiver system

Far InfraRed Tangential Interferometer/ Polarimeter (Before Upgrade)

- Retro-reflectors (5 external, 2 internal) used to make double-pass measurements
- 6 channel operation as of 2008/2009
- Channels #1 and #2 used as overall density monitors
- Channels #3, #4 and #5 monitor core fluctuations
- Channels #5 and #7 monitor edge fluctuations

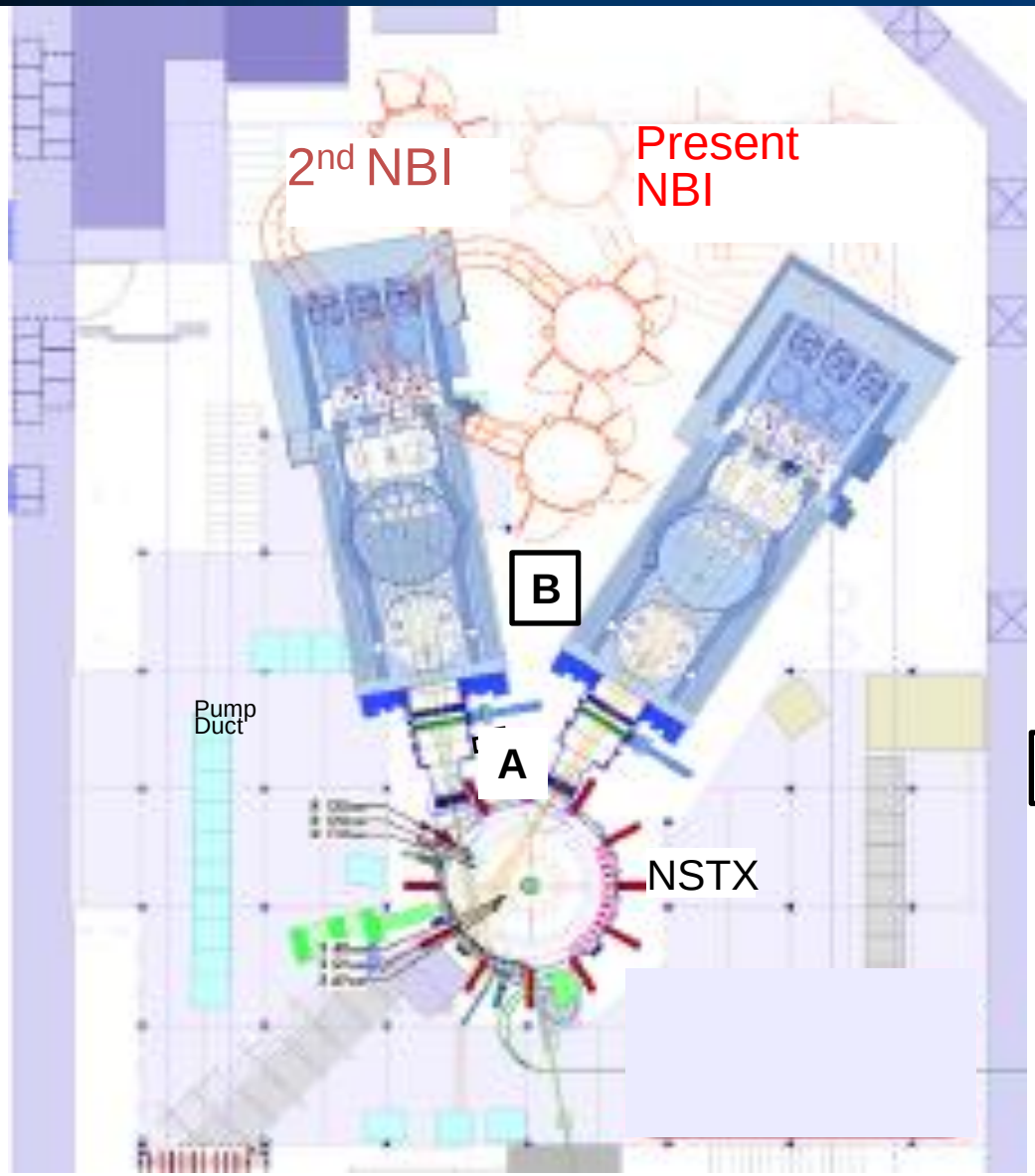


FIReTIP System (After Upgrade)



- Ch1 : used as overall density monitors & density feedback control
- Ch2 : monitor core fluctuations (MHD location)
- Ch3 : monitor edge fluctuations

Locations of Poloidal Scattering and FIReTIP Diagnostics after Upgrade



A: poliodal scattering optics & FIReTIP optics

B: FIReTIP lasers and receivers location (three level stack on 10’x2’ footprint)

C: poloidal scattering source location (outside NSTX test cell, in the same area where high-k source was located)

FIReTIP System Goals

- Upgrade Goals
  - Reconfigure laser entrant/exit port locations

	Entrance	Exit
Ch 1	Beside NBI on Bay K	Bay F
Ch 2	Bay L	Bay I
Ch 3	Bay L	Bay B

  - Better SNR with increased beam power
  - Higher efficiency mixing of LO and output FIR

Poloidal Scattering System Status

- Current Status
  - Rebuilding and optimizing CO_2 and FIR lasers
    - Investigating methyl flouride versus formic acid as lasing mediums
    - Maximizing beam power
      - ≈150 W CO_2 laser
      - ≈100 mW FIR laser
  - Cost benefit analysis of new laser system

FIReTIP System Status

- Current Status
  - Refurbishing and optimizing CO_2 , FIR, Stark lasers
  - Remodeling Stark laser cavity for improved LO coupling
  - Optics redesign (TBD, restricted space will require multi-level platform for lasers and optics)

Microwave Imaging Reflectometry

- Higher B_T operation (0.5 T → 1.0 T) allows broader X-mode accessibility
- Scattering window at Bay L has a large clear aperture (34cm x 12.7cm) able to accommodate imaging optics
- Possibility of swapping high-k receiver and MIR system
- Back-end electronics would be identical to planned DIII-D system