Upgrade plan of the tangential system and poloidal high-k measurement on NSTX

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Introduction

- Experience of the present ~1mm system on NSTX
  - Ample S/N at the highest k warrants to investigate higher k*s*
  - Limited radial coverage (near the edge and core region) with full coverage of wavernumbers
- Upgrade plan for the Tangential system and system for Poloidal wavenumbers
  - Upgrade the tangential system up to $k_r \sim 50\ cm^{-1}$
  - Scattering system capable up to $k_\theta \sim 50\ cm^{-1}$
- Probe beam source and detection technology advancement
  - Stable and powerful laser sources between 1.5 ~ 3 THz
  - Recent advances in detection technology in space and atmospheric application enable a scattering system based on THz laser (0.1 ~ 0.2 mm source)

Collective scattering

- Scattered Power is

$$P_s = \frac{c}{4\pi} < |\overline{E}_s(R,t)|^2 >_T A_r$$

$$\overline{E}_s(\overline{R},t) = \frac{r_0}{|R|} \mathrm{Re} \int n_e(\overline{r}', t')[\hat{s}x(\hat{s}x\overline{E}_{io}(\overline{r}')]e^{i(\omega t' - \overline{k}\cdot\overline{r}')_i} dV_s$$

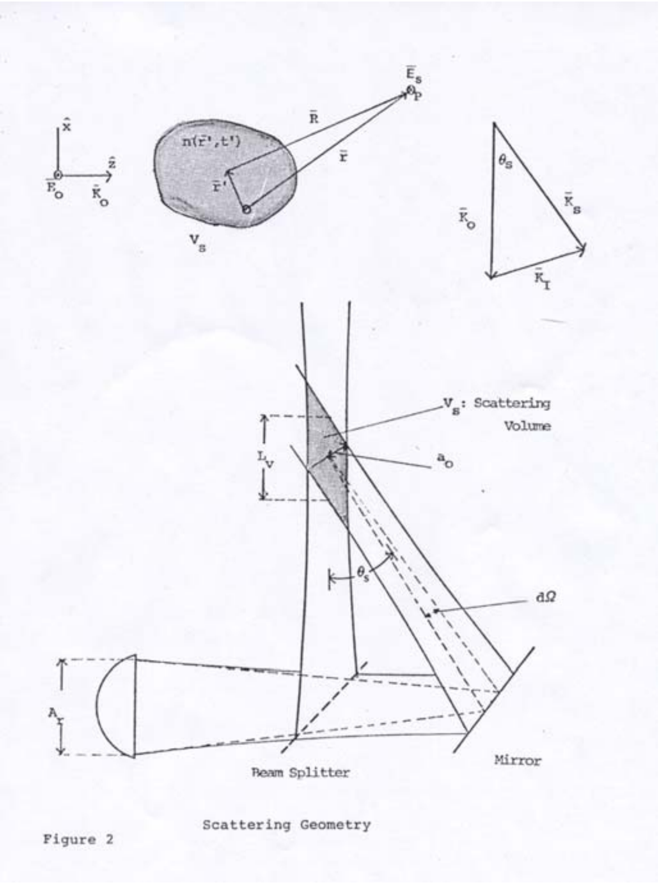
  - For the case of a coherent fluctuation

$$P_s = \frac{1}{4} r_0^2 \lambda_0^2 P_i L_v^2 \tilde{n}^2$$

    Here, P_i is the incident power, r_0 is the classical electron radius, λ_0 is the probe beam frequency, L_v is the scattering length varies with k

  - Bragg condition sets the scattering angle

$$k_w = 2k_o \sin\theta_s$$



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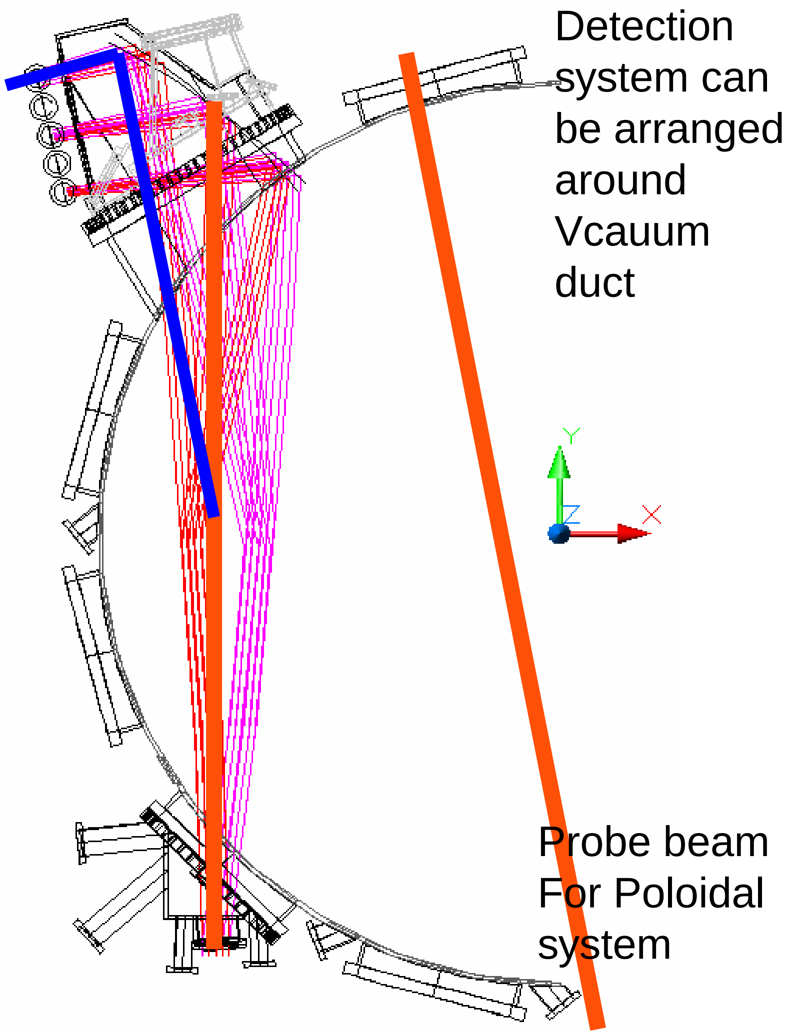
Upgrade plan for the Tangential system

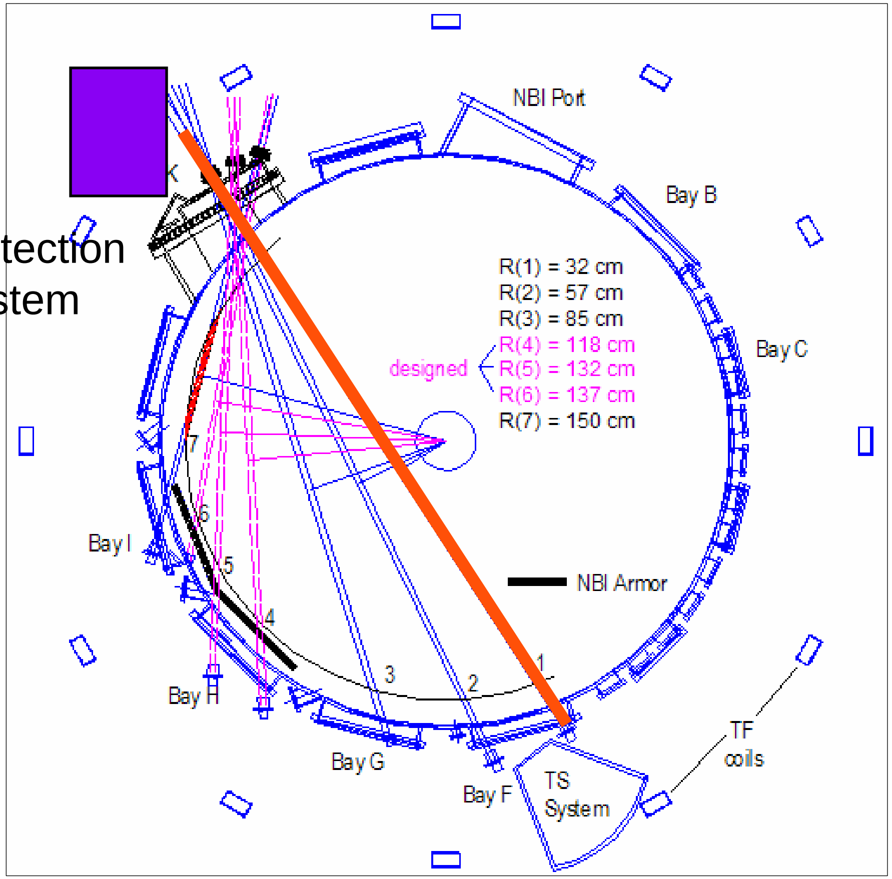
- Wider range of spatial coverage and wave-numbers
  - k_r up to ~ 50 cm^{-1}
  - Cover areas near the r/a ~ 0.5 with a full range of wavenumbers
  - Minimum impact on the present system
- Choice of the probe beam
  - Scattering angle will be 10 degree at k_r~50 cm^{-1} for 0.2 mm source
  - Reduction of S/N due to scattering power dependence on wavelength ($p_s \propto \lambda_o^2$)
  - Laser power is higher (~factor of 10) than ~ 1mm source

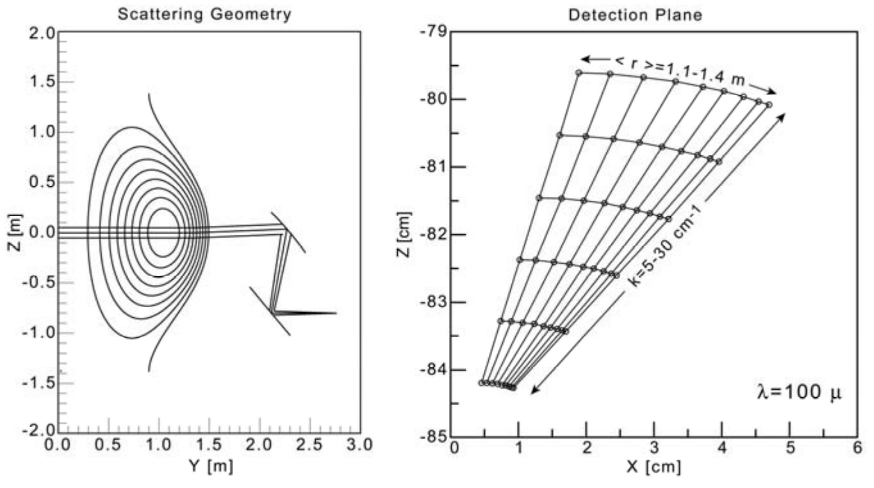


Poloidal high-k system

- Objective of the poloidal system
  - Full range of spatial coverage
  - k_θ up to ~ 50 cm^{-1}
  - Minimum impact on the port and in-vessel work
- Possible configuration
  - Launch the probe beam through FIReTIP ch#1.
  - Detection system will be close to the right side of the FIReTIP tower.

Detection system





Conclusion

- Choice of probe beam source - laser can be operated next to the ~1mm source and will be shared for two systems
  - CH_3OH (119 μm) or CD_3OD (185 μm) lasers
  - Power level is ~ 1W
- Detection system
  - Recent THz detection technology
    - Super low noise mixers (sensitivity is comparable to the present ~1mm regime)
    - JPL, CA and Radiometer GMbH, Germany
- Tangential system and poloidal system
  - Need modification of the Bay-k window and new detection system
  - Poloidal system shares the FIReTIP channel #1 beam line through polarizer and detection system can be installed near the FIReTIP tower
  - Wavenumber coverage for both k_r and k_θ can be up to ~50 cm^{-1} with a wide spatial coverage
  - S/N is slightly worse than the present ~1 mm system