

Modeling of Polarimetry for \tilde{B} Measurements on NSTX

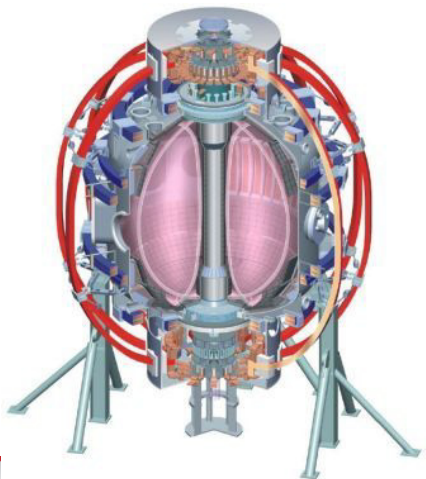
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NSTX Research Forum



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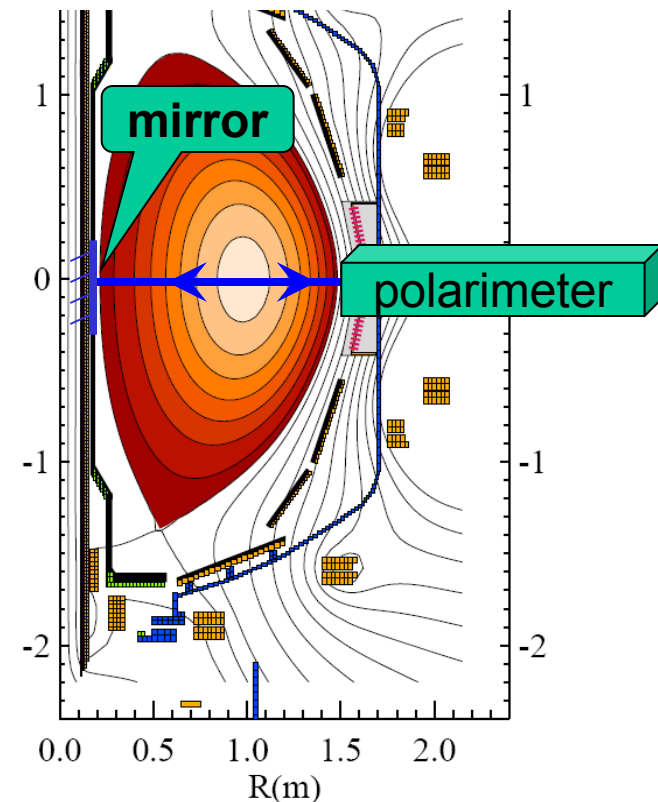
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Planned polarimeter for NSTX can directly measure $\tilde{\mathbf{B}}$

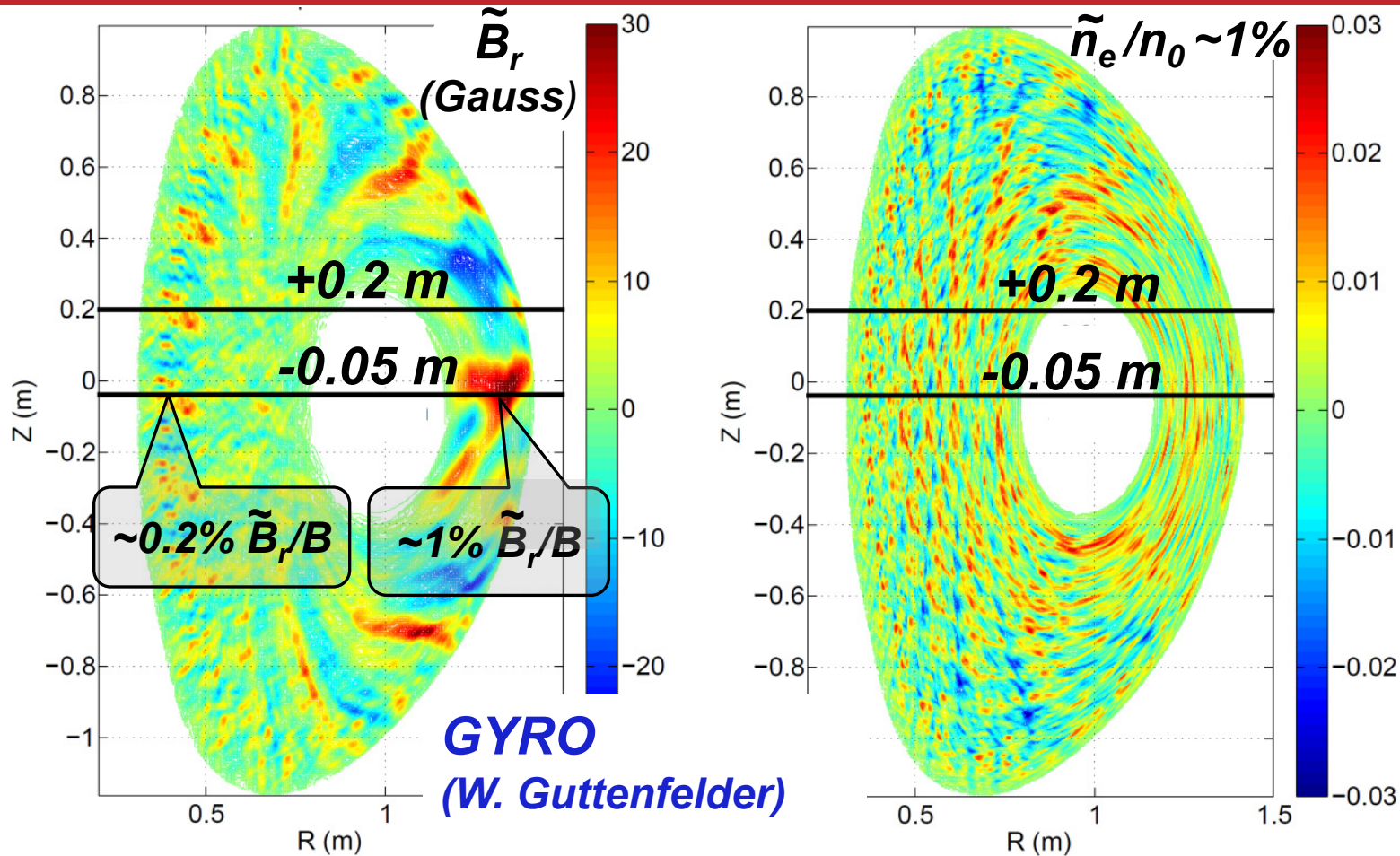
- Polarimetry measures change of wave polarization (ψ) caused by magnetized plasma
- Polarimetry on NSTX can investigate $\tilde{\mathbf{B}}$ of various modes
 - Microtearing modes (T&T milestone R11-1)
 - Tearing modes
 - Alfvén eigenmodes
- 288 GHz polarimeter planned for NSTX
 - Horizontal retroreflection from Center Stack
 - Expect subdegree phase resolution at 1 MHz sweeping rate
 - **Laboratory testing underway**

Faraday rotation:

$$\psi \propto \int n \underline{\mathbf{B}} \cdot d\underline{\mathbf{l}}$$
$$\tilde{\psi} \propto \int \bar{n} \tilde{\underline{\mathbf{B}}} \cdot d\underline{\mathbf{l}} + \int \tilde{n} \bar{\underline{\mathbf{B}}} \cdot d\underline{\mathbf{l}}$$

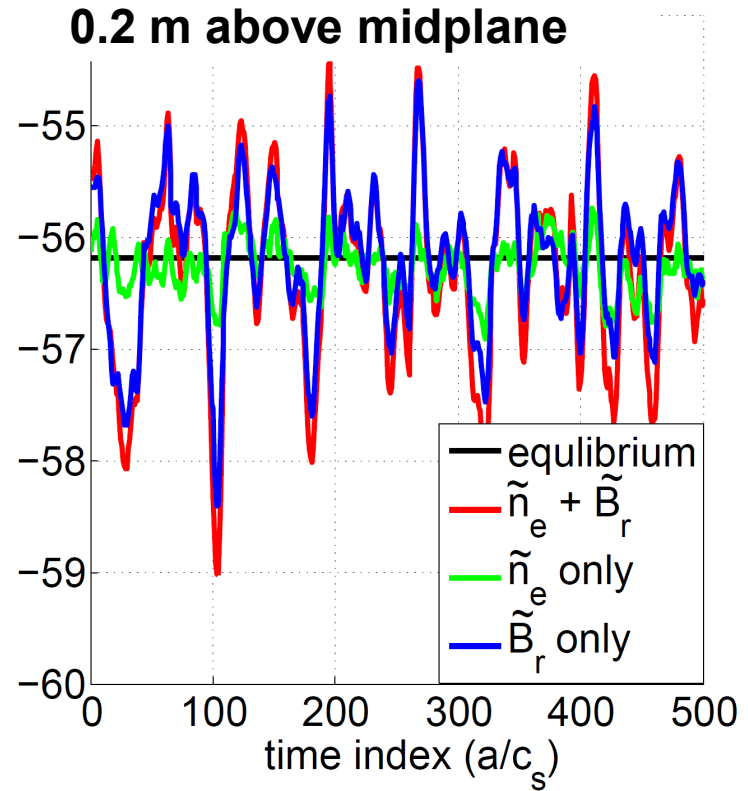
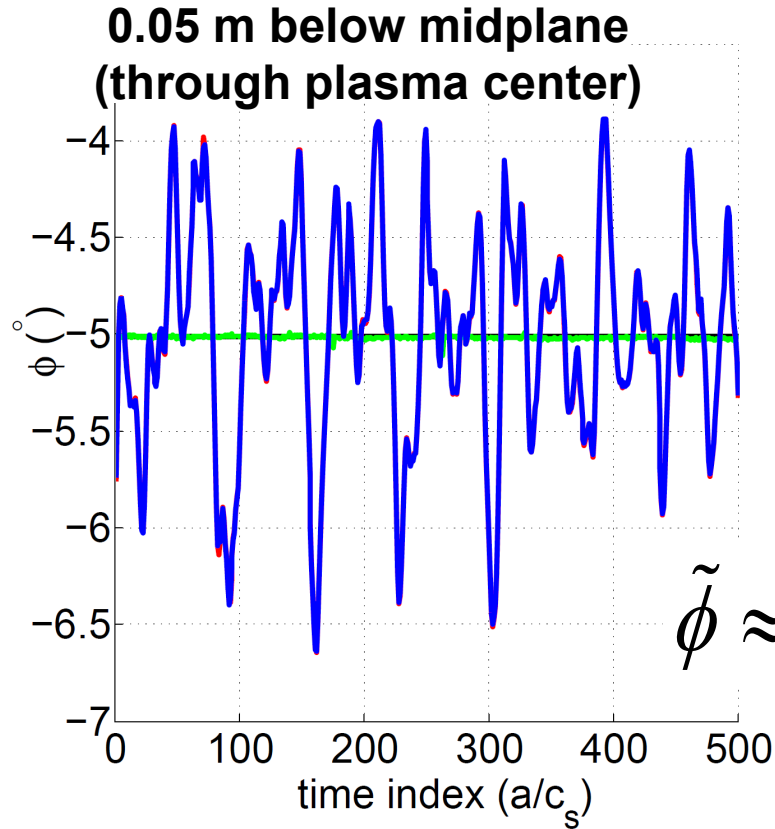


Modeling used to evaluate polarimetry sensitivity to microtearing modes



- \tilde{B}_r and \tilde{n}_e of microtearing modes from GYRO simulations
- Chord heights varied to evaluate polarimetry sensitivity to \tilde{B}_r , \tilde{n}_e respectively

Polarimeter sensitive to primarily \tilde{B}_r for chords near plasma center



- $\tilde{\phi} \sim 1\text{--}2^\circ$, expected to be detectable

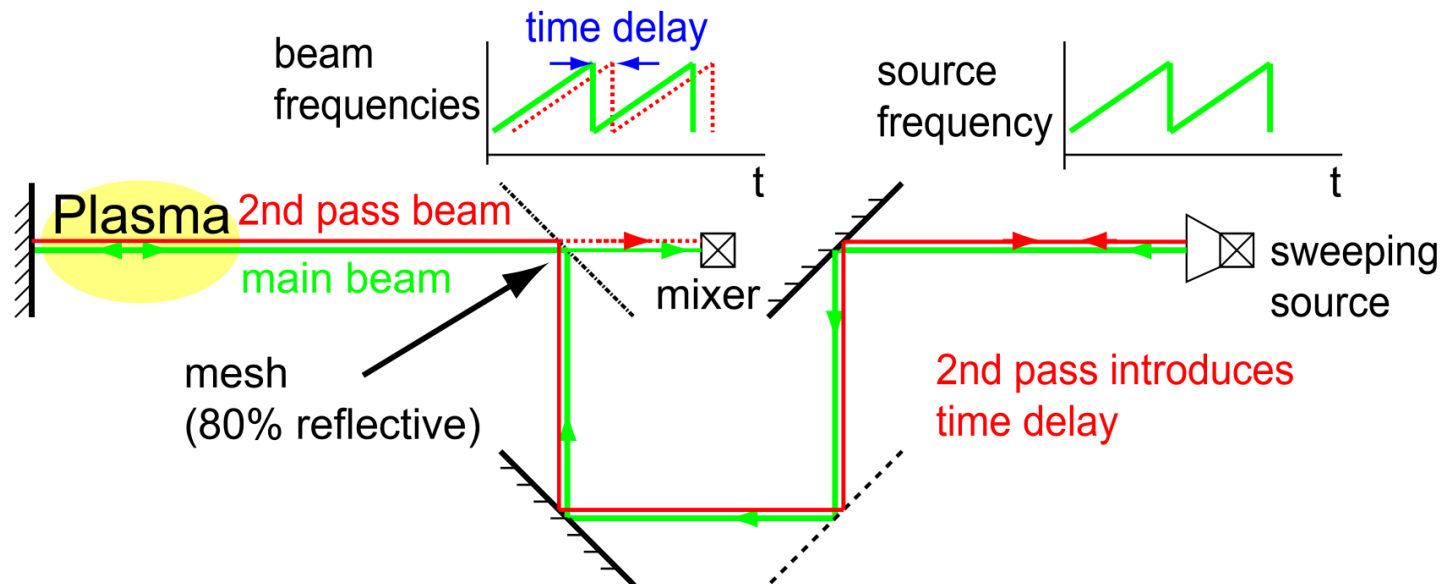
$$\tilde{\psi} \propto \int \bar{n} \tilde{\underline{B}} \cdot d\underline{l} + \int \tilde{n} \bar{\underline{B}} \cdot d\underline{l} \quad \bar{\underline{B}} \cdot d\underline{l} \sim 0$$

for chords near plasma center

Time-line for polarimeter installation

- Current status:
 - Phase noise too large (a few degrees)
 - Cause understood
 - Multiple reflections between millimeter-wave source and center stack
 - Awaiting new hardware (quasi-optical isolator)
- March/April:
 - Perform laboratory tests to reassess phase noise
 - Establish readiness for installation (sub-degree phase noise)
- May/June:
 - Install on NSTX in preparation for upcoming run

Backup#1: Multiple reflections degrade phase resolution



- Microwaves returning from plasma mostly (80%) channeled to source and partially reflected back to plasma (i.e. 2nd pass)
 - 2nd pass beam strongest among multiple reflections
- Interferometry effect is caused by 2nd pass beam
 - Phase of beating signal with main beam very sensitive to path length change ($\lambda \sim 1 \text{ mm}$)
 - Path length changes due to mechanical vibration and plasma turbulence

Backup#2: Optical isolation expected to improve phase resolution

