New Magnetic Diagnostics

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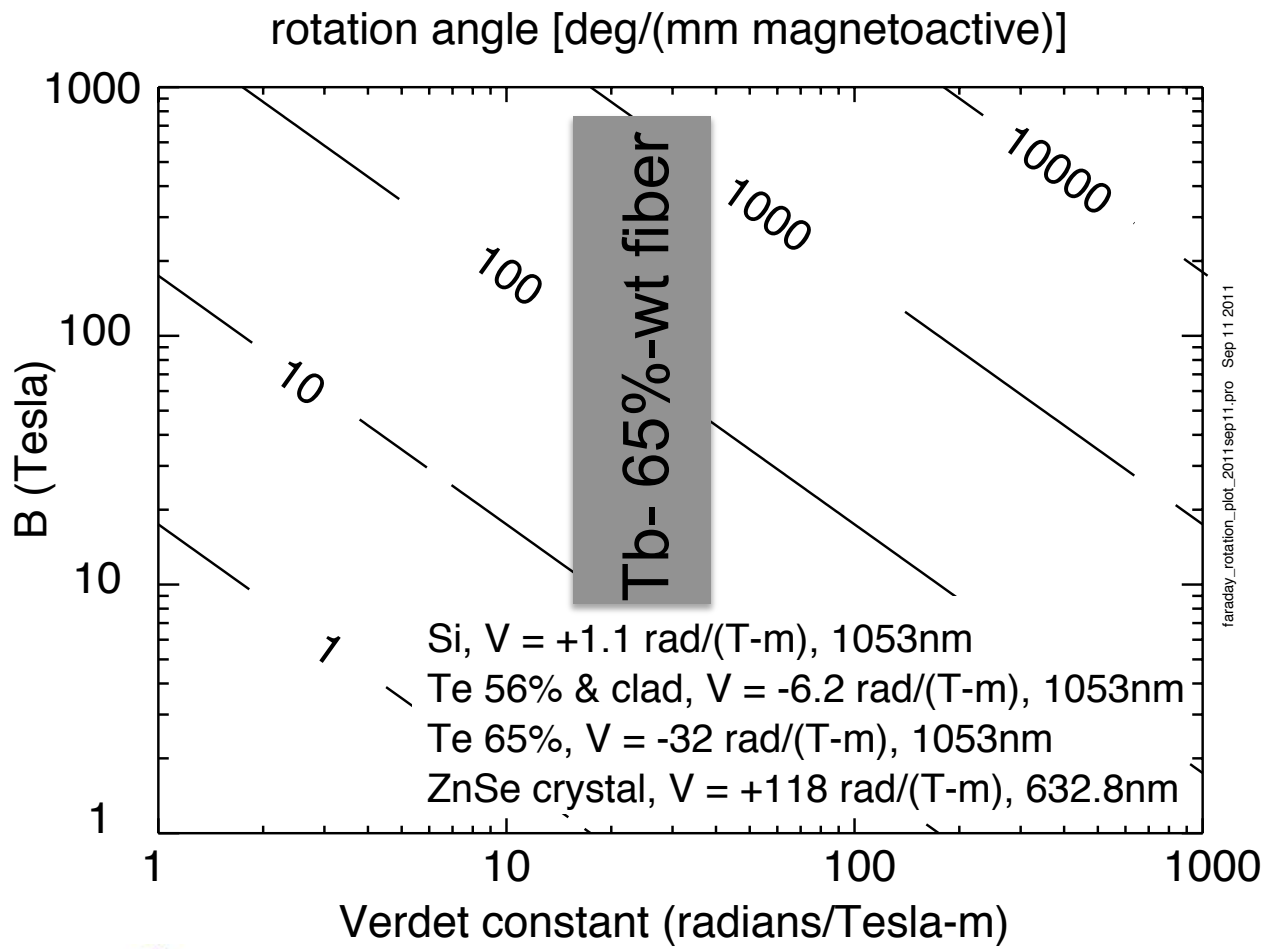
abstract

One Grand Challenge for Magnetized High Energy Density is to Invent and refine techniques to measure the magnetic fields that transform fundamental features of magnetized HED plasmas (possibly ICF capsules too). We briefly describe several techniques that could transform our ability to measure magnetic fields.

MHED Grand Challenge

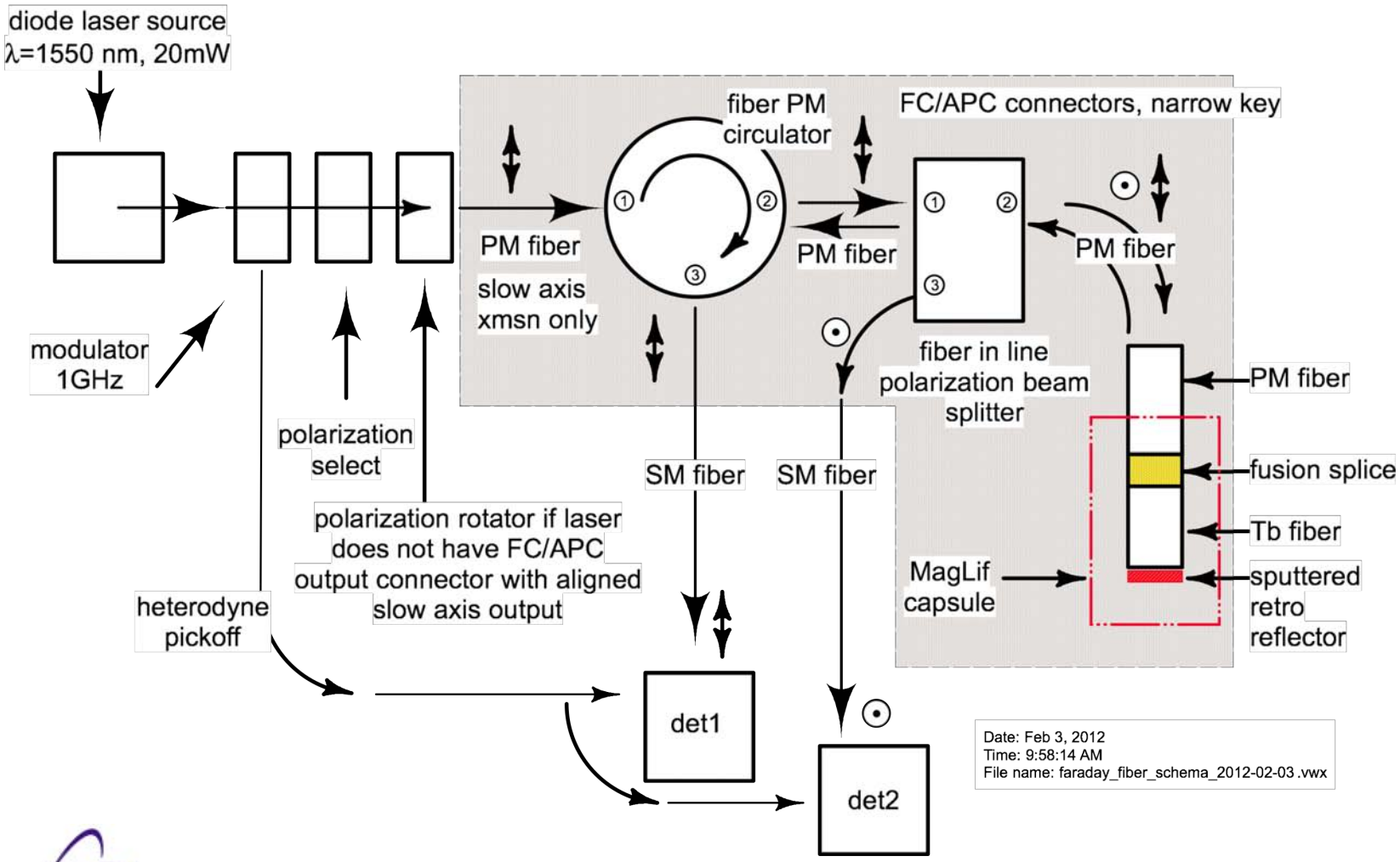
Invent and refine techniques to measure the magnetic fields that transform fundamental features of magnetized HED plasmas (possibly ICF capsules too).

Optically coupled magnetic field measurements

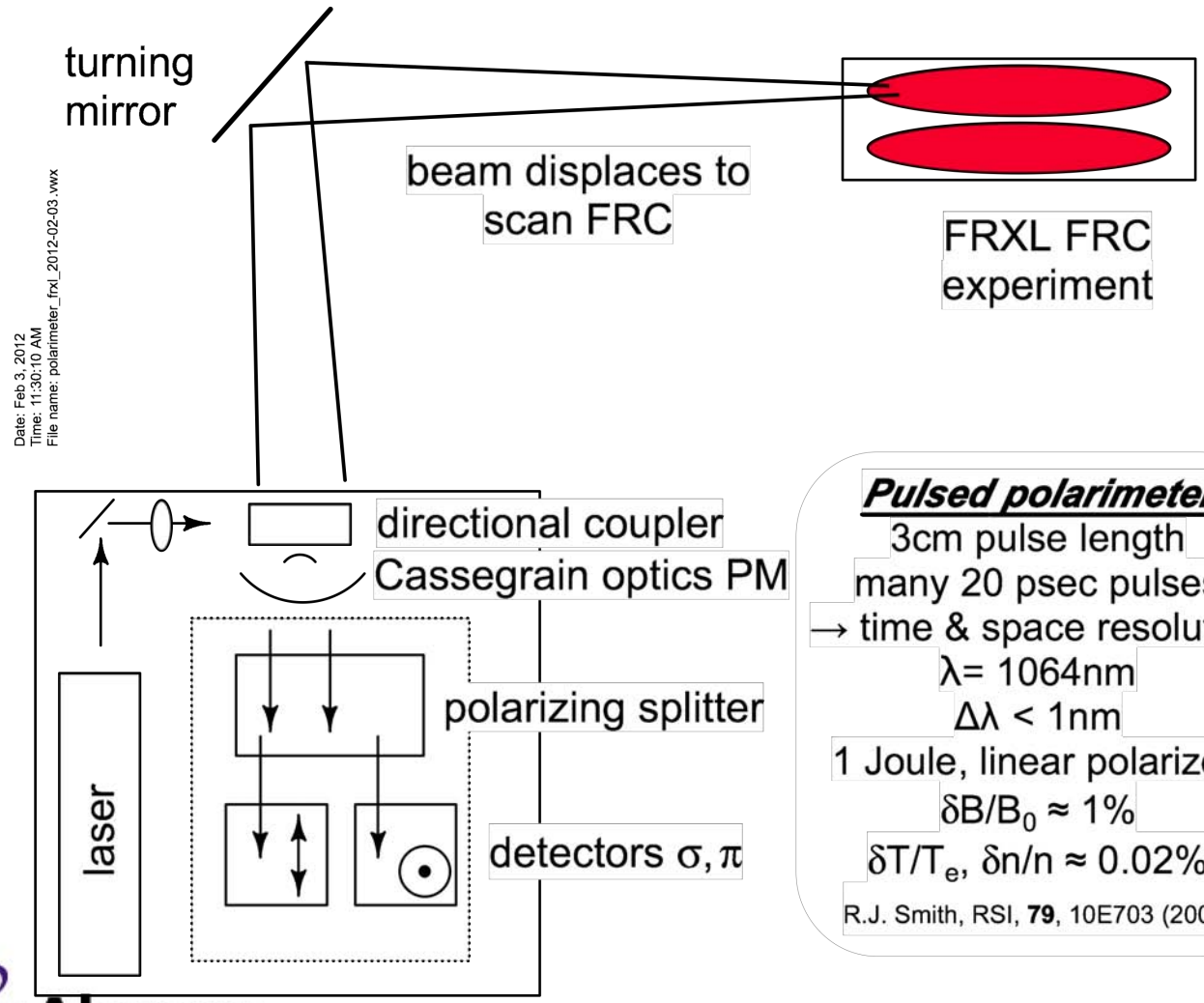


- 3mm Tb fiber → 30 deg rotation at 10 Tesla
- Measure 0.5-1000 Tesla
- Signal can be optically coupled without electrical noise, quadrature measurement with heterodyne modulation

Faraday Tb fiber: MaGLIF vacuum B



Pulsed LIDAR polarimeter FRXL: R. Smith



Pulsed polarimeter

3cm pulse length

many 20 psec pulses

→ time & space resolution

λ= 1064nm

$\Delta\lambda$ < 1nm

1 Joule, linear polarized

$\delta B/B_0 \approx 1\%$

$\delta T/T_e$, $\delta n/n \approx 0.02\%$

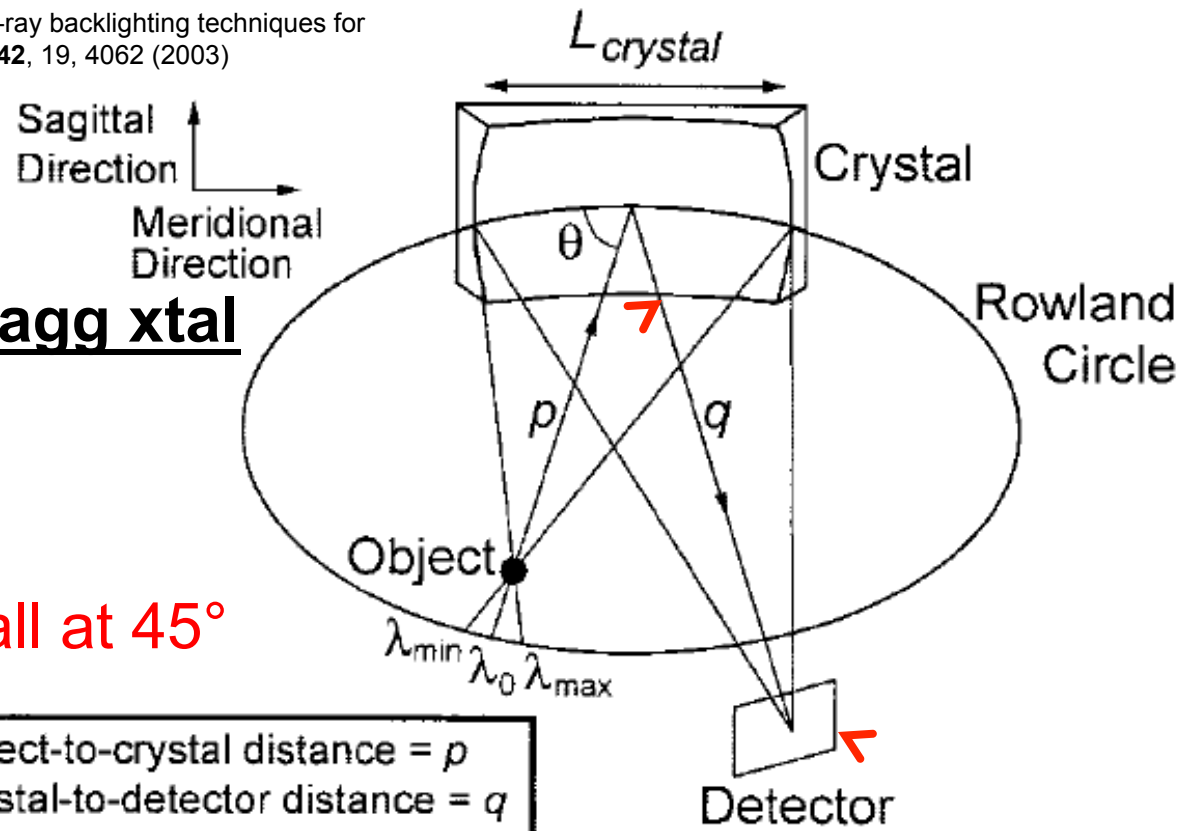
R.J. Smith, RSI, **79**, 10E703 (2008)

Bragg reflecting optics: X-ray Faraday

- Short X-ray pulses & Bragg reflecting optics can open new wide ranging applications in pump-probe experiments
  - ***Faraday rotation***
  - Spectroscopy
  - Thomson scattering
  - Diffractometry
  - Imaging

Possible Faraday rotation with plasma

Sinars et al, Evaluation of bent crystal x-ray backlighting techniques for the Sandia Z machine, Applied Optics, **42**, 19, 4062 (2003)



Toroidally bent Bragg xtal

- X-ray backlight
- Collimated
- Monochromatic
- π polarized ≈ small at 45°
- X-ray source
- Faraday rotn

Object-to-crystal distance = p
Crystal-to-detector distance = q
Crystal bending radius = R
Rowland Circle radius = $R/2$

X-rays for Faraday rotn in optically thick plasma