NSTX

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2-Dimensional ion flow measurement

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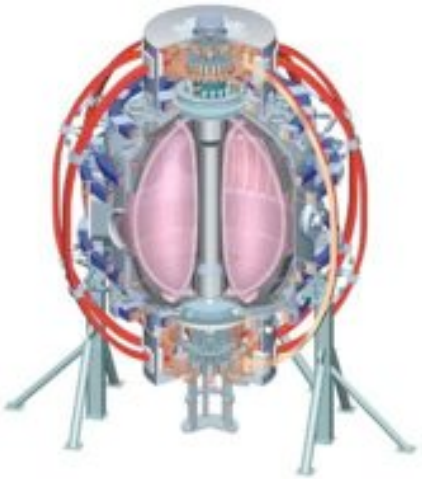
N.Nishino, Hiroshima Univ.

S.Paul, L.Roquemore, R.Kaita

and the NSTX Research Team

2010 NSTX Research Opportunities Forum
PPPL
Dec. 1-3, 2009



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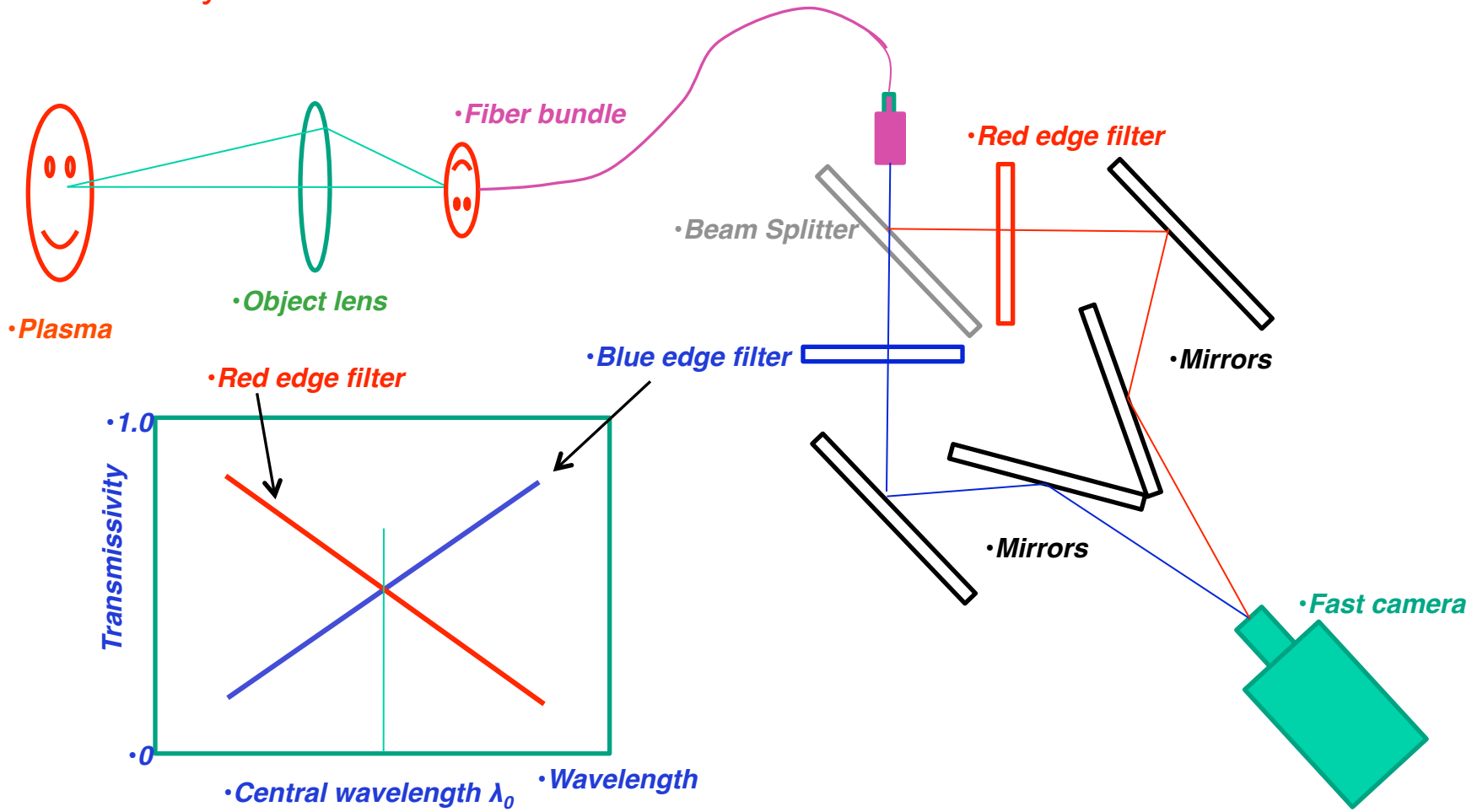
SWIFT for 2-dimensional flow measurements

- SWIFT (Shifted Wavelength Interference Filter Technology) was first proposed by S. Paul.
- Original SWIFT is a point measurement.
  - However, it has the possibility for enhancement to perform 2-dimensional measurements.
- Under US-JAPAN collaborative activity N. Nishino proposed to work on development of 2-D SWIFT capability.
  - Includes making optical paths equal for “red” and “blue” shifted wavelength measurements.
    - Can be used with one or two fast visible cameras.
- Brief report presented on development status and future plans.

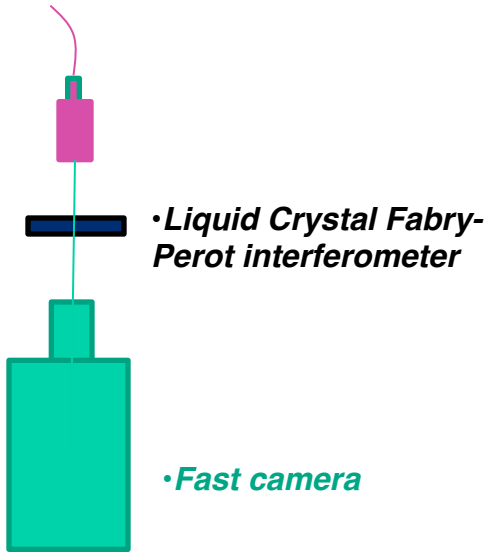
Optics for 2-d measurement system

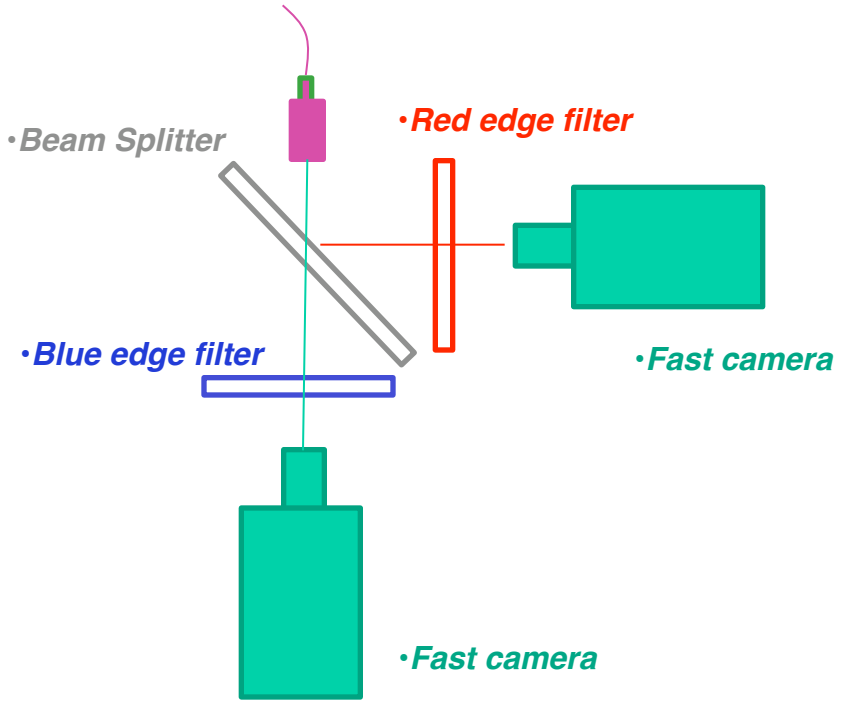
- Measurement requires two special filters (red and blue).
  - Concept quite simple.
    - System assembled and tested in 2009.



Other optical configuration possibilities

- One camera with liquid crystal Fabry-Perot (FP) interferometer insures data from same field-of-view (left)
  - Alternate in time between “red” and “blue” wavelengths.
  - Issue is relatively low transmission through FP interferometer.
- Two cameras with “red” & “blue” filters also possible (right)
  - Issues include matching camera characteristics and synchronization for high time resolution.





Status

- Test in 2009 with prototype confirmed adequacy of light intensity from He II emission to perform measurement.
- Image though one filter was out of focus
  - Filter surface roughness suspected
- Problems to be solved
  - Characteristics of special filters
    - Transmissivity dependence on wavelength should be precisely specified.
      - Should be provided with 0.005 nm resolution.
      - Surface roughness should be sufficiently small for adequate image quality.
  - Fast cameras
    - Need minimum of 12-bit resolution.
      - High cost of fast cameras may mean two cameras are not affordable.
        - » Two NAC Image Technology GX-1 Plus cameras are ~$60,000.
        - » Two Photron SA5 cameras are ~$120,000.
      - Note that liquid crystal Fabry-Perot interferometer costs as much as camera
        - » ~$50,000.

Future plans

- Consider changing from He to Li filters
  - Optical system operation confirmed in principle.
  - Intensity of He light not sufficient for measurements on every shot.
- Determine if filters with transmissivity that is not linear function of wavelength are still usable.
  - Transmissivity ratio of two filters should be single-valued function of wavelength.
- Perform tests of modifications and upgrades using intense light source.
  - Testing will no longer depend on NSTX plasmas.
  - Installation on NSTX will follow after completion of diagnostic development.

Schedule

- 2010: Confirmation of operation of two-filter system
- Selection of two filters for NSTX plasmas
- Development of codes for image analysis
- 2011: Installation of optical system to NSTX
- Obtaining and analyzing ion flow data
- 2012: Modifications for high space and time resolution
- <2013: Measurement of ion flows in presence of blobs and/or filamentary structures