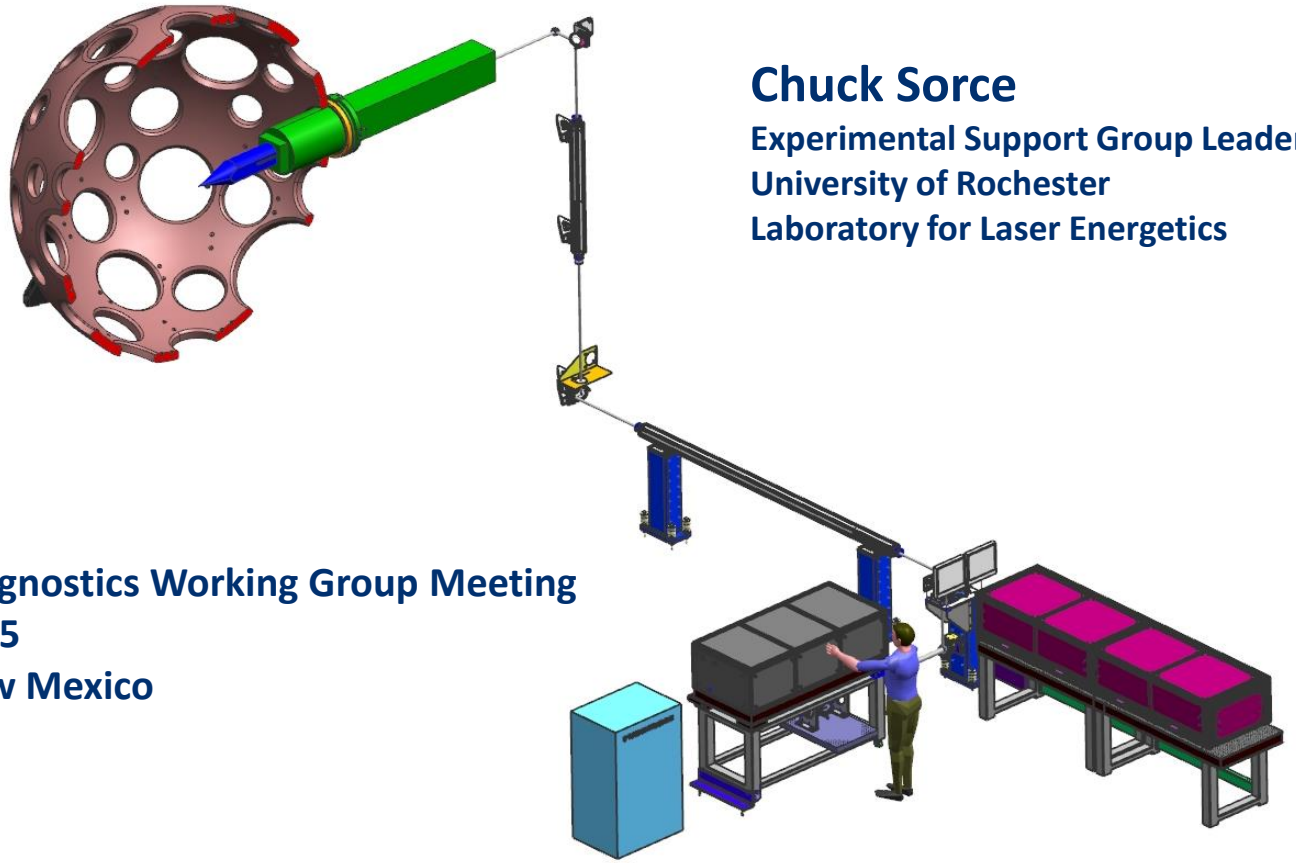
OMEGA EP's Streaked Optical Pyrometer



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Contributors

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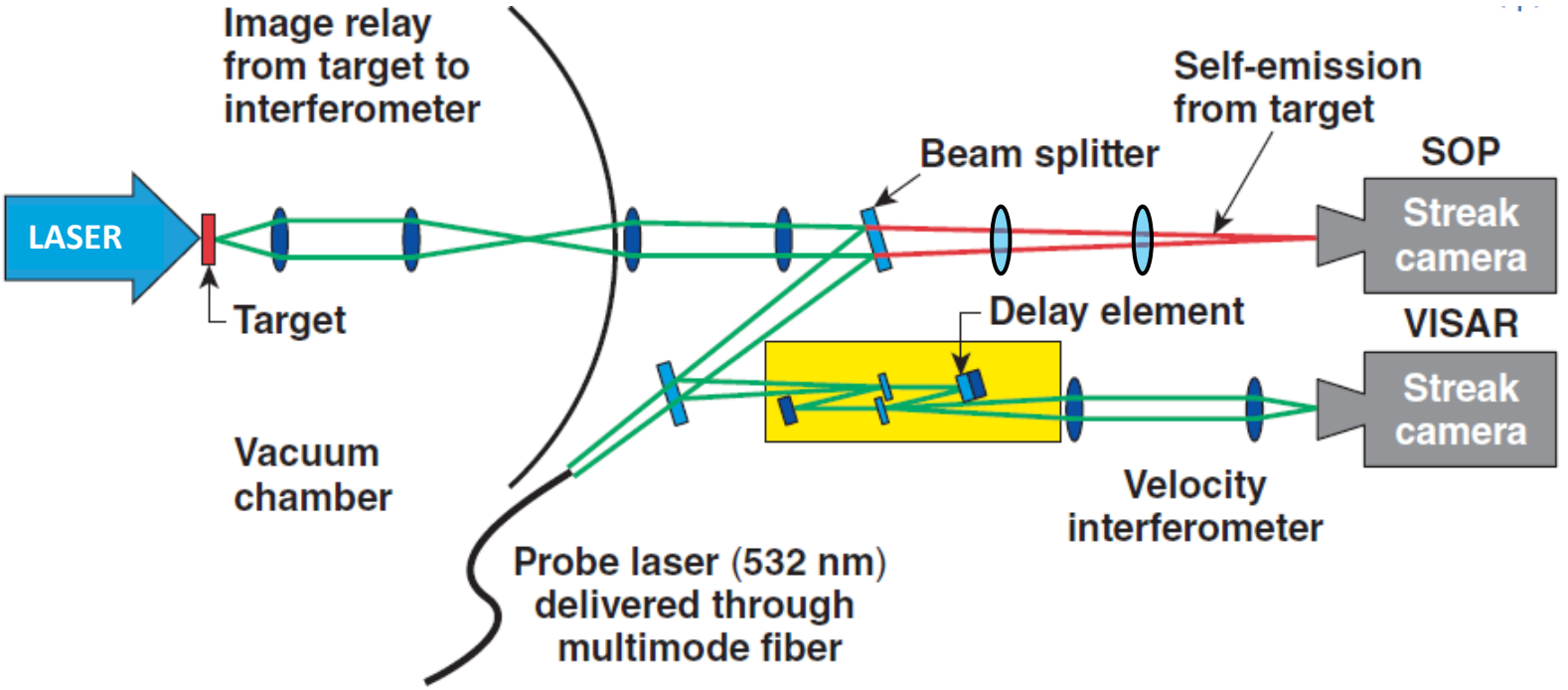
OMEGA EP has added a streaked optical pyrometer diagnostic to the VISAR line of sight

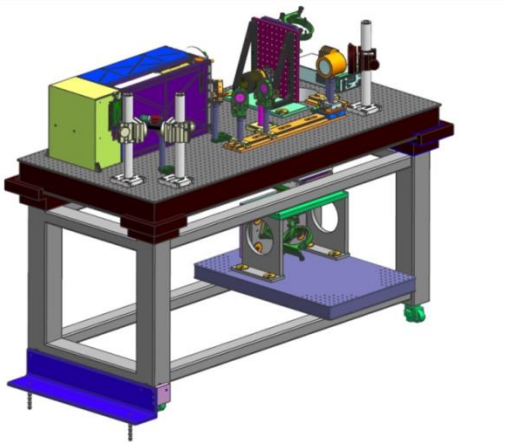
- The OMEGA EP Streaked Optical Pyrometer (SOP) diagnostic is based on the successful OMEGA 60 design
- The OMEGA EP SOP has been cross-calibrated to the absolutely calibrated OMEGA 60 SOP system using dedicated target shots
- Direct absolute calibration of the OMEGA EP SOP is planned for FY16
- Preliminary designs to improve the SOP optical transport to improve the calibration have been completed

OMEGA EP's SOP diagnostic design was based on the existing OMEGA 60 system



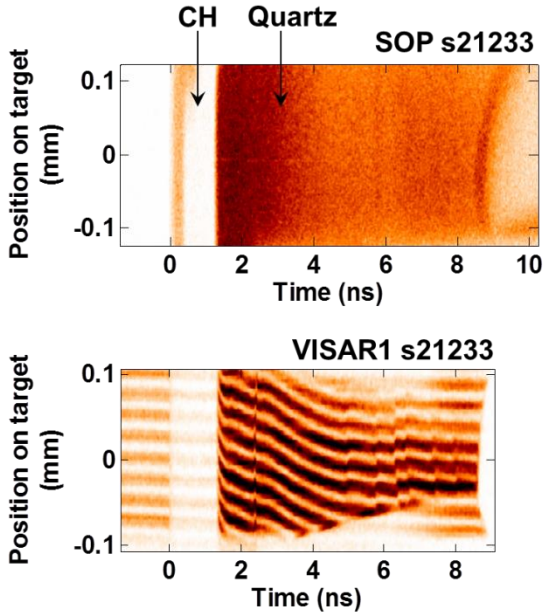
- 590- to 850-nm light is imaged onto a streak camera
- Spatial and temporal data are collected simultaneously with a velocity interferometer system for any reflector (VISAR)
- The brightness temperature is inferred from self-emission intensity using the relative calibration derived from the absolutely calibrated OMEGA 60 SOP

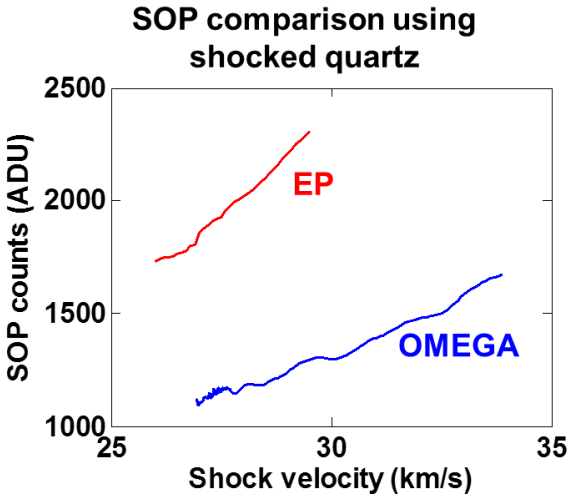
OMEGA EP's SOP was incorporated with minimal changes to the VISAR diagnostic



*OCM = Optical Calibration Module

OMEGA EP's SOP has been cross-calibrated to OMEGA 60's system using quartz target shots



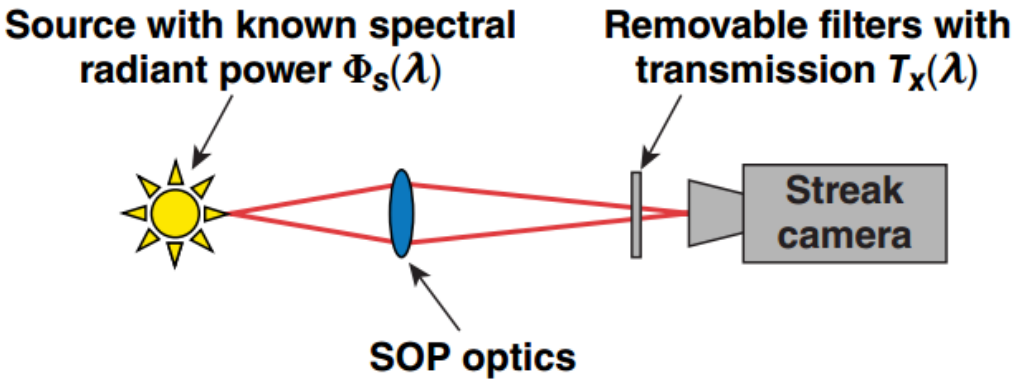


- VISAR and SOP data from quartz target shots on EP and OMEGA were compared
- Brightness temperatures for the OMEGA EP shots were inferred* using the results of the OMEGA SOP calibration
- Differences in the SOP sensitivities are attributed to:
  - The VISAR probe beam dichroic mirror transmission differences
  - Number and quality of mirrors and lenses in the optical relays
  - Photocathode sensitivity differences

*D. G. Hicks et al., Phys. Rev. Lett. 97, 025502 (2006).

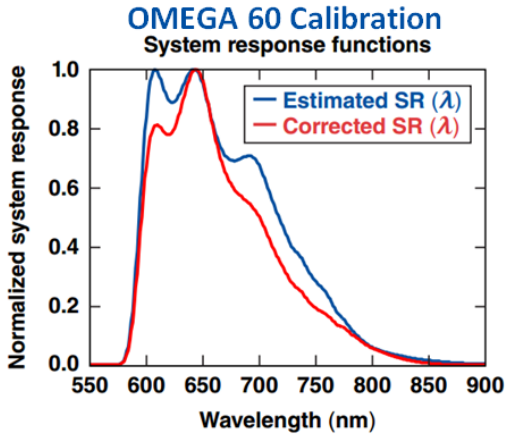
The OMEGA EP SOP will be absolutely calibrated in FY16

- Camera output I is related to a NIST-traceable source of known spectral radiant power $\Phi_s(\lambda)$



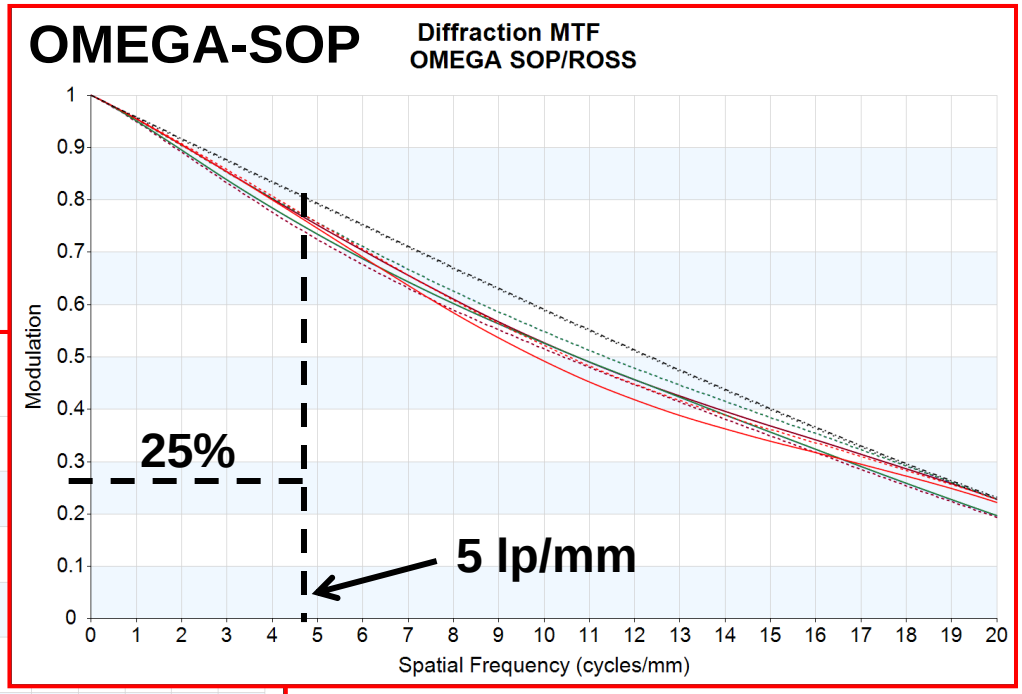
$$I = \Delta t \int_{\text{all}\,\lambda} d\lambda T_x(\lambda)\Phi_s(\lambda)\text{SR}(\lambda)$$

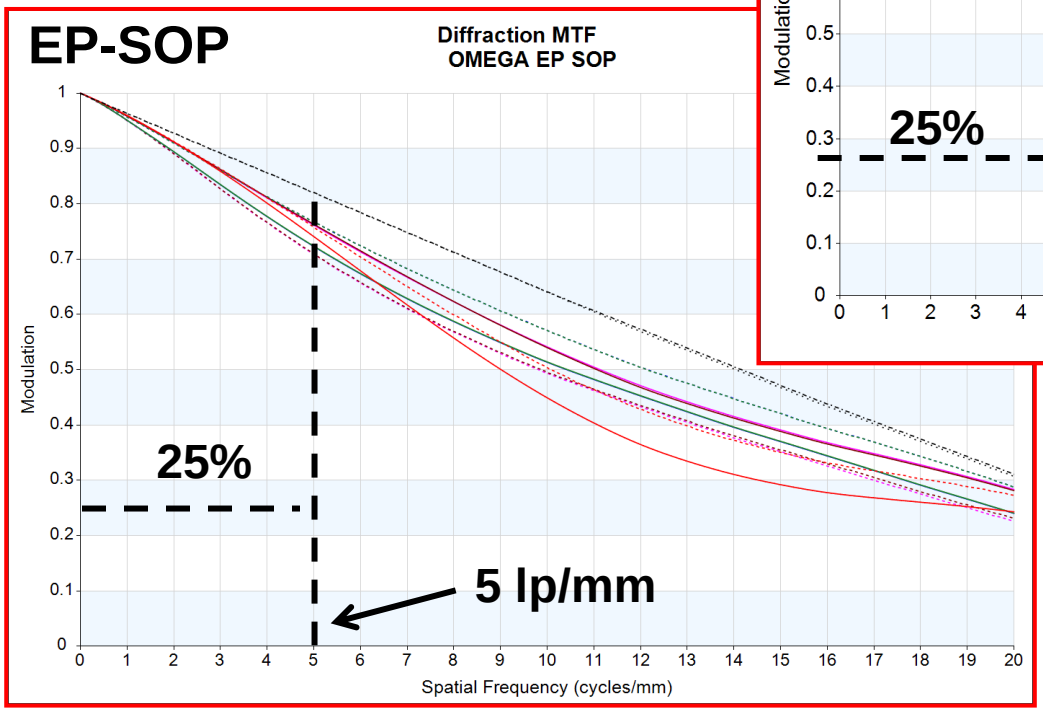
- System response SR (λ) includes S20 photocathode sensitivity and optical transmission of the system
- SR (λ) is measured in seven wavelength regions by the addition of 40-nm-wide bandpass filters with transmissions $T_x(\lambda)$



OMEGA EP's SOP meets modest specifications but its imaging performance can be greatly improved

System performance is limited by the current ASBO/VISAR transport optics

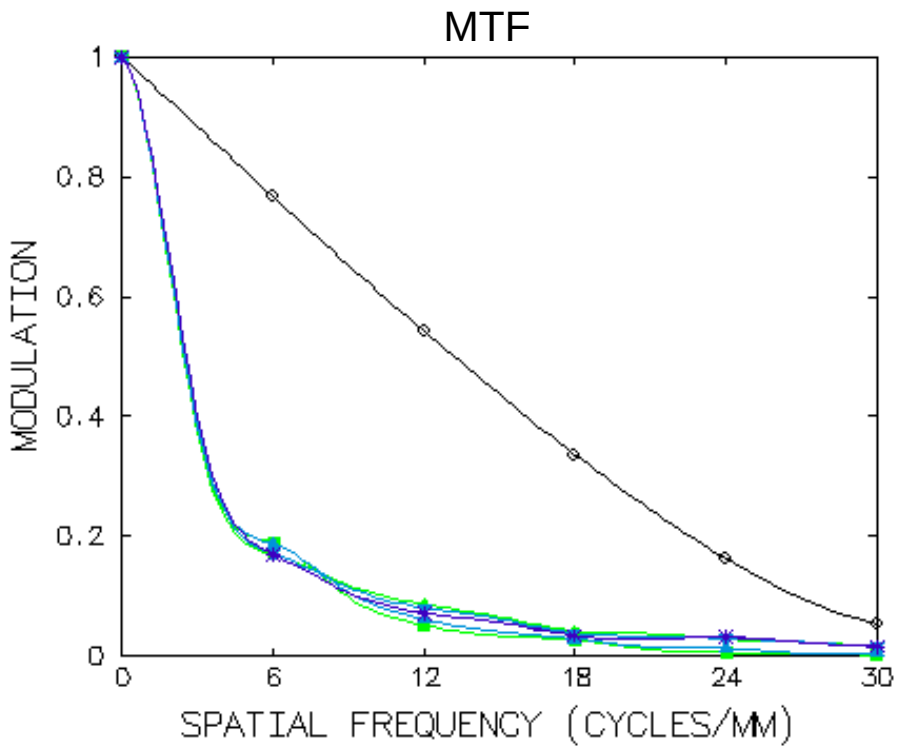




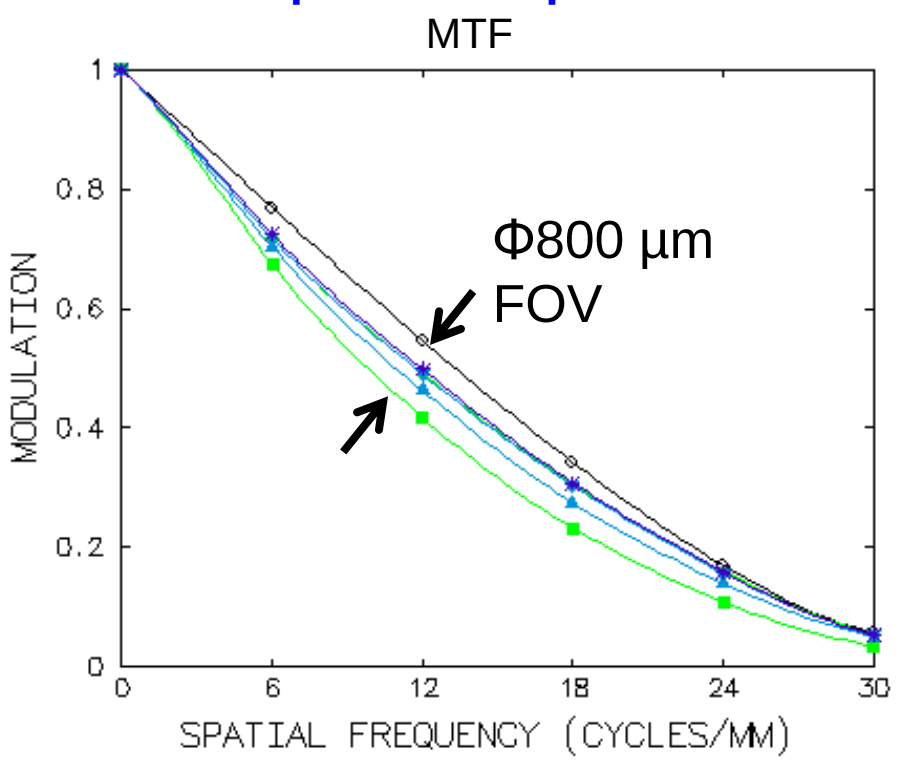
Performance Specifications:
Contrast ≥ 25% at 80 lp/mm
⇒ 5 lp/mm at ROSS
Single λ @ 650 nm

The current optical transport is not achromatized over the full SOP bandpass

Current system performance

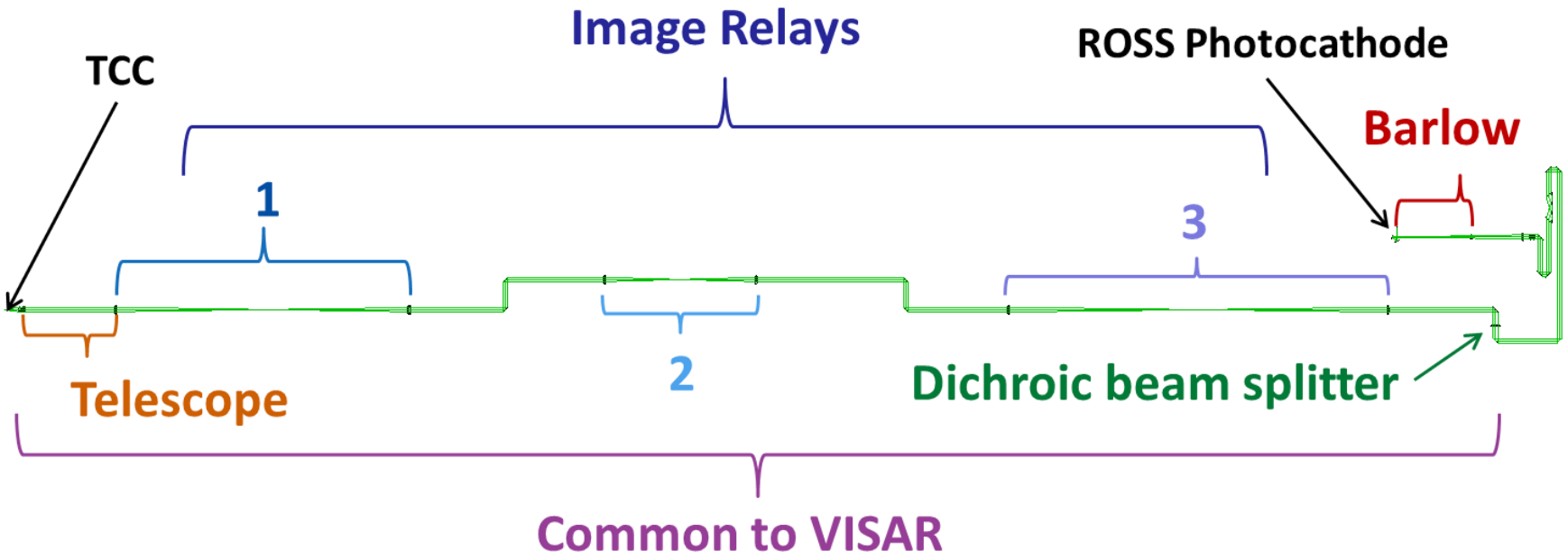


Proposed redesign of the optical transport



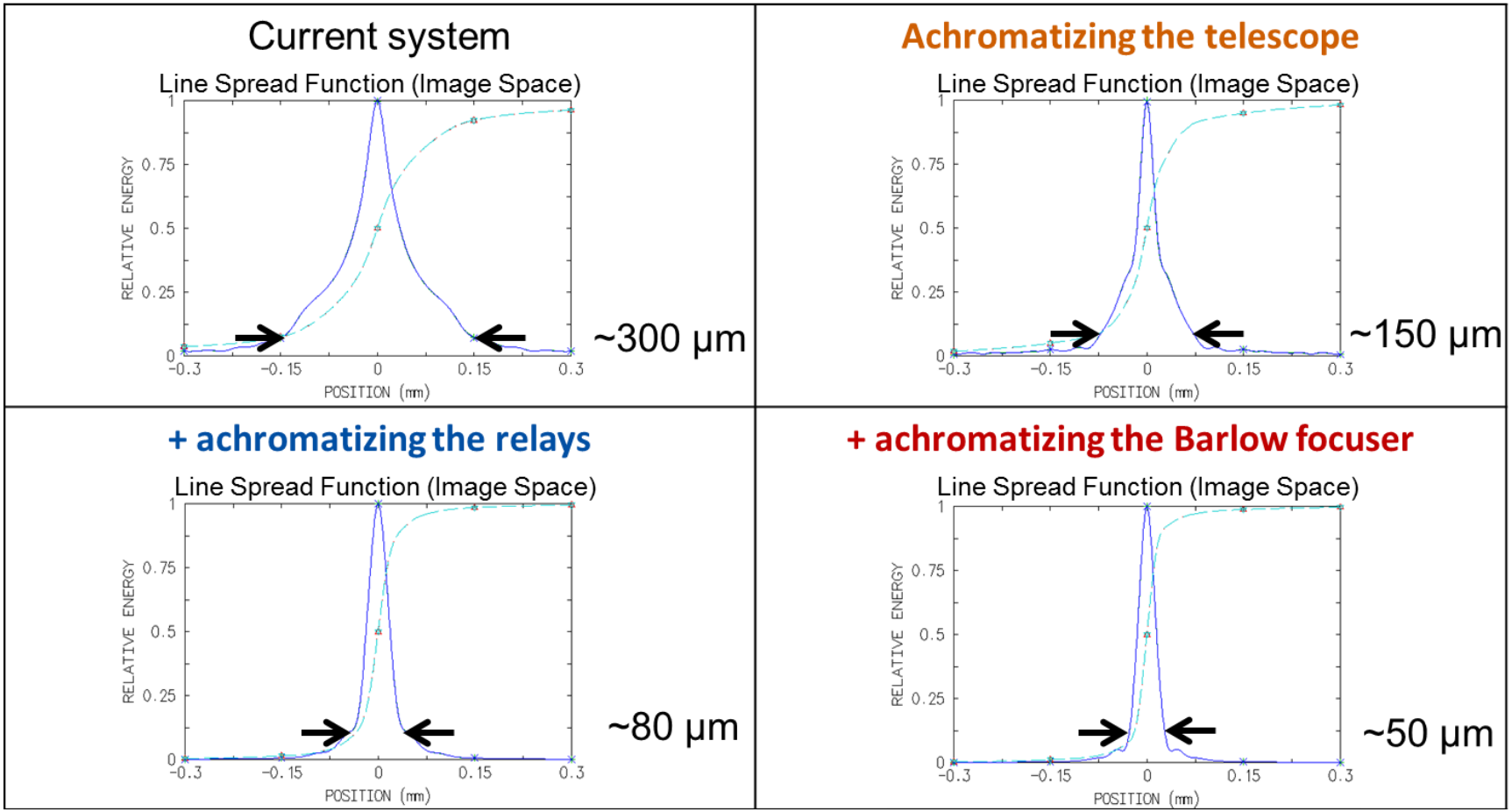
Evenly weight spectrum from 590-850 nm

Optical improvements are proposed for the telescope, relays and final focusing elements



- All relay systems keep the same optic locations and a magnification (1x)
- The Barlow focuser system keeps the same slit, streak camera, mirror positions and effective focal length ($13.3 \times f_{front}$)
- All components redesigned to be apochromats

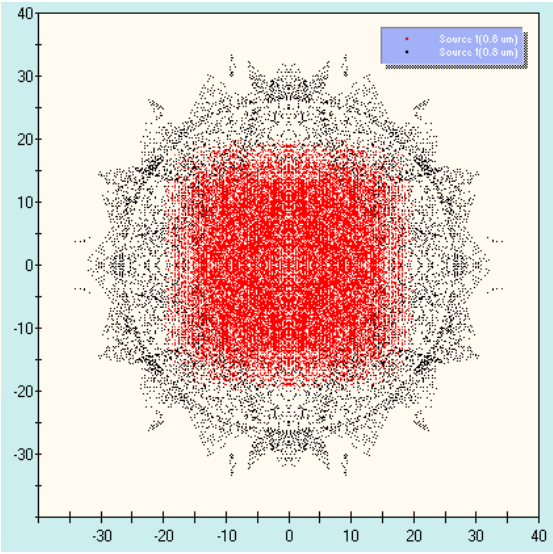
The redesigned system focuses 90% of the encircled energy into a ~50 μm spot



Achromatic imaging reduces uncertainty of the effective source size

Optical modeling of the VISAR telescope in FRED has shown “pipe shine” may be an issue

FRED model of the VISAR/SOP telescope



TIM window

- **Rays shown in red are directly imaged from a 2mm source**
- **Rays shown in black originate from 2mm source but are scattered in the telescope**

A mechanical redesign of the telescope is planned in FY16

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