NEVADA NATIONAL NNSS SECURITY SITE
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TRANSFORMATIONAL DIAGNOSTICS AND IMAGING
Los Alamos, New Mexico

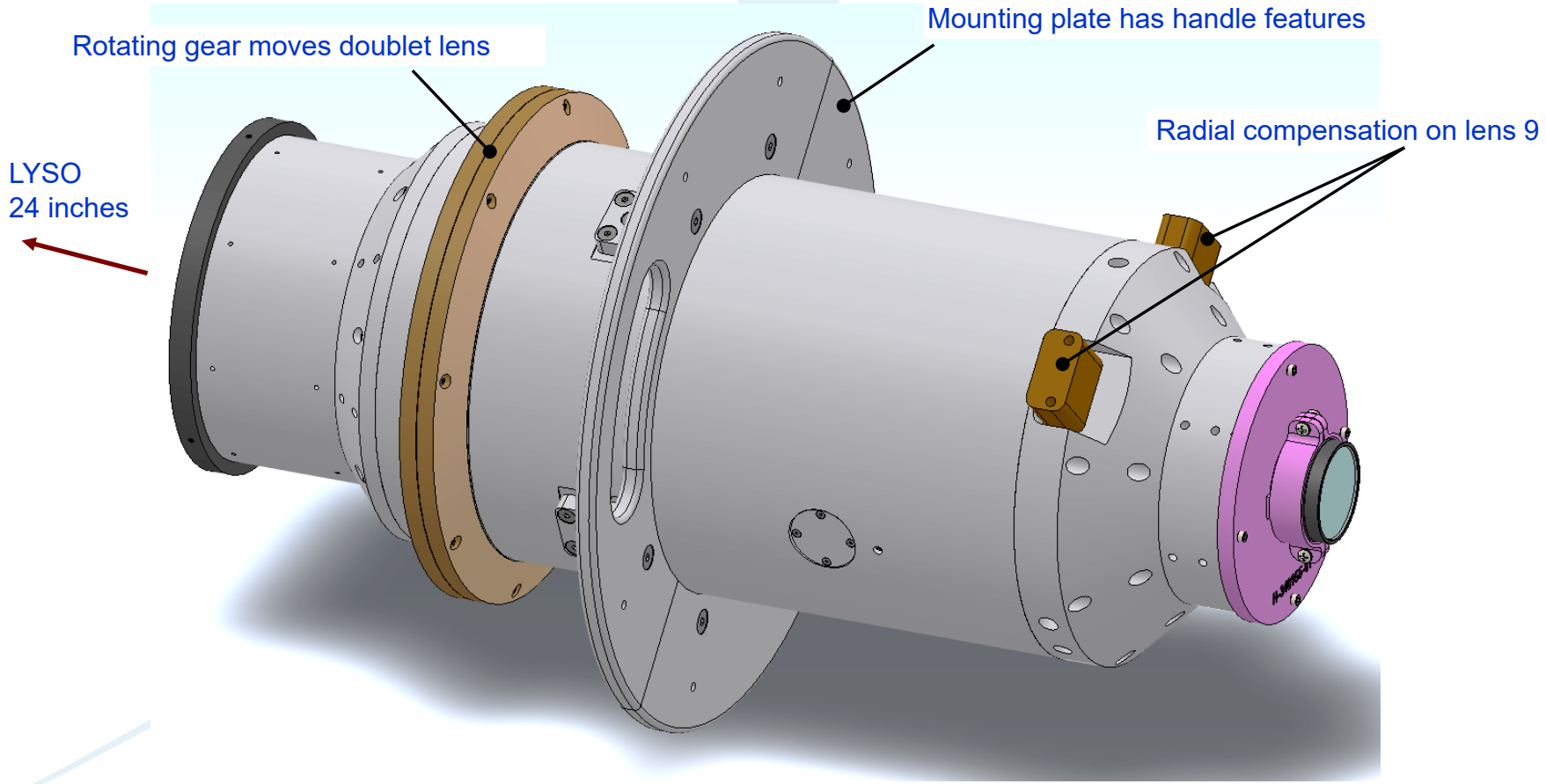
SPIE Optics+Photonics

DOE/NV/03624--0863

Adapting a prototype zoom lens to work outside its zoom range

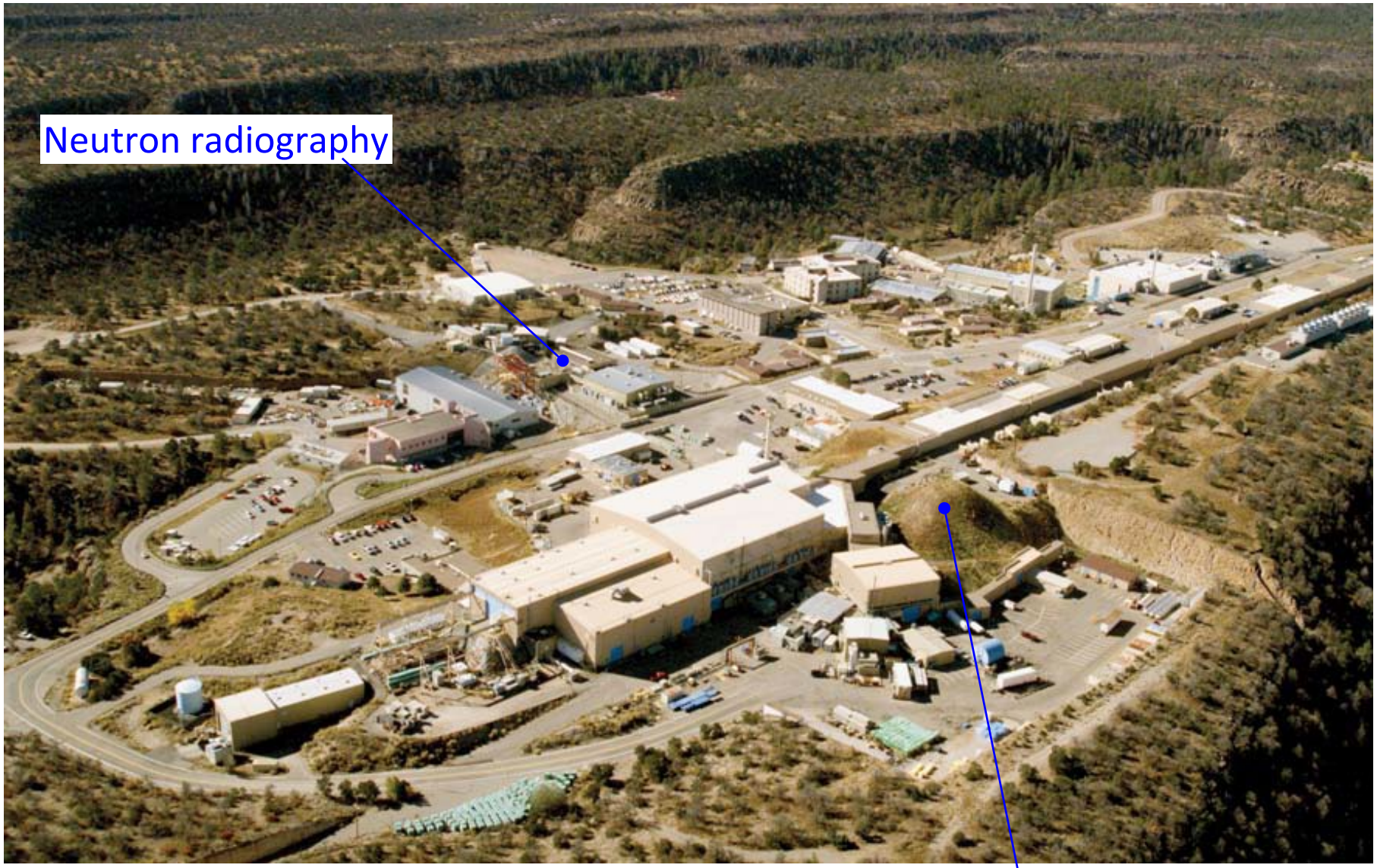
Robert M. Malone, Jeremy J. Bundgaard, Jesus J. Castaneda, and Morris I. Kaufman

Nevada National Security Site, Transformational Diagnostic and Imaging, Los Alamos, NM, USA



This work was by Mission Support and Test Services, LLC, under Contract No. DE-NA0003624, with the U.S. Department of Energy. DOE/NV/03624--0863.

LANSE produces 800 MeV Protons



Hydrogen in rose strongly attenuates neutrons

A rose is transparent to x-rays, but not inside lead!

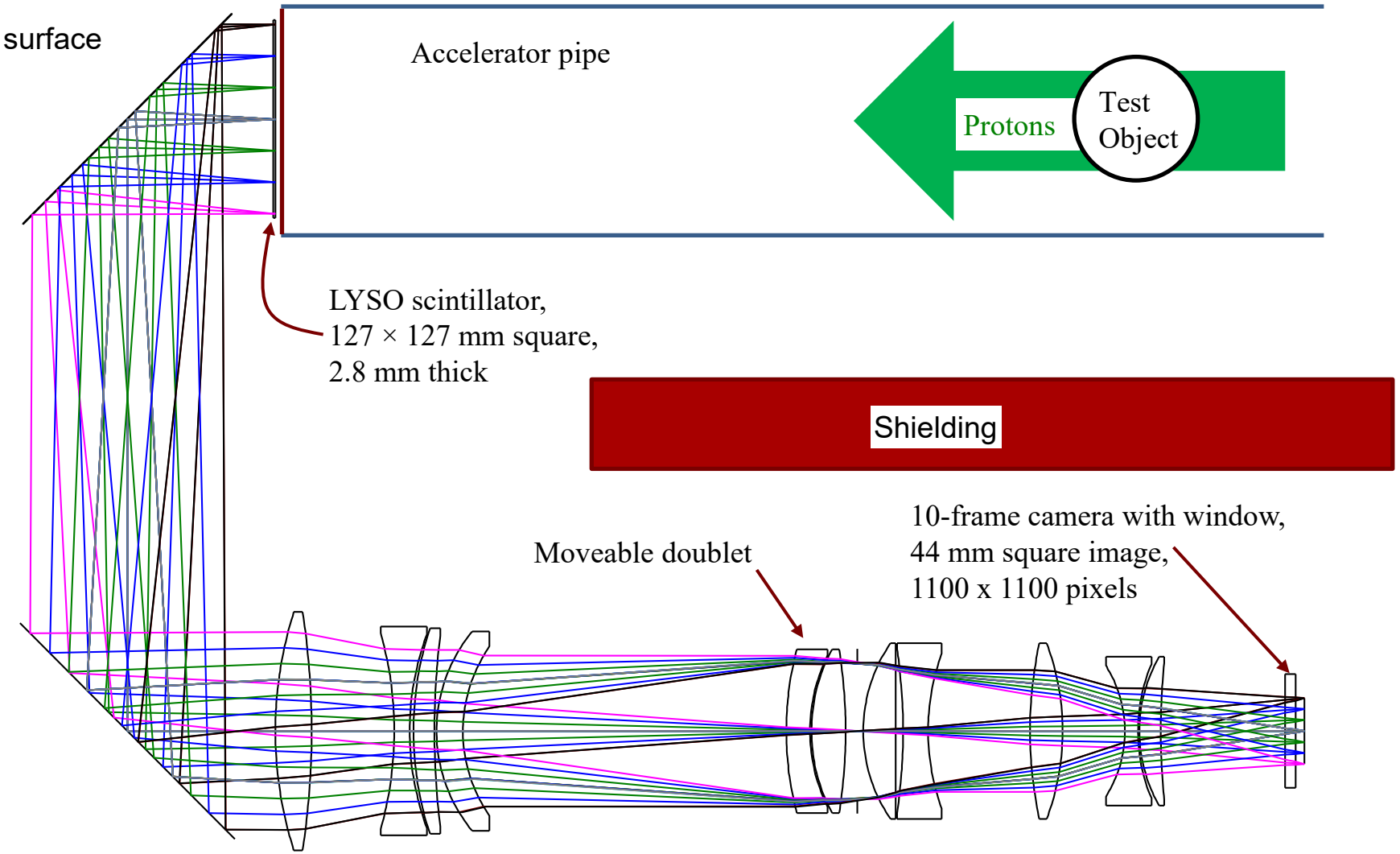
G. B. Winkelman, C. Dwyer, T.S. Hudson, D. Nguyen-Manh, M. Döblinger, R.L. Satet, M.J. Hoffmann, D.J.H. Cockayne, *Phil. Mag. Lett*. **84**, 755–62 (2004).

LYSO scintillator, emits light from 380 to 550 nm

Resolve 60 μm detail at the LYSO scintillator surface

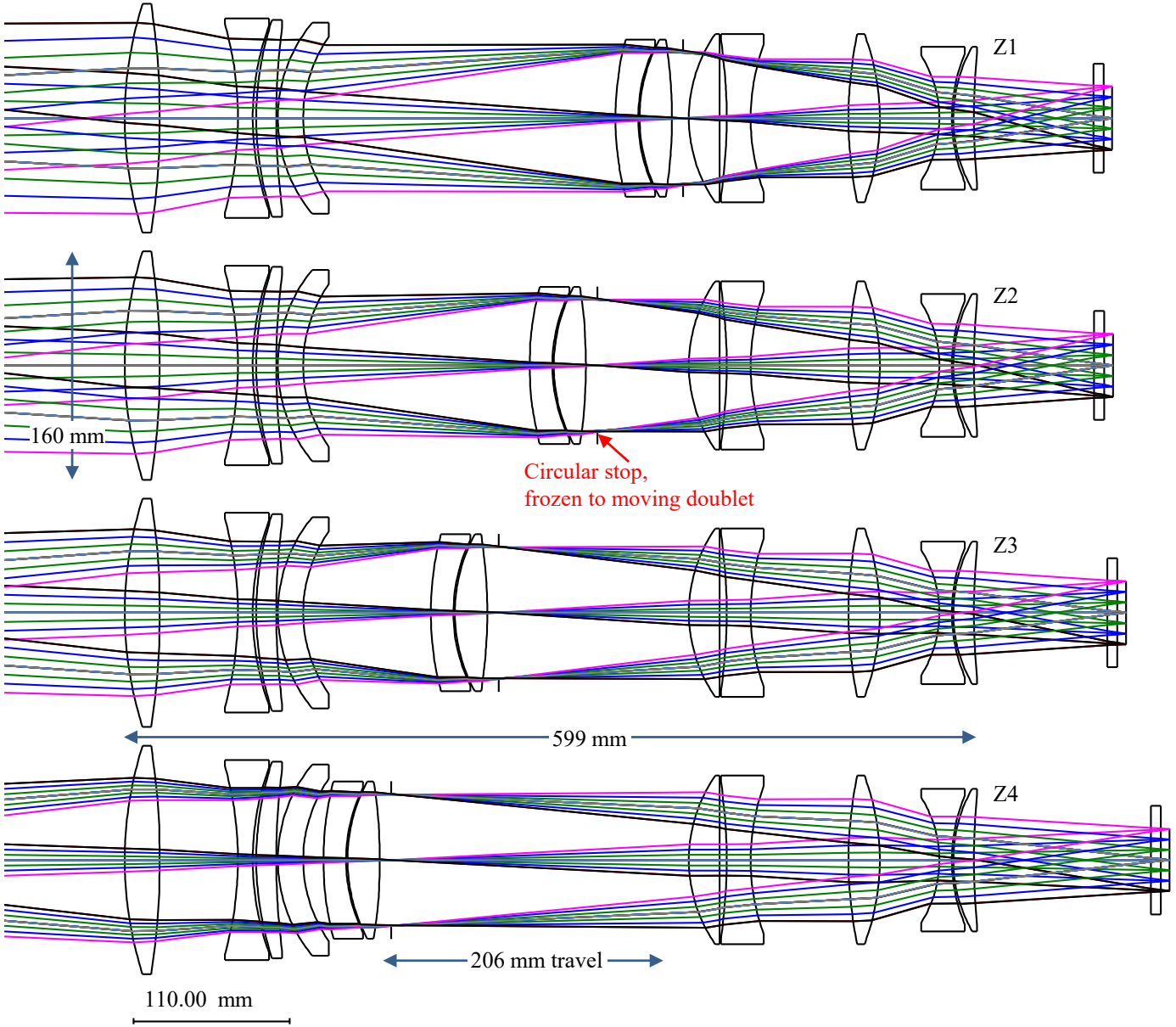
Scintillator size is 127 × 127 mm square

2 to 1 magnification changes



Malone, R. M., Clayton, D. J., Frayer, D. K., Kaufman, M. I., "Assembly and testing of a large zoom lens for proton radiography," Proc. SPIE, 10747, 1074704 (2018).

Adapting a prototype zoom lens to work outside its zoom range: August 23, 2020



127 mm dia. object,
collecting 0.0572 NA,
onto 44 mm image,
f/# = 3.06

104.7 mm dia. object,
collecting 0.0625 NA,
onto 44 mm image,
f/# = 3.37

82.3 mm dia. object,
collecting 0.0700 NA,
onto 44 mm image,
f/# 3.83

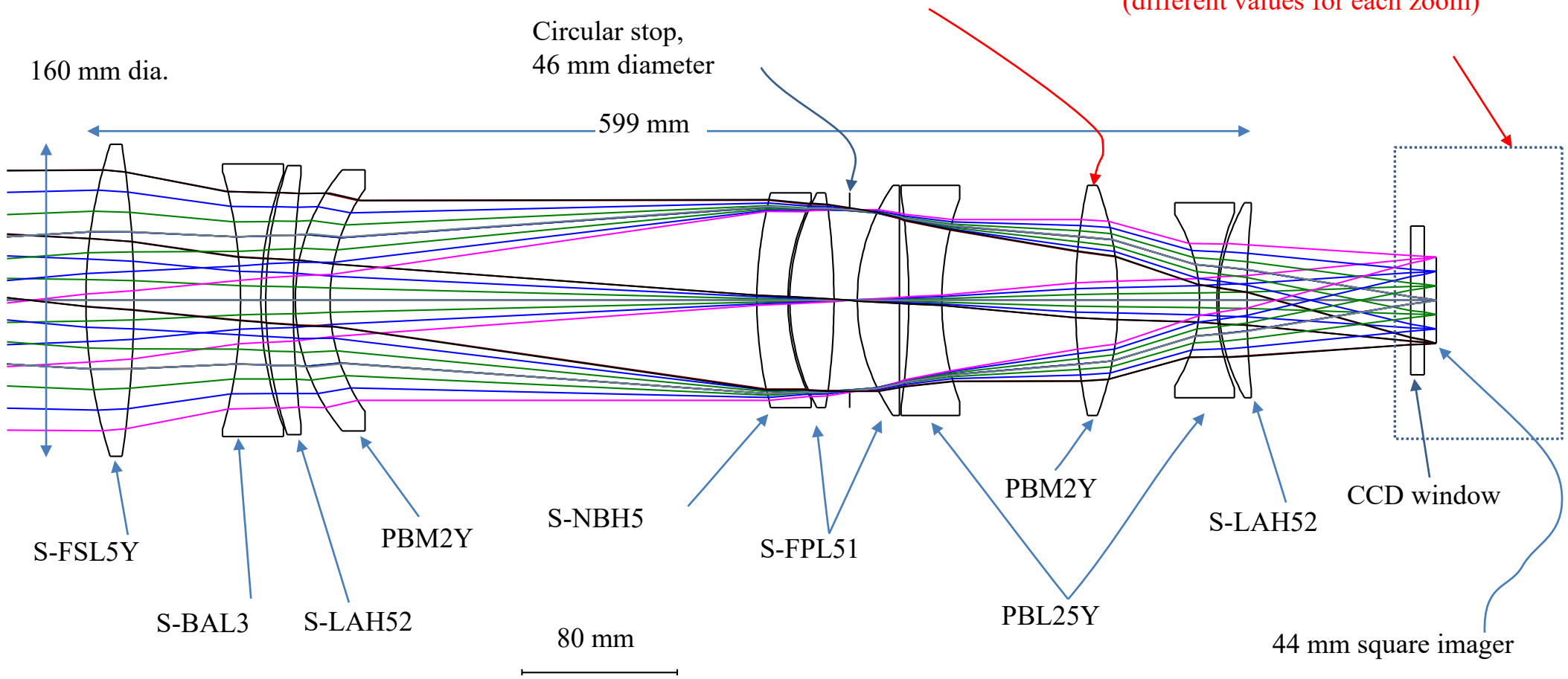
60 mm dia. object,
collecting 0.0805 NA,
onto 44 mm image,
f/# = 4.52

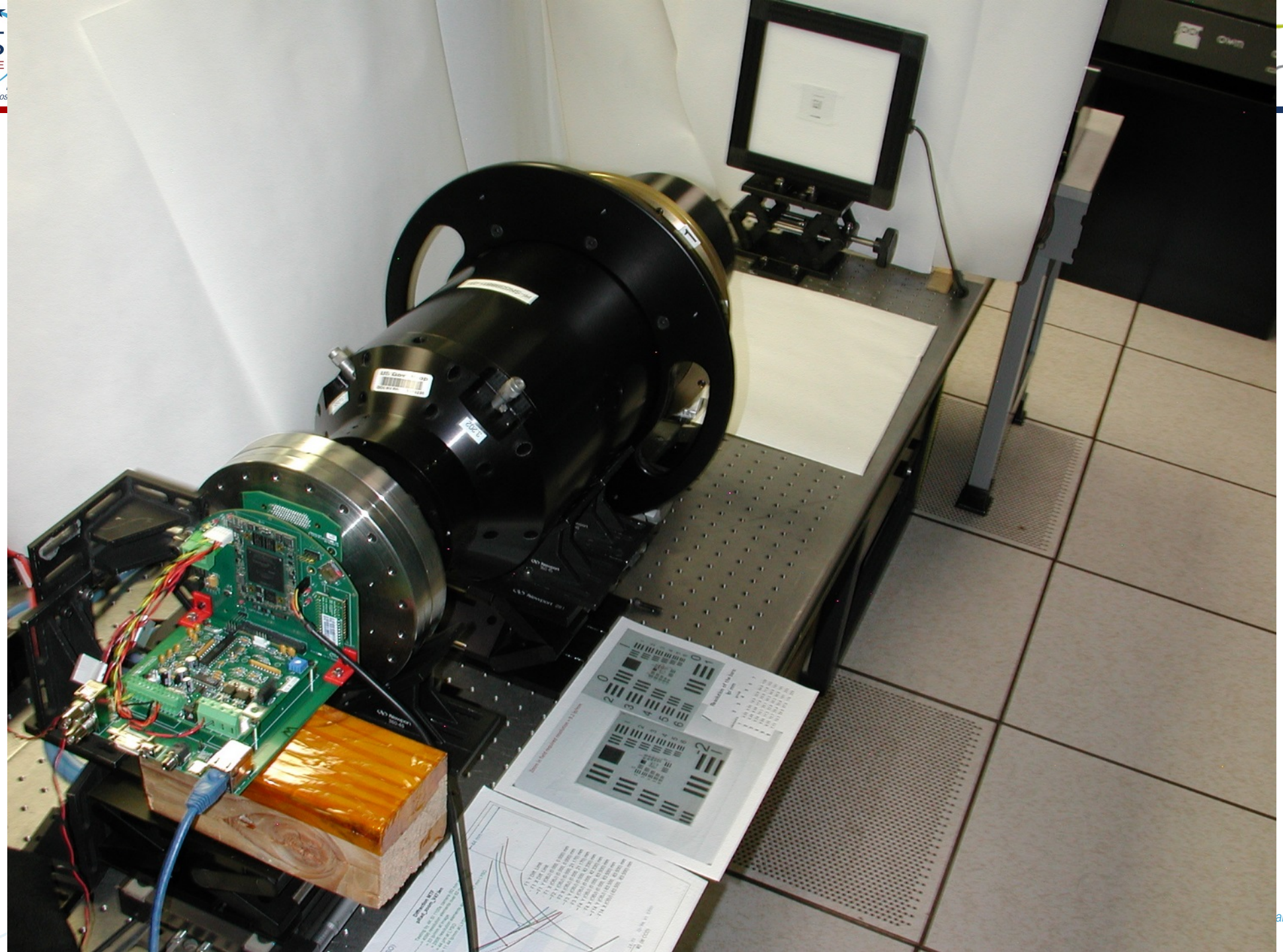
Zoom is varied by moving a doublet lens as well as the camera

Zoom Position #1
(Max FOV)

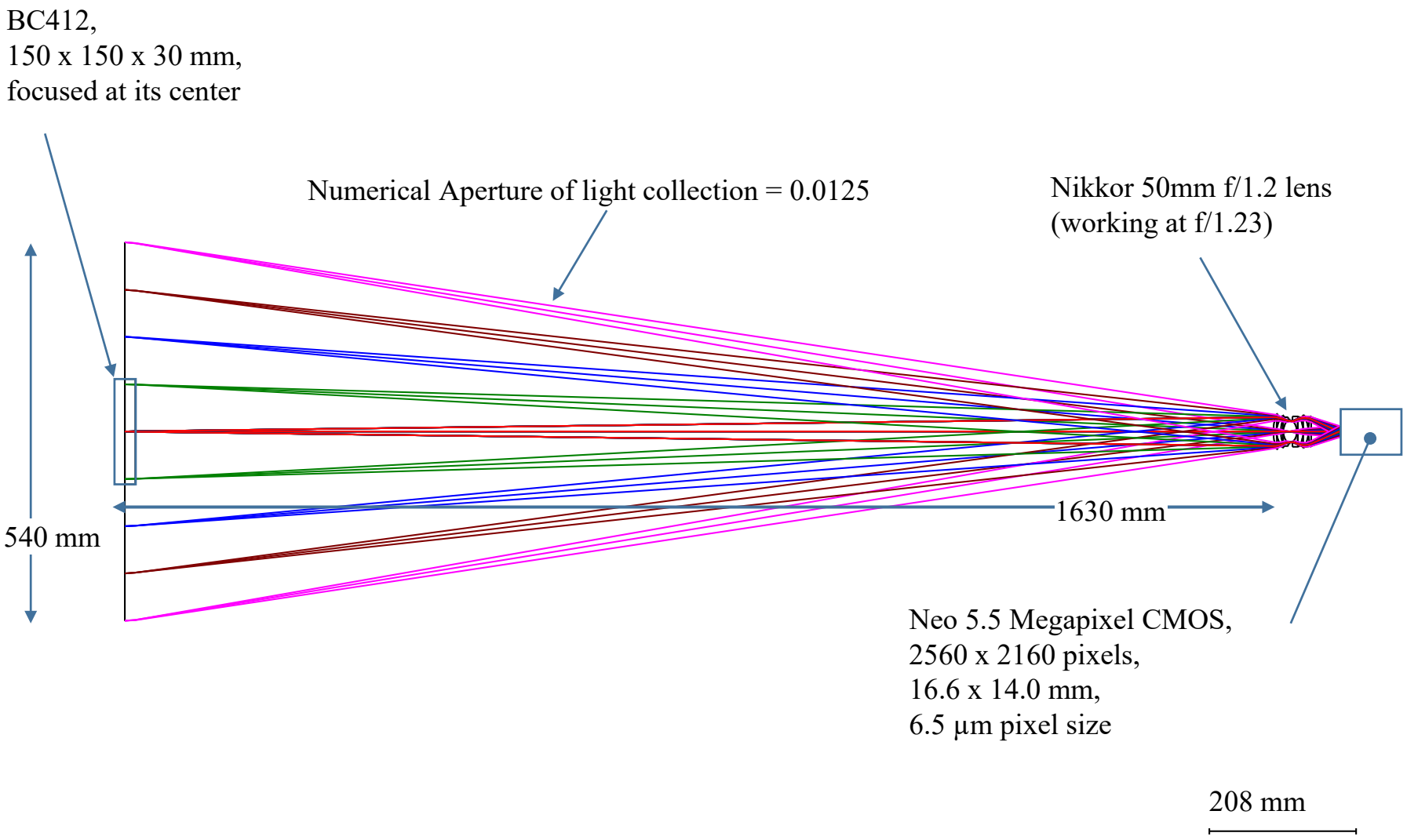
Radial Compensator,
±4.0 mm in X & Y (set & forget)
(same value for each zoom position)

Camera is compensator,
±7.0 mm in X & Y
±1° alpha and beta tilts
(different values for each zoom)





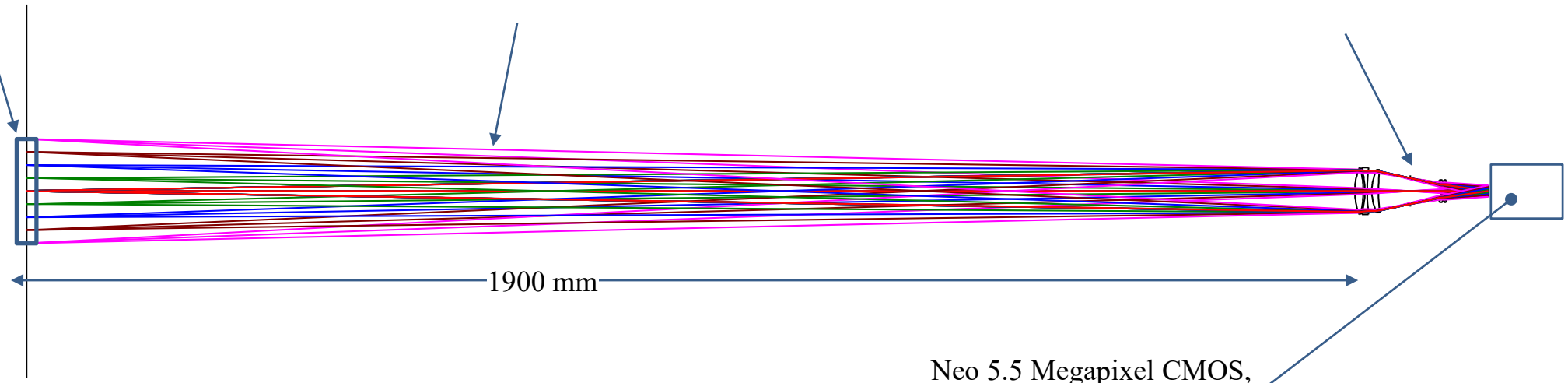
anaged and operated by MSTS under
contract number DE-NA0003624.


BC412,
150 x 150 x 30 mm,
focused at its center
Numerical Aperture of light collection = 0.0125
Nikkor 50mm f/1.2 lens
(working at f/1.23)
540 mm
1630 mm
Neo 5.5 Megapixel CMOS,
2560 x 2160 pixels,
16.6 x 14.0 mm,
6.5 µm pixel size
208 mm

BC412,
150 x 150 x 30 mm,
focused at its center

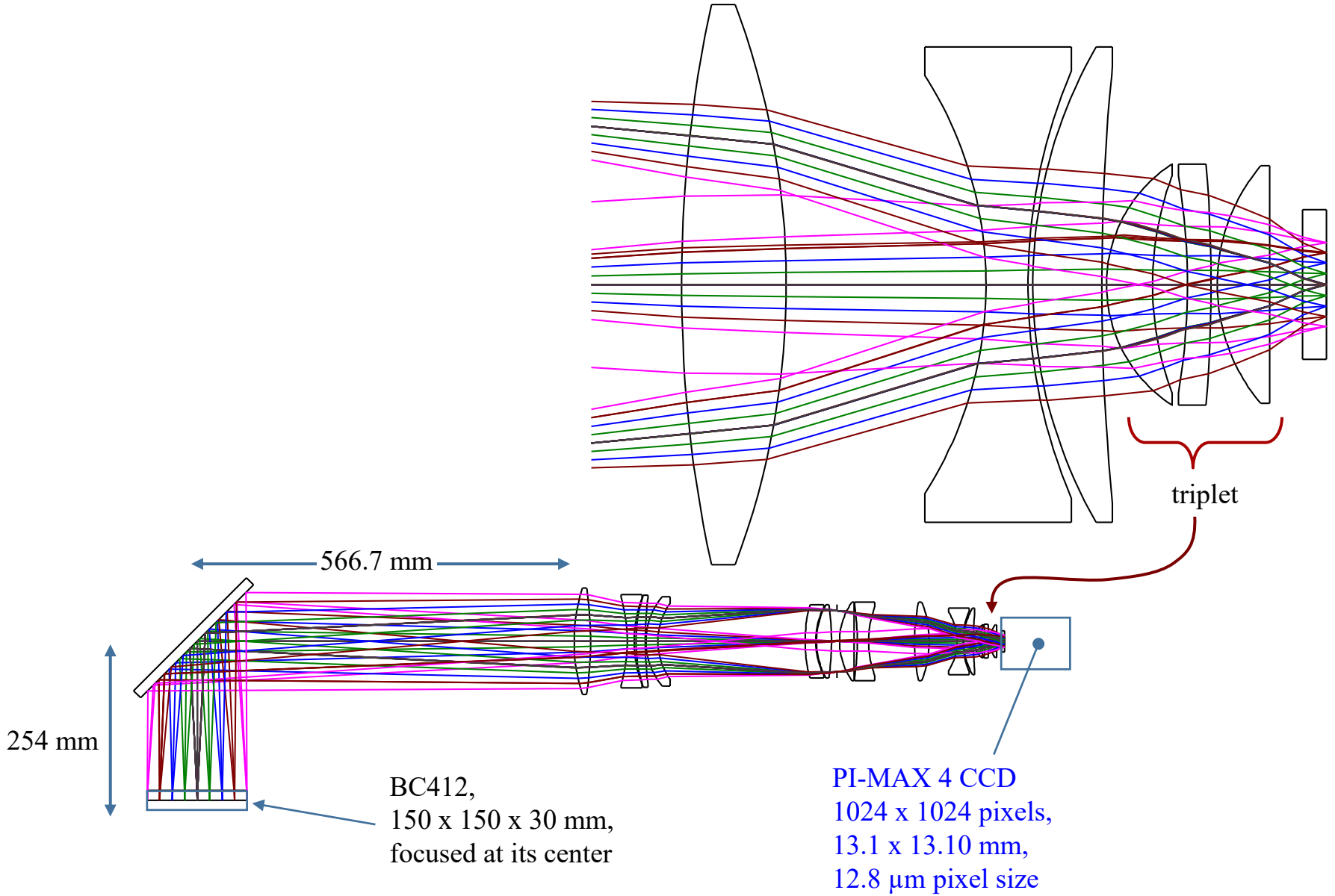
Numerical Aperture of light collection = 0.0159

Nikkor 180 mm f/2.8 lens
(working at f/3.47)

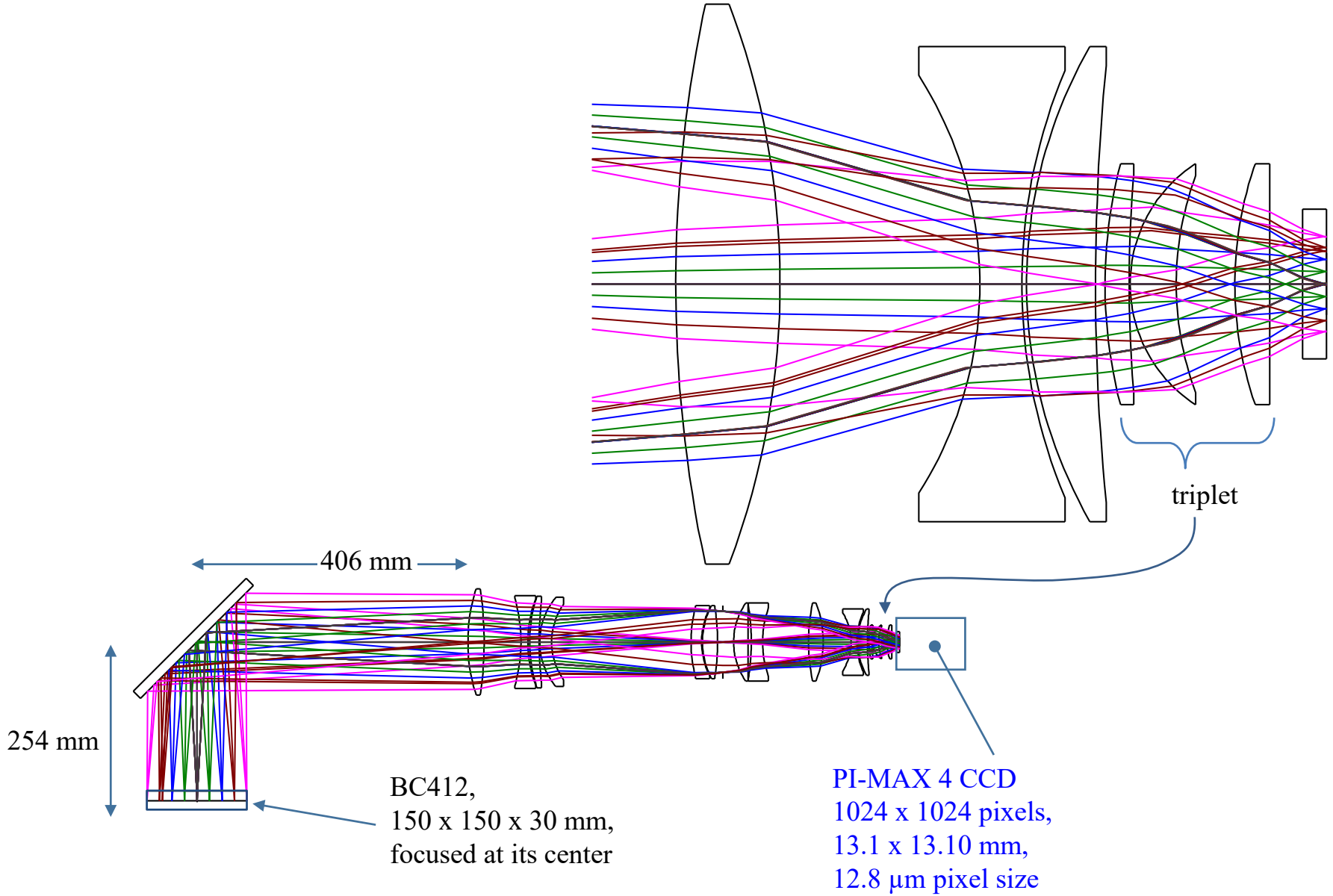


Neo 5.5 Megapixel CMOS,
2560 x 2160 pixels,
16.6 x 14.0 mm,
6.5 µm pixel size

250 mm


triplet
566.7 mm
254 mm
BC412,
150 x 150 x 30 mm,
focused at its center
PI-MAX 4 CCD
1024 x 1024 pixels,
13.1 x 13.10 mm,
12.8 µm pixel size

Adapting a prototype zoom lens to work outside its zoom range: August 23, 2020



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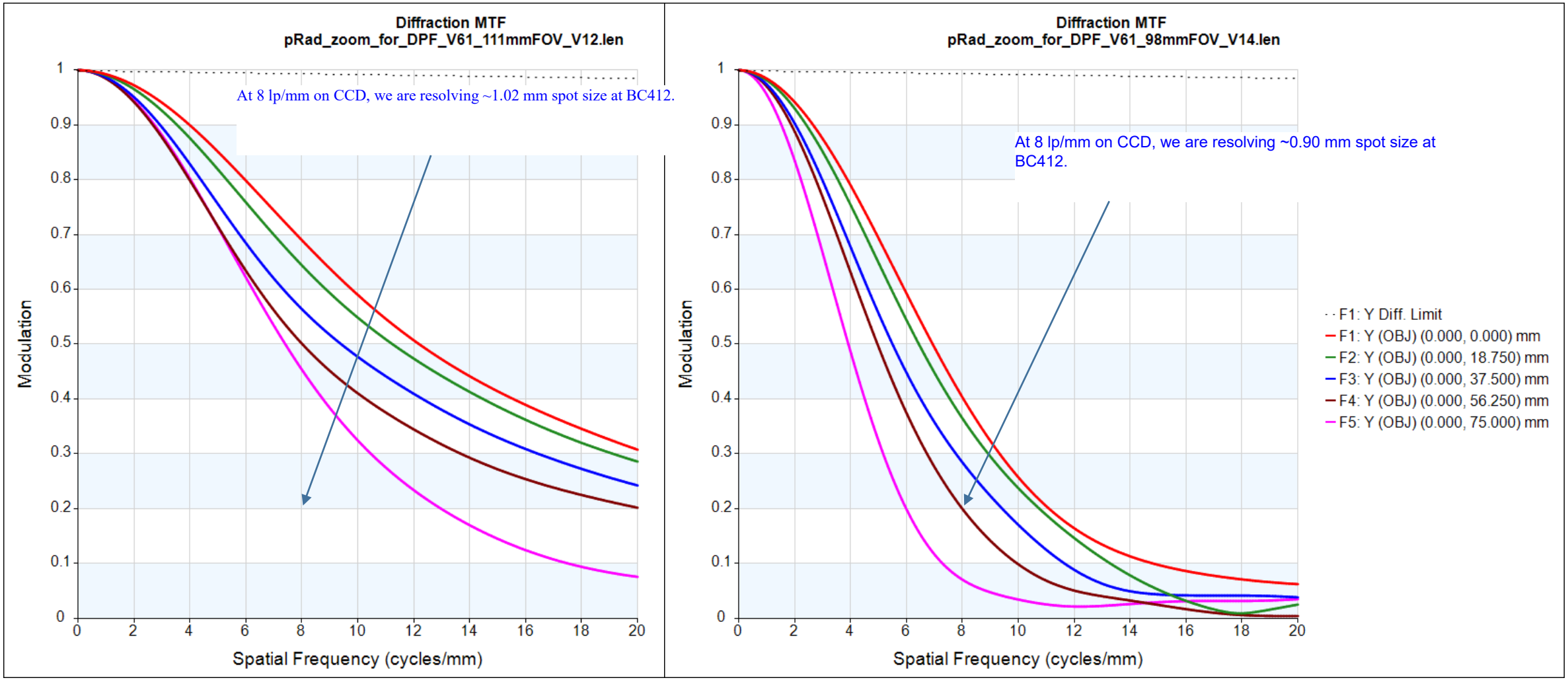
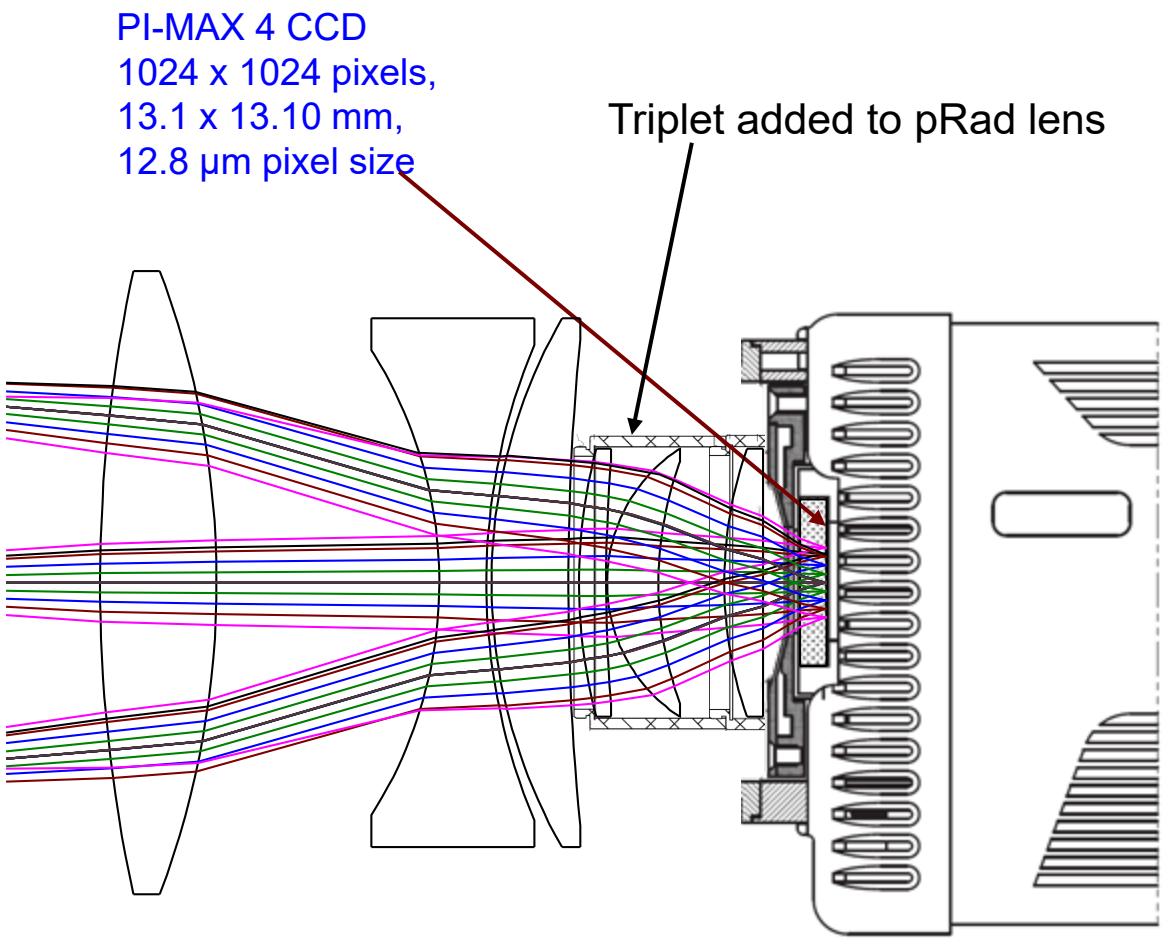


Neutron imaging at the WNR-60R



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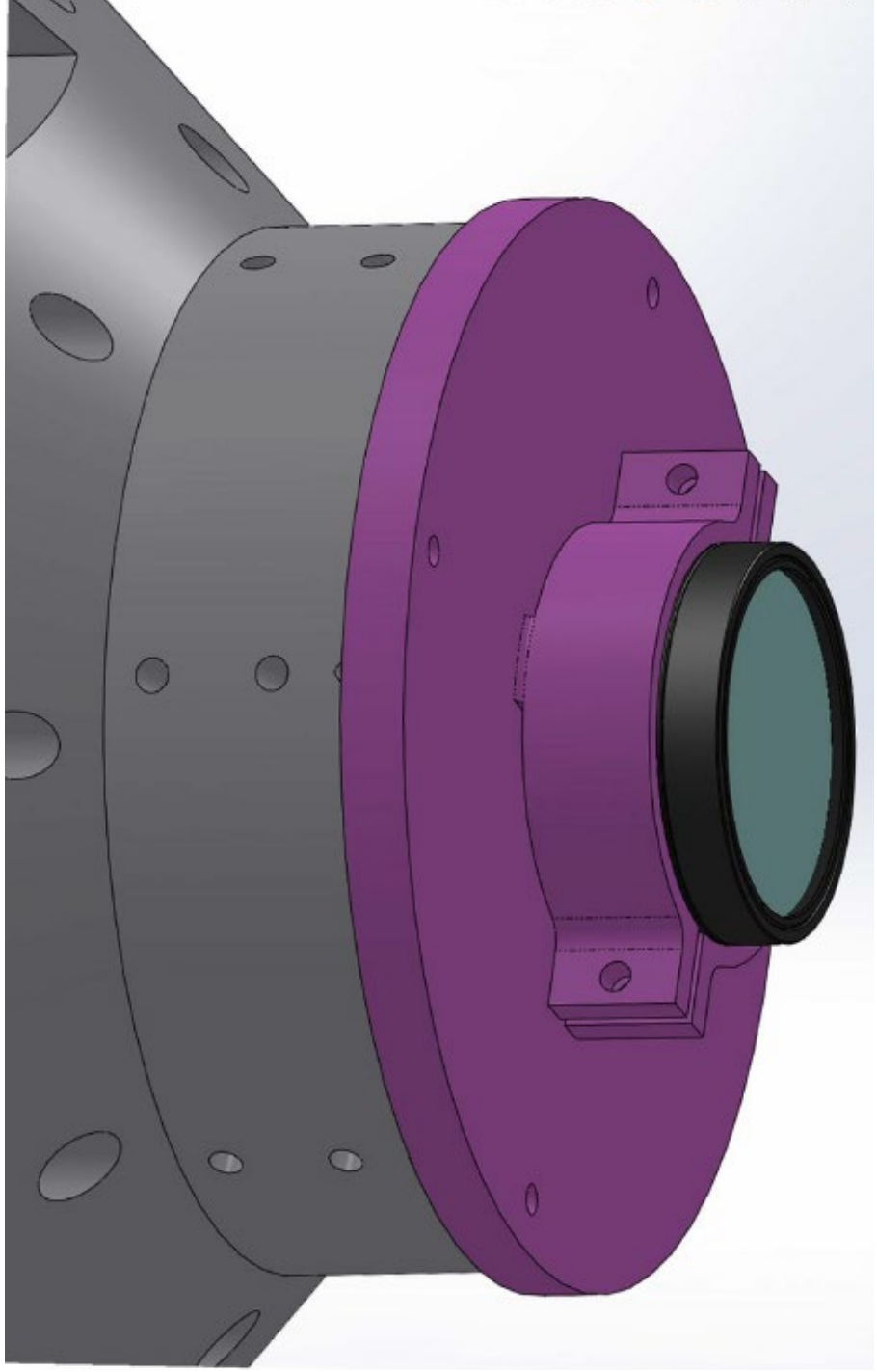

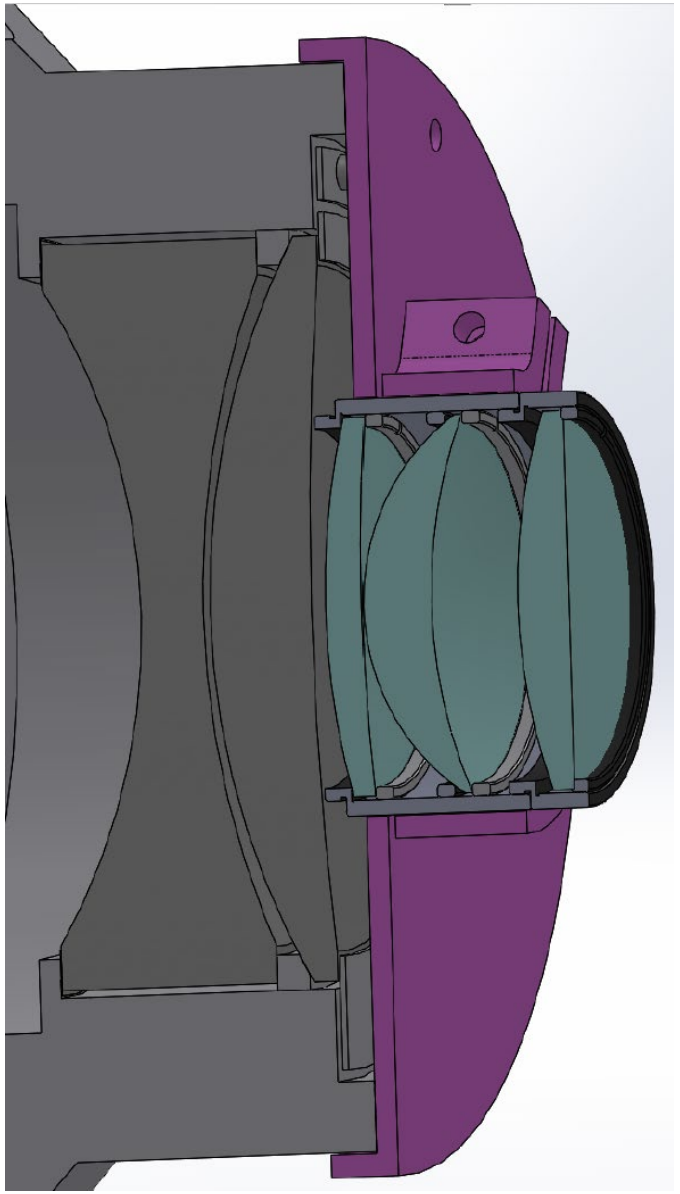

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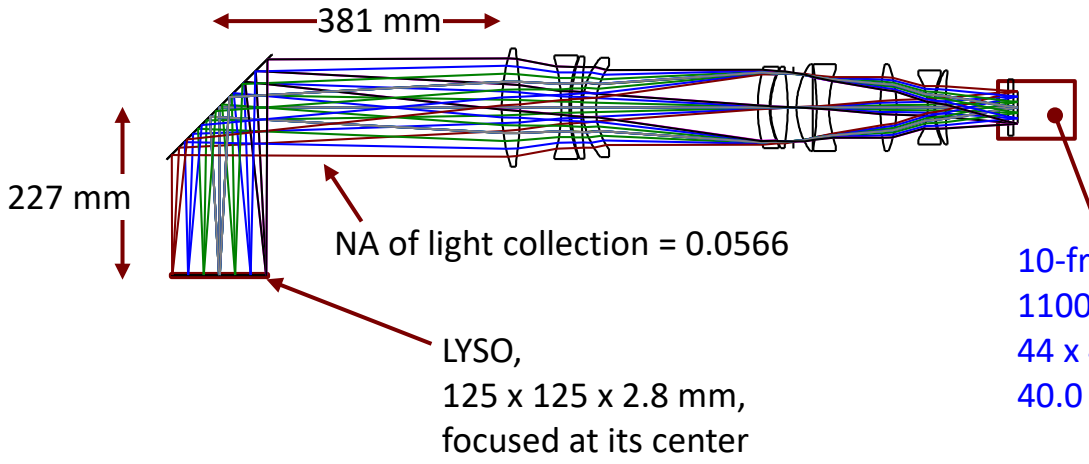
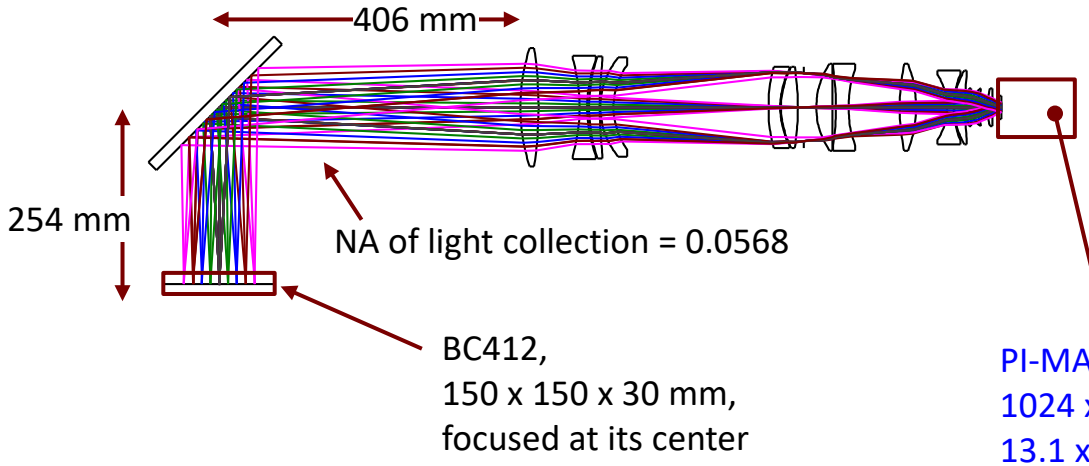


Original design use of pRad zoom lens

10-frame CCD
1100 x 1100 pixels,
44 x 44 mm,
40.0 µm pixel size



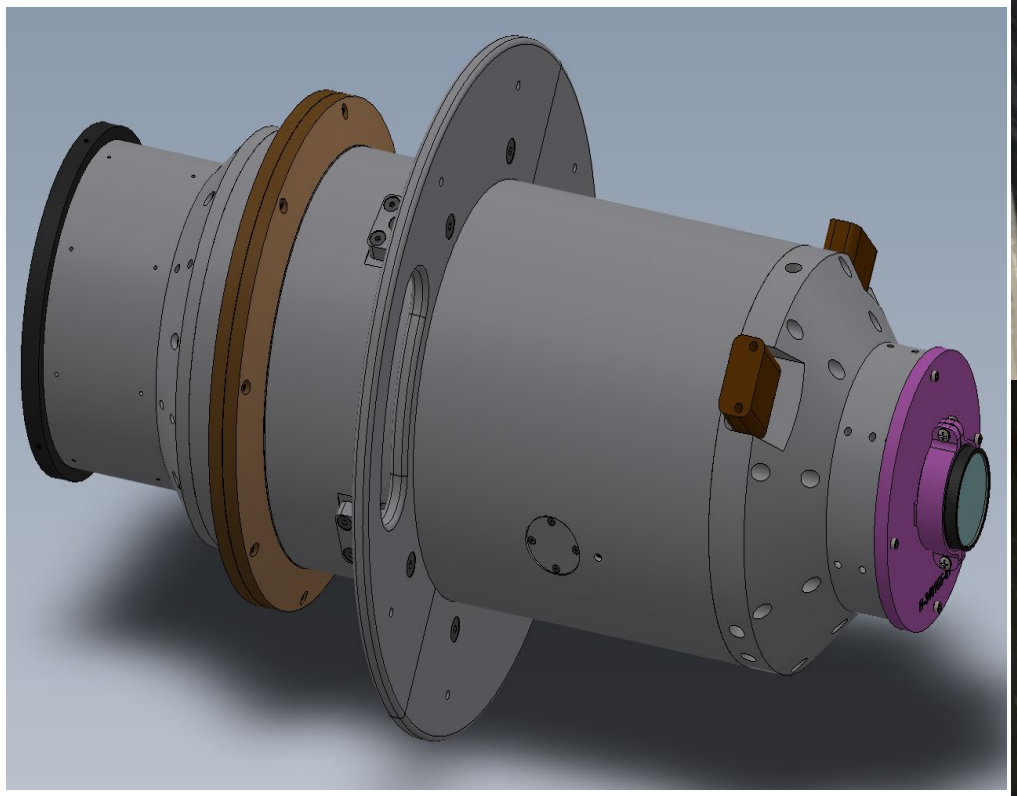
PI-MAX, with lens adaptor, sees 95 mm diameter light from BC412

PI-MAX 4 CCD
1024 x 1024 pixels,
13.1 x 13.10 mm,
12.8 µm pixel size

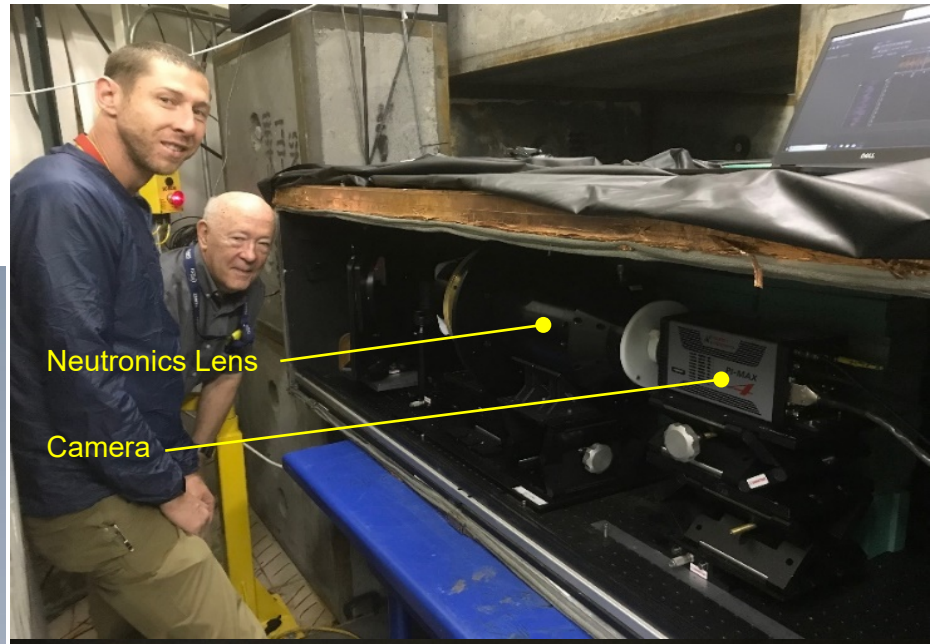
250.00 MM

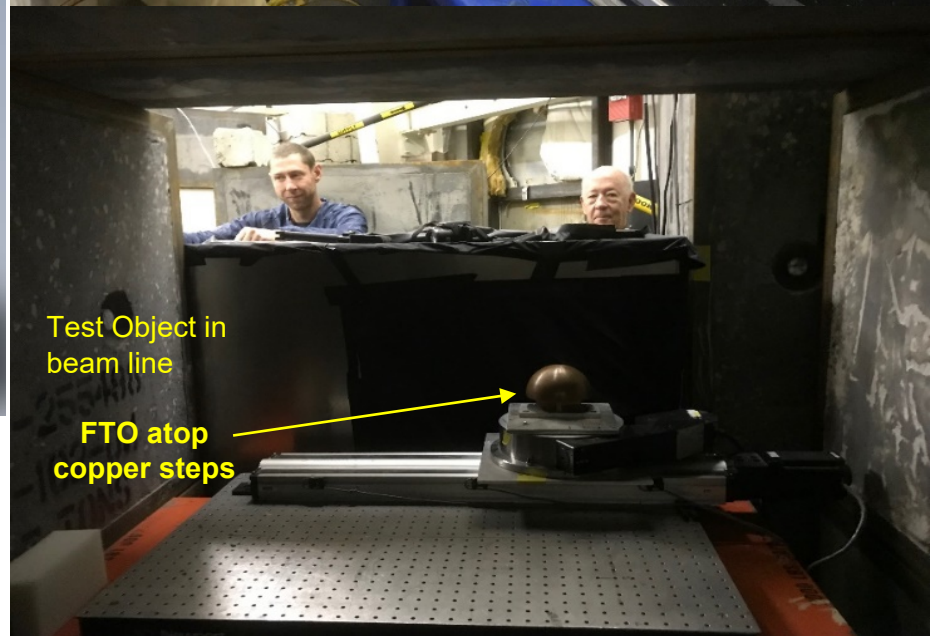
Neutron Radiography at LANSCE: Neutronics Lens

Custom NNSS lens designed for the 10-Frame camera is adapted to our gated MCP camera provides much better light collection



pRad 10-Frame Neutronics Lens

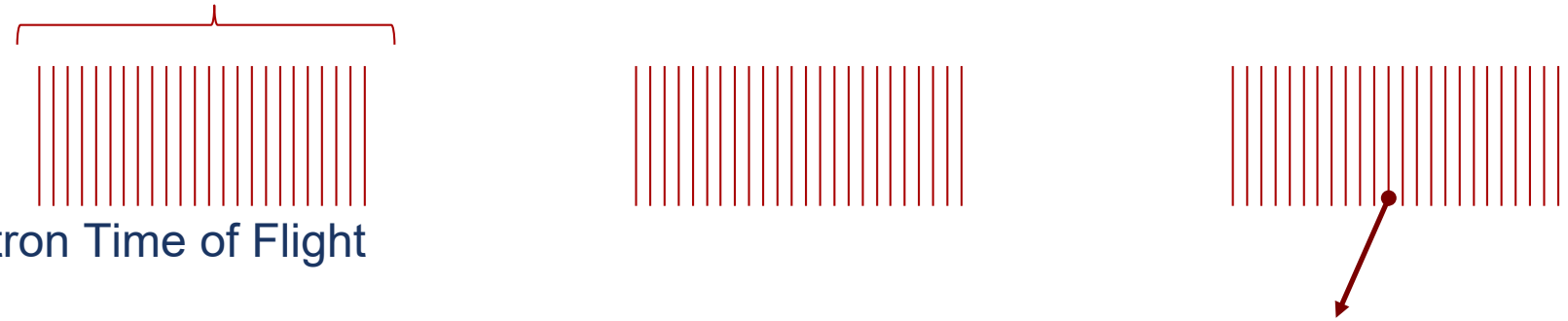




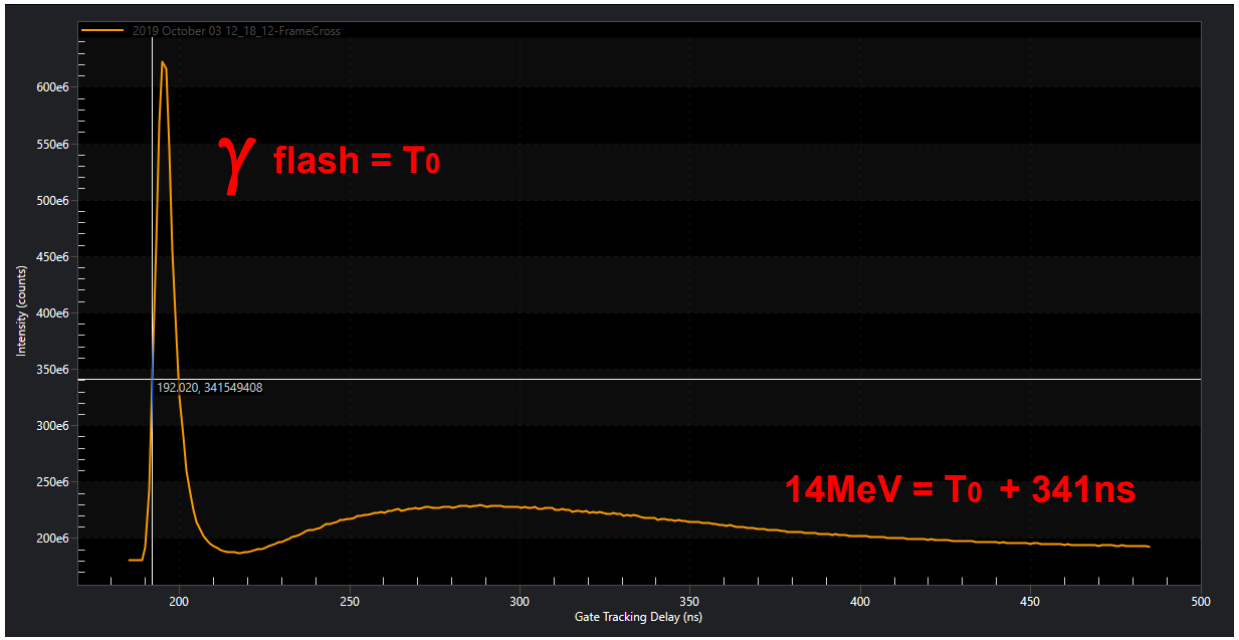
Neutron Radiography at LANSCE

LANSCE – Beam Structure

384, 1.8us pulses = **macro**pulse 100 macropulse/second

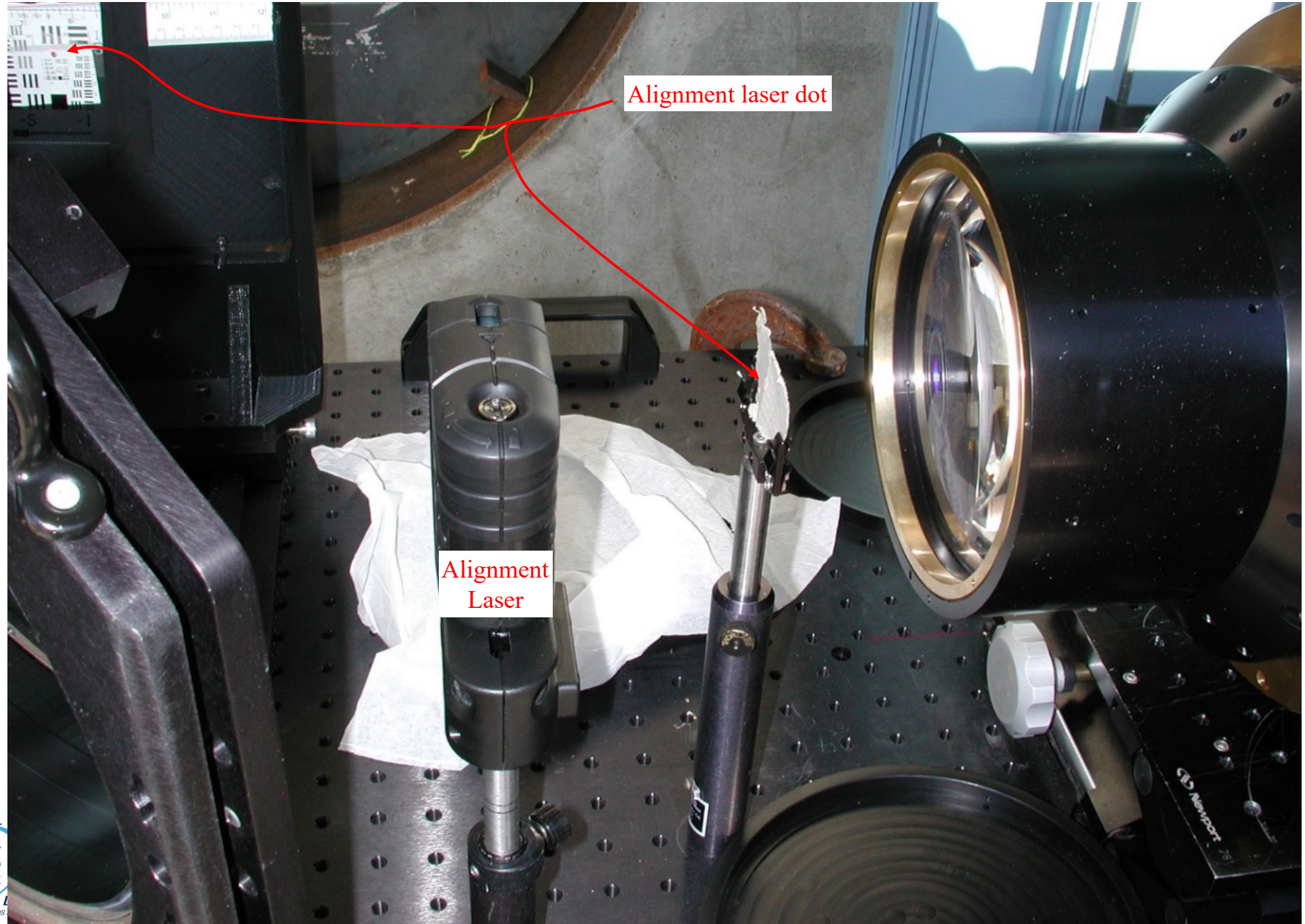


Neutron Time of Flight



Course alignment of the TV box.
Operator said his alignment accuracy was ± 5 mm, if he can see the laser alignment pointer.

A 5-axis self-leveling alignment laser provided enough accuracy to correct tilts of optical elements.



Outdoor precision alignment can be a 2 person operation.

Hydrogen in rose strongly attenuates neutrons