IR spectrometer using 90-degree off-axis parabolic mirrors

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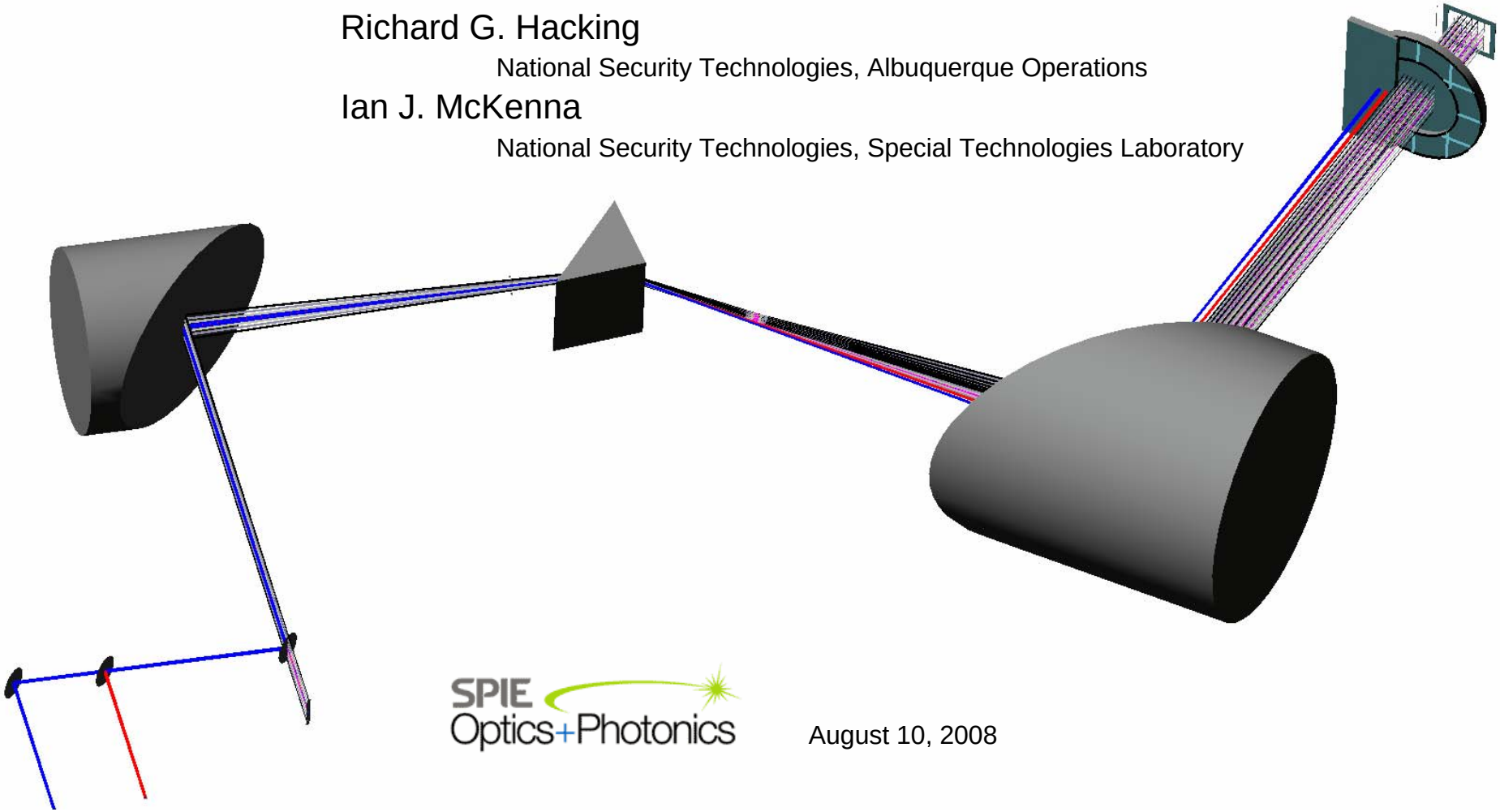


SPIE Optics+Photonics

August 10, 2008

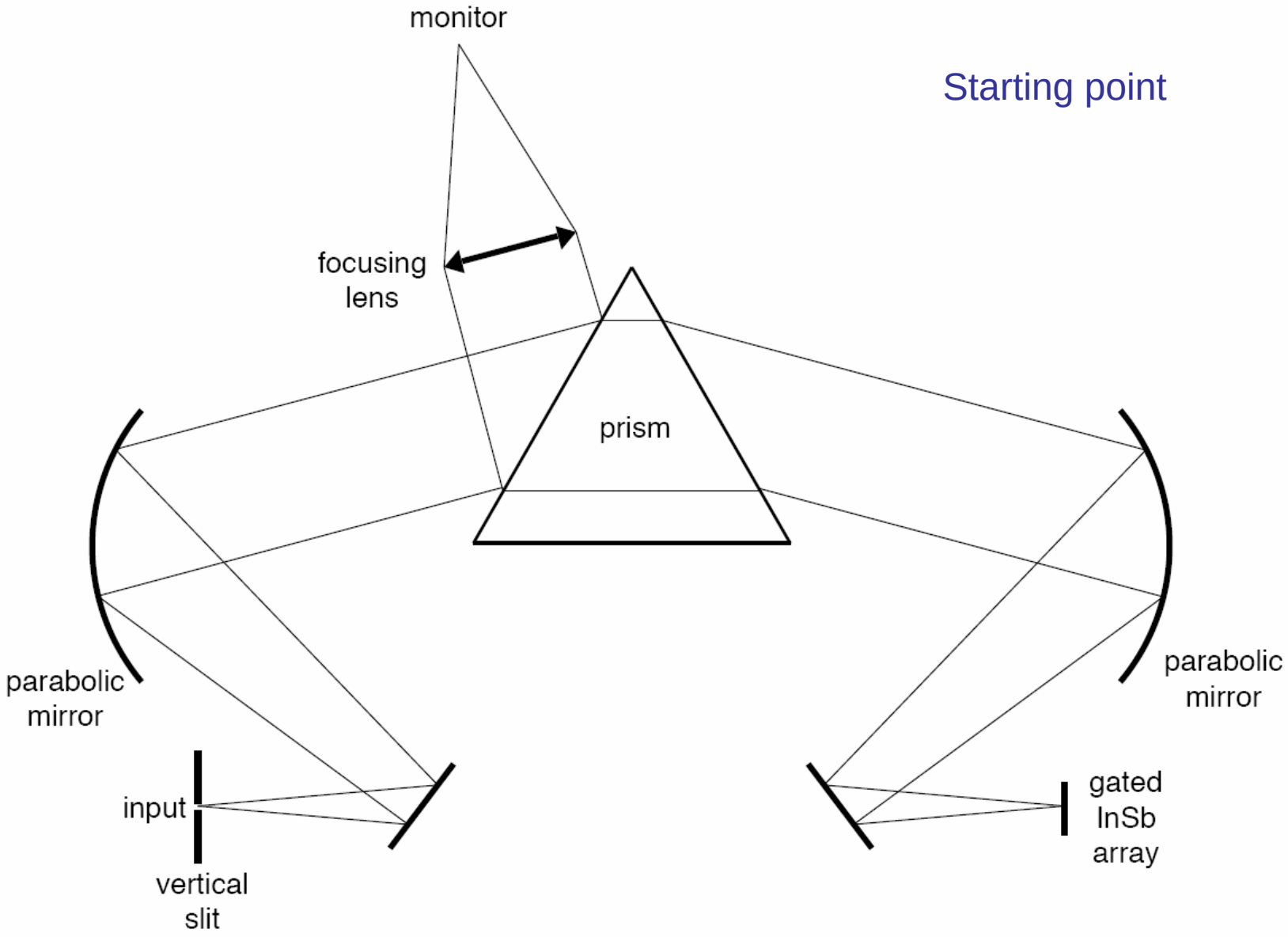
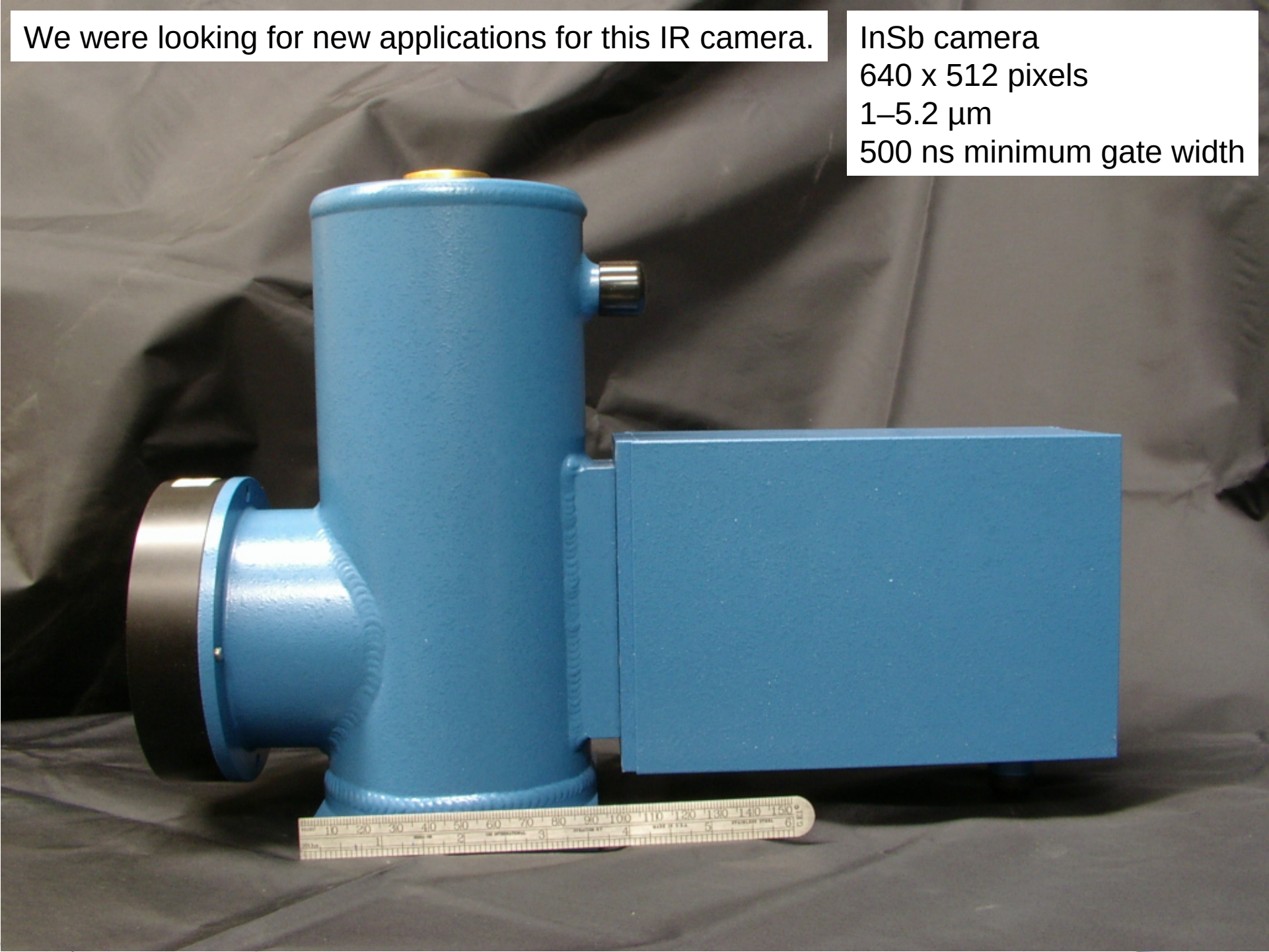
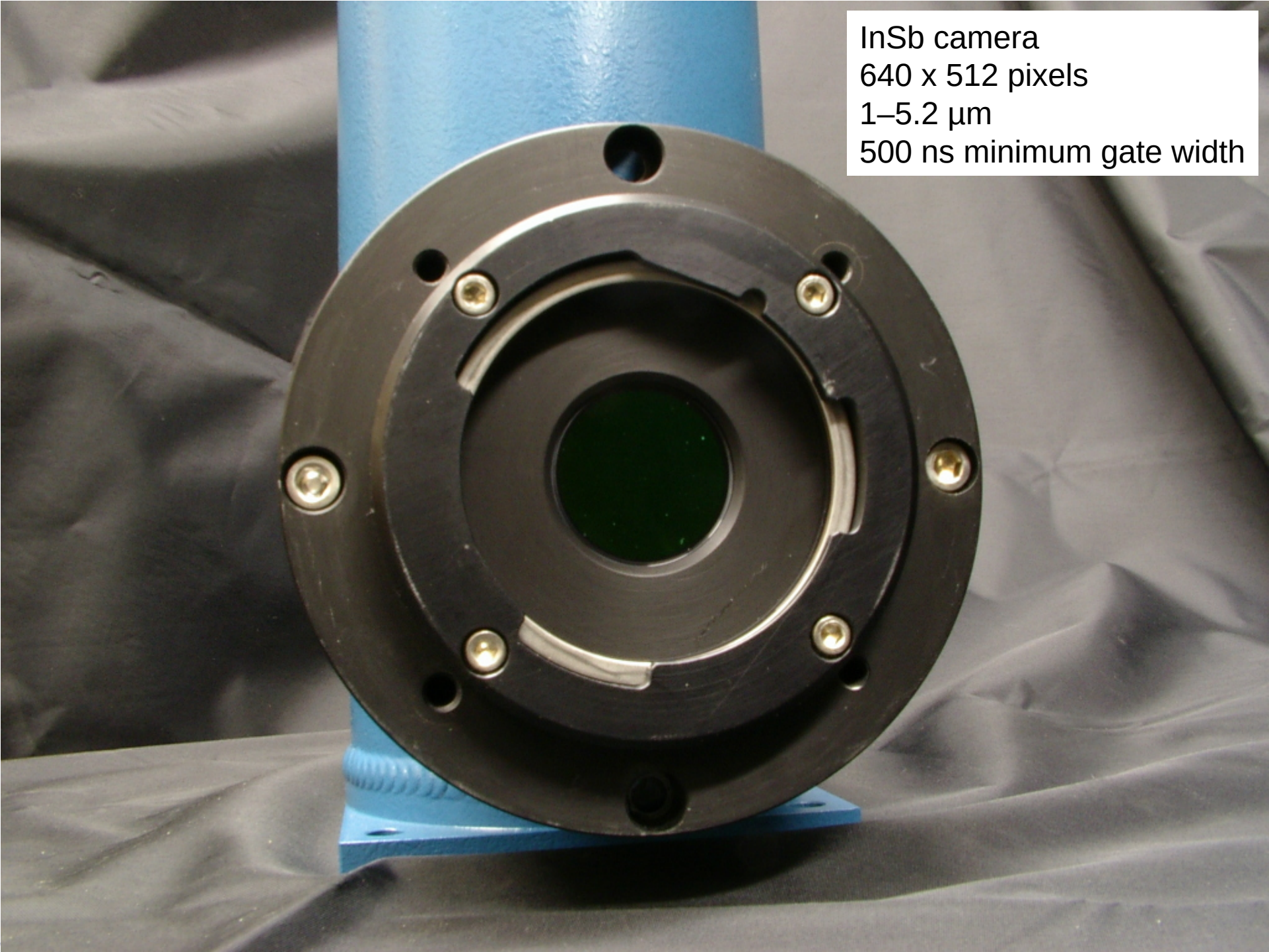


Figure 1: Conceptual layout for a gated IR spectrometer (not to scale). Given our previous experience with parabolic mirrors, 1:1 imaging with low reflectance angles is desirable.

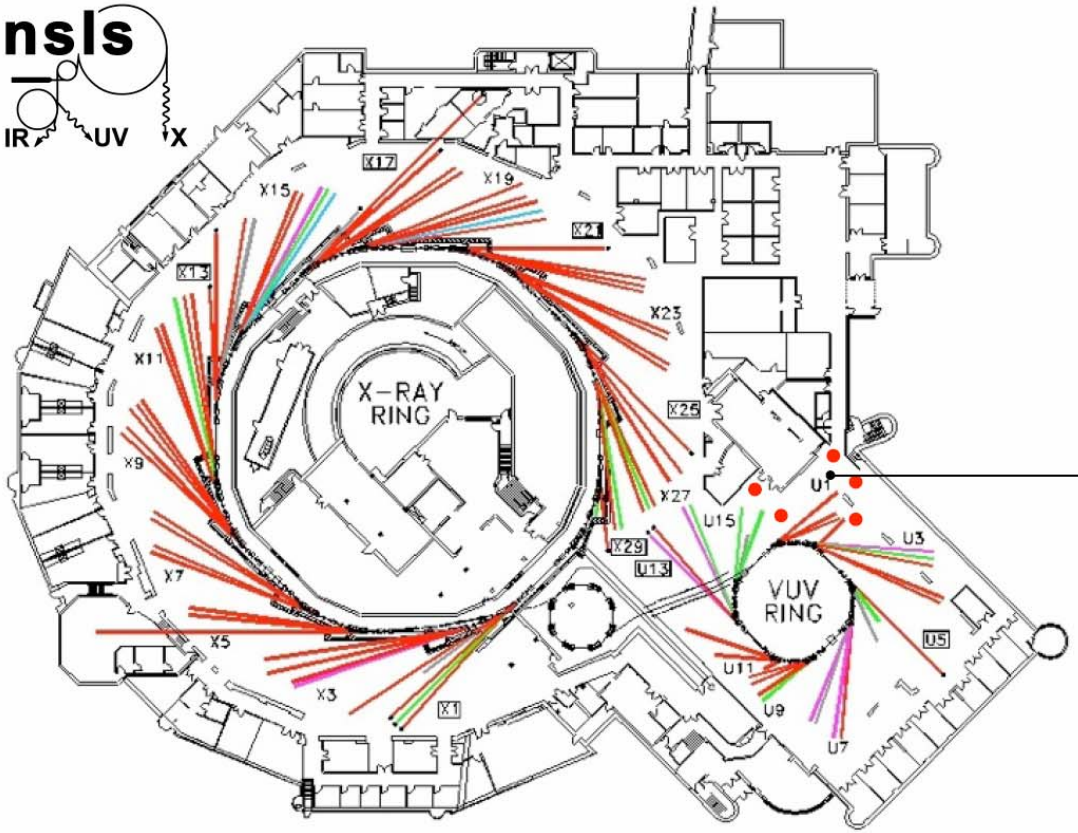
We were looking for new applications for this IR camera.

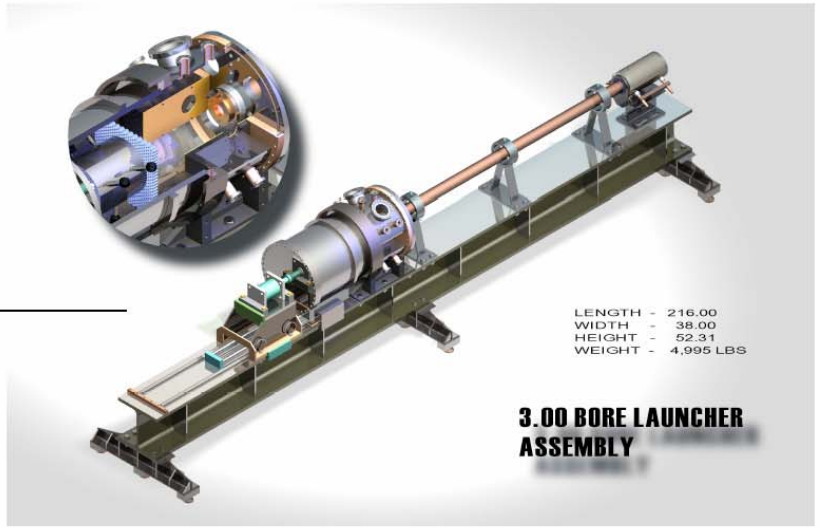
InSb camera
640 x 512 pixels
1–5.2 µm
500 ns minimum gate width

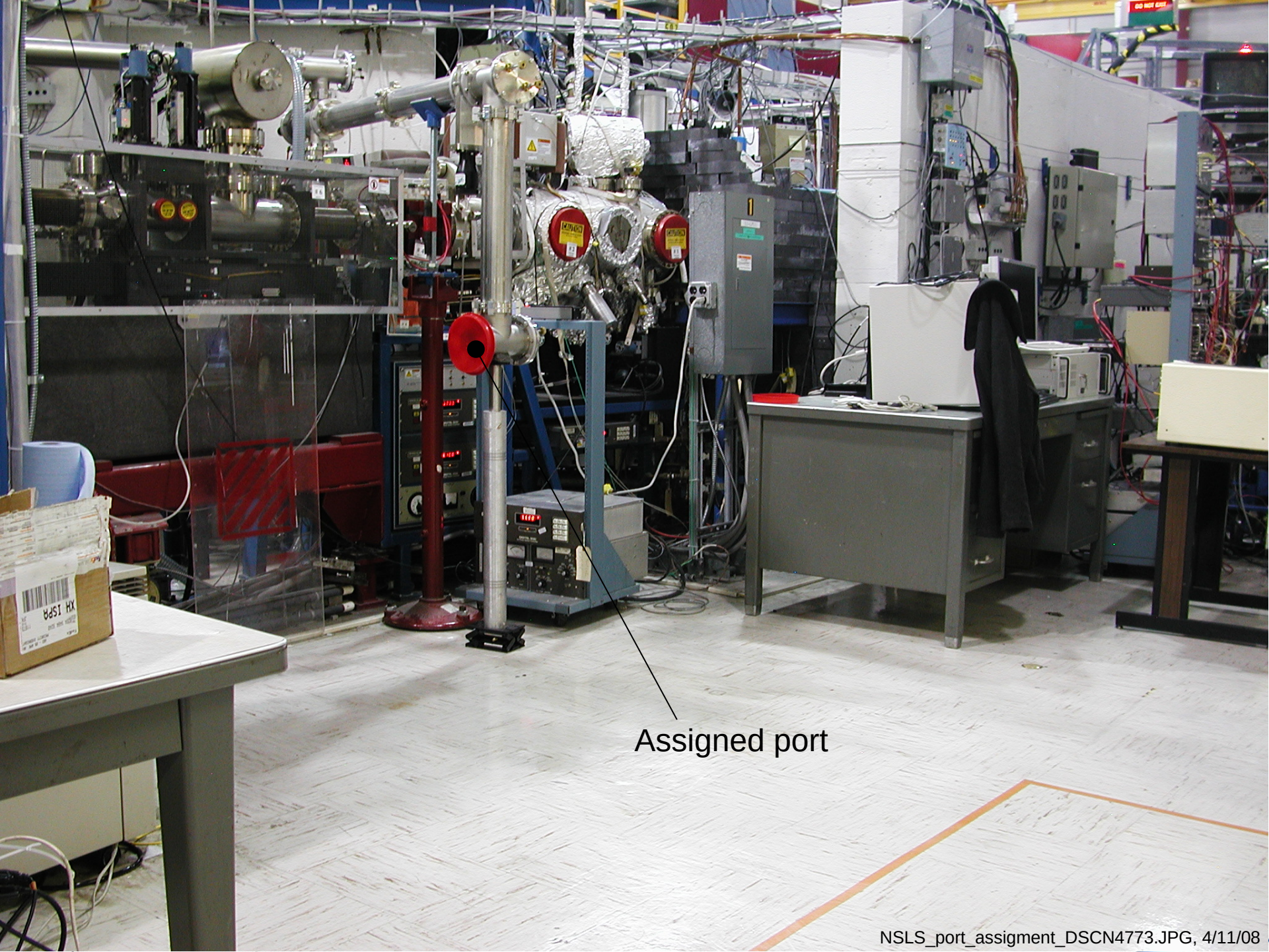



InSb camera
640 x 512 pixels
1–5.2 µm
500 ns minimum gate width

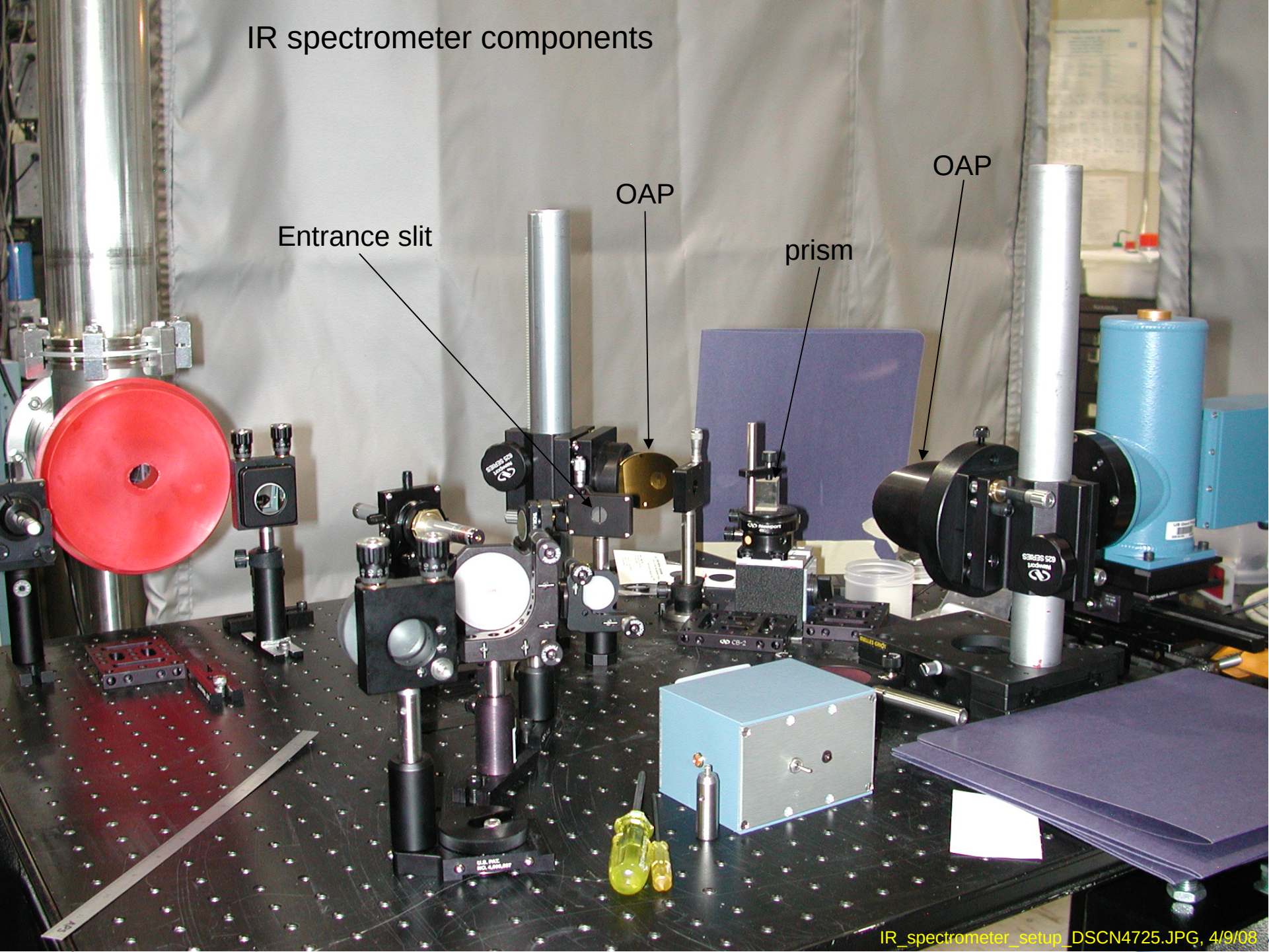
Brookhaven National Synchrotron Light Source (NSLS)



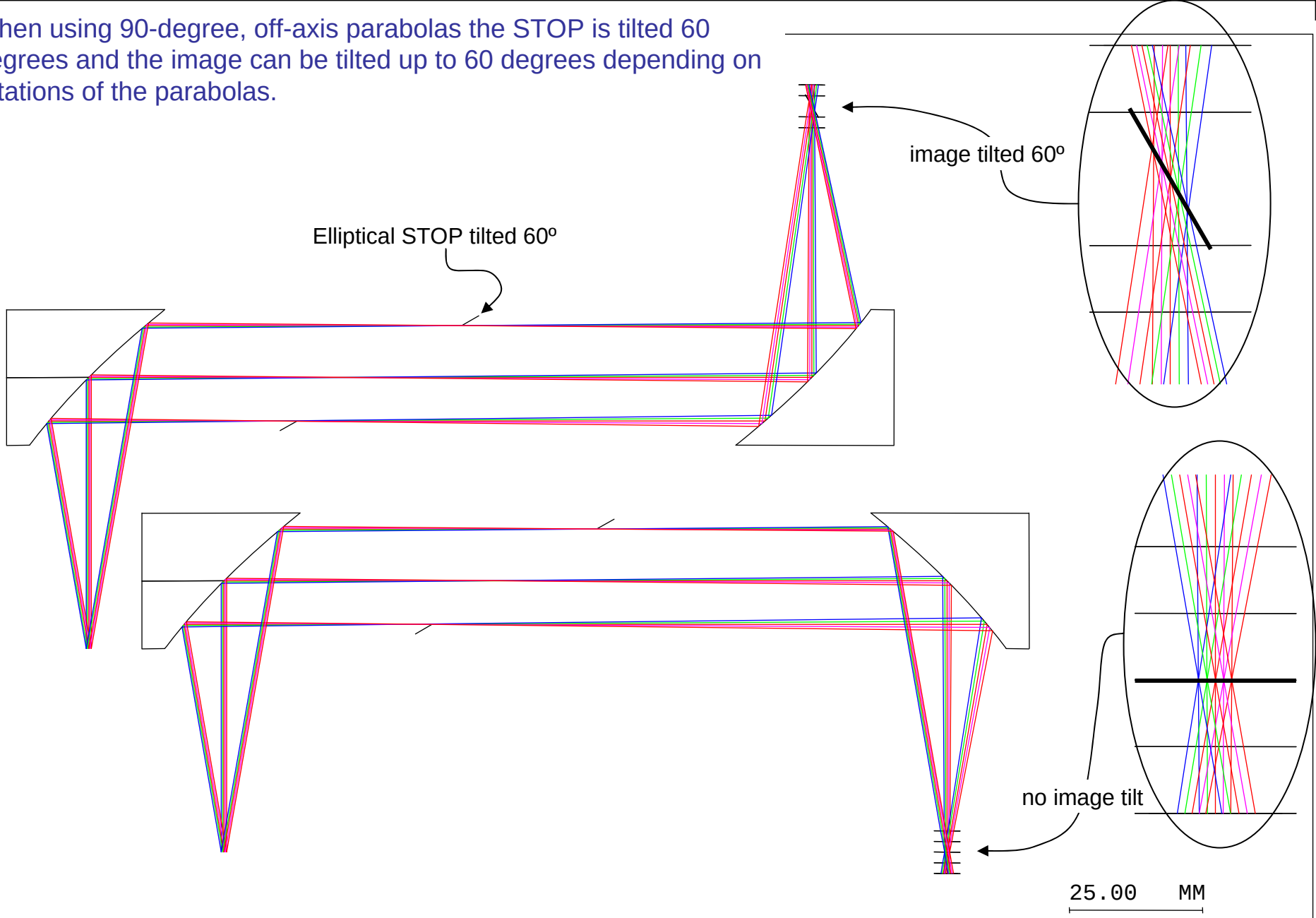




NSLS_port_assigment_DSCN4773.JPG, 4/11/08


IR spectrometer components
Entrance slit
OAP
prism
OAP
IR_spectrometer_setup_DSCN4725.JPG, 4/9/08

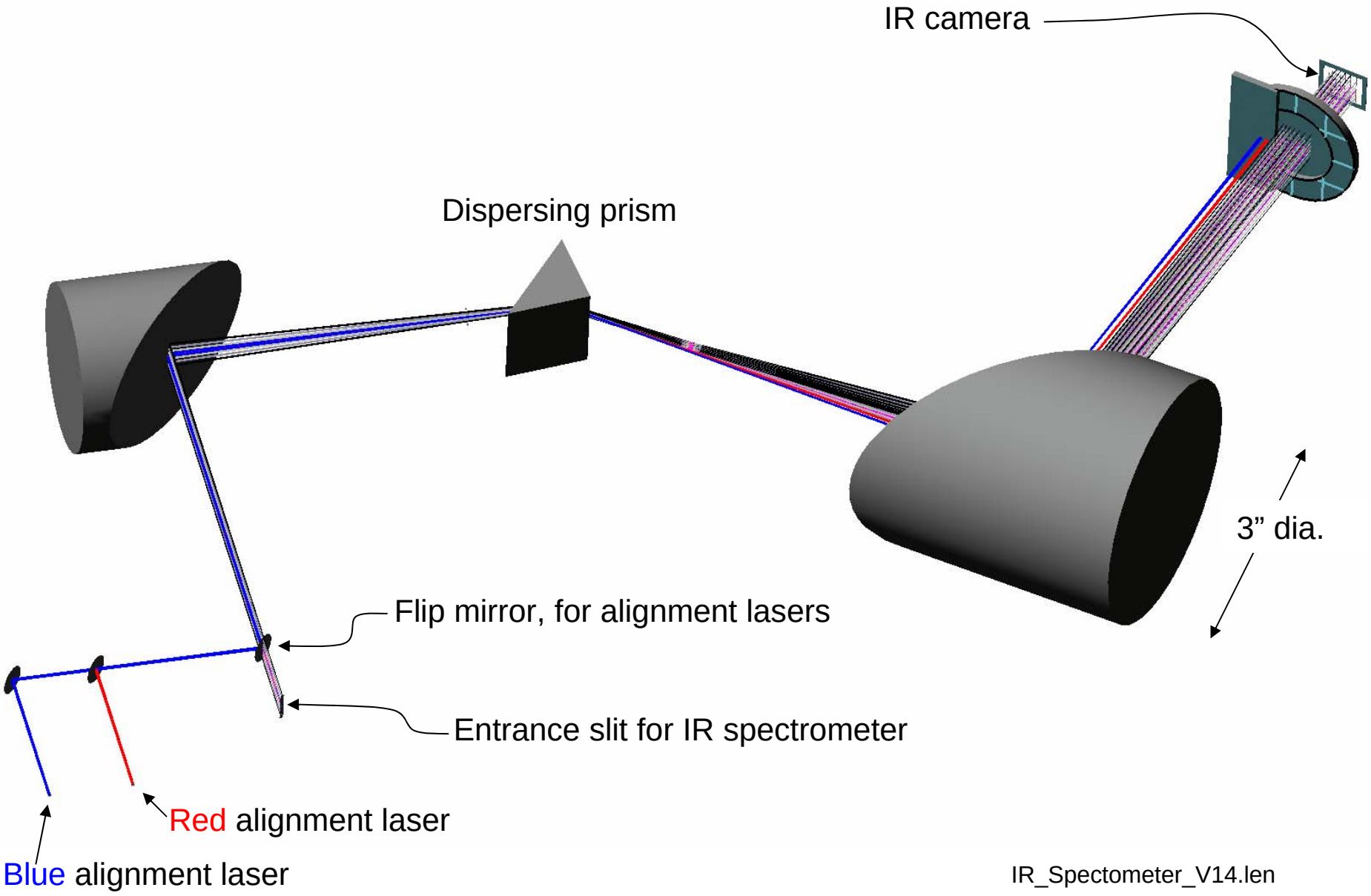
When using 90-degree, off-axis parabolas the STOP is tilted 60 degrees and the image can be tilted up to 60 degrees depending on rotations of the parabolas.



Parabolic_pair_1-1_imaging_V1.len

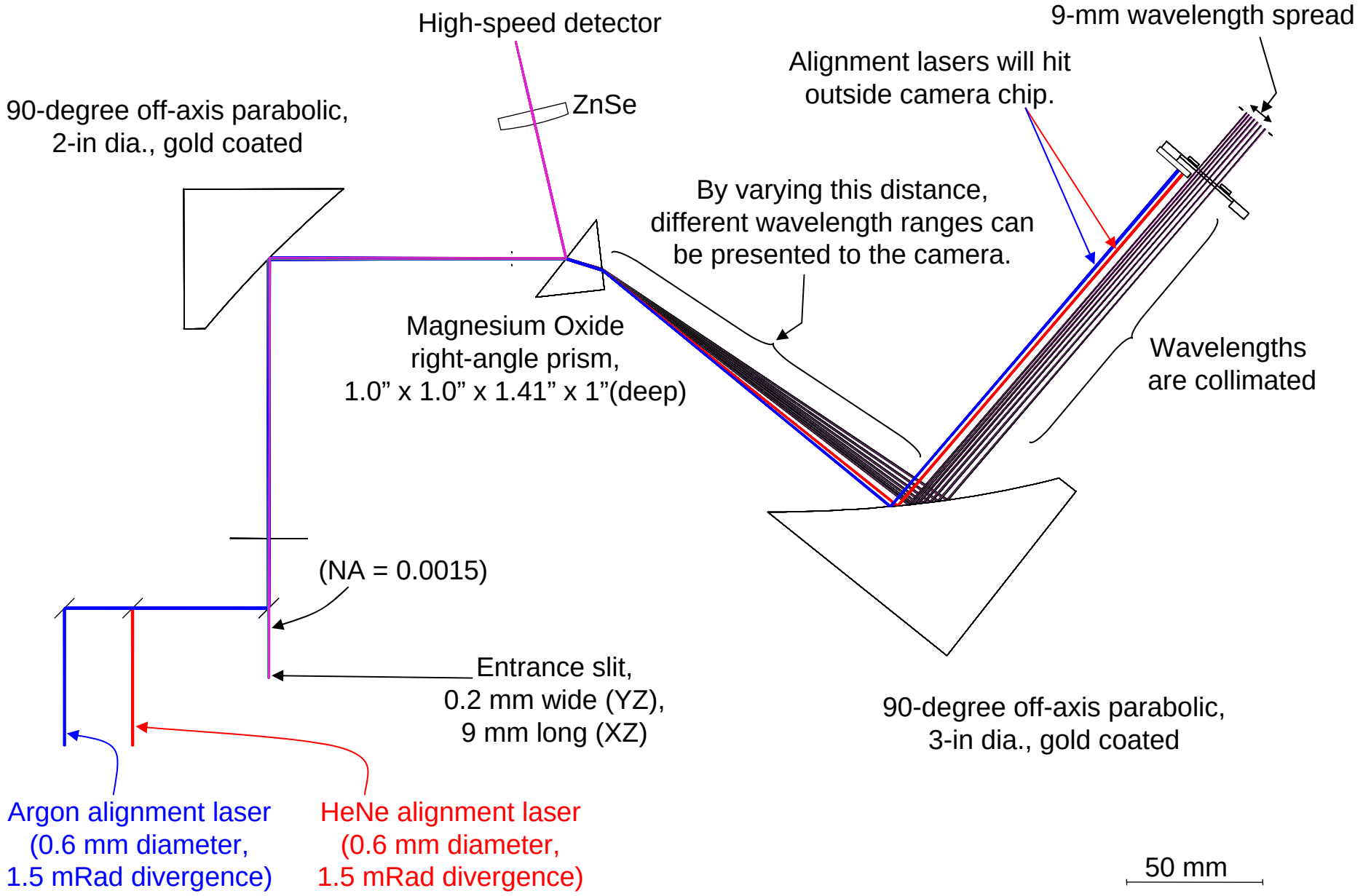
Positions: 1-2 RMM 08-Nov-07

Brookhaven NSLS Infrared Spectrometer Design

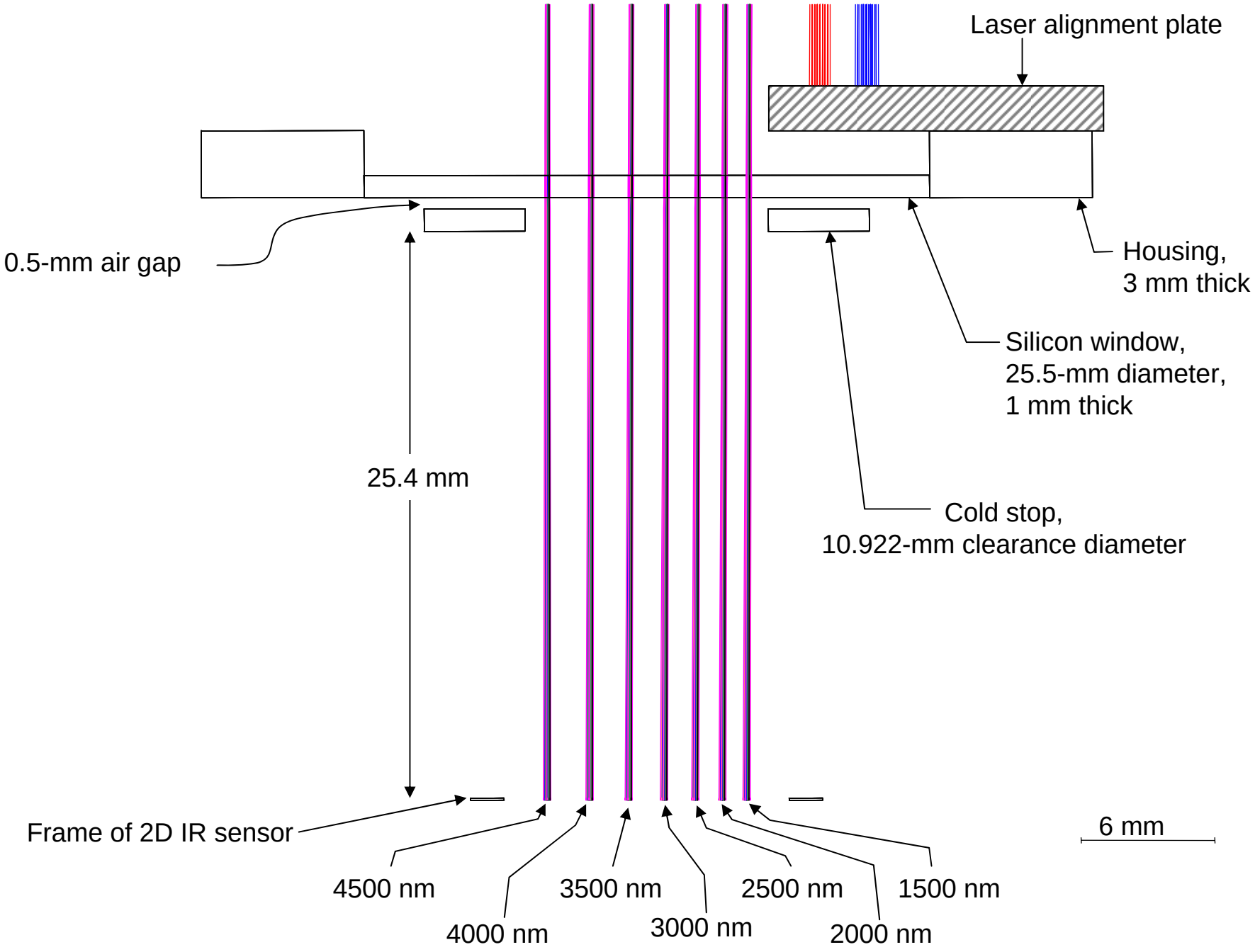


IR_Spectometer_V14.len

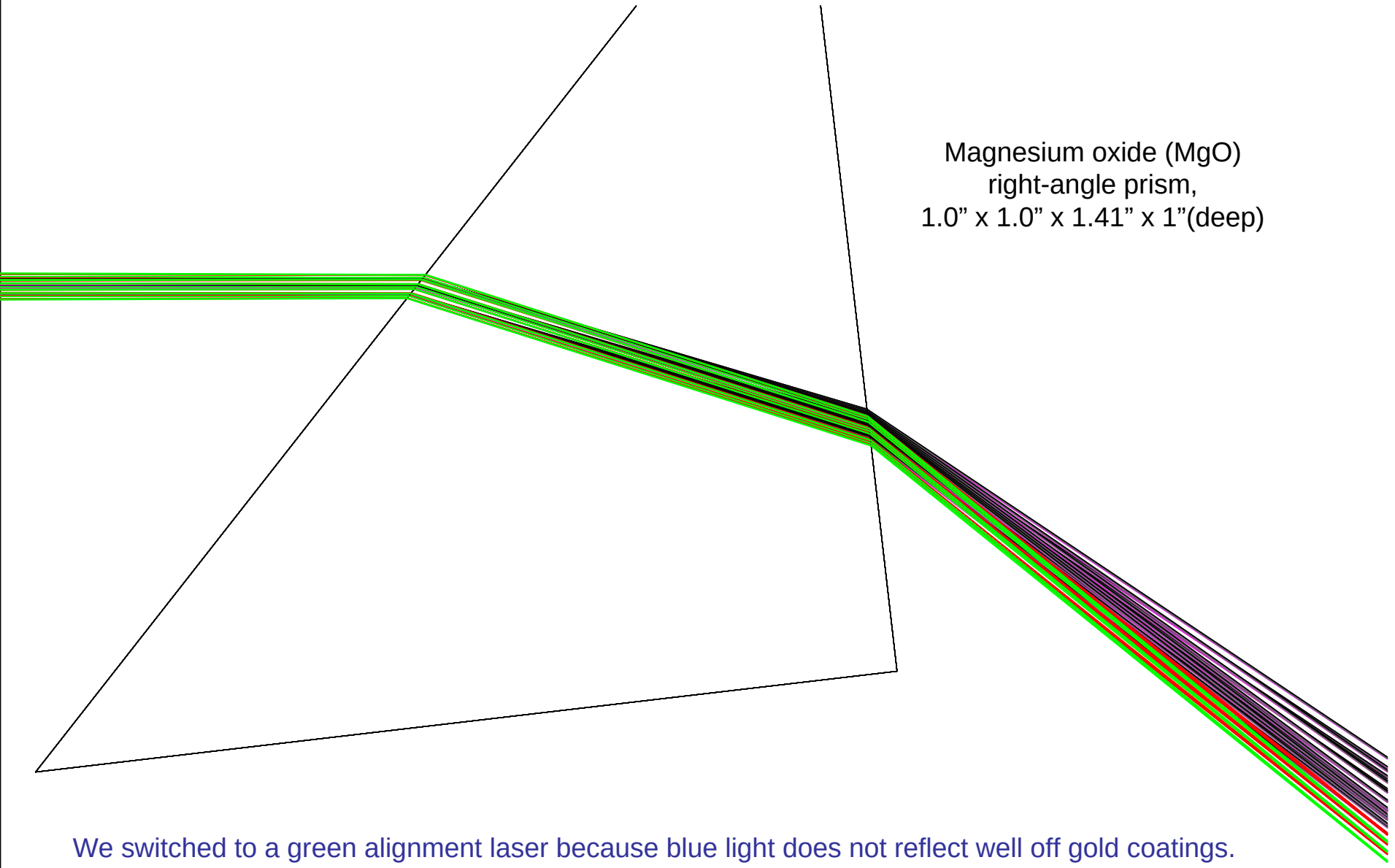
Optical components used for the IR spectrometer.



Wavelengths are spread unequally across the IR imaging array.



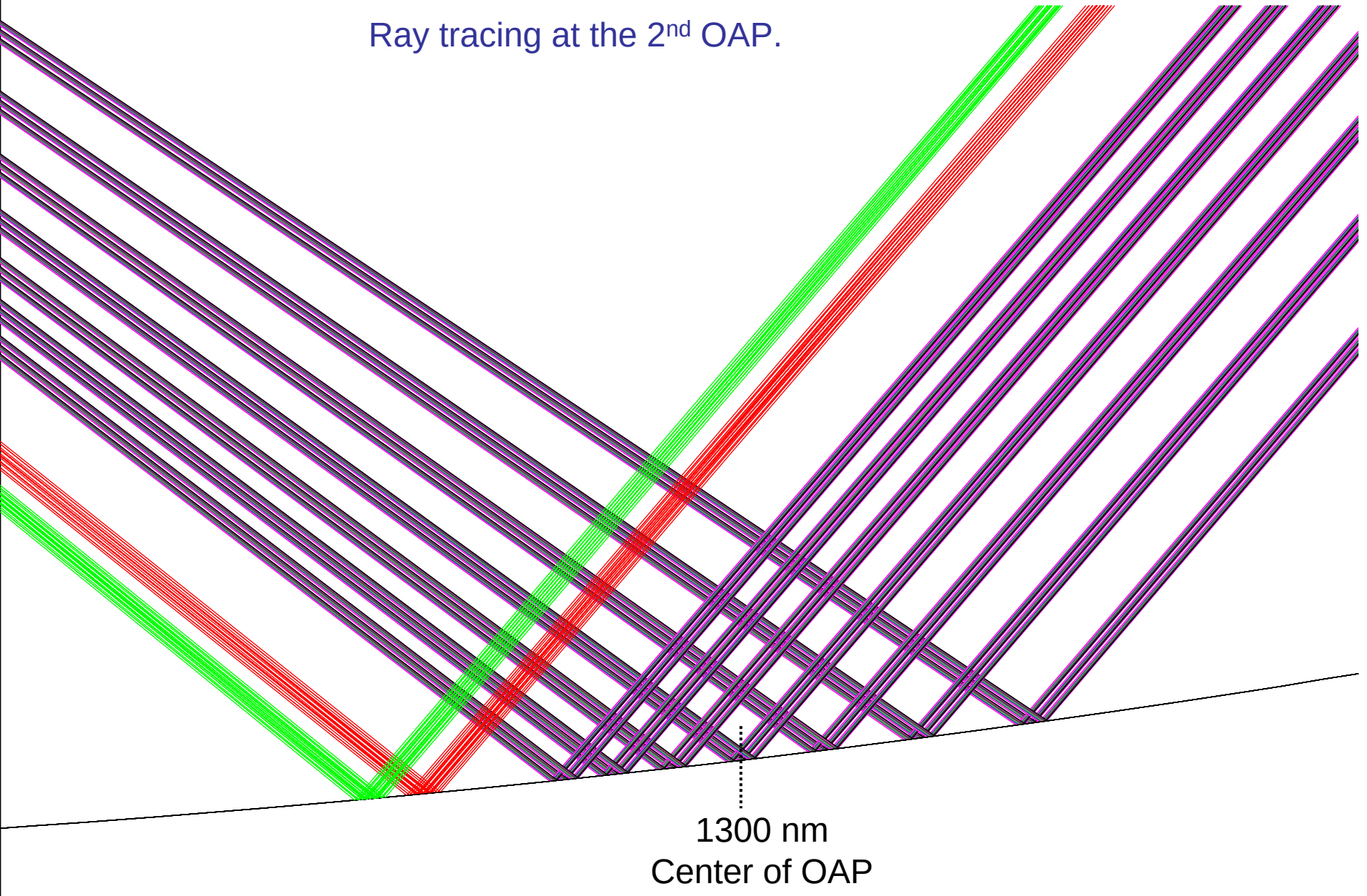
Ray tracing through the MgO dispersion prism.

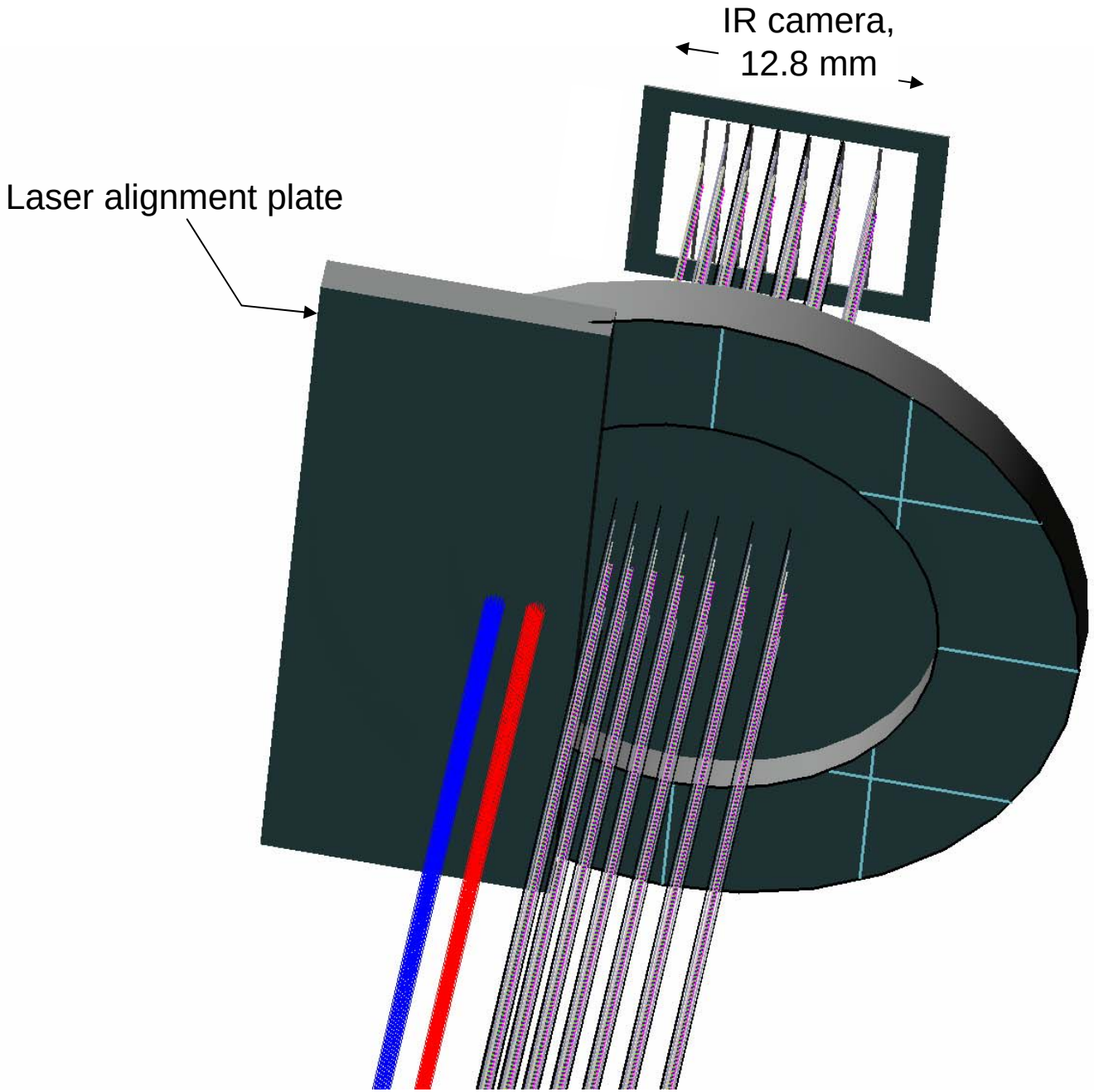


Magnesium oxide (MgO)
right-angle prism,
1.0” x 1.0” x 1.41” x 1”(deep)

We switched to a green alignment laser because blue light does not reflect well off gold coatings.

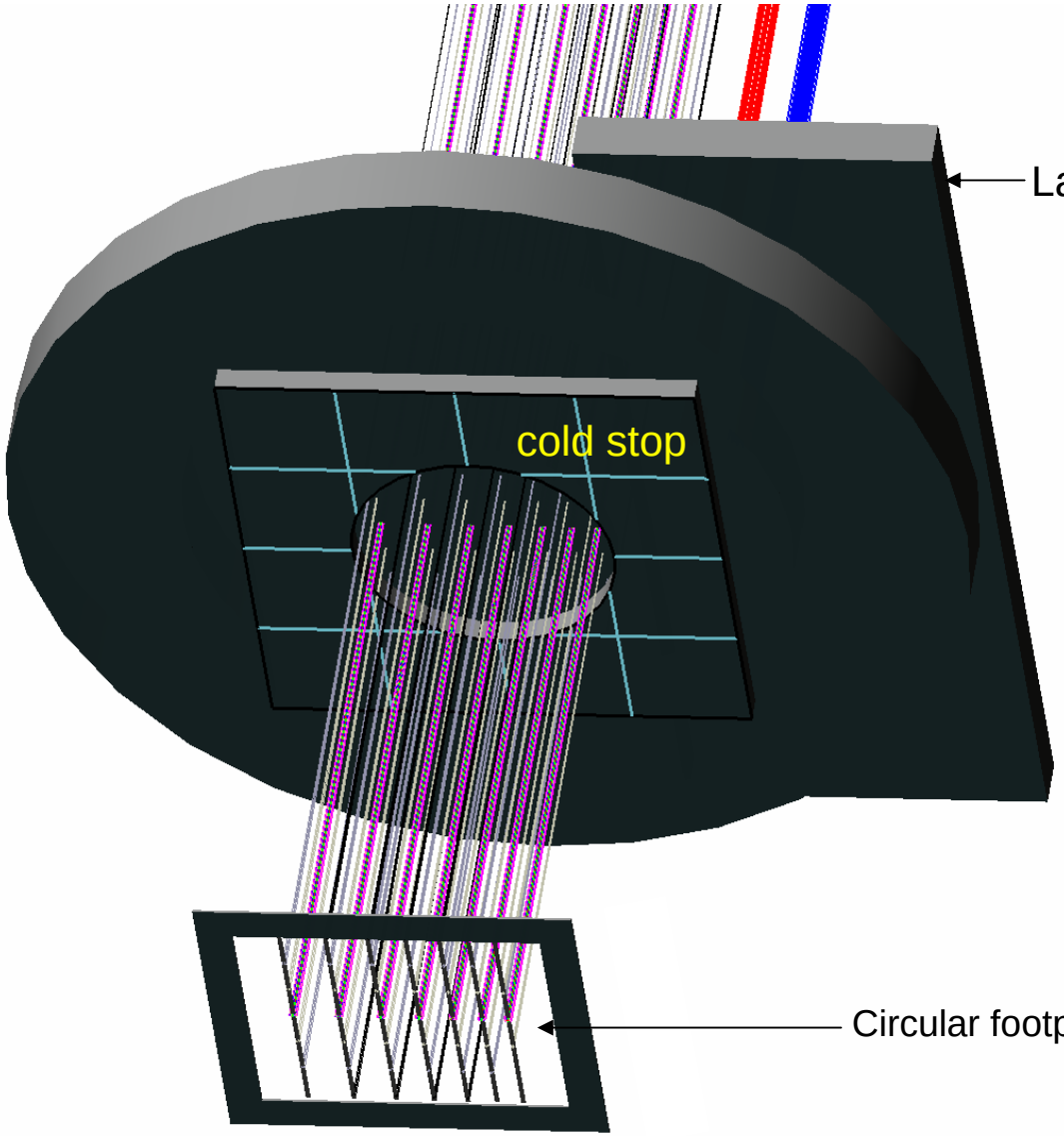
Ray tracing at the 2nd OAP.



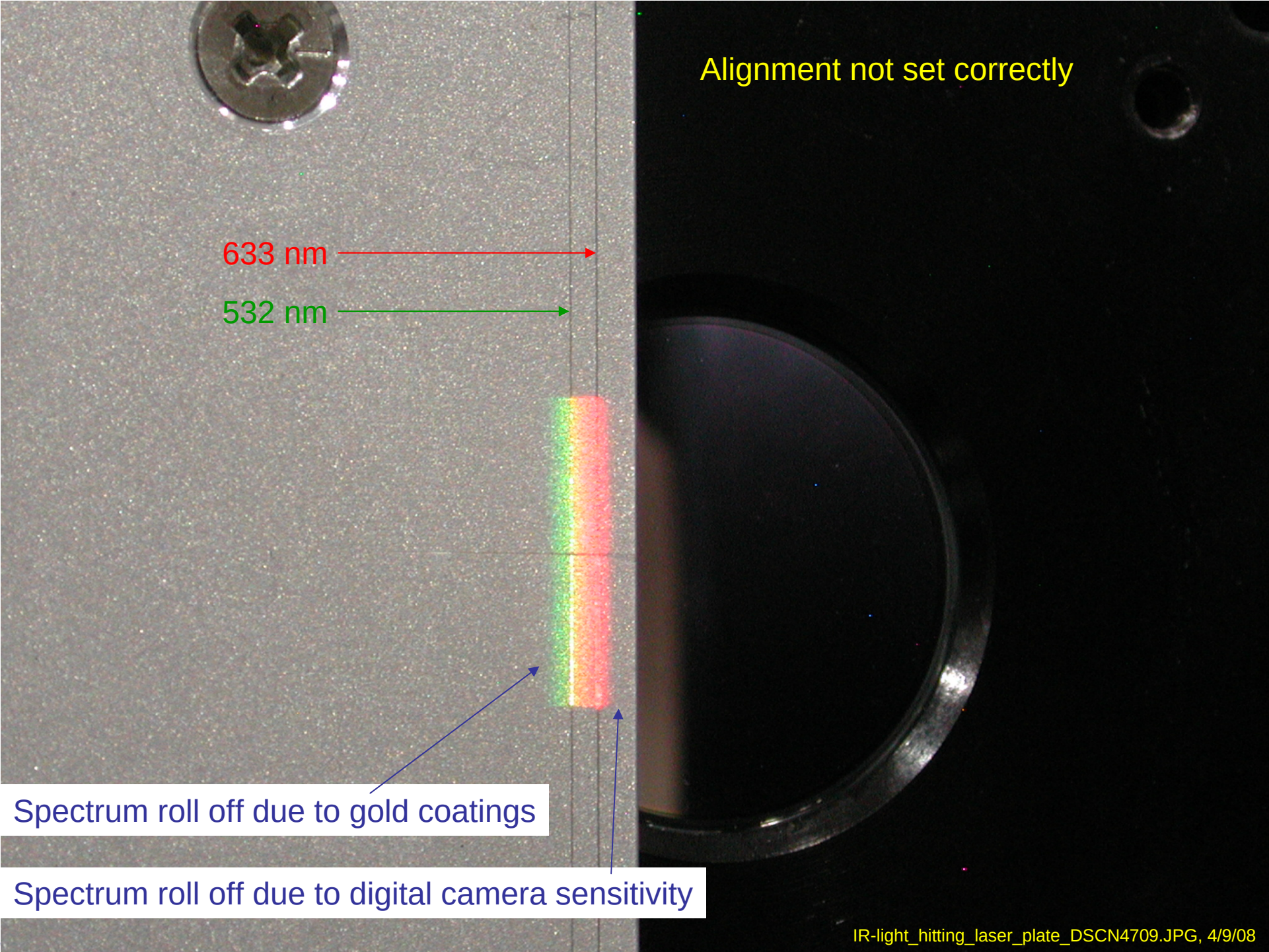


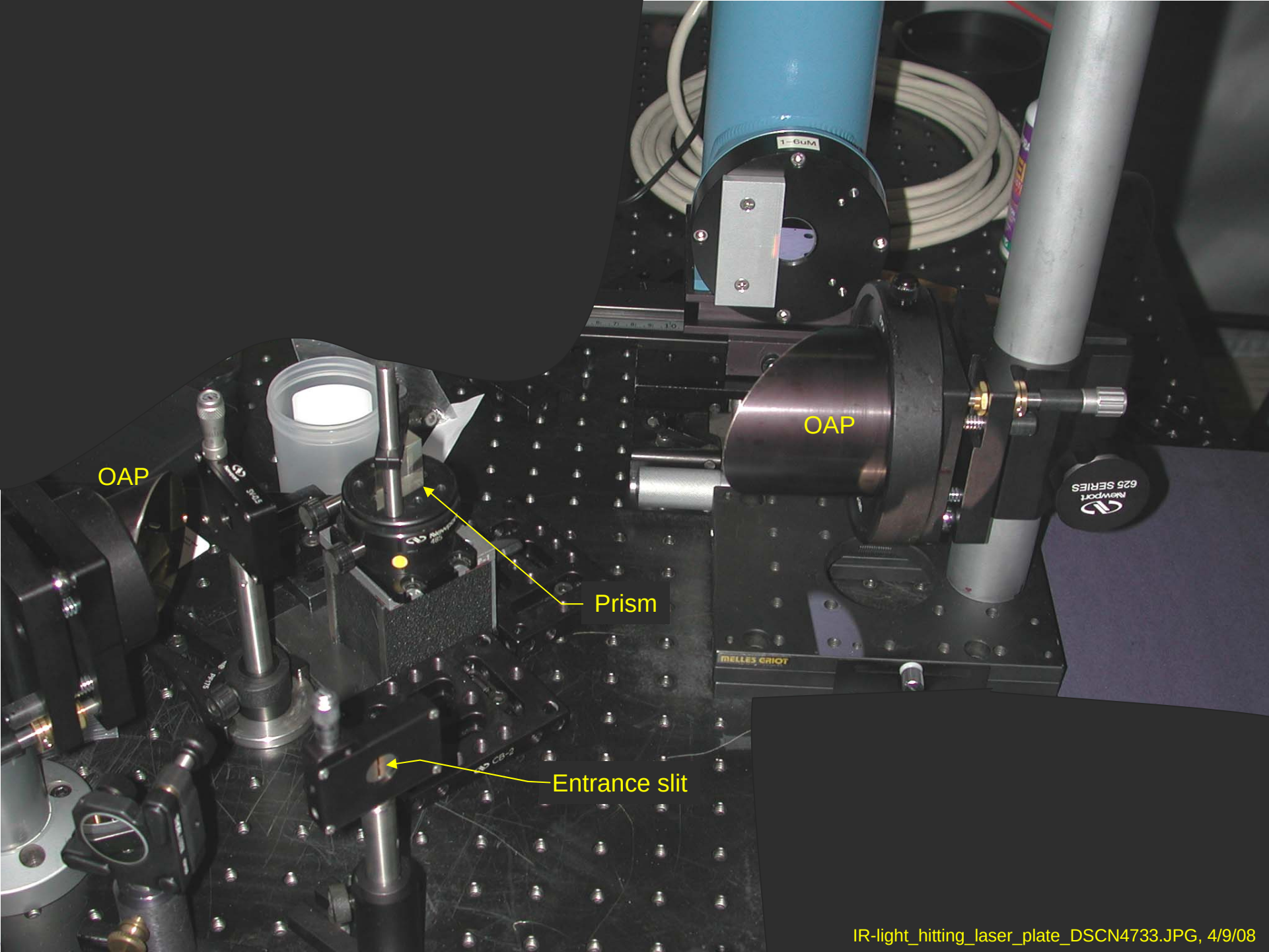
IR_Spectometer_V14.len

The circular cold stop will clip light at the edges of the wavelength range.



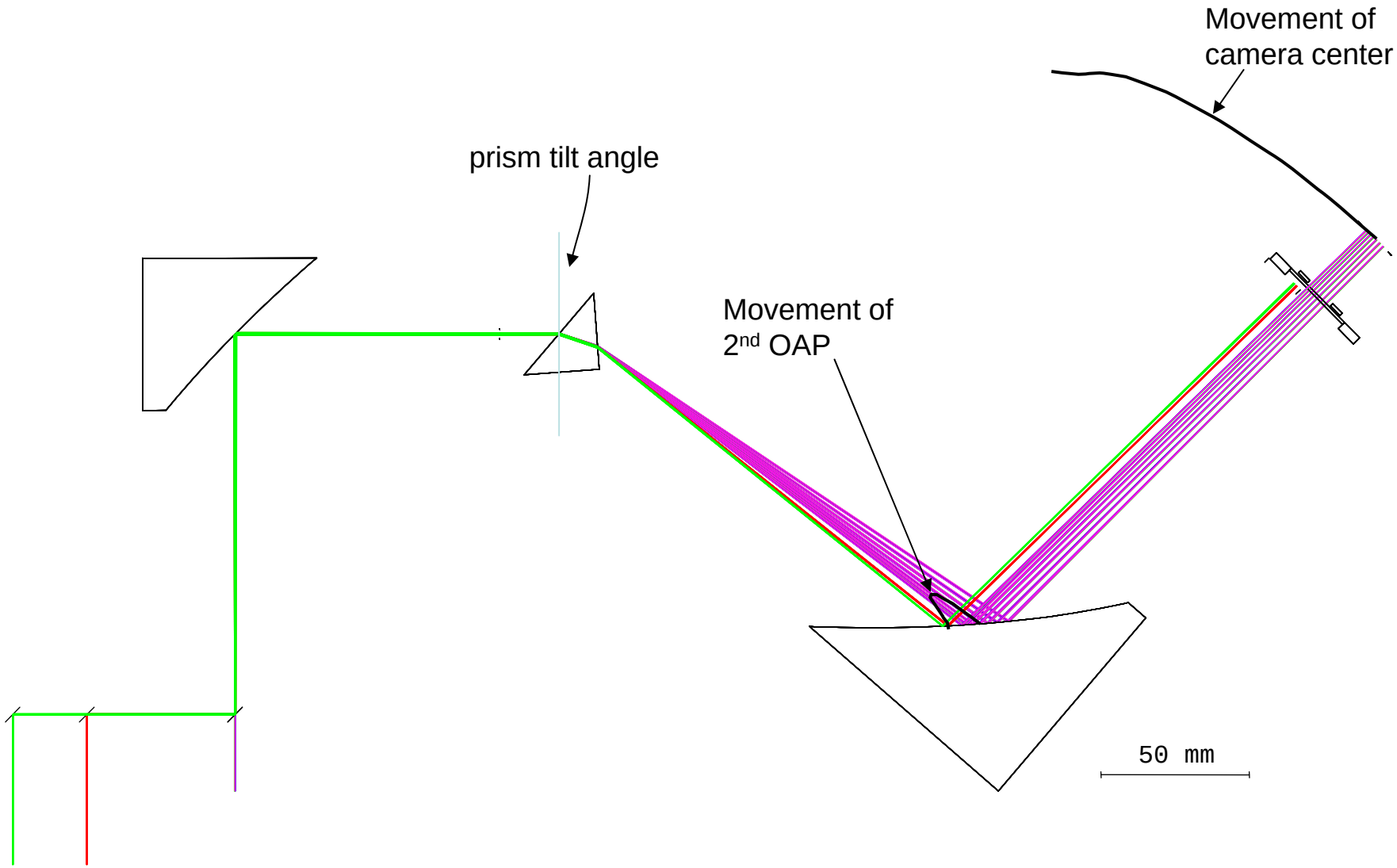
IR_Spectometer_V14.len


Alignment not set correctly
633 nm
532 nm
Spectrum roll off due to gold coatings
Spectrum roll off due to digital camera sensitivity
IR-light_hitting_laser_plate_DSCN4709.JPG, 4/9/08



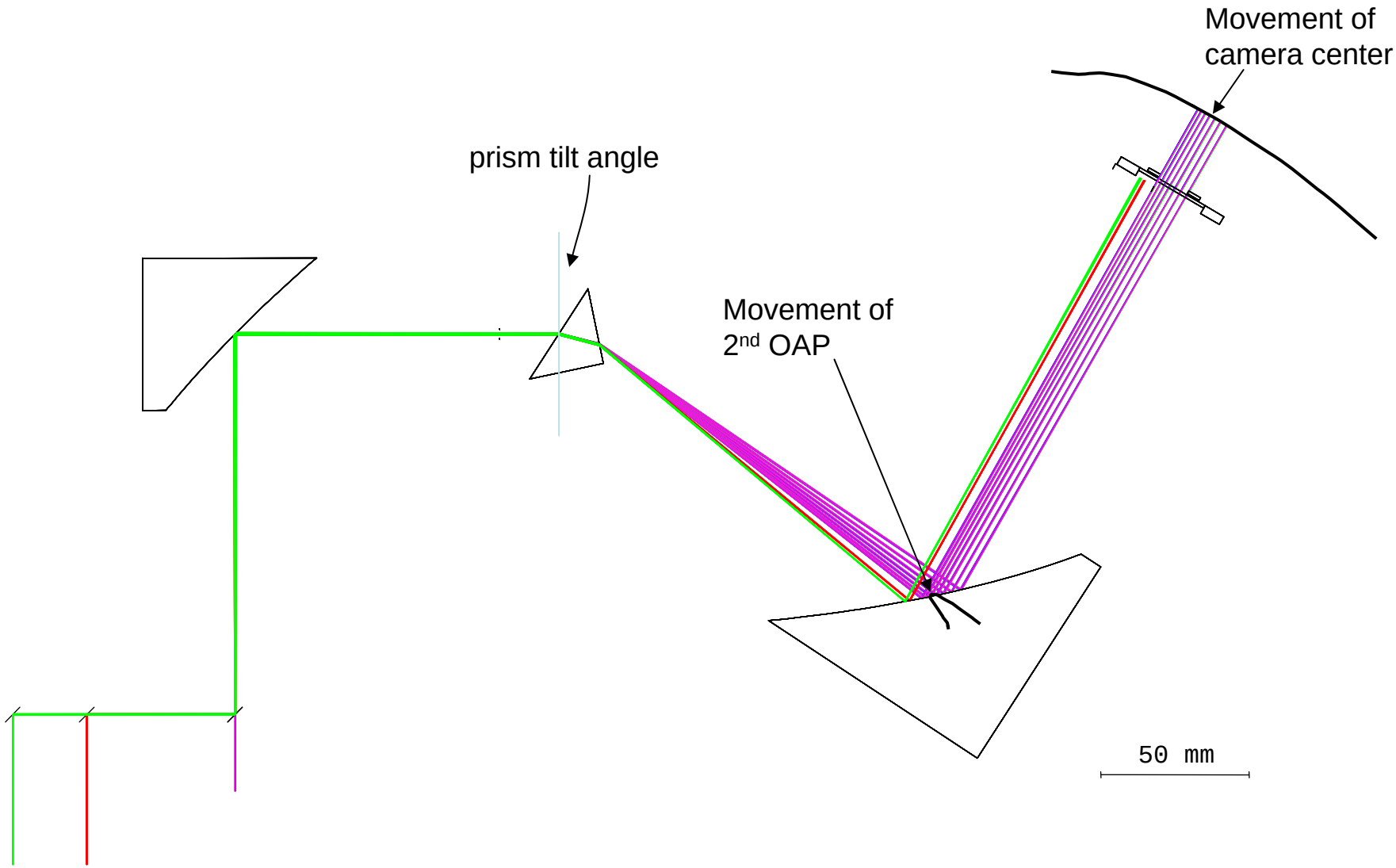
IR-light_hitting_laser_plate_DSCN4733.JPG, 4/9/08

Adjusting the wavelength spread received by the IR camera.



Centering middle λ (3000 nm) on parabolic mirror center

Adjusting the wavelength spread received by the IR camera.



Centering middle λ (3000 nm) on parabolic mirror center

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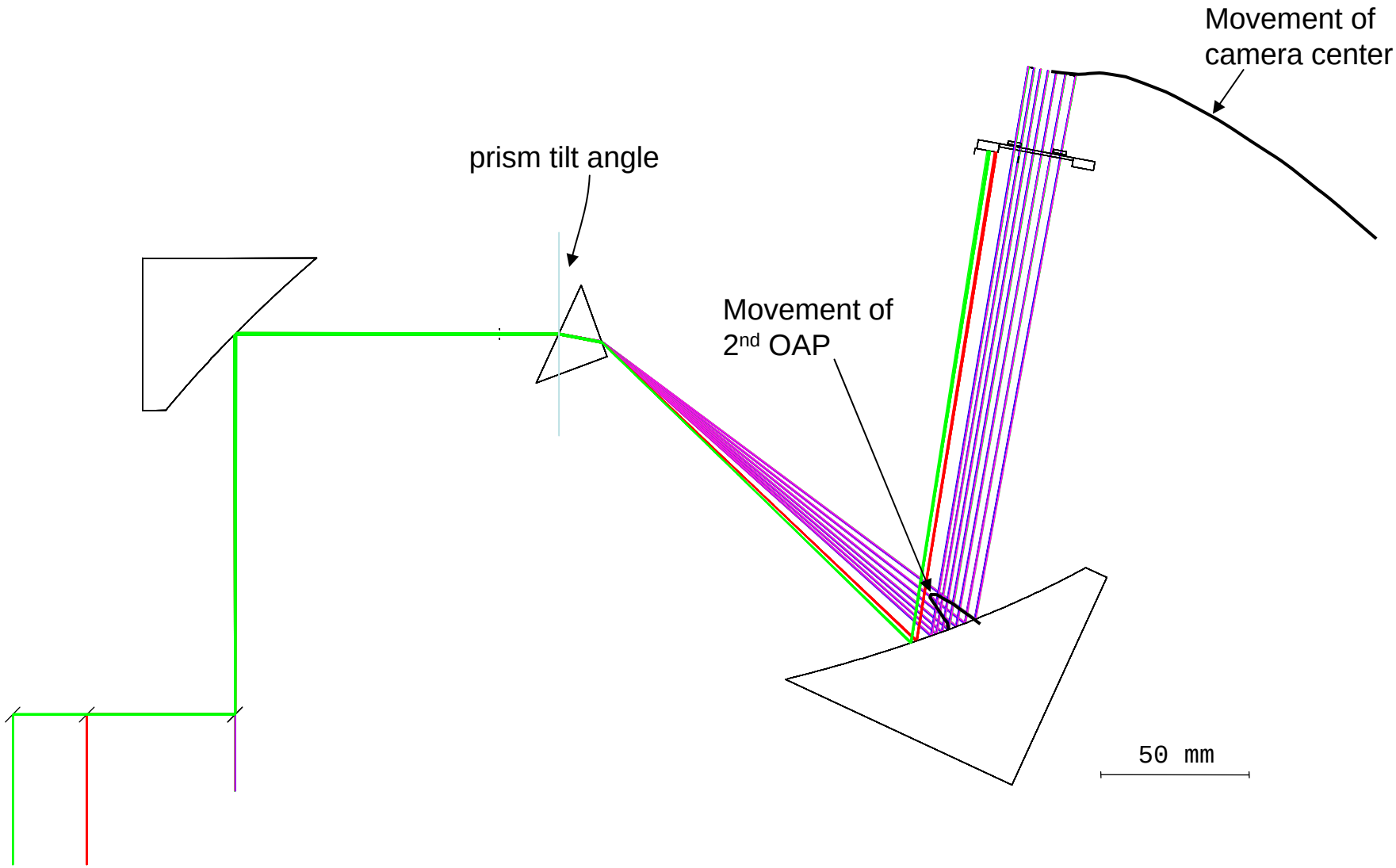
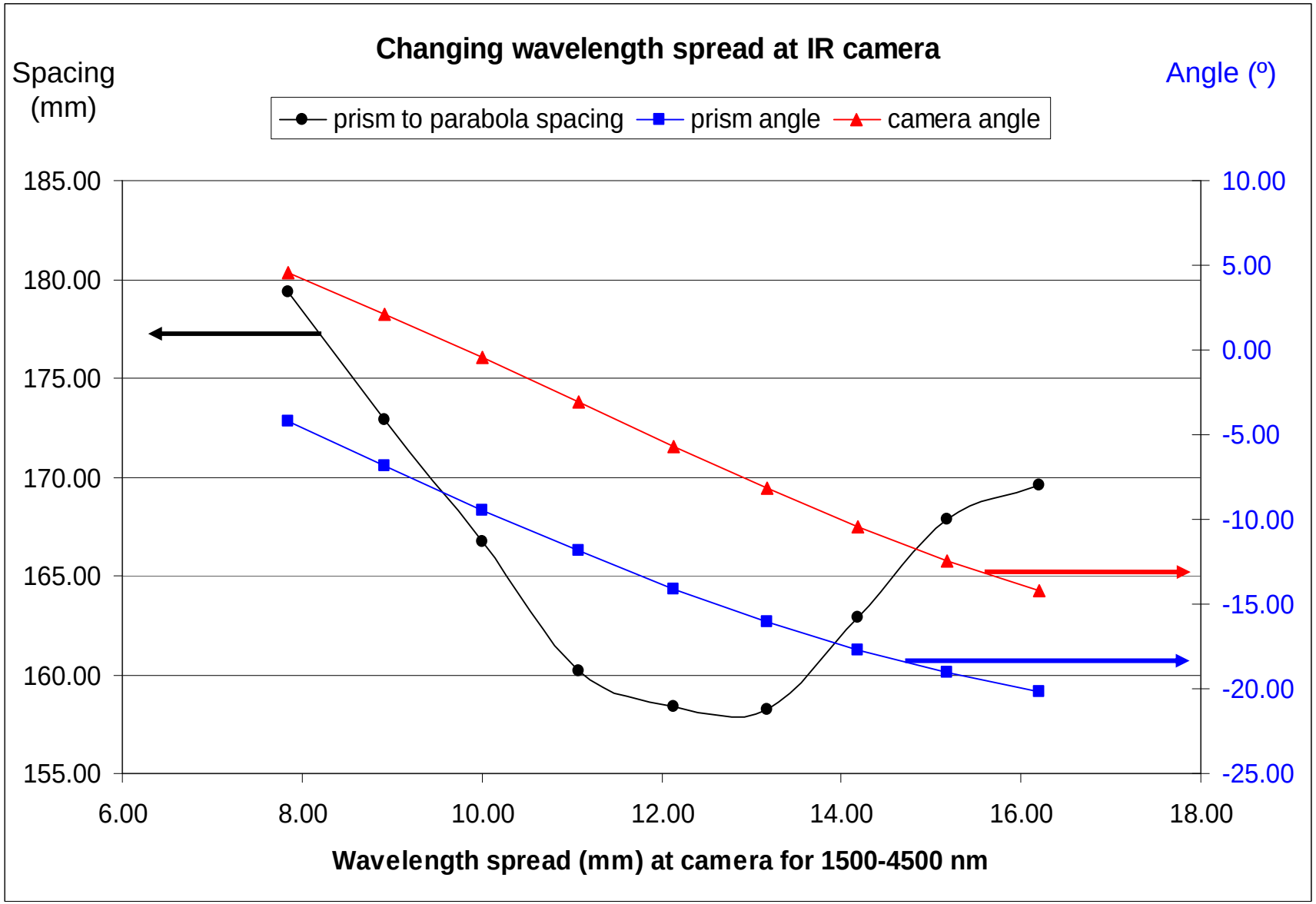
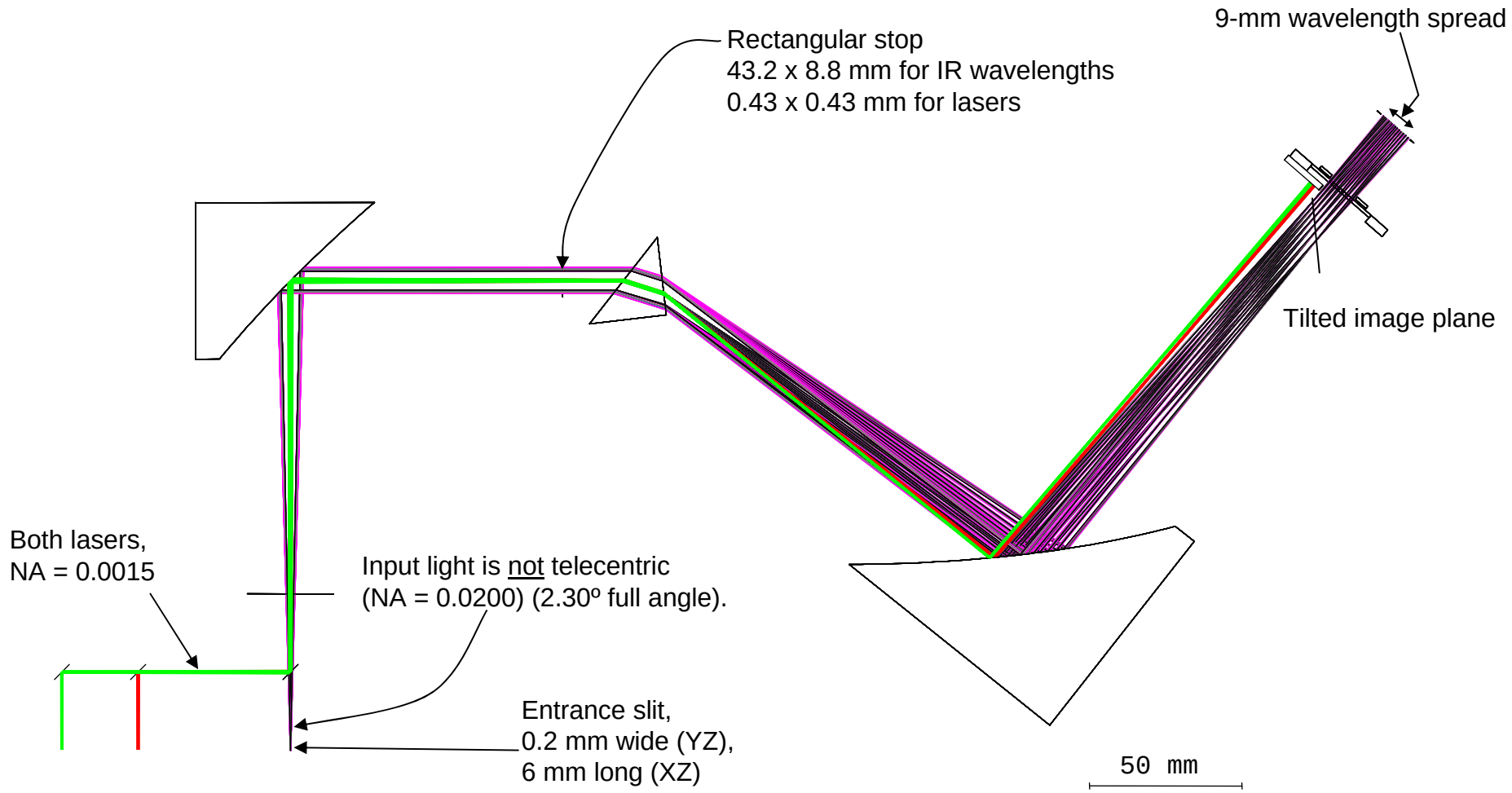


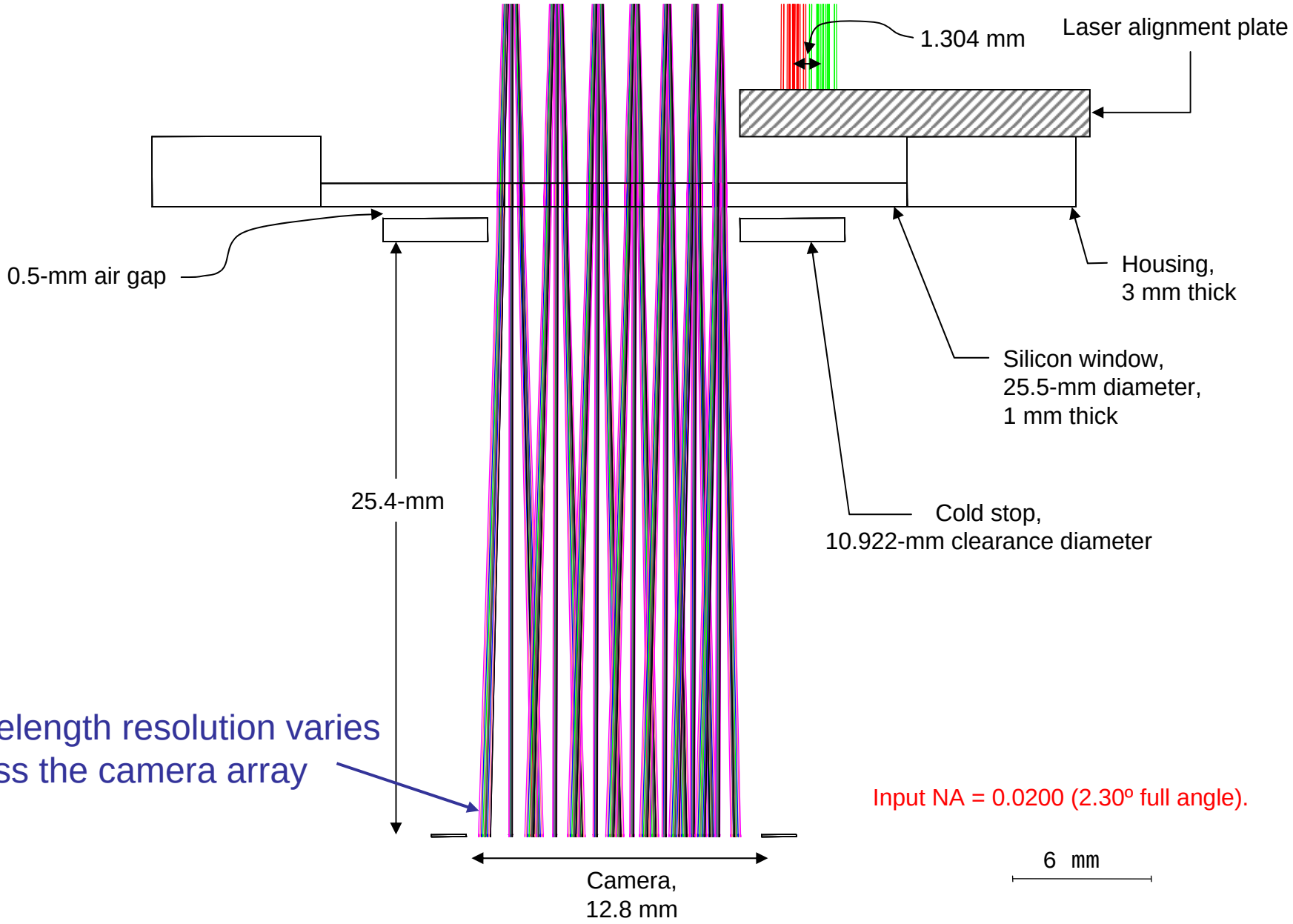
Centering middle λ (3000 nm) on parabolic mirror center


Changing wavelength spread at IR camera
Spacing (mm)
Angle (º)
prism to parabola spacing
prism angle
camera angle
185.00
180.00
175.00
170.00
165.00
160.00
155.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
Wavelength spread (mm) at camera for 1500-4500 nm

Changing the divergence of the light source.

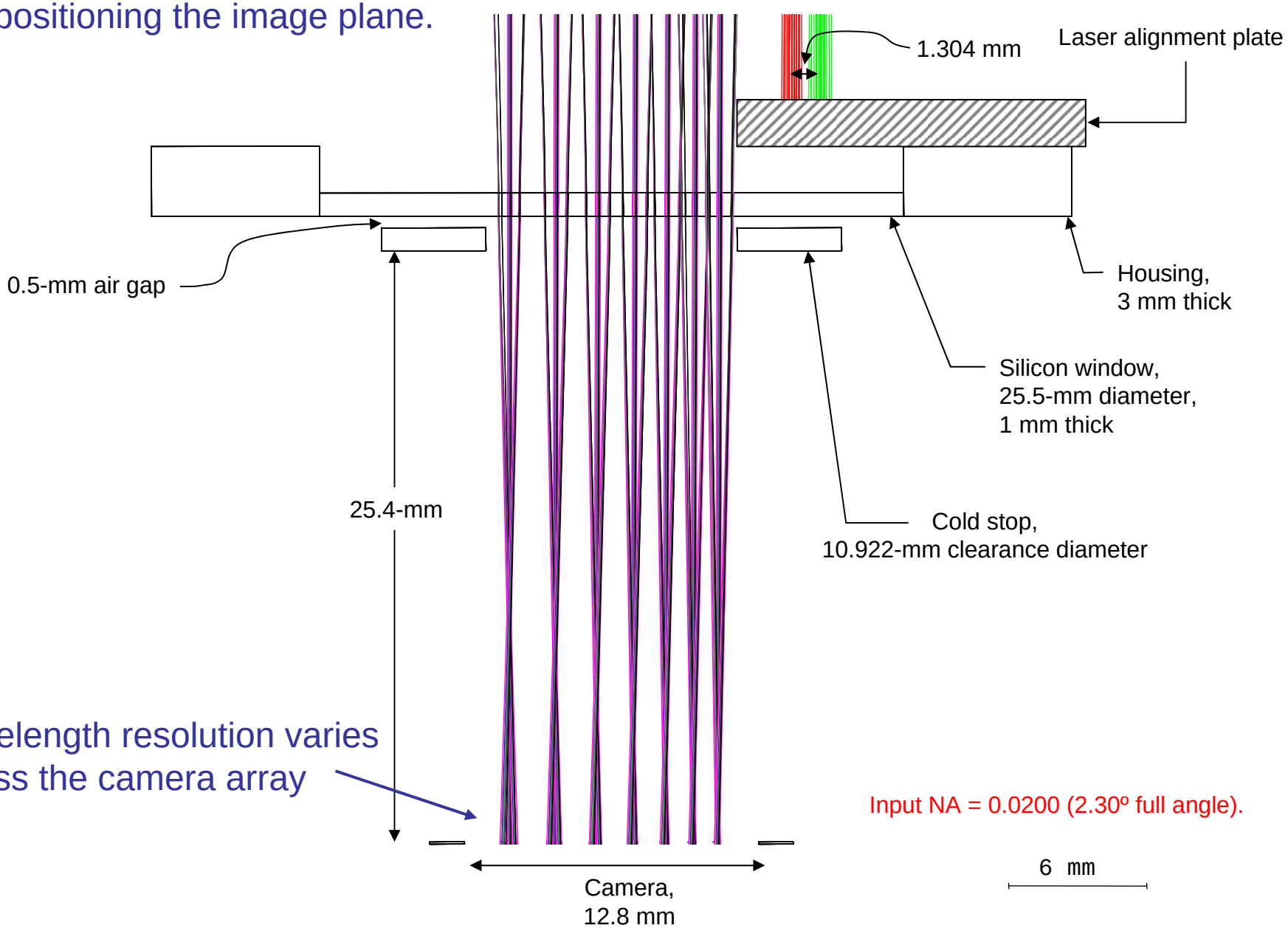


Changing the divergence of the light source.



Changing the divergence of the light source.

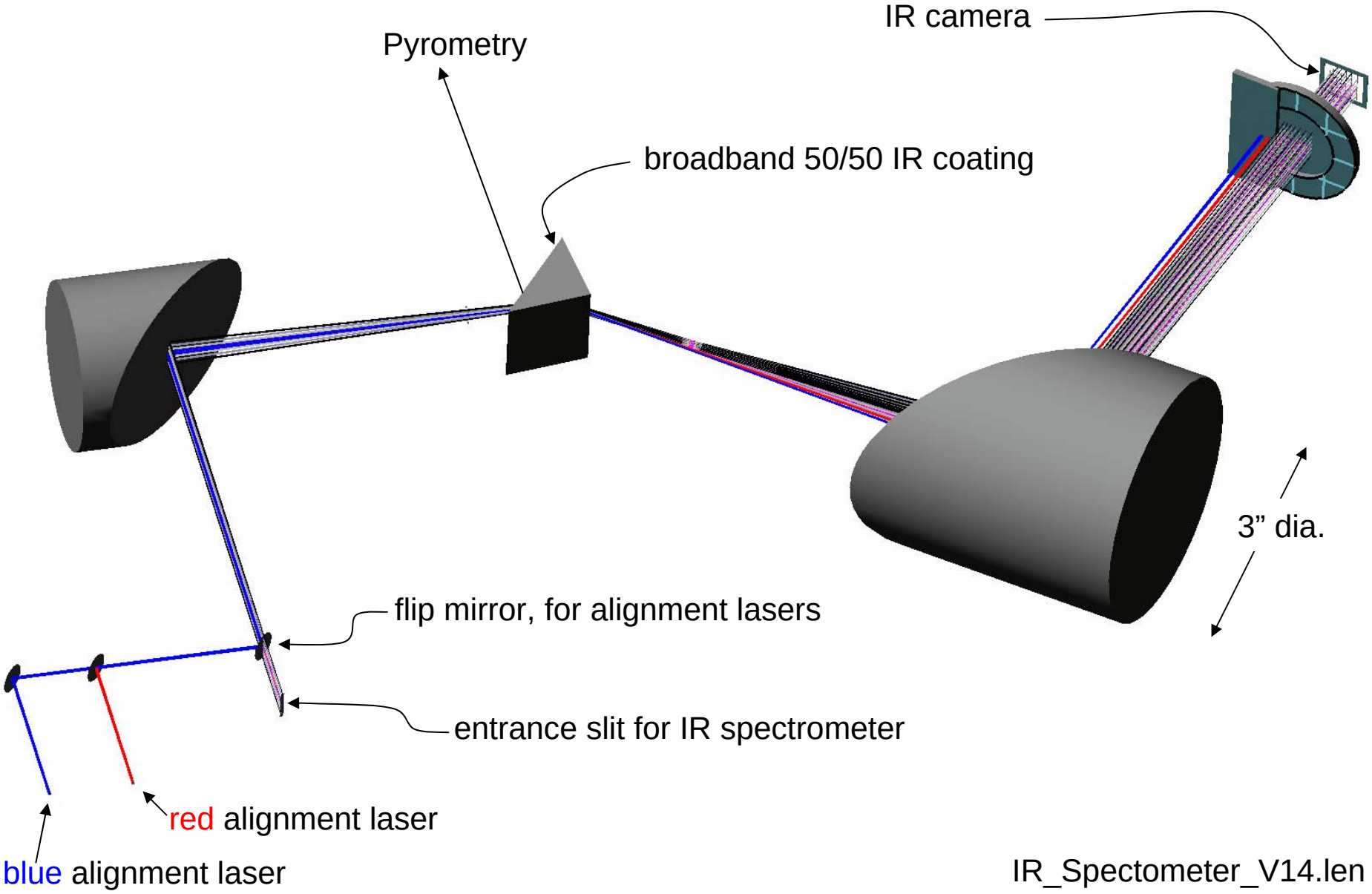
Repositioning the image plane.



Wavelength resolution varies across the camera array

Input NA = 0.0200 (2.30º full angle).

Add another 90º off-axis parabolic mirror to direct the light into a multipoint Pyrometry array.



IR_Spectometer_V14.len