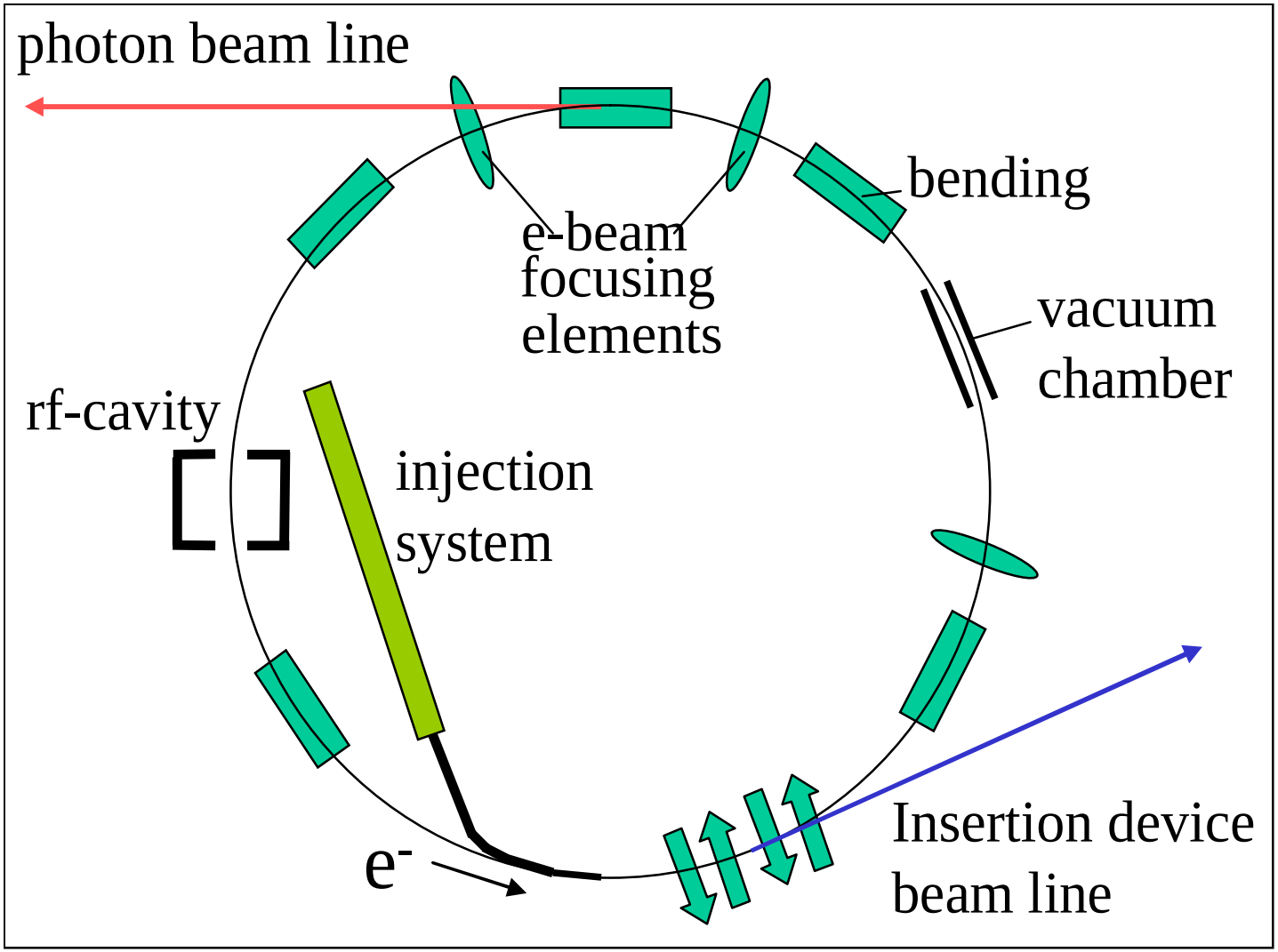
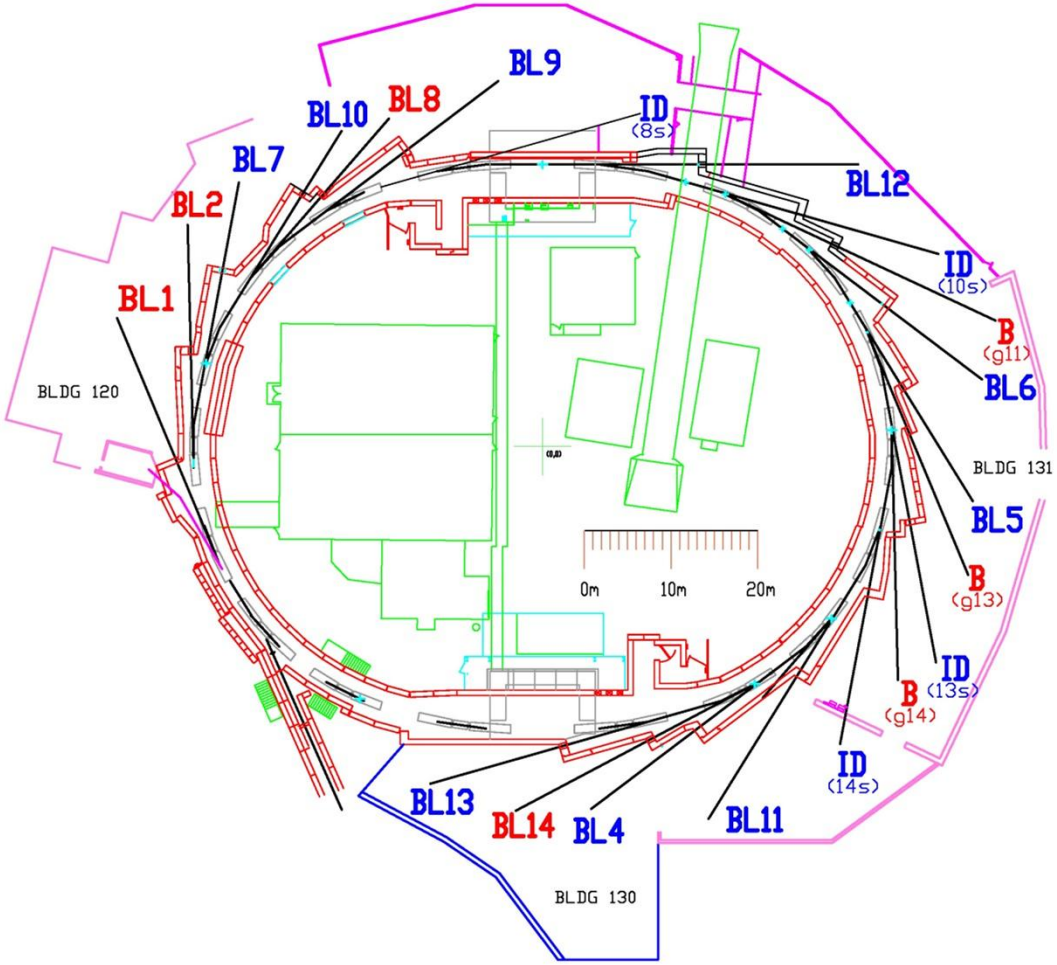
SSRL Scattering Beam Lines

Bart Johnson
Beam Line Operations

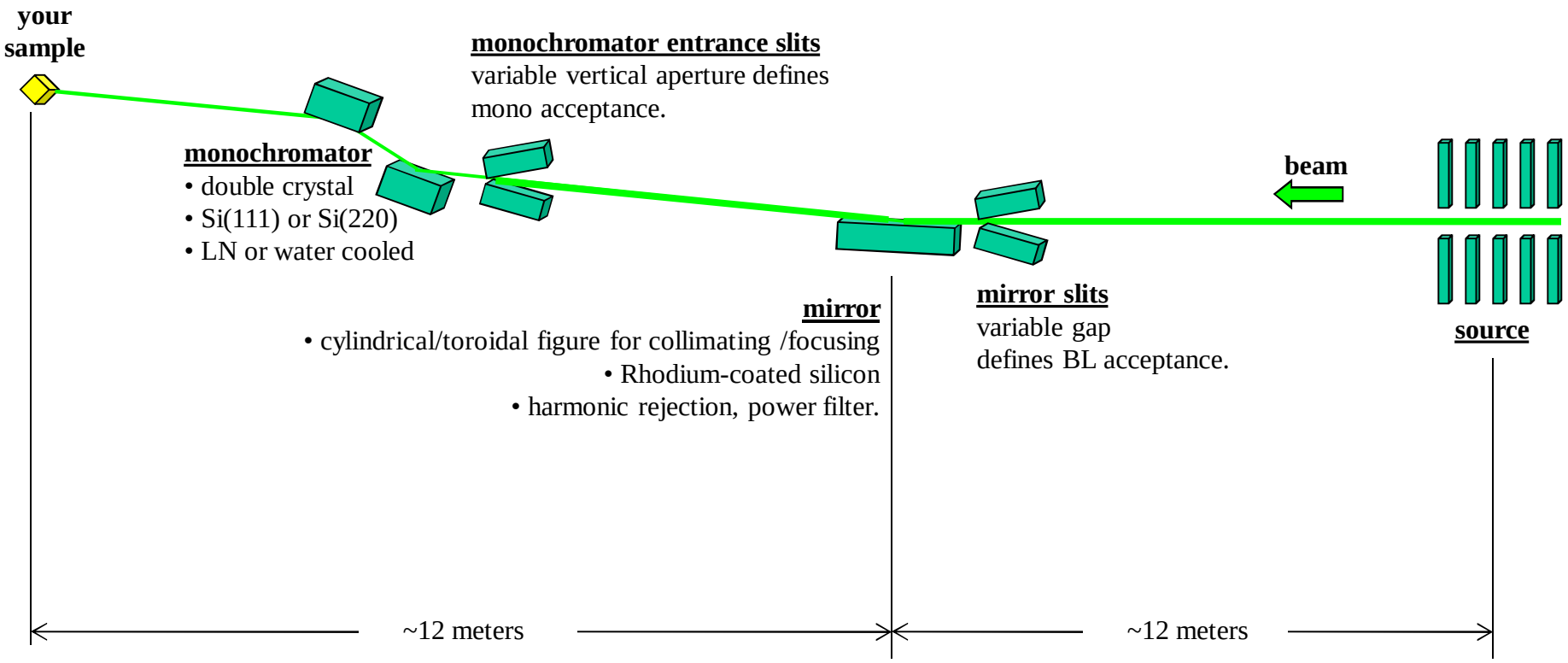
- Storage Ring and Beam Lines Overview
- Beam Line Optical Elements
- Beam Characteristics and Quality
- Resources and Acknowledgements

Generic Synchrotron Components




BL9
BL10
BL8
ID
(8s)
BL7
BL12
BL2
ID
(10s)
BL1
B
(g11)
BL6
BLDG 120
BLDG 131
BL5
0m
10m
20m
B
(g13)
ID
(13s)
B
(g14)
ID
(14s)
BL13
BL14
BL4
BL11
BLDG 130

Typical Beam Line Optical Concept

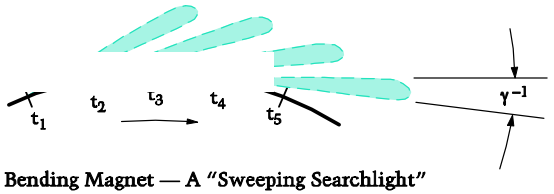


SSRL Scattering Beam Line Sources

Two Types: **Bend Magnets & Wigglers**

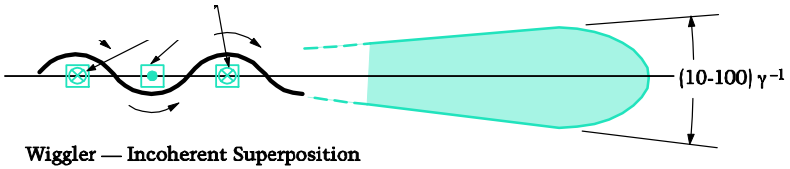
- Continuous spectrum with half-power point "critical energy" $\varepsilon_c(keV) = 0.665*B(T)E^2(GeV)$
- 250 microradian vertical divergence at critical energy but broad horizontal fan.

Bend Magnets: BL1-5 and BL2-1 (50 Watts/350mA/horizontal milliradian, e_c= 7.8 keV.)



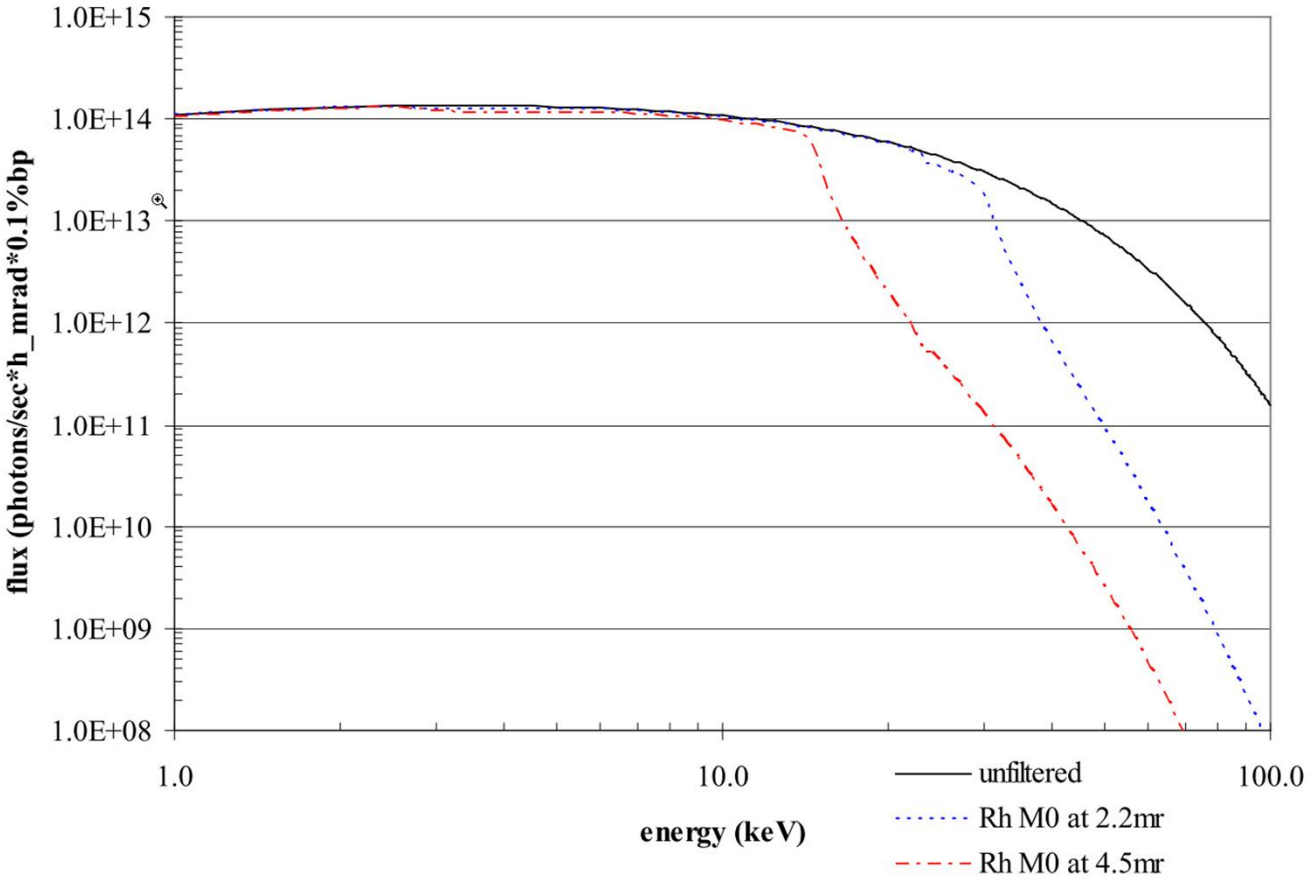
Bending Magnet — A "Sweeping Searchlight"

Wigglers: 7-2 (19 poles,1.7 kW, 11.6keV), 10-2 (30 poles 1.9 kW, 7.6 keV), 11-3 (2.1 kW, 11.7keV)



Wiggler — Incoherent Superposition

BL7-2 Source Spectra

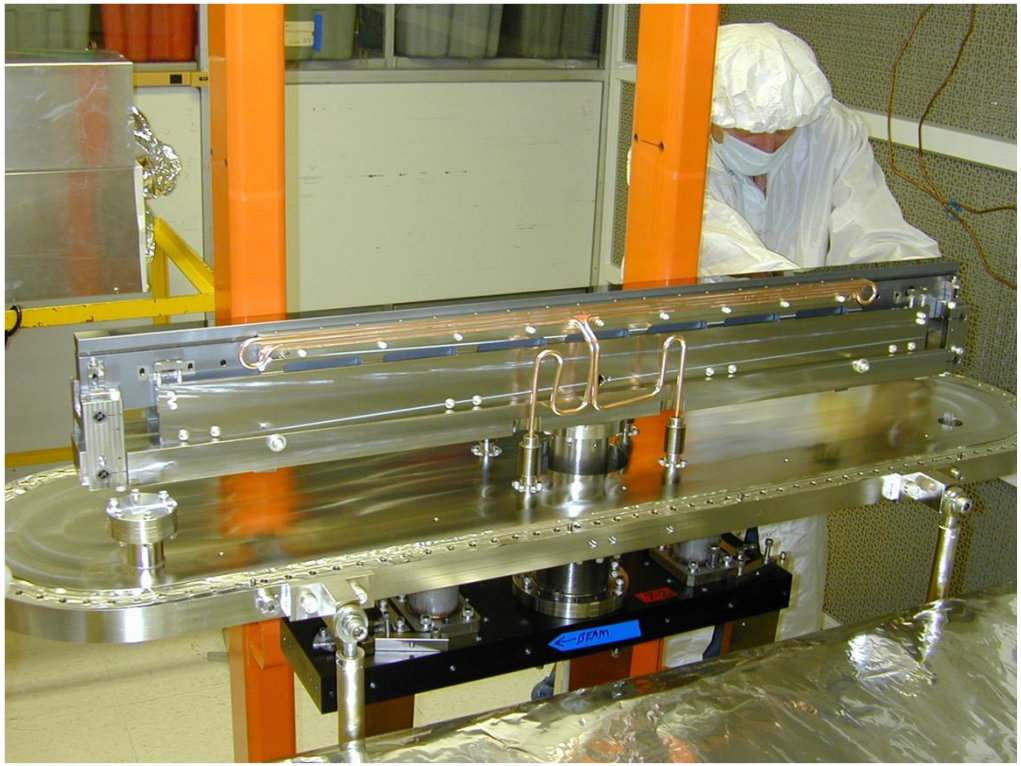


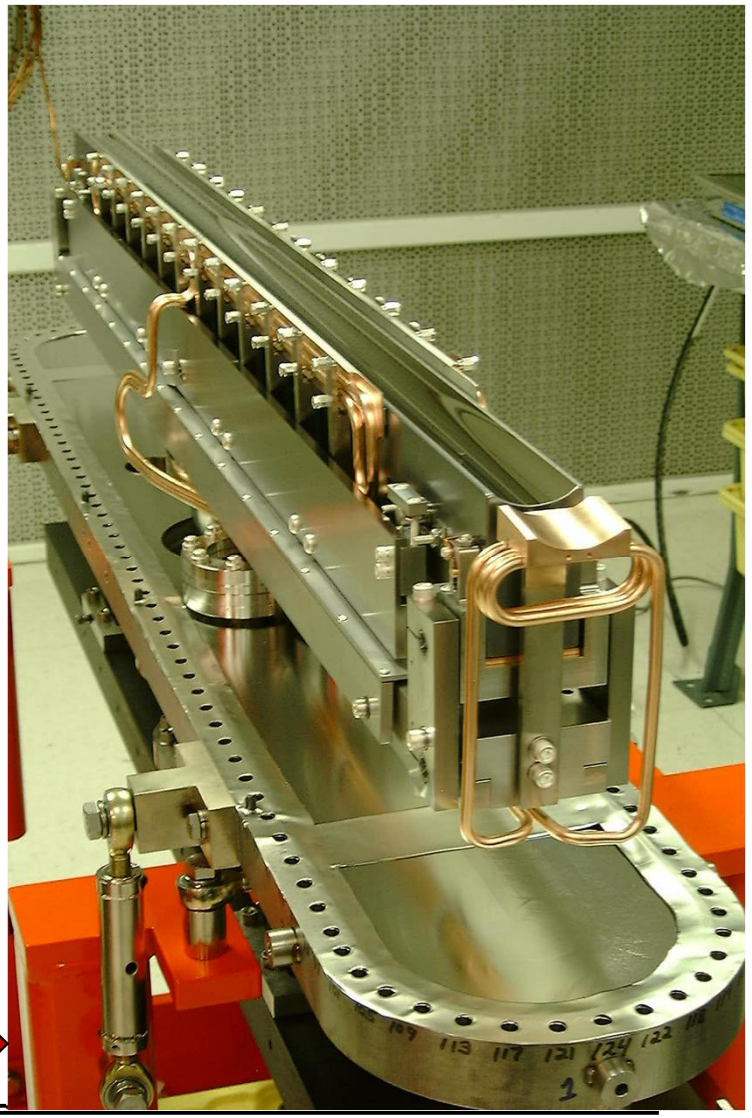
Beam Line Optical Elements

- *Focusing and Collimating Mirrors*
- *Monochromators*
- *Apertures*
- *Filters*

Mirrors

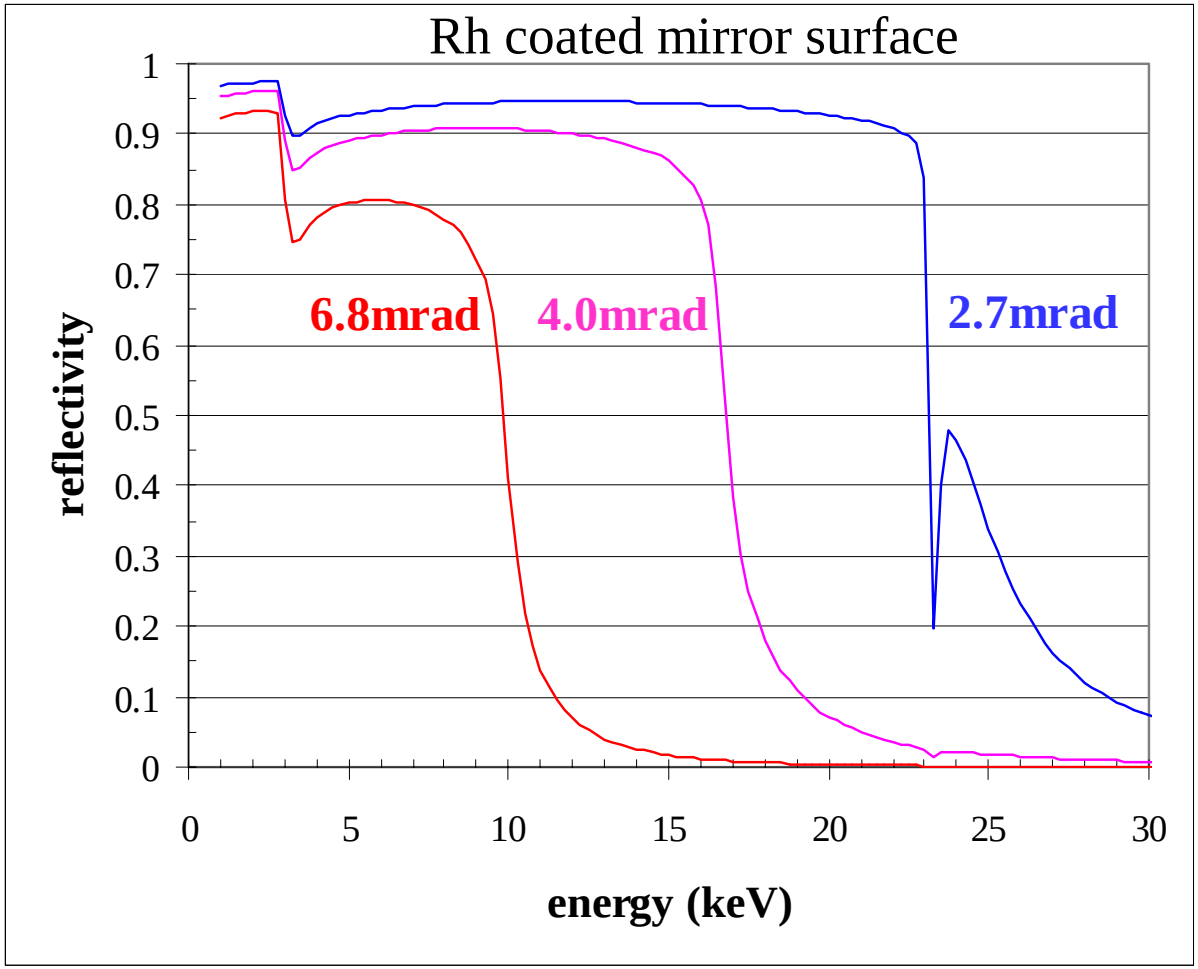
BL7-2:1.2 m long, central 0.8 m with cooling and vertical focusing/collimating optical figure





BL10-2: 1.2m, vertically and horizontally focusing cylindrical mirror

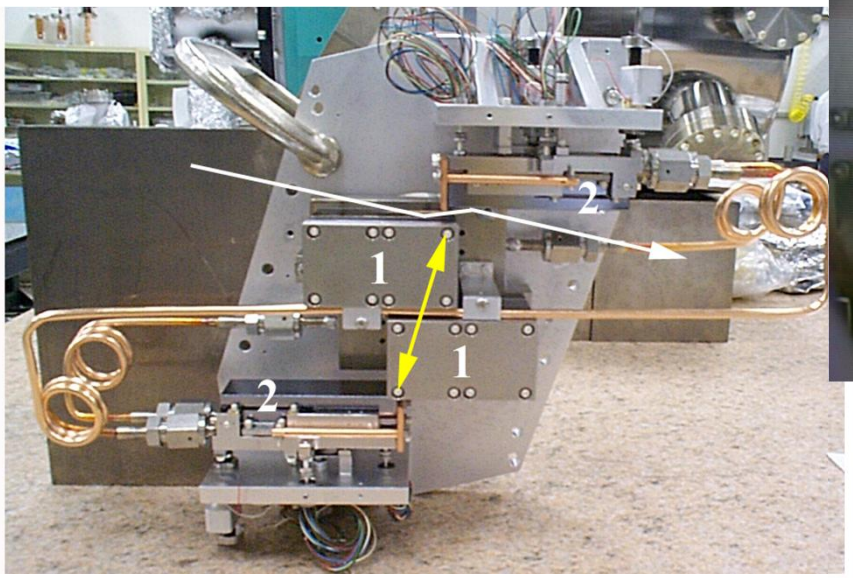
Mirrors Reflectivity vs. Angle

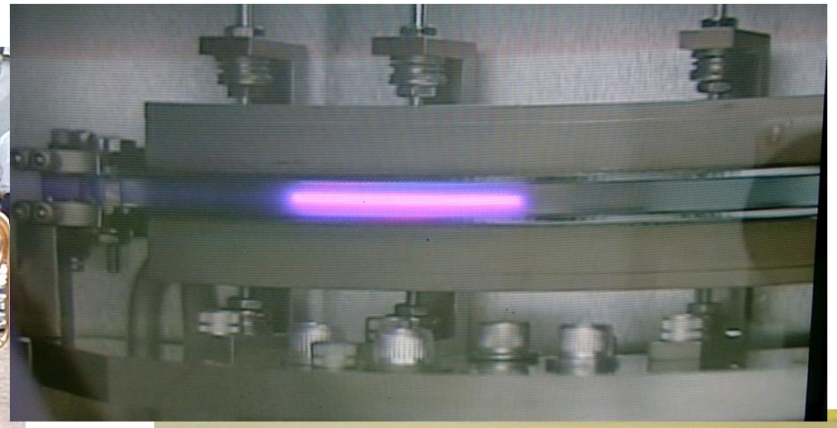


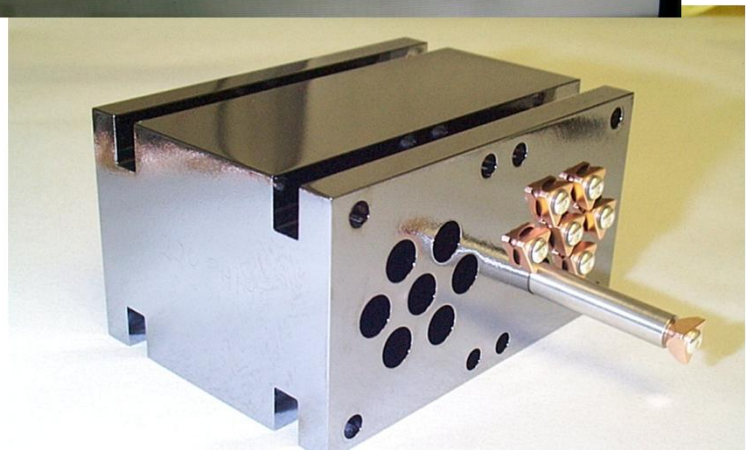
Adjustable low-pass filter for harmonic rejection.

X-ray Monochromators: Function

Select a narrow energy band pass from the broad spectrum synchrotron source; typical crystal mono energy resolution ~1e-4 (or better)







above left - LN mono crystal mount plate
above right – side scattering mono
lower right – LN mono first crystal with cooling channel bundle

X-ray Crystal Monochromators: Improving Energy Resolution

- employ higher index monochromator crystal (eg., Si(111) >>Si(220))
- use a collimating mirror upstream of monochromator to reduce vertical angular spread (BL7-2 M0 mirror can be used to collimate the beam at the expense of vertical spot size)
- reduce horizontal angular acceptance if monochromator is preceded by toroidal focusing mirror (BL2-1, BL10-2)
- reduce monochromator vertical angular acceptance with monochromator entrance slits.

Beam Characteristics/Quality

Beam Characteristics:

- Intensity
- Position, Size and shape
- Monochromaticity: energy resolution and harmonic rejection

Beam Quality = Stability in the above three characteristics

Beam Stabilizing Efforts

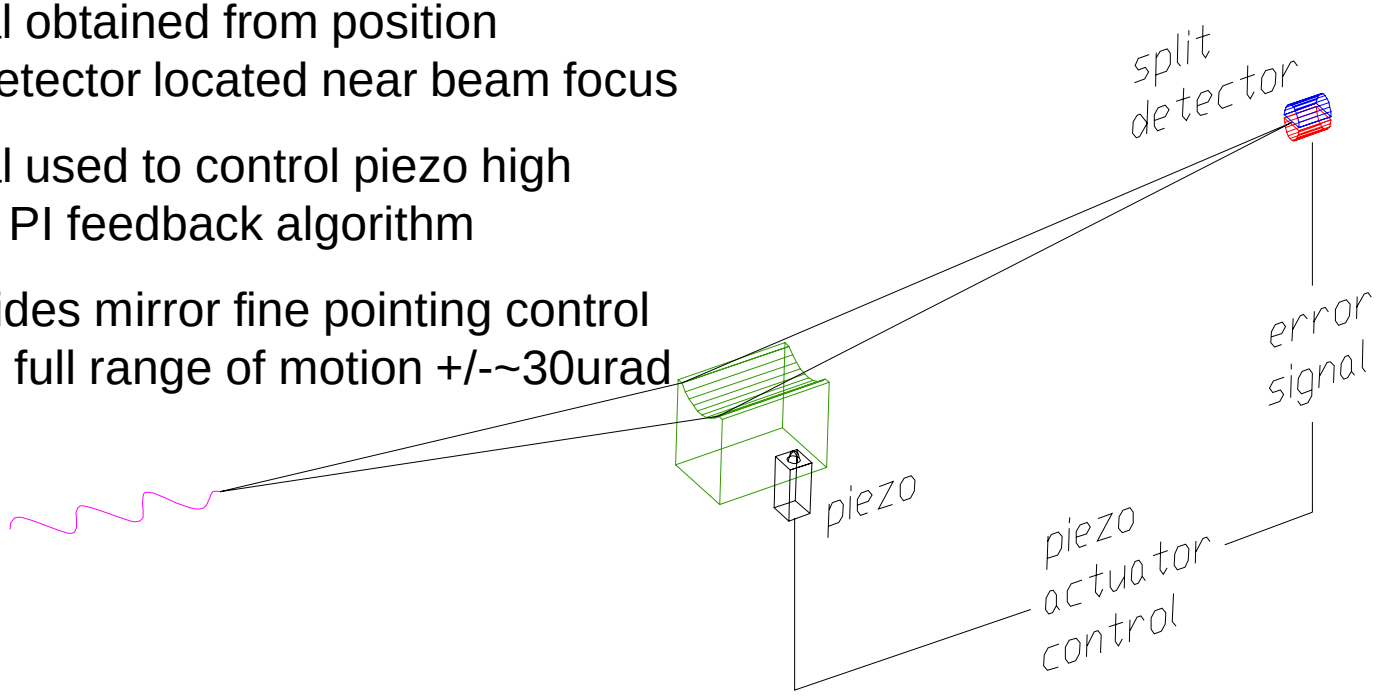
- **Mirror Pitch Feedback**
- **Mirror Coolant (LCW) Temperature Stabilization**
- **SPEAR3 Tunnel Temperature Stability**

Mirror Pitch Feedback at SSRL

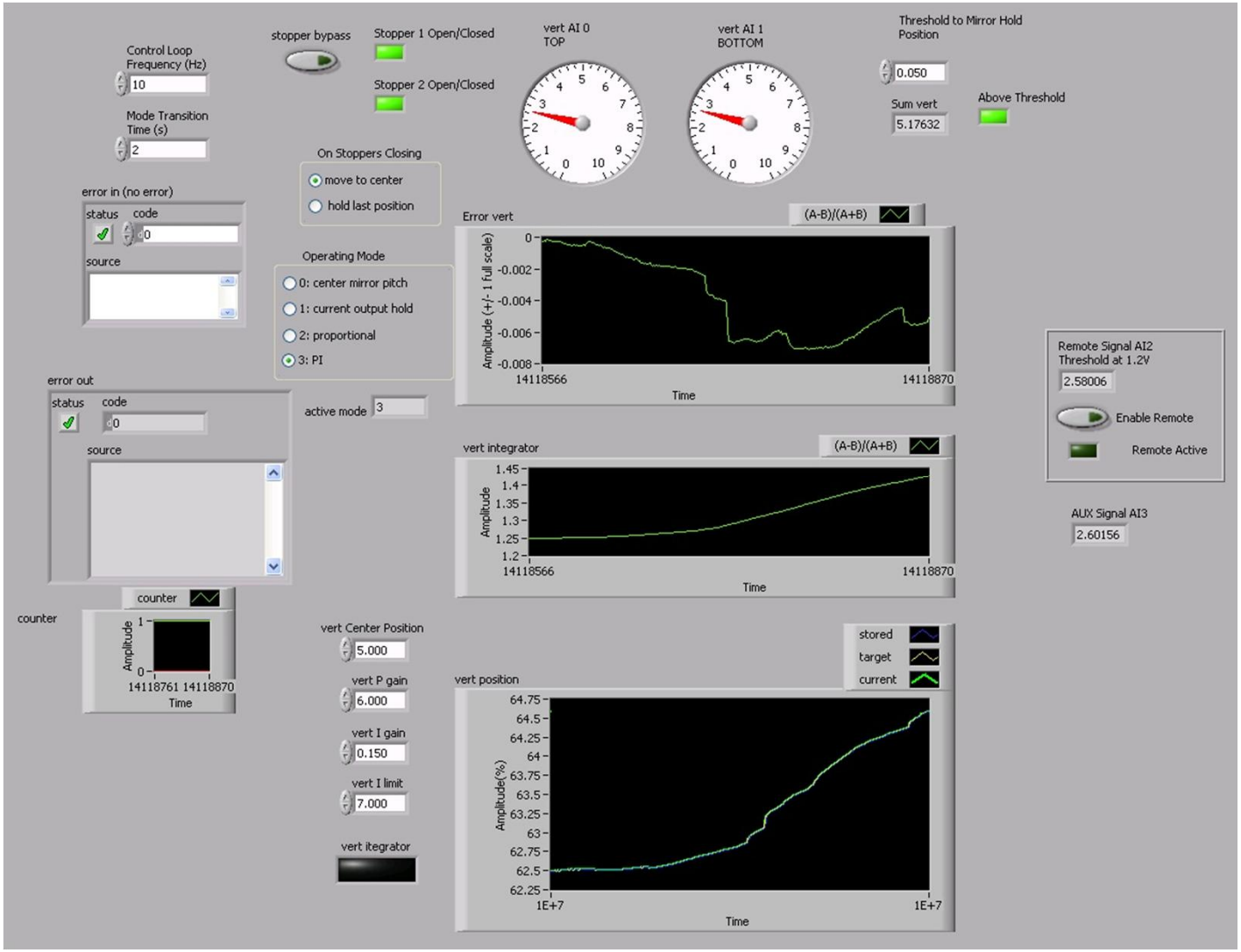
Concept

Compensates for floor and beam line support frame motion

- Error signal obtained from position sensitive detector located near beam focus
- Error signal used to control piezo high voltage via PI feedback algorithm
- Piezo provides mirror fine pointing control with typical full range of motion +/-~30urad



Mirror Pitch Feedback
LabView Control Panel



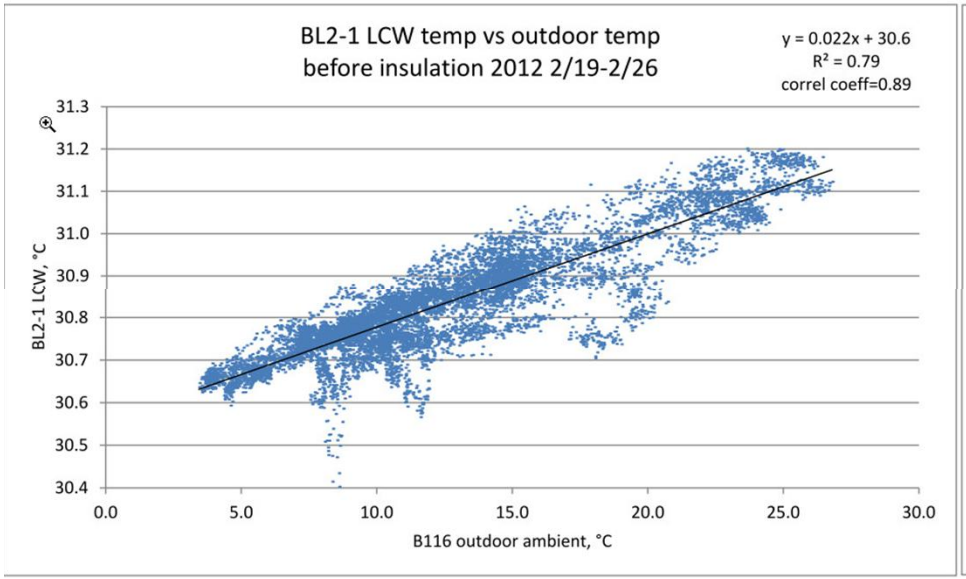
Mirror Coolant (LCW) Temperature Stabilization

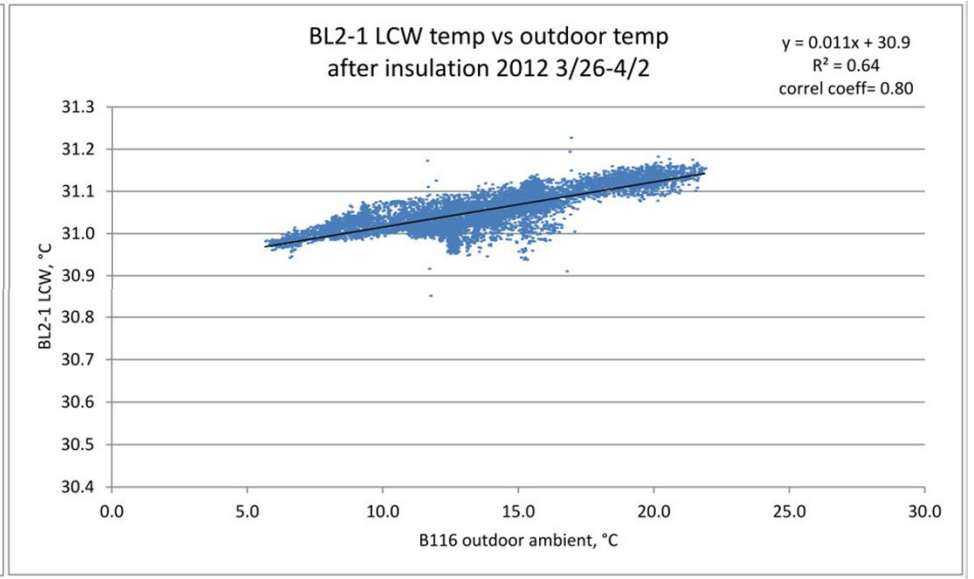
Last time: “0.6 degree C temperature change in mirror cooling water is enough to degrade image quality. Feed back system holds to +/- 0.1 degrees C”

1. Coolant exterior piping insulation.
2. BL local heater feedback.
3. 20-gallon mixing tanks.

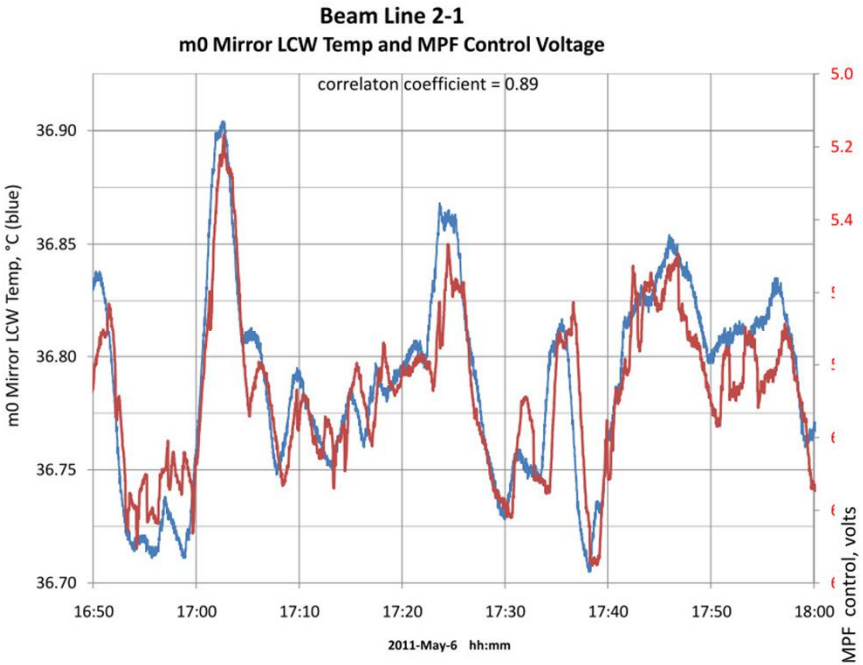
LCW Piping Insulation Project

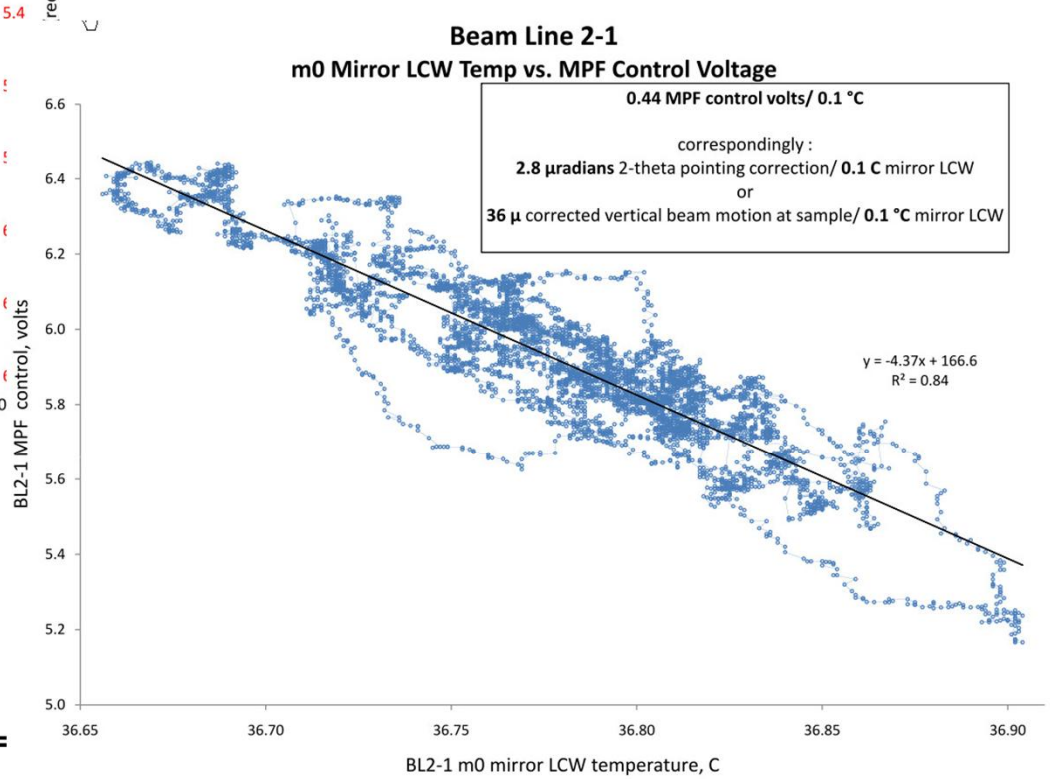
Cooling water exterior piping insulation reduced the effect of outdoor temperature on mirror cooling temperature by 50%. The data scatter reduction in second plot can be interpreted as the effect of the shading from direct sun, wind and rain provide by insulation. With optics sensitive to <0.05 °C variation in cooling water temperature, the addition of the insulation results in improved focused x-ray beam stability.



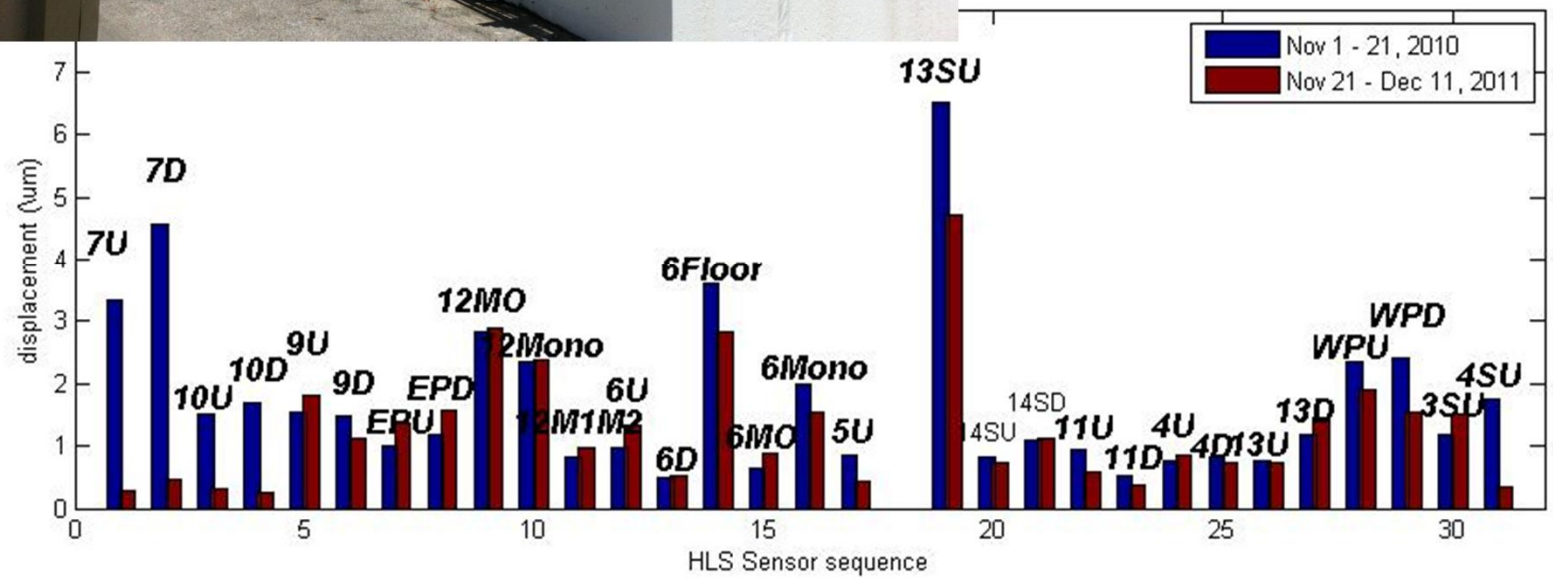


Mirror Coolant Temperature Variations Drive Mirror Focusing Instabilities





SPEAR Tunnel Insulation Project



Scattering Beam Line Engineers

John Pople
BL1-4 Engineer/
Staff Scientist

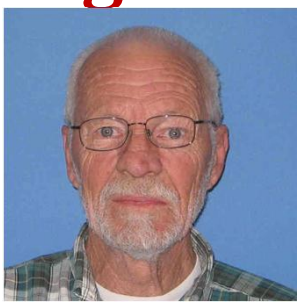
Jr. Troxel
BL2-1
Sci/Eng Associate

Ron Marks
BL7-2 Engineer

Valery Borzenets
BL10-2 Engineer

Doug Van Campen
BL11-3 Engineer

Scattering Beam Line Technicians



Tom Hostetler

Dave Day

Beam Line Duty Operators x4040

Wes Leonard

Tyler French

Josh Cuppett