Stability Requirements for 0.1 meV IXS

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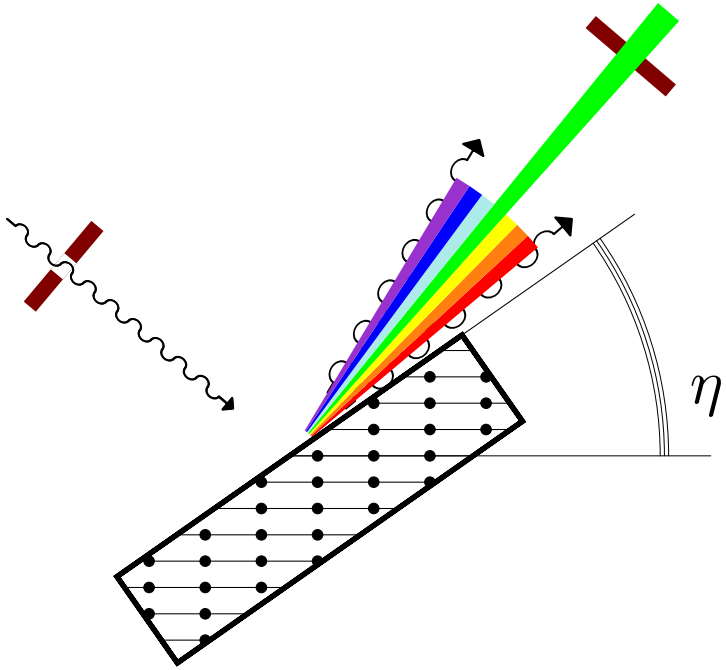


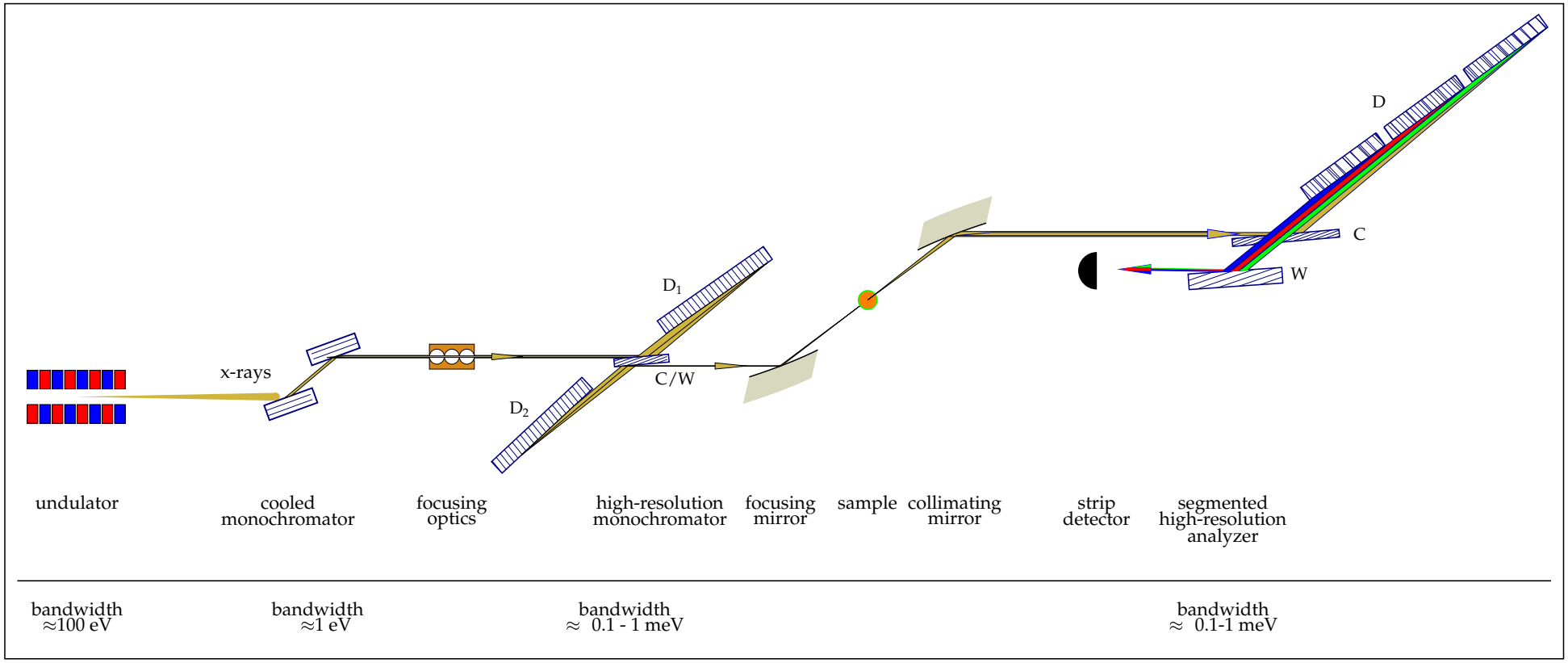
Argonne NATIONAL LABORATORY

Content

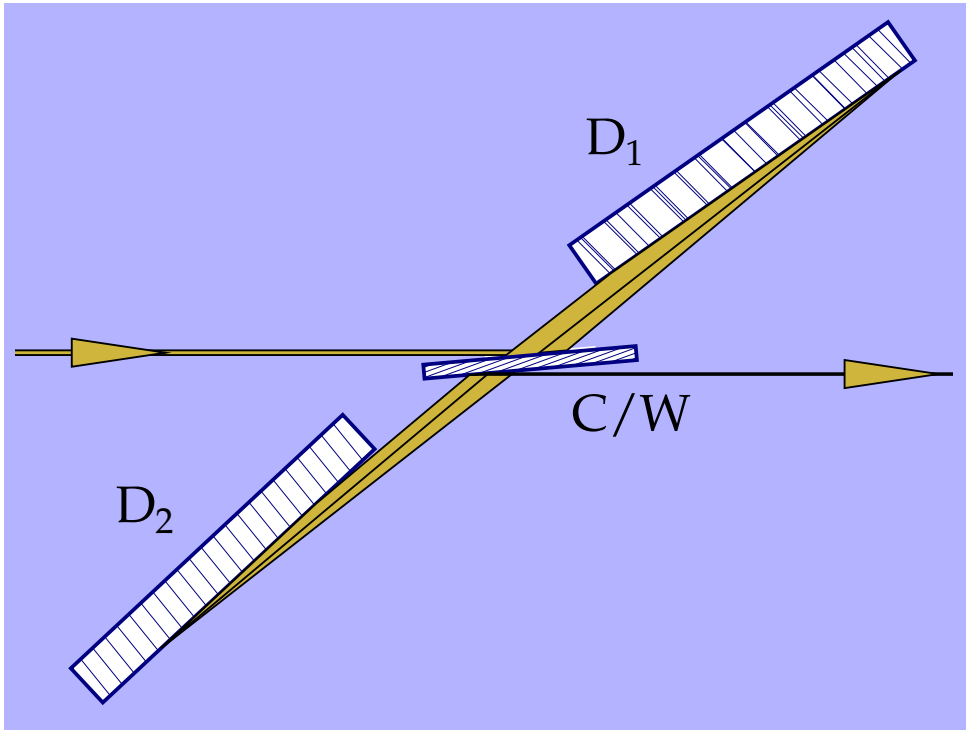
- **Main components of the 0.1 meV IXS instrument.**
- **Beam stability requirements for the 0.1 meV monochromator.**
- **Temperature stability requirements for the experimental station.**

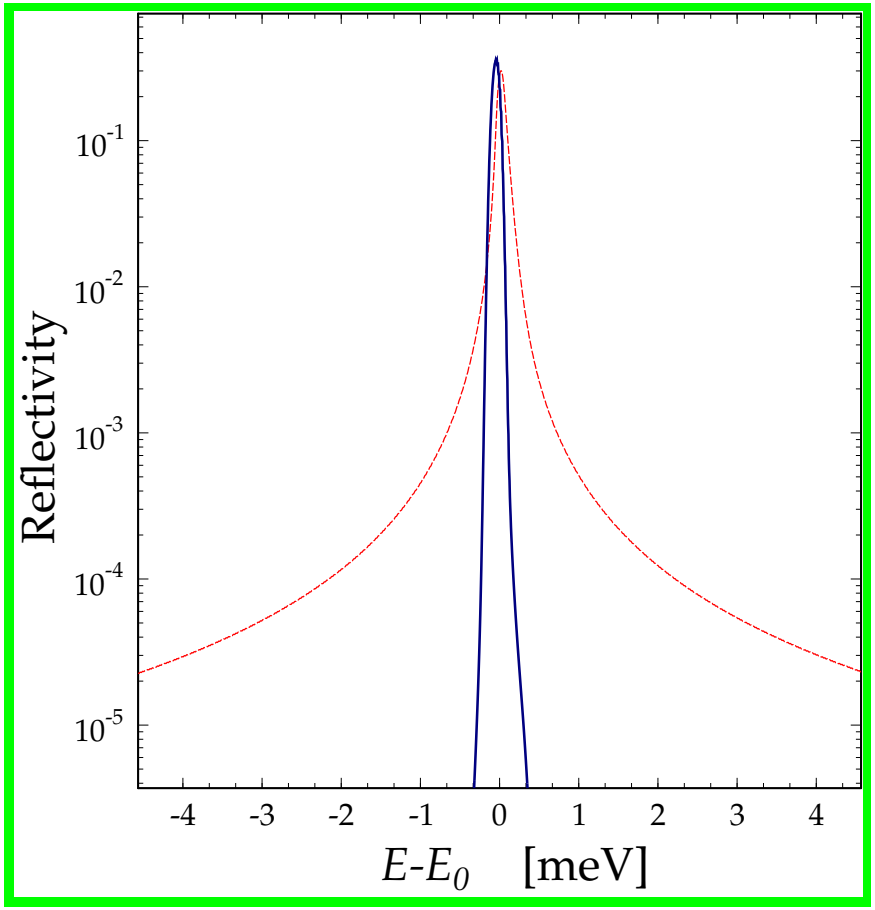
Layout of the 0.1 meV IXS Instrument

Photon energy: 9.1 keV.



Angular-Dispersive In-line CDDW-monochromator

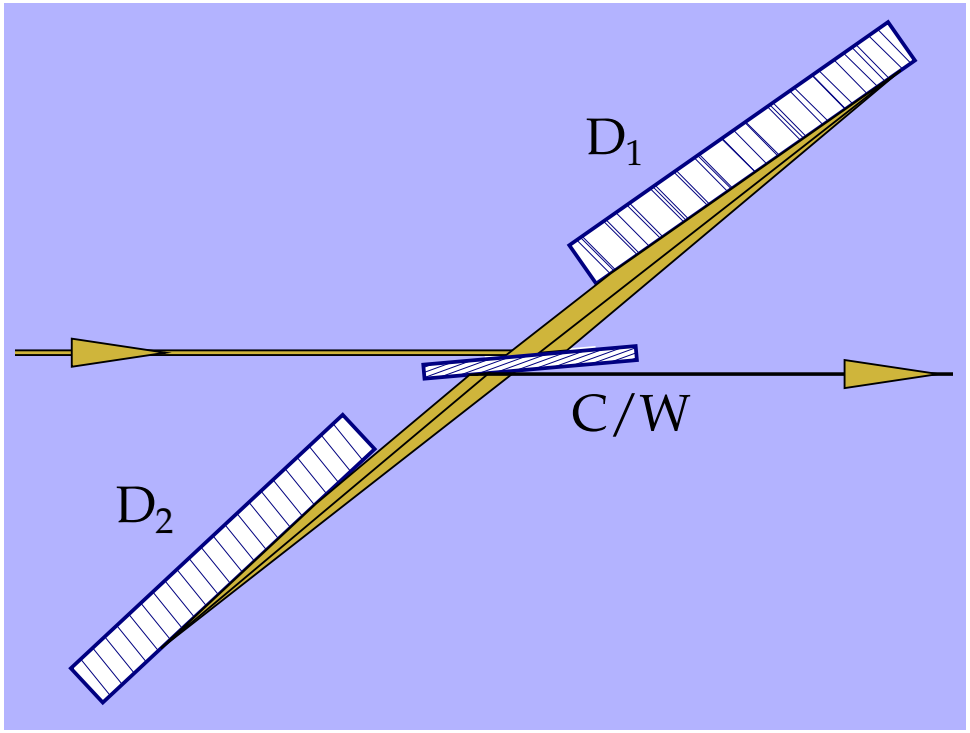


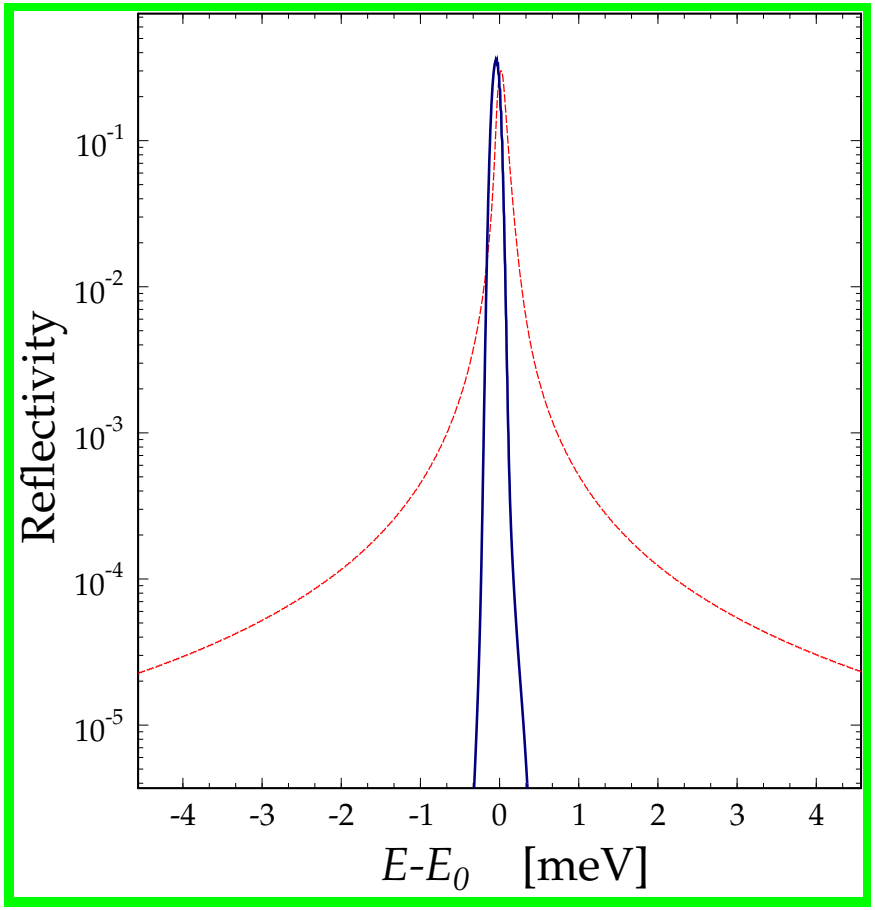


Angular-dispersive CDDW monochromator:
$E = 9.1315$ **keV,** $\Delta E = 0.1$ **meV, D=Si(008)**

Single-bounce backscattering monochromator:
$E = 31.02$ **keV,** $\Delta E = 0.1$ **meV, Si(1 3 27).**

Stability requirements for the 0.1 meV mono





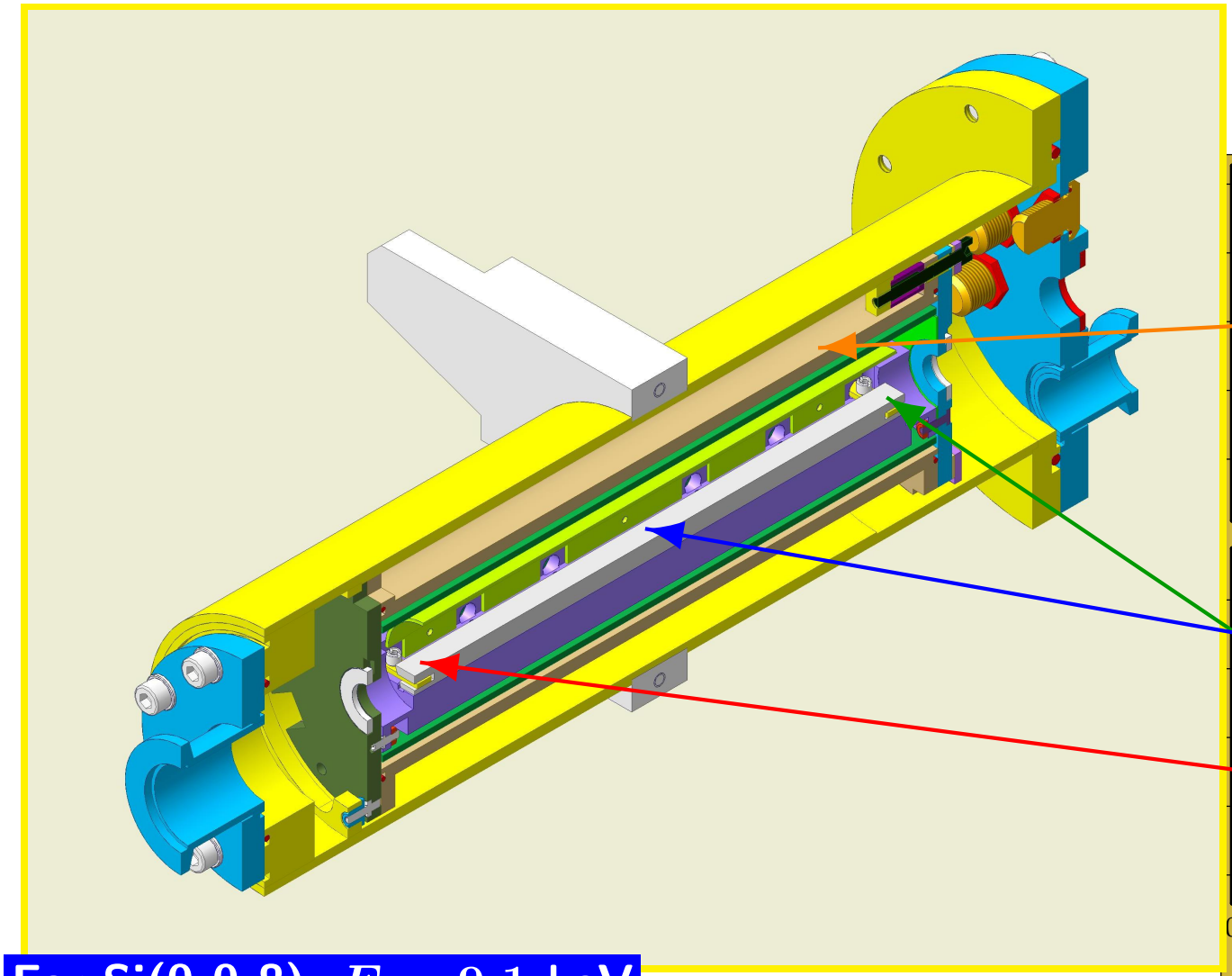
Variation $\mathrm{d}\theta$ of the beam direction in the vertical plane changes E_0!

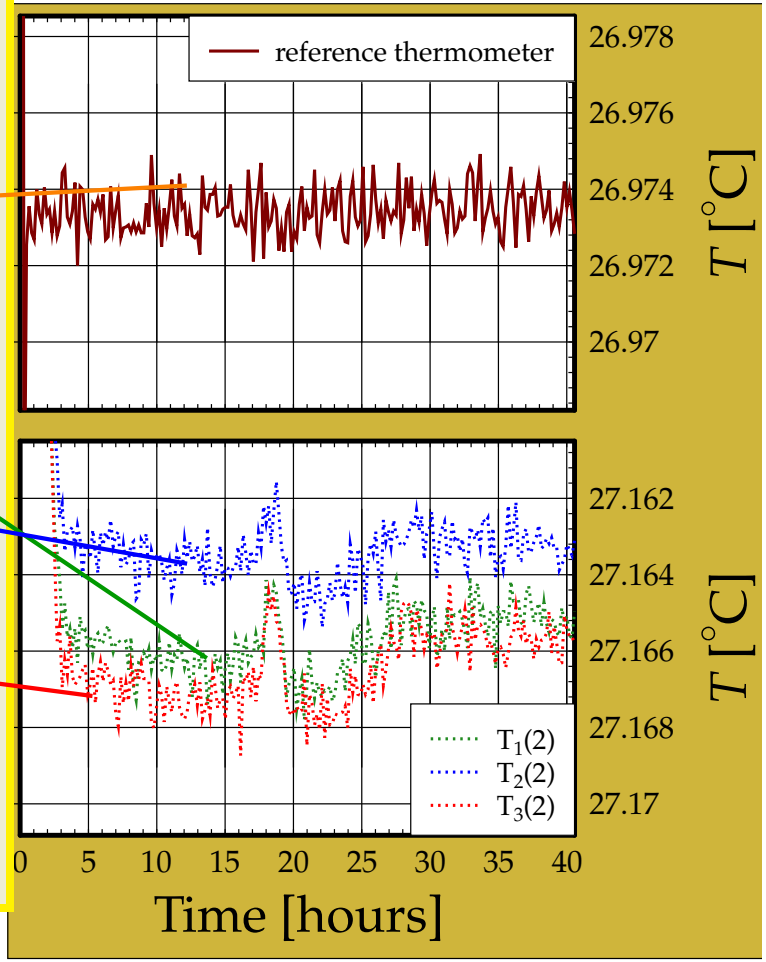
$\delta E_0/E_0 = \delta\theta/(2\tan\eta)$.

Assuming $\eta = 87.5°$:

$\delta\theta = 0.25\ \mu\mathrm{rad} \Rightarrow\ \delta E_0 \simeq 0.05$ meV; $\Delta E_{\mathrm{tot}} = \sqrt{0.1^2 + \delta E_0^2} = 0.11$ meV (+10%)

Temperature Variations Along the Dispersing Element



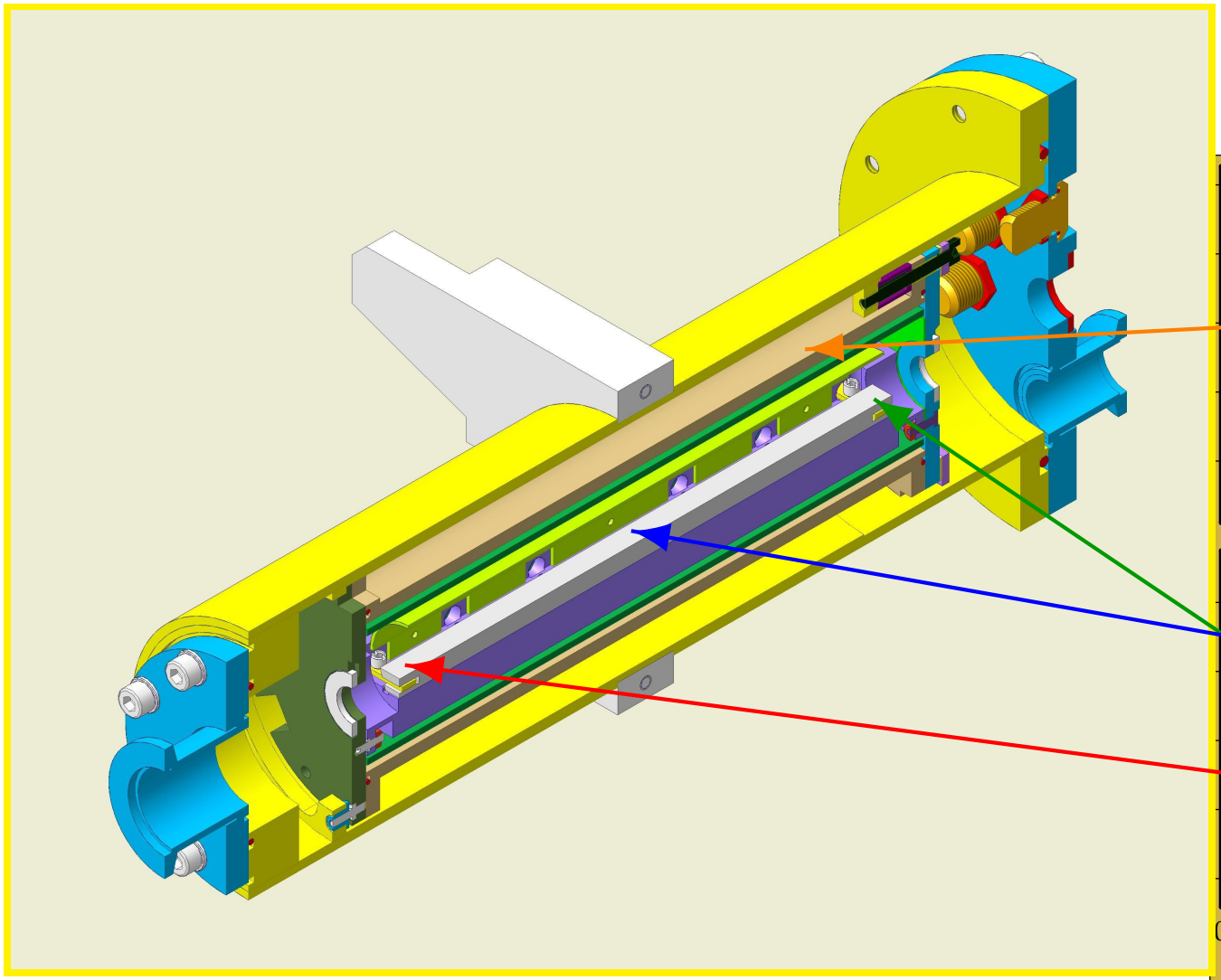


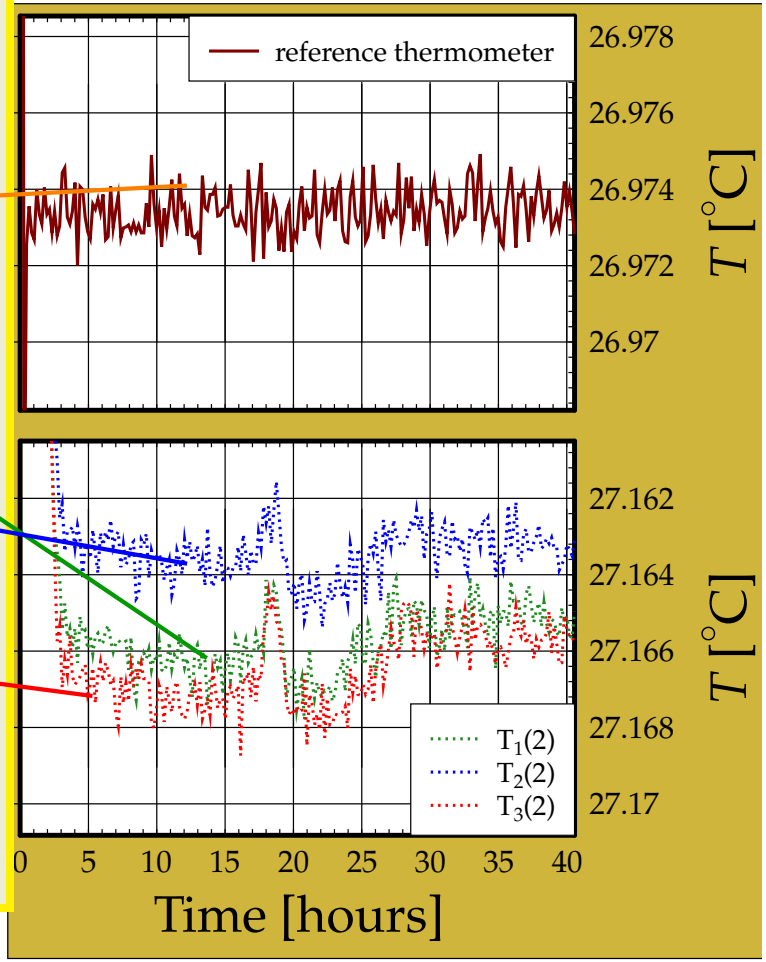
For Si(0 0 8), $E = 9.1$ keV

2 mK $\Rightarrow$ 0.05 meV $\Rightarrow$ 10% energy broadening

Achieved: $\Delta T \lesssim 4$ mK

Temperature Stability for the 0.1 meV IXS Station





10% broadening requires $\lesssim$ 1 K temperature stability inside the station.

Summary

0.1 meV energy resolution requires:

- 0.25 μrad incident beam direction stability (in the vertical plane).

- 0.25 μrad relative angular stability of the monochromator and analyzer single crystal components.

- $\lesssim$ 1 K temperature stability inside the station.