Synchrotron Radiation Interferometer (SRI) for ΔE/E

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JSA

Absolute Energy, Energy Spread, & Energy Jitter

- Use Synchrotron Radiation Interferometer (SRI) to monitor beam size
  - In a high dispersion location energy spread ~ beam size/dispersion
  - Goal is to resolve beam energy spread ~1 x 10^{-5}
- Absolute energy & energy jitter is monitored via new BPM system

Figure 2: High dispersion location 3C12 (experimental Hall C beam line).

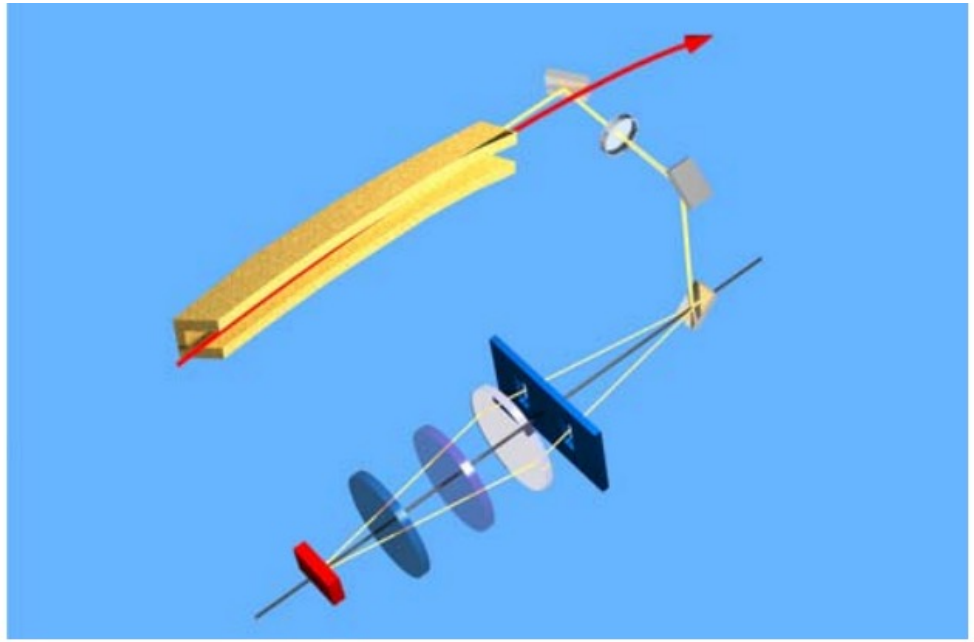


Figure 6. SLI structure.

Why Synchrotron Radiation Interferometer?

- Much higher resolution than standard optical systems
- Goal would be to resolve beam energy spread 1 x 10^{-5}
  - Update rate in EPICS ~1 second – is this good enough?
- "Non-invasive Energy Spread monitoring for the JLAB Experimental Program Via SLI's"
  - https://inspirehep.net/literature/703570
- "Advanced Beam Energy Spread Monitoring Systems and Their Control at Jefferson Lab"
  - https://www.osti.gov/biblio/837546
- Note; Cooled CCD cameras now have 2X Q_e compared to last install

Draft Plan

- Monitor is also needed for Moller
- SLI prime candidate
- Design ‘firmed up’ by April
- Initial test bed may be in CEBAF Arc 7
- Begin install in summer SAD
- Begin testing & refinement Fall 2024

Summary of Topical Workshop: Emittance Measurements for Synchrotron Light Sources and FELs

Ubaldo Iriso (ALBA-CELLS),

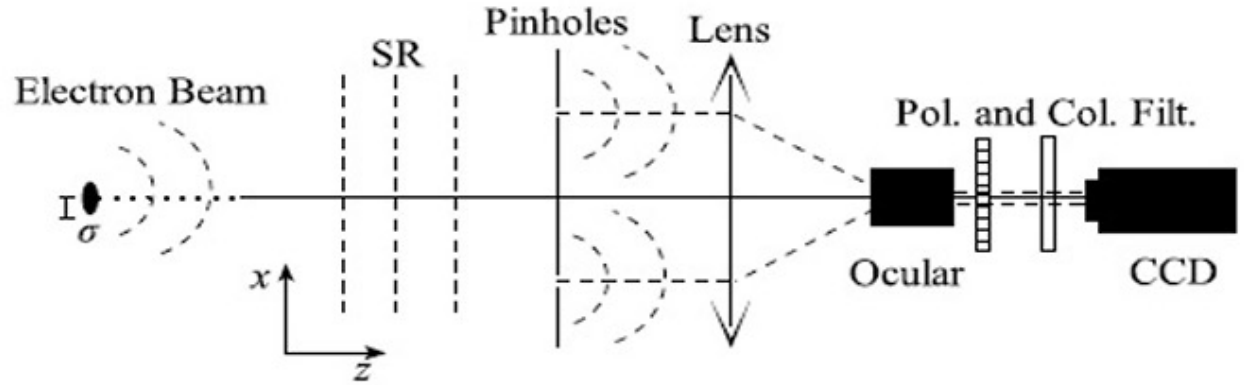
F. Ewald (ESRF), G. Kube (DESY), T. Mitsuhashi (KEK),
V. Schlott (PSI) and K. Wittenburg (DESY)

ALBA – CELLS (Barcelona)
Jannuary 2018
https://indico.cells.es/indico/event/128/

Visible Synchrotron Radiation Interferometry (SRI)

T. Mitsuhashi (KEK) & L. Torino (ESRF)

Typical Setup:



$$I = I_0 \left\{ \frac{J_1\left(\frac{2\pi a x}{\lambda f}\right)}{\left(\frac{2\pi a x}{\lambda f}\right)} \right\}^2 \times \left\{1 + V \cos\left(\frac{2\pi D x}{\lambda f}\right)\right\}$$

$$\sigma_x = \frac{\lambda L}{\pi D}\sqrt{\frac{1}{2}\ln\frac{1}{V}}$$

- I_0: Intensity
- a: Pinholes radius
- λ: SR wavelength
- f: Focal distance of the optical system
- D: Pinholes distance
- V: Visibility
- L: Distance from the source

Visible SRI - T. Mitsuhashi (KEK)

Precision using SRI -- Error Analysis

In actual optical component, for optical components of surface ~λ/10, this error corresponds to **0.26μm**

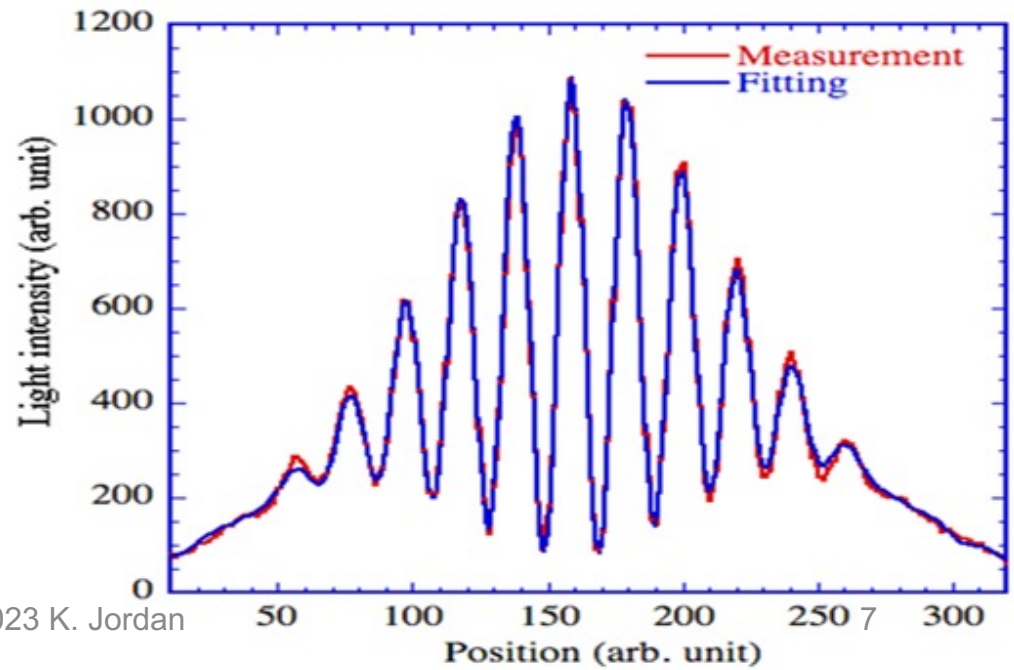
Real life: other limits show up

- Turbulence of air in the optical path
- Floor vibration
- Noise in CCD

Example:

ATF at KEK

beam size is 4.73μm±0.55μm



Questions?

- Thank you for your attention!