

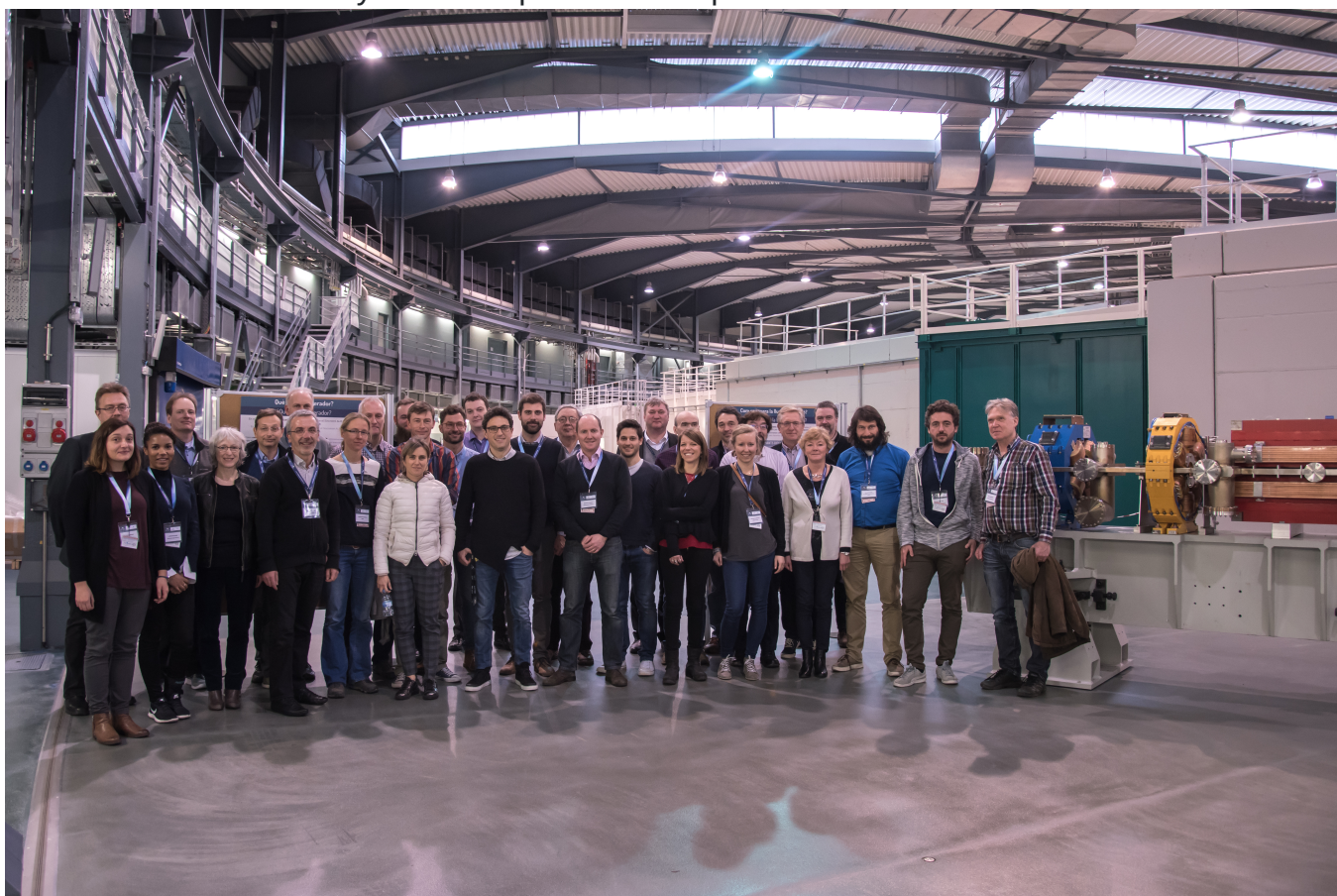
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Different techniques of emittance measurements for SLS and FELs

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[emittance measurements](#) [Synchrotron Light Sources](#) [SLS](#) [Free Electron Lasers](#) [FEL](#)

The status of different techniques and some new approaches of emittance measurements for SLS and FELs were analyzed in a topical workshop at ALBA.



The [Topical Workshop on Emittance Measurements for Synchrotron Light Sources and FELs](#) held at ALBA-CELLS in January 2018 brought together experts working on emittance measurements for electron machines, like Synchrotron Light Sources (SLS)

and Free Electron Lasers (FEL). The workshop presented the status of the different techniques and discussed the challenges that this community is facing for the next generation of ultra-low emittance machines.

The emittance itself is not a direct measurable parameter and most accelerators monitor its surrogate: the electron beam size. In the case of SLS, the preferred techniques to infer the beam size are based on the analysis of the synchrotron radiation due to its non-destructive nature. In order to overcome the diffraction limit, direct imaging techniques like pinhole cameras or Compound Refractive Lenses use the x-ray part of the synchrotron radiation to avoid the diffraction limit. These techniques were reviewed and compared by L. Bobb (Diamond) and F. Ewald (ESRF), and it was concluded that they can be used down to the $\sim 4\mu\text{m}$ level.

Other SLS like KEK or Max-IV use techniques based on the analysis of the synchrotron light coherence, like the double-slit interferometry presented by T. Mitsuhashi (KEK), or the polarization methods shown by A. Andersson (Max-IV). These techniques analyze the visible part of the synchrotron light, but in order to measure beam sizes below the $\sim 2\mu\text{m}$ level, the system should be adapted to smaller wavelengths, like ultra-violet or even x-rays. This was the topic of A. Snigirev's (IKBF) presentation, highlighting the challenges of performing diffraction or interferometry in the x-rays part.

On the other hand, the beam sizes in FELs are measured through the interaction with obstacles in the electron beam trajectory, which often detrimentally affect the electron beam. Such is the case of Optical Transition Radiation (OTR) screens, which can be used for direct beam imaging or to produce Diffraction Radiation Interferometry, as shown by E. Chiadroni (INFN). Other obstacles like Wire Scanners (reviewed by K. Wittenburg from DESY) are nowadays getting thinner (down to the $1\mu\text{m}$ level) using lithography and electroplating, which improves the method resolution, thus allowing to measure beam sizes down to the 500nm level (S. Borrelli, SLS). This level of resolution can also be achieved by using a laser wire, where the electron beam does not interact with a solid (metallic) object, but a "light pencil", as shown by P. Karataek (JAI). However, this solution involves an important team of experts to maintain and operate the technique.

To measure the ultra-low emittance of the future SLS and FELs requires significant knowhow, while a new machine may need to combine different techniques, as presented by B. Yang (ANL) for the APS upgrade, whose design of the emittance measurement system already combines an x-ray pinhole camera, a diffractometer, and an x-ray interferometry. Perhaps this type of designs are the new path for the emittance measurement techniques. Finally, the workshop set forth new ideas like the beam size measurements using Heterodyne Speckle Fields or Cherenkov radiation, as well as a review of the methods used in other accelerators like hadron colliders or laser plasma accelerators.

The diagnostics experts on emittance measurements for SLS and FELs will strongly benefit from all the synergies between the different communities.

Header image: Group picture from the Topical Workshop on Emittance Measurements for SLS and FELs (Image credit: ALBA-CELLS)