A Snapshot of CERN Beam Instrumentation R&D Activities

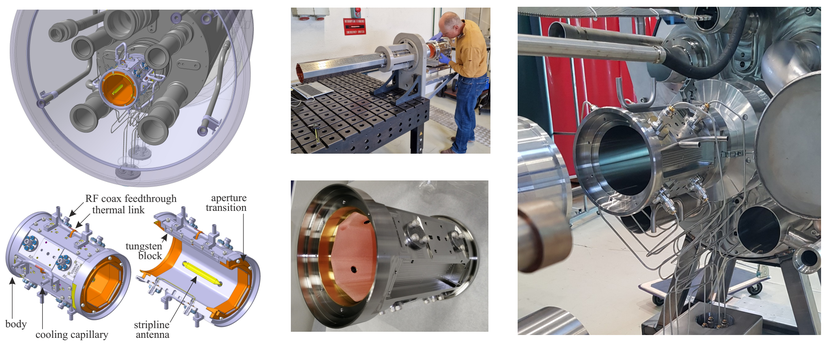
D. Alves louro, A. Boccardi, S. Jackson, ***T. Lefevre****, F. Roncarolo, J. Storey, R. Veness, C. Zamantzas,* CERN, Geneva, Switzerland

Abstract

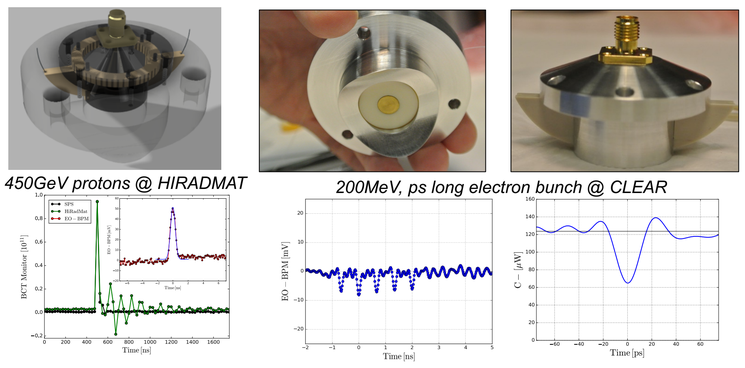
The CERN accelerator complex stands out as unique scientific tool, distinguished by its scale and remarkable diversity. Its capacity to explore a vast range of beam parameters is truly unparalleled, spanning from the minute energies of around a few keV and microampere antiproton beams, decelerated within the CERN antimatter factory, to the 6.8 TeV high-intensity proton beams that race through the Large Hadron Collider (LHC). The Super Proton Synchrotron (SPS) ring plays also a crucial role by slowly extracting protons at 400 GeV. These proton currents are then directed toward various targets, generating all sorts of secondary particle beams. These beams, in turn, become the foundation of a diverse fixed-target research program, enabling scientific exploration across a wide spectrum. Moreover, as CERN looks ahead to future studies involving electron-positron colliders, the development of cutting-edge diagnostics for low emittance and short electron pulses is also underway. This contribution serves as a snapshot, shedding light on the main R&D initiatives currently underway at CERN in the field of beam instrumentation.

Complex design of electromagnetic Pick-ups

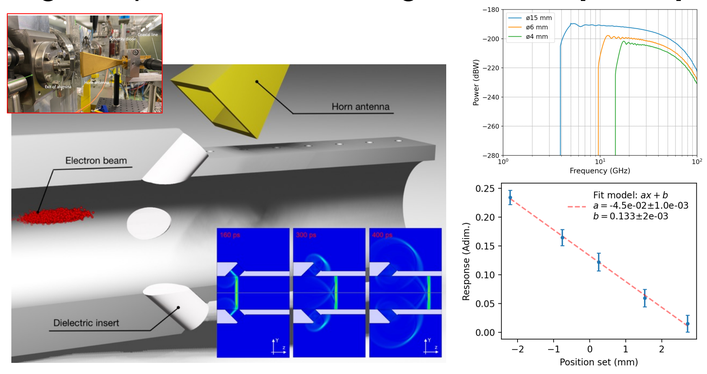
High directivity cryogenic stripline BPM for HL-LHC



High bandwidth BPM using ***electro-optical pick-up***

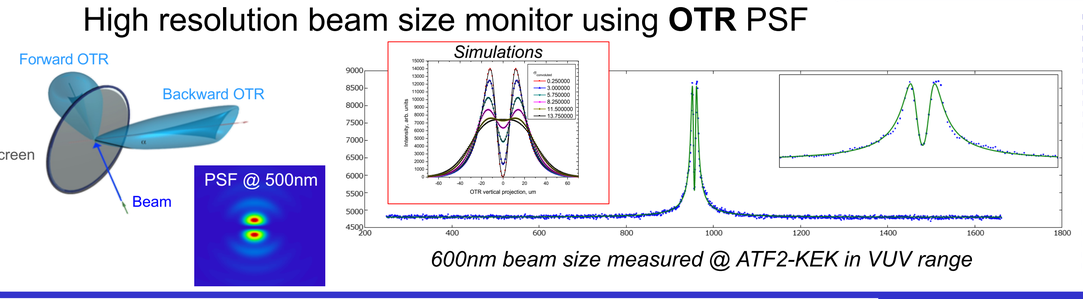


High frequencies BPM using **dielectric pick-up**

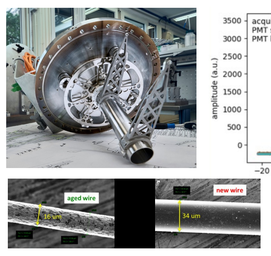


State-of -the art in interceptive diagnostics

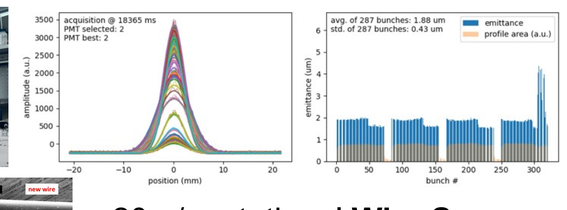
High resolution beam size monitor using **OTR** PSF



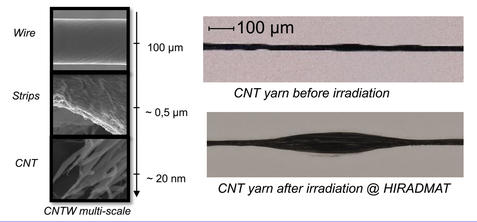
600nm beam size measured @ ATF2-KEK in VUV range



20m/s rotational **Wire Scanner**

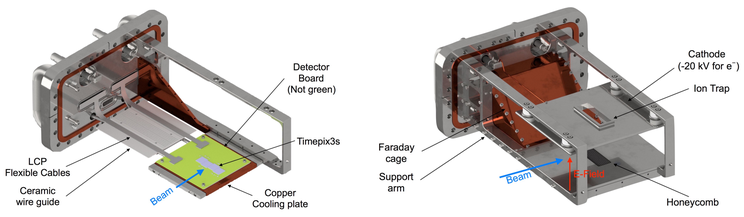


Low density materials for advanced wires and screens

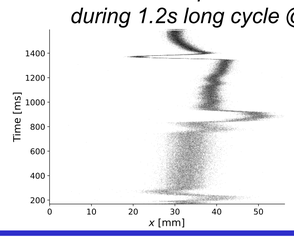


Non-invasive beam size monitoring

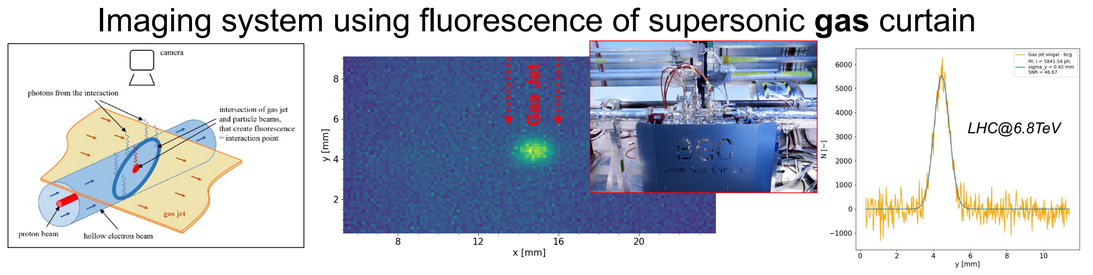
Gas ionization monitor using hybrid pixel detector



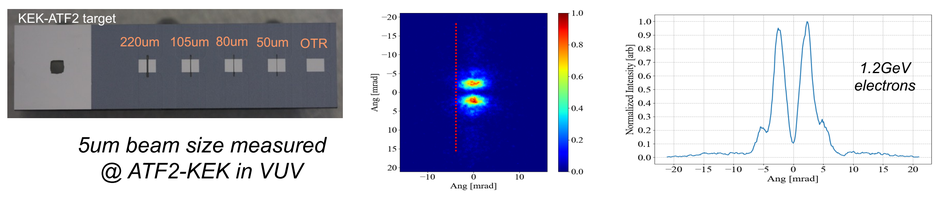
Hor. beam size/position evolution during 1.2s long cycle @ PS



Imaging system using fluorescence of supersonic **gas** curtain

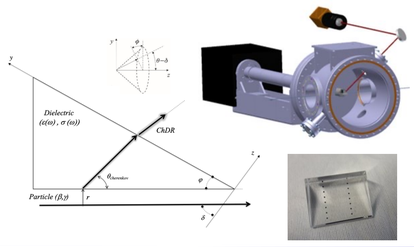


Diffraction radiation from high precision slits

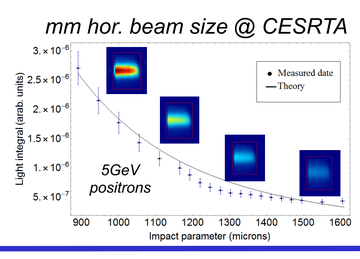


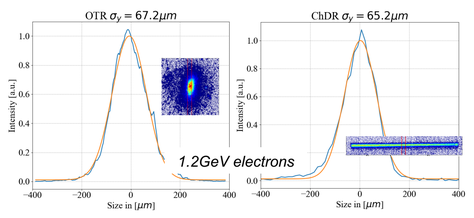
5um beam size measured @ ATF2-KEK in VUV

Diffraction Cherenkov radiation imaging system



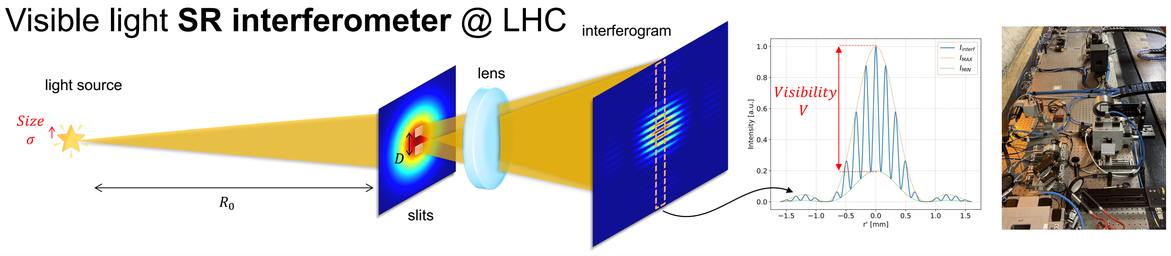
mm hor. beam size @ CESRTA

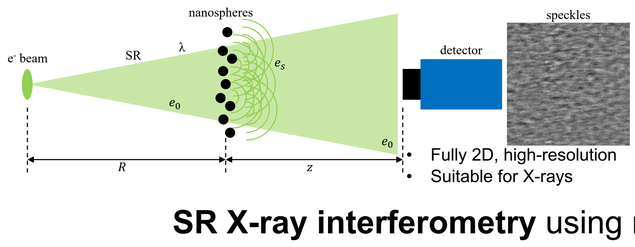




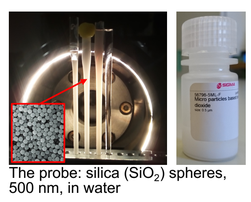
hor. beam size @ ATF2-KEK

Visible light **SR interferometer** @ LHC

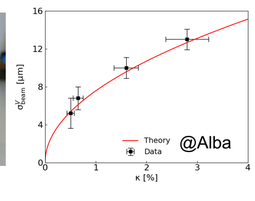




- Fully 2D, high-resolution
- Suitable for X-rays



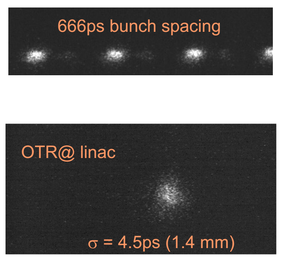
The probe: silica (SiO_2) spheres, 500 nm, in water



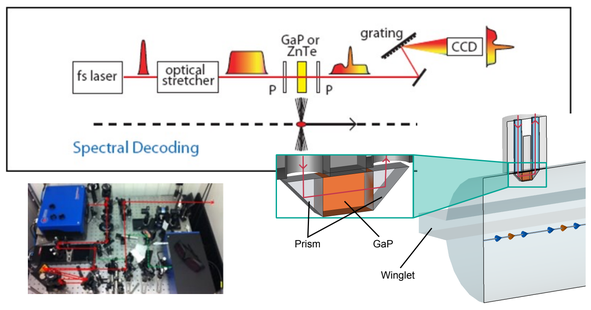
SR X-ray interferometry using near field speckles

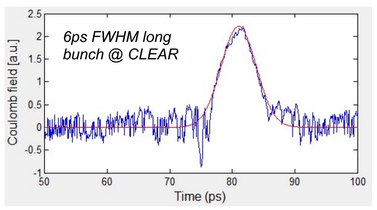
Measuring the longitudinal profile of short bunches

Streak Camera

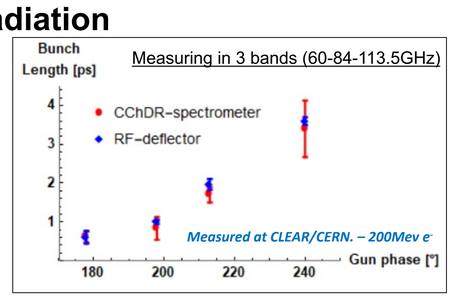


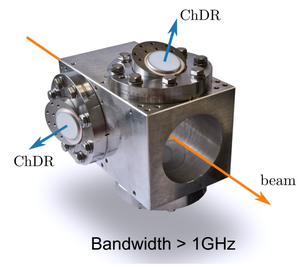
Electro-optical sampling for sub-ps time domain measurement





Bunch spectrum measurement using **Coherent Cherenkov Diffraction Radiation**

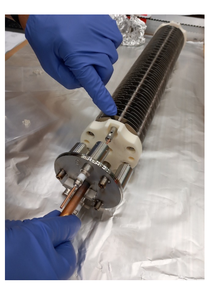


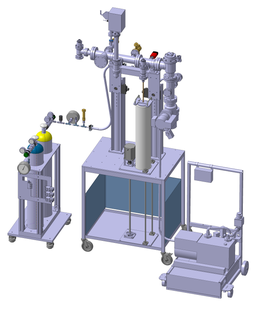


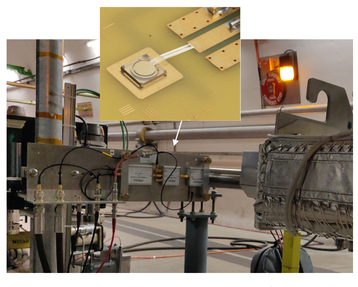
Bandwidth > 1GHz

Developing particle detectors for beam loss monitoring

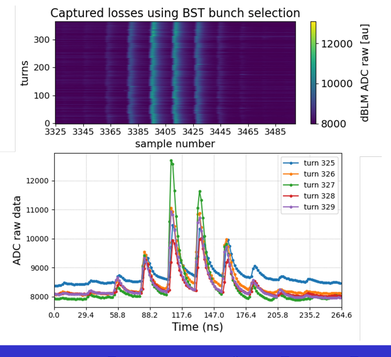
High sensitvity **Ionisation chamber**



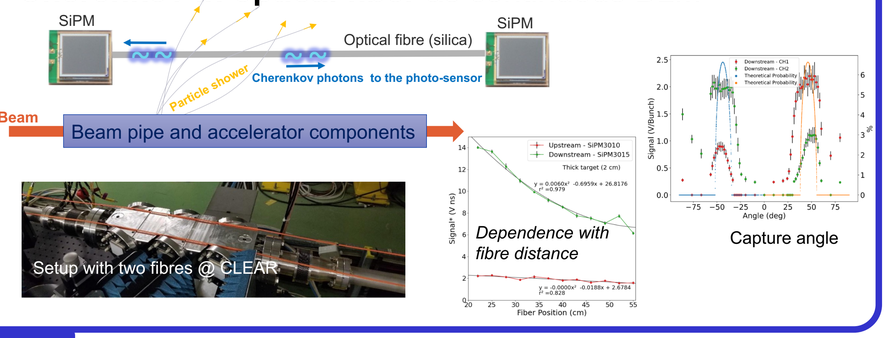




Semiconductor as fast BLM



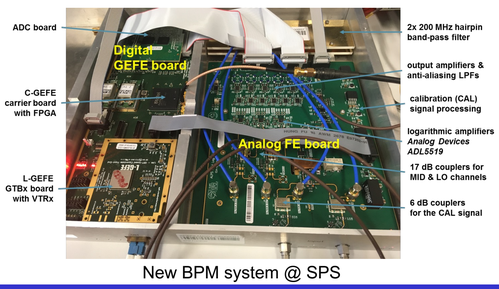
Cherenkov in optical fiber as continuous BLM



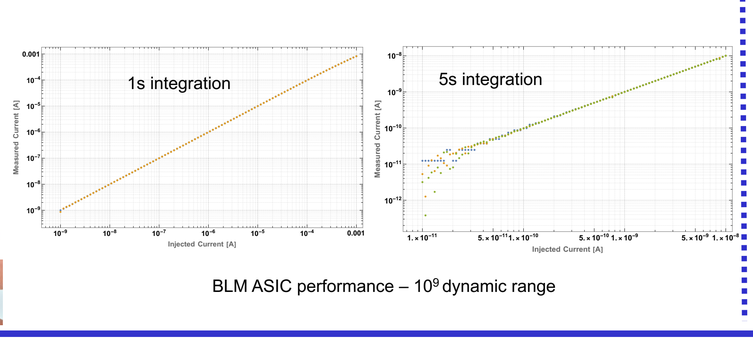
State-of-the art electronic development

Standardising read-out platform

Rad-tol / Rad-hard Front-Ends

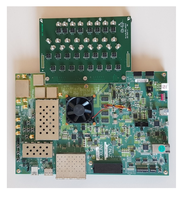


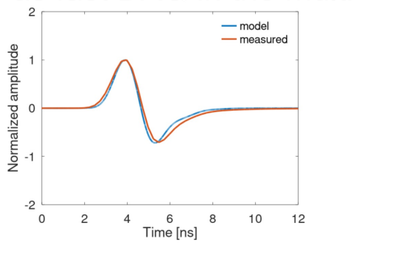
New BPM system @ SPS



BLM ASIC performance – 10^9 dynamic range

RF System-on-Chip as fast DAQ in the multi GSa/s





Next-**Time stretch EO techniques** for >100GSa/s