Specifications and Planning for future wirescanners at CERN

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- Specification
- Limitation of existing scanners
- Goals for new design
- Planning
- Personal

Specifications

Functional Specification

(EDMS n. 772786)

MEASUREMENT OF THE TRANSVERSE BEAM DISTRIBUTION IN THE LHC INJECTORS

5.1.3.1 PROFILE MONITOR FOR EMITTANCE COMPARISON AND CALIBRATION

The main use of the circulating beam profile monitors is to provide accurate profile measurements to determine accurately the beam emittance for comparison purposes between different machines to detect possible blow-up during extraction and/or injection.

The required accuracy in the beam size measurement is of few percents if accuracies in the range of 5% have to be achieved for the emittance measurement as required for the LHC proton and ion beams with nominal intensity. This level of accuracy requires a very good measurement of the optics properties at the beam profile monitor which might demand the

Functional Specification

MEASUREMENT OF THE TRANSVERSE BEAM DISTRIBUTION IN THE LHC RINGS

EDMS Document No.

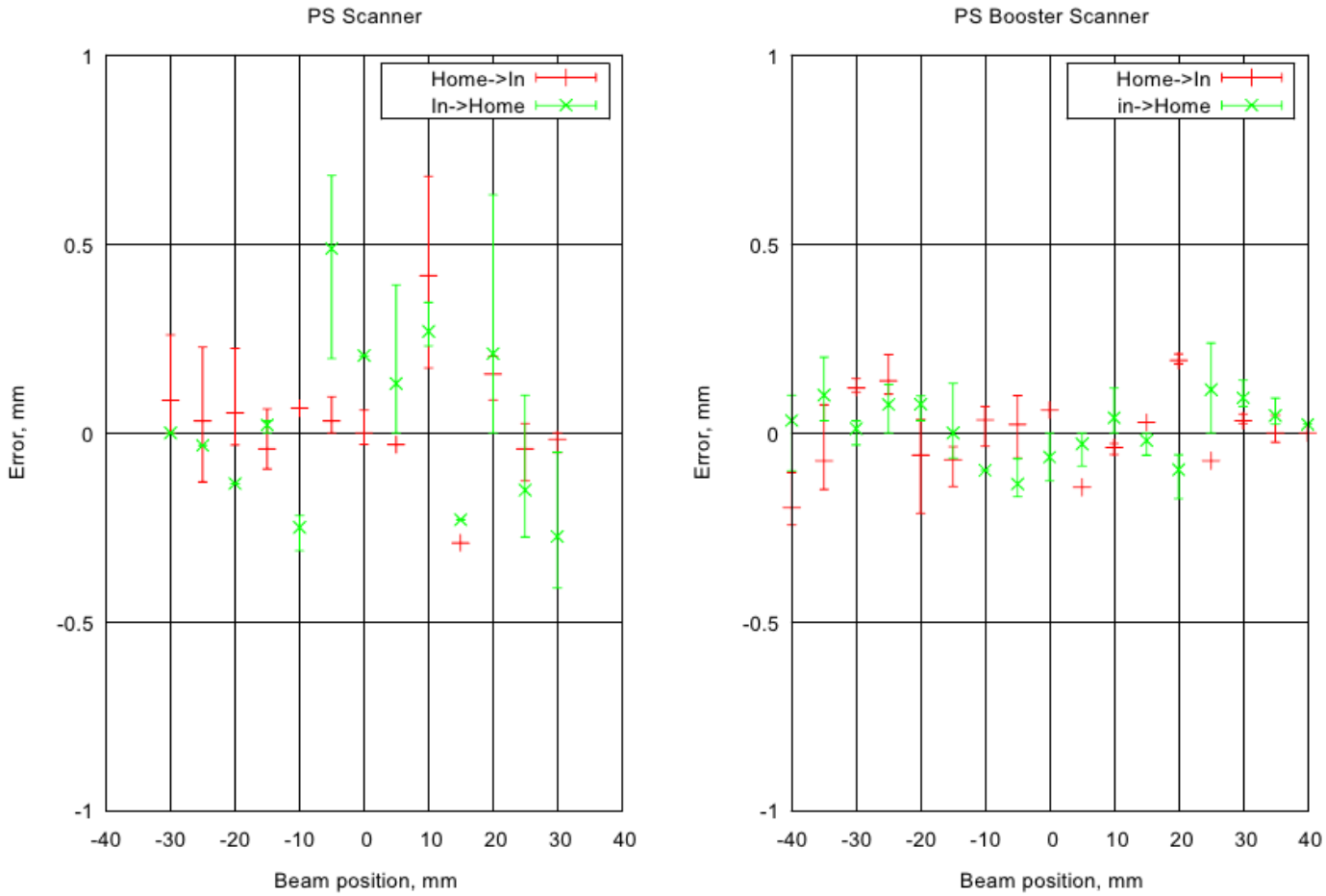
328147

Aim: Common basic layout of design for all CERN rings

Monitor type/mode		Beam scenario	Observation mode	Precision mode/value
Single-pass to Few-pass	Beam spot	1 pilot to 1 nominal SPS batch	Turn-by-turn	Accuracy: • 20% rms on σ • average position: ≈ 300 μm rms
Circulating	matching	1 intermediate bunch to SPS batch	Turn-by-turn over 20 turns	Resolution: ± 20% on σ
		Intermediate to ultimate SPS batch		
	beam size and profile	Pilot to intermediate beam	10^3 turns	Resolution: 10% rms on beam σ
		intermediate to ultimate beam		Resolution: • 1% rms on beam σ • 5% rms on bunch σ • 10% rms on transv. distribution points • (± σ/10 in beam position)
			10^2 turns	Resolution: 5% rms on beam σ
	Beam emittance		10^3 turns	Accuracy: ± 5% on beam σ
	tail	intermediate to ultimate beam	10^4 turns	Resolution: 10% rms on transv. distribution points

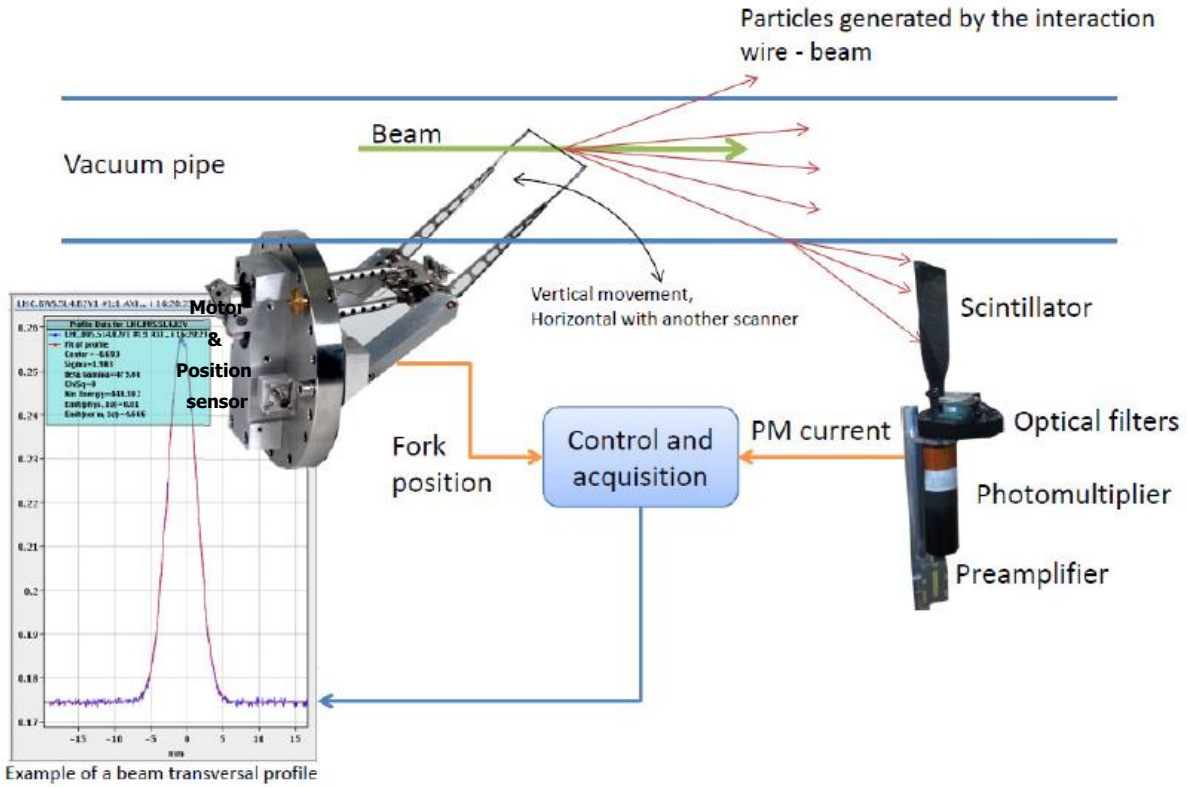
LASER beam reproducibility test measurements

Verification measurement accuracy after having introduced calibration data



- Fluctuation up to several 100 um
- Fluctuation due to principle of scanner hardware

Limitations



Example of a beam transversal profile

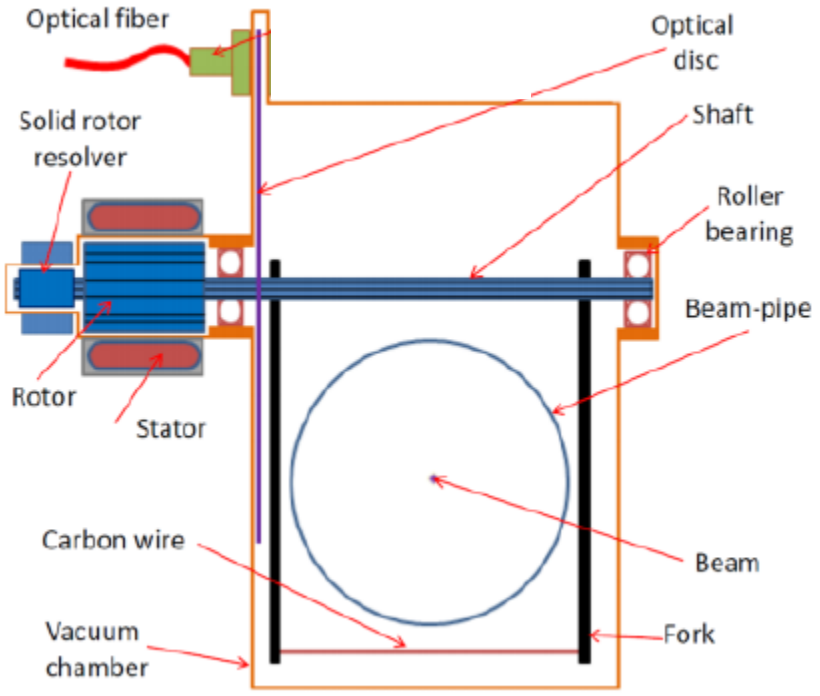
- Reproducibility much larger as required by specification
  - Beam size min LHC 130, PSB 2000 um
  - Flexible design of wire fork
    - Deformation of fork are not measured
  - Angular position measurement outside of vacuum system
    - Lever arm play is not measured
- Speed regulation circuit
  - Analog feedback loop difficult to optimize
- Secondary particle acquisition system
  - Requires accurate adjustment of working range
    - Saturation effect of PM
  - Dynamic of working range small < 200
    - Tail measurement limited by noise
  - High intensity beams cause an increase of background signal
    - Dynamic of working range reduced
- Aging of bellows

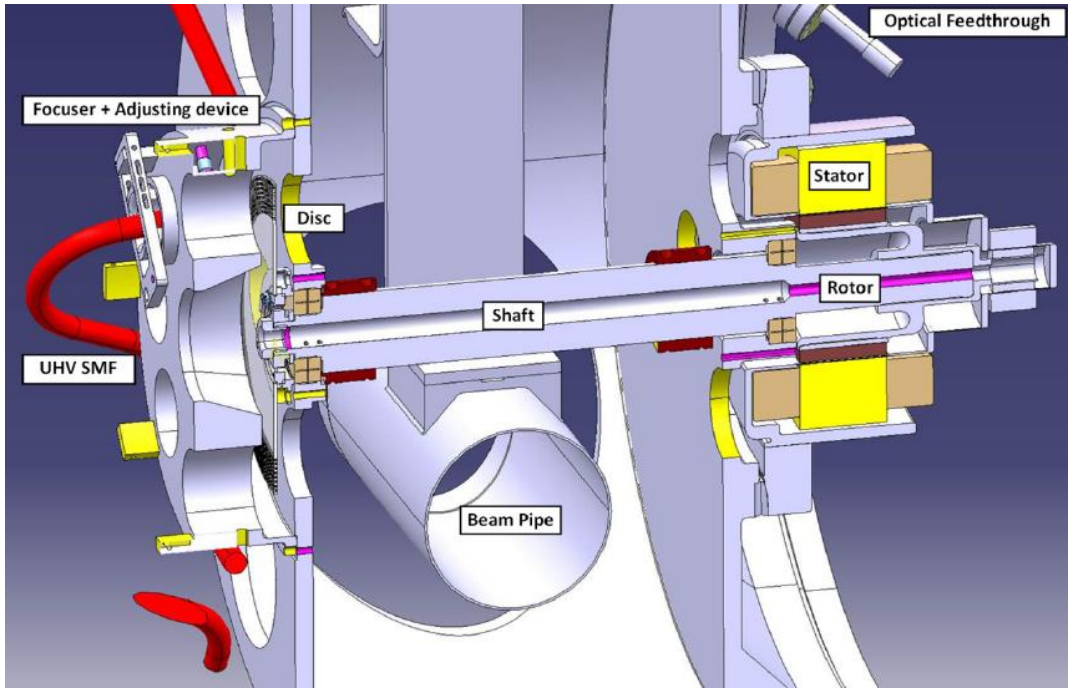
Goals

- Scan at least as fast as the existing system (20 m/s needed to avoid wire damage)
  => Rotational system (power ~ inertia ~ m * r^2)
- Absolute accuracy of beam width determination of about 5 um
  - Reduction of play in mechanical system
    => all elements mounted on same axis
  - Position measurement
    => high accuracy angular position sensor
  - Overcome bellow limitations:
    - Low lifetime
    - Friction

    => Locate all moveable parts in the vacuum
  - Minimize fork and wire deformations
    => Study of dynamic behavior of fork/wire system
    => Vibration mode optimized acceleration profile
- Large dynamic range for secondary particle detection
  => Usage of sensor with large dynamic (diamond)
  => Automatic electronic switching of gain ranges (**range dynamic 1E4**)
- Increase MTBF compared with existing systems

Schematic and First Design





Planning

- Finished first mechanical design begin 2013
- Produce first prototype Q3 2013
- Produce second prototype Q1 2013
- Installation of second prototype in SPS before startup 2014 (cell 517)
- Commission system up to 2015/16
- Production of system for installation in 2018

People involved

- BE-BI-BL
  - Jose Sirvent Blasco (Master: past: optical angular position sensor, future: PhD on diamond acquisition electronics)
  - Bernd Dehning (scanner system)
  - Jonathan Emery (electronic system)
  - Juan Herranz Alvarez (PhD: accuracy of mechanical system)
  - Carlos Pereira (electronic designed)
- BE-BI-ML
  - Raymond Veness (mechanical system)
  - Sebastian Samuelsson (Master: mechanical design)
- EN-MME
  - Nicola Chritin (design office)