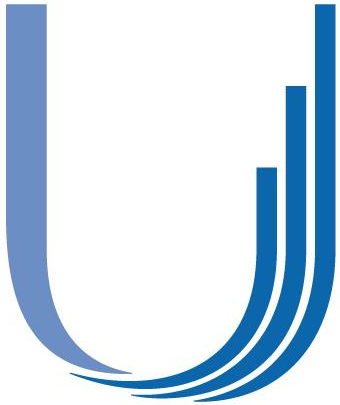

LHC Injectors Upgrade

LHC Injectors Upgrade

Matching and Synchrotron Light Diagnostics

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CERN

Contents

- SPS Beam Synchrotron Radiation (BSR) Monitor
- SPS Matching Monitor

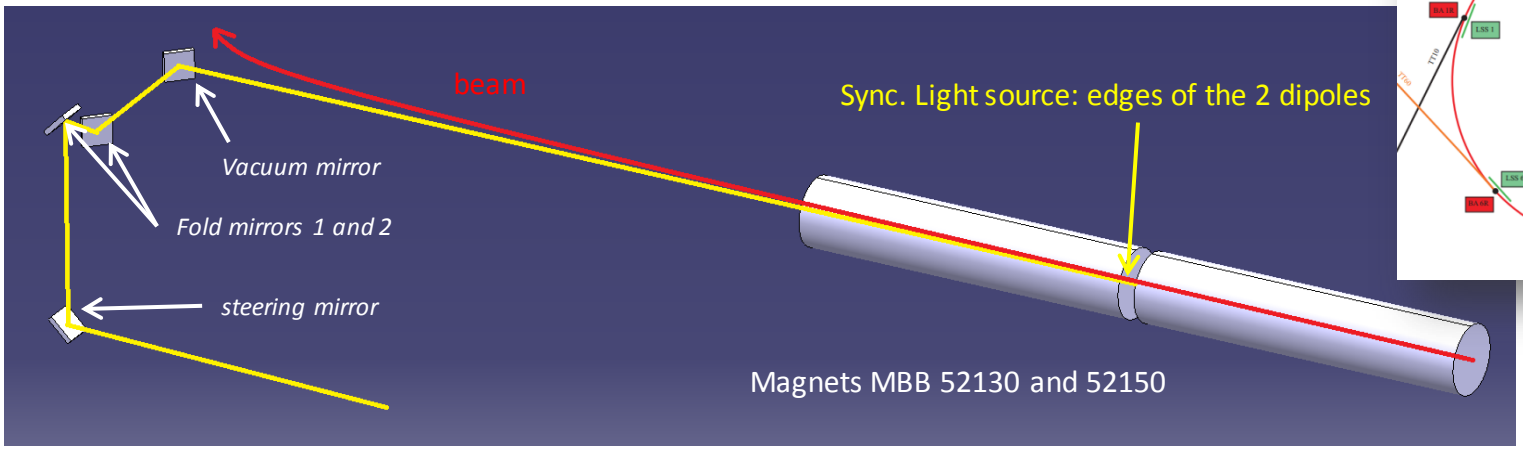
SPS Synchrotron Light Monitor

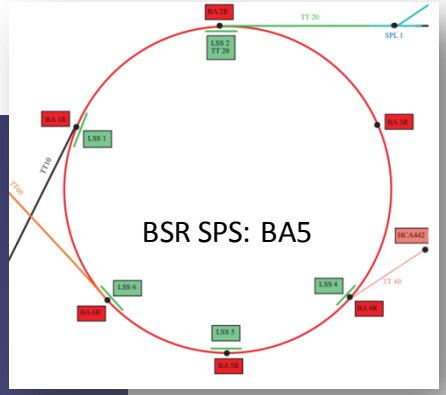
SPS BSR Specifications

- Transverse profile measurements
- We don't have detailed specifications. We assume we have to provide:
  - Continuous monitoring (as technically possible) at high energy (>300 GeV seen to work)
    - Mentioned as beam quality check device before extraction
  - Bunch gating (if technically feasible)
  - Integrating over minimum number of turns
  - Size evolution during ramp

Proposed Technology

Synchrotron light used for imaging is emitted by the falling edge of MBB52130 and rising edge of MBB52150





	distances (mm)
light source to vacuum mirror	**14150**
Vacuum mirror to 2d fold mirror	450
2d fold mirror to motorized mirror	600
mirror to camera	4300

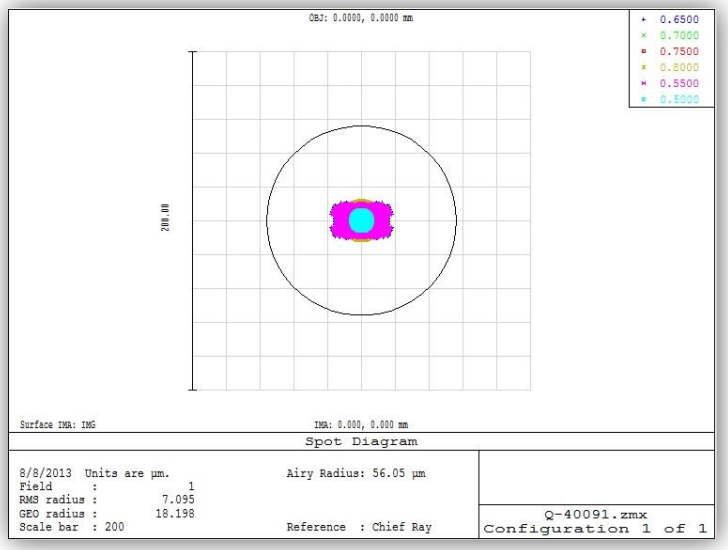
Undulator for working below 270 GeV would require very short period structure
- Investigating status of technology, but no conclusions yet

Proposed Technology

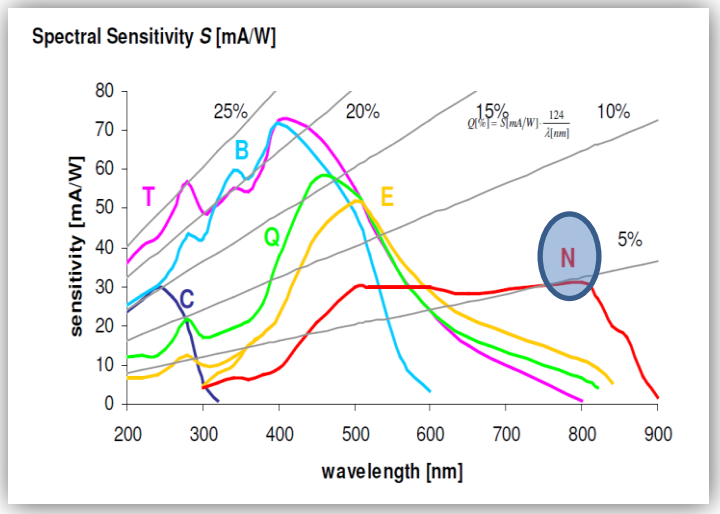
Imaging with 1 lens f=3300mm, achromat, optimized between 500 and 800nm

- Magnification = 0.27
- **Resolution expected to be ~120um (considering chromatic aberrations and diffraction)**
- Beam size expected (450 GeV,emit=2um):
  H = 600um (450um with no dispersion control), **V = 580um**
- Gated camera Proxitronic HSF4, photocathode N type (LHC-BSRT)

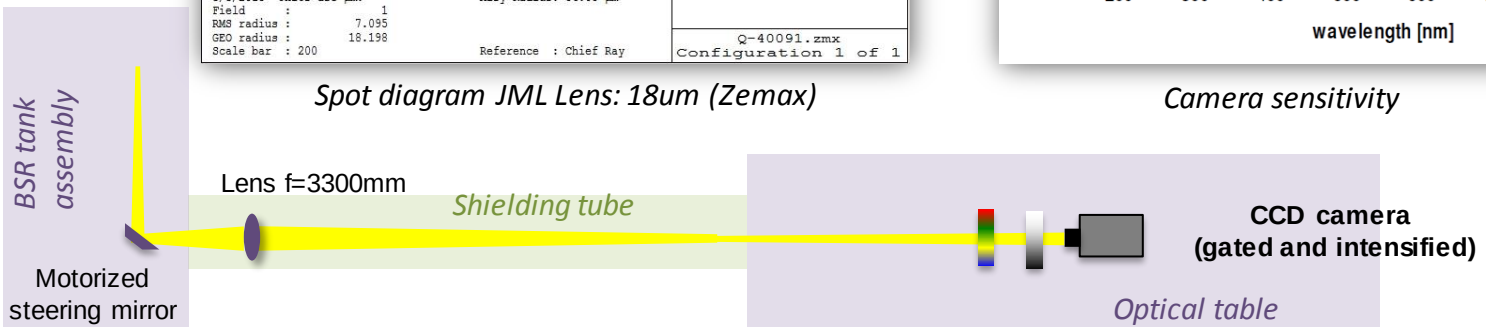
A.Goldblatt



Spot diagram JML Lens: 18um (Zemax)

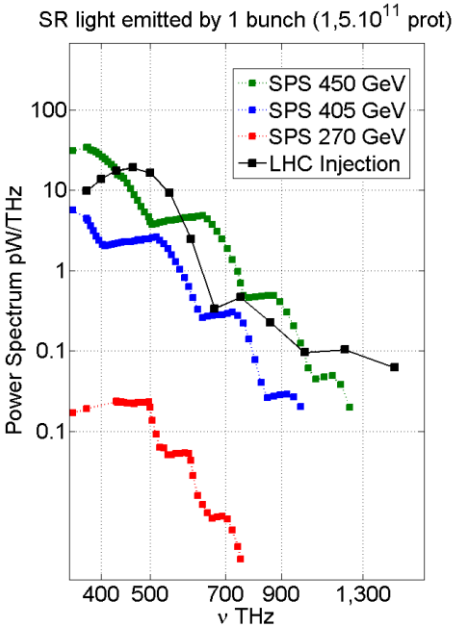


Camera sensitivity

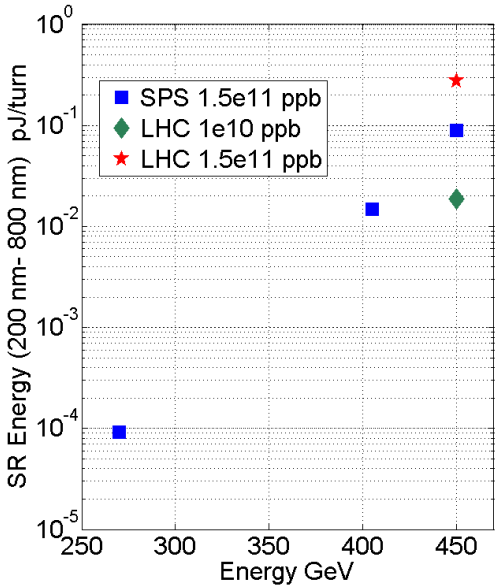


Expected performances

PRELIMINARY SIMULATIONS



SR intensity vs radiation frequency



G.Trad

Energy on extraction mirror per bunch per turn (integrated between 200 to 800nm wavelength range)

Acquisition rate: BTV acq. period 20ms – Gate trigger 5 ms
LHC : max integration in 20 ms == 4 turns
SPS: max integration in 20ms == 15 turns

LHC period: 89us
SPS period: 23us

@ 450GeV:
LHC: we can measure pilot single turn every 20ms (== 225 turns)
→ SPS: should see single bunch integrated over 3 turns (separated by 290 turns) every 20ms

Expected performances

- As shown: not so much light, especially below 300 GeV
- SPS optics knowledge ~10% (beta-beating meas. foreseen?)
- Relatively high horizontal **dispersion (Dx=1.4m)**
  - **Need good knowledge of Dx and dp/p**
  - **Dy ~= 0, should be ok**

Status of Development

Will use mostly mechanics already installed:
- tank with extraction mirror
- fold mirrors
- enclosed optical bench, displaced of about 1.5m.
- calibration system

Elements which will be replaced:
- steering mirror
- cabling (already pulled)
- optics (lens, camera, filters)
- control

The mechanical system will be ready for restart after LS1

Installation and Commissioning Plan

- Little mechanics involved

- We assume BSR SPS is not needed from day 1

  (**need parasitic commissioning with beam)**

Budgetary Requirements

- 2014: 60 kCHF (camera+optics+HW)
  - Foreseen for 2013, basically not spent
- 2015-2019
  - Depends on tests with beam
  - Baseline
    - Do not change tank
    - Possible upgrade of optics and movable stages control
- Still to be sorted out:
  - Request for SPS Longitudinal Density Monitor ?
  - Digital Camera as long-term solution

SPS MATCHING MONITOR

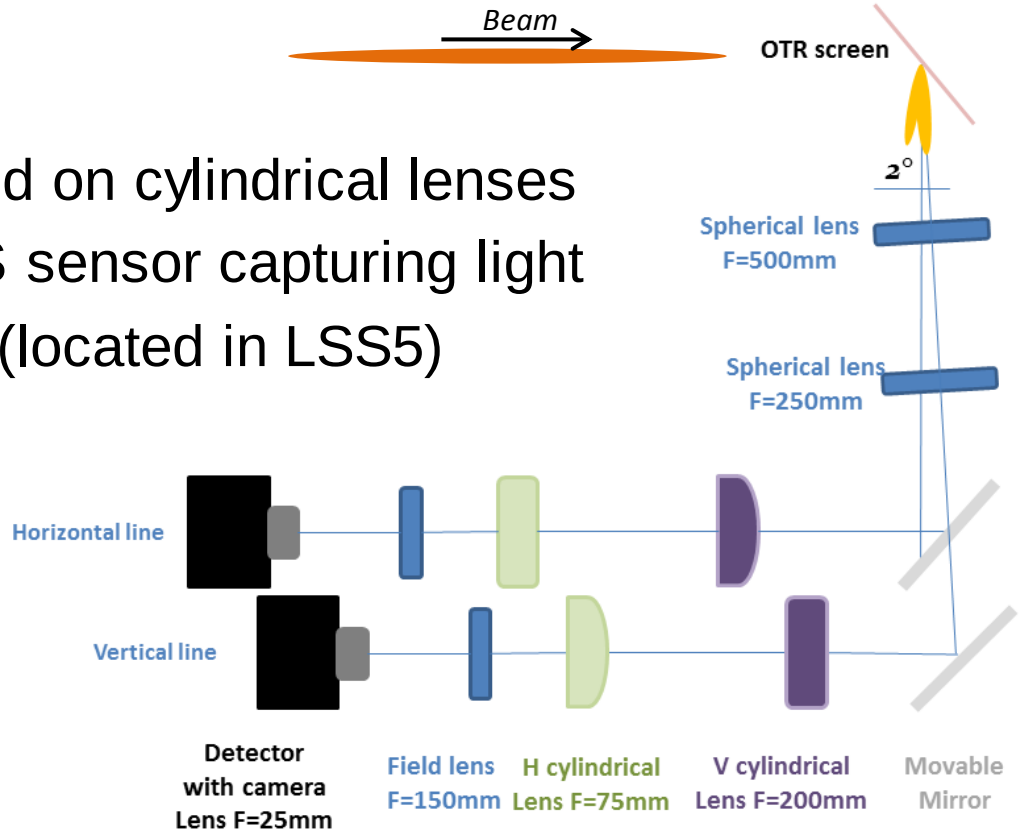
SPS Matching Specifications

What is requested

- Transverse Profile
  - turn per turn acquisition, single bunch
  - 1e10 protons to 1e11 protons per bunch
- Accuracy:
  - Variation channel to channel of <1%
  - Absolute accuracy on beam size not so important – say 10%
- Resolution :
  - For good fit should be able to resolve to 1-2% of peak density, with 1e10 p+ per bunch injected
- Repeatability:
  - Turn-to-turn variation (relative accuracy) of <1%
- Monitors at low and high dispersion regions to disentangle dispersion mismatch

Matching Proposed Technology

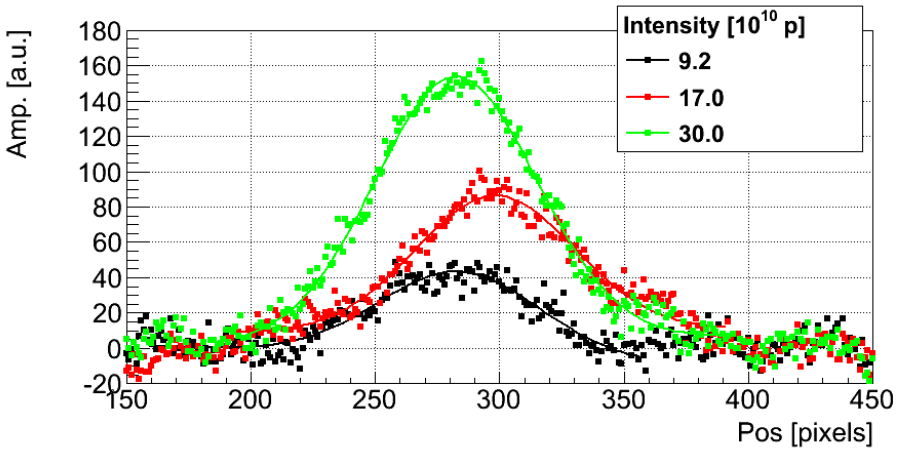
- For after LS1:
  - Existing system based on cylindrical lenses and fast linear CMOS sensor capturing light from an OTR screen (located in LSS5)

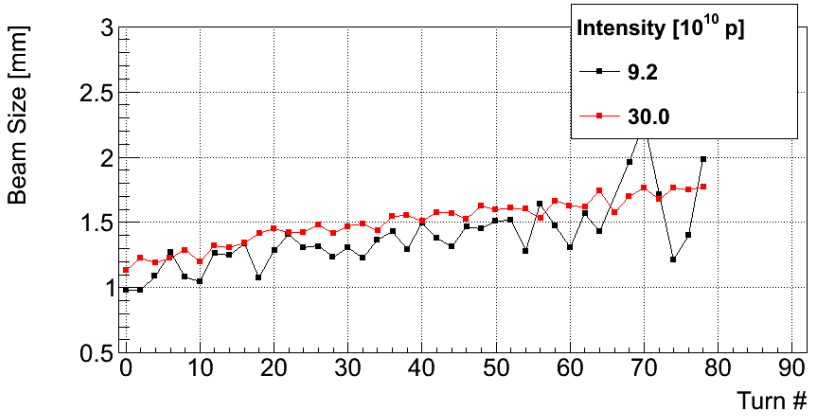


- Long term:
  - Replace tank
  - Replacement chamber
  - New detector MCP/PM if upgrade needed (sensitivity issue)

Matching Expected performances

- System commissioned in January 2013
  - Calibration 1px == 64um
  - Reasonable S/N ratio only above 2E11p with the present system
  - Acquisition every second turn
  - Max 300 turns to avoid screen damage





- After LS1:
  - Changing the magnification to reach1px == 100um should improve the S/N
  - Turn by turn acquisition

Matching Status of Development

- System already installed in SPS.
- Need
  - realignment
  - reinstall the acquisition electronics
  - more commissioning time to validate the instrument as operational Matching Monitor (inject and dump, MD time needed)

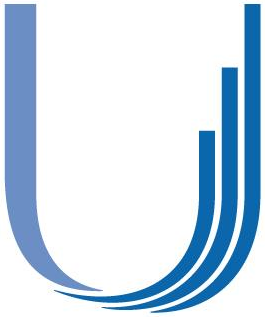
Matching Installation and Commissioning Plan (for after LS1)

- Is there a conflict between machines?
  - No
- Where are we limited by available manpower?
  - Restart of all machines may result in manpower concerns
  - But:
    - We believe matching monitor not required from Day1

      (we need dedicated MDs anyhow)

Matching Budgetary Requirements

- No specific budget assigned yet to this project
- General cost breakdown up until 2019
  - 2014-2015: 20kCHF
  - 2017-2019: 100kCHF



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THANK YOU FOR YOUR ATTENTION!