Operation of the new synchrotron radiation extraction

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New BSRTM motivations

• For the HL-LHC era the synchrotron radiation based diagnostics need to be extended
• Need a second SR extraction point
• Identified location requires a new tank design
  • Taking advantage to improve functionalities
Scope of present installation

- Verify with beam that the RF heating is under control
- Study the properties of the new SR source
- Validate the design in general
- One device (B1 in 4L) is sufficient for this
- ECR document
  [https://edms.cern.ch/document/2610870/1.0](https://edms.cern.ch/document/2610870/1.0)
New SR source(s) location

BSRTR
BSRT
MU

~25 m
420 mm

~60 m
~44 m

194 mm

Q6 Q5 D4

New BSR

B2

B1
New BSRTM
New source timeline

• Design and install new extraction tank
  ✓
• Validate RF impedance
  ✓
  • Simulations, stretched wire, beam tests
• Enlarge beam pipe between D4 and new BSRTM
  <LS3
• Install shielding, optics and instruments
  LS3
Aperture restriction

- Mirror can be moved IN/OUT
  - Max IN ~11mm from beam axis
  - Max OUT ~35mm from beam axis
- Mirror can become an aperture restriction
- Need to control and interlock the actuator that controls the position of the mirror
- Mirror will be always placed in safe position
Beam aperture at injection

- **Aperture limits calculated by APB**
  - $\text{emittance}_{\text{norm}} = 2.5 \times 10^{-6} \text{ um}$
  - $\sigma$ error = 5%
  - dispersion error = 14%
  - orbit error = 0.002
  - energy = 450 GeV
  - energy error = 0.00086
  - $N_1 = 13 \text{ sigma}$

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<tbody>
<tr>
<td>Aperture [mm]</td>
<td>22.9</td>
<td>22.9</td>
</tr>
<tr>
<td>Beta $x$ [m]</td>
<td>381.2</td>
<td>381.2</td>
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<tr>
<td>Beta $y$ [m]</td>
<td>263.4</td>
<td>243.1</td>
</tr>
<tr>
<td>$\sigma x$ [mm]</td>
<td>1.409 (16.2 sigma aperture)</td>
<td>1.409 (16.2 sigma aperture)</td>
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<tr>
<td>$\sigma y$ [mm]</td>
<td>1.172</td>
<td>1.1255</td>
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Beam aperture at FLATTOP

- **Aperture limits calculated by APB**
  - \( \text{emittance}_{\text{norm}} = 2.5 \times 10^{-6} \text{ um} \)
  - \( \text{sigma error} = 10\% \)
  - \( \text{dispersion error} = 10\% \)
  - \( \text{orbit_error} = 0.002 \)
  - \( \text{energy} = 6500 \text{ GeV} \)
  - \( \text{energy_error} = 0.0002 \)
  - \( N1 = 20 \text{ sigma} \)

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<tbody>
<tr>
<td><strong>Aperture [mm]</strong></td>
<td>11.2</td>
<td>11.2</td>
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<tr>
<td><strong>Beta x [m]</strong></td>
<td>381.2</td>
<td>381.2</td>
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<tr>
<td><strong>Beta y [m]</strong></td>
<td>263.4</td>
<td>243.1</td>
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<tr>
<td><strong>Sigma x [mm]</strong></td>
<td>0.371</td>
<td>0.371</td>
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<tr>
<td>(30.2 sigma aperture)</td>
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<tr>
<td><strong>Sigma y [mm]</strong></td>
<td>0.308</td>
<td>0.296</td>
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Actuator

- Actuator controlled by stepping motor
  - Resolver on motor axis
  - Two limit switches to limit the stroke and indicate the fully retracted/inserted position
  - Two linear potentiometers that monitor real position of mirror support
  - Mechanical stop limits insertion to ~10 mm (can be adjusted)
Control

- Motor, resolver and potentiometers controlled by two PXI (Motion and potentiometer) systems from BE-CEM
- StepperAxis FESA class
- Mirror position controlled by sequencer tasks
- Position vs. energy limits stored in LSA as MCS
- Mirror temperature monitor by SY-BI FESA class and logged in NXCALS
  - One probe inside mirror itself
  - One probe on mirror support (both inside vacuum)
Interlock

- The interlock is based on the potentiometer readings
  - Two redundant sources (two FESA devices)
- If the position read is outside of limits a maskable BIS channel is triggered
  - Limits are functions of beam energy
    - For now we only need one value < FT and one value >= FT
  - MCS role allowed to change the settings?
Operation

- Before injection mirror sent to injection position: 23mm + δ
- At FLATTOP (after end of ramp) mirror sent to FT position: 11.2mm + δ
- δ to be determined based on readout noise of potentiometers (avoid spurious dumps)
Conclusions

- A new BSRTM device has been installed for validation
- New design can pose aperture restriction danger
- Actuator position precisely monitored and connected to BIS
- Safe position values calculated by ABP vs. energy
- System fully installed
- Software configuration ongoing (LSA, sequencer etc.).
- MP document being prepared.