Status of BSRT and coronagraph

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Simulations and plots by D. Butti

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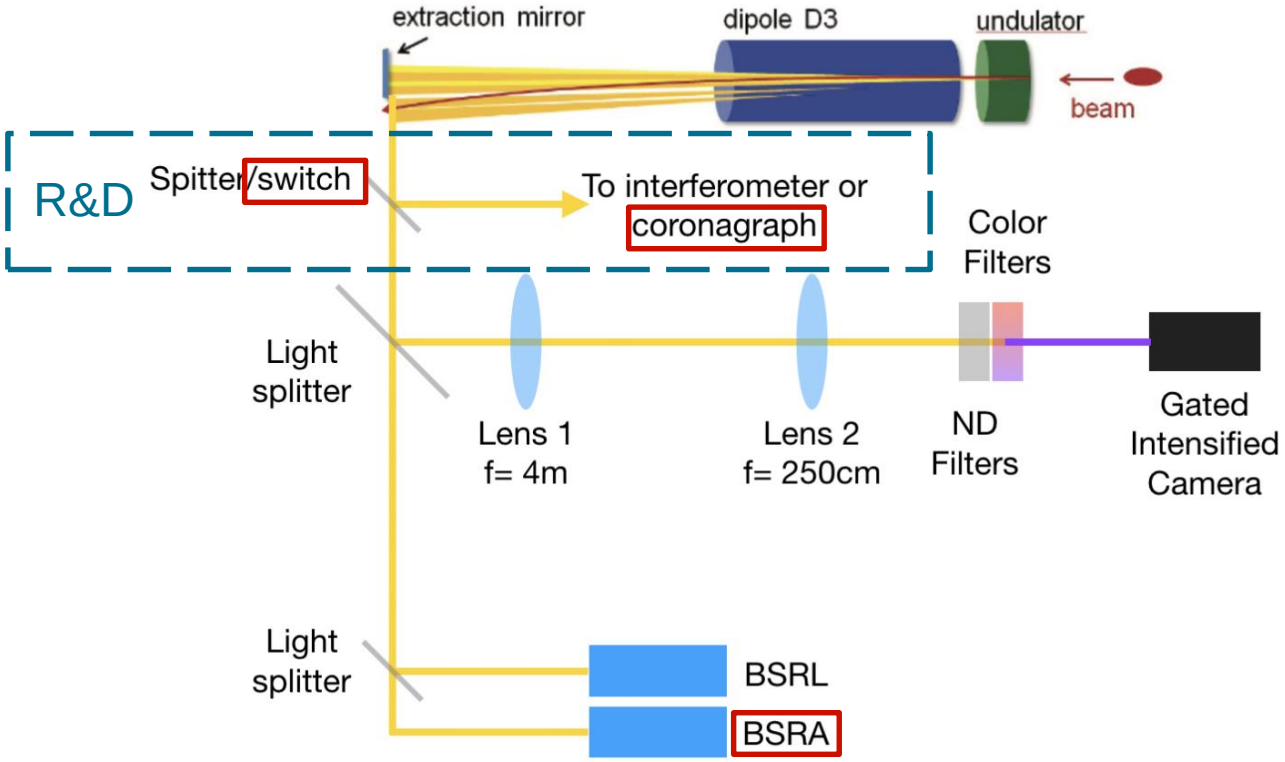
Present synchrotron light systems

- BSRT - Imaging telescope for beam size measurement
  - Cross calibrated with Wire Scanners
  - Performance limited by diffraction of SR
- BSRA – photo detector that measures amount of charges in the abort gap (machine safety device)
- BSRL – photo detector that measures the longitudinal distribution of charges with high DR and high time resolution

BSRT layout today



(original) Additional requirements for HL-LHC

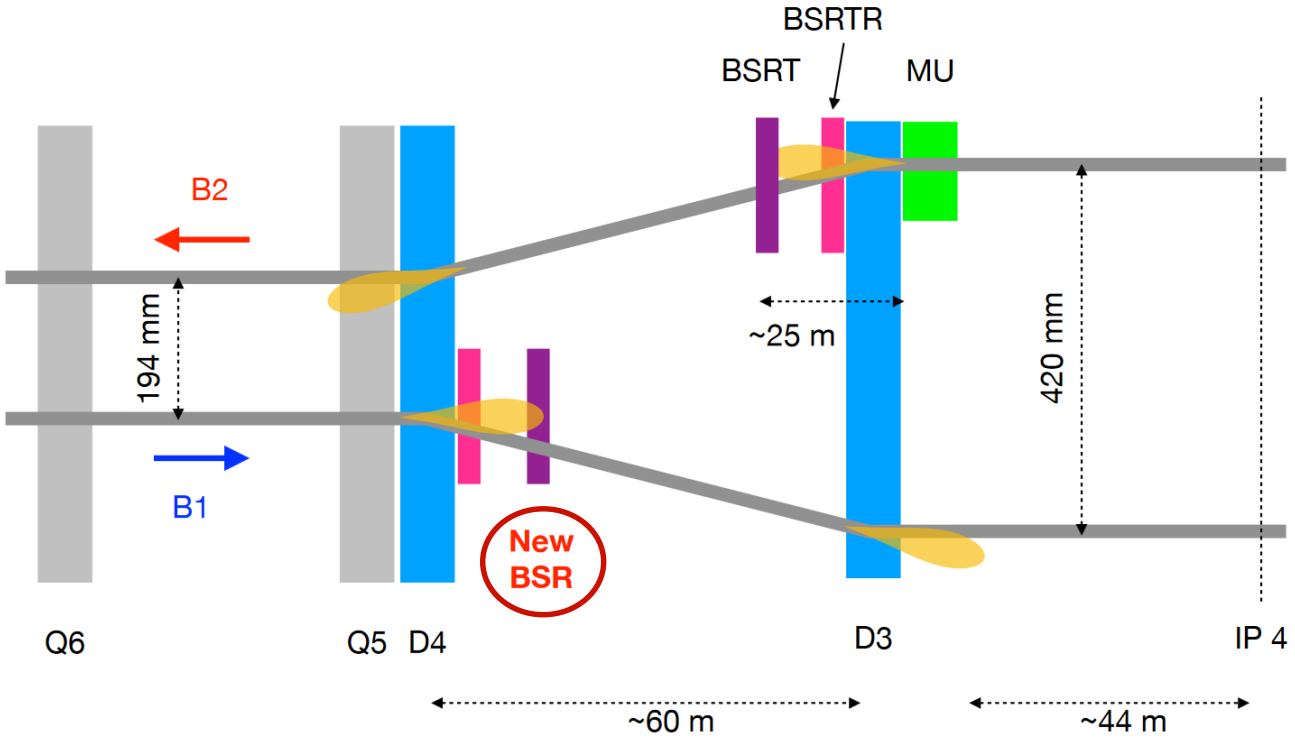
- Measure the tails of the beam (Halo)
  - Required for tuning of e-lenses
  - Danger of damaging the collimators in case of failure of the crab-cavities

Requires new SR extraction

- Monitor the non closure of the crabbing bumps
  - Baseline with closed crab bumps
  - Requires long optical lines to an optical hutch in the UA (radiation)

Will be done using BPMs
(unsuitable phase advance)

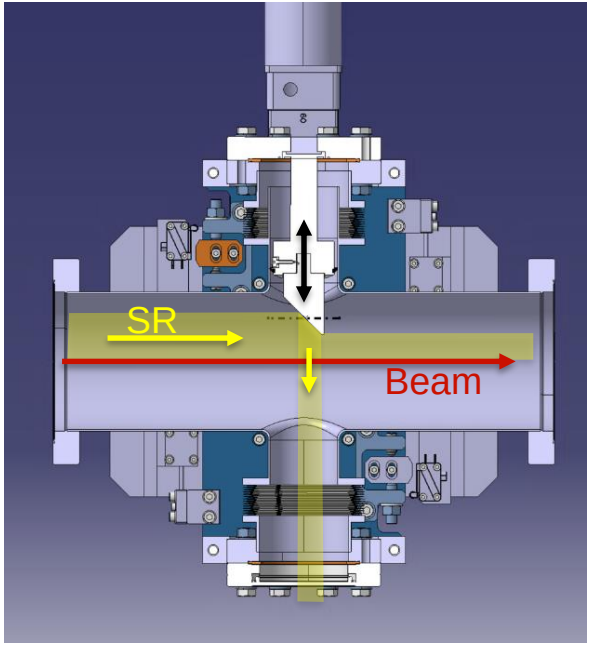
Synchrotron light in IP4 (Left)

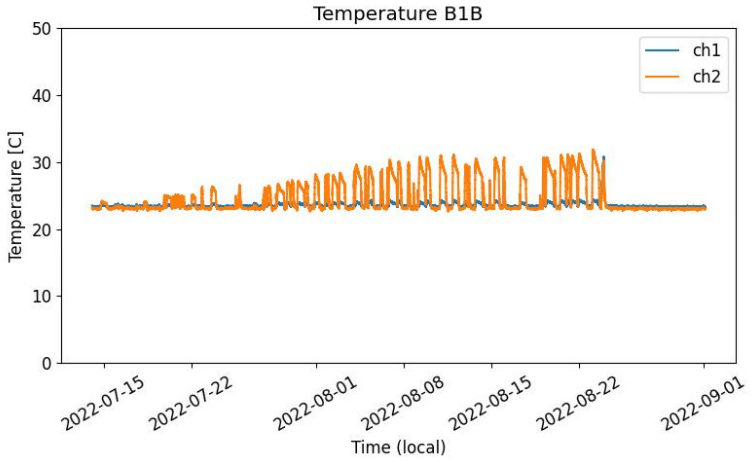


New SR extraction

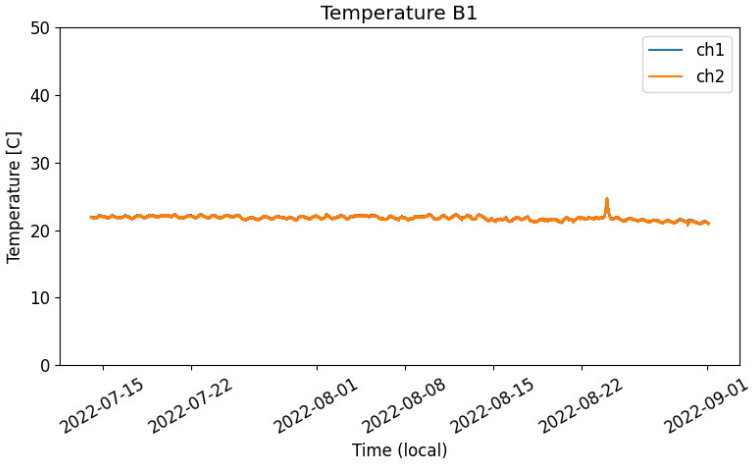
- Use SR from D4 without an undulator
  - Need a more compact extraction tank
  - Only useable at high energy (no MU)
- Need to verify RF compatibility to avoid heating the mirror
- Tanks designed and installed in LS2
  - RF validation done
  - T increase of few degrees on mirror with full intensity

New BSRTM tank





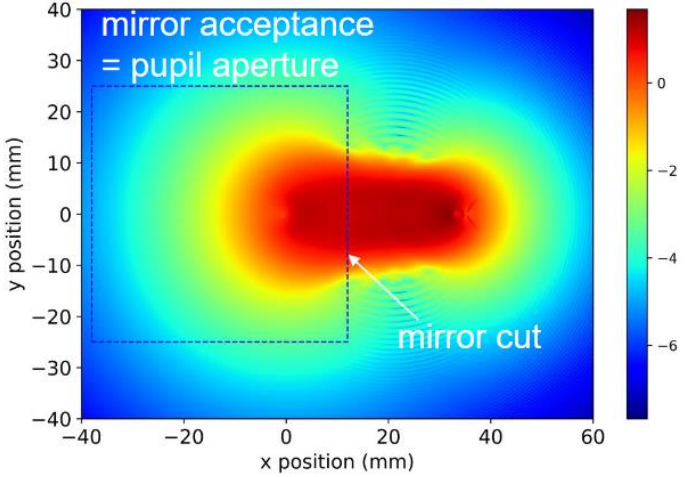
New BSRTM
@ 11 mm

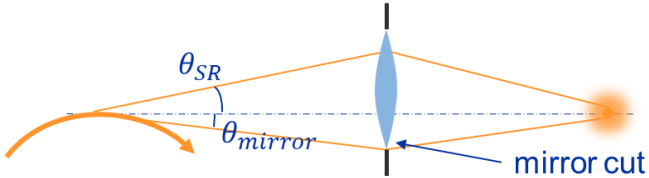


Old BSRTM
@ 21 mm

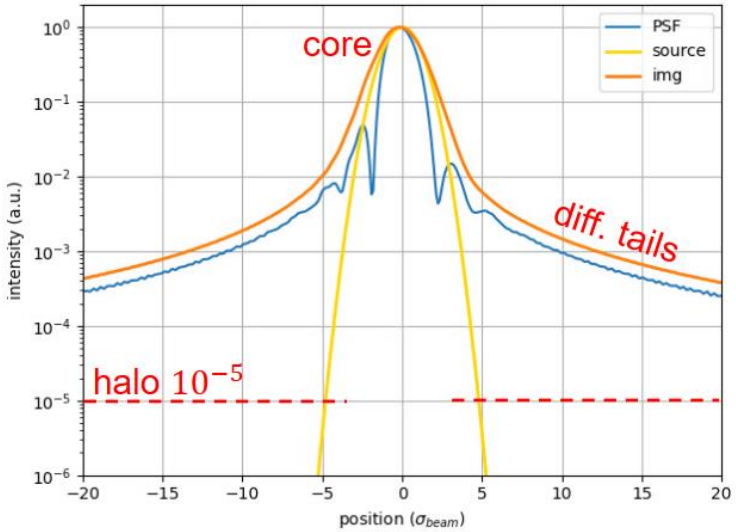
Halo monitoring imaging SR

SR @ BSRTM

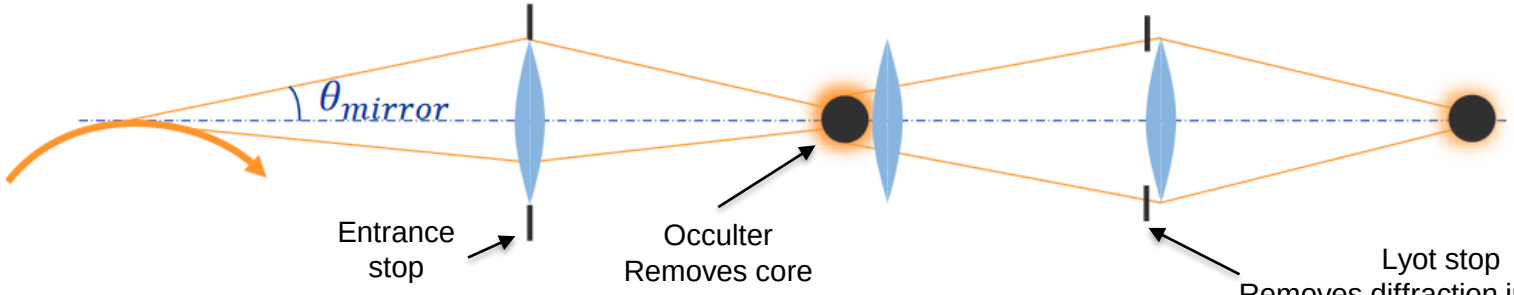


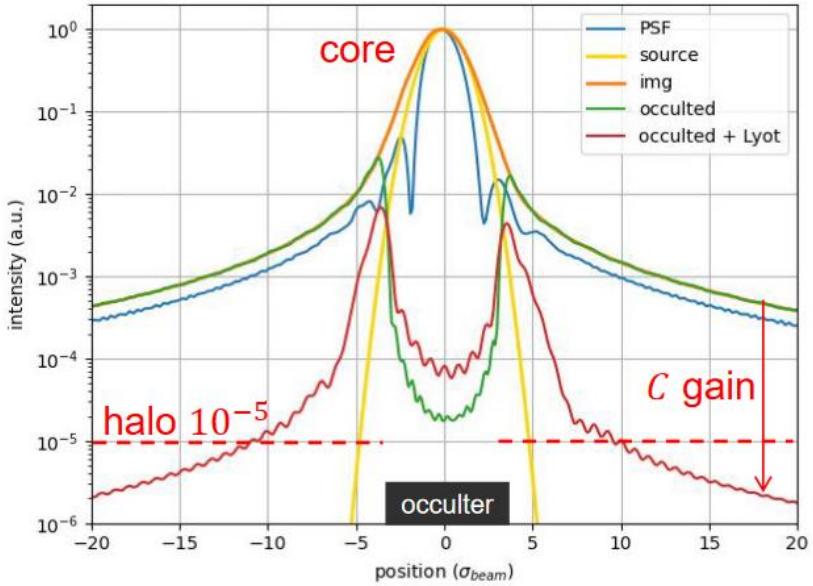


- The extraction mirror defines the optical acceptance
- No cut in the vertical plane
- Cut at the mirror edge in the horizontal plane



Lyot coronagraph



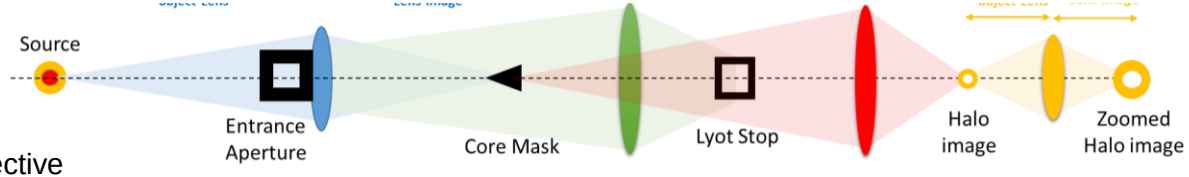


The gain in contrast is only outside 7 sigma

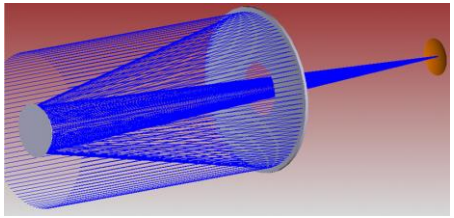
BSRH (coronagraph) R&D

- First R&D device installed on B2 during run2
  - Based on existing components from KEK
- Completely new device installed on B2 during LS2
  - Reflecting telescope as objective lens
  - Being commissioned
    - Requires shut off of BSRA, limited time available.
  - Copy installed in ISR tunnel

BSRH (coronagraph) R&D



Reflecting objective

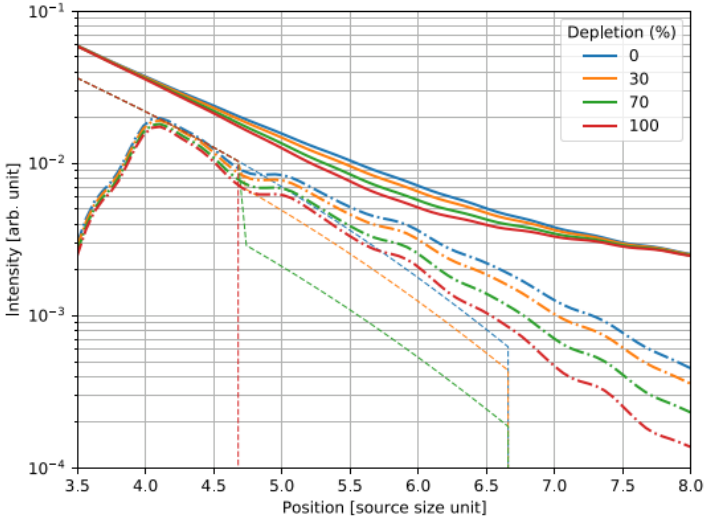


LHC B2

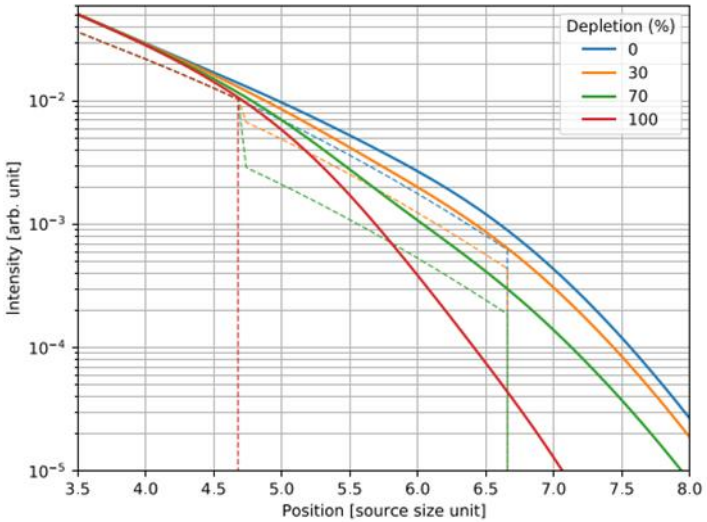
ISR

What can we expect from BSRH

Measured profile of realistic proton distributions with halo suppression



Horizontal



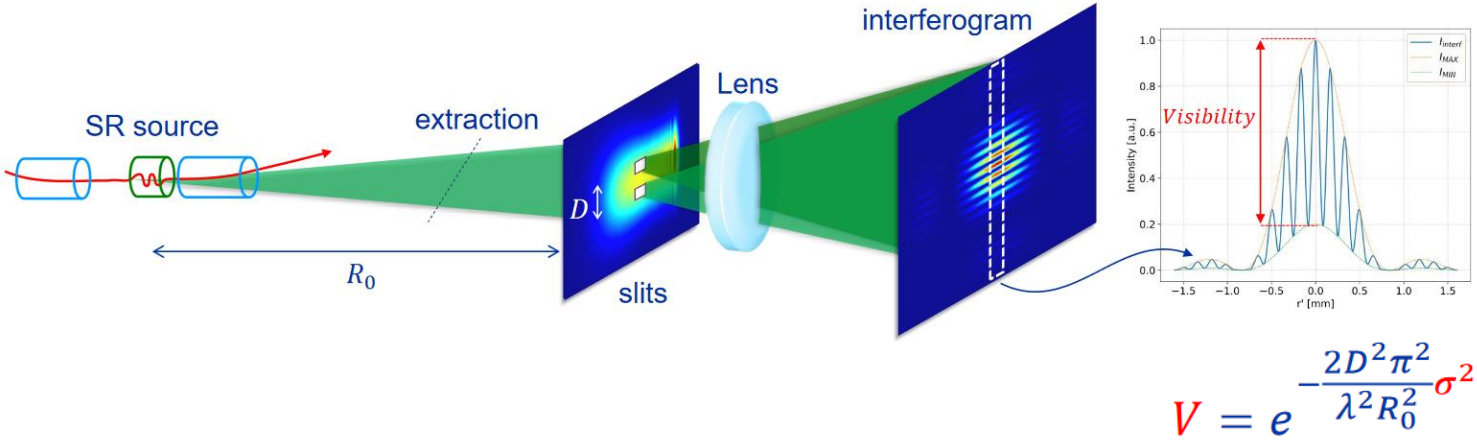
Vertical

Solid lines are for imaging, dot-dashed lines for coronagraph
Fine-dash proton distribution

BSRH R&D plan for run3

- 2022 commission the system and identify improvements
- YETS 22/23 modify entrance stage to allow // operation with BSRA (like for interferometer)
  - This may reduce the performance, but very likely the effect is well below the limitations due to SR
- 2023-2024 Characterize the device and compare to simulations

SR interferometer



$$V = e^{-\frac{2D^2\pi^2}{\lambda^2 R_0^2}\sigma^2}$$

Ongoing R&D to develop a SR double slit interferometer
Could provide independent absolute beam size measurement
Alternative device to the wire scanners
If successful could allow crosschecking the BSRT calibration continuously
SR properties complicates the results and may reduce the accuracy
Simulations confirm that the VCZ theorem can be used

Conclusions

- New SR extraction tank designed, installed and validated (RF)
- Detailed simulations of SR based halo monitor
  - SR properties limits the performance
  - Beam based measurement required to quantify the potential
- SR interferometer designed and installed
  - First measurements are very promising
- For the moment the 2nd SR extraction is on hold
  - Next step would be vacuum chamber enlargement between D4 and BSRTM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