



H I G H L U M I N O S I T Y L H C

# 12<sup>th</sup> HL-LHC Collaboration Meeting

## UPPSALA - Sweden

### 19 - 22 September 2022

The 12<sup>th</sup> HL-LHC Collaboration Meeting will take place in Uppsala, Sweden, from 19<sup>th</sup> to 22<sup>nd</sup> September 2022, as an in-person meeting.

Based on the traditional programme with plenary and work package parallel sessions, this meeting will serve as a technical update forum for the 6<sup>th</sup> Cost and Schedule Review, planned at CERN in November 2022, and provides the framework for additional collaborative meetings between the project partners.

This year, the main objectives will be to update all HiLumi collaborators on the results of key HL-LHC prototypes tests, to highlight the progress made in the transition from prototype validation to series production, and to update all collaborators on the latest schedule changes.



**CERN - Organizing Committee**

<i>Oliver Brüning</i> Project Leader	<i>Tord Ekelin</i> Chairperson
<i>Markus Zerlauth</i> Deputy Project Leader	<i>Richard Branner</i> Head of Physics Department
<i>Cécile Noels</i> Project Office	<i>Maja Olwegård</i> Head of FREJA Department
<i>Irène Garcia Obervo</i> Project Office	<i>Rocio Santiago Kim</i> Technical Leader (DHF project)

**Uppsala - Organizing Committee**

*cécile.noels@cern.ch*  
[www.hilumihc.web.cern.ch](http://www.hilumihc.web.cern.ch)

*For more details and registration*



# Status of BSRT and coronagraph

Enrico Bravin for the SY-BI BSR team

Simulations and plots by D. Butti

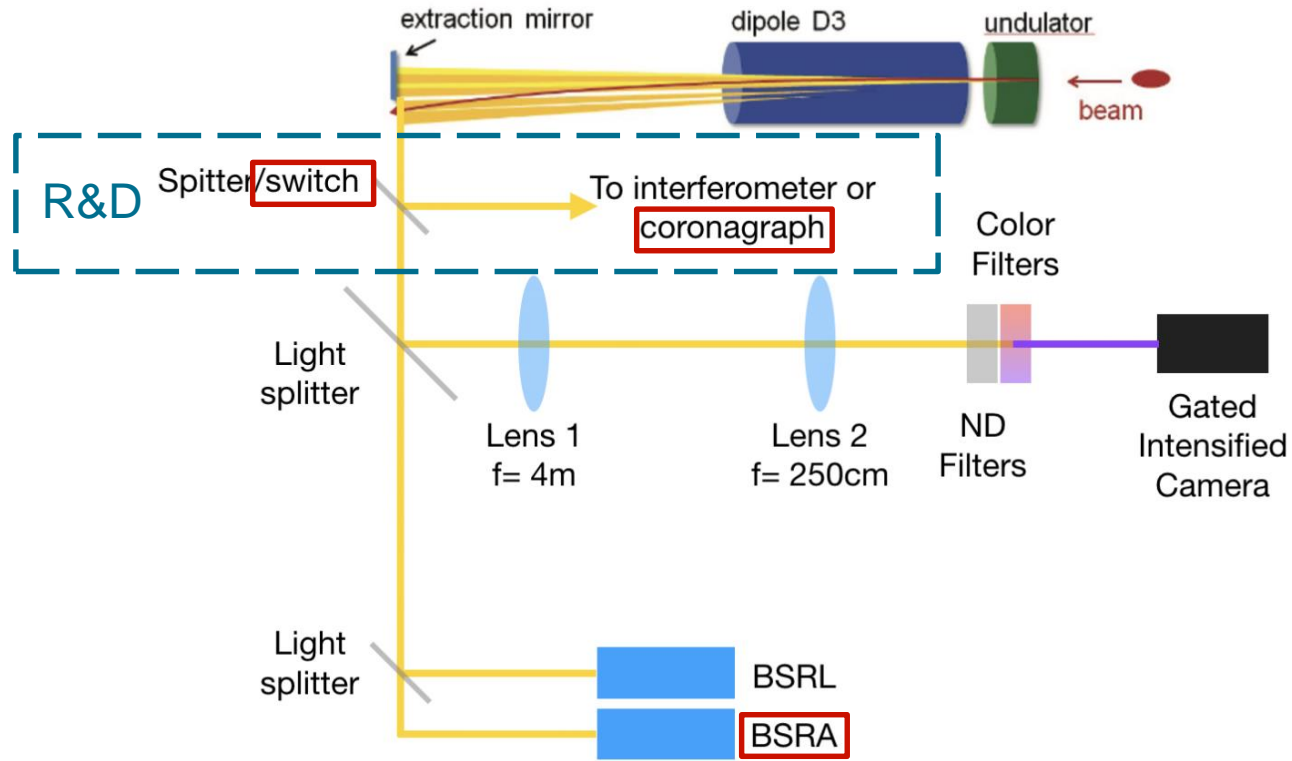
12th HL-LHC Collaboration Meeting – Uppsala (Sweden) – 19-22 September 2022



# 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

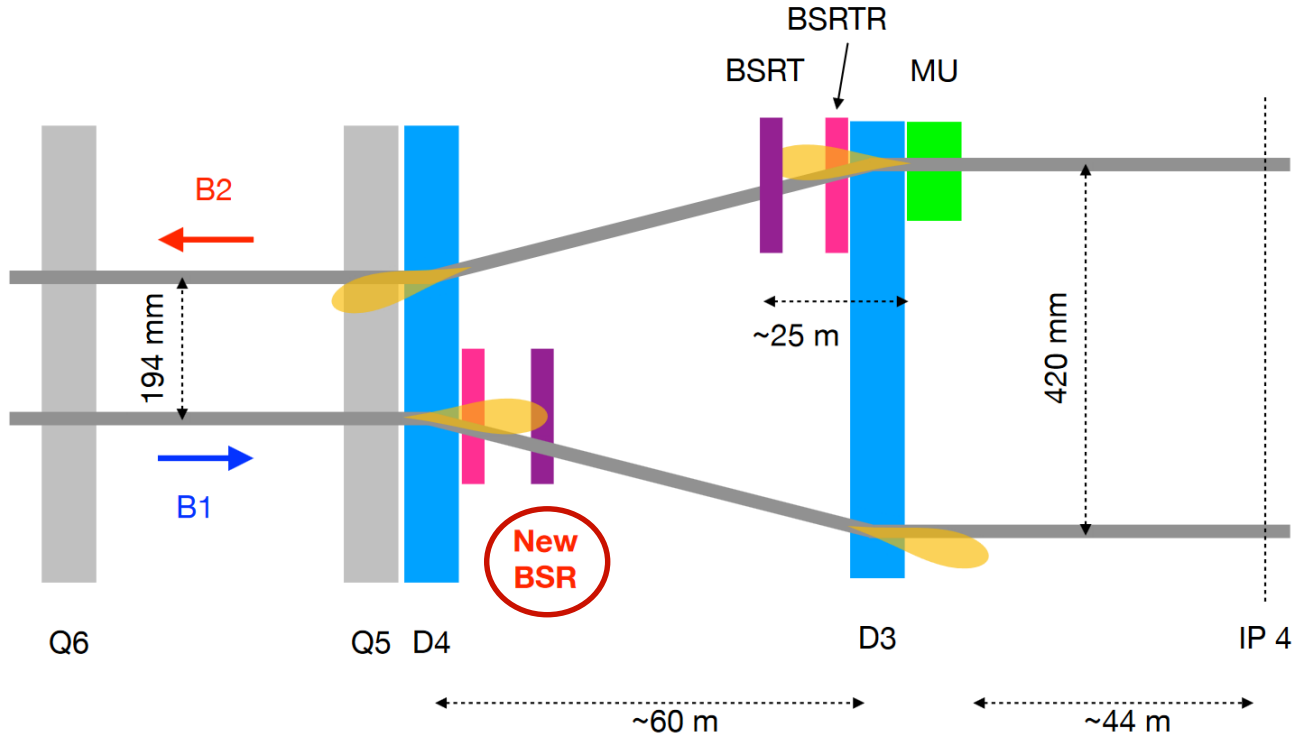
# BSRT layout today



# (original) Additional requirements for HL-LHC

- Measure the tails of the beam (Halo)
  - Required for tuning of e-lenses
  - Requires new SR extraction
  - Danger of damaging the collimators in case of failure of the crab-cavities
- Monitor the non closure of the crabbing bumps
  - Baseline will be done using BPMs
  - Requires (unsuitable phase advance)
  - UA (radiation)

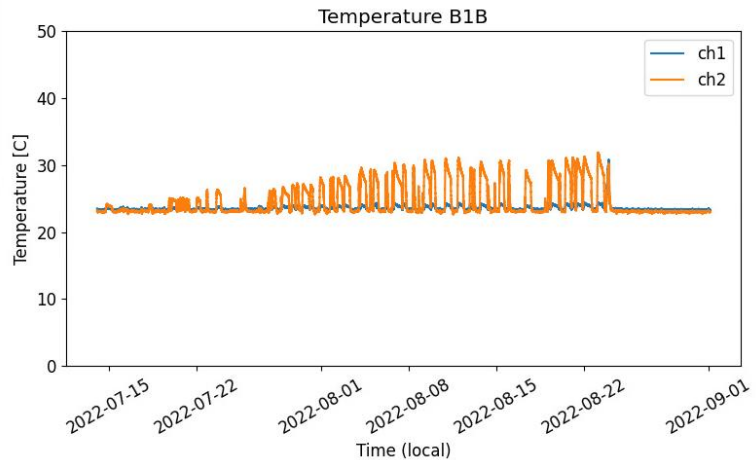
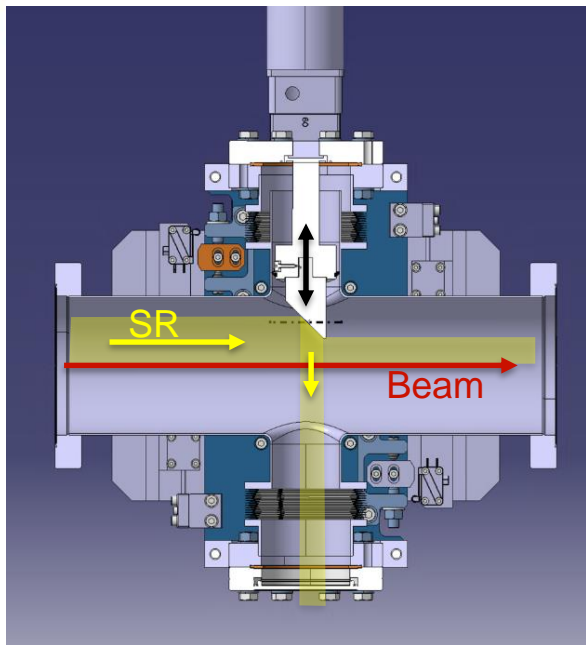
# Synchrotron light in IP4 (Left)



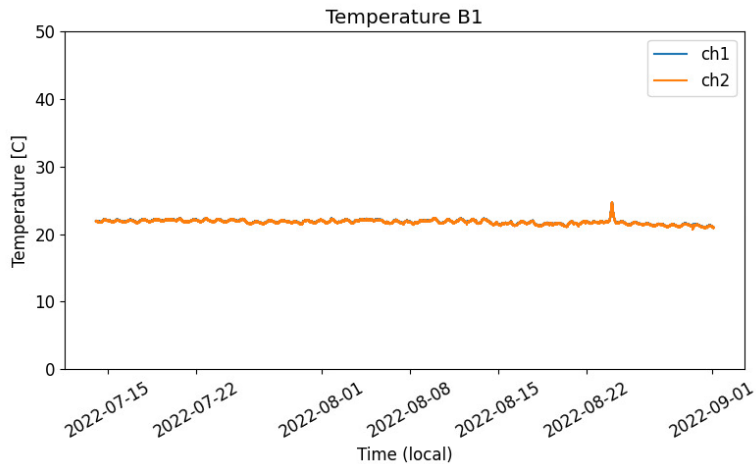
# New SR extraction

- 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



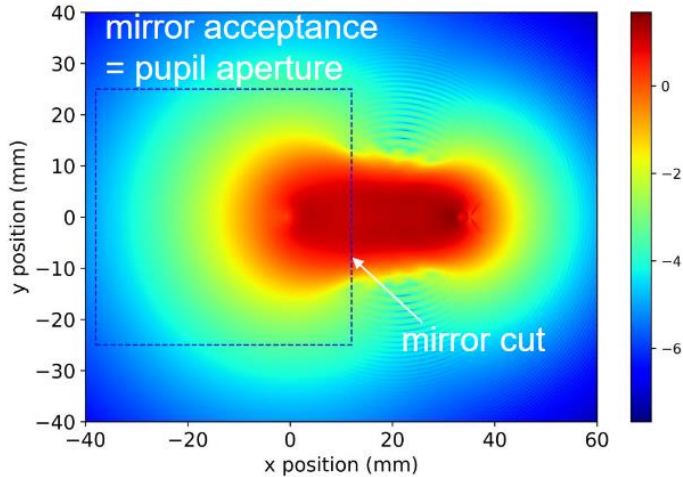
New BSRTM  
@ 11 mm



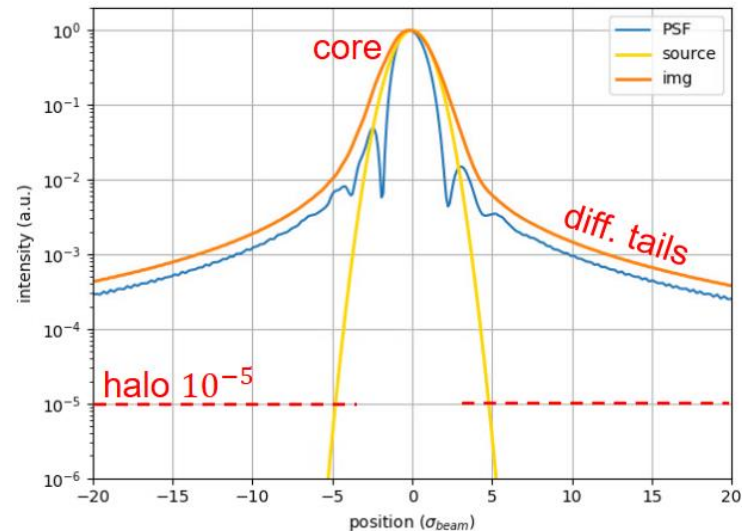
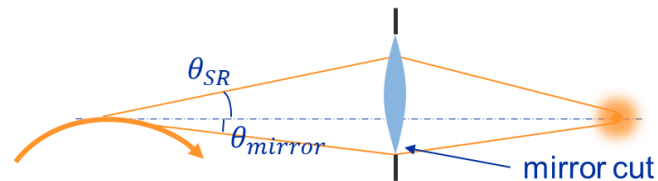
Old BSRTM  
@ 21 mm

# Halo monitoring imaging SR

## SR @ BSRTM

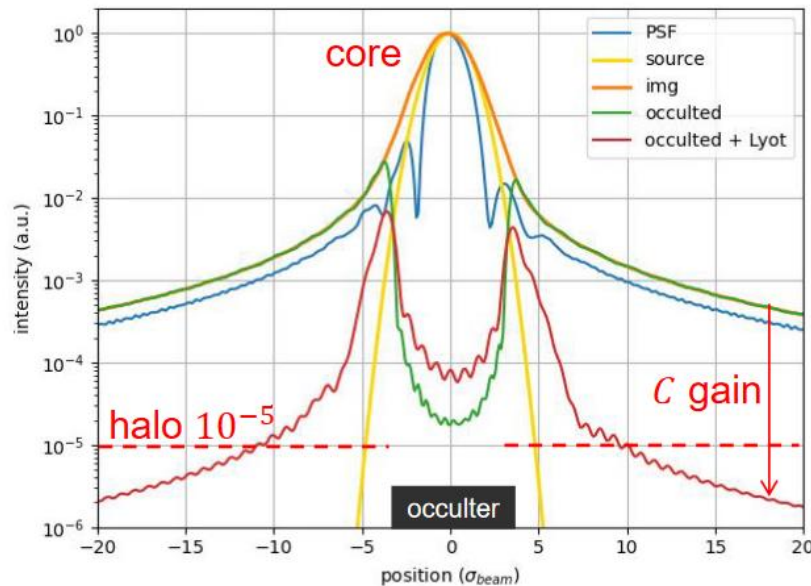
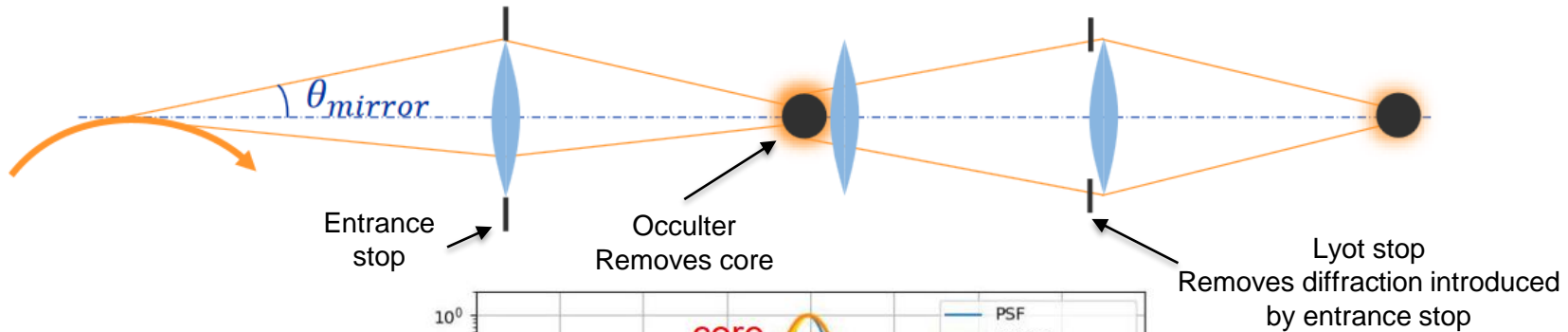


- The extraction mirror defines the optical acceptance
- No cut in the vertical plane
- Cut at the mirror edge in the horizontal plane





# Lyot coronagraph

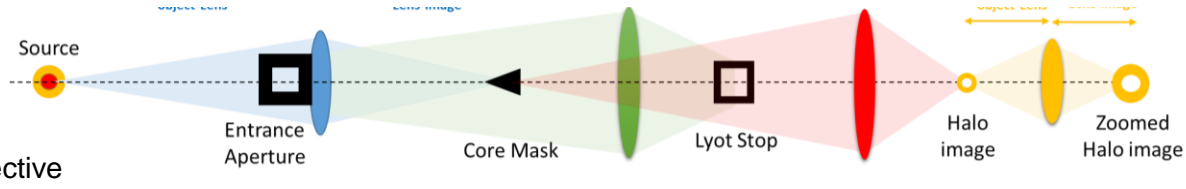


The gain in contrast is only outside 7 sigma

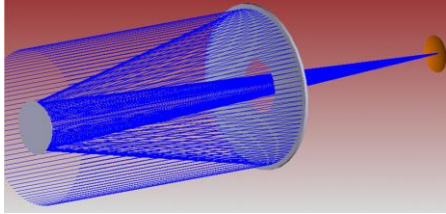
# BSRH (coronagraph) R&D

- 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



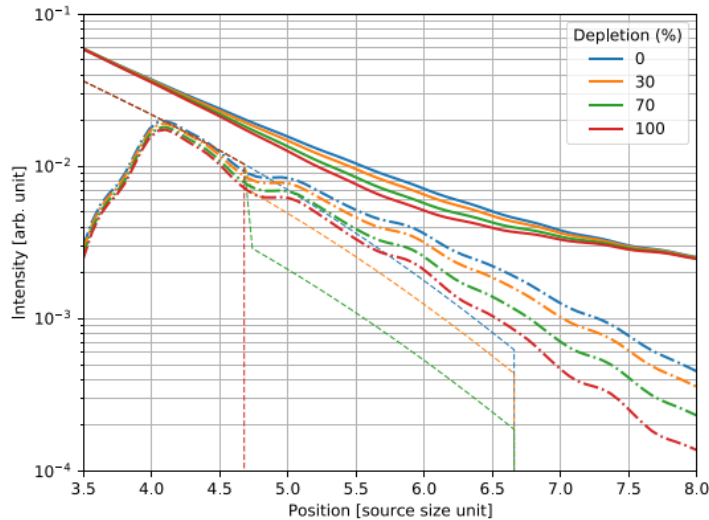
LHC B2



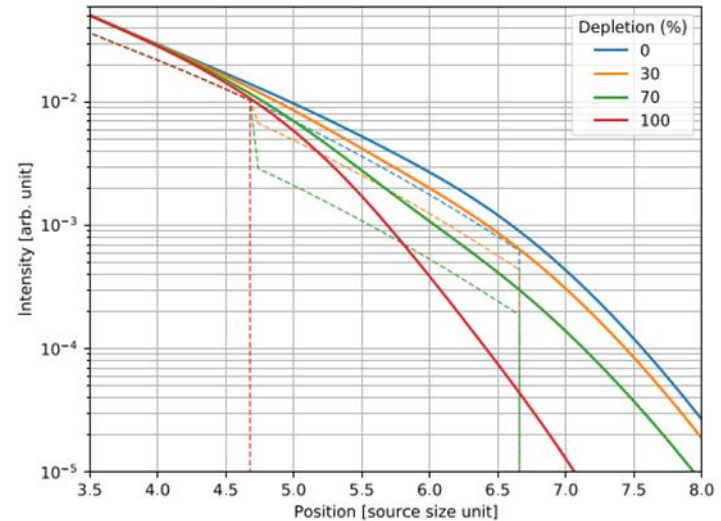
ISR

# What can we expect from BSRH

Measured profile of realistic proton distributions with halo suppression



Horizontal



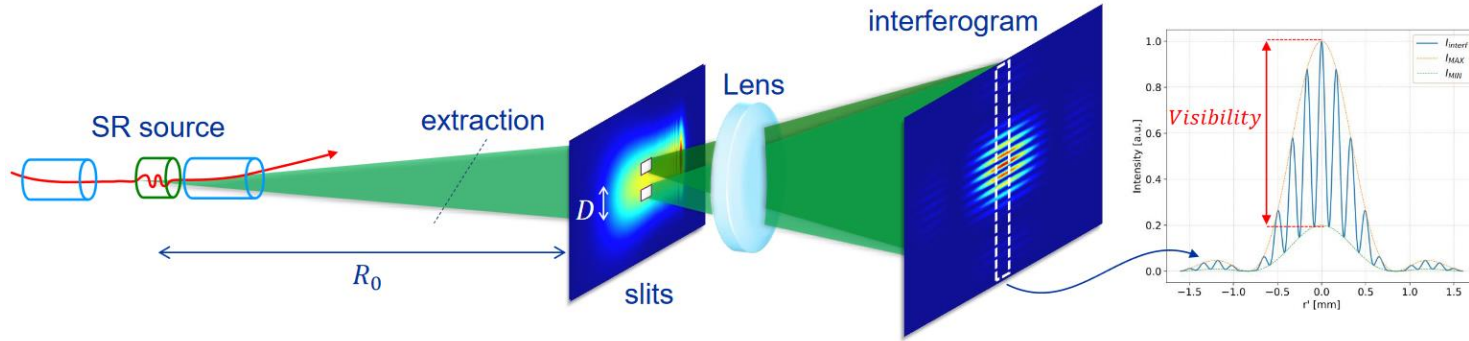
Vertical

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 2<sup>nd</sup> SR extraction is on hold
  - Next step would be vacuum chamber enlargement between D4 and BSRTM



