Beam gas curtain experimental programme

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for the

BGC Collaboration team

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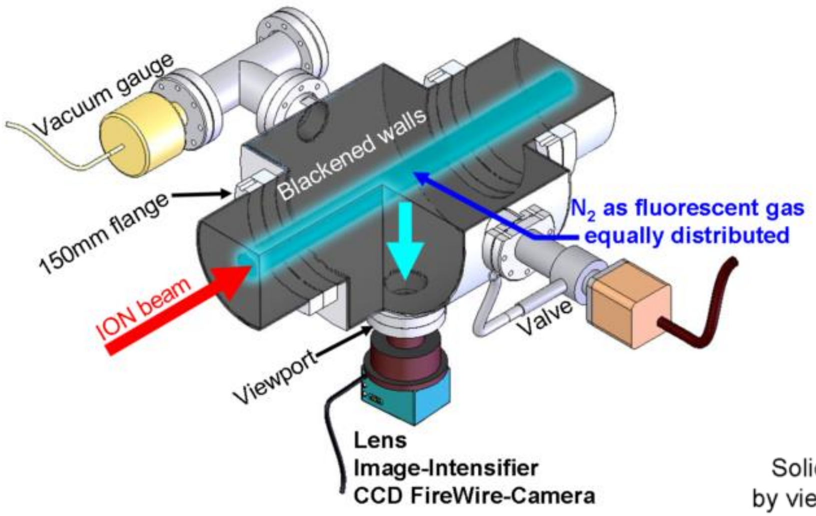
Outline

- Motivation
  - Potential diagnostics for e-lens project and HLLHC.
- Principle of the supersonic gas jet beam profile monitor in beam induced fluorescence (BIF) mode.
- Building a prototype
  - Current status
  - Vacuum condition test
  - N_2 and neon gas jet test
  - Optimization of gas jet generation
- Future plan

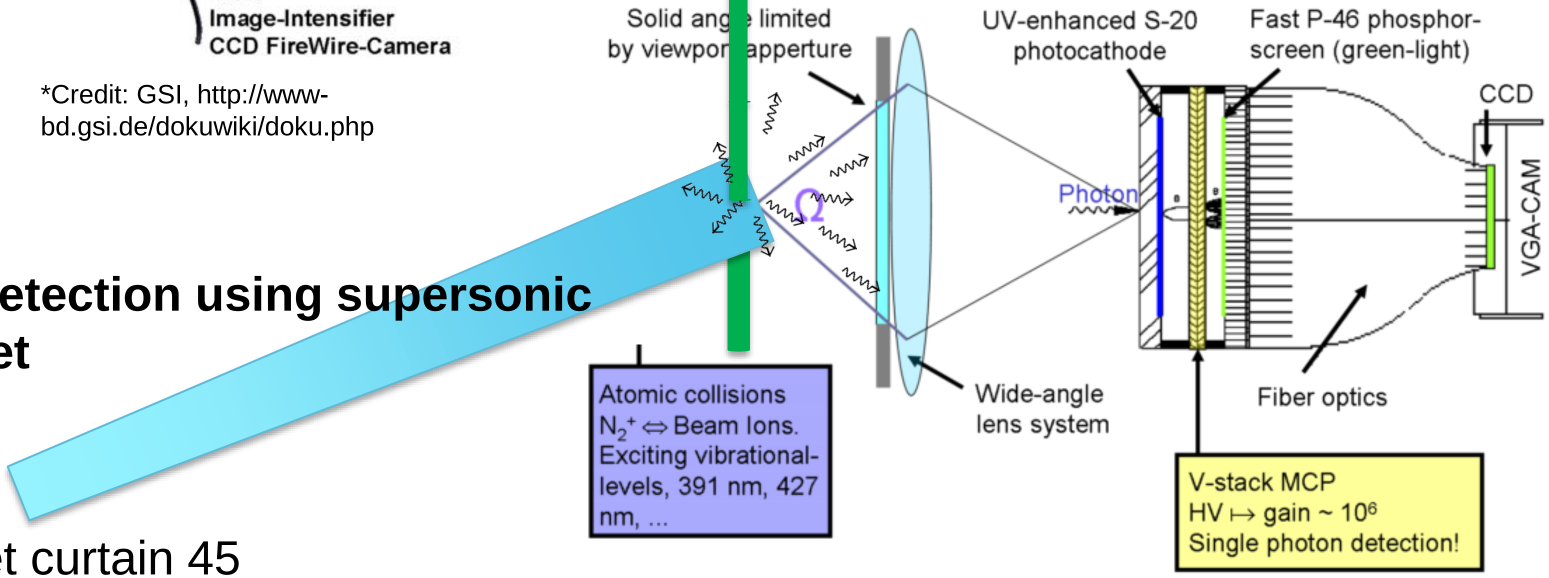
Principle of detection



*Credit: GSI, http://www-bd.gsi.de/dokuwiki/doku.php

BIF detection using residual gas

Particle Beam propagate to the jet curtain perpendicularly



BIF detection using supersonic gas jet

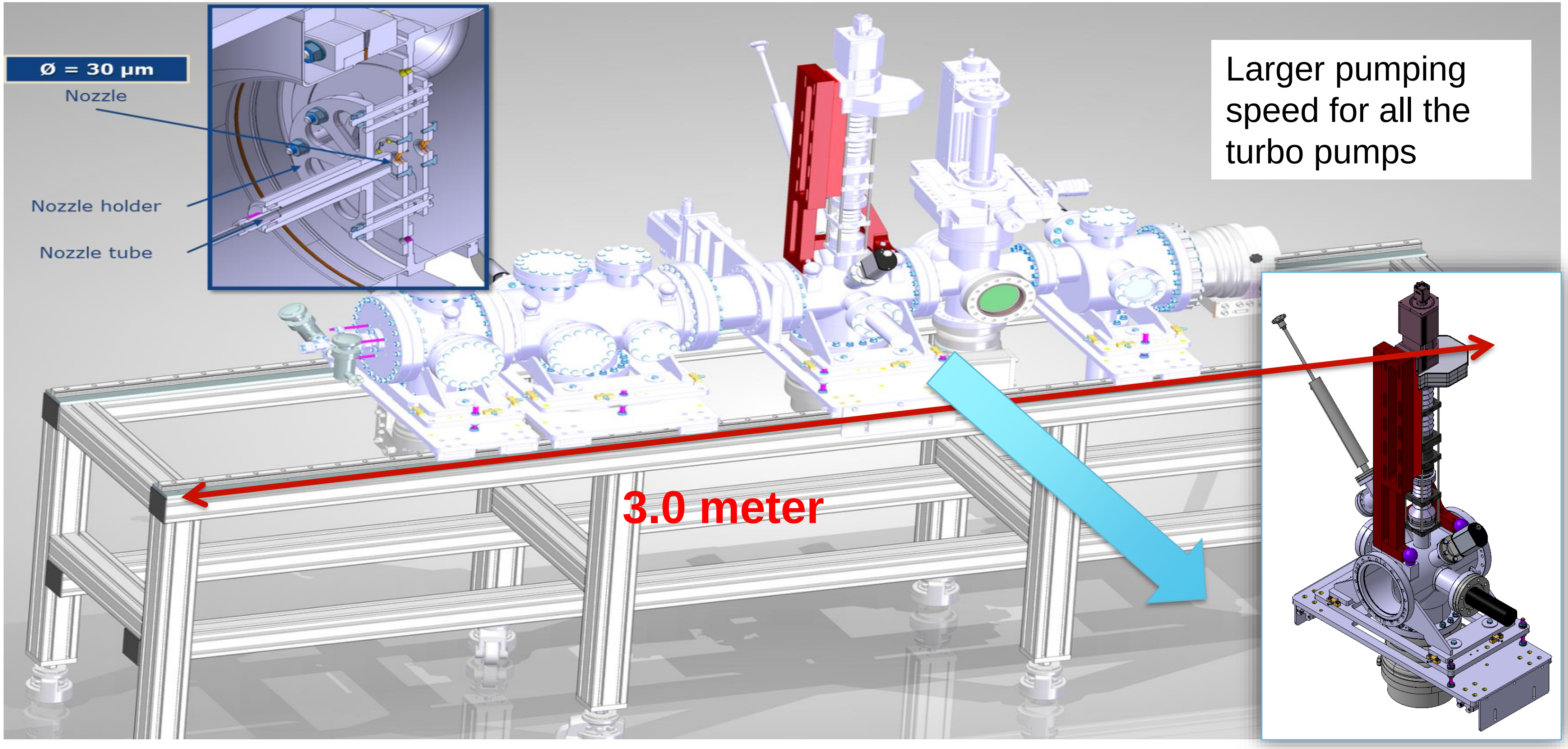
Gas jet curtain 45 degree tilted

*Credit: GSI, http://www-bd.gsi.de/dokuwiki/doku.php

N_2 V.S. Ne as working gas

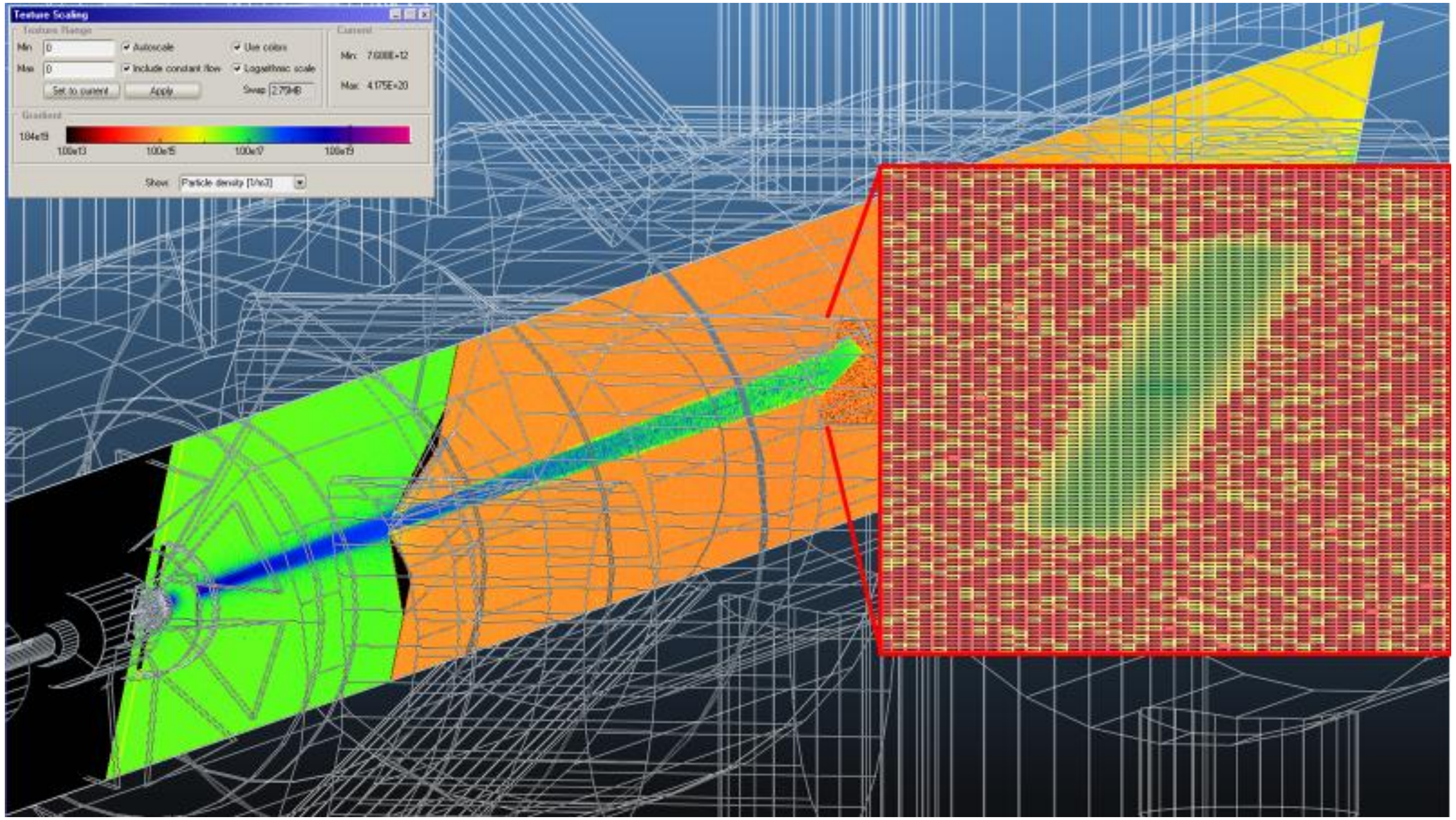
	Advantages	Disadvantages
N_2 N_2^+ emitter 391.4 nm	• Higher photon rate, shorter integration time. • lower dark counts rate for the photocathode • Higher quantum efficiency of photocathode	• Ion emitter with 60ns lifetime, potential distortion due to space charge and external EM field on the N_2^+ • Vacuum concern
Ne Ne emitter 585.4 nm	• Fluorescence due to neutral Ne (yellow line), not affect by space charge of the primary beam and external EM field • LHC vacuum compatible	• Lower photon rate, longer integration time • Higher dark counts rate for the photocathode • Lower quantum efficiency of photocathode

Building a prototype in CI

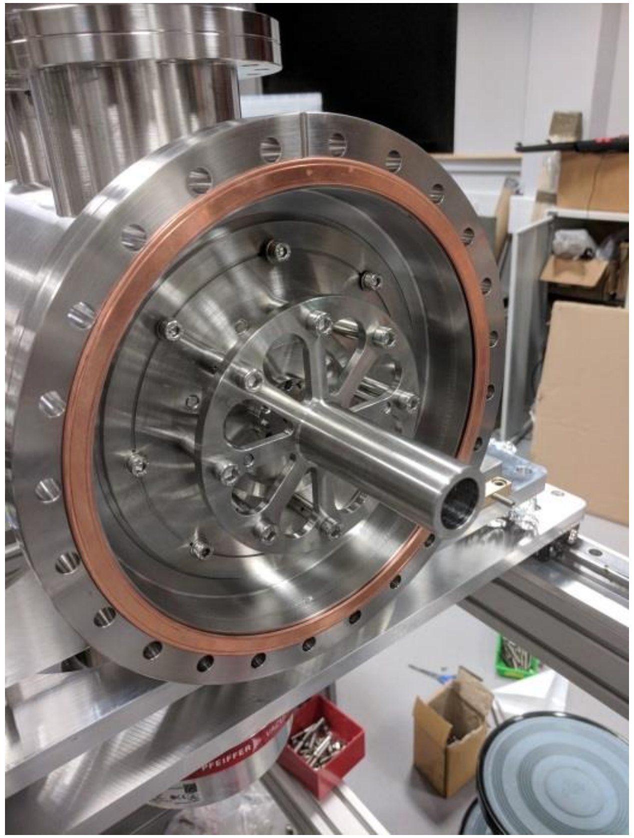


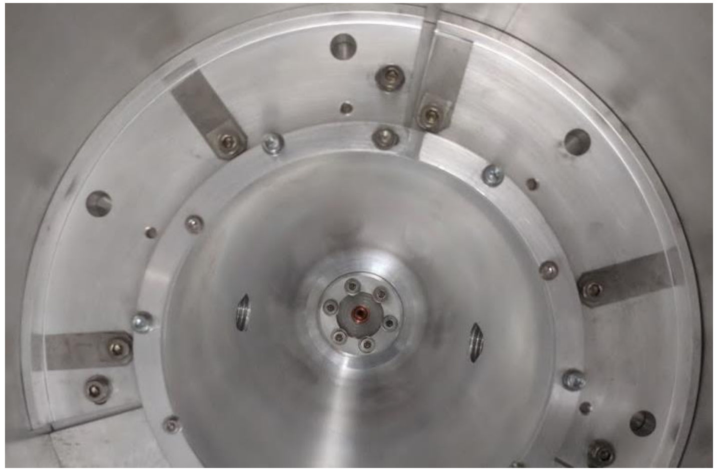
Vacuum condition test

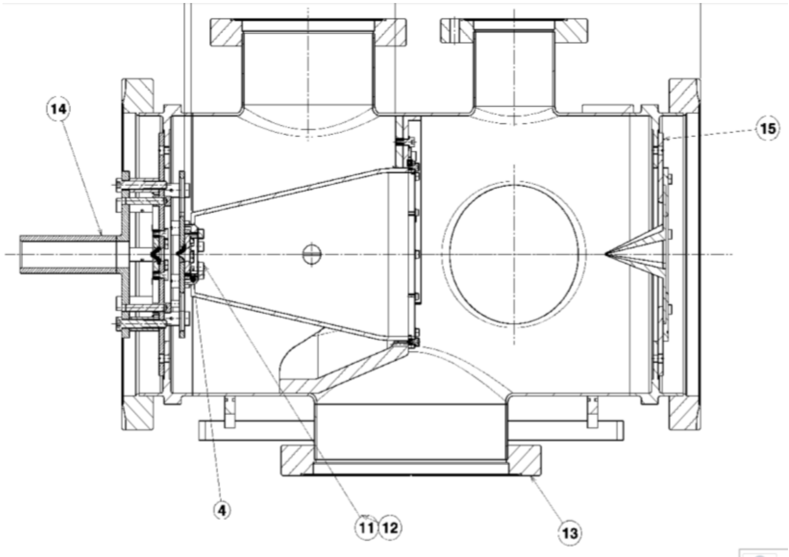
- Ultimate pressure matches with simulation
- Pressure in the interaction chamber is ~1.0e-9 mbar without bake-out with jet on.

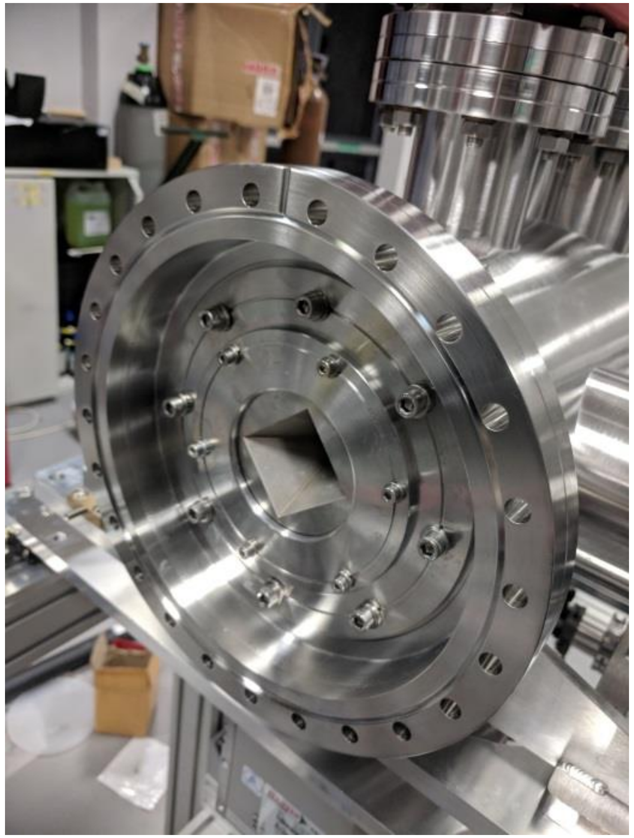


Nozzle and skimmers



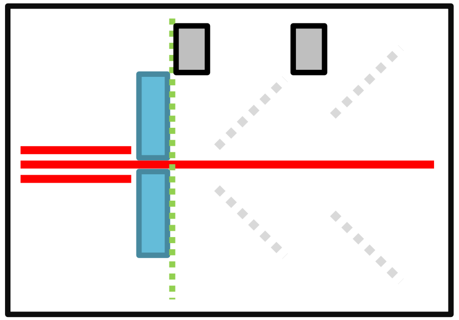


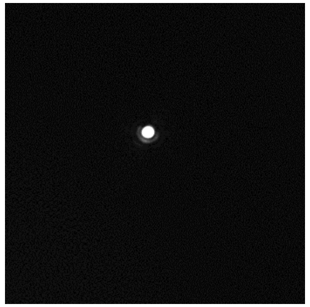




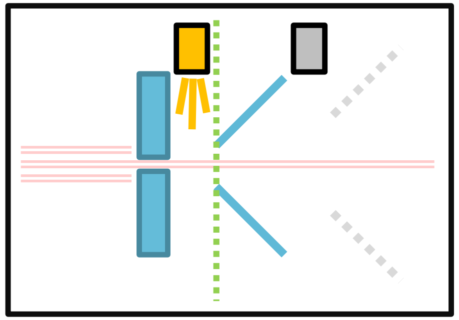
Alignment of the nozzle skimmers assembly

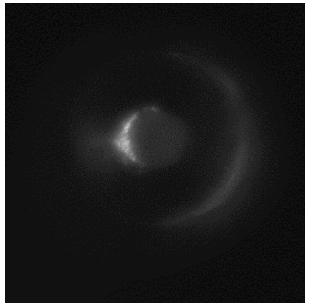
1. Only nozzle is mounted → marker on nozzle position



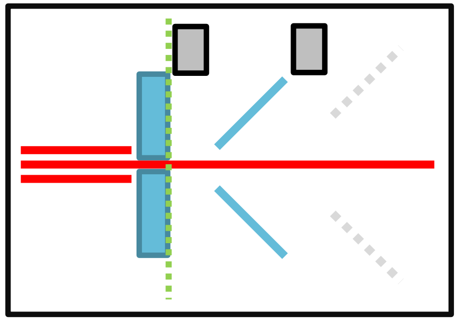


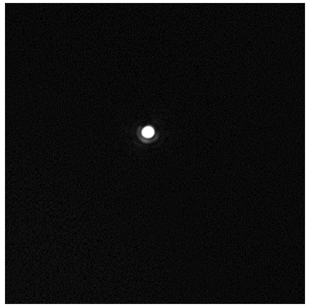
2. 1st 2nd skimmer mounted



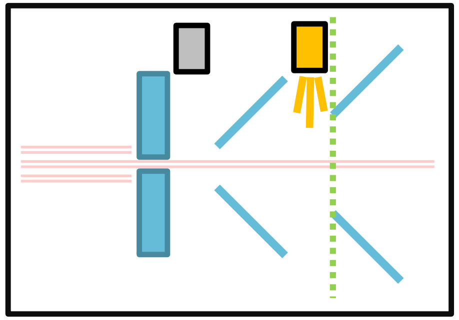


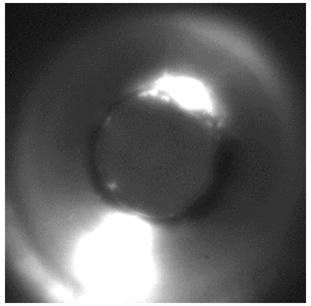
3. Adjust nozzle precisely, according to preparation





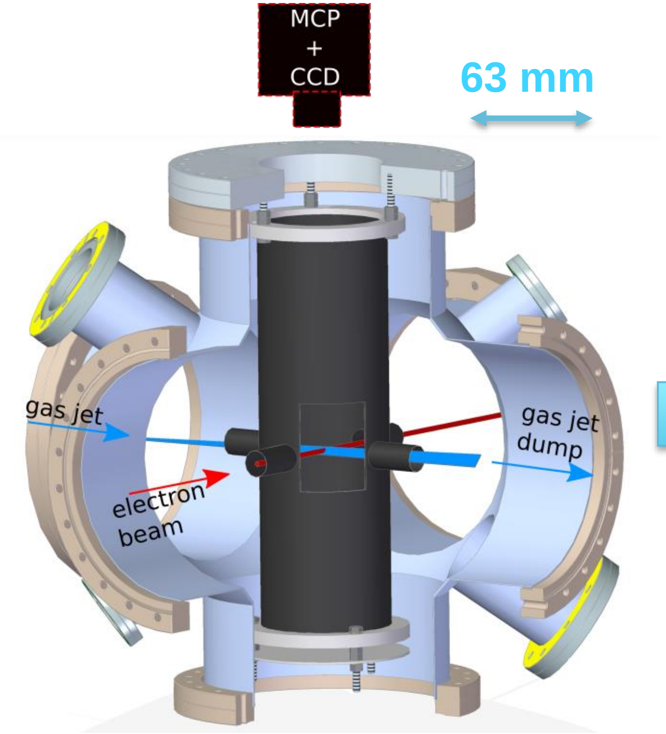
4. Mount 2nd skimmer and adjust it precisely, according to the preparation

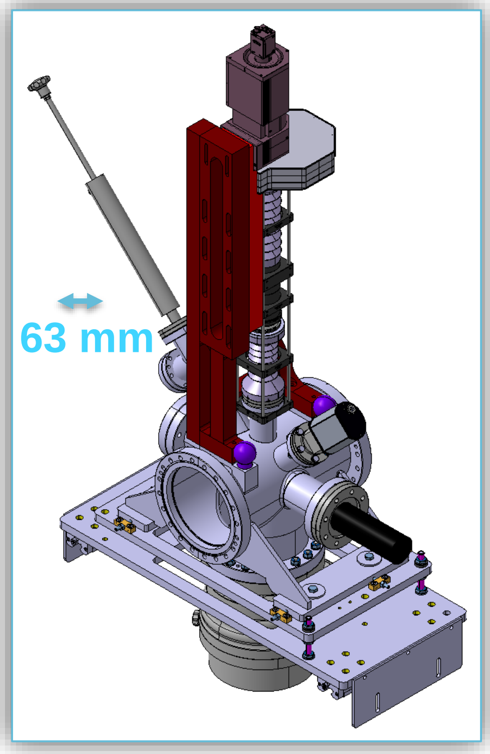




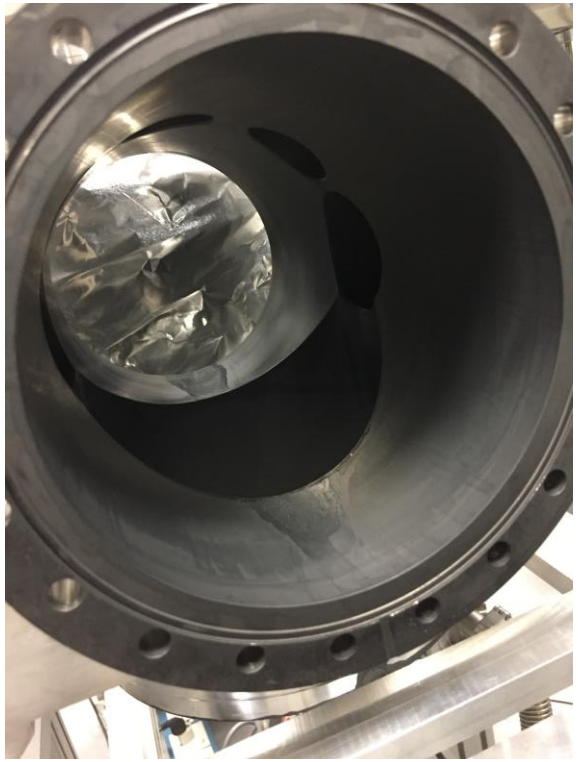
Interaction chamber

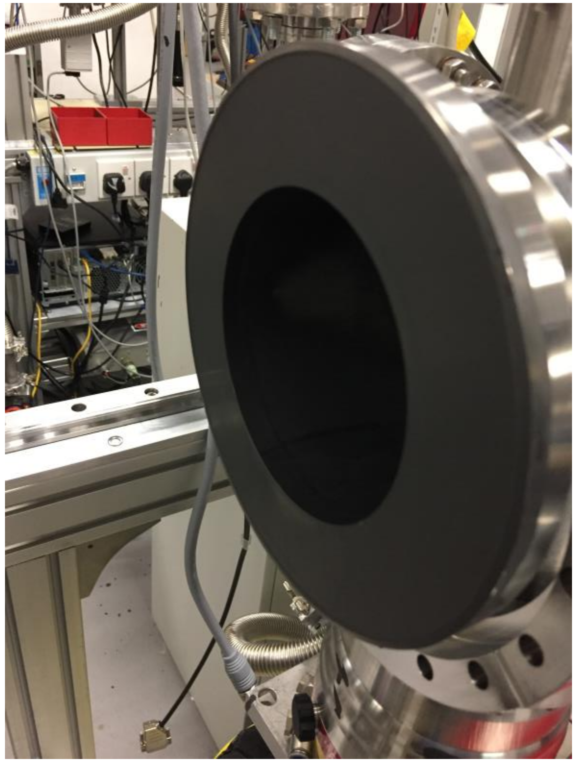
- Compact chamber
- New optical system
- New Electron gun
- More diagnostics

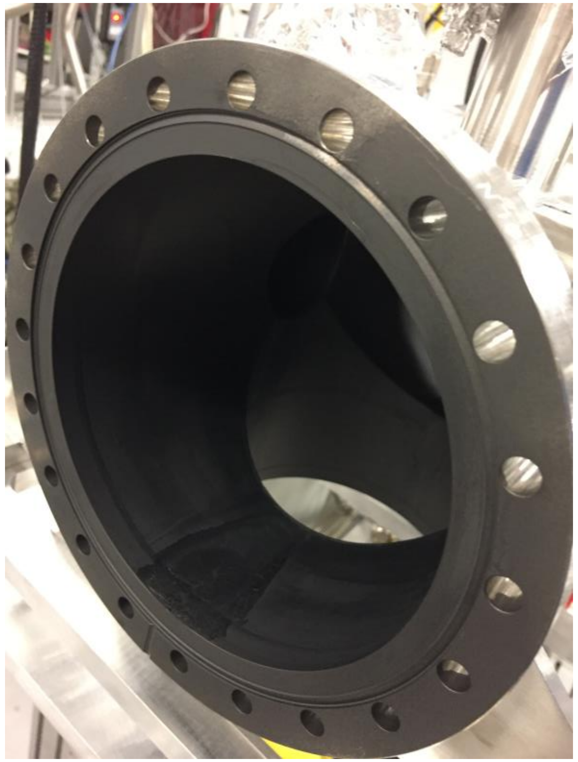




Blackening of the interaction chamber

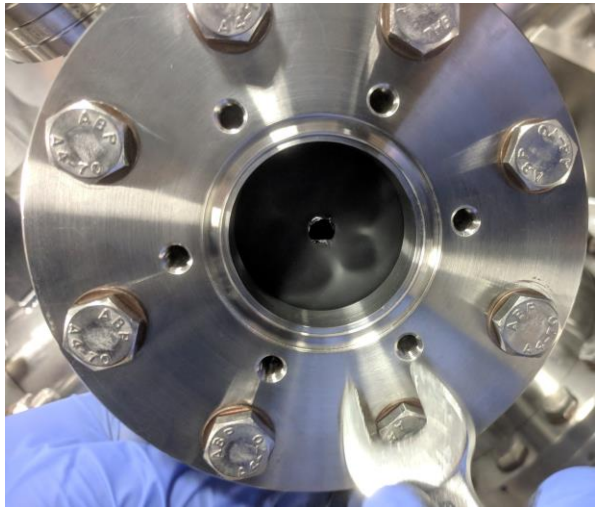


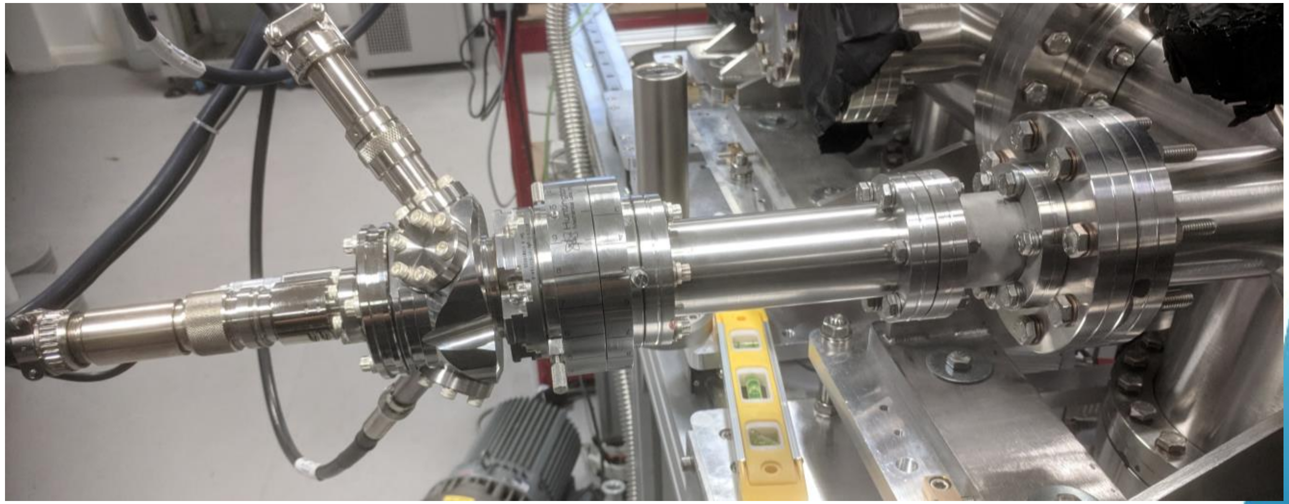




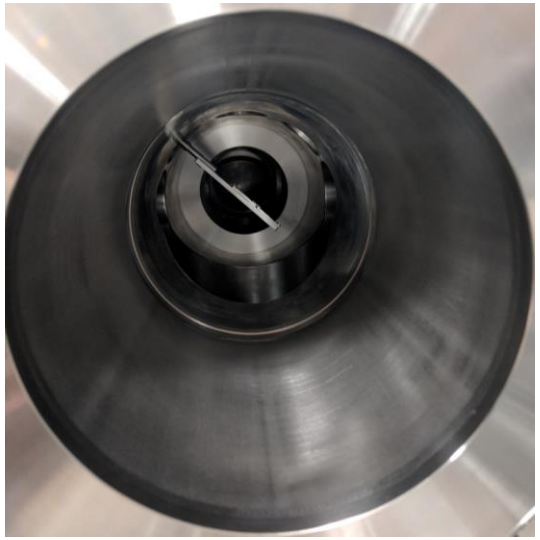
Electron gun

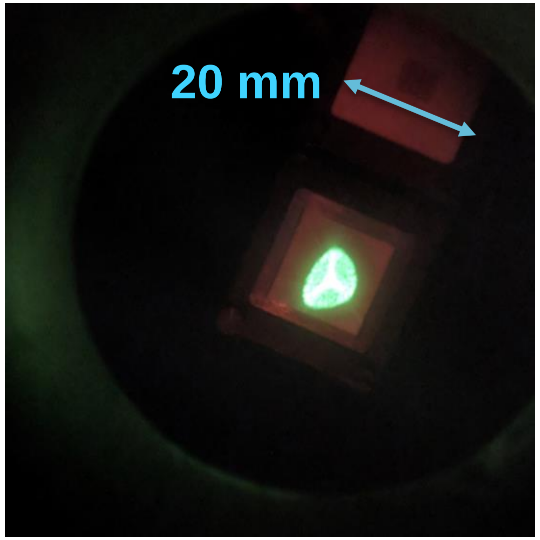
- Energy: 100 eV to 10 keV
- Current: 200uA to 10mA
- Spot size: 1.5mm to 20 mm



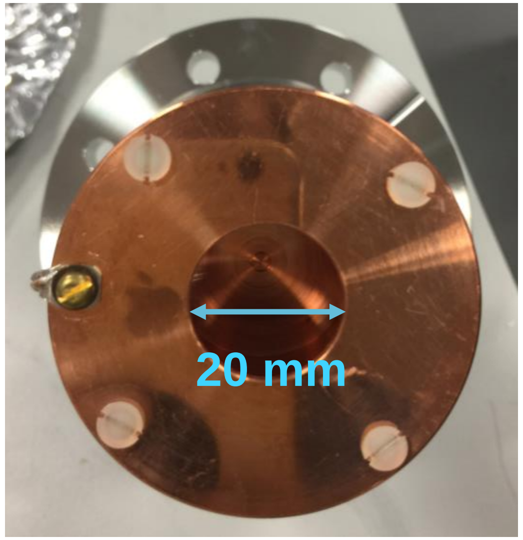


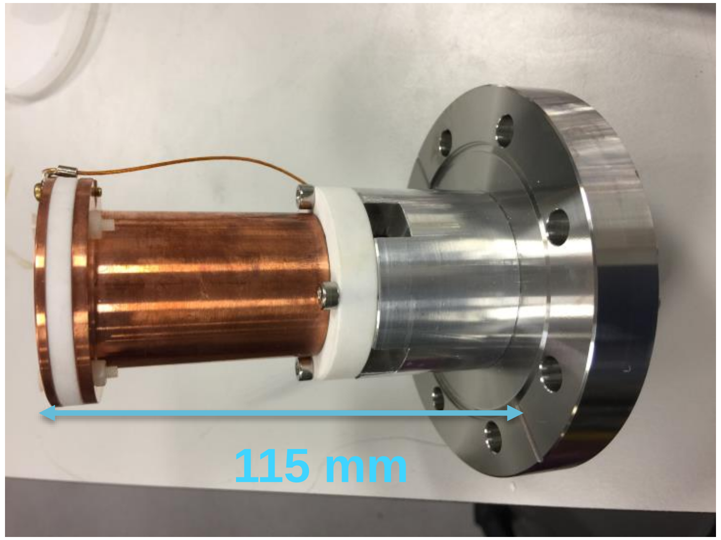
Electron beam diagnostics





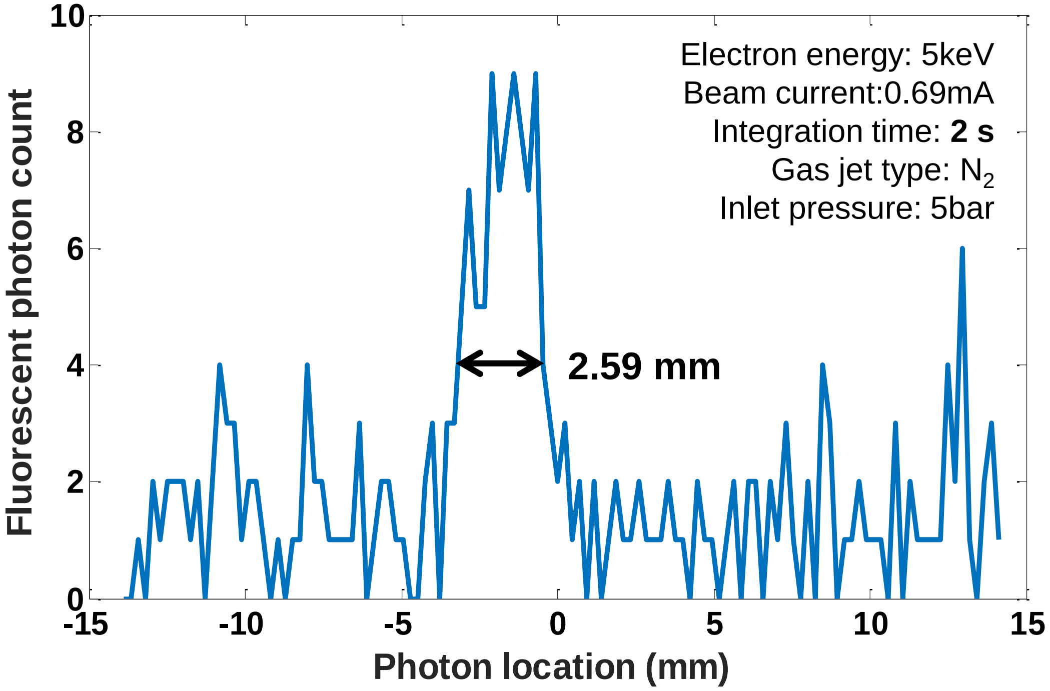
Phosphor screen

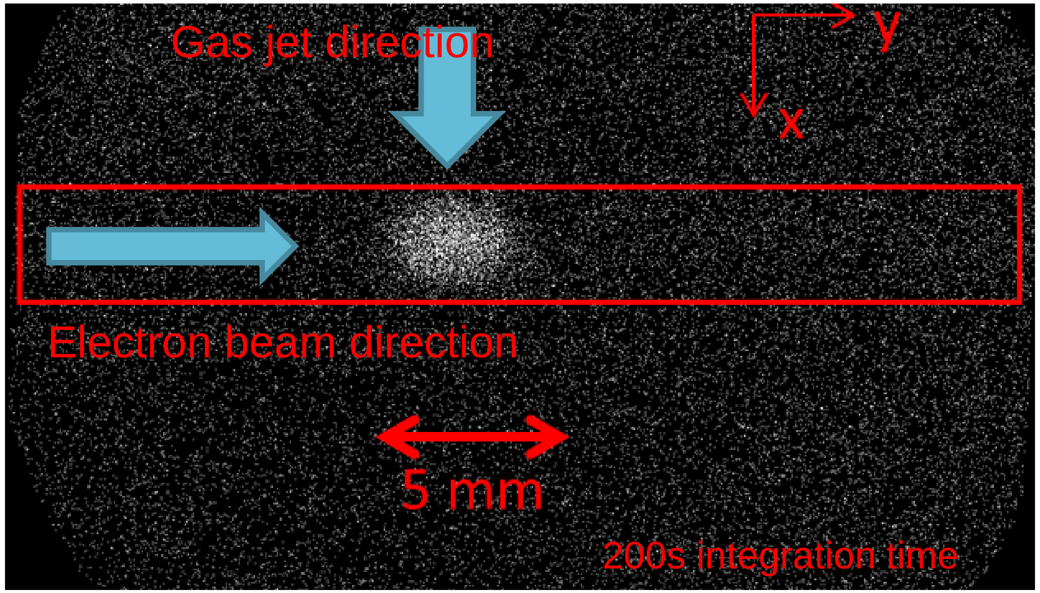




Faraday Cup

Nitrogen gas jet test



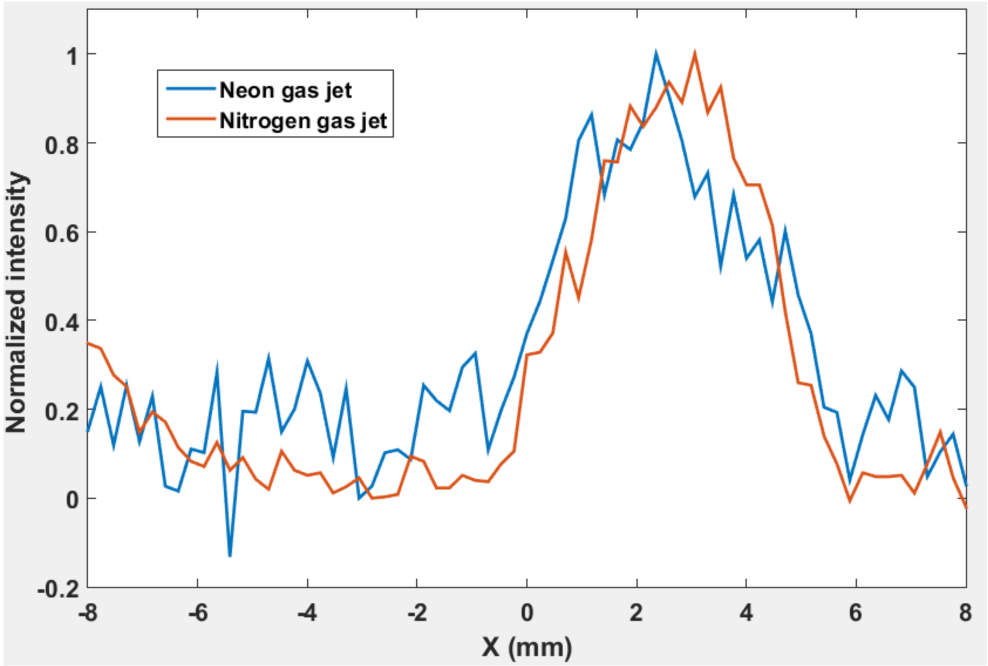


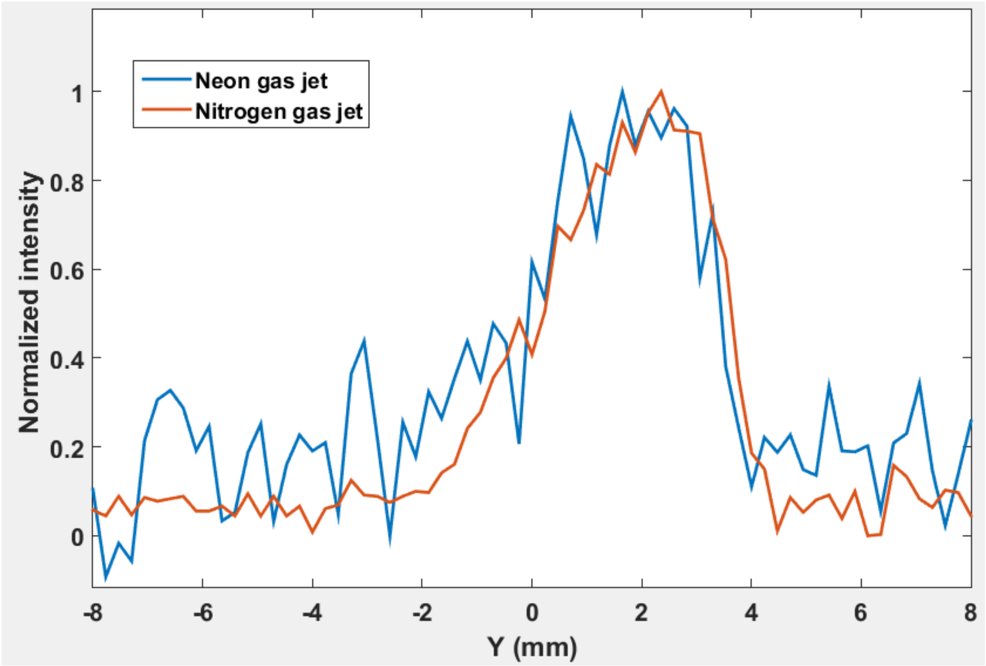
2s integration time to give a profile

More time to give a 2D detailed image

Background pressure: 1.56E-08mbar

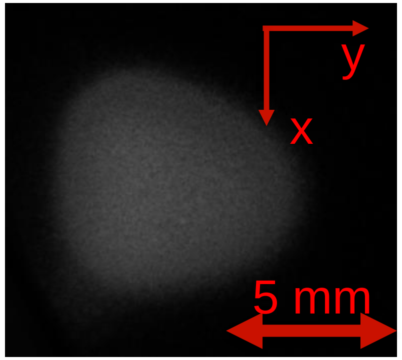
Preliminary results of Neon gas jet





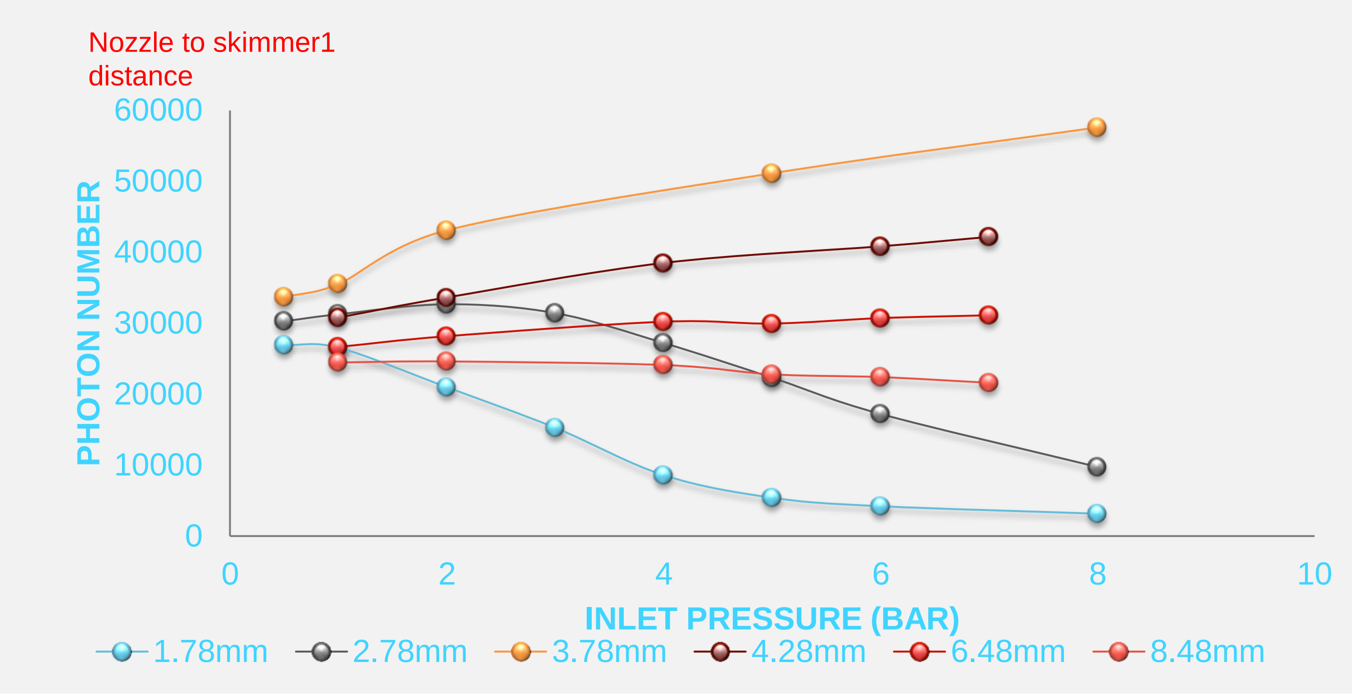
Electron energy: 3 keV
Beam current: 0.50mA
Integration time: 200 s for N_2, 4000 s for Neon
Inlet pressure: 5bar

Image from the phosphor screen



Optimize the gas jet parameter

- Inlet pressure
- Geometry (Nozzle to skimmer1 distance)



Summary of highlight

- A prototype supersonic gas jet monitor based on BIF mode was designed, built and successfully commissioned;
- N2 and Neon have been successfully tested as working gas using laboratory electron beam source;
- Optimization of key parameters for gas jet generation has been completed.

Future work

- Continue to optimize the design and geometry
  - E.g. new De Laval nozzle
  - Skimmer geometry
- Argon used as a working gas
- Design and building of v3 gas jet system (LHC compatible)
  - Final deliverable for the HL-LHC-UK

Thanks for your attention

Thanks to the BGC collaboration:

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