Manufacture and Alignment of the BGC Skimmer and Nozzle Assembly

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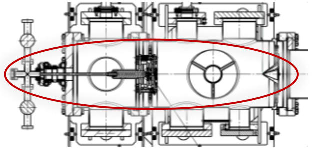
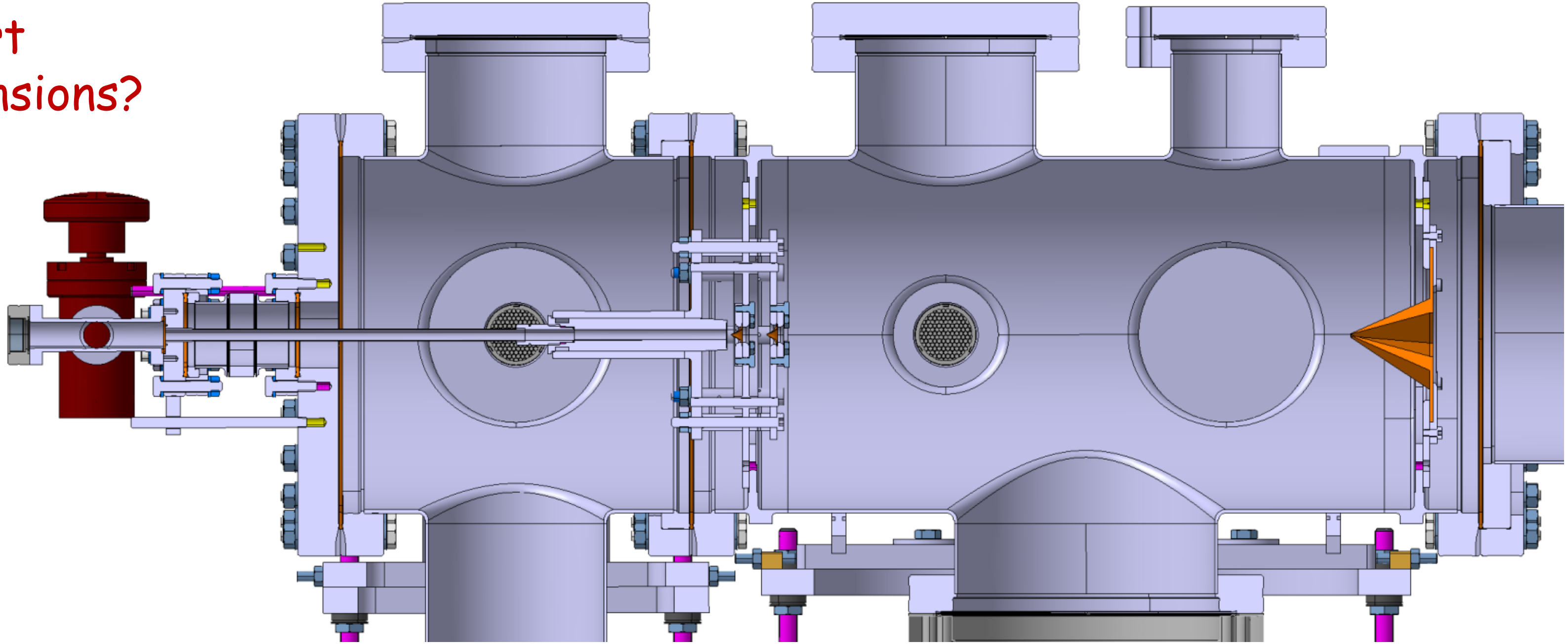
BE-BI-ML

Nozzle and Skimmer Assembly



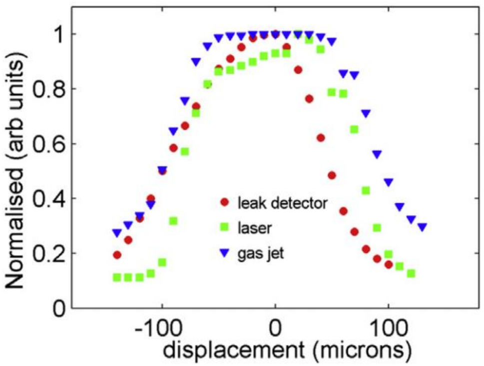
What do we want?- Concentric alignment of Skimmers and Nozzle.

Insert dimensions?

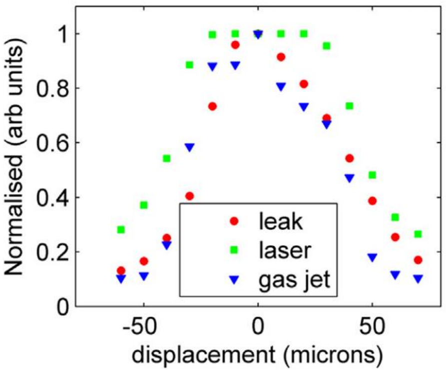


Central Assembly

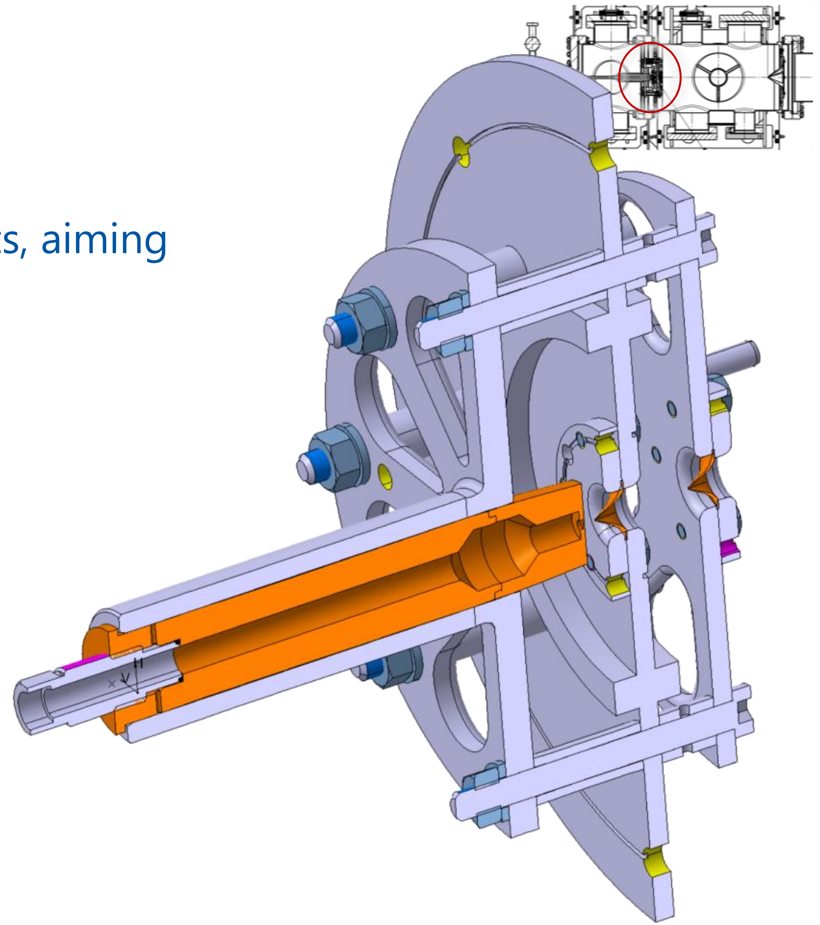
- Based on previous beam profile measurements, aiming within<50µm alignment range
- Pins used to align the three critical parts
- Central skimmer position fixed



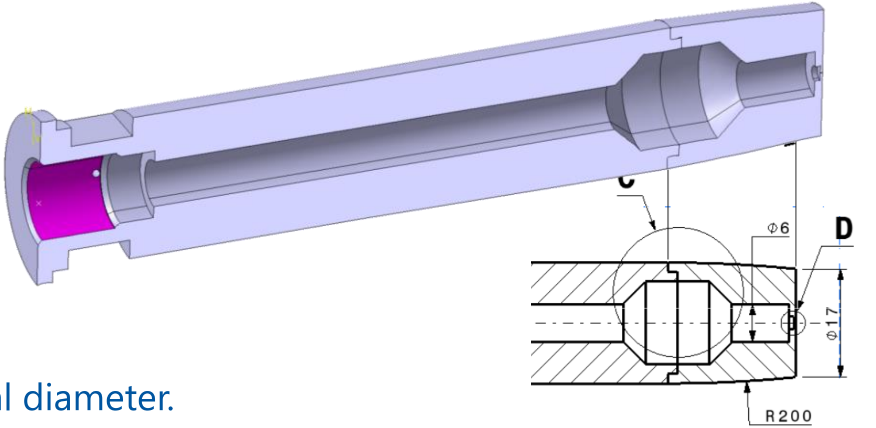
X axis



Y axis



Nozzle Manufacture

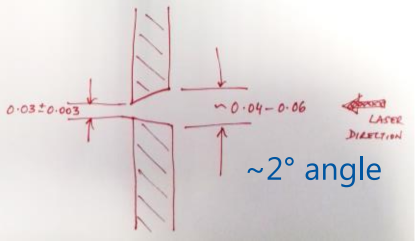


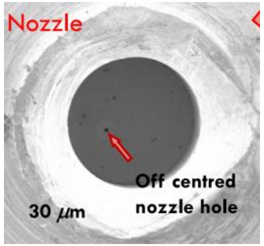
To be machined in 2 parts at CERN

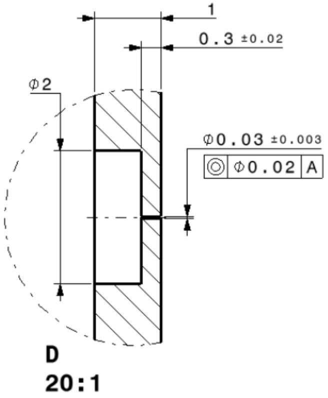
- Full depth weld to join parts
- Re-machined external diameter.
- 30µm hole must be tightly concentric with external diameter.

Manufacture:

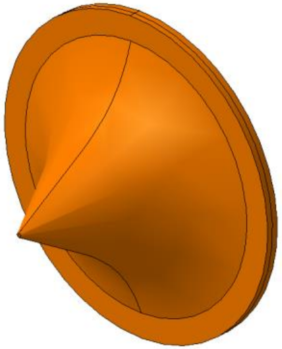
- Previously drilled in platinum foil, clamped between 2 Al plates.
  - Precision, concentricity, internal angle unknown.
- Laser Micromachining, UK
- Contact at TU Darmstadt.







Skimmer 1 & 2

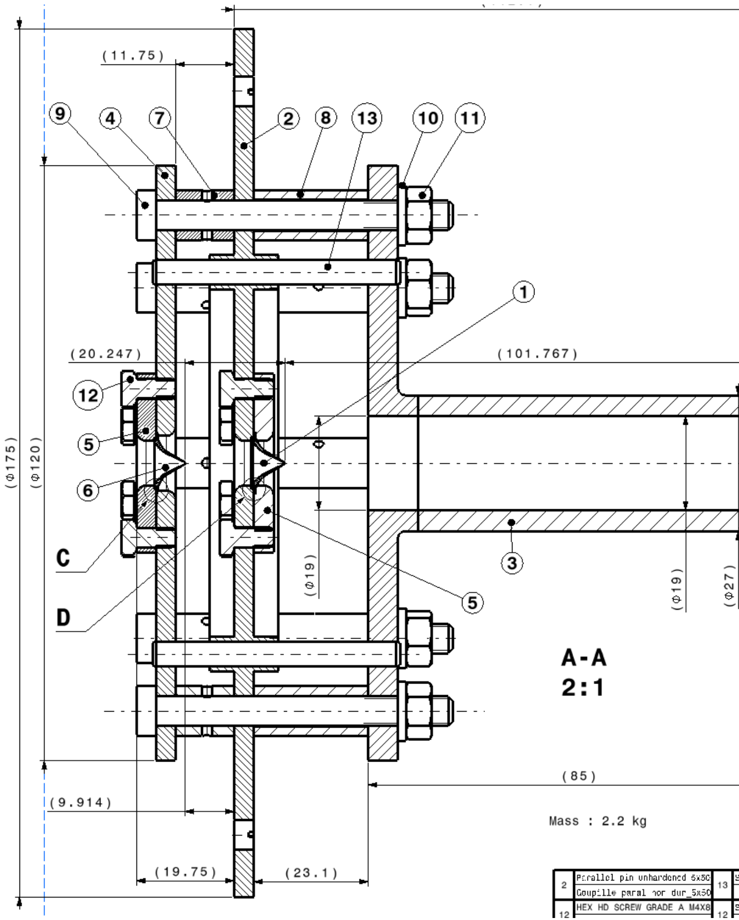


0.18 and 0.4mm diameter holes

Sharp edges are essential

Previously manufactured by

- Beam Dynamics Inc, US
- Feedback welcome
- New skimmers have been purchased 10/06



Skimmer 3

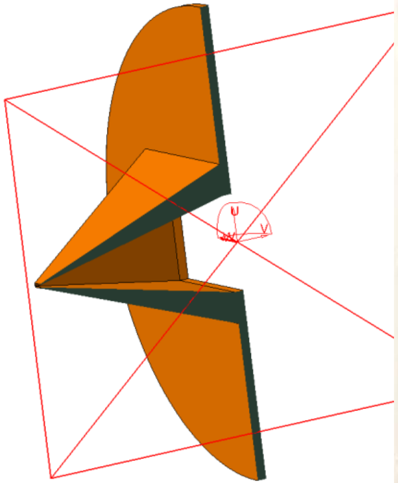
Rectangular, 0.4*4mm

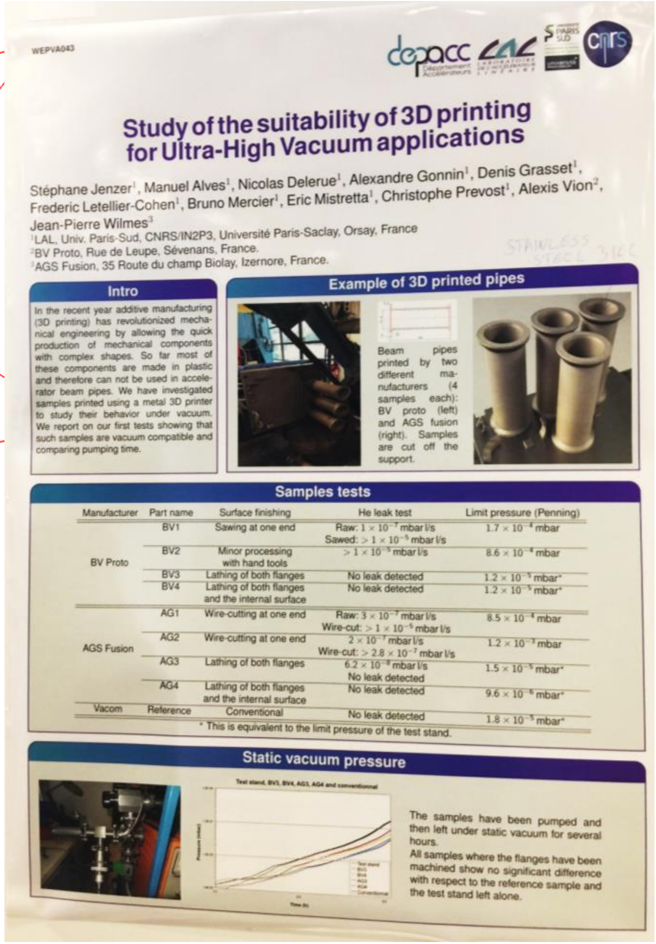
Previously manufactured by

- CRDM rapid prototyping
- TJW polishing

New Skimmer

- IPAC poster about 3D metal printing
- Will contact manufacturers to discuss





WEPVA043

Study of the suitability of 3D printing for Ultra-High Vacuum applications

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[3]AGS Fusion, 35 Route du champ Biolay, Izernore, France.

Intro

In the recent year additive manufacturing (3D printing) has revolutionized mechanical engineering by allowing the quick production of mechanical components with complex shapes. So far most of these components are made in plastic and therefore can not be used in accelerator beam pipes. We have investigated samples printed using a metal 3D printer to study their behavior under vacuum. We report on our first tests showing that such samples are vacuum compatible and comparing pumping time.

Example of 3D printed pipes

Beam pipes printed by two different manufacturers (4 samples each): BV proto (left) and AGS fusion (right). Samples are cut off the support.

Samples tests

Manufacturer	Part name	Surface finishing	He leak test	Limit pressure (Penning)
BV Proto	BV1	Sawing at one end	Raw: 1×10^{-7} mbar l/s Sawed: $> 1 \times 10^{-5}$ mbar l/s	1.7×10^{-4} mbar
	BV2	Minor processing with hand tools	$> 1 \times 10^{-5}$ mbar l/s	8.6×10^{-4} mbar
	BV3	Lathing of both flanges	No leak detected	1.2×10^{-5} mbar*
	BV4	Lathing of both flanges and the internal surface	No leak detected	1.2×10^{-5} mbar*
AGS Fusion	AG1	Wire-cutting at one end	Raw: 3×10^{-7} mbar l/s Wire-cut: $> 1 \times 10^{-5}$ mbar l/s	8.5×10^{-4} mbar
	AG2	Wire-cutting at one end	2×10^{-7} mbar l/s Wire-cut: $> 2.8 \times 10^{-7}$ mbar l/s	1.2×10^{-3} mbar
	AG3	Lathing of both flanges	6.2×10^{-8} mbar l/s No leak detected	1.5×10^{-5} mbar*
	AG4	Lathing of both flanges and the internal surface	No leak detected	9.6×10^{-6} mbar*
Vacom	Reference	Conventional	No leak detected	1.8×10^{-5} mbar*

* This is equivalent to the limit pressure of the test stand.

Static vacuum pressure

Test stand, BV3, BV4, AG3, AG4 and conventional

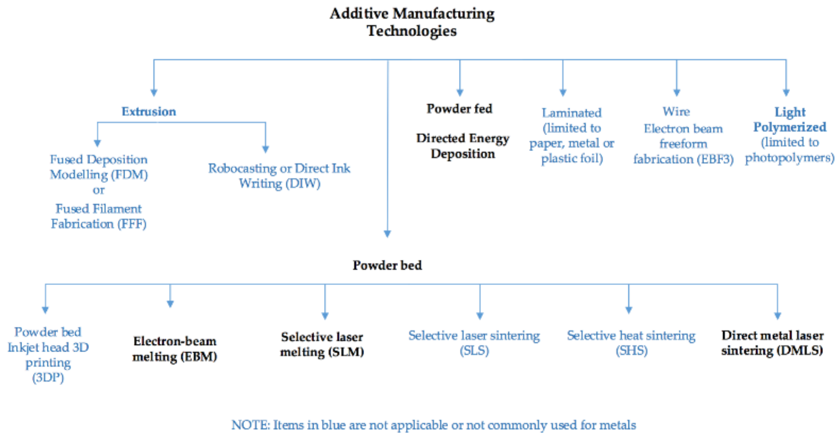
The samples have been pumped and then left under static vacuum for several hours.
All samples where the flanges have been machined show no significant difference with respect to the reference sample and the test stand left alone.

Additive Manufacturing Study

Review carried out by ML, Ana Miarnau.

Key issues:

- Porosity and Lamination
- Columnar grain structure
- Orientation of the structure whilst printing
- Print area and wall thickness limitations
- General tolerance is ± 0.2 mm ± 1% of length
- Surface roughness ~ Ra 12µm. Post-processing required



Combination of additive manufacturing and CNC machining

Exciting potential, but technology not ready to provide desired tolerances.

Alignment

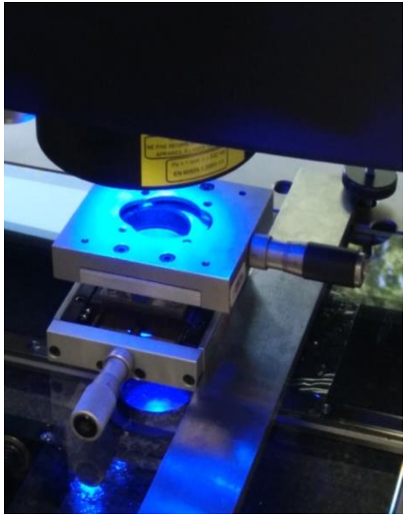
What do we want?

Skimmer 1, 2 & 3 aligned to Nozzle hole within 50 µm.

Perfect solution would not require alignment:

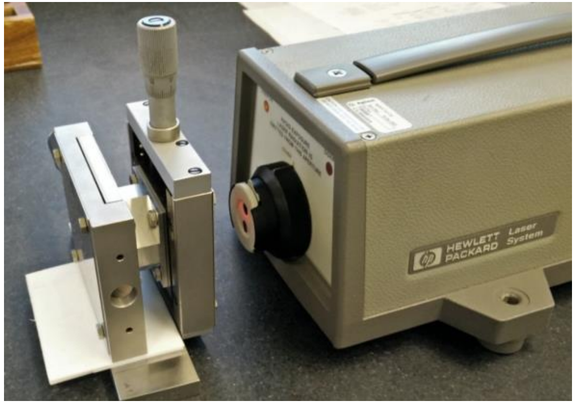
3D print as one part. ✗

Perforate all holes with laser into assembled system. ✗



Previous study by Ana Miarnau.

Alignment of two 50µm holes at CERN with metrology team



Alignment proposal

Build test rig at CERN for alignment preparation.

Central plate, holding skimmer 1, is fixed.

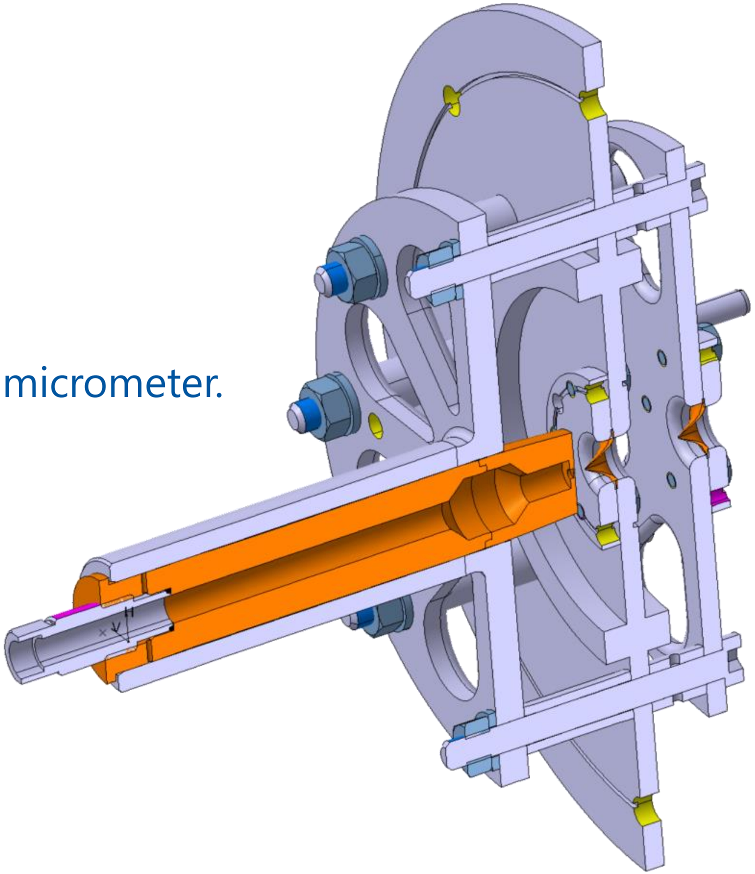
Nozzle housing and skimmer 2 plate adjustable with micrometer.
Alignment done manually using

 Optical lasers *or*

 Zeiss O-Inspect camera (CERN metrology)

Could manufacture part to hold laser in place

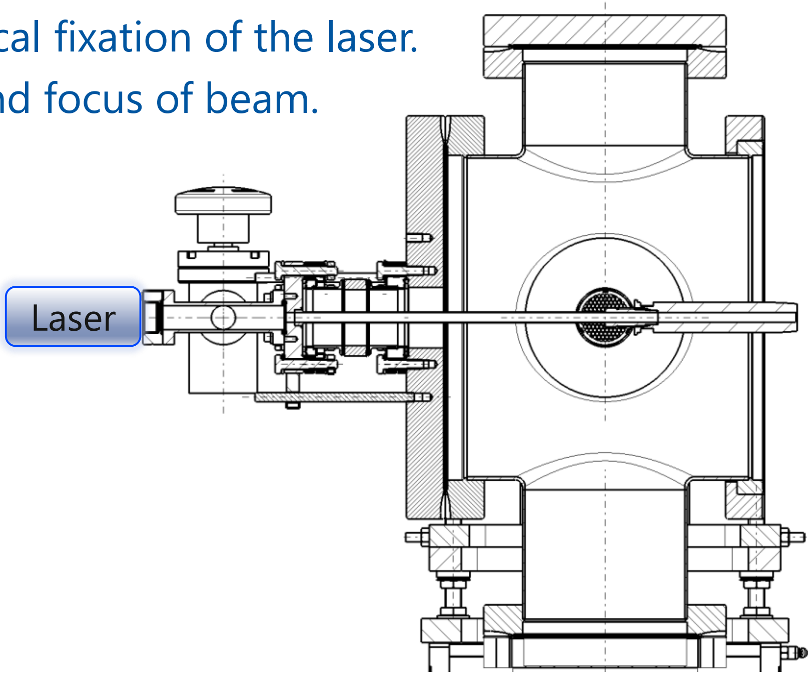
Once this system is aligned it can be installed in the BGC and then checked.

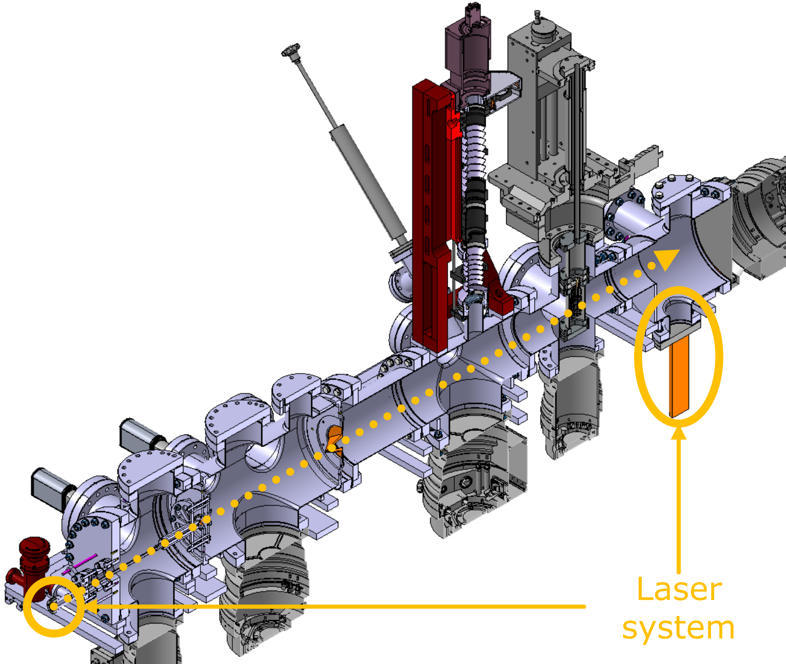


Laser Optical alignment

Mechanical fixation of the laser.

Adjust and focus of beam.





E. Barrioz

Drawing approval

All drawings ready to be signed

- Have begun checking all the drawings
- Hope to have signed before design review
- Manufacture to begin ASAP
- Discuss with Cockcroft Institute

References

Slide 1: Gas dynamics considerations in a non-invasive profile monitor for charged particle beams *Vasilis Tzoganis, Adam Jeff, Carsten P. Welsch*

Slide 4: Poster at IPAC, *provided by Hao Zhang*

Slide 5: Alignment of Beam Gas Curtain (BGC) test plates *Ana Miarnau* home.cern