Quality Assurance

QA is organized to allow essential acceptance tests on 100% of components plus in-depth sample characterization

QA stations organized in order to

- Be close to the assembling site
- Ensure adequate personnel training
- Provide redundancy & investment synergy
- Support specific in-deep characterization studies

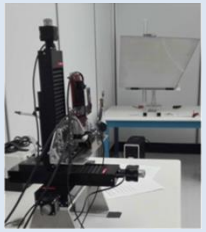
Aerogel: Integrity, defects, transmittance, refractive index, dimensions, planarity

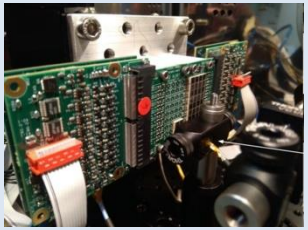
Mirror: Dimensions, shape accuracy, radius, reflectivity

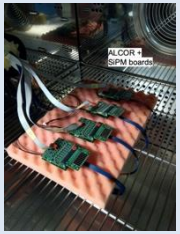
Sensors: Electrical connections, quench resistor, I-V characteristics, DCR, relative PDE

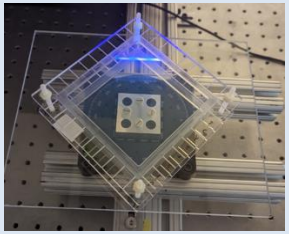
Readout: Electrical connections, bias levels, threshold and gain scans, time jitter, DAQ rate

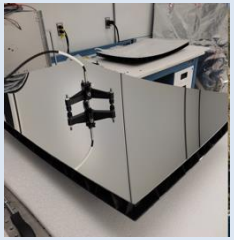
Gas: Refractive index, transparency, sound speed, leakage rate









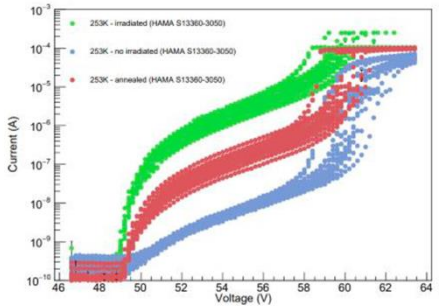


Component	QA station 1	QA station 2	QA detail and backup	QA Acceptance	In-depth
Aerogel	Temple U.	BNL	INFN-BA	100 %	5%
Gas	BNL		INFN-TS	2 %	2%
Mirror	JLab	Duke U.		100 %	10%
Sensor (SiPM)	INFN CS-SA-CT	INFN-TS	INFN-BO	100 %	1%
Readout	INFN-BO	INFN-FE	INFN-TO	100 %	1%

Photo Sensor Quality Assurance

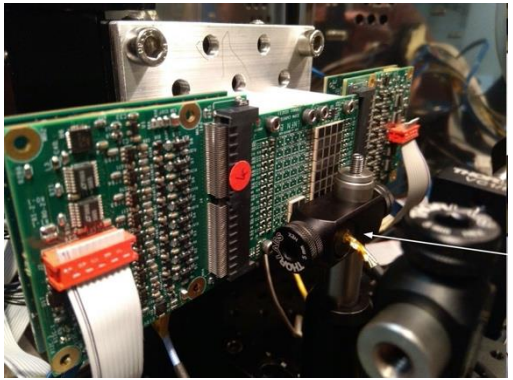
ALCOR based QA stations developed at INFN CS-SA-CT and INFN TS in collaboration with local Universities

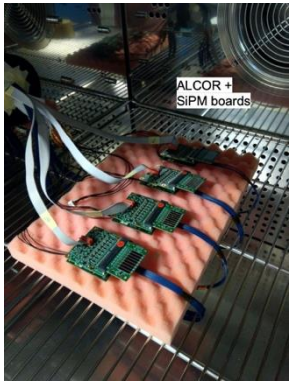
IV-curves



- 253K-no irradiated
- 253K-annealed
- 253K-irradiated

In-depth characterization station stays operative at INFN-BO: e.g. PDE, Timing





Gas Monitor System

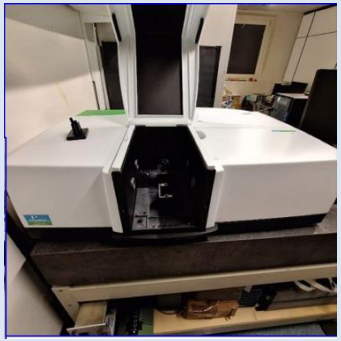
- **Spectrophotometer:** monitor of gas transparency
  - A cell of 10 cm length can be used → need to enhance the absorption by pressure: **measure at 10 bar**
  - **A stable optical table** needed to ensure correct spectrophotometer performance

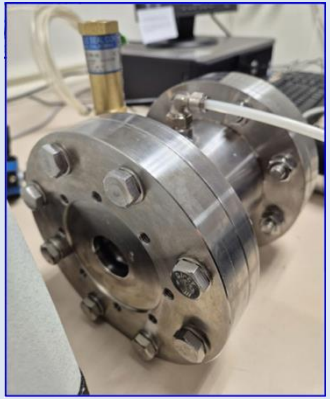
- **Sonar system:** measuring the fraction of standby-gas in the vessel atmosphere (particularly relevant during filling and gas recovery)

Measured speed of sound in C_2F_6: 139.68 m/s

- **Interferometer:** real-time measurement of the refractive index (interferometer response combined with T and P monitors allows for quasi real-time data processing)
  - As for the spectrophotometer, **a stable optical table** needed to ensure the stability and preserve the alignment of the optical components

Spectrophotometer





Sonar

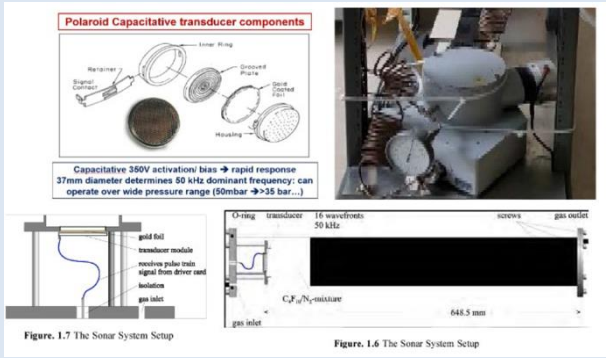
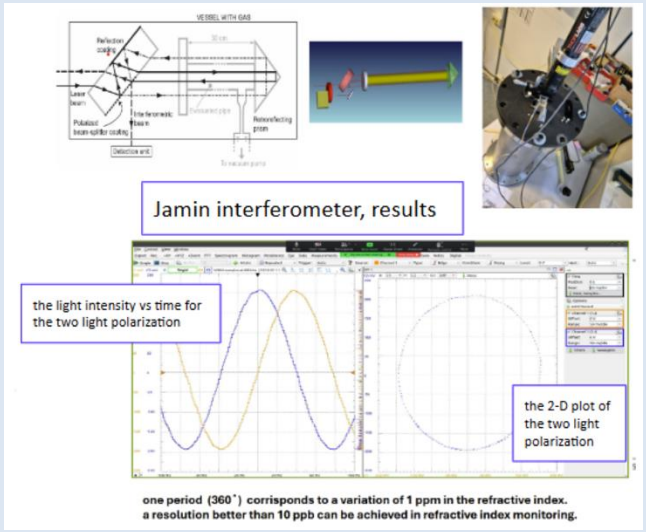
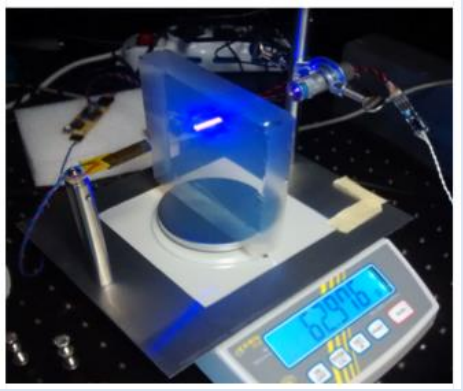


Figure. 1.7 The Sonar System Setup

Figure. 1.6 The Sonar System Setup

Interferometer



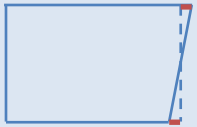


OPTICAL (example)

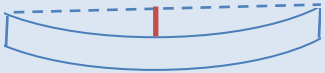
Density		$0.0926 < \rho < 1.00$ gr/cm^3
Refractive index	$(n^2=1+0.27\ \rho)$	$1.025 < n < 1.027$
Scattering length		$L_{sc} > 45$ mm
Absorption coefficient		$A>0.95$

MECHANICAL (example)

No bubbles, crackes; chips limited to less than 1 % area



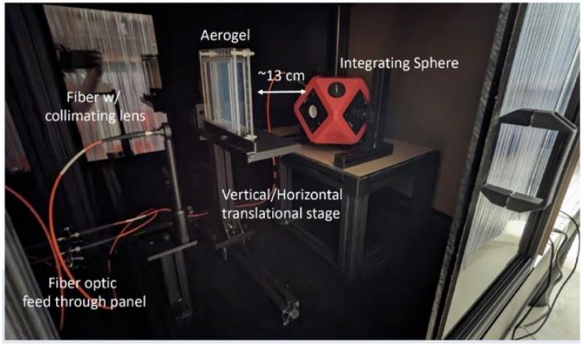
Side to side length variation	$\Delta L_{side} < 0.25$ mm
Tile to tile thickness variation	$\Delta H_{tile} < 1.5$ mm
Surface planarity	$\Delta S_{surf} < 1$ % of lateral side

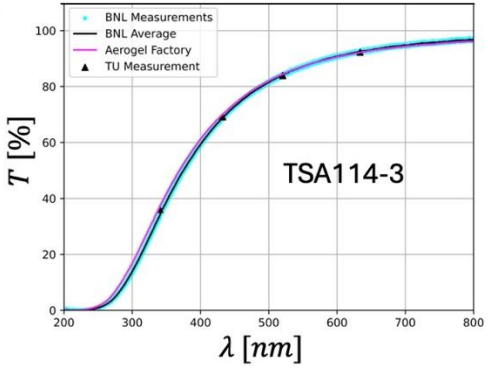


Aerogel Quality Assurance

Primary station at Temple University devloped as a common facility

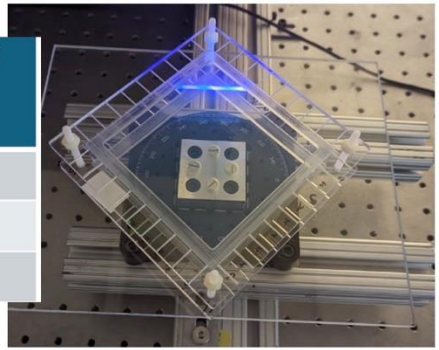
Transmission by LEDs + Integrating sphere – Temple U.





Refractive index by Prisma test – Temple U.

Tile	(TU-AF)/AF [%]
TSA120-1	0.087
TSA120-2	0.000
TSA114-3	0.062

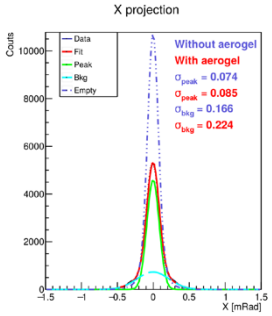


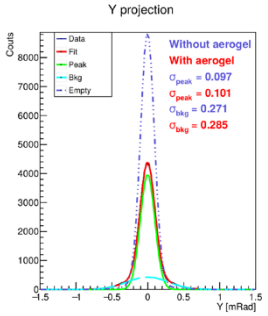
Secondary station at INFN (BA-FE) available for sample tests or in-depth characterization

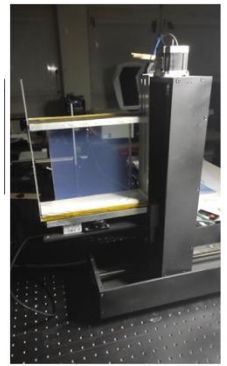
Perkin Elmer 650S (INFN FE)

Transmission by Spectro-photometers Agilet Cary (INFN BA)

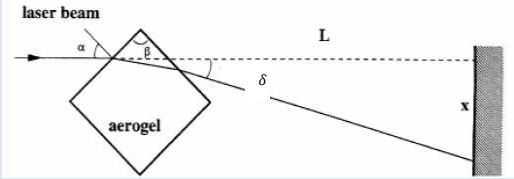
Forward Scattering by Laser + CMOS camera



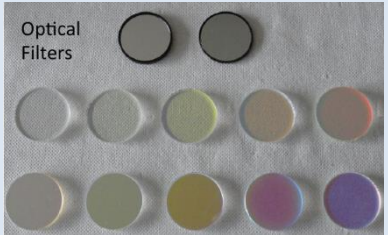


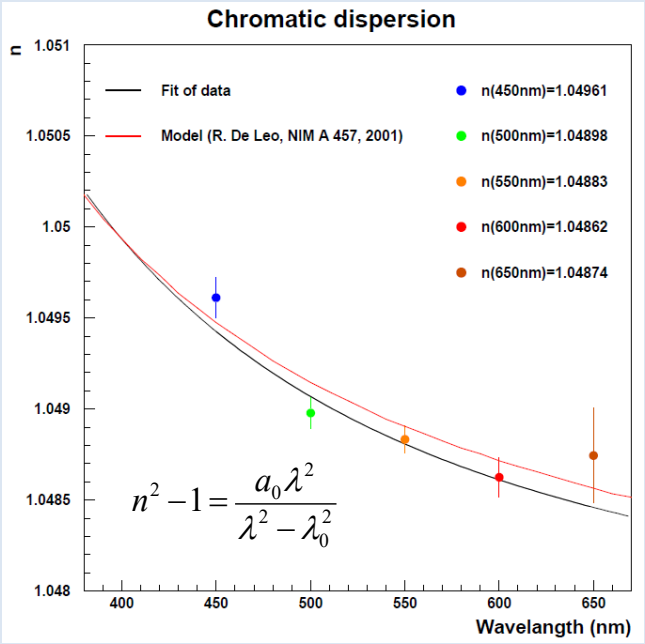


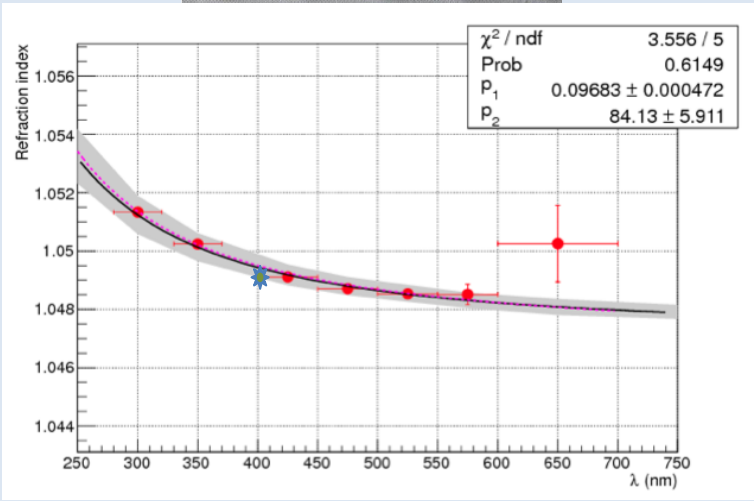
Measured by prisma method:



Measured by prototype with optical filters:

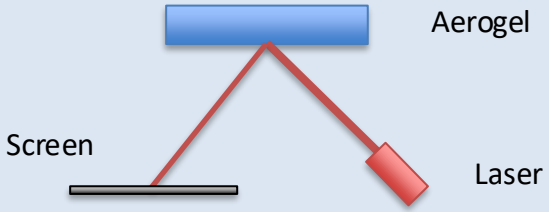


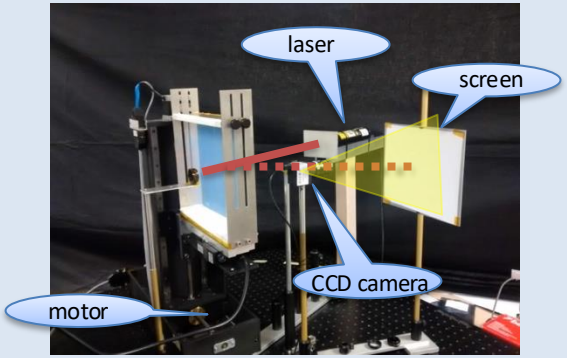




Expected value from density:
$n(400nm) = [1+0.438\rho]^{1/2} = 1.0492$

Aerogel Surface Planarity

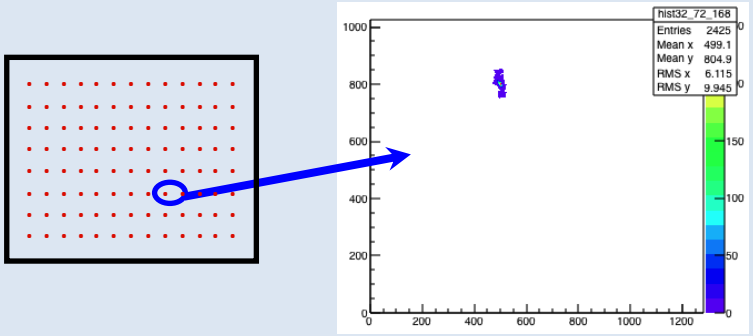




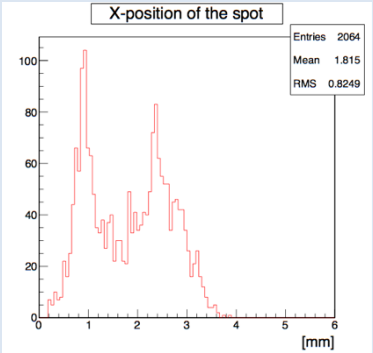
x-y axis movable table

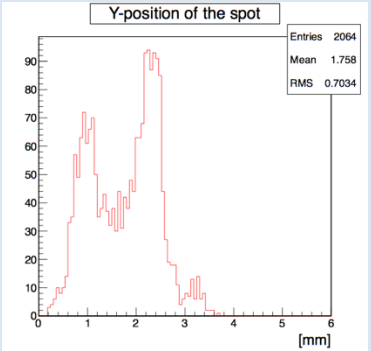
CCD camera [ThorLabs DCU 224c]
- sensitive area [5.95-4.76 mm]
- resolution [1280-1024 pixels]
- pixel size 4.65 µm

Scan of aerogel surface



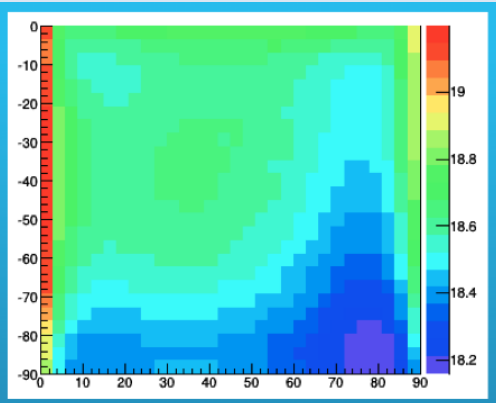
Distributions of X & Y positions of the spot



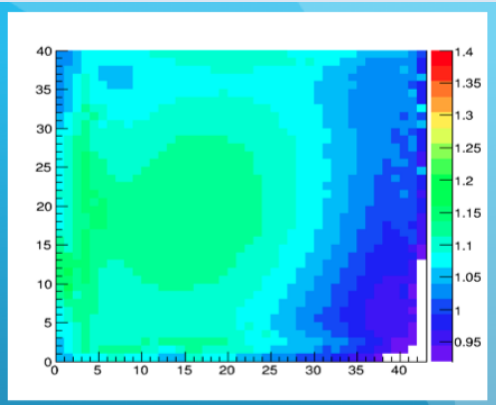


Face 1

Touch Machine



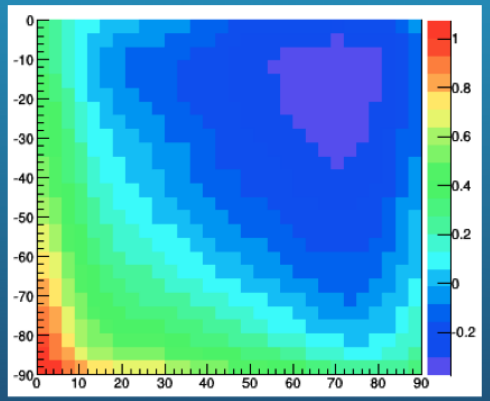
Laser Setup



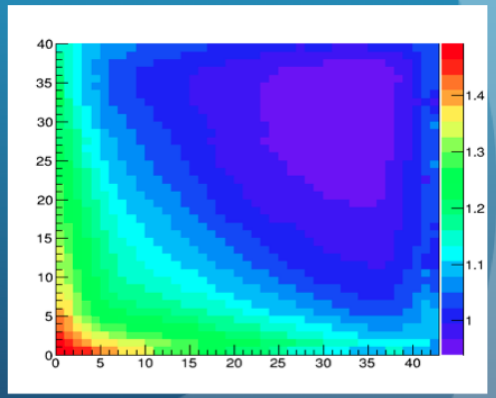
Possibility to derive the thickness profile

Face 2

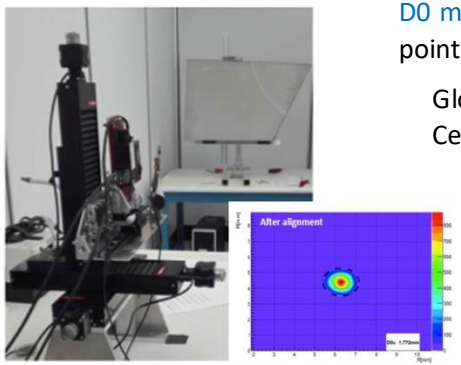
Touch Machine



Laser Setup



Main station at Duke-JLab developed as common facility (i.e. with existing INFN instrumentation)



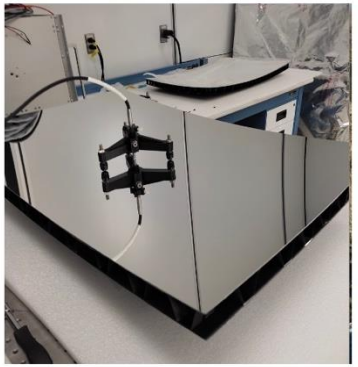
D0 measurement:
point-like image dimension

Global surface QA
Center of curvature

Stepper motor for alignment and center scan

LED source (1 mm dia.)

CMOS camera



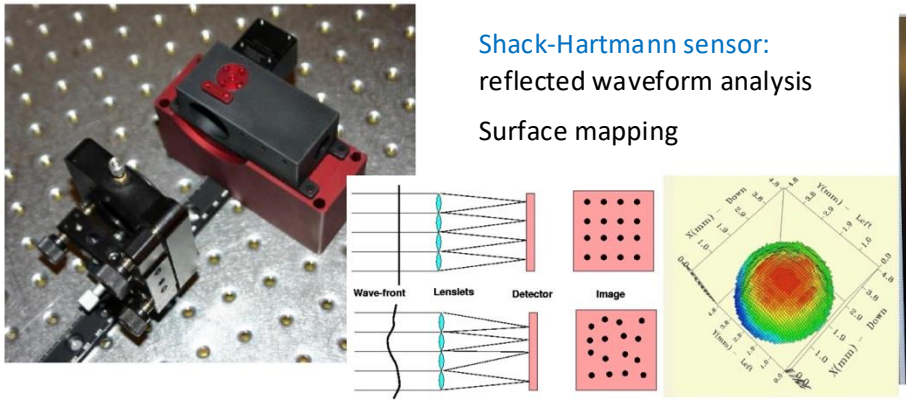
Reflectivity:
Portable instrument

Custom source + fiber distribution

Reference sensor

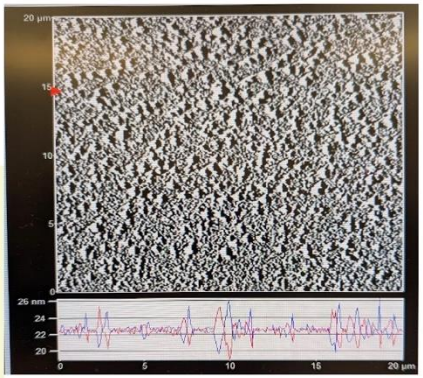
Compact spectrophotometer

Various instrumentation for in-depth characterization is available at DUKE



Shack-Hartmann sensor:
reflected waveform analysis

Surface mapping



SMiF | SHARED MATERIALS INSTRUMENTATION FACILITY

Access to a variety of instruments for precision characterization of materials

AFM images of coated surface (SBU) showing roughness of $< 100\ nm$

CFRP substrate mid-size (~50 cm side) demonstrator validated with lab tests before coating

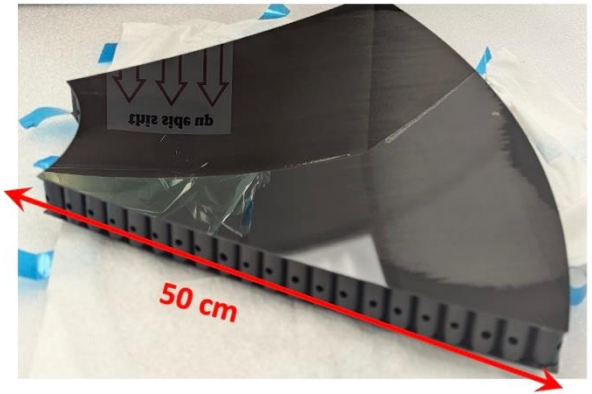
Annex C. Technical Requisite

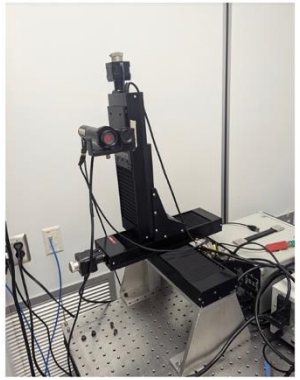
Each spherical mirror is supplied with

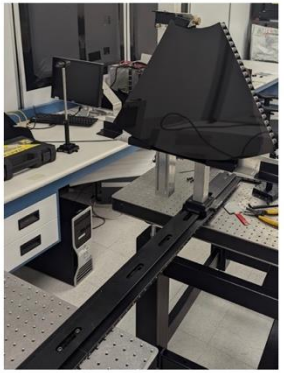
- a spot-size measurement,
- a report on dimensions,
- no reflective coating.

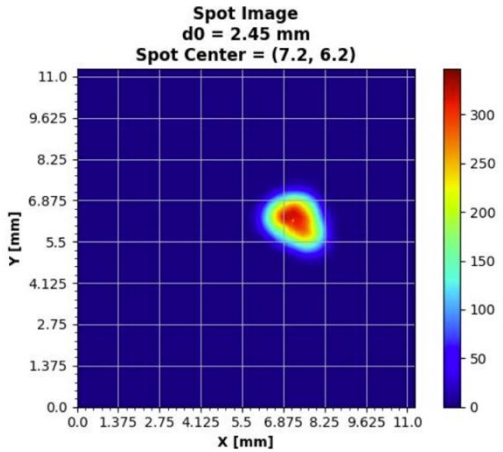
The spherical mirrors are replicated from the same mandrel. The latter is realized with the novel cost-effective technology that reduces the mandrel total mass and cost. Each mirror fulfills the following optical quality specification:

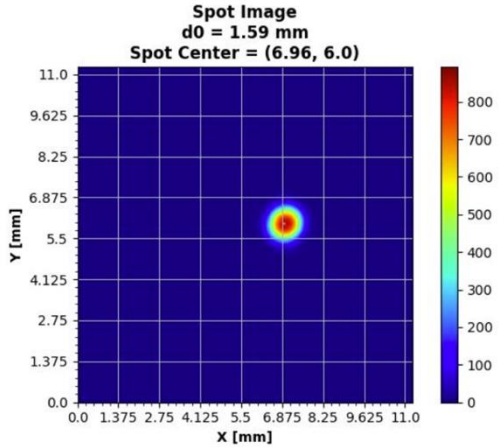
- Radius within 1% of nominal RoC value (the nominal RoC values is defined by the customer before production in the range 2000 mm +/- 10%),
- Roughness < 2 nm,
- Pointlike image spot size D0 < 2.5 mm,
- Compatibility with fluorocarbon gases (C_2F_6),
- Compatibility with SiO_2 reflecting coating.



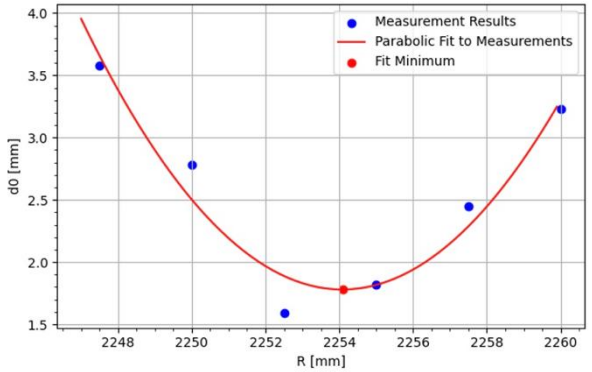








✓ D0 < 2.5 mm ✓ R = 2200 +/- 1%



Mirror Substrate & Coating

Ongoing activities with possible synergies with pfRICH to be completed by 2026

Developing portable reflectivity test beanch

Tripod head to scan spherical surface with proper alignment