Synergies - Characterization and QA stations:

Mirrors: Duke, JLab, BNL, INFN (FE)

Aerogel: Temple, INFN (BA), INFN (FE)

Laser/LED, Slow control, …. still to be activated

Annex C. Technical Requisite

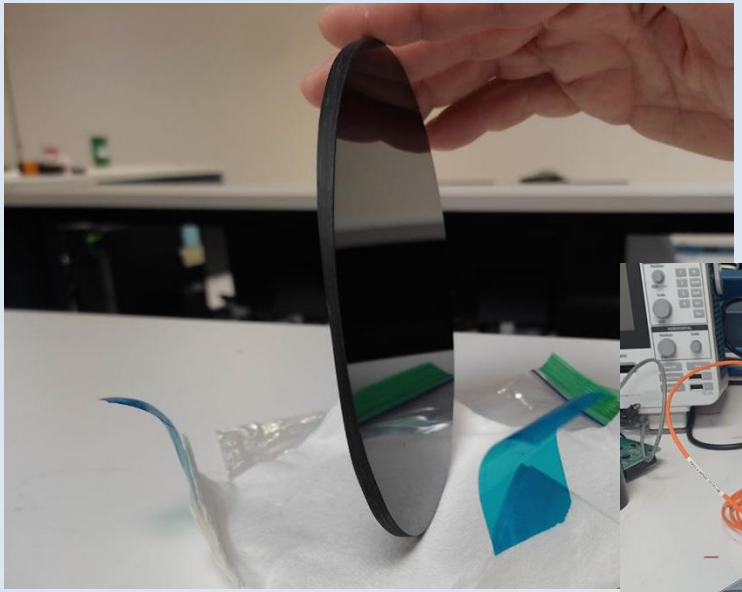
Each spherical mirror is supplied with

- 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.

Studying special material (ultra-low degassing)

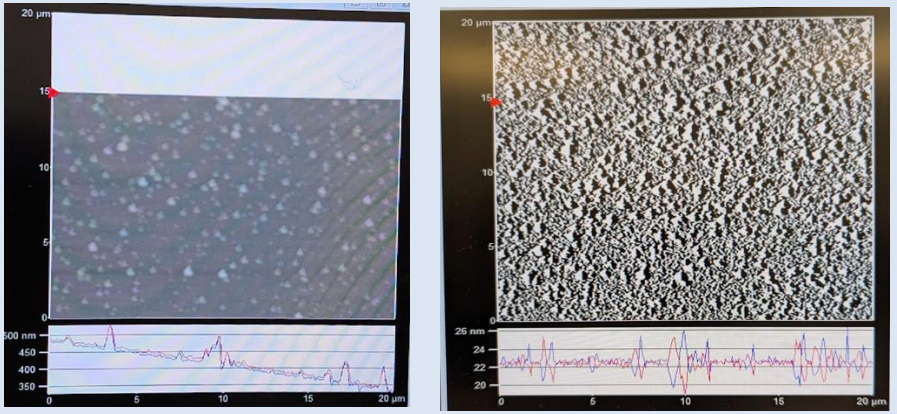


Developing reflectivity test beanch

Testing coating (SBU) on dRICH samples

Mirror Quality Assurance (Duke)

- SMiF | SHARED MATERIALS INSTRUMENTATION FACILITY
  - Access to a variety of instruments for precision characterization of materials
  - Vossen's group members trained on Atomic Force Microscope, Spectrophotometer

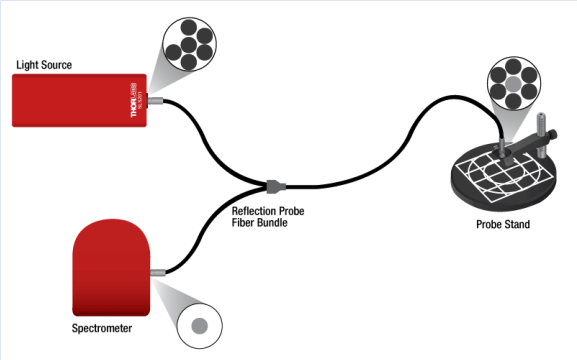


Screenshot of Atomic Force Microscope images of reflective surface coated at SBU showing roughness of $< 100\ nm$

- Variety of workshops and engineering facilities at Triangle Universities Nuclear Laboratory (TUNL) e.g. for 3D printing etc…

- Reflectivity probe
  - Deuterium Lamp 200-700nm
  - Spectrometer 200-1000nm
  - Currently waiting for quote for custom, UV compatible (solarized) probe with reference leg

- D0 test currently at JLab
  - Can be moved to (temporarily) to Duke to make use of local workforce



Portable reflectivity meter

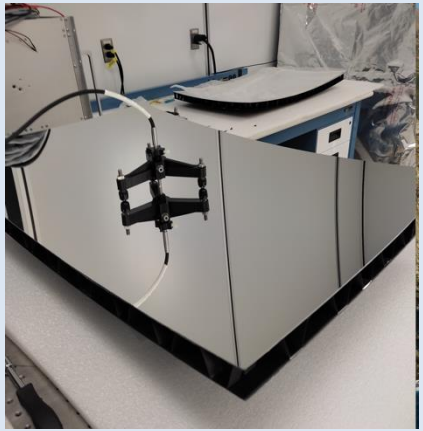
Mirror Quality Assurance (JLab)

Reflectivity:
Portable instrument

Custom source + fiber distribution

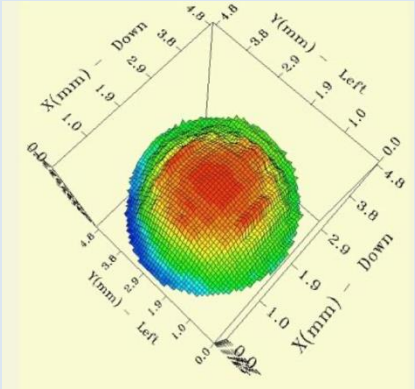
Reference sensor

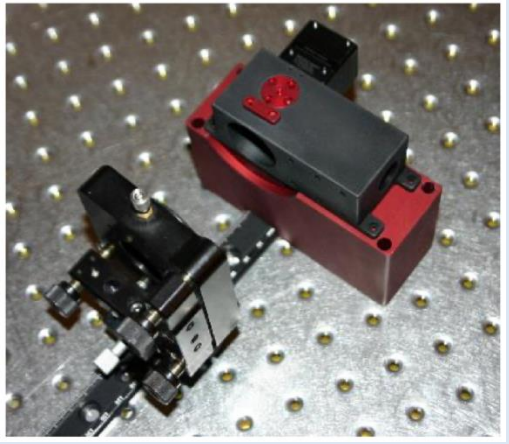
Compact spectrophotometer



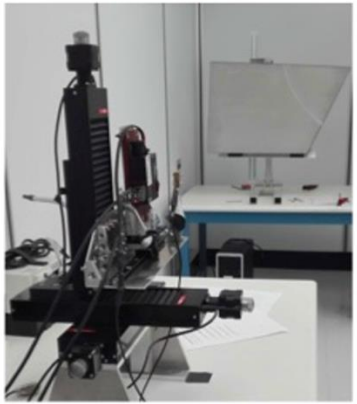
Shack-Hartmann sensor:
reflected waveform analysis

Surface mapping





Surface Quality



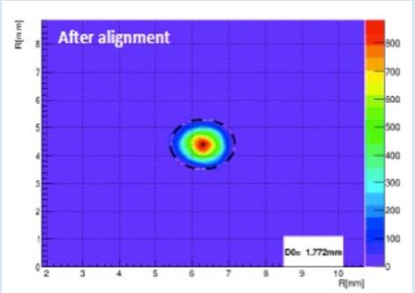
D0 measurement:
point-like image dimension

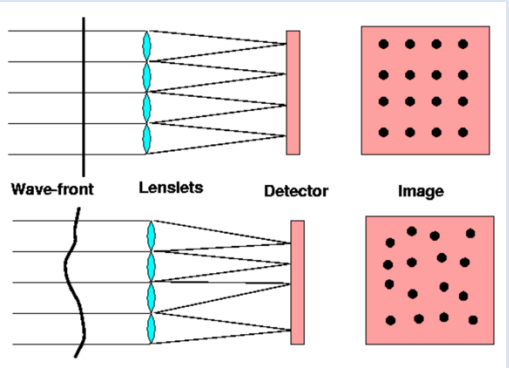
Global surface QA
Center of curvature

Stepper motor for alignment and center scan

LED source (1 mm dia.)

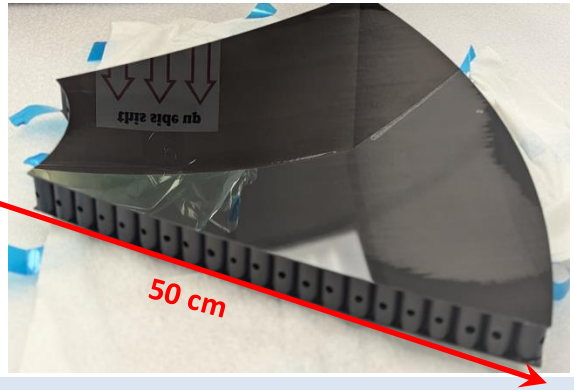
CMOS camera

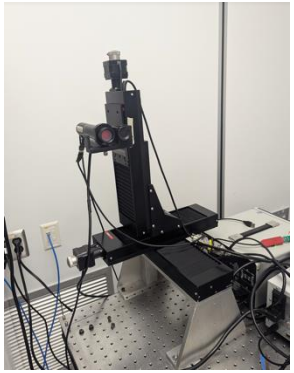


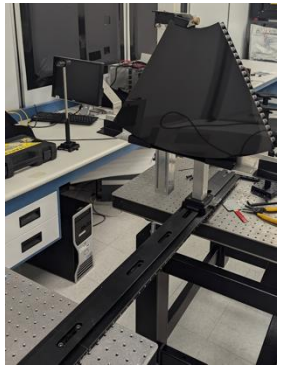


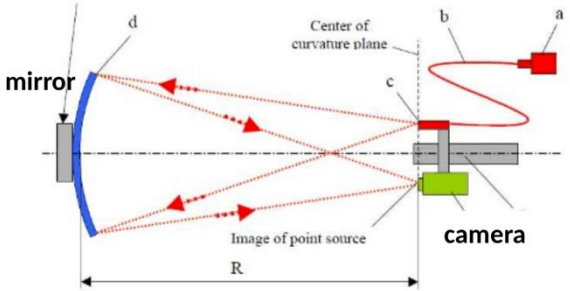
Under study: transfer to Duke

Characterizing the medium-size (~30 cm side) demonstrator CFRP substrate before coating

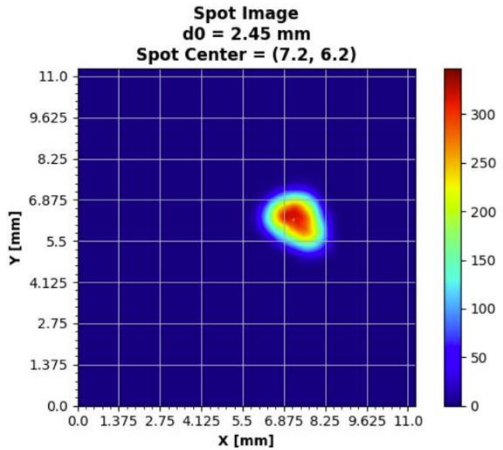


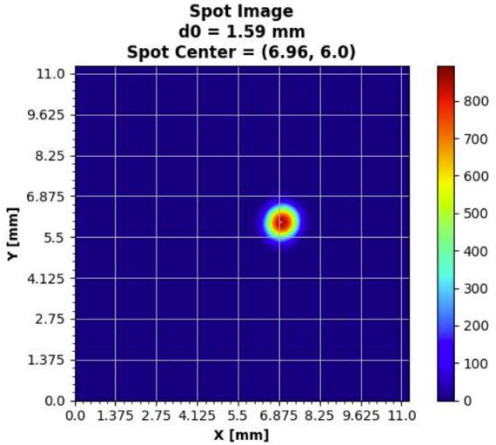


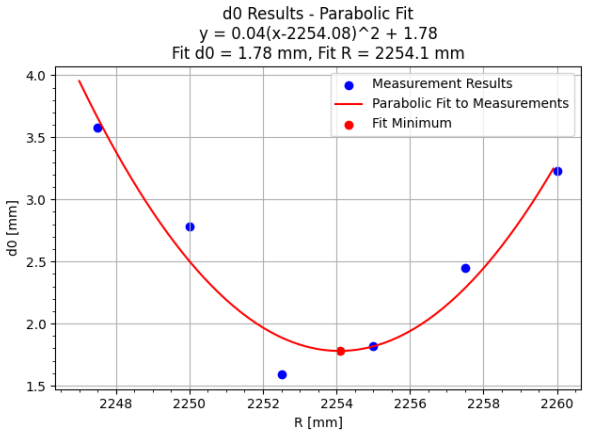




✓ D0 < 2.5 mm ✓ R = 2200 +/- 1%







Synergies - Characterization and QA stations:

Mirrors: Duke, JLab, BNL, INFN (FE)

Aerogel: Temple, INFN (BA), INFN (FE)

Laser/LED, Slow control, …. still to be activated

Aerogel Specifications

An effort should be pursued by the vendor to keep the aerogel quality parameters as close as possible or better than the following reference values.

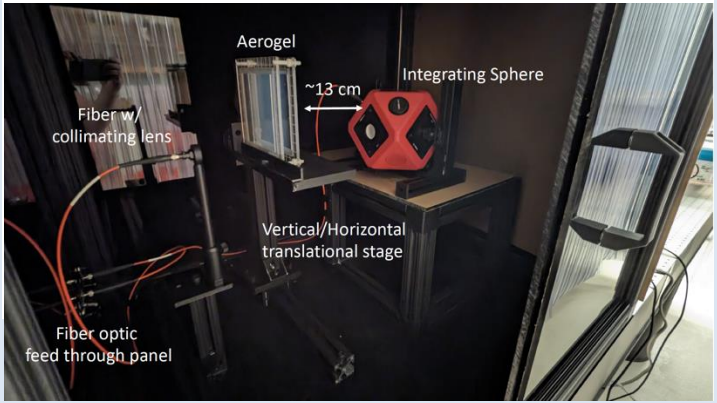
General specifications:

- No cracks or bubbles inside the block. Single spallings which decrease its area no more than 0.25 % are acceptable on the top surface;
- Lateral dimension tolerance within 0.25 mm;
- No evident disuniformity inside the tile volume.

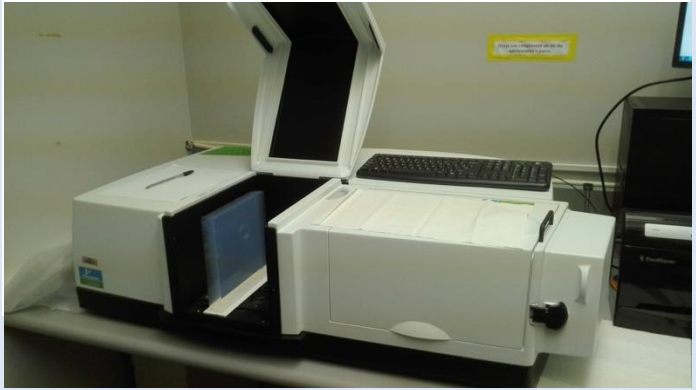
Technical specifications:

- Refractive index, to be chosen by the customer, in the range from 1.025 to 1.030, with a maximum tile-to-tile variation of +/-0.002;
- Tolerance on thickness +/- 1 mm, being the error intended as the maximum tile-to-tile variation;
- Absorption coefficient, defined as the constant term of the Hunt parameterization of the aerogel transmission, bigger than 0.95;
- Scattering length wavelength bigger than 45 mm at 400 nm;
- Planarity of the transmission surface, defined as the maximum peak to valley variation, does not exceed 1.5 % of the lateral dimensions.

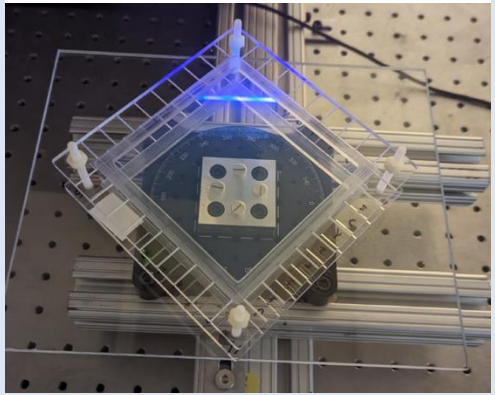
Integrating sphere - Temple



Perkin Elmer 650 S - INFN - Ferrara

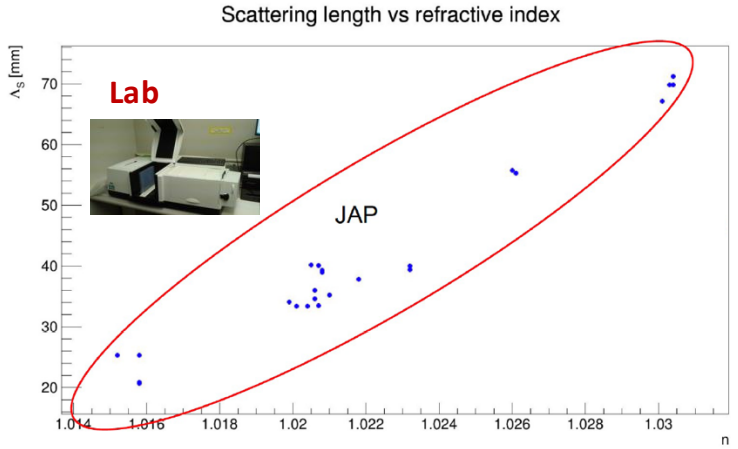


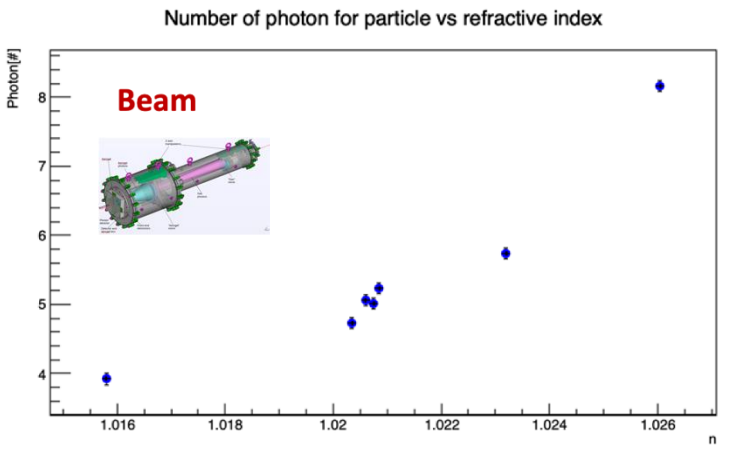
Prisma test - Temple

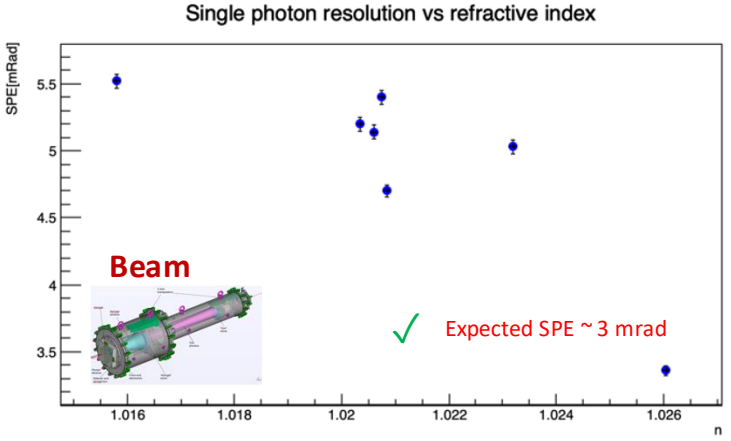


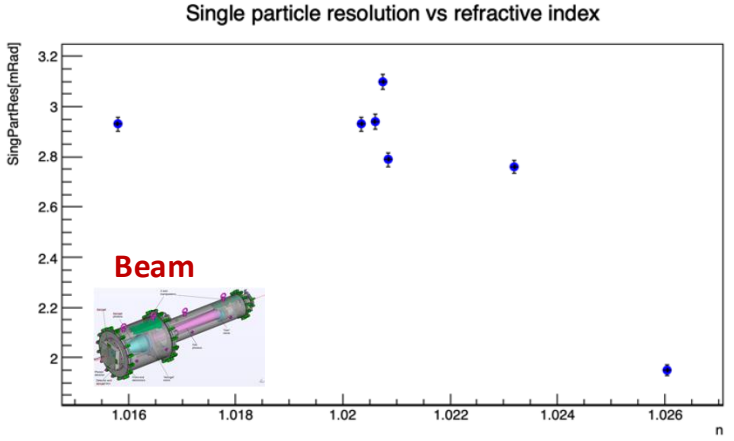
Agilent Cary - INFN - Bari

Aerogel Radiator: Optimization



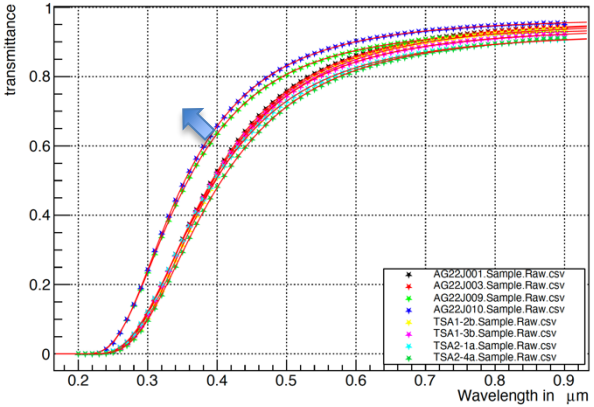






INFN in-kind in synergy with ALICE3

Ongoing: reproducibility at n=1.026

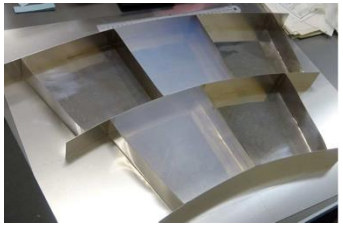


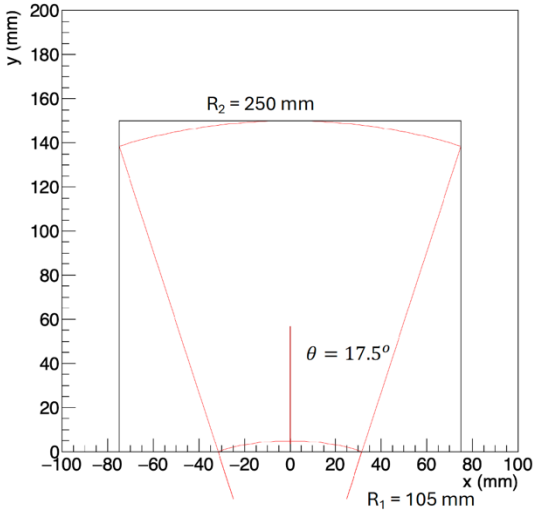
Next step: move to real dimensions & specs

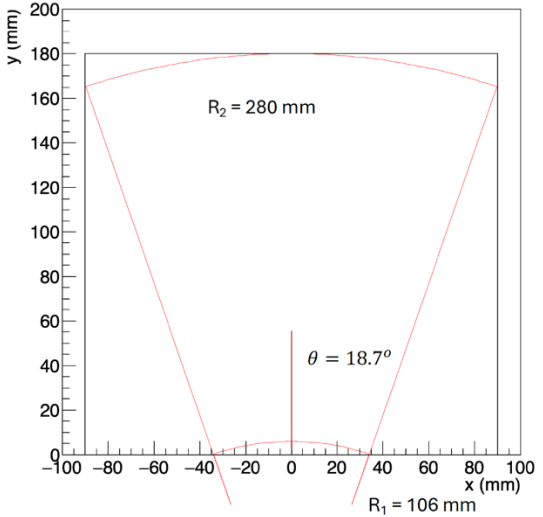
ePIC quality specs: clarity, absorption, planarity, dimension tolerance, …

Squared and water-jet cutting shaped

- 15 x 15 x 3 cm2 volume
- 18 x 18 x 2 cm2 volume (BELLE-II standard)







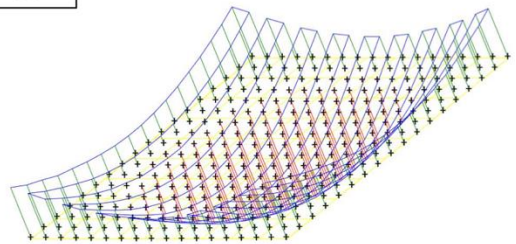
TOUCH PROBE

Samples from Aerogel Factory

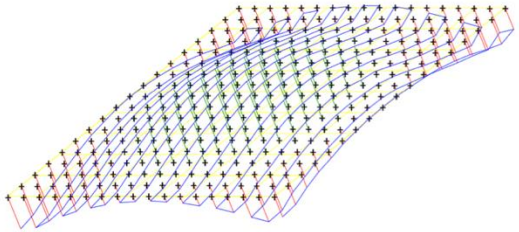
Minimum, maximum, average and std deviation of the measured thickness:

n = 1.03

Y -



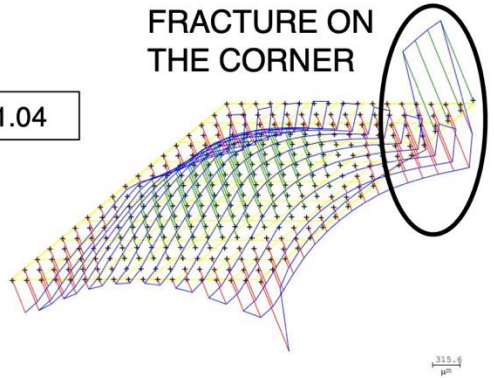
Y +

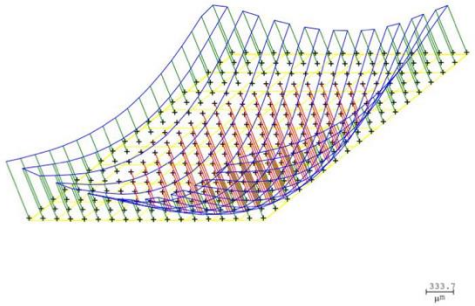


n=1.03
min tickness (mm): 19.690
max tickness (mm): 20.385
standard deviation: 0.172
average (mm): 19.955

n=1.04
min tickness (mm): 19.271
max tickness (mm): 21.798
standard deviation: 0.335
average (mm): 19.641

n = 1.04

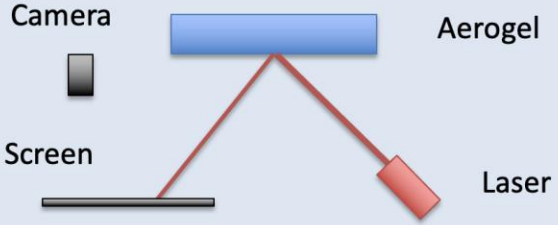


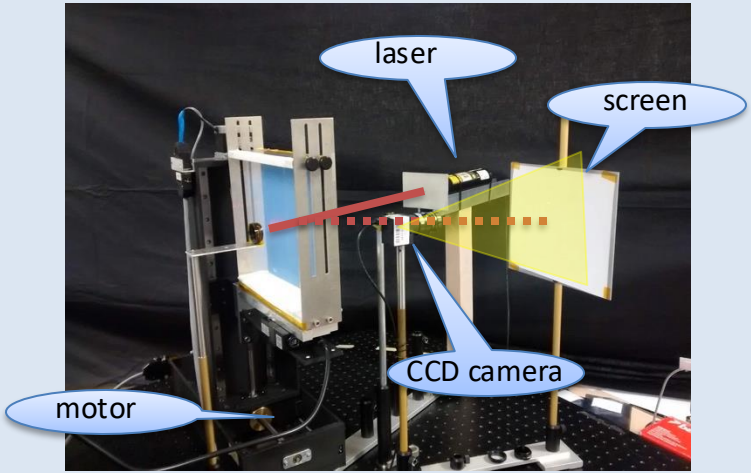


n=1.05
min tickness (mm): 19.965
max tickness (mm): 20.479
standard deviation: 0.098
average (mm): 20.106

MENISCUS SHAPE DUE TO FABRICATION PROCESS

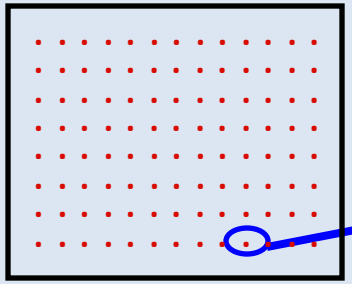
Courtesy INFN Bari

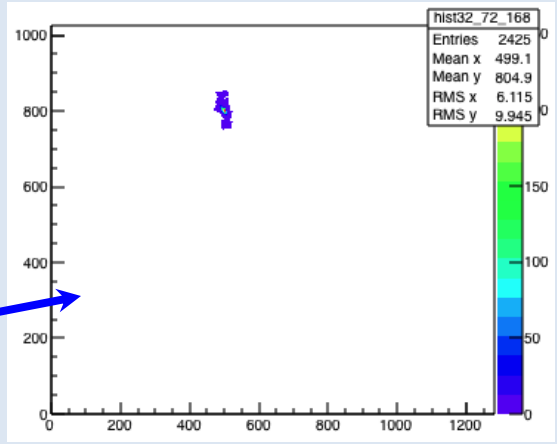




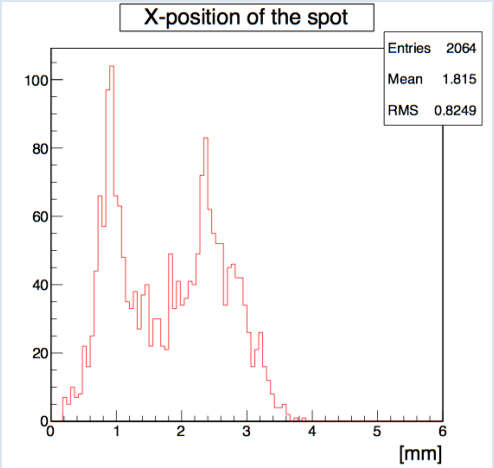
x-y axis movable table
CCD camera [ThorLabs DCU 224c]
- sensitive area [5.95-4.76 mm]
- resolution [1280-1024 pixels]
- pixel size 4.65 µm

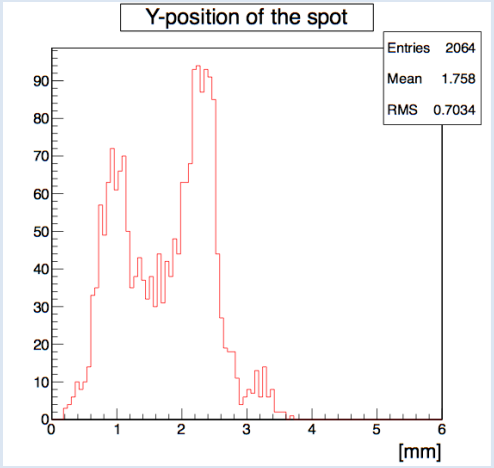
Scan of aerogel surface





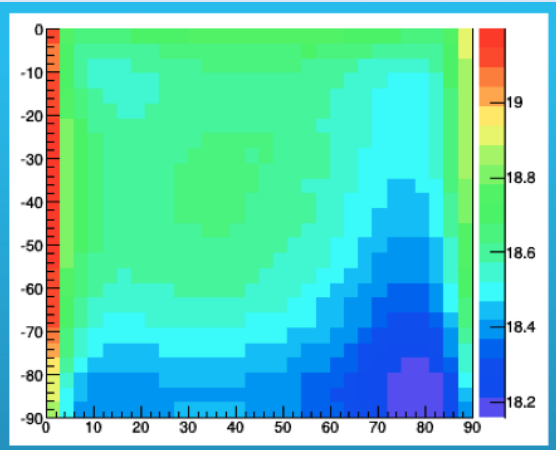
Distributions of X & Y positions of the spot



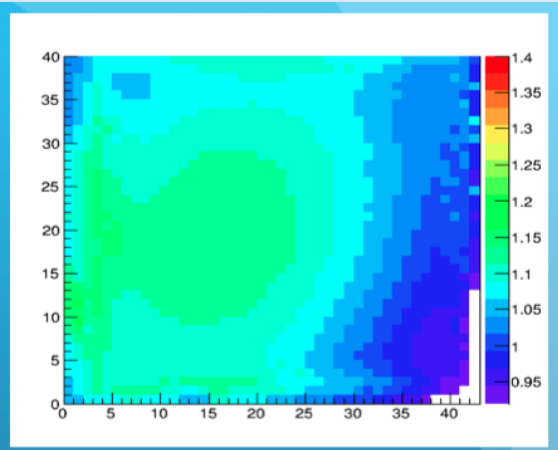


Face 1

Touch Machine



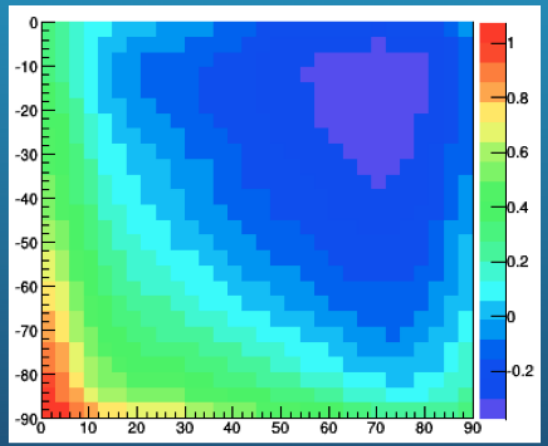
Laser Setup



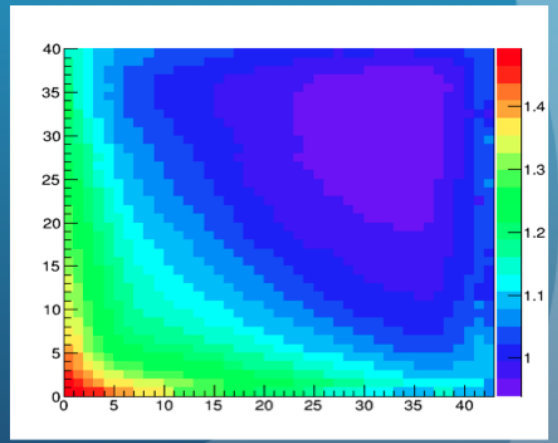
Old samples from Chiba University

Face 2

Touch Machine



Laser Setup



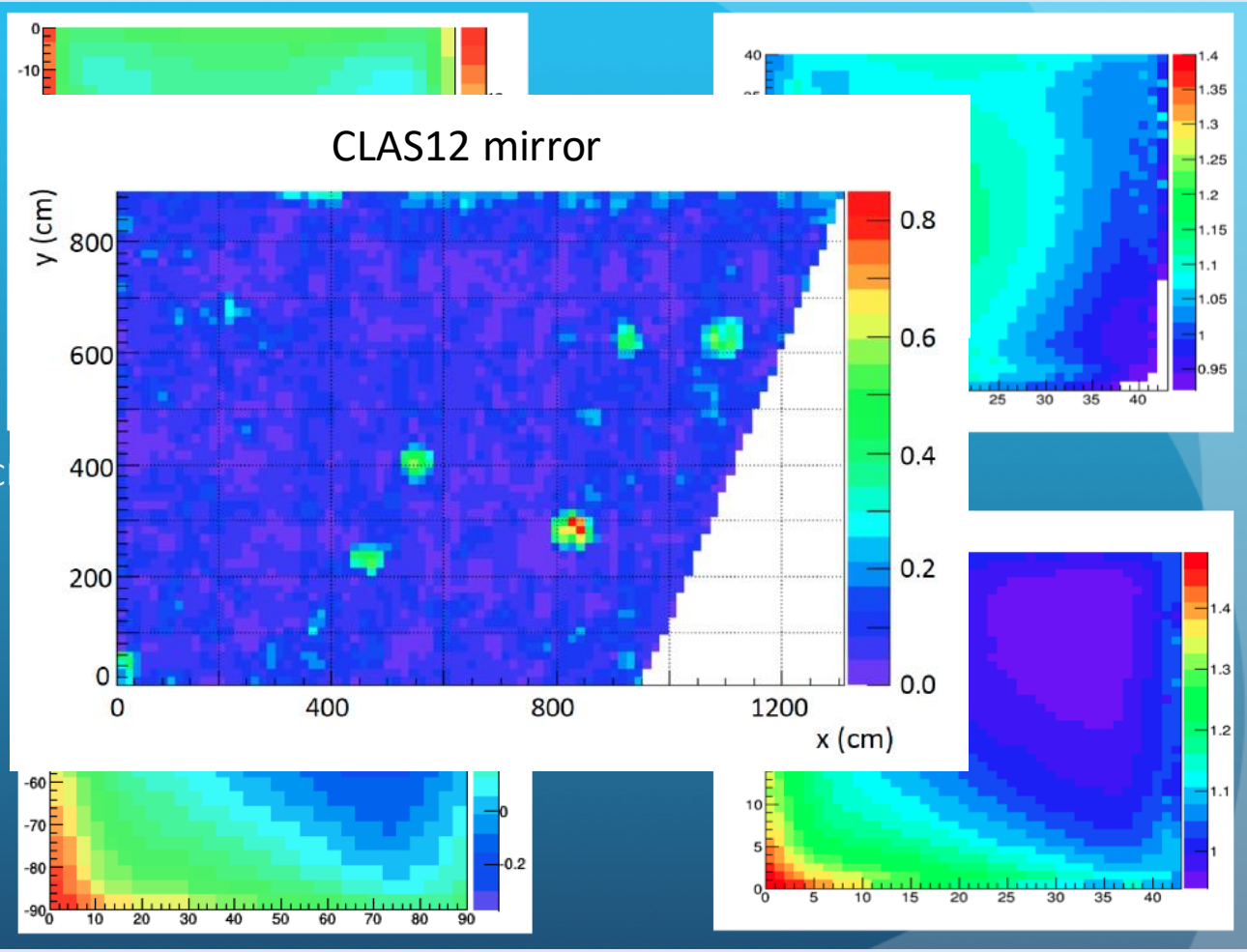
Face 1

Touch Machine

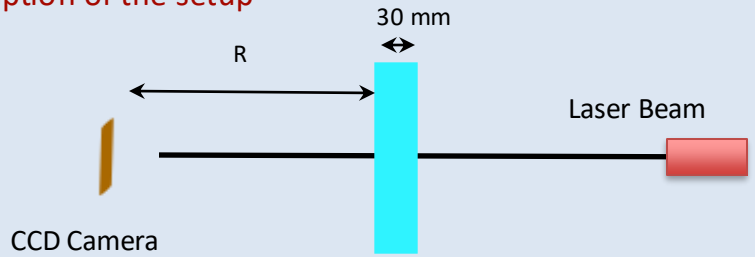
Old samples from C

Face 2

Touch Machine



Description of the setup



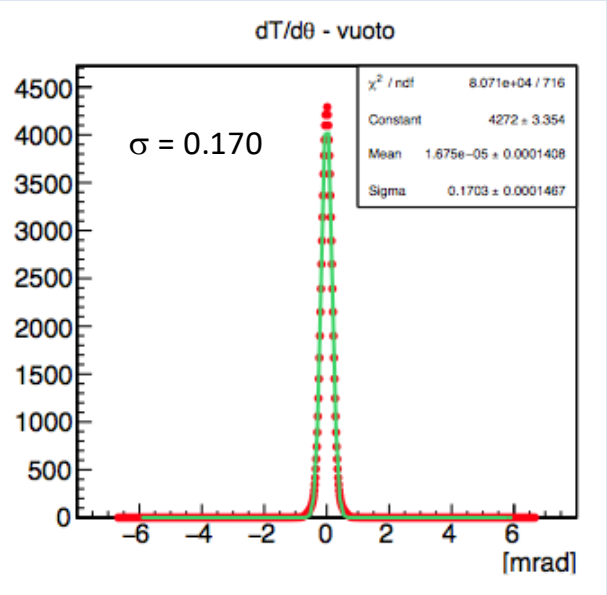
Scattering of the light in the medium due to the anisotropy of the dielectric properties caused by density microscopic fluctuations

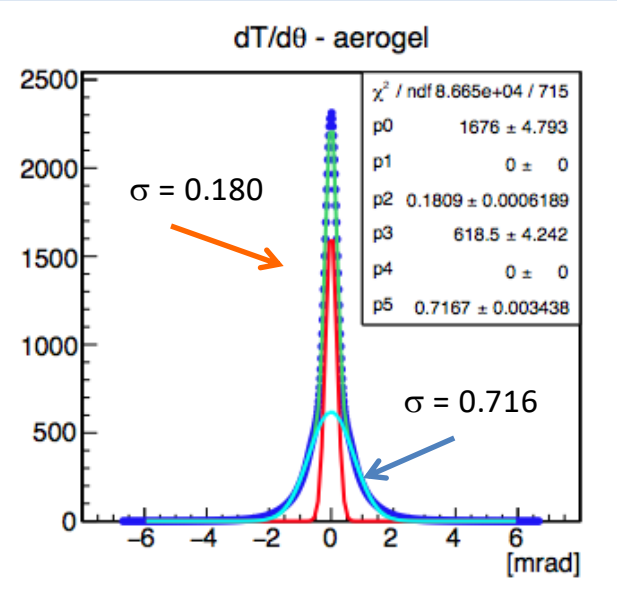
Take the average X & Y profiles of the spot

M. Contalbrigo et al., NIMA 876 (2017) 168

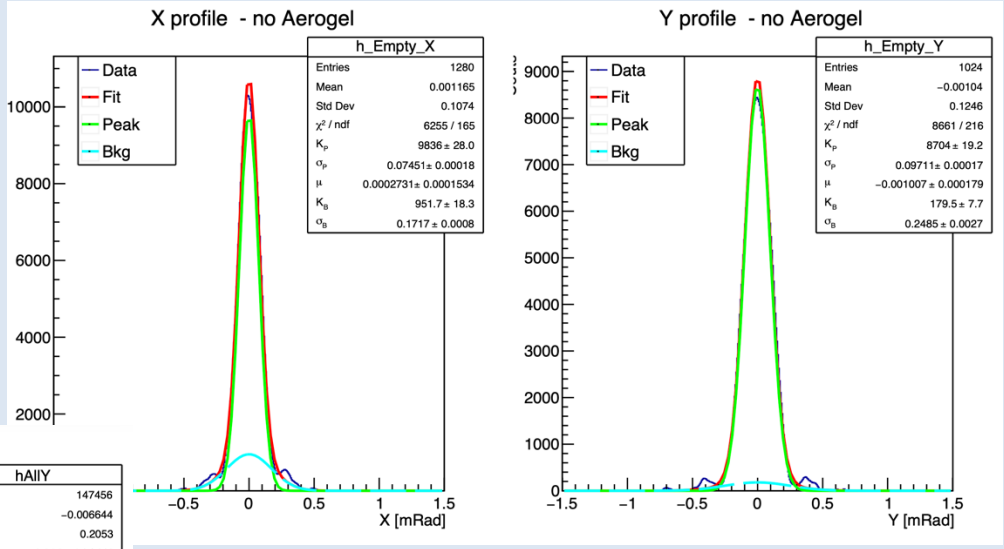
Analysis steps:

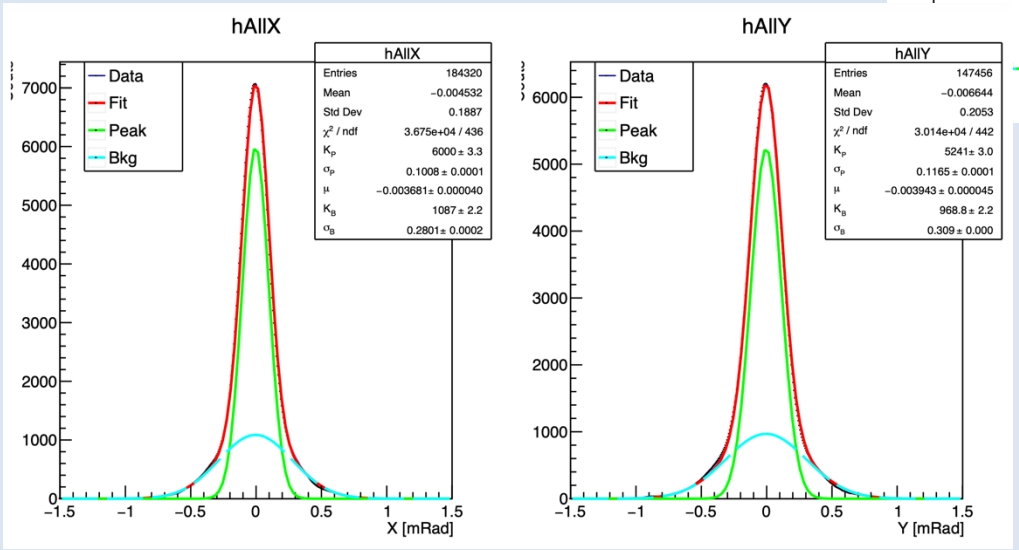
- Reference beam profile taken without aerogel
- Extract laser beam profile and compare with reference measurement
- Extract angular dependence of light intensity after passage through the aerogel





No aerogel

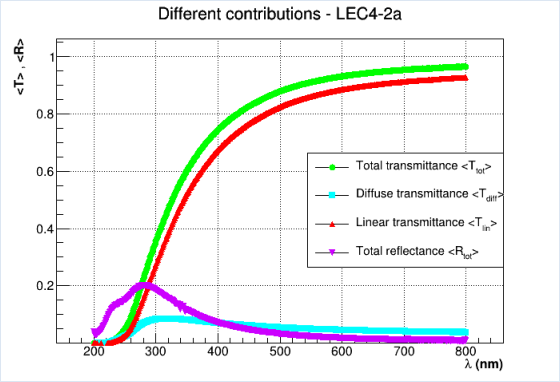




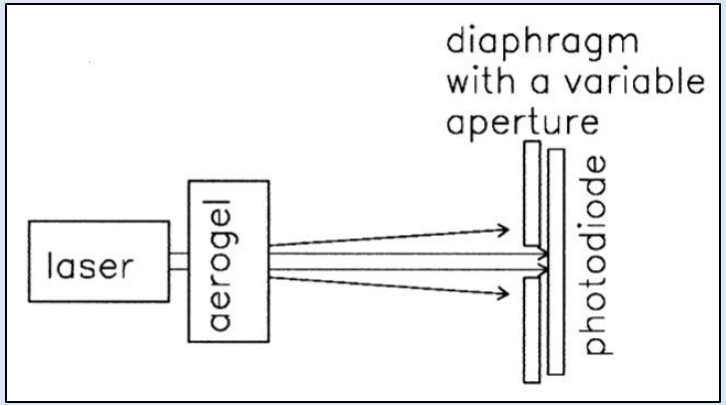
Samples from Aerogel Factory

3 x 2 cm aerogel

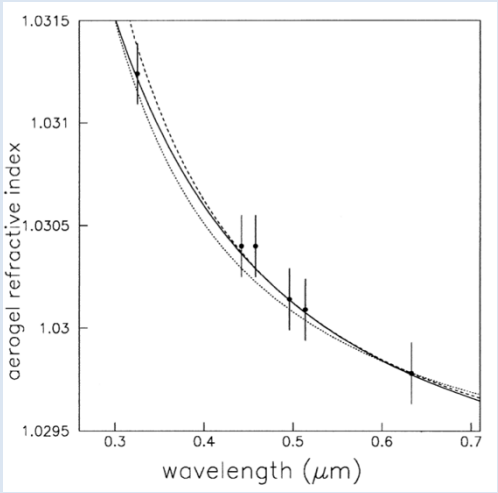
Since the beginning of this year, the laboratory in Bari has been equipped with an **Agilent Cary 4000 Series UV-Vis Spectrophotometer** with integration sphere. The total and diffuse transmittance, together with the total reflectance, are experimentally measured by the spectrophotometer



The scattering of light at small angles (not Rayleigh) and the dependence of the refractive index of silica aerogel on wavelength will be investigated in the range of interest as done in the past.



R. De Leo et al.,
NIMA 457 (2001) 57



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Mirrors: Duke, JLab, BNL, INFN (FE)

Aerogel: Temple, INFN (BA), INFN (FE)

Laser/LED, Slow control, …. still to be activated