# Measures of aerogel optical properties in Ferrara

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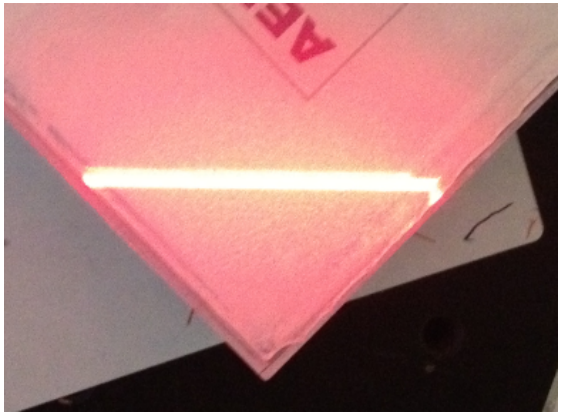
# Part 1: Measures of refracting index

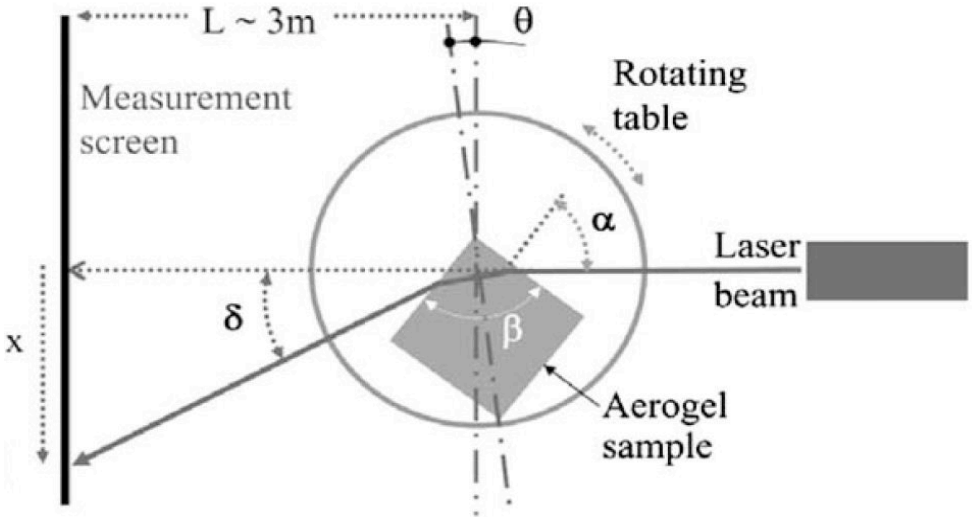
# The "standard prism" method

- The adjacent sides of the aerogel tile form a prism
- Measure the deviation of a laser beam passing through the aerogel tile edges
- The position of the laser beam spot is measured on a screen placed downstream



- The aerogel refractive index *n* can be determined by fitting the angular distribution of the spots of the refracted beam with the **Snell-Descartes law:**

$$\delta = \alpha - \beta + \arcsin\left\{ n \cdot \sin\left[ \beta - \arcsin\left( \frac{\sin\alpha}{n} \right) \right] \right\}$$

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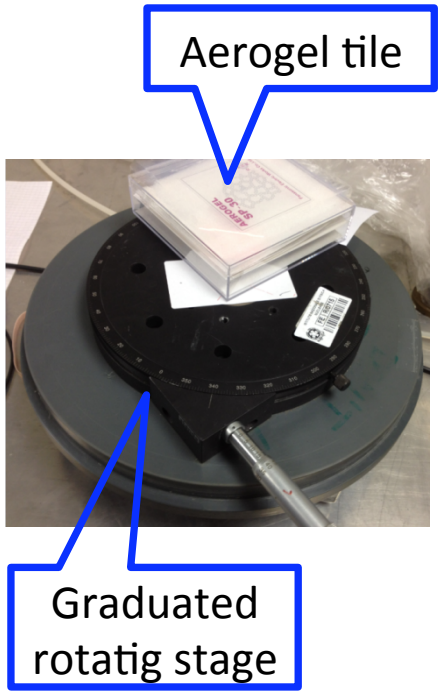
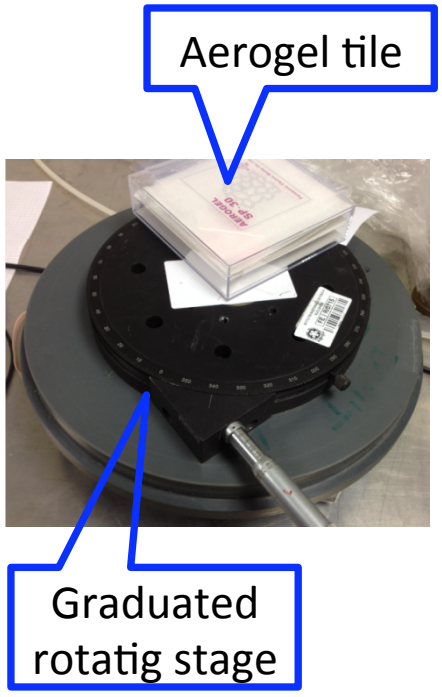
# The Ferrara set-up

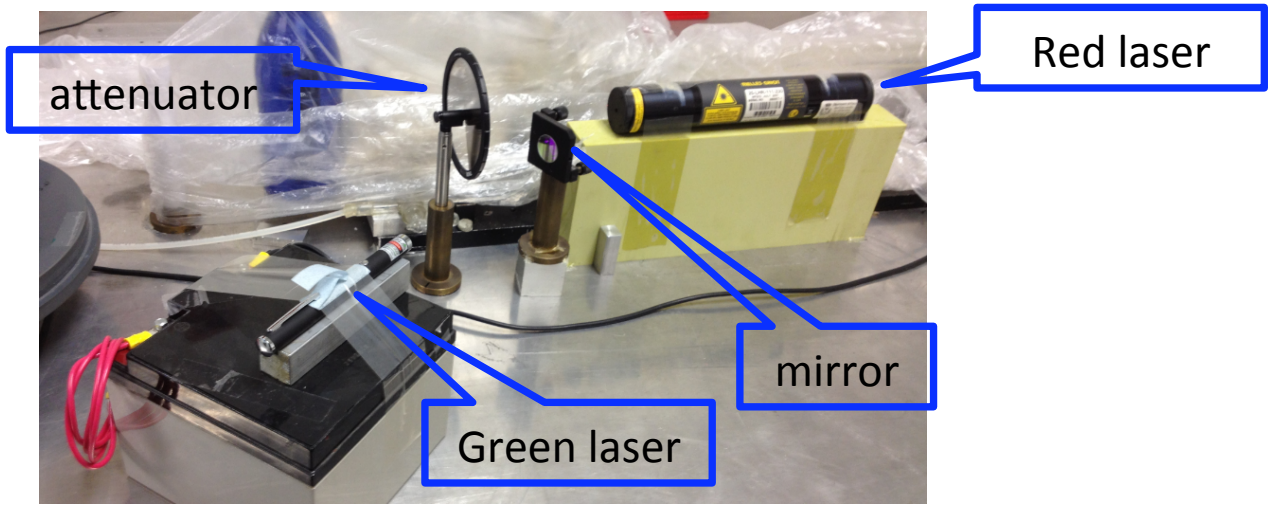
- The aerogel tile is positioned upon a graduated rotating stage



# The Ferrara set-up

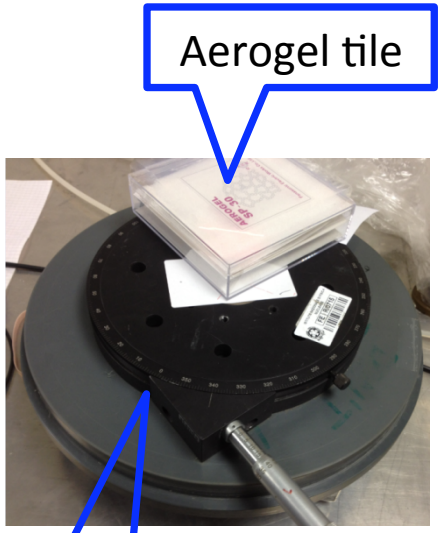
- The aerogel tile is positioned upon a graduated rotating stage
- Two lasers were used: **red** (λ=632.8 nm) and **green** (λ=532 nm)

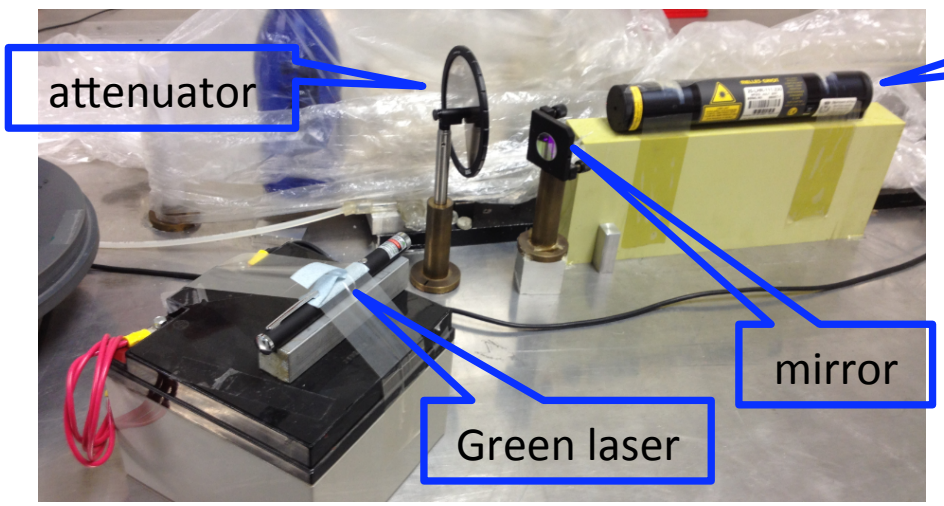


# The Ferrara set-up

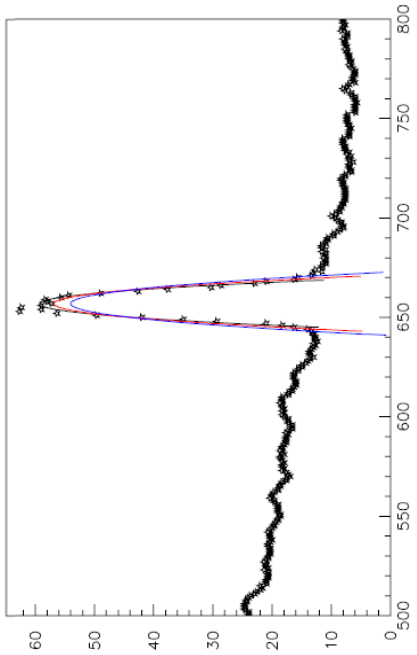
- The aerogel tile is positioned upon a graduated rotating stage
- Two lasers were used: **red** (λ=632.8 nm) and **green** (λ=532 nm)
- The beam spots on the screen are recorded by a standard webcam (logitech 800X600 pxl)
- The screen was placed at a distance L=3965mm
- The "zero" position was obtained using the direct beam (i.e. without the aerogel tile)

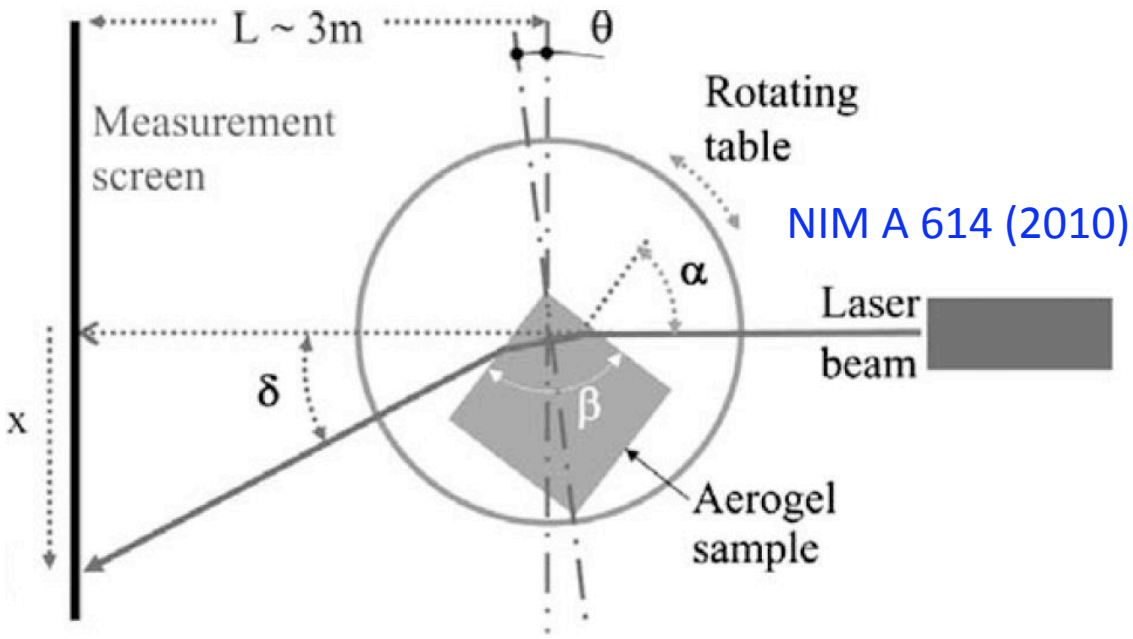



# Procedure

1. The intensity spectra are extracted from the analysis of the spot images (800x600 pxl)
2. The peaks are fitted with a parabola to obtain the position of the maxima

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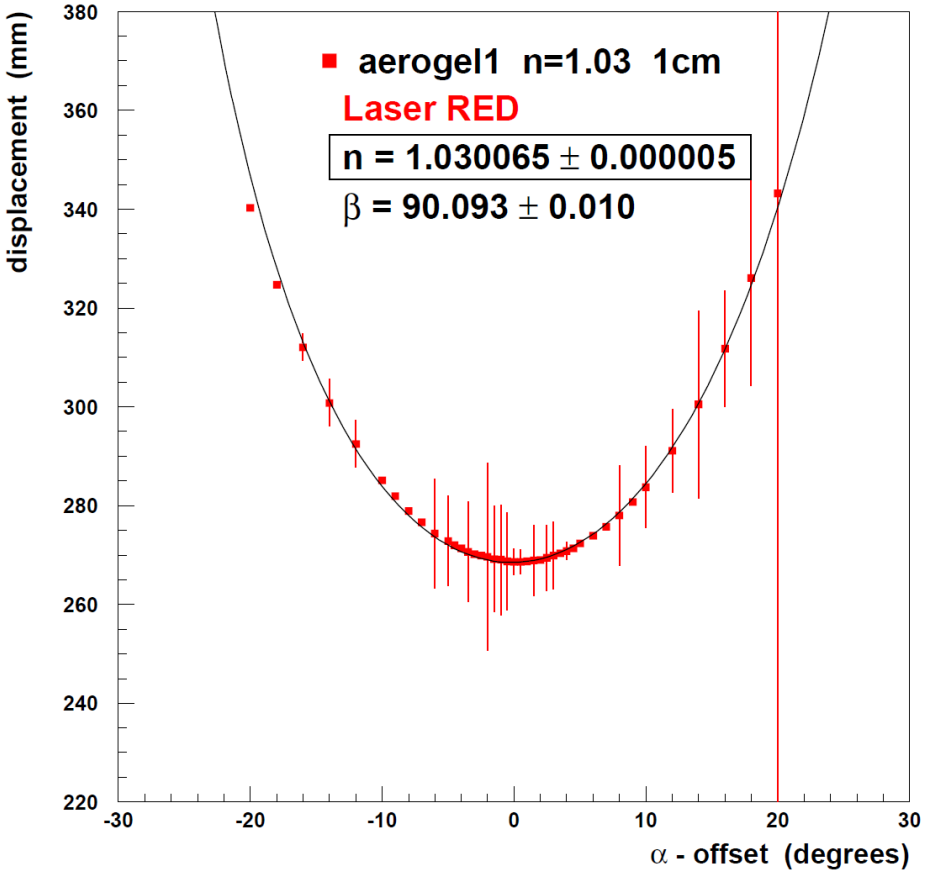
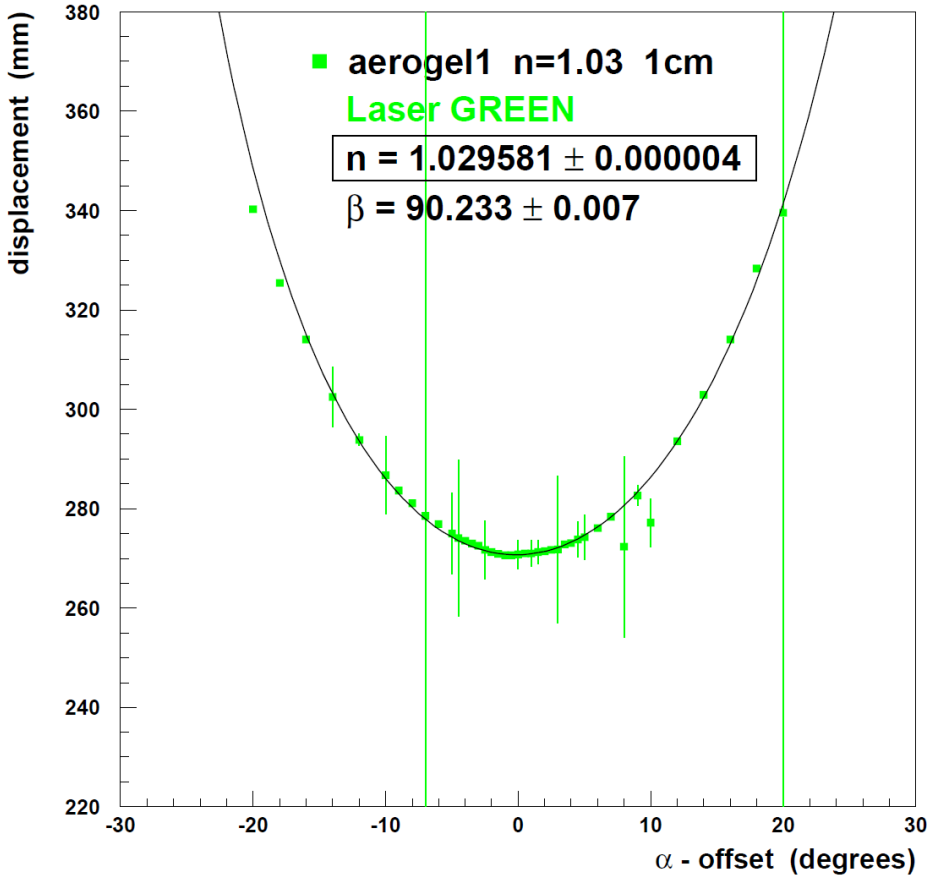
3. The positions of the maxima are plotted vs. the angle ($\alpha$) of the incident beam and fitted with the **Snell-Descarted law**

# Very preliminary results (aerogel n=1.03, 1cm)

RED Laser (λ=632.8 nm)




GREEN Laser (λ=532 nm)



# Outlook (part 1)

- Evaluation of systematic errors:
  - measurement of distance L (± 0.5 cm)
  - measurement of angle $\alpha$ (± 0.5 degrees)
  - pixel → mm conversion
  - Laser/aerogel alignment
  - imperfections of aerogel edges
  - .....

- Optimization of fit of intensity spectra (peaks):
  - try different ranges
  - try different fit functions

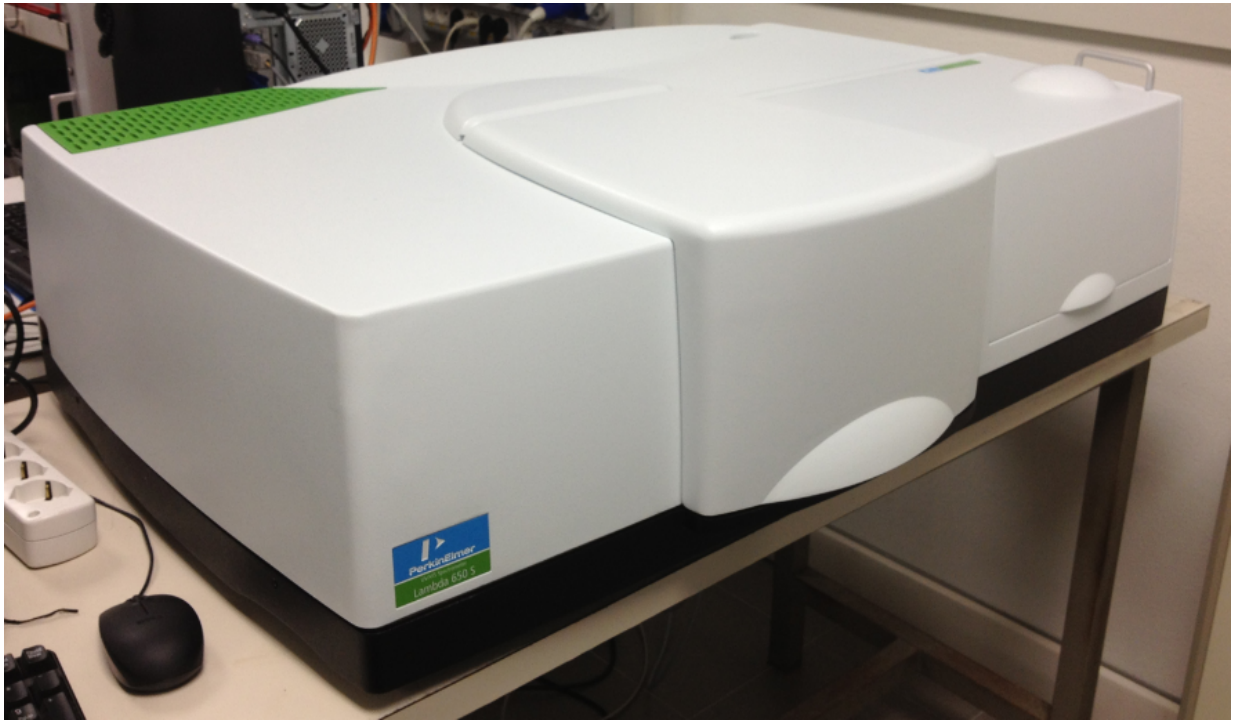
- Optimization of final fit:
  - study impact of additional parameters (opening angle $\beta$ and angular offset on $\alpha$)
  - study impact of input values

- Extract **dispersion law** from measurements with **RED**, **GREEN** and **BLUE** lasers

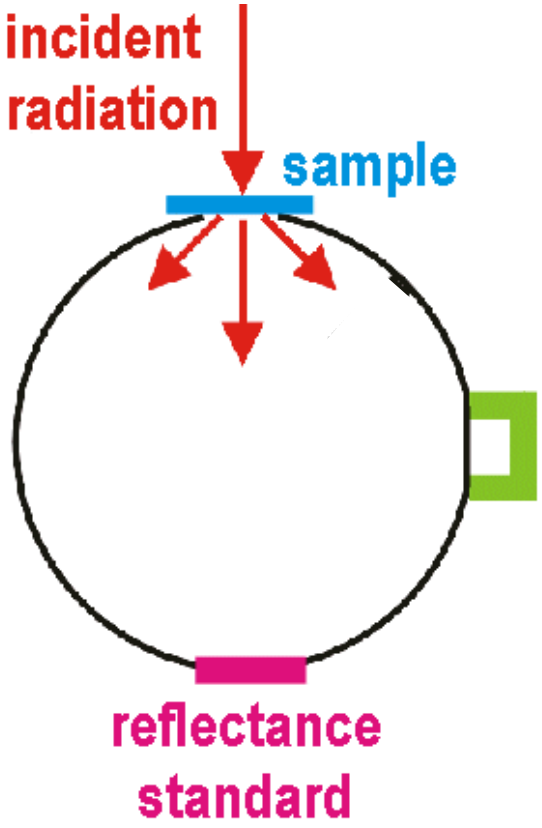
- Repeat measurements with n=1.05 aerogel tiles

# Part 2: Measures of Transmittance

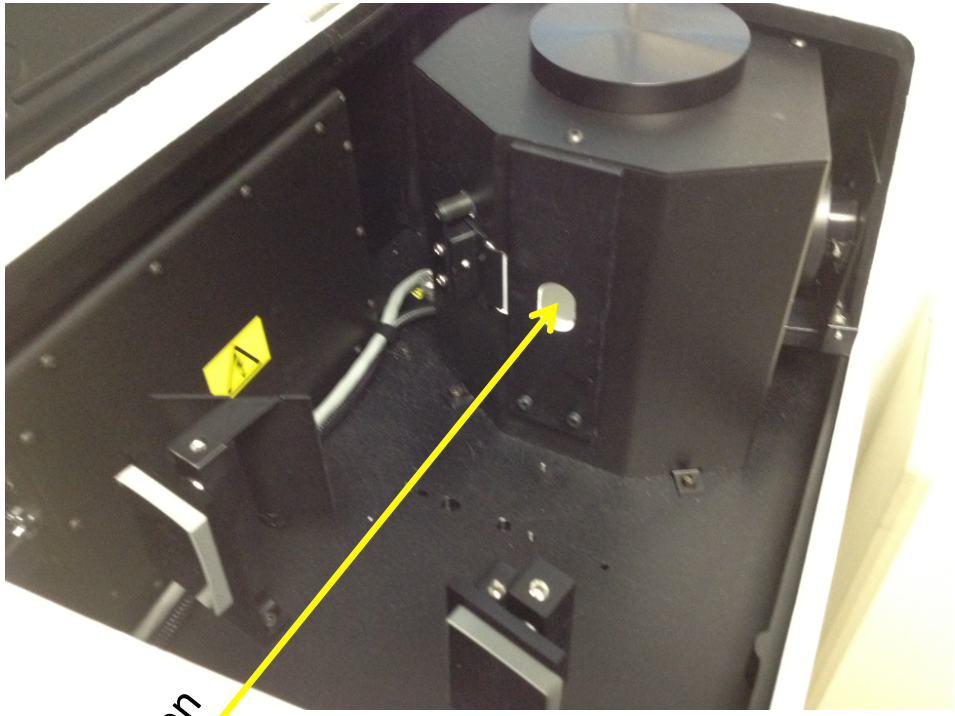
# Our brand new spectrophotometer

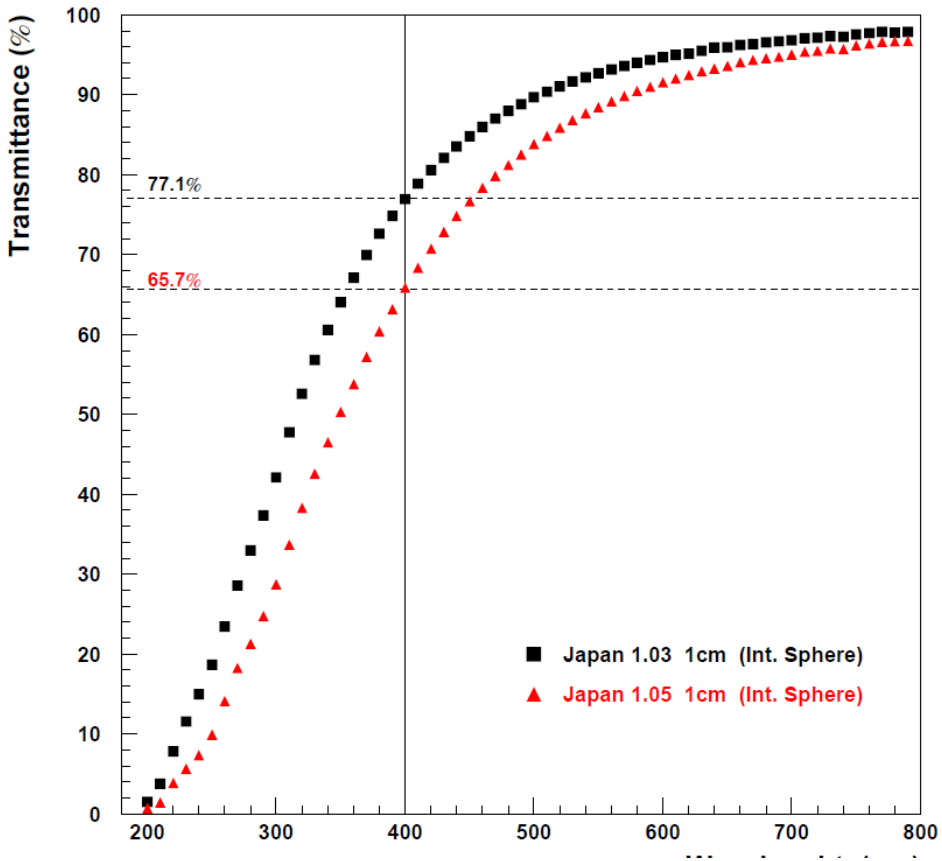
# The integrating sphere

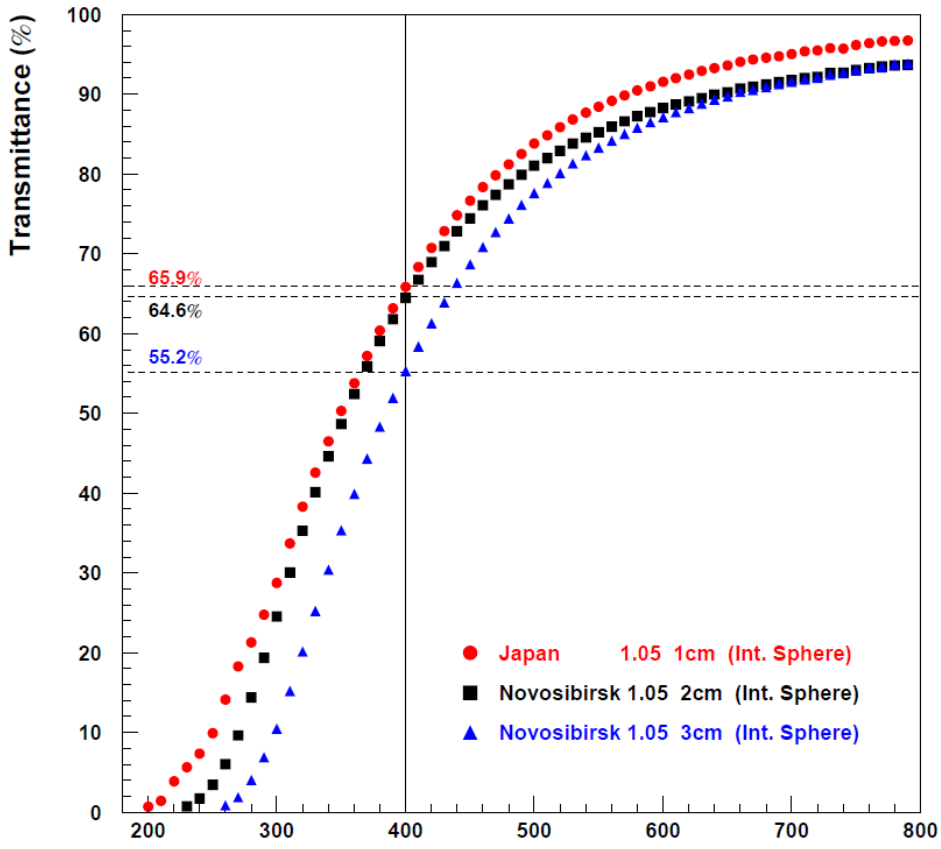



transmittance measurement



# The first measurements



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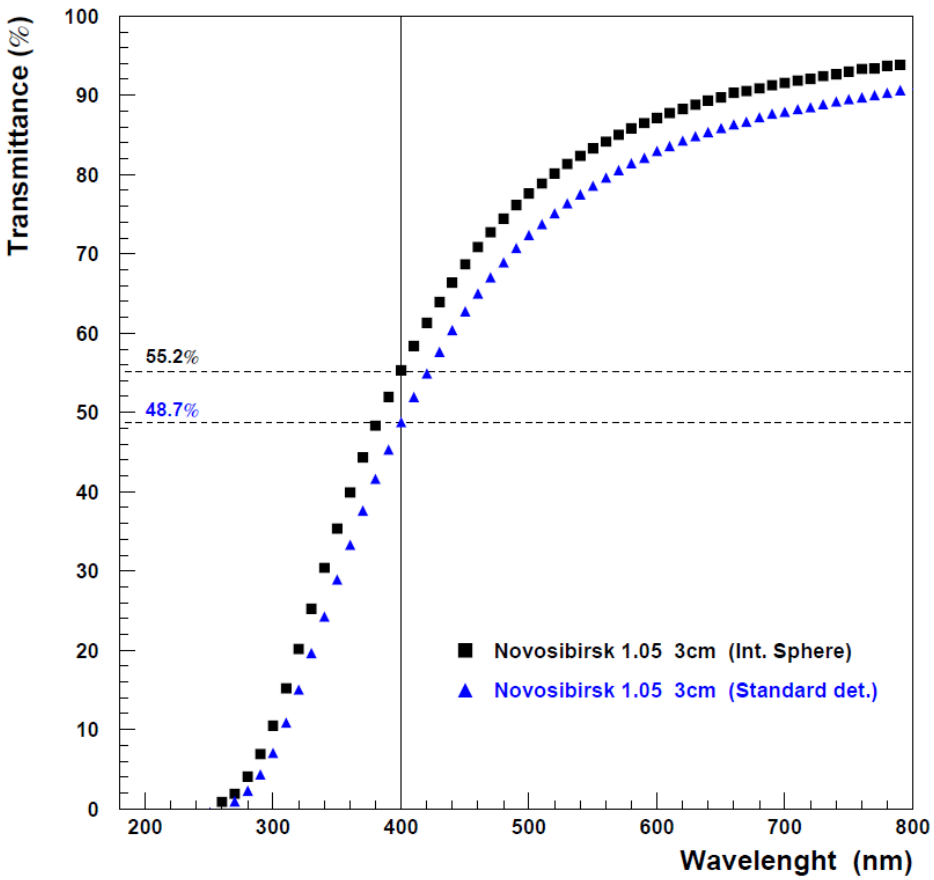
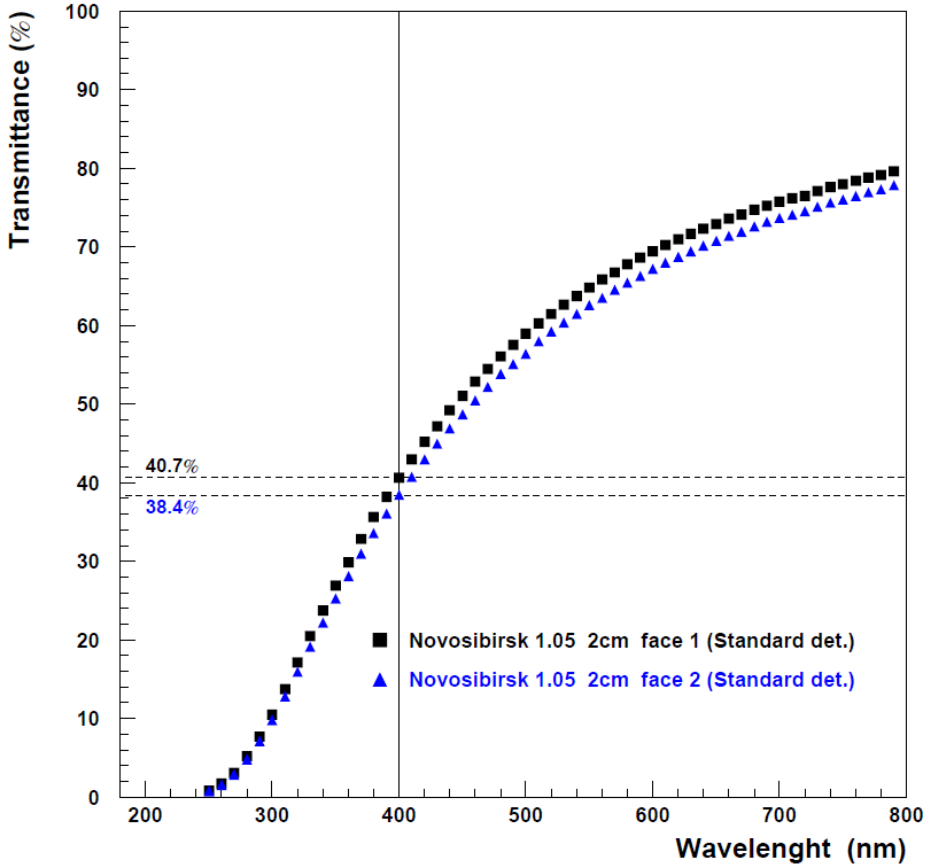
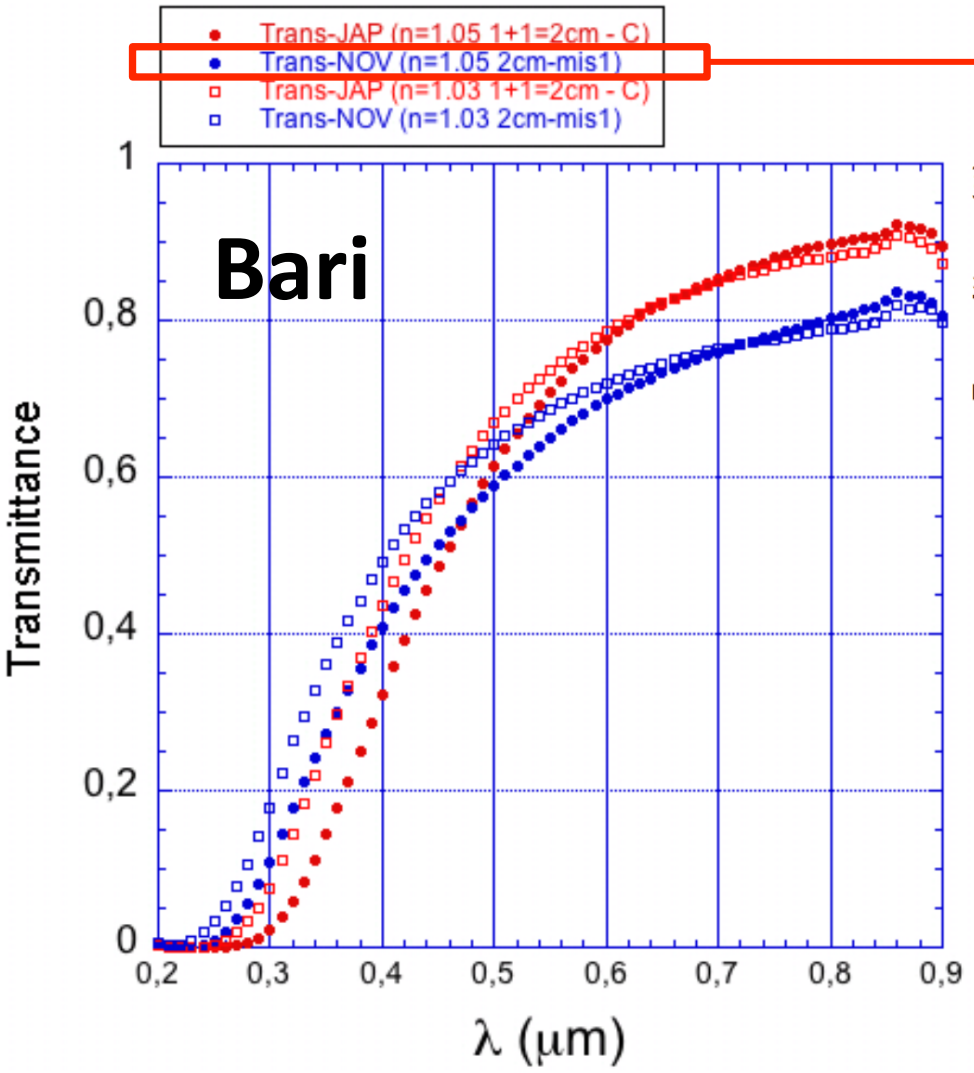
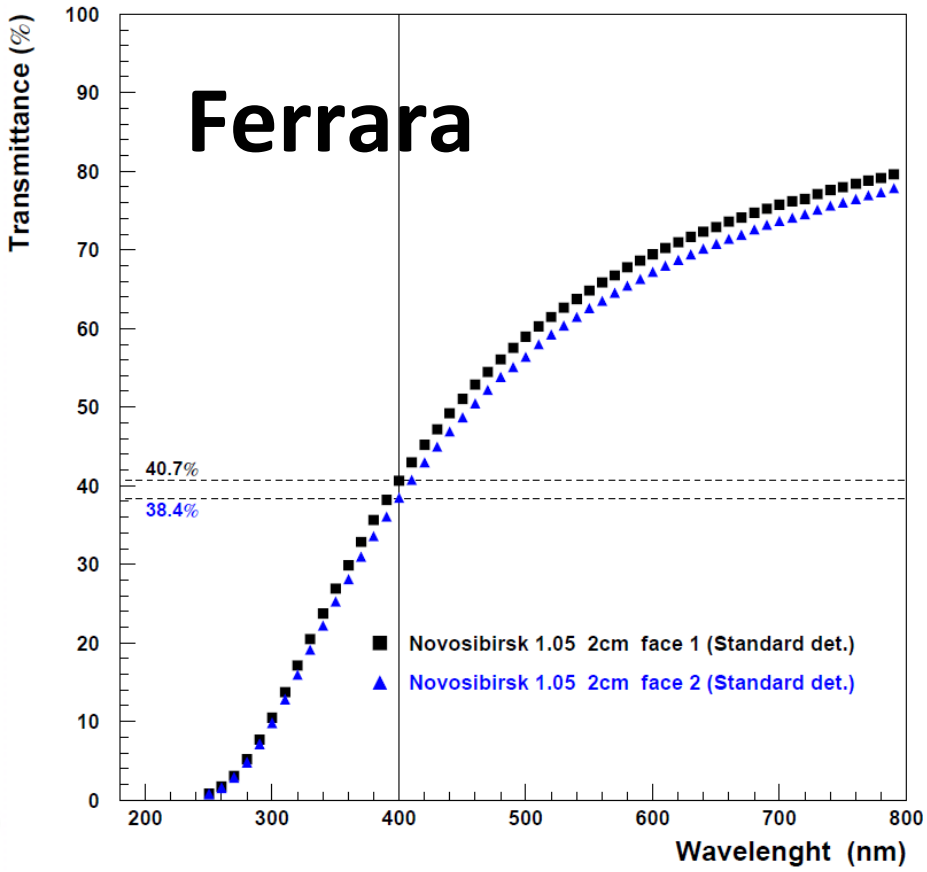


# Comparison with Bari measurements




The two measurements are consistent:

- T≈ 40% at λ=400 nm
- T≈ 80% at λ=800 nm

# Conclusions and outlook

Ferrara is developing skills and tools for the characterization of the optical properties of aerogel tiles for the CLAS12 RICH

- Very preliminary measurements of refractive index were performed with the standard prims method using red and green lasers
  - the procedure needs to be refined
  - the systematic uncertainties need to be evaluated and propagated
  - fits can be optimized
  - systematic studies are foreseen for different aerogel tiles (n, manufacture, etc)
  - a future use of a BLUE laser will allow for the extraction of the dispersion law

- A brand new high-performances spectrophotometer is being employed for transmittance measurements
  - preliminary results are in agreement with expectations and with previous measurements (Bari)