Status report on the optics optimization for the laser II project

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The new (and hopefully final) geometry of the beam-expander

Proposed geometry for the final beam-expander

No empty volumes between optical elements !

23 mm diameter PMMA cylinder

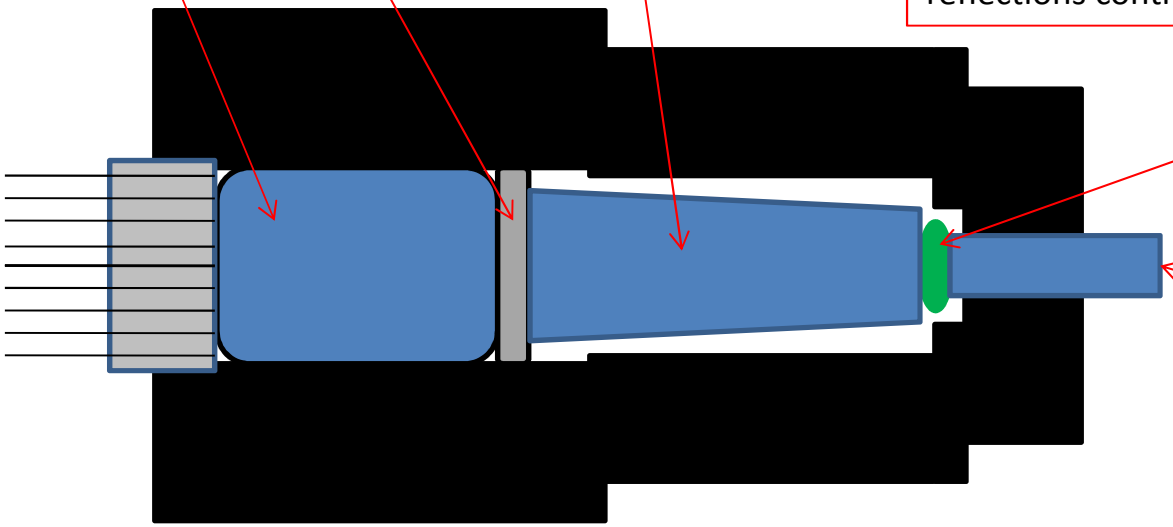
23 mm is minimum diameter to patch 400 fibers (1 mm diameter) in a circle

23 mm diameter diffuser

The exit and the entrance faces of the “tapered” PMMA were unpolished to restore the total number of unpolished surfaces after removal of all other diffusers.

12 to 20 mm diameter “tapered” PMMA cylinder

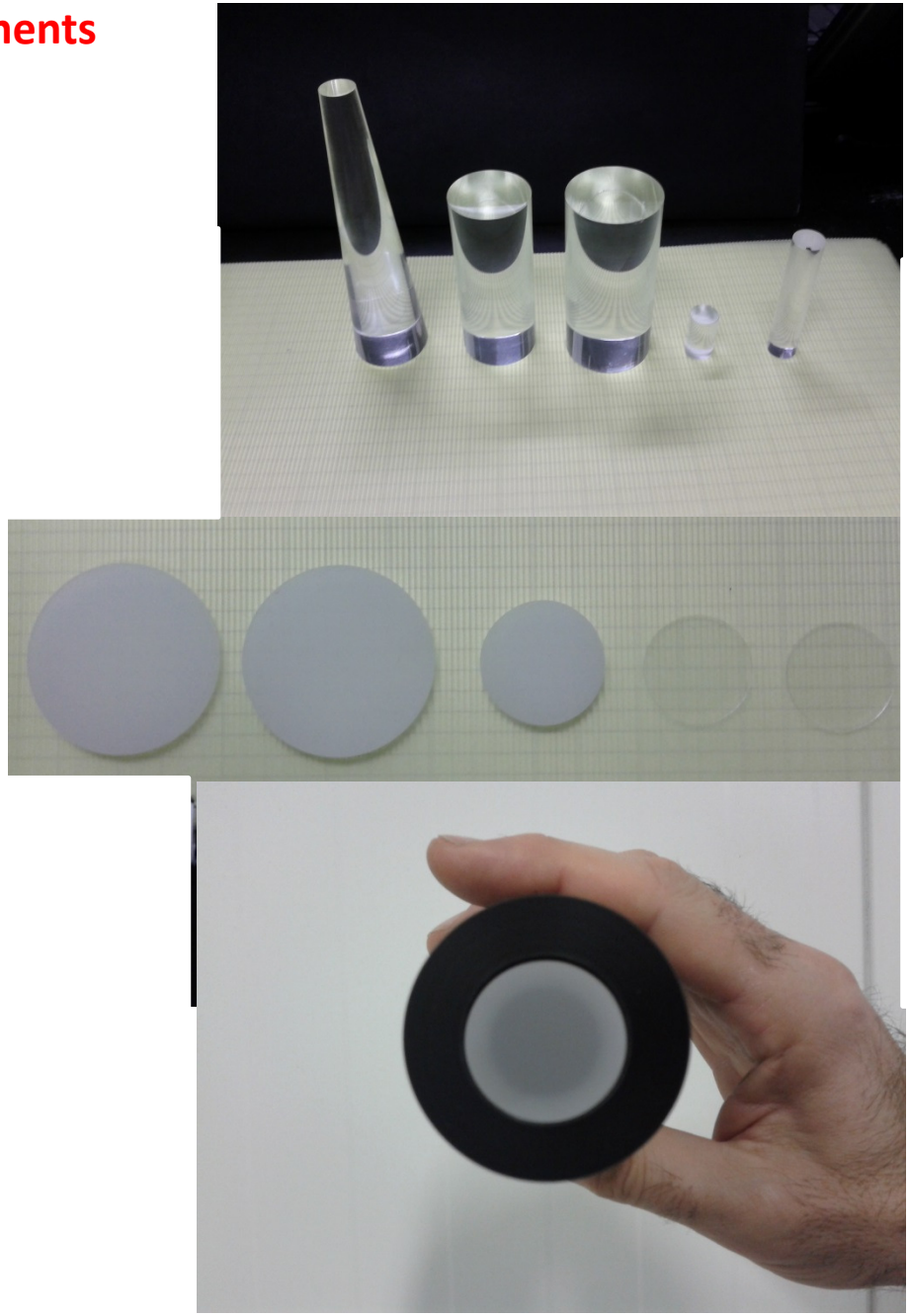
With a 6 mm focal length lens and 10 mm beam spot, the length of the “tapered” PMMA cylinder must be L > 9 mm; if L = 50 mm, about 5 internal reflections contribute to a better light mixing



12 mm diameter 6 mm focal length divergent lens

PMMA cylinder 10 mm diameter **Entrance face unpolished**

Photographs of the beam-expander elements



New beam-expander main performances

Uniformity response from angular scan of the border region (extreme points on the fiber bundle diameter) at the output PMMA still about 1% (same as before)

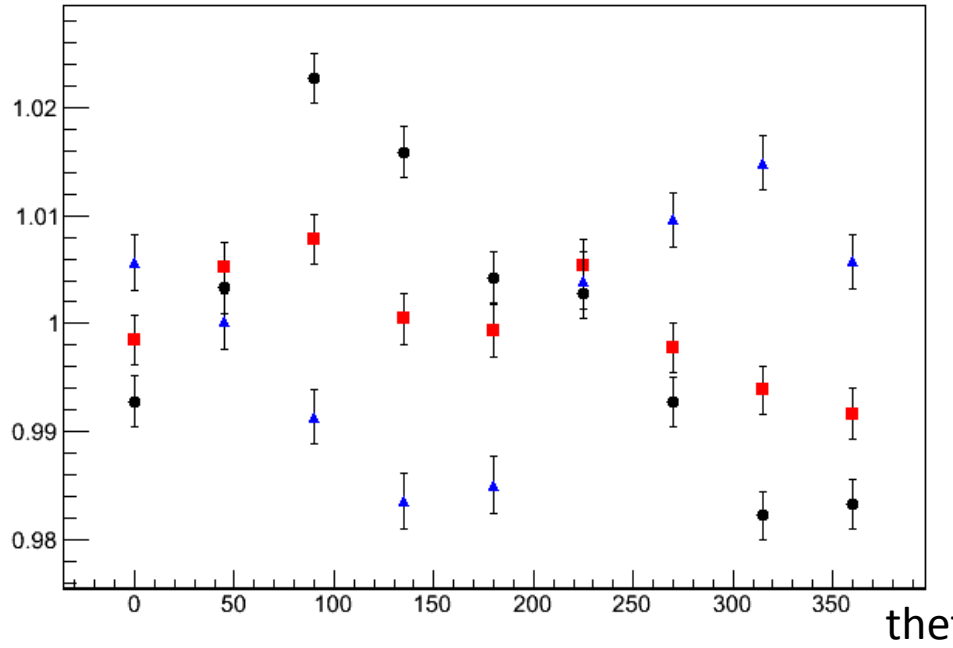
--- > More accurate surface scan still to be done

Big gain, a factor 5, in the transmitted light with the tapered internal light-guide

Verified that the uniformity response depends on the number of unpolished surfaces in the optical path

Very good stability of the monitor system (PMT1/D1, PMT2/D2 stability below 0.5%)

….. but it was discovered a new issue with the transmission uniformity as a function of the laser entry point in the beam-expander



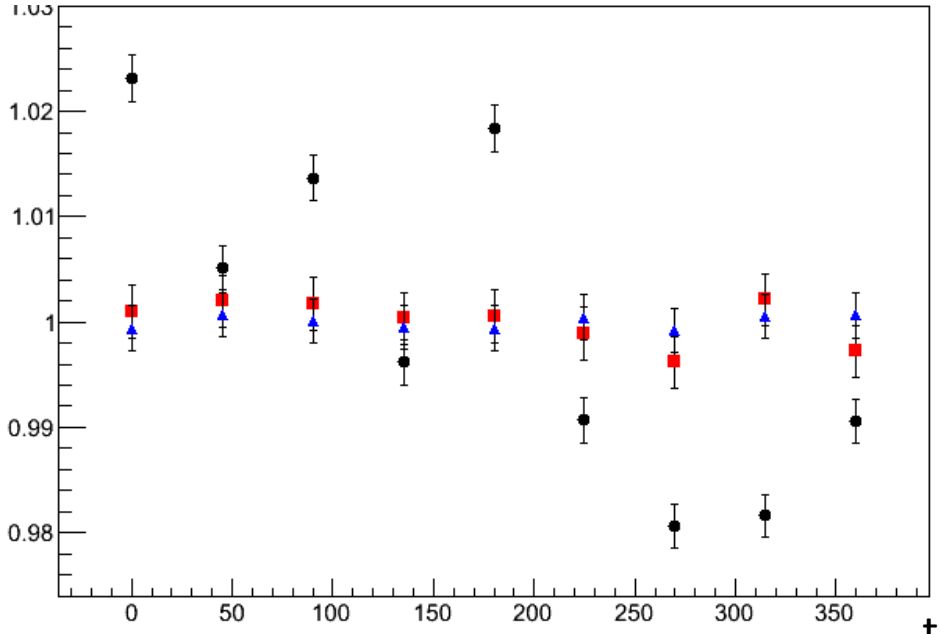
Uniformity response
(laser beam on the expander axis)

Black : D2 normalized to D1 : RMS 1.5%

Blue: D4 normalized to D1: RMS: 1.3%

Red: D3 normalized to D1 : RMS: 0.3%
(center of fiber bundle < --- > expander axis)

Run 3547, default geometry
Low laser intensity (16K)
Filter wheel at 0.3% transmission



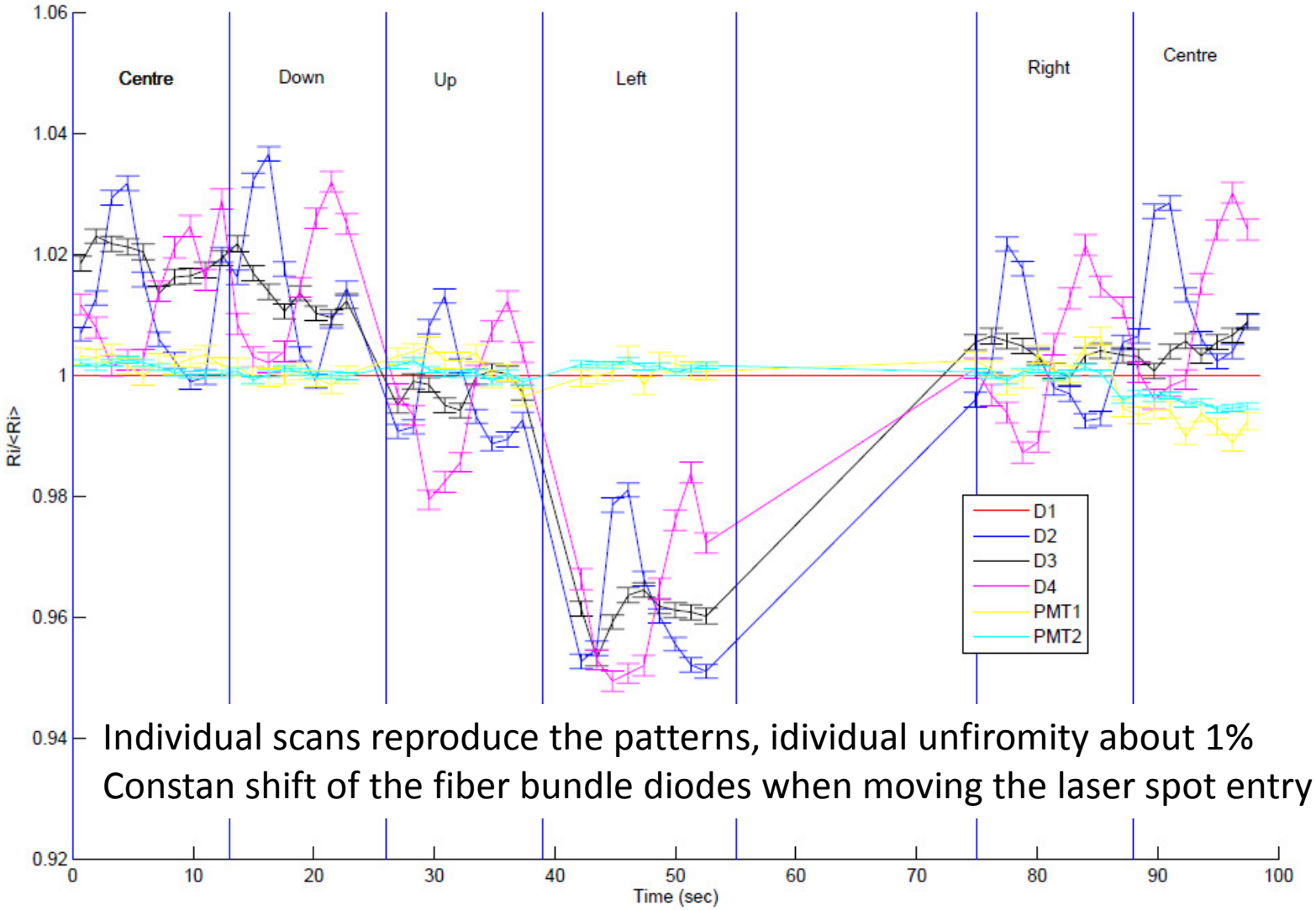
Monitor stability

Black: D1 normalized to its mean over 9 points
(laser intensity fluctuation in 30': 2%)

Blue: PMT1 normalized to D1: RMS: 0.2%

Red: PMT2 nromalized to D1 : RMS: 0.3%

Beam pointing effects (1)



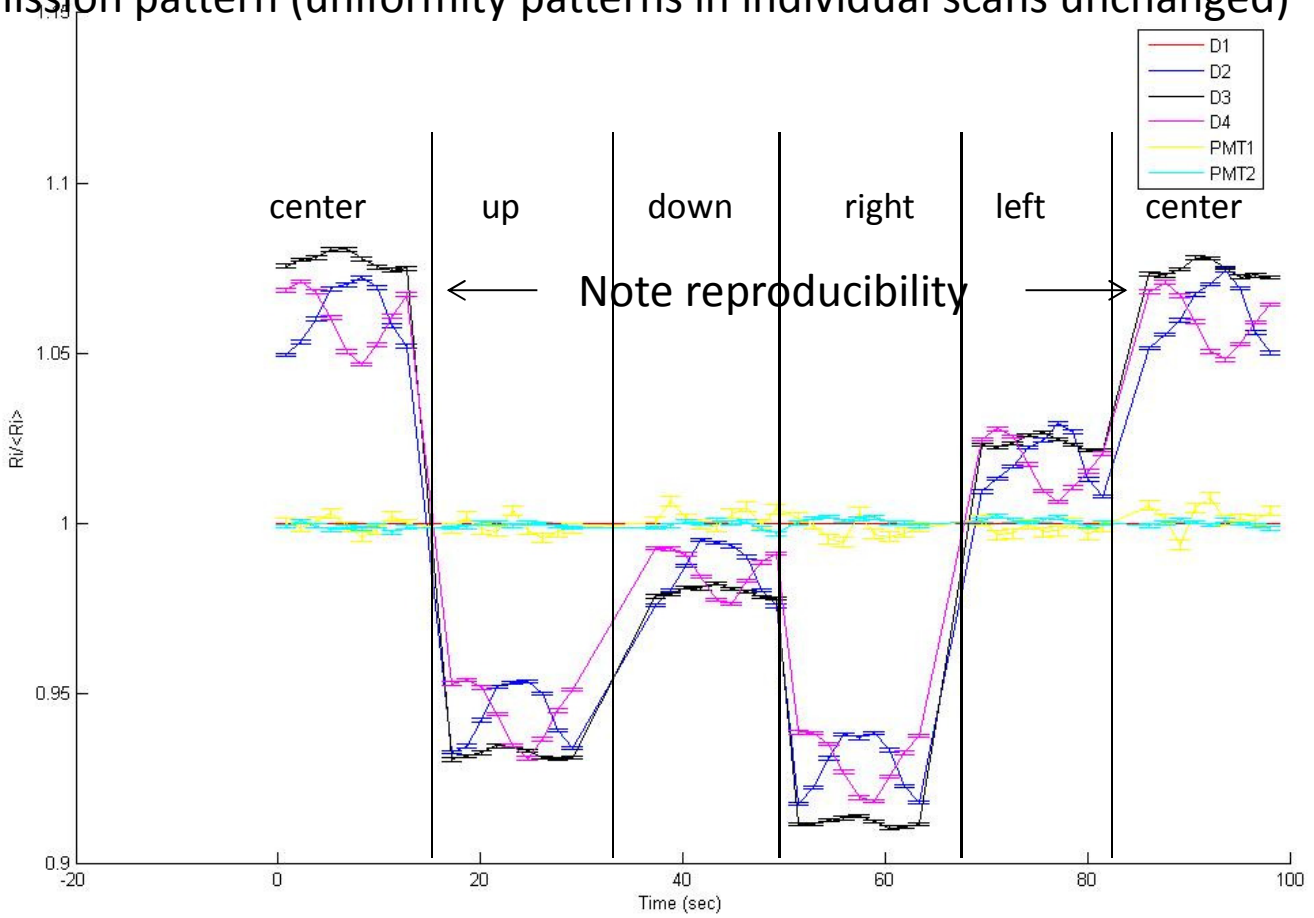
Individual scans reproduce the patterns, idividual unfiromity about 1%

Constan shift of the fiber bundle diodes when moving the laser spot entry point

Displacements of the laser beam entry point up/down - left/right of 1 mm

Beam pointing effects (2)

The beam entry point in the first (upolished) face of the entry light-guide determines the overall transmission factor; when rotating by 180° only the entry light-guide (all remaining parts of the expander unchanged), left-right and up-down swap in the transmission pattern (uniformity patterns in individual scans unchanged)



Summary remarks:

Uniformity patterns at the exit not affected by the beam-pointing

Intensity change up to 4%, common to all diodes reading out the fiber bundle

This effect seems to be only, or mainly, determined by the quality of the unpolishing of the first surface

If the only effect of beam pointing fluctuations is a uniform (w.r.t the bundle fiber position) variation in the transmiited light, this can be mitigated by using some output fiber signals as a reference.

What observed now is compatible with what measured by Nino on the calibration data: individual cell full correlation (uniformity in the distributed light), but fluctuations of the average transmitted light w.r.t. to the monitors.

Conclusions and work plan

Many progresses done, but still to be demonstraed that the laser pointing effects can be controlled/mitigated.

A complete surface scan of the output PMMA still to be systematically done.

Laser intensity scans should be considered to apply the calibration methods normally used with the detector data also with the bld. 175 test data

Very unlikely that the test program will be completed before the system moves to Clermont-Ferrand. How to proceed?
Exploit the laser facilities in the Atlas-Pisa lab?

When the laser system will be back (September ?), long term stability test must be scheduled; also test of full chain including long fibers, drawer expander and single module read-out should be performed with the arrangement in 175 before installation …