Report on the Pisa activities in the laser II project

S. Leone, F. Scuri – INFN Pisa

ATLAS-Pisa meeting, April 12, 2013

The working group:

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A. Maio – L.I.P. Lisboa

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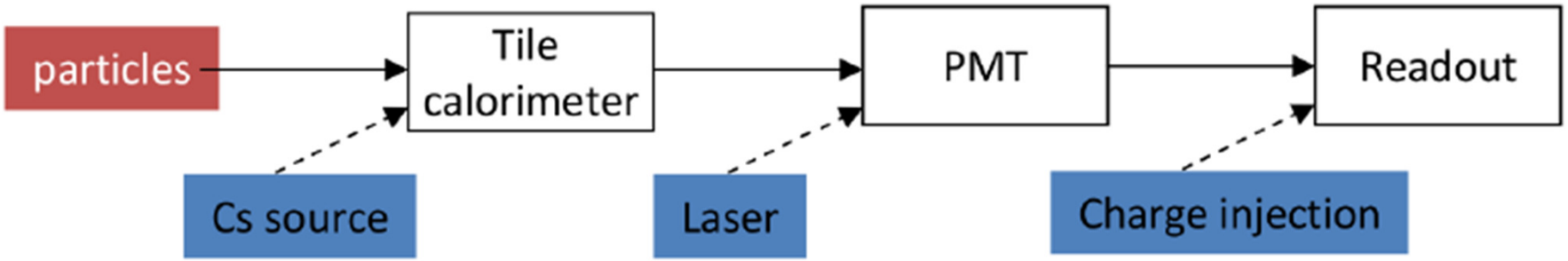
Outline

- Sistemi calibrazione di TileCal
- Caratteristiche di stabilità attuali
- Goal per la ripresa di LHC nel 2015
- Modifiche al sistema attuale di calibrazione laser col progetto LASER II
- Primi risultati di test del prototipo
- Contributi del gruppo di Pisa

Calibration Systems Overview



Three calibration systems:

- Cesium: Keep cell response at EM scale *Taken monthly*
- Laser: Monitor PMT gain and timing of individual channels

3 times/week + Empty bunch crossings (1Hz)

- Charge Injection: Monitor electronics stability, ADC to pC *3 times/week*

Calibration strategy: Use the laser to tune channels that drift more than a few % in between monthly Cs runs

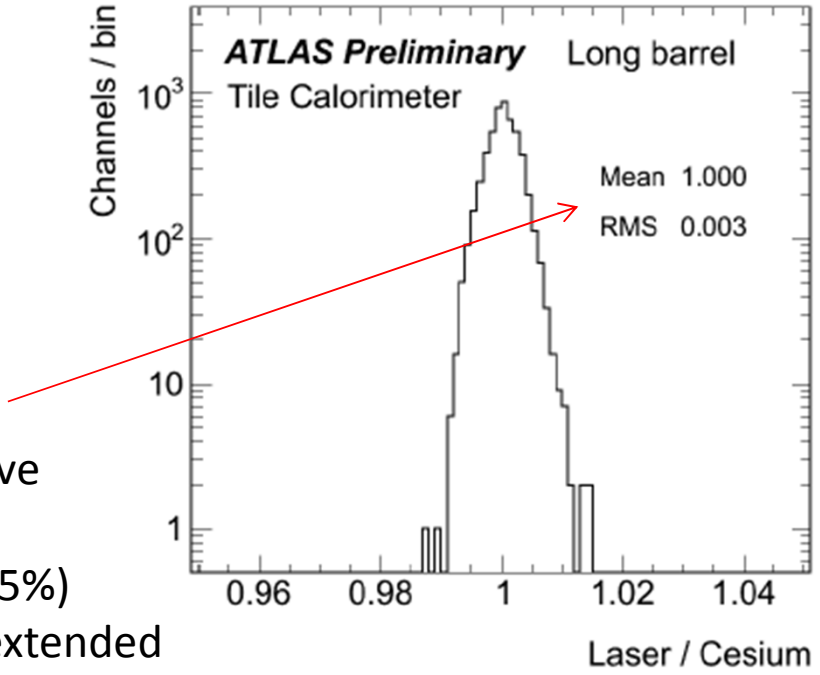
Stabilità della risposta dei sistemi di calibrazione

La stabilità di risposta della calibrazione con la sorgente Cs è al 0.3%

La stabiltà di risposta della calibrazione Laser è dell'ordine dell' 1%

Perfetto accordo tra il sistema laser e quello con la sorgente nelle celle meno attive

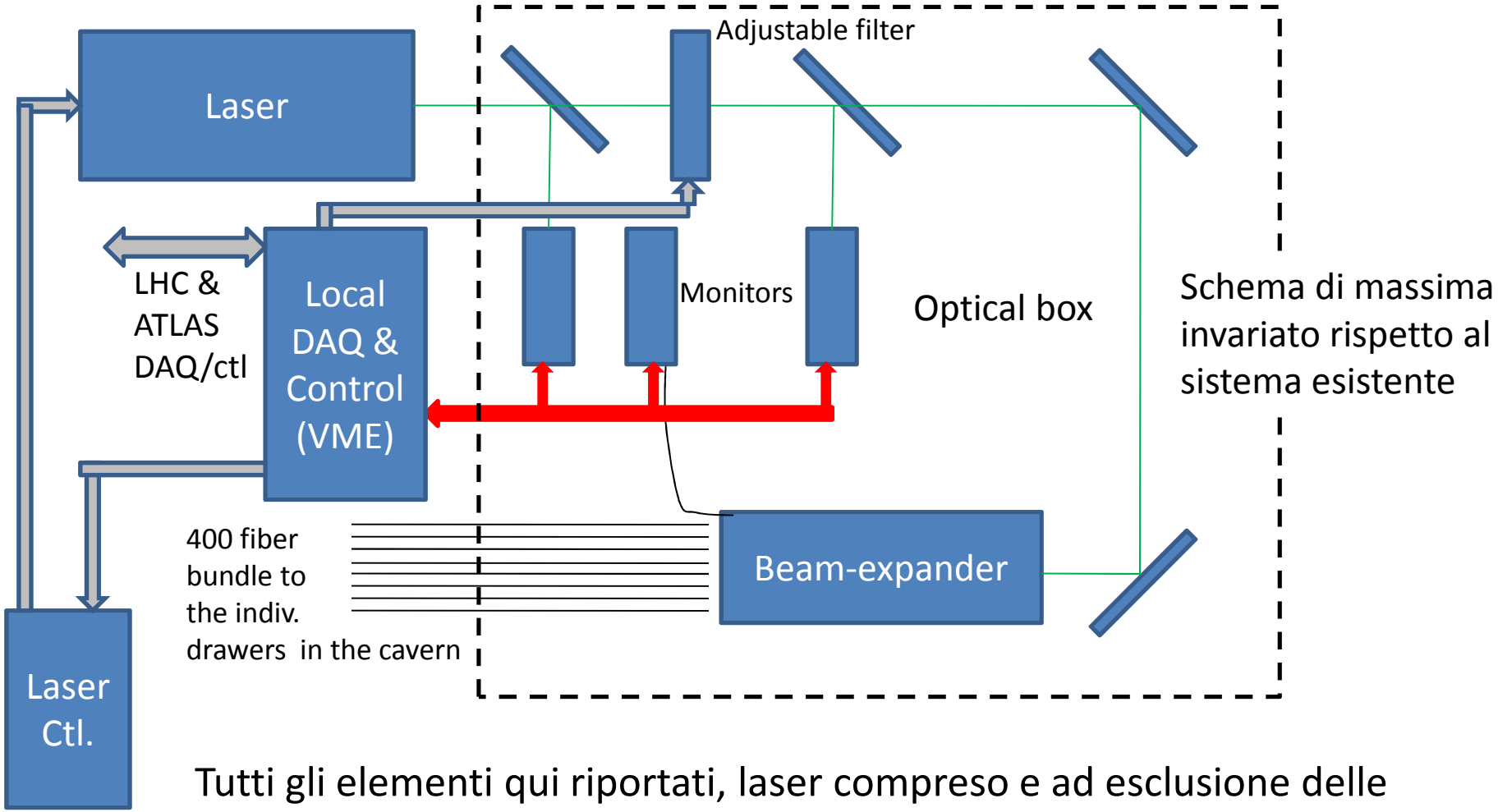
I drift nella calibrazione osservati (fino a -3.5%) nelle regioni più calde di TileCal (A13/A14 extended barrel, E1->E4 gap/crack special modules) sono ascritti al drift in guadagno dei PMT



Goal: tenere uniforme la risposta alla scala EM di ogni singola cella in periodi dell'ordine di qualche giorno (frequenza della calibrrazione laser)

Metodo: portare la stabilità di risposta della calibrazione laser a livello < 0.5 % (very difficult !)

Gli elementi principali del sistema di calibrazione laser



Tutti gli elementi qui riportati, laser compreso e ad esclusione delle 400 fibre, verrano cambiati/aggiornati nella versione LASER II

IL PROGETTO LASER II PER IL CALORIMETRO TILECAL DI ATLAS

- <u>Migliorie in corso d'opera rispetto al sistema esistente</u>:

• Nuova elettronica di controllo per essere compatibili con il nuovo protocollo di comunicazione con LHC e con la nuova distribuzione dei segnali di controllo del rivelatore	Univ. Clermont-Ferrand
• Nuovo disegno del sistema di monitoring (splitter, mixer, filtri e fotodiodi) della trasmissione e distribuzione della luce laser dalla sorgente ai singoli drawers (fino a 48 canali di read-out)	INFN – Sezione di Pisa Univ. Clermont-Ferrand
• Nuovo disegno dell'ottica di rinvio ed espansione del fascio laser nella "optical box" collocata in superficie a valle del laser.	INFN – Sezione di Pisa Univ. Coimbra
• F. Scuri coordina il programma di test dei nuovi elementi via via disponibili nella replica del sistema laser completo allestito nel buiding 175 e del programma dei test di stabilità a lungo termine (dead-line Aprile 2014, installazione completata del nuovo sistema Laser II)	CERN INFN – Sezione di Pisa Univ. Clermont-Ferrand Univ. Coimbra

People, work organization, methods and goals for designing the optical system

- New people (Alberto, Fabrizio, Marco, Sandra) have recently joined the working group which is now largely renewed w.r.t. to the past years.

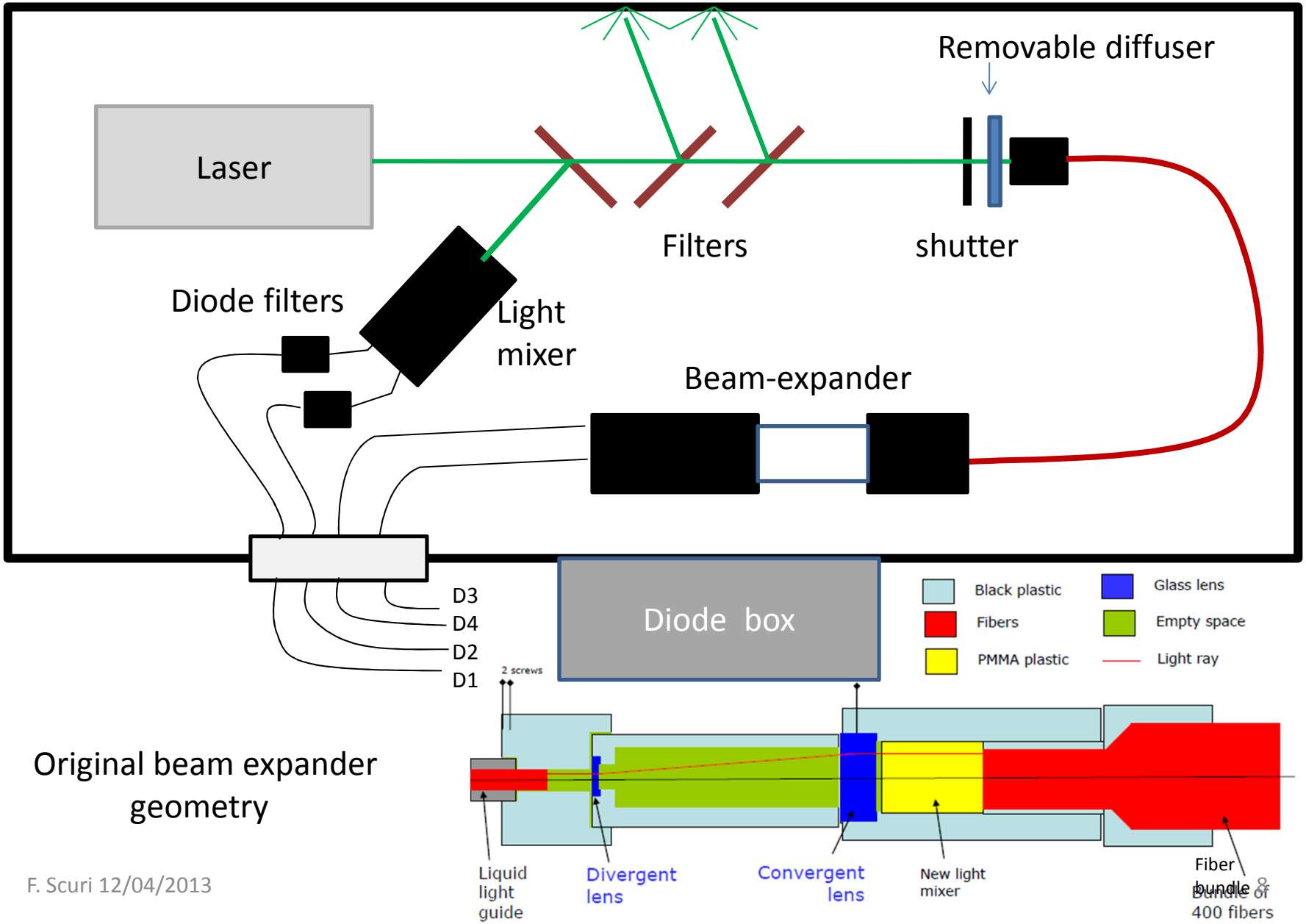
- In the first (present) phase methods and characterization of individual elements are mainly performed by using the system replica available in building 175.

- Work is organized in weekly sessions of intensive tests in bld. 175 followed by longer periods for data reduction and analysis; results are used to determine the priorities for the next session tests.

- Specific tests are performed to improve and to qualify:
  - the long term (months) performances of the monitors;
  - the overall uniformity of the light transmission of each optical element;
  - the geometrical limits in "squeezing" the optical arrangement to fit inside the available space in USA-15;

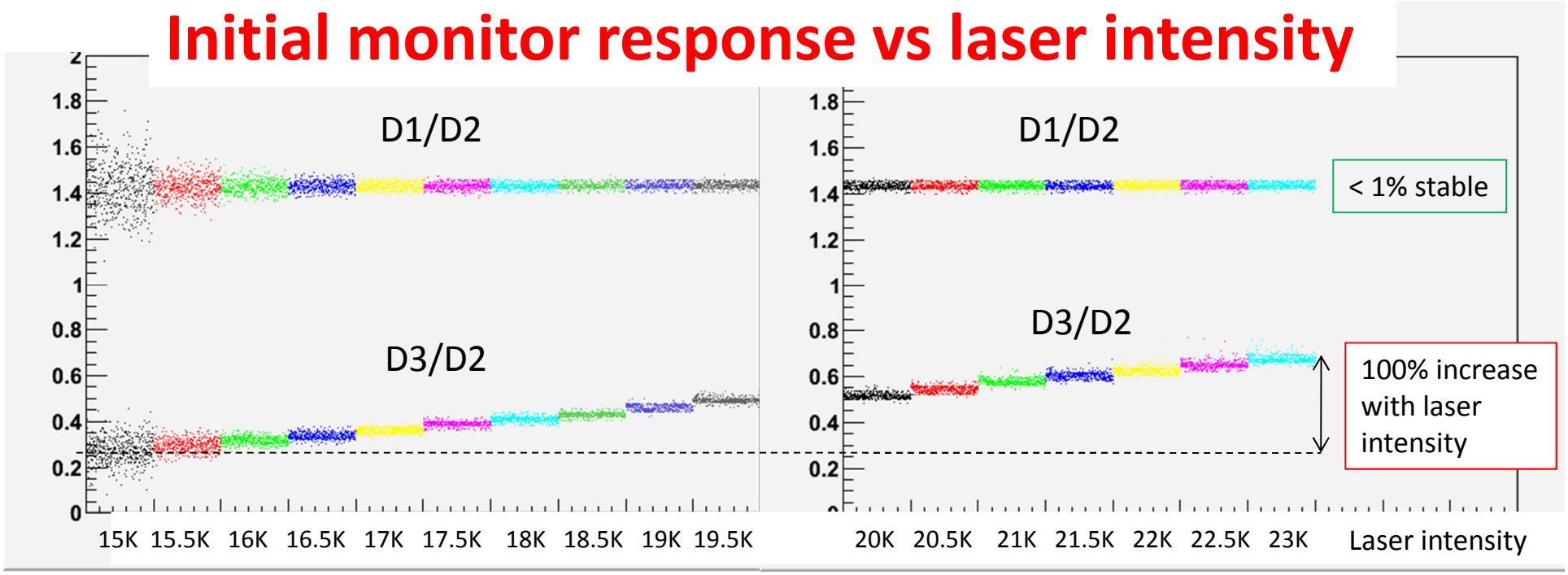
- Goals are:
  - < 1% long term stability of the monitor response;
  - O(1%) uniformity at the beam-expander exit and its robustness against effects from beam-pointing stability (laser intrinsic or generated from other optical elements);
  - Overall system robustness (reproducibility) against any required intervention.

Original arrangement: poor light mixing, sensitive to laser pointing



Original beam expander geometry

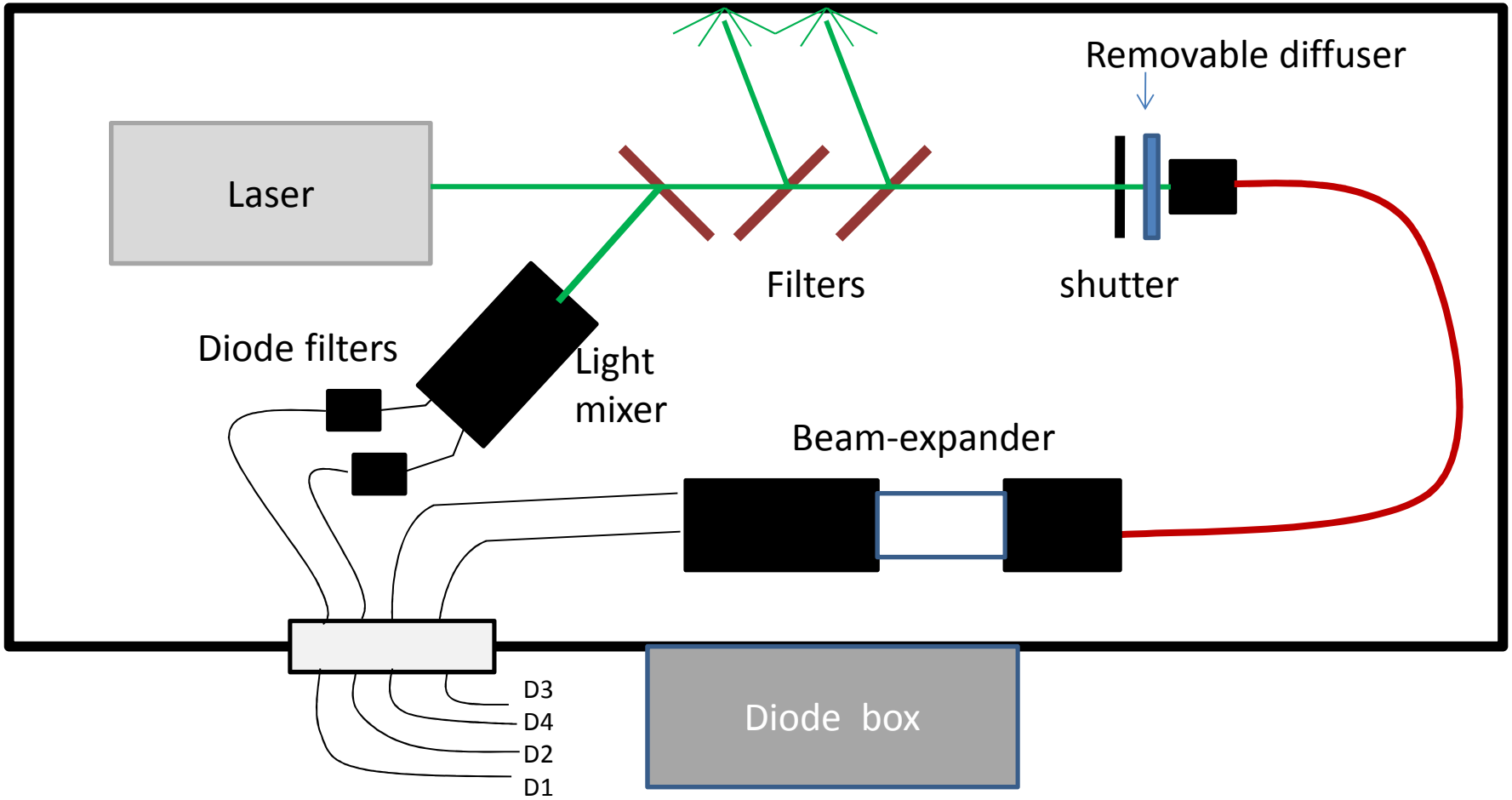
Initial monitor response vs laser intensity



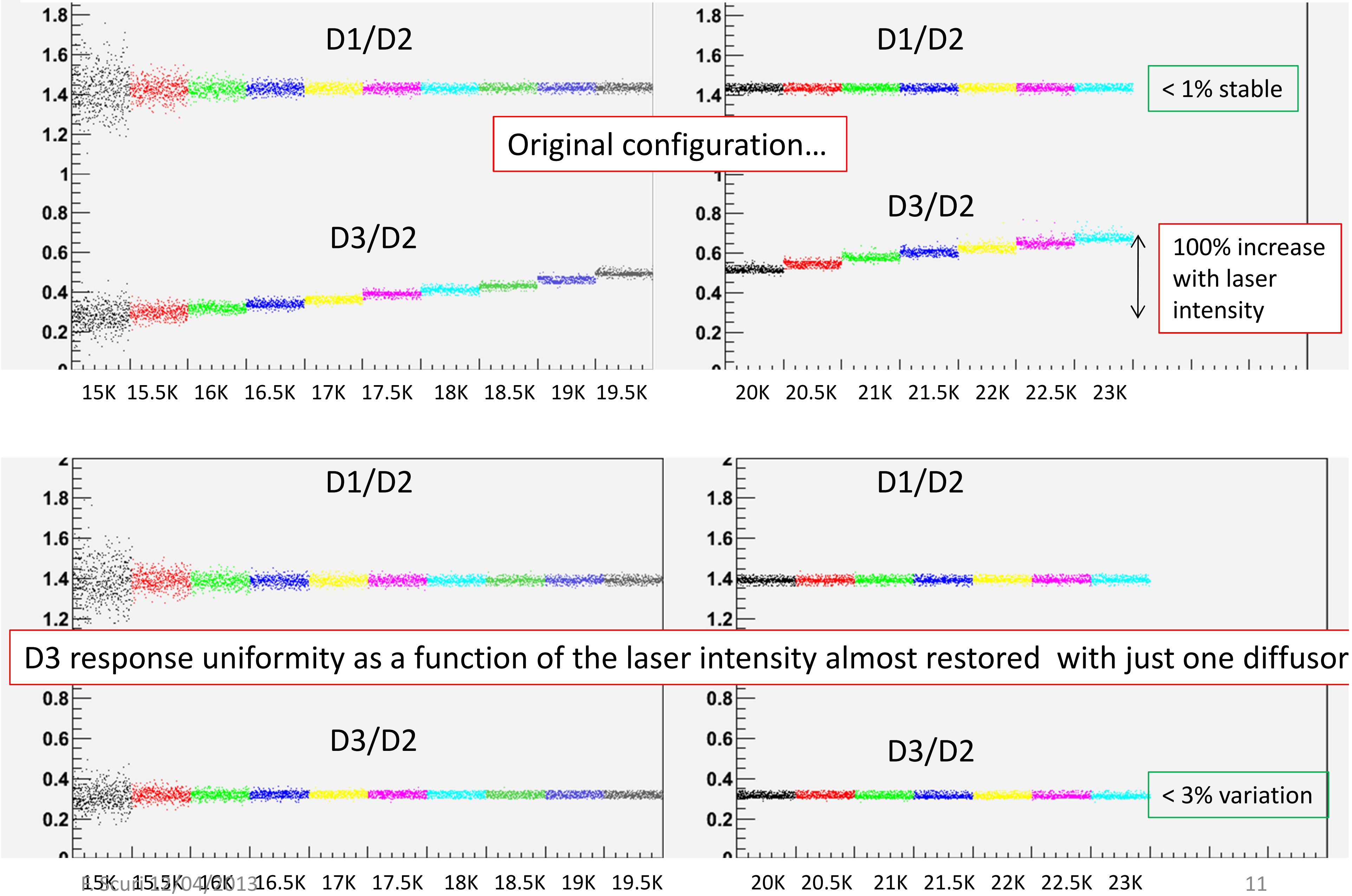
D1 and D2 are monitors of the beam intensity exiting the laser

D3 is diode coupled to the fiber in the exit bundle placed on the system axis

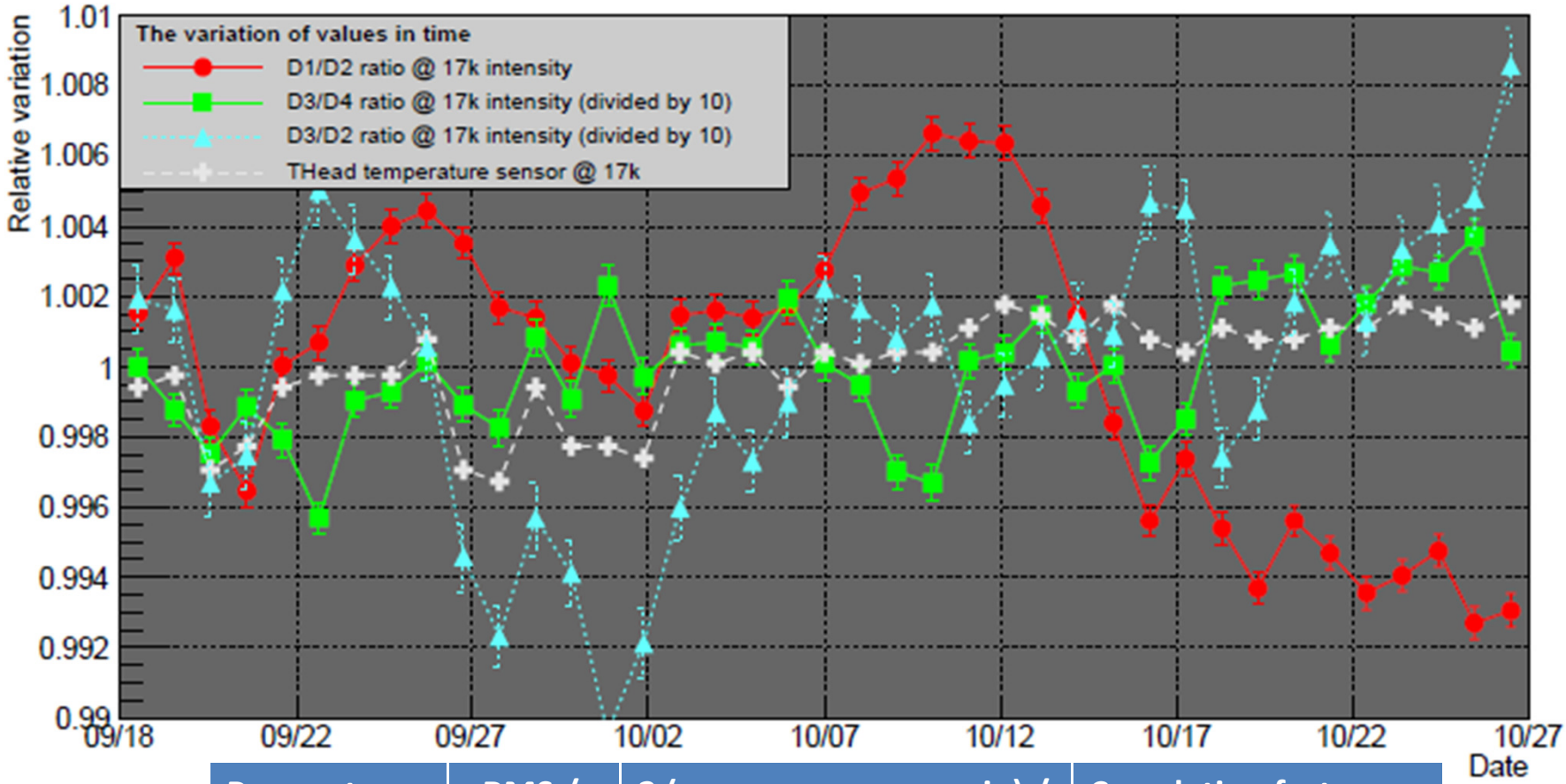
First small modification proposed by Pisa: light diffusion !



Monitor response vs laser intensity with light mixing



Long term stability tests (Sept.-Nov., 2012



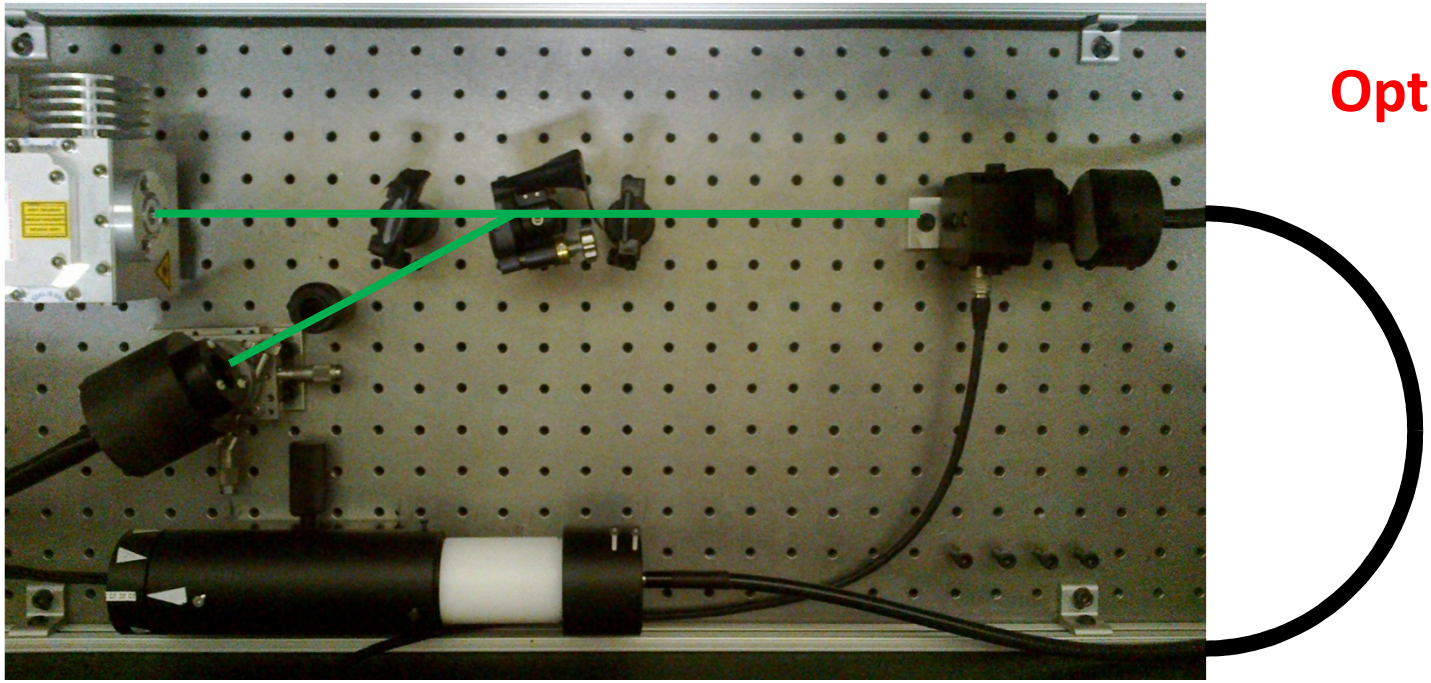
D4 measures the light transmitted at the beam expander boundary

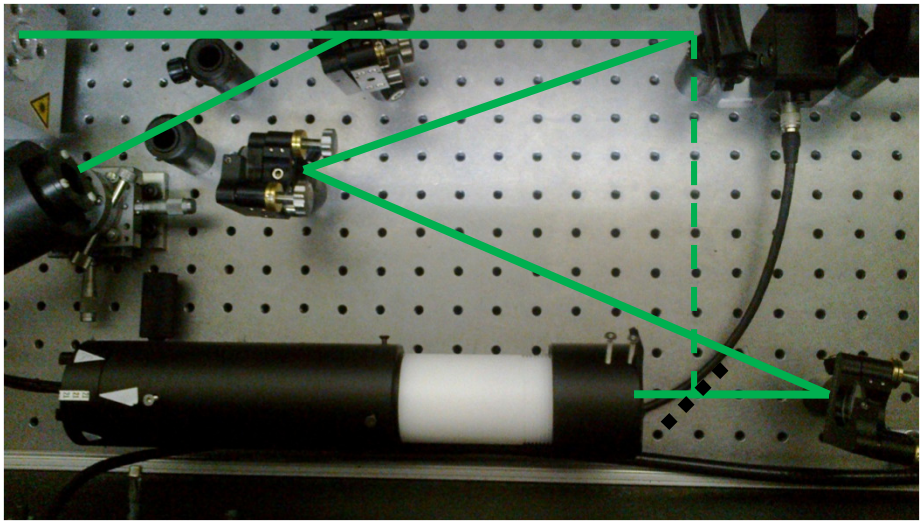
Parameter	RMS / average	2 (par_max – parm_min) / (par_max + par_min)	Correlation factor with l. head temp.
D1/D2	0.4%	1.4%	0.17
D3/D2	4.0%	19%	0.68
D4/D3	1.8%	8%	0.34
Laser head T	0.2%	0.5%	-------

Optics test/optimization in bld. 175 in the period Jan.-May, 2013

- Reproducibility tests : system dismounted and re-mounted in different configurations many times; stability and uniformity responses always within 1%. ✓
- Optical path optimized to shrink the optical box to fit in a rack in USA15. ✓
- Beam expander: improved design and tests. ✓
- Light loss measurements. ✓
- Beam-expander uniformity response — In progress, completion by summer 2013
- Beam-expander final design: prototype test — In progress, completion by mid-May 2013

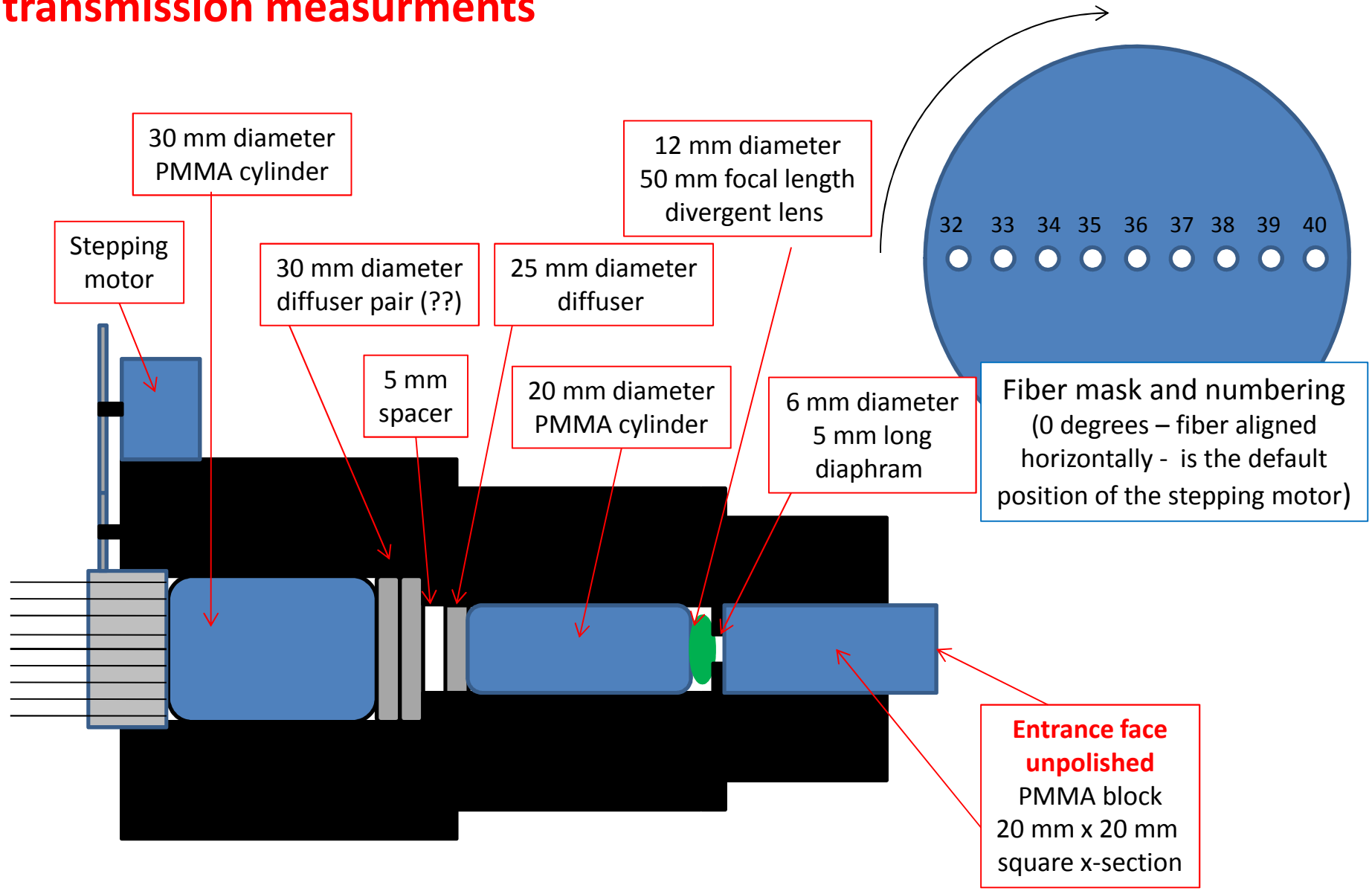
Optical paths



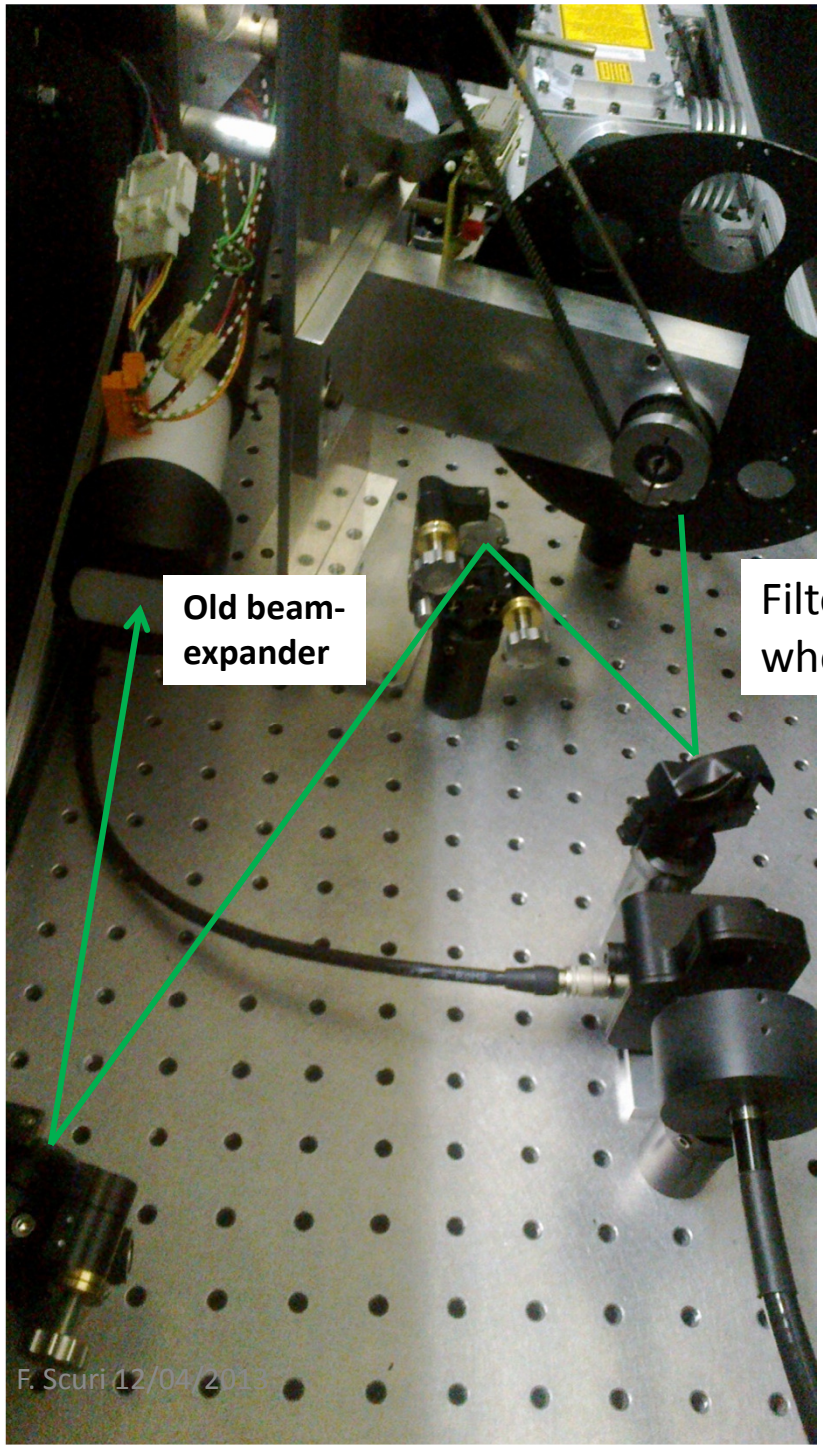


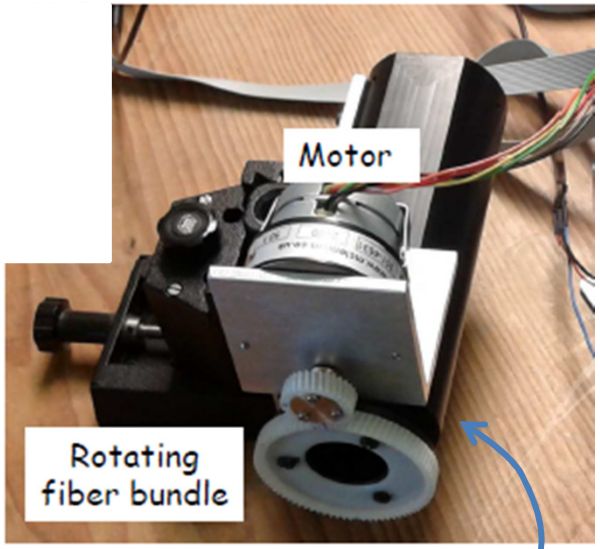
Without the liquid fiber a lot of space can be gained, very important for the final arrangement in UA15 if planning to shrink all pieces in one box on in the rack

Beam expander configuration used for uniformity test and transmission measurments



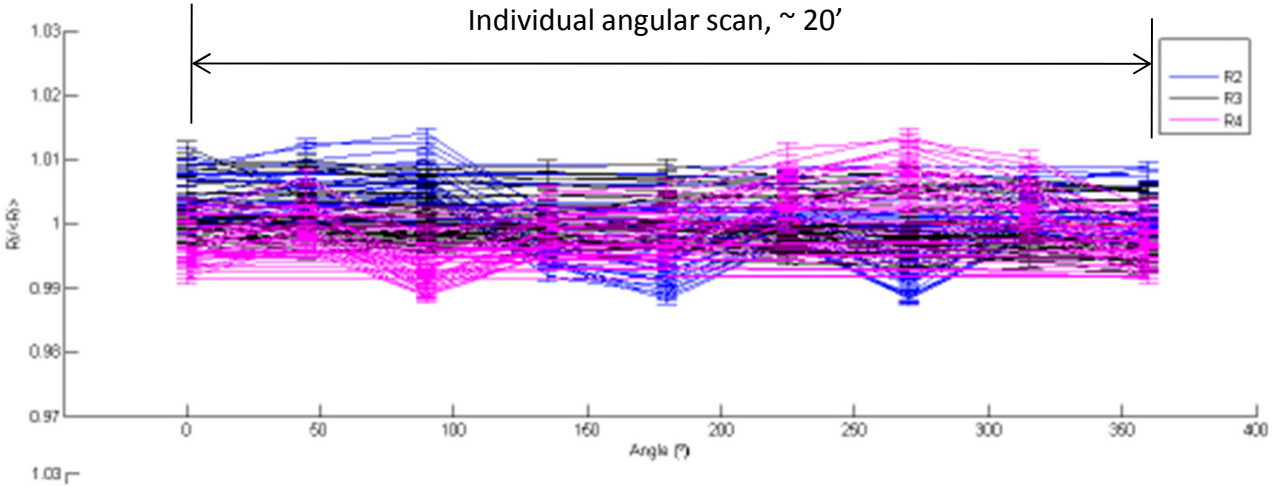
Mechanics for the optical set-up

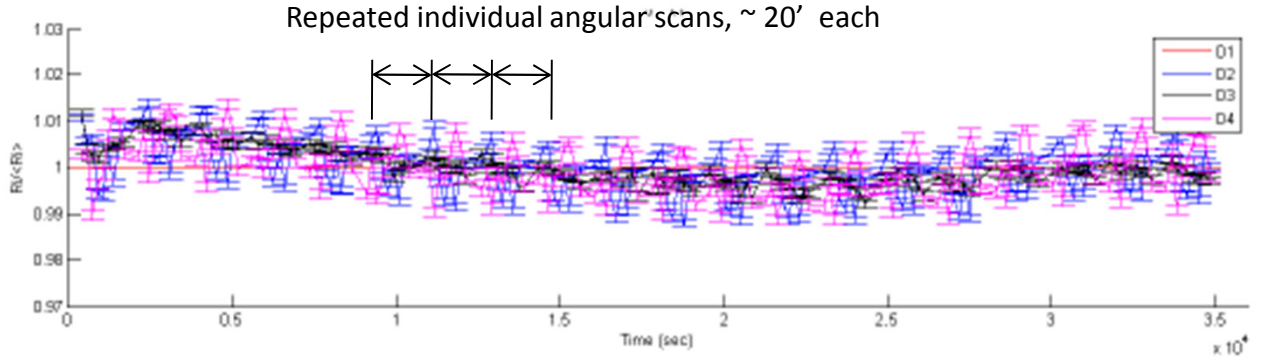




9 positions along the diameter

Last results on uniformity and stability of light transmitted by the beam-expander





$R_i = D_i / D_1$

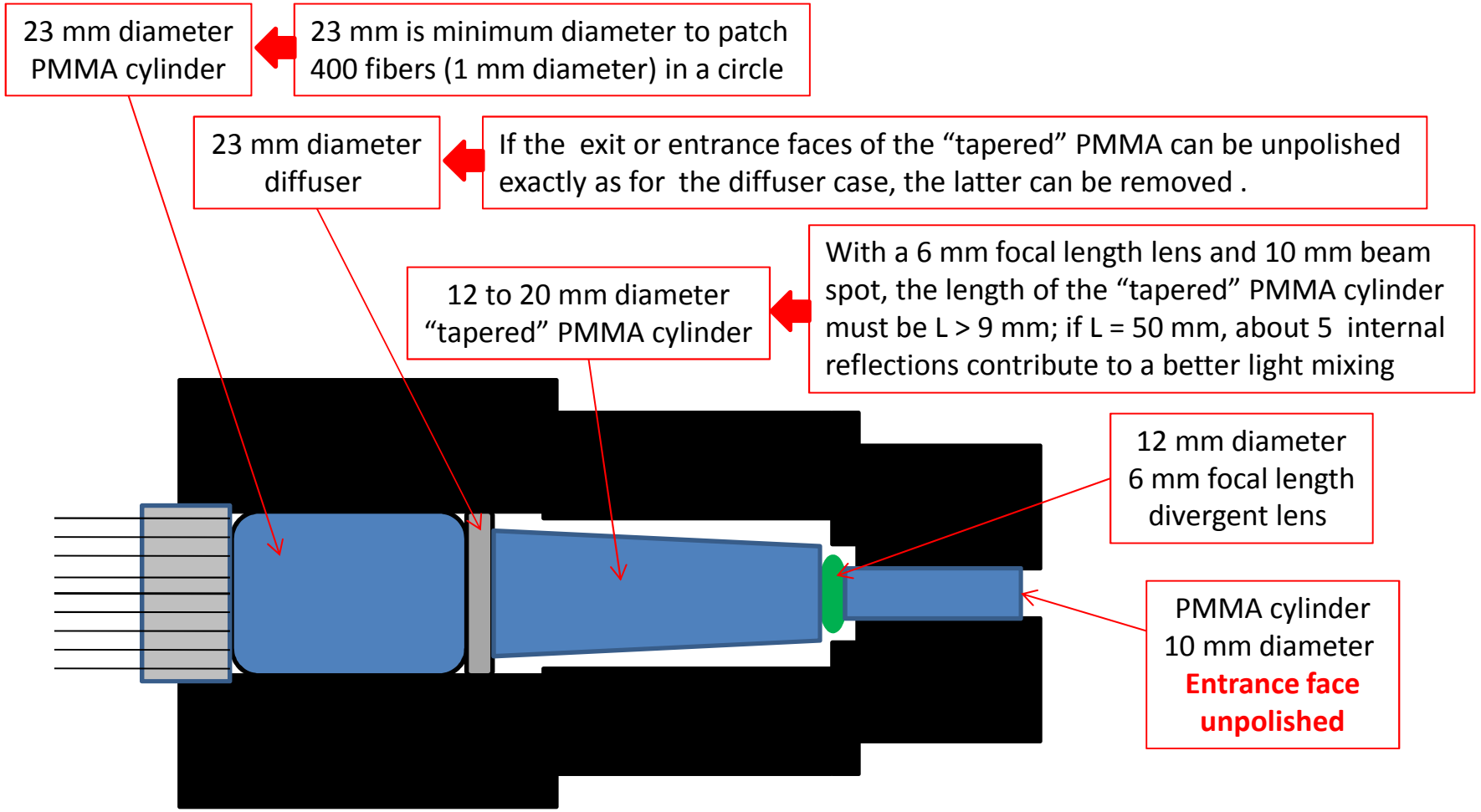
D_1 is the laser int. monitor
D_3 reads-out the fiber on the axis of the expander
D_2, D_4 read out the fibers on the diameter extremes of the bundle.

Deviation from the average value on the full interval (10 hours)

Maximum deviations <= 1%

Proposed geometry (Pisa) for the final beam-expander

No empty volumes between optical elements ! Too much light lost on the walls at present …



Design finalized and production already started in Coimbra

PRIMI RISULTATI CON IL PROTOTIPO LASER II NELLA SALA 175

	Sistema laser usato fino allo shut-down	prototipo LASER II
Stabilità elettronica di Front-End per lettura di fotodiodi e PMT di monitor	0.3 %	0.1%
Stabilità monitor prima del beam-exp. breve termine (8 ore)	0.5%	0.2 %
Stabilità monitor prima del beam-exp. lungo termine (4 mesi)	2 %	1 %
Stabilità monitor in uscita al beam-exp. breve termine (8 ore)	1 %	0.3 %
Stabilità monitor in uscita al beam-exp. lungo termine (4 mesi)	1 %	N/A
Uniformità mixing del beam expander*)	5 %	1%

*) Miglioria fondamentale per correggere il drift in stabilità dei monitor dovuto al variare, in funzione della temperatura della testa del laser, dell'intensità del fascio, della caratteristica di beam-pointing stability .

Short and medium term program (Sandra, Fabrizio)

Short term:

-Test the final geometry beam-expander (mid-May).
- Make an accurate surface scan of the exit surface of the beam-expander
  (difficult to do by mid-May, system in 175 will move to C-F for electronics upgrade,
  most likely we will do it in the Atlas-Pisa lab).
- Order mechanical parts (45° mirrors, optical holders, micrometric stages) for installation.

Longer term :

-Prepare for long term stability test with final set-up in building 175.
- Prepare for the installation at ground level in USA-15.

Meanwhile :

- Learn about SW tools and methods used to analyze TileCal calibration data
-Be prepared to perform calibration analysis with the new system

Open problem: an accurate measurement of the light budget is missing

- Light loss in the optical box and in the long (100 mt) PMMA fiber recently measured.
- No solid data about the distribution (x48 (x27)) inside the drawers.
- Waiting for setting-up a system with spares to measure the remaining losses …

Conclusions

- Pisa is keeping a leading role in the design and in the test of the optics for the TileCal laser calibration system (Laser II project).

- A lot of work done on the optical box, with proven improvements, made since Sept. 2012

- A fruitful collaboration with the CERN, Clermont-Ferrand, and Coimbra groups established.

-Tests almost completed and final design of the optical box (Pisa-Coimbra) and of the new control electronics (Clermont-Ferrand) almost finalized.

- Work in progress with a time schedule adequate for long term stability test (Autumn 2013-Winter 2014) and installation (Spring/Summer 2014).