Status report on the Pisa activities for the TileCal Laser II project and detector calibration analysis

S. Leone and F. Scuri

Atlas- Pisa meeting, Oct. 28, 2013

Activities in progress:

- Design, contruction and installation of the optical line for the laser II calibration system
- Set-up and test program for the optics Atlas-Pisa lab

Presented today

- Contributions to the analysis of the laser calibration runs:

  a) debug of the official code to compute the laser stability constants ''k'';

  b) study of the perfomances of the Pisa method (statistical approach to measure the PMT absolute gain) in:
  1) no-collision devoted calibration runs;
  2) intra-collision calibration laser pulses.

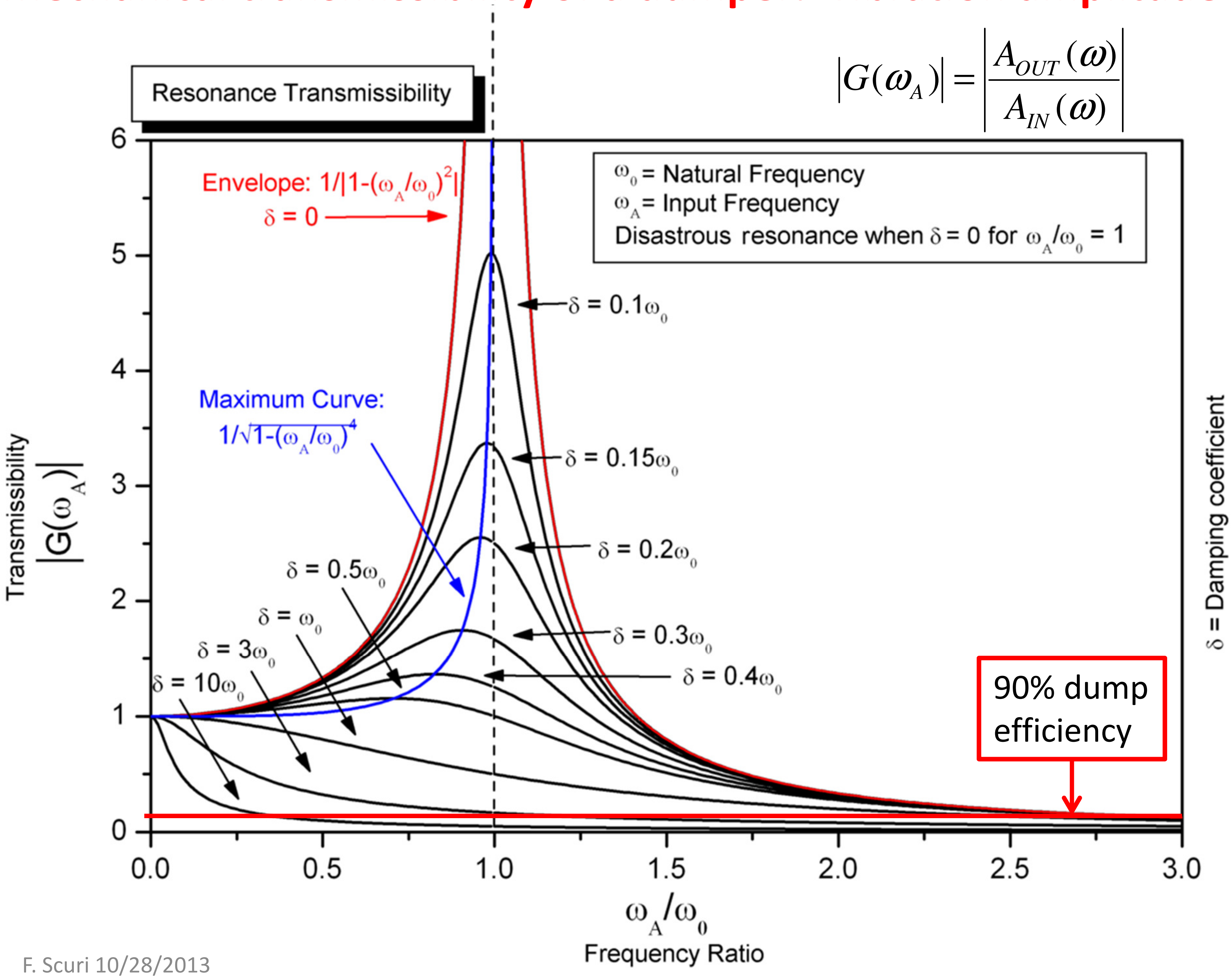
Details next time

Introduction to the vibration dumping strategy

- Attenuation of the vibrations transmitted to the optics box by environmental noise is a relevant feature of the final assembly for the new Laser II system.
- In the present set-up, all optical elements, but the expander for the 400 fiber bundle, are fixed to a vertical optical commercial breaboard, the base of the present optics box that is fixed to the rack with anti-vibrations mounts;.
- The beam-expander is located in a separated rigid box (Coimbra box) direcly fixed to the rack and optically connected to the other element box with a liquid fiber.
- With the 2012/13 test campaign in bld.175 we showed how many potential problems the use of the liquid fiber can generate.
- We decided to put all optical elements in the same optics box, horizontally located in the rack and that must mechanically coupled to the rack with a powerfull anti-vibration system.
- Clermont-F. would prefer to use again an optical breadboard for the box base, but this must be custom designed and produced ==> high costs, long delivery time (months).
- Pisa is developping a different project with rigid box base and suitable anti-vibration coupling to the rack

Mechanical transmissibility of a dumper: vibration amplitude ratio

$$|G(\omega_A)| = \left|\frac{A_{OUT}(\omega)}{A_{IN}(\omega)}\right|$$



What should we worry about ?

- Producers quote the natural frequency of any device, but never they give the dumping coefficient (or ratio);

- However, we know that, even in the case of under-dumping ($\delta > \omega_0$), at $\omega > 3\ \omega_0$, the transmitted vibration amplitude is reduced to some 10% percent of the input one.

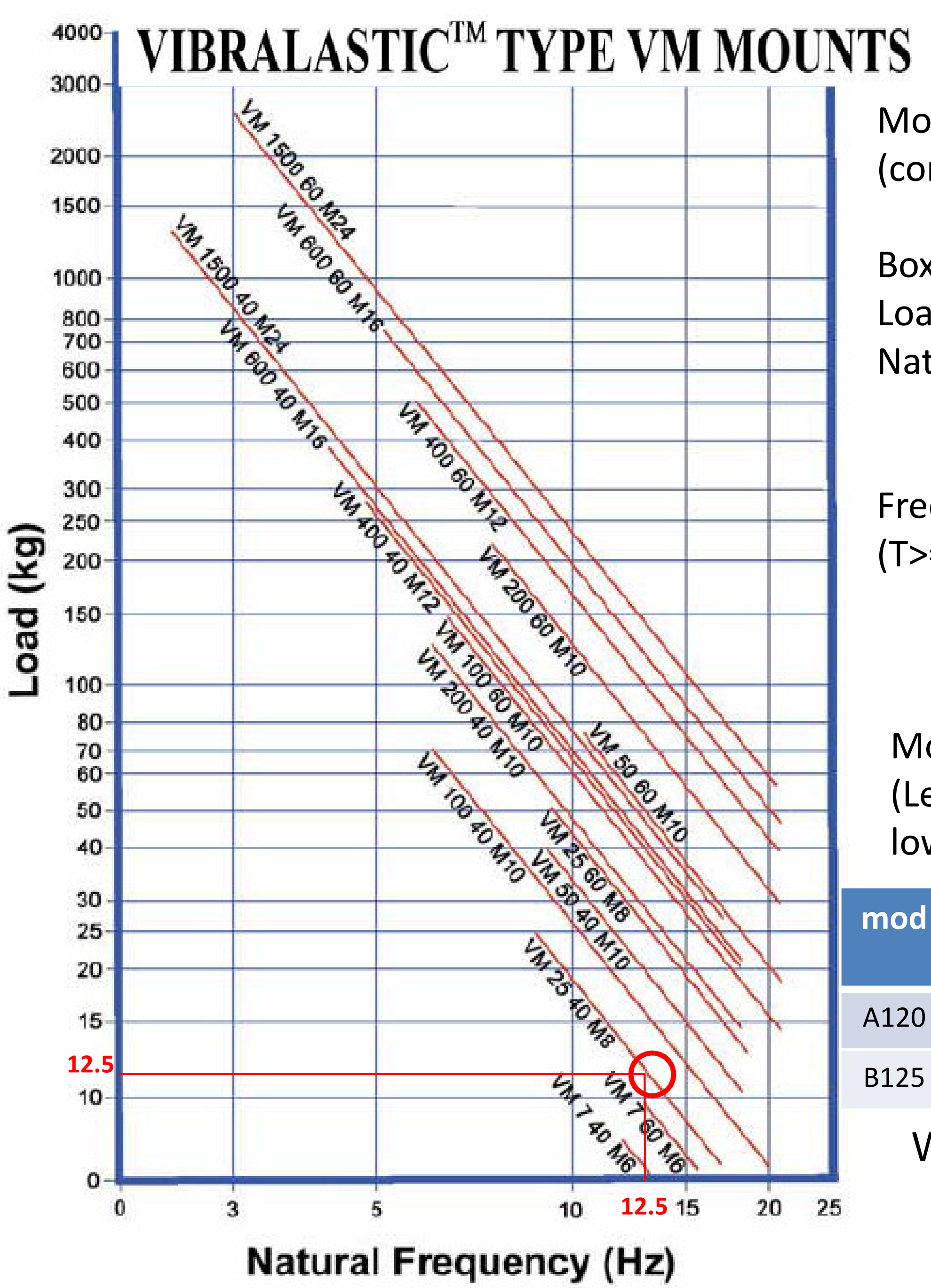
==> first receipt:

select the lowest natural frequency device for the given optics box total weight.

Caveat: in general, the higher the load, the lower the natural frequency …..

…. but we cannot artificially increase the weight of the box because of the constraint on the rack load and on the fixing bars.

Example of mounts



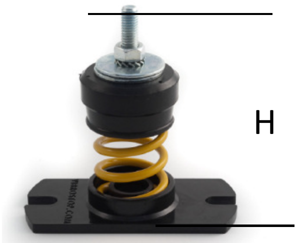
Model VM25 40 M8:
(compact solution)

H = 25 mm

Box weight (optical elements included) : 50 Kg
Load per mount (4) : 12.5 Kg
Natural frequency : ω_n = 12.5 Hz

Frequency dump threshold (above resonance)
(T>=10%) at ω_{TH} = 37.5 Hz

Model Vibrastop (MI) GX
(Less compact, but with
lower natural frequency)



H

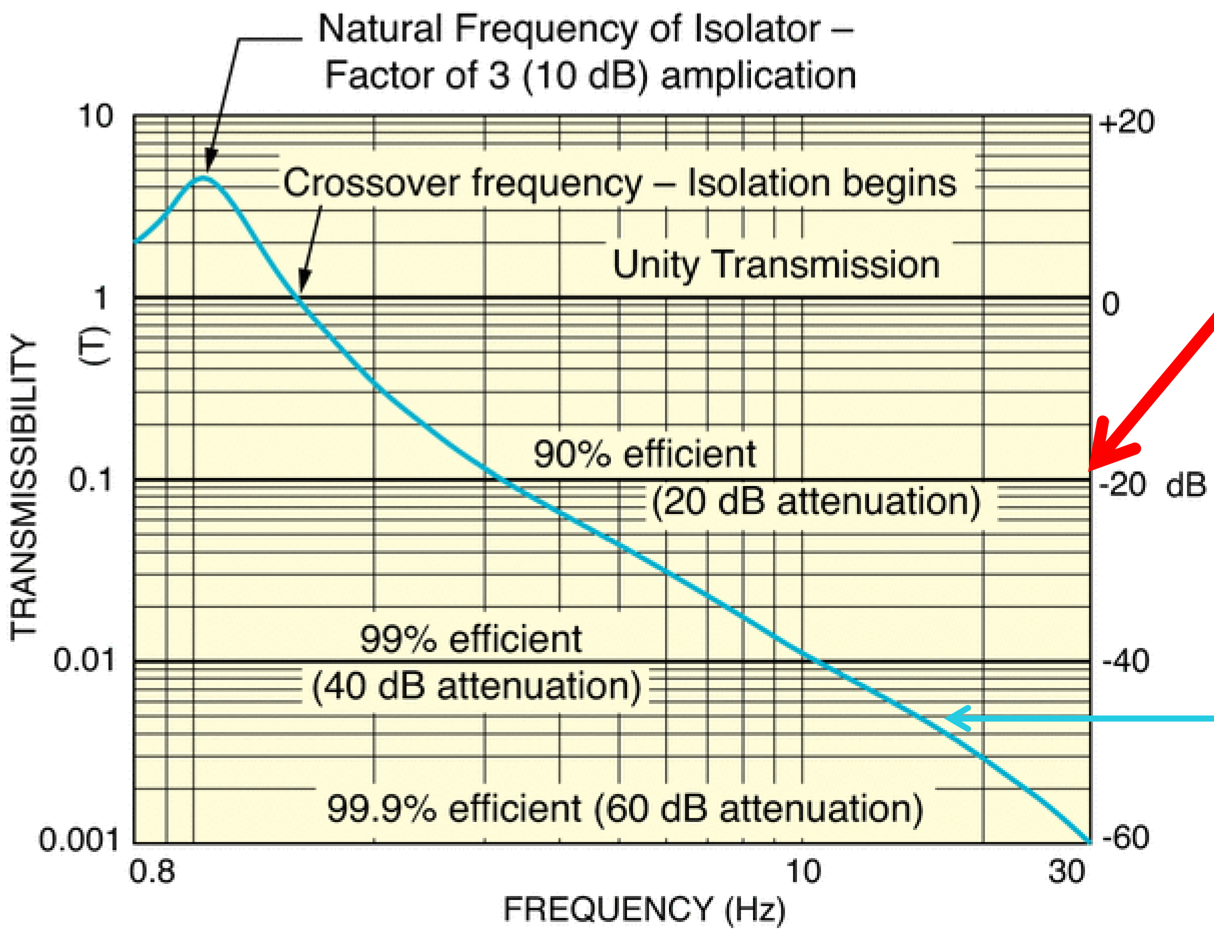
mod	ω_n(Hz)	ω_{TH}(Hz) @ T=0.1	H(mm)
A120	6	18	55
B125	4	12	73

12.5 Kg per mount

We want to test several models …

Impossible to do better with small anti-vibration mounts

… only large volume pneumatic isolators, higher load ….

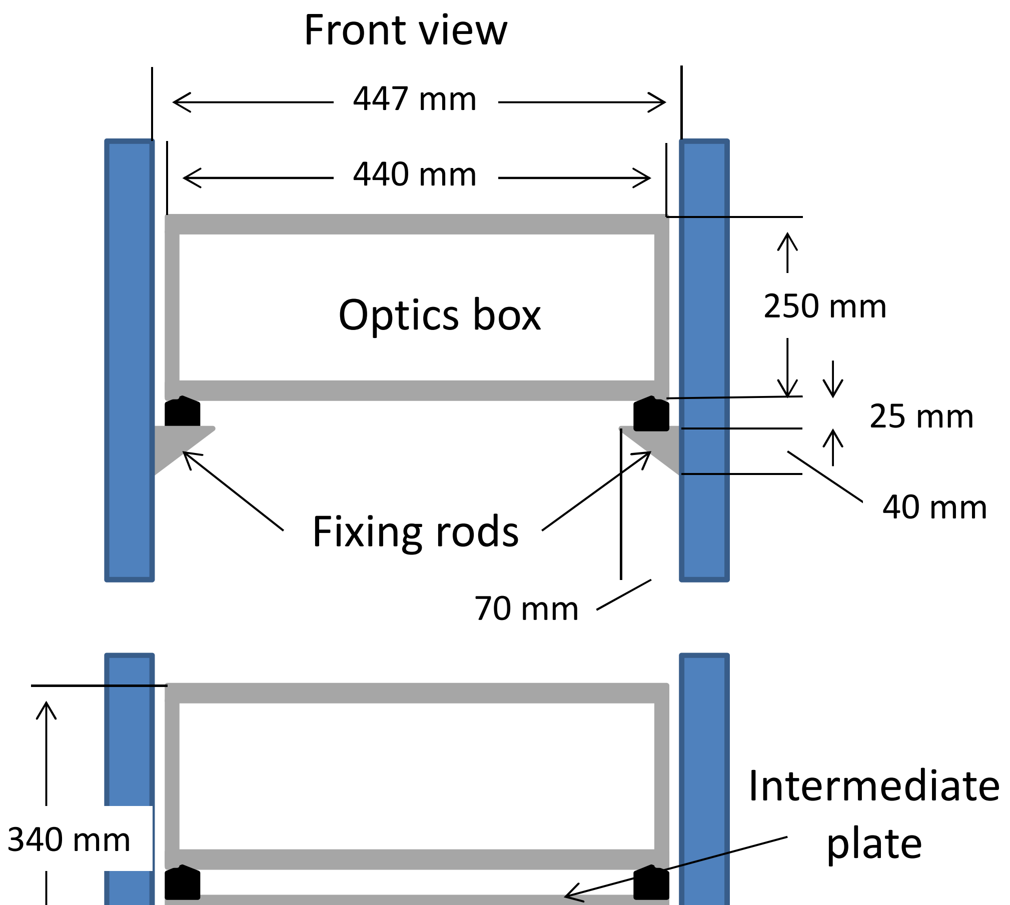


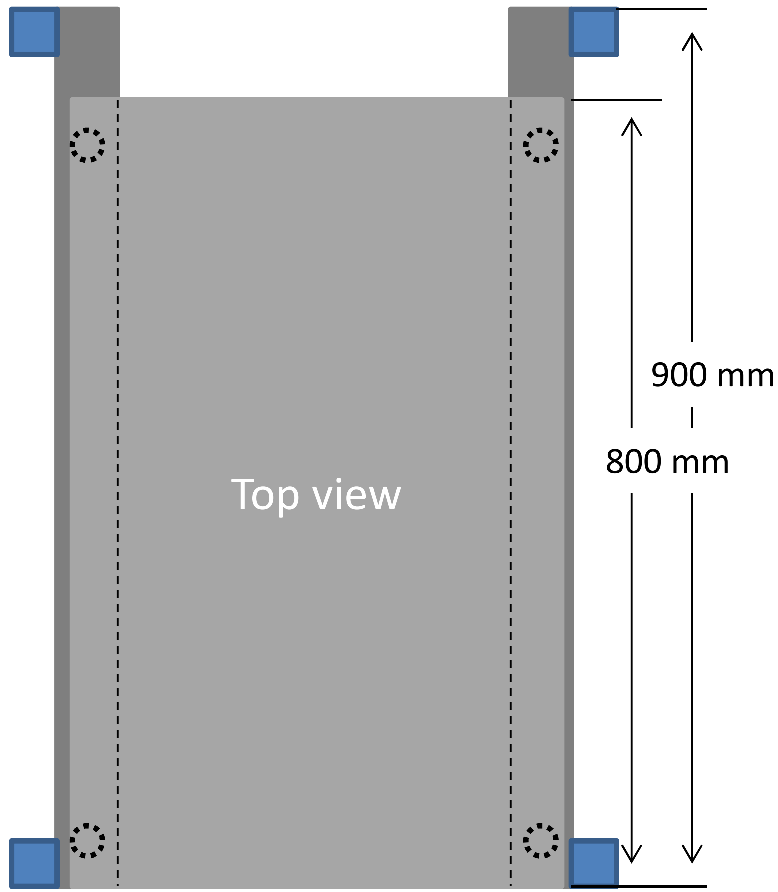
(load range 300 – 3000 Kg)

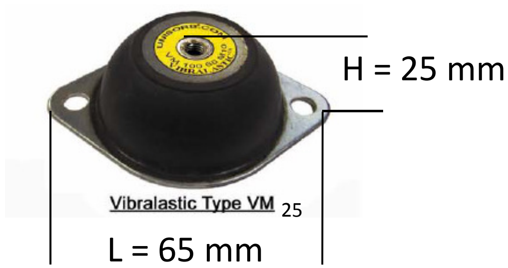
For comparison:
Vibralastic mounts
(50 = 12.5 x 4 Kg total load)
are 90% efficient at ω > 30 Hz

Similar curves for the OPTA anti vibration table supports

Proposed mount geometries (rough sketch, not to scale)

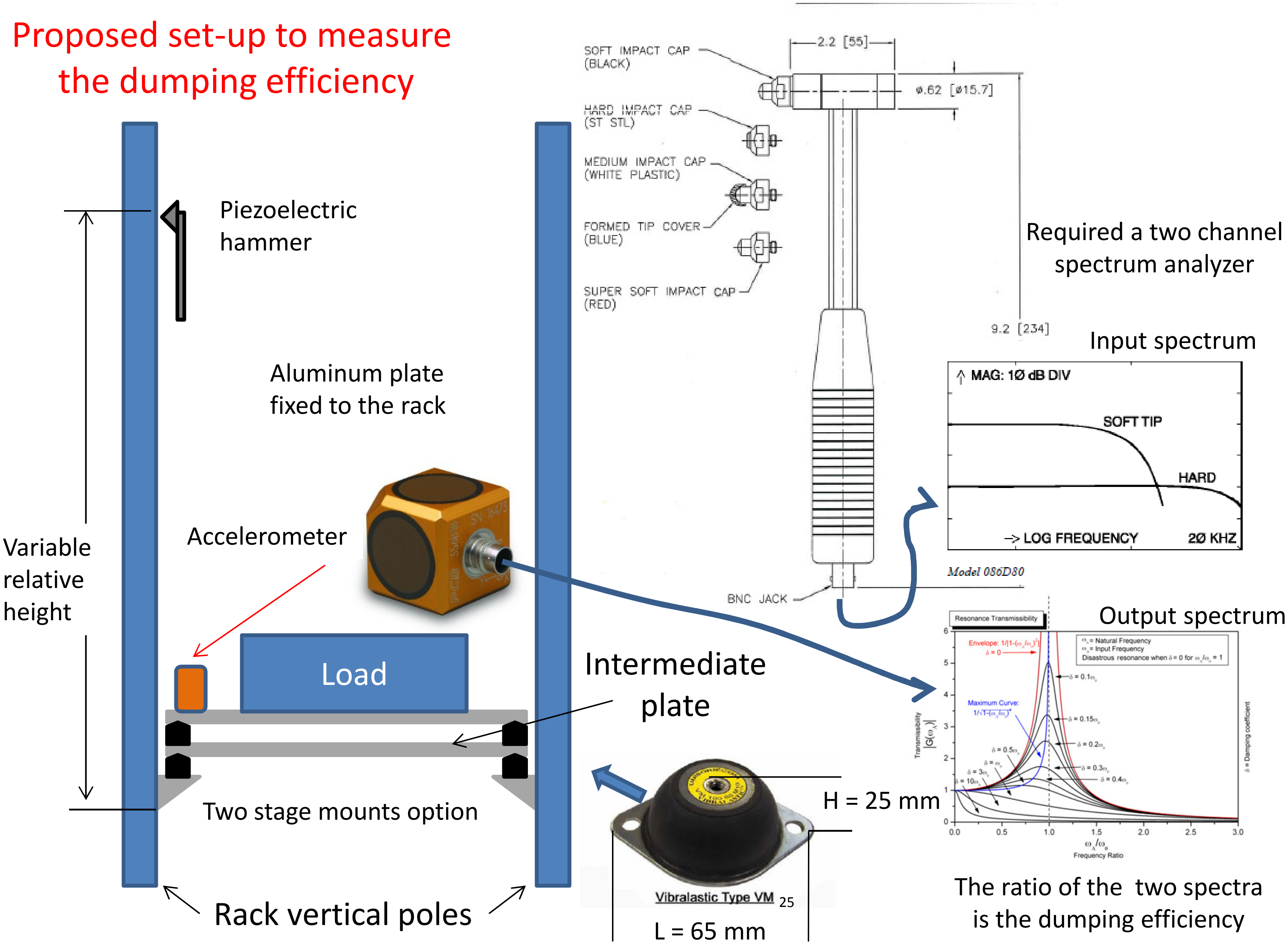






With the two stage mounts the low frequency threshold could be as low as 10 (3) Hz

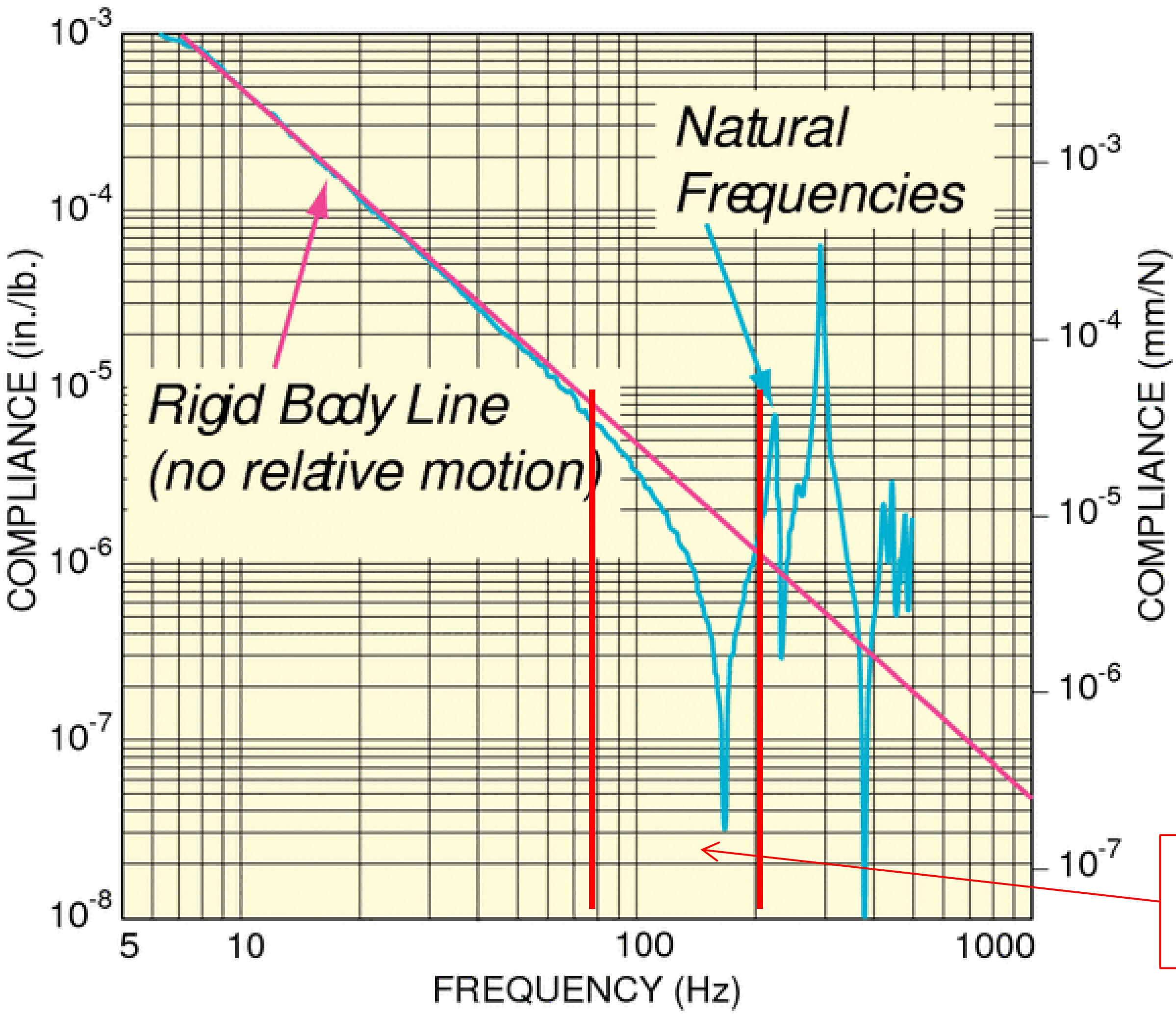
Proposed set-up to measure the dumping efficiency



What about commercial breadboards ?

For an almost complete mathematical treatment see for instance :

http://www.newport.com/About-Optical-Table-Performance-Specifications/168086/1033/content.aspx



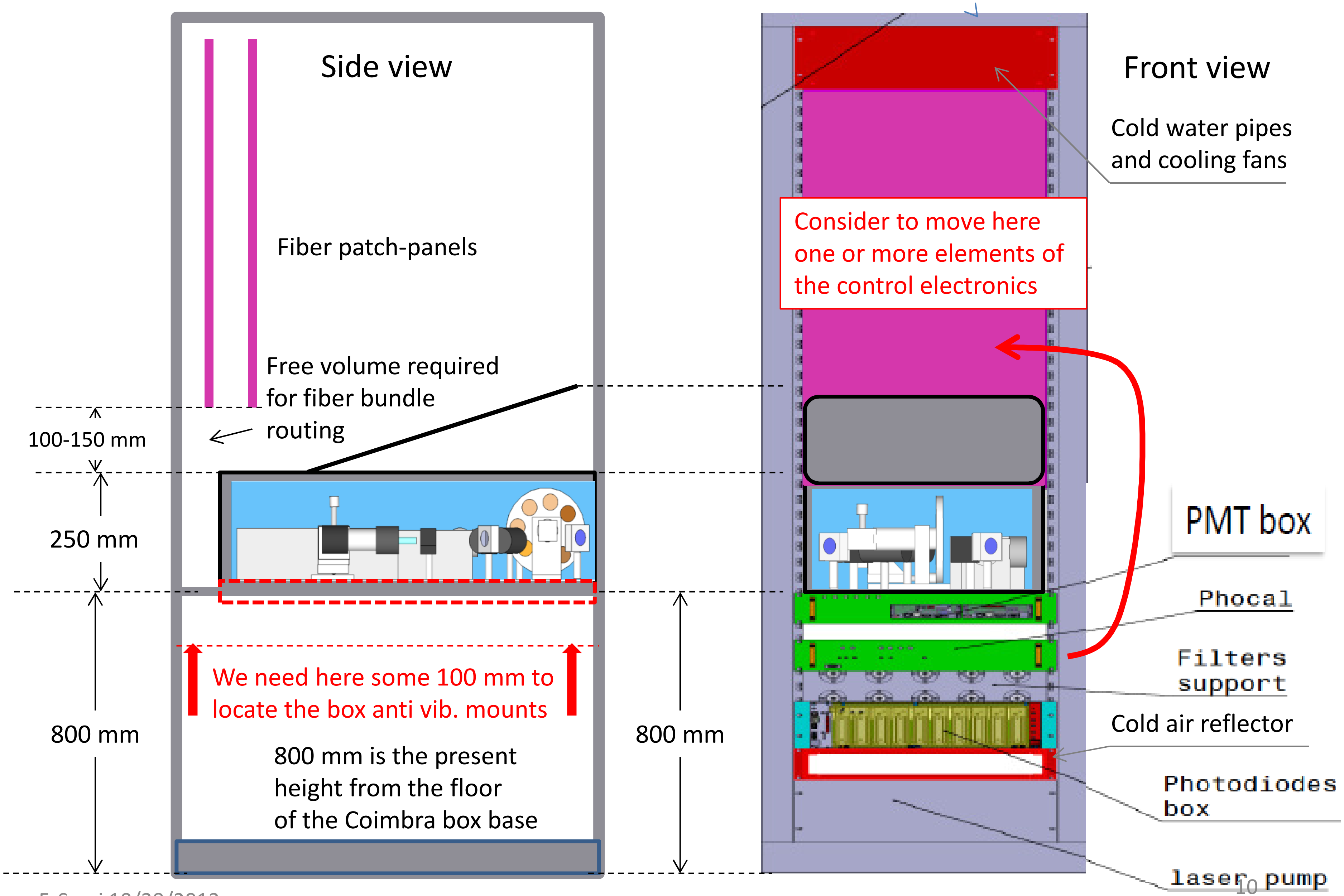
Typical characteristic of **Newport** breadboards

This curve depends on the transmissibility of the antivibration support system; here it is assumed T < 0.01 above 5 Hz

Similar curves for the OPTA breadboards (proposed by Coimbra)

Spectral range of effective dump

Impact on the element mount constraints in the rack



Open issues with the instllation in the USA-15 rack

- We realized only very recently some problems related to additional constraints set by the anti-vibration system and by the cooling system of the electronics

- The anti-vibration system (rigid base or optical breadboard) will probably require more room with respect to the original design

- Nobody considered before the strong constraints set by the complicate system for cold air flow in the rack.

- Clermont-F. is, at the moment, strongly against any change in the location they have planned for each new electronics element (with many evident reasons).

- The solution of the puzzle must be found (and soon):

==> a new inspection in USA-15 (C. Santoni, F. Scuri) required to carefully consider the possible configurations to locate all elements (big fibe patch-panel, optics and electronics) in the same rack. (Inspection made today at 12:00)

Agreed strategy for the optics box(es)

- Decided to keep a spare system operating in bld. 175 to study any modification eventually suggested by the new system operation after installation in USA-15.
  ==> new laser, 2° optics box equipped with spare elements, …

- Defined the work plan and sharing to optimize construction, qualification and assembly steps:

  - 1st alluminum rigid base machined in Coimbra and on the way to Pisa; black anodization postponed after its use in the first anti-vibration test;

  - box walls and top-cover designed by Andrea; step files to be sent to Coimbra by this week;

  - Coimbra will machine walls and top-cover; to save time and leave flexibility, the rear wall will have two big holes, one fitting the laser rear connector panel and the other to be closed with a panel mounting all feed-through connectors (fibers and controls/power) once the type will be decided;

  - in parallel, Pisa will produce the box fixing system to the rack and will test the antivibration system(s) with different dumpers and loads on the base.

  - if tests will be positive, Pisa will proceed to the black anodization of all pieces and Coimbra will produce (and anodize) a second speare box;

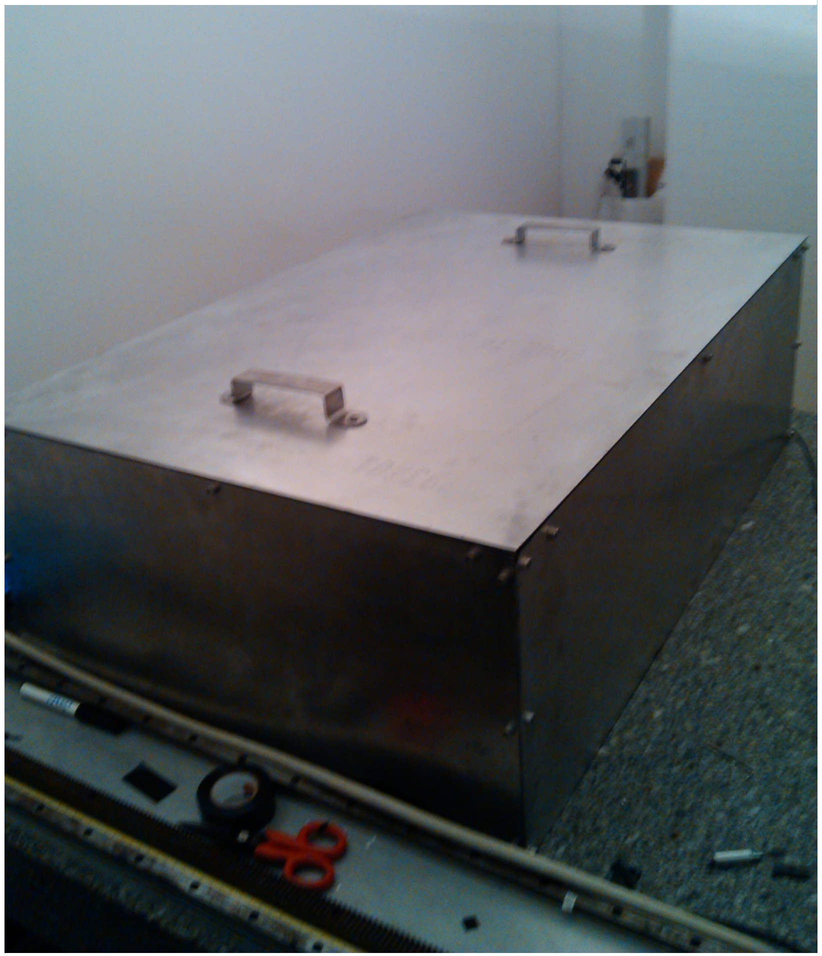
  - if tests will be negative, Coimbra will proceed with the order of an optical breadboard; the produced rigid base will be used in the test system maintained in bld. 175

Revised short term time schedule

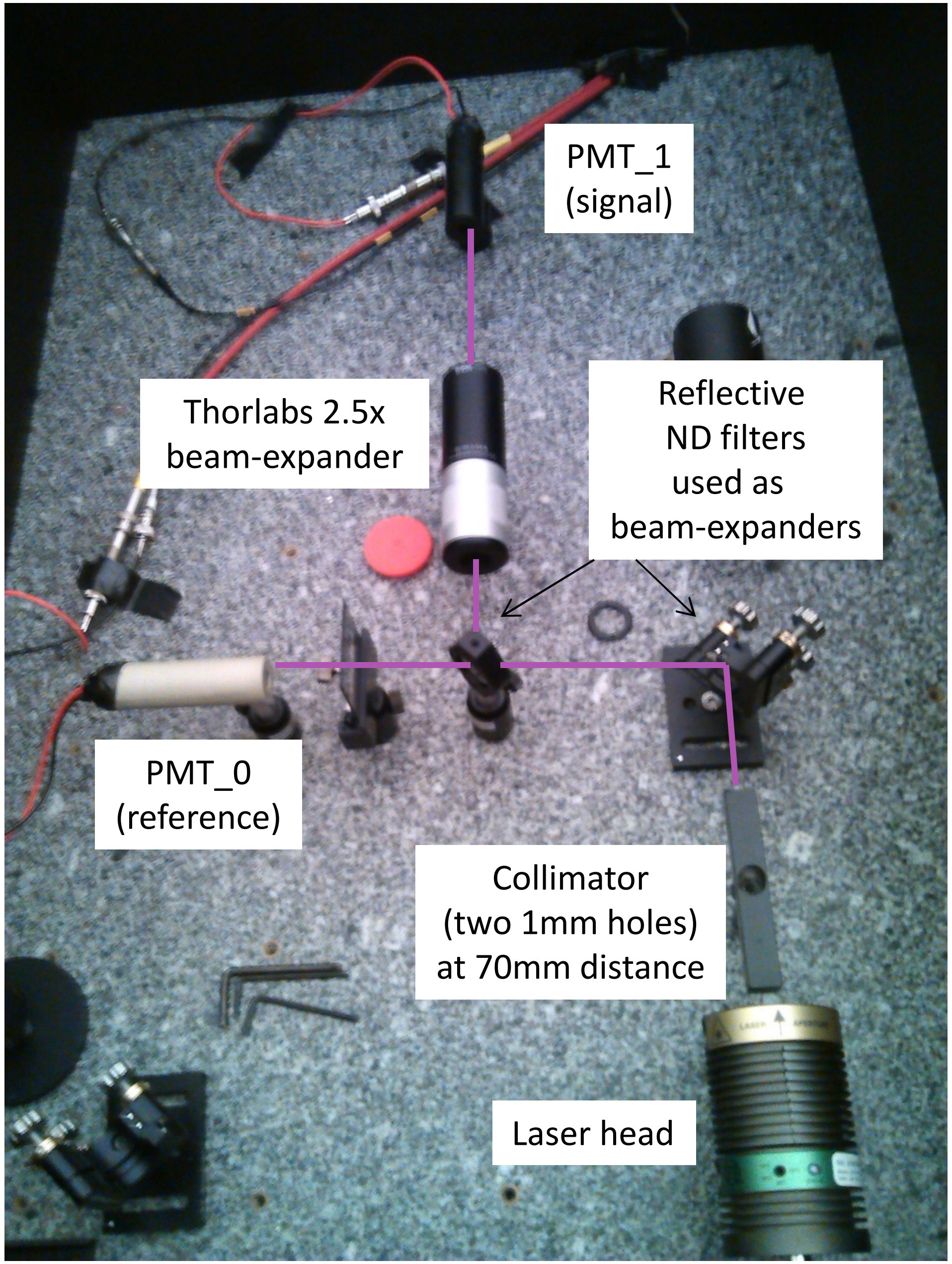
Activity	Timing	Site	People
1st box production (walls)	Oct 28 – Nov 11	Coimbra	Coimbra
Antivibration tests	Nov 18 – Dec 6	Pisa	Pisa
1st box assembly	Dec 9 – Dec 14	Pisa	Pisa
1st box installation in 175	Dec 16 – Dec 20	CERN 175	Pisa + CERN(?)
2nd box production or breadboard order	Dec 16 – Feb 28	Coimbra	Coimbra
Laser + new electronics + old optics box back to 175	Nov 18 – Nov 22	CERN 175	Clermont
Tests in 175: new electronics with the old box	Nov 25 – Nov 29	CERN 175	Pisa + C-F (?) + CERN(?)
Tests in 175: 1st new optics box fully equipped	Jan 6 – April 30	CERN 175	all

The Atlas-Pisa Optics Lab

The optical bench (granite)
and the optics box



Inside the optics box



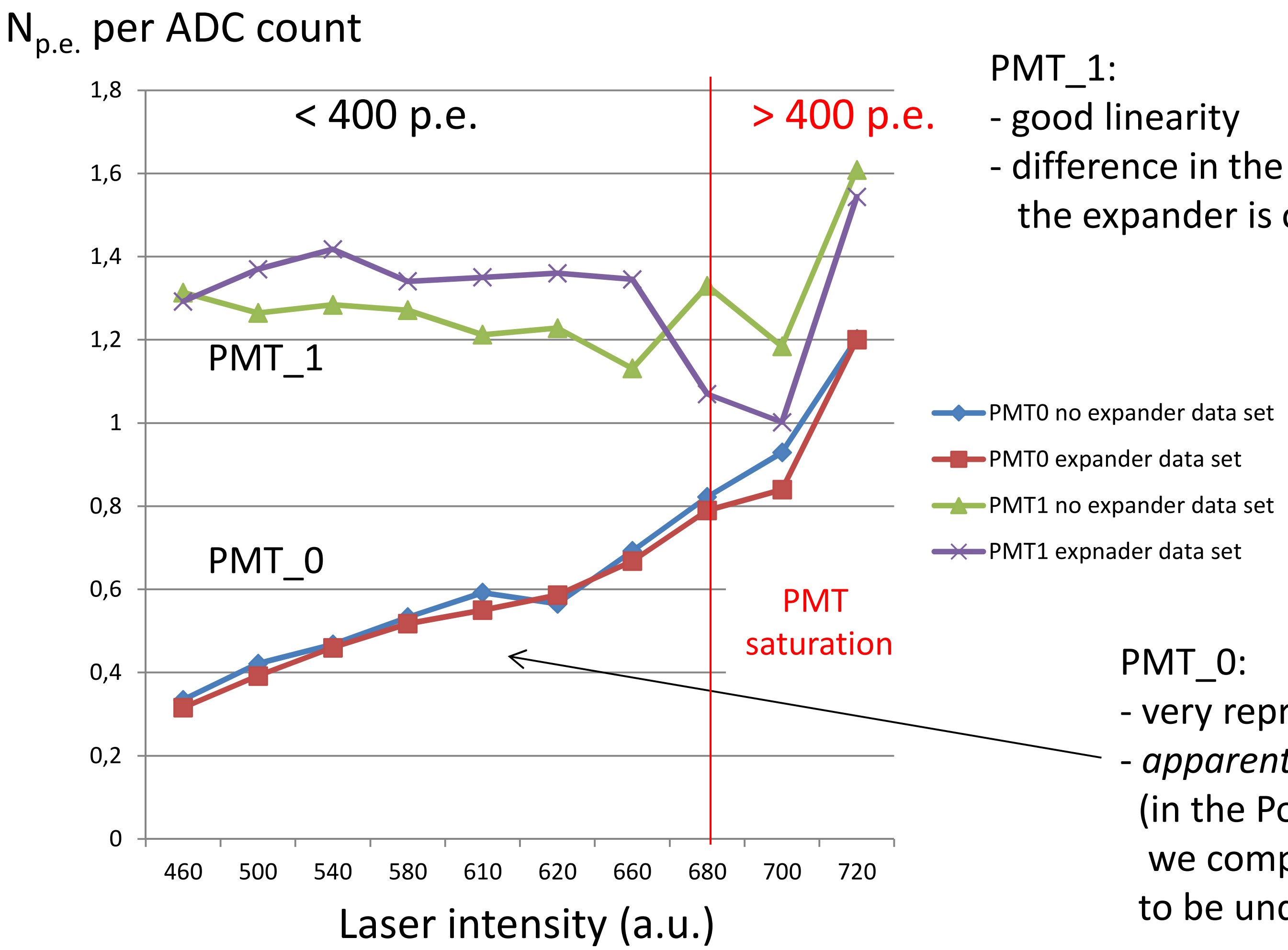
Forewords

- The Hamamtsu R1635 PMTs used for laser pulse detection are small cathode active surface (8 mm):

==> narrow signals, short rise time (1 ns) and trailing edge, but ….
…. they easily saturate at large photo-electron number ($N_{p.e.}$ > 300-400)

- This is what we tried first; if necessary, we could use in the future Hamamatsu photo-cells (similar to the ones used in bld. 175) readout with electronics cards used for the diodes in 175 and delivered to Pisa from Clermont-F.

PMT linearity response



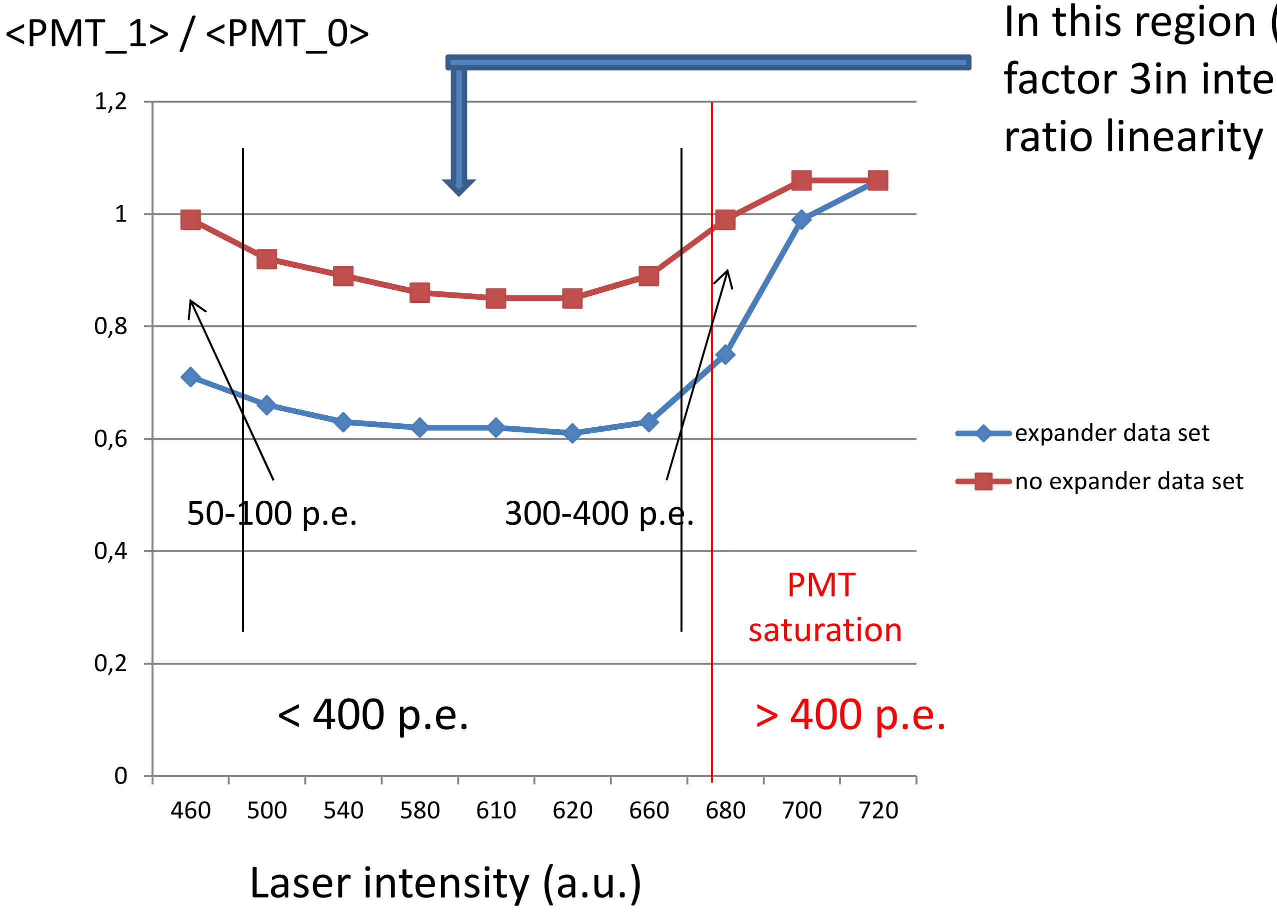
PMT_1:
- good linearity
- difference in the p.e. yield, higher when the expander is on the optical line;

PMT_0:
- very reproducible response,
- *apparently* not linear (in the Poisson statistics approx. we compute $N_{p.e.} = (ave/RMS)^2$) to be understood (see below)

- Statistical errors negligible in each individual point
- Anyway, what matters is the stability of the ratio <PMT_1>/<PMT_0>

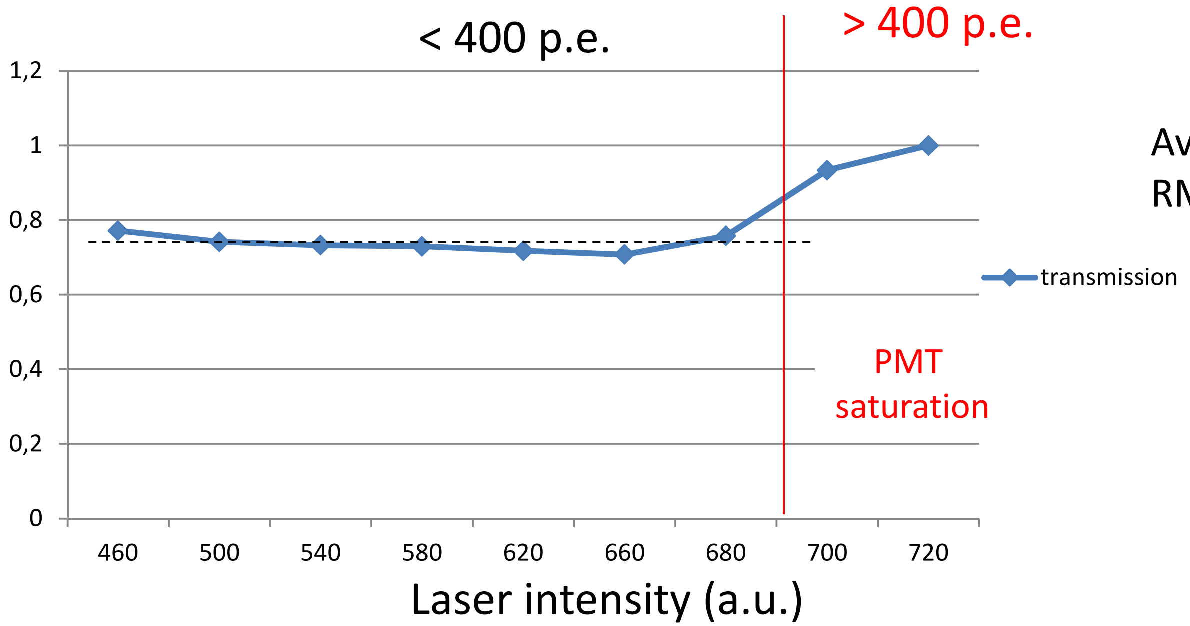
PMT_1 / PMT_0 signal ratio

In this region (almost a factor 3in intensity), ratio linearity is within 3%



Beam-expander transmission factor (at λ=440 nm)

$$\text{Transmission} = (\text{PMT\_1} / \text{PMT\_0})_{\text{expander}} / (\text{PMT\_1} / \text{PMT\_0})_{\text{no\_expander}}$$



Average: 0.76
RMS : 0.01

This is much less w.r.t. the Thorlabs specs:

T > 0.96 in the range 400 nm < λ < 650 nm

Possible reasons:

- Expanded beam halo not fully contained in the cathode sensistive area (quite likely, beam halo (visible) >= 5mm, cathode diameter of the sensitive area is 8 mm)
- Spectral transmission effect; at λ = 440 nm we are close to the expander coating spectral window (not very likely, spectral reflectance spectrum of the coating is quite flat in a range wider than 400-650 nm)
- Geometrical effects: non orthogonal incidence; this can be studied more carefully …
- Wrong measure method: we can check by measuring the OD of our ND filter set

Conclusions

- Defined the short term schedule for optics box construction, qualification and assembly; much work to be done in Pisa from now till mid December (intallation in 175)
  - order of different dumper models;
  - design and construction of the mechanics for fixing the optics box to the rack;
  - test on vibration-dump efficiency (attuator and sensor from Virgo colleagues).

- Location of the new optics box in the rack in USA-15 has stringent constraints;
  ==> (re)location of the electronics in the same rack to be agreed with Clermont-F., maybe not an easy task …

- Optical line in Pisa is now operative;

- Qualification of the optical line in progress

- First measurements done to qualify of the Thorlabs 2.5x beam-expander;
  - difference between measured and expected transmission to be understood;
  - a set of new measurements in Pisa to be done to establish the method and to fully qualify the set-up and the Thorlabs 2.5x expander.