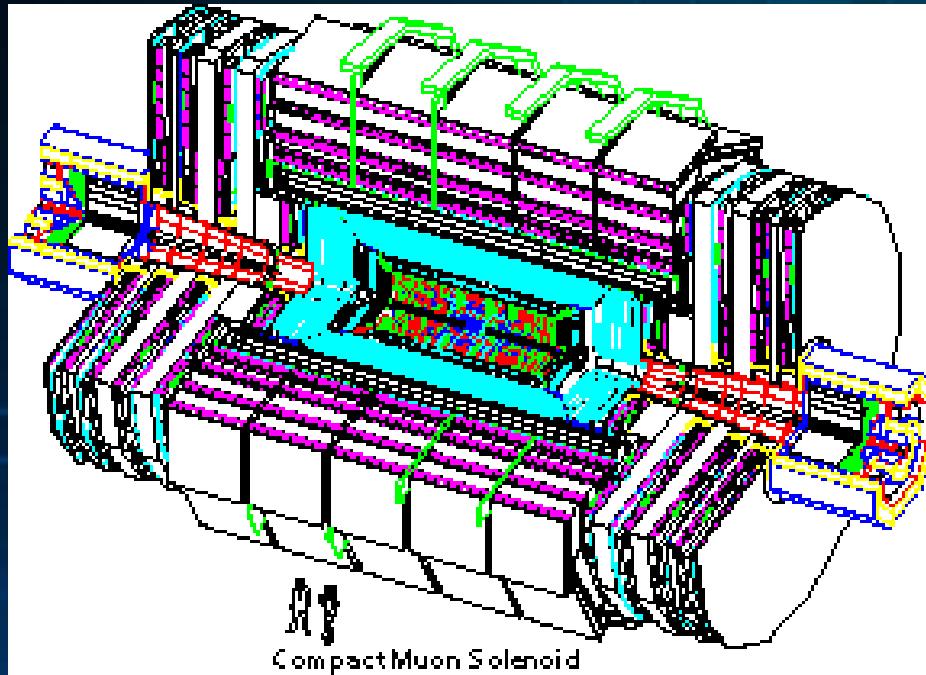


Calibration of clinometers for the alignment of muon chambers in the CMS experiment.

Thomas MOSCHOUTIS, Marion RIPERT
and Georgia KARAGIORGI
with Dr HOHLMANN and Dr CARAWAY

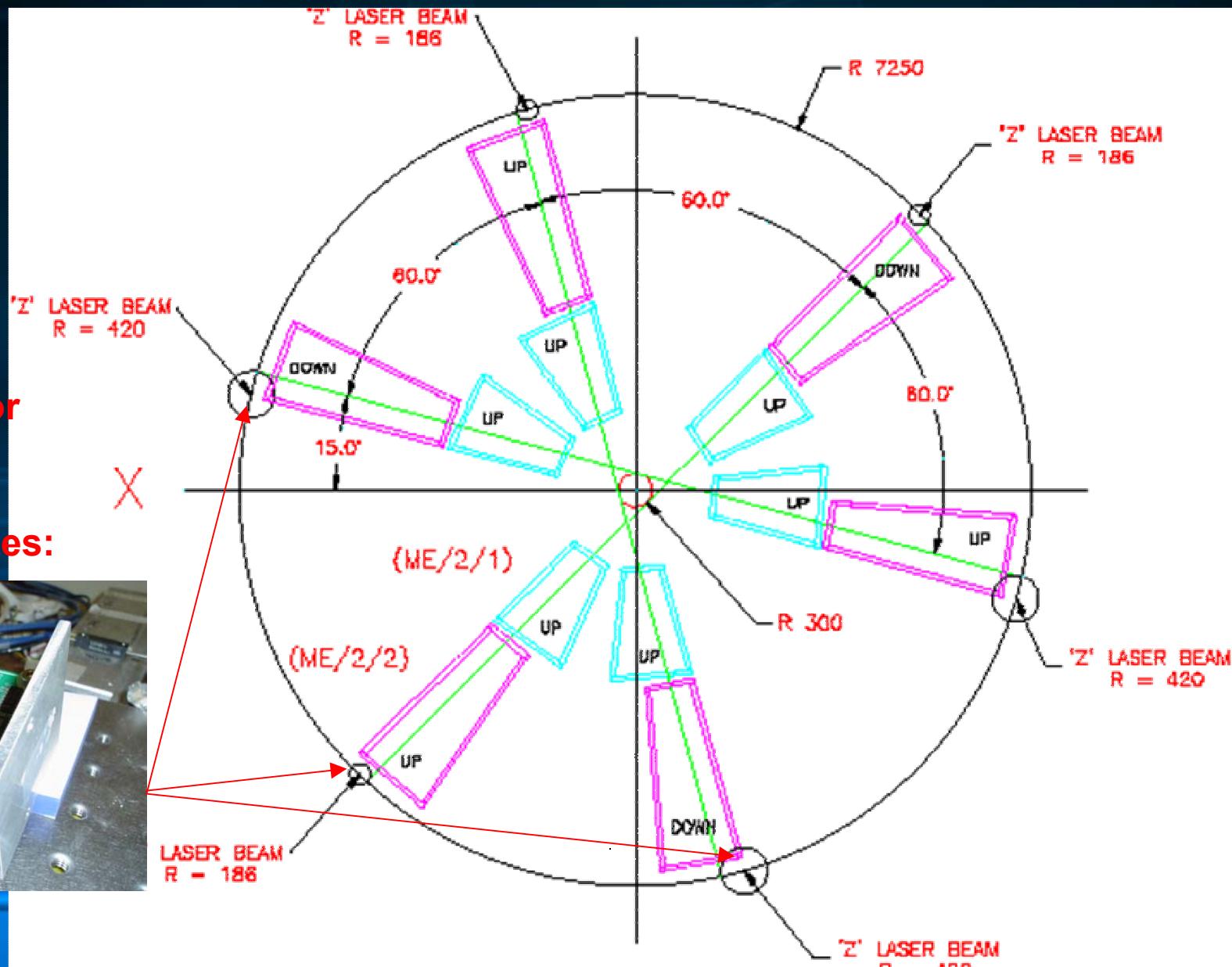
Florida Academy of Science – F.S.U., Tampa , 18 Mars 2005

Global view of the Compact Muon Solenoid

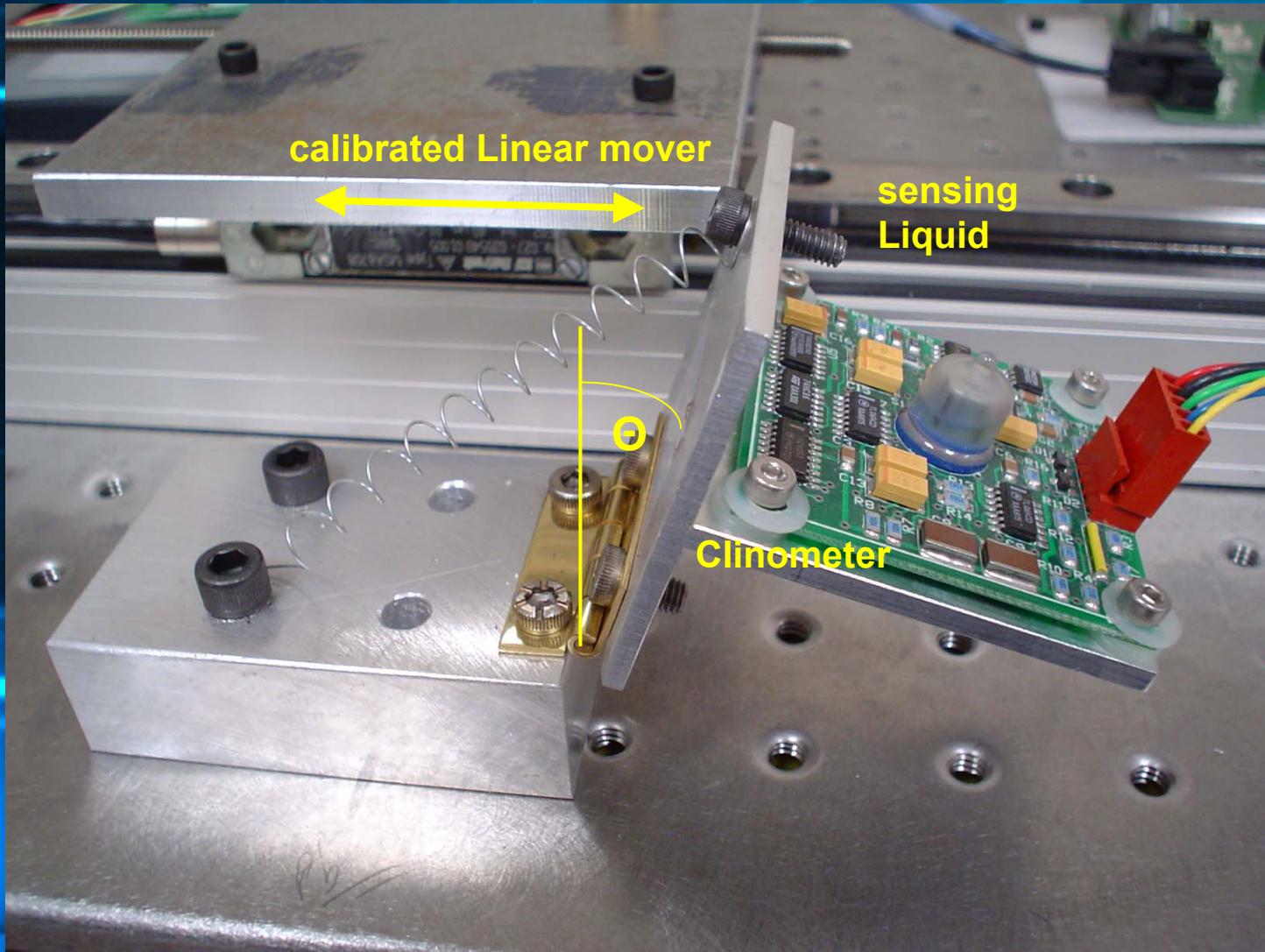


View of one Disk

Dual-axis
clinometers for
monitoring
orientation
of transfer pates:

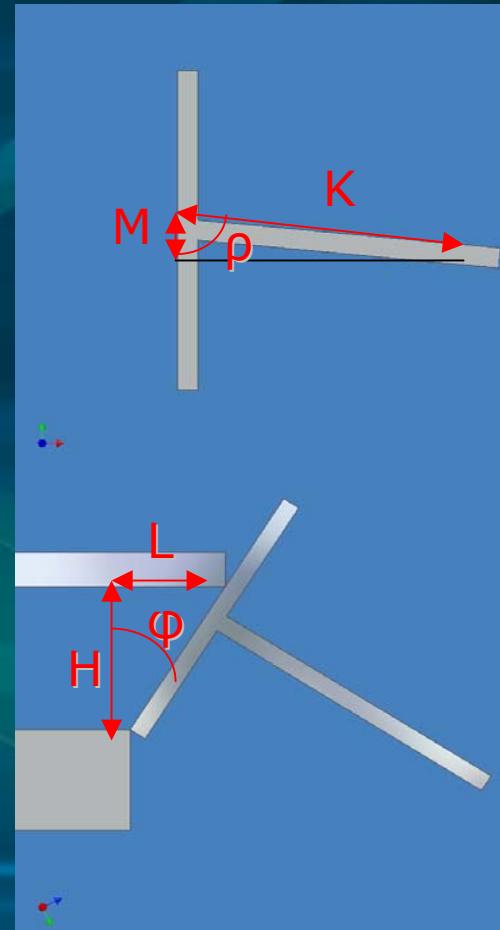


Calibration bench



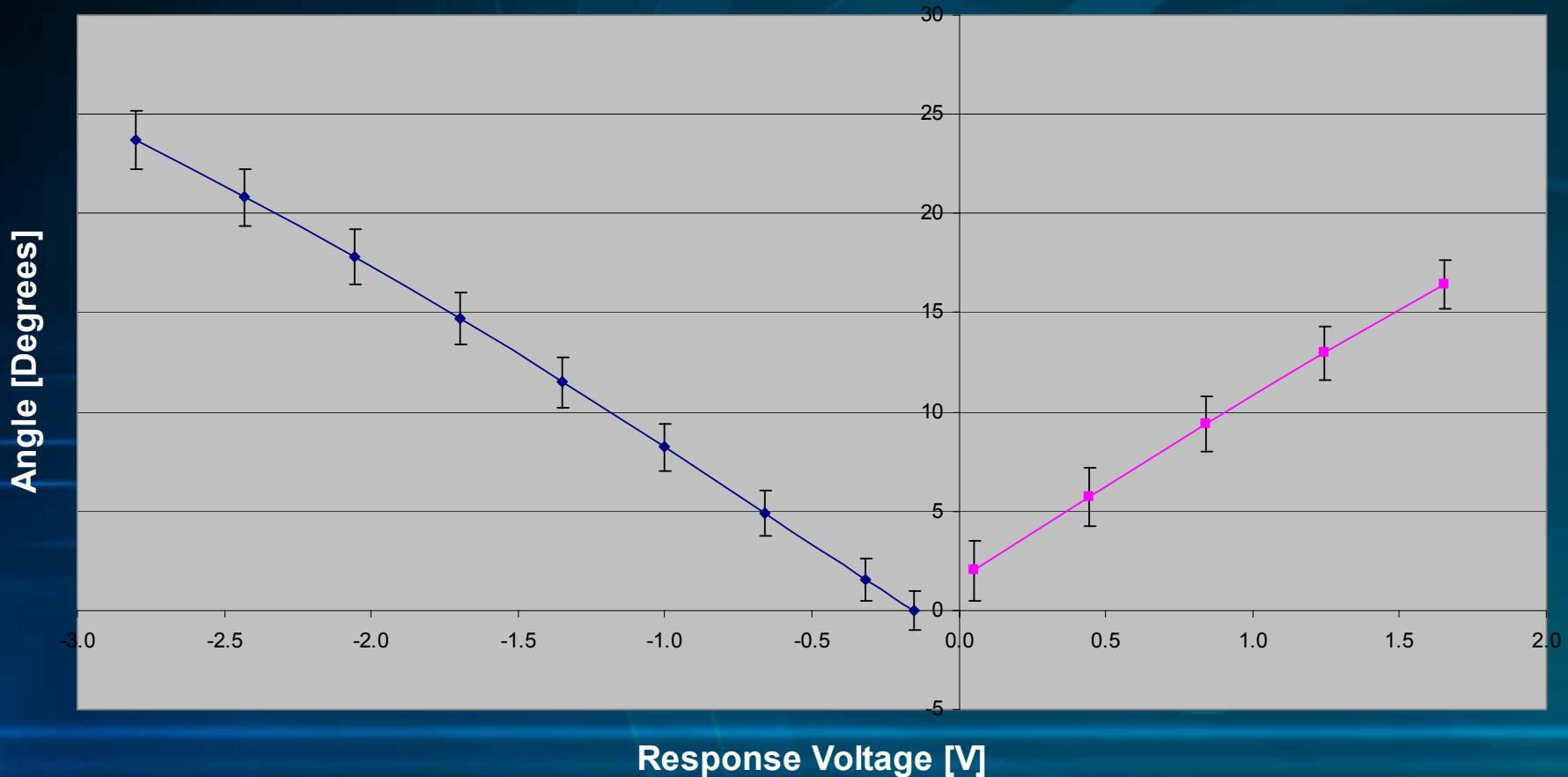
Error calculation

- Error in ϕ :
 - $\phi = \tan^{-1}(L/H)$
 - $\sigma_\phi = (\partial\phi/\partial L)*\sigma_L + (\partial\phi/\partial H)*\sigma_H$
 $= (1/(L+H))^2 * \sigma_L - 2L/(H^2+H*L)^2 * \sigma_H$
- Using the same formula:
 - $\sigma_\Omega = (1/(L+M))^2 * \sigma_L - 2L/(M^2+M*L)^2 * \sigma_M$
- Taking $\rho = \cos^{-1}(M/K)$ and $M \rightarrow 0$
 - $\sigma_\rho = \sigma_M / K$
- So the total error is:
 - $\sigma_\theta = (\sigma_\phi^2 + \sigma_\Omega^2 + \sigma_\rho^2)^{1/2}$



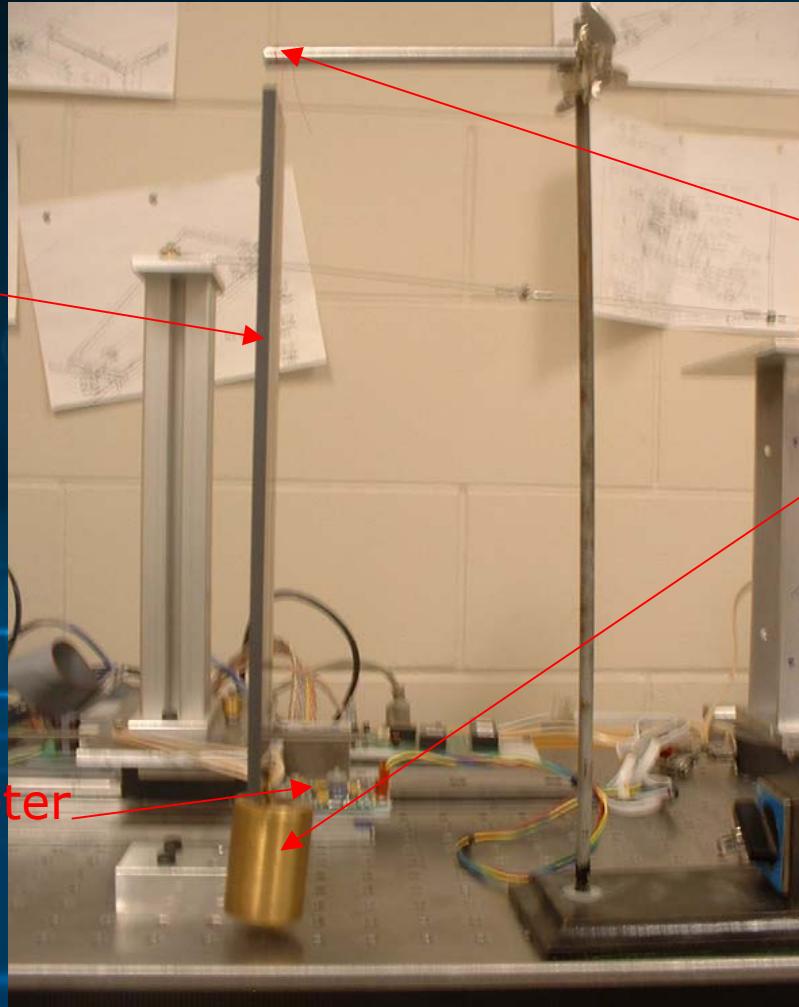
First test curve

Angle vs clinometer voltage output



Zero degree measurement

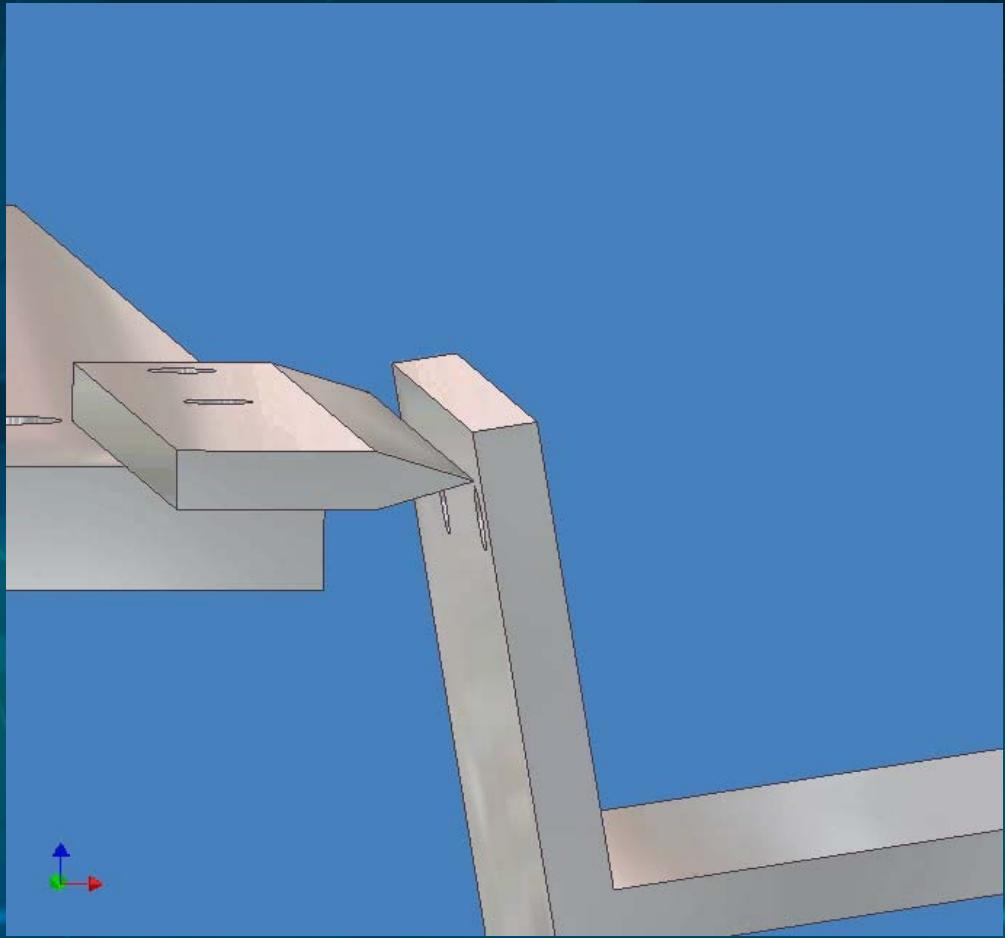
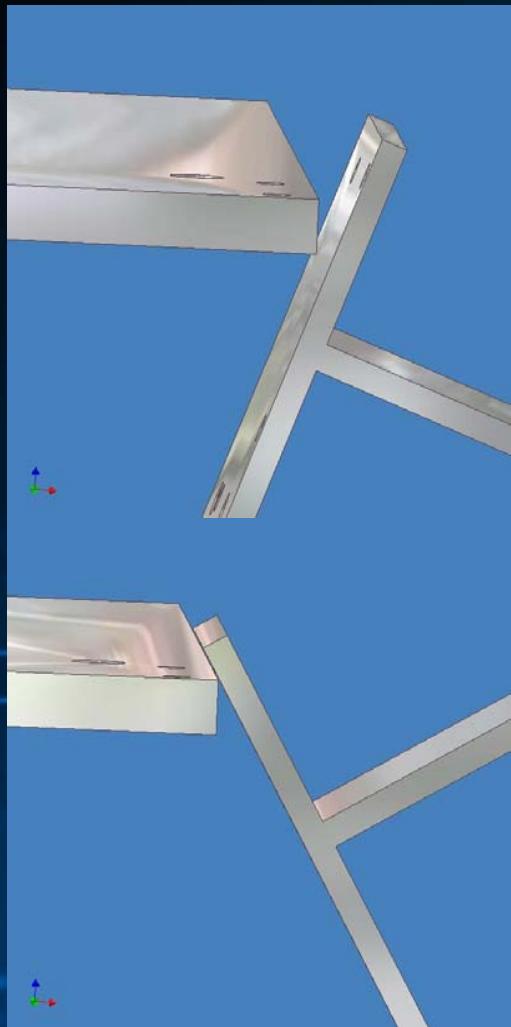
Long rod to get more precision



Pendulum

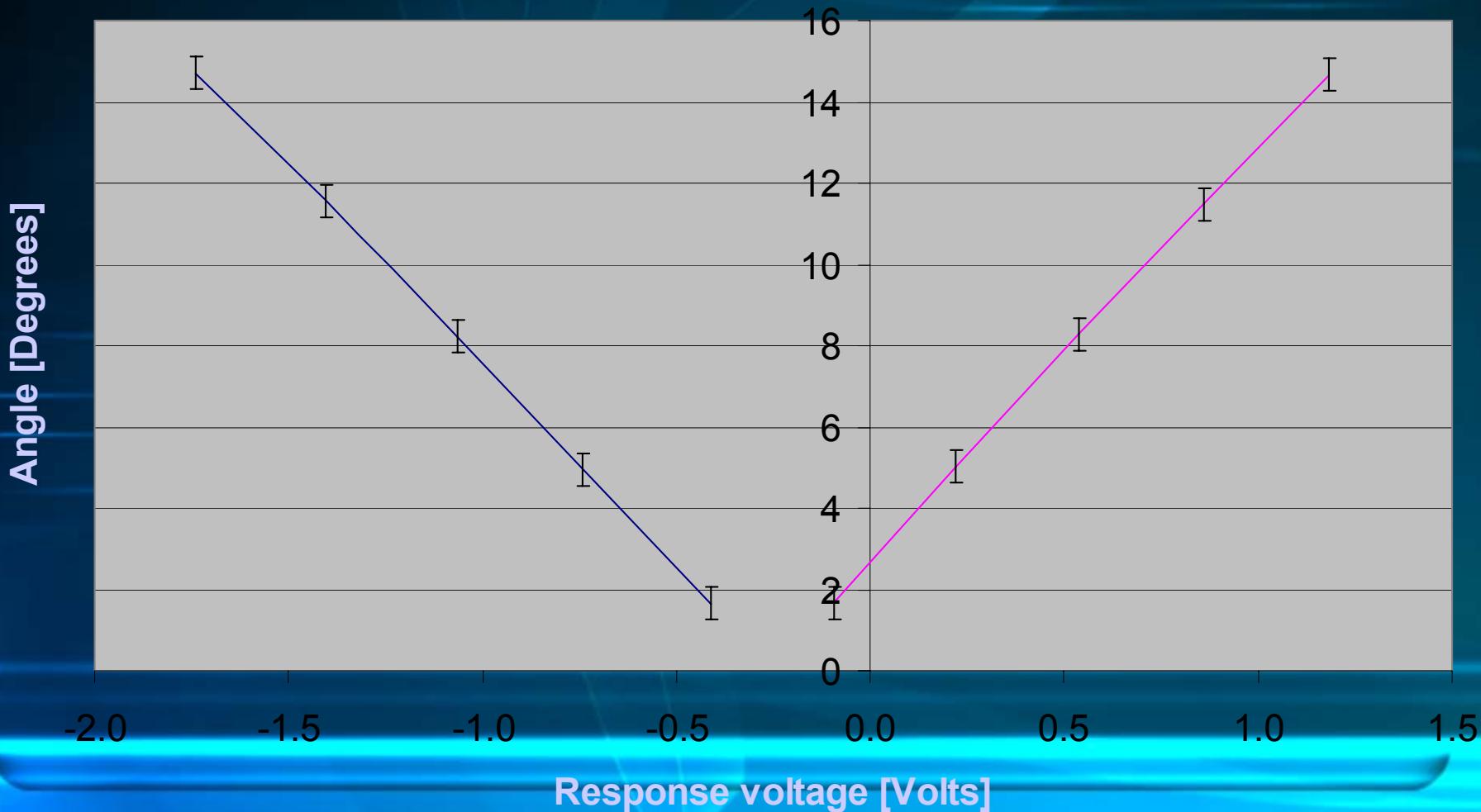
clinometer

Problem induced by the plate thickness



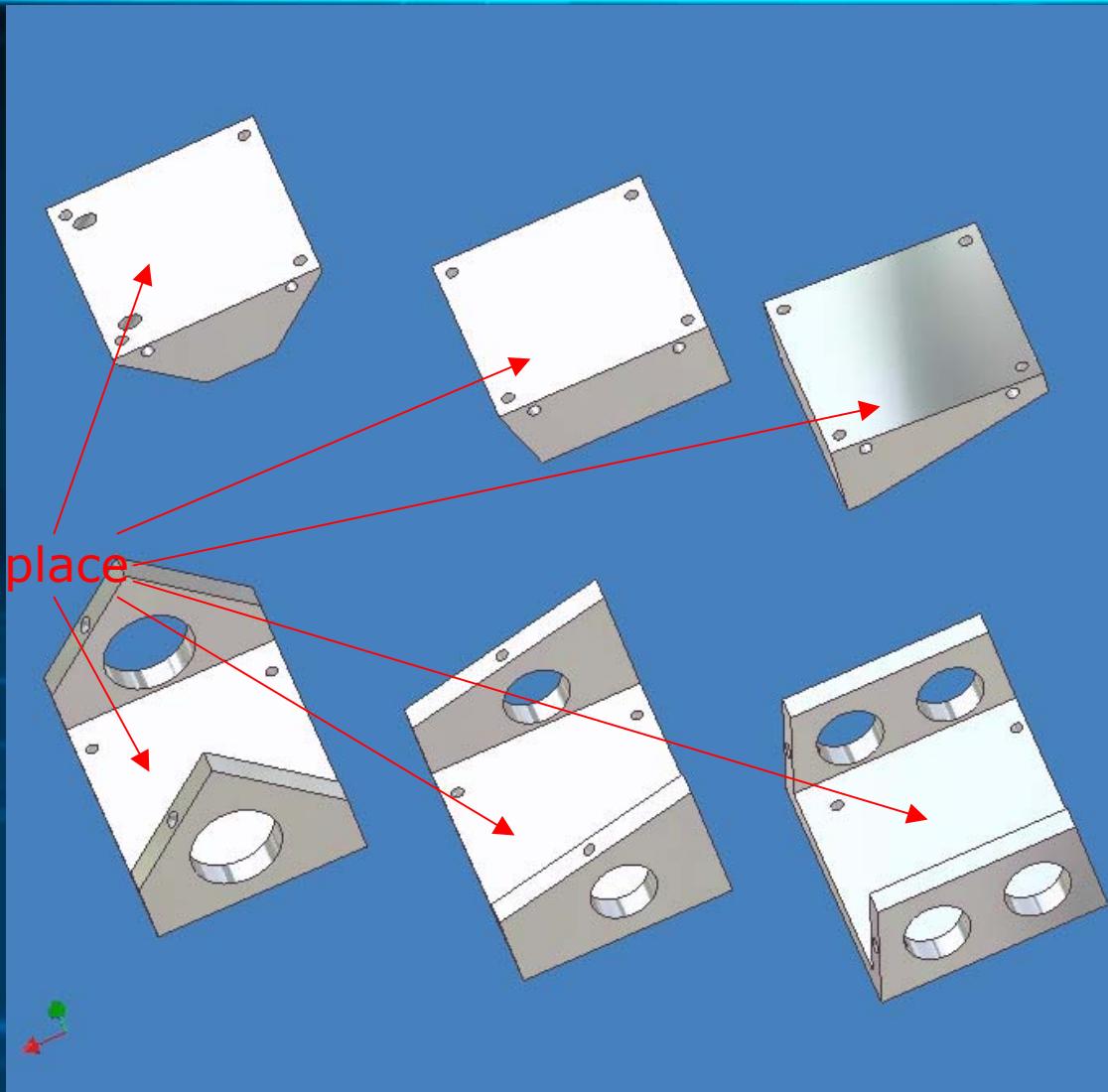
Second test curve

Angle vs clinometer voltage output



The 6 different mounting plates

Clinometer's place



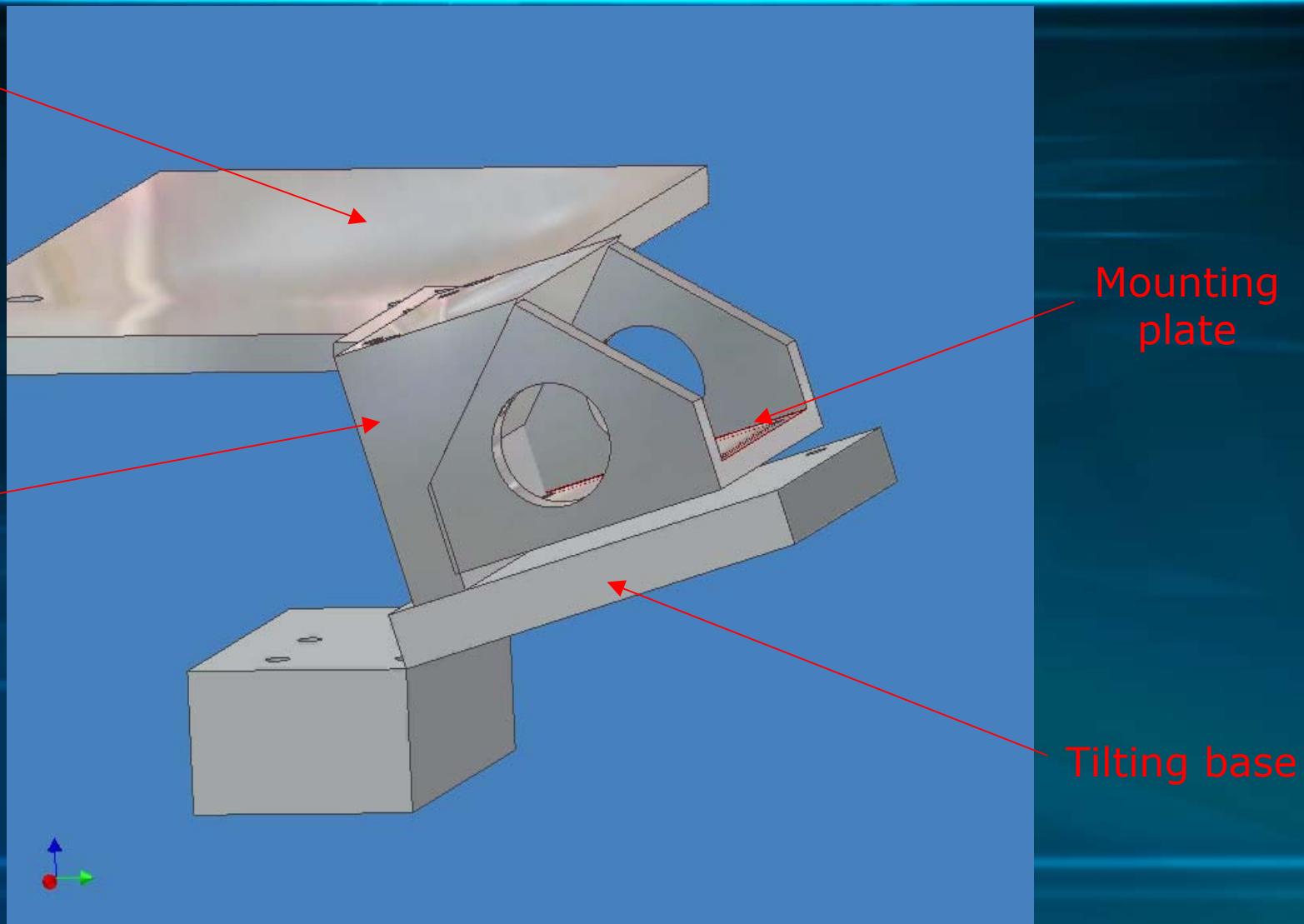
Next setup

Linear
mover

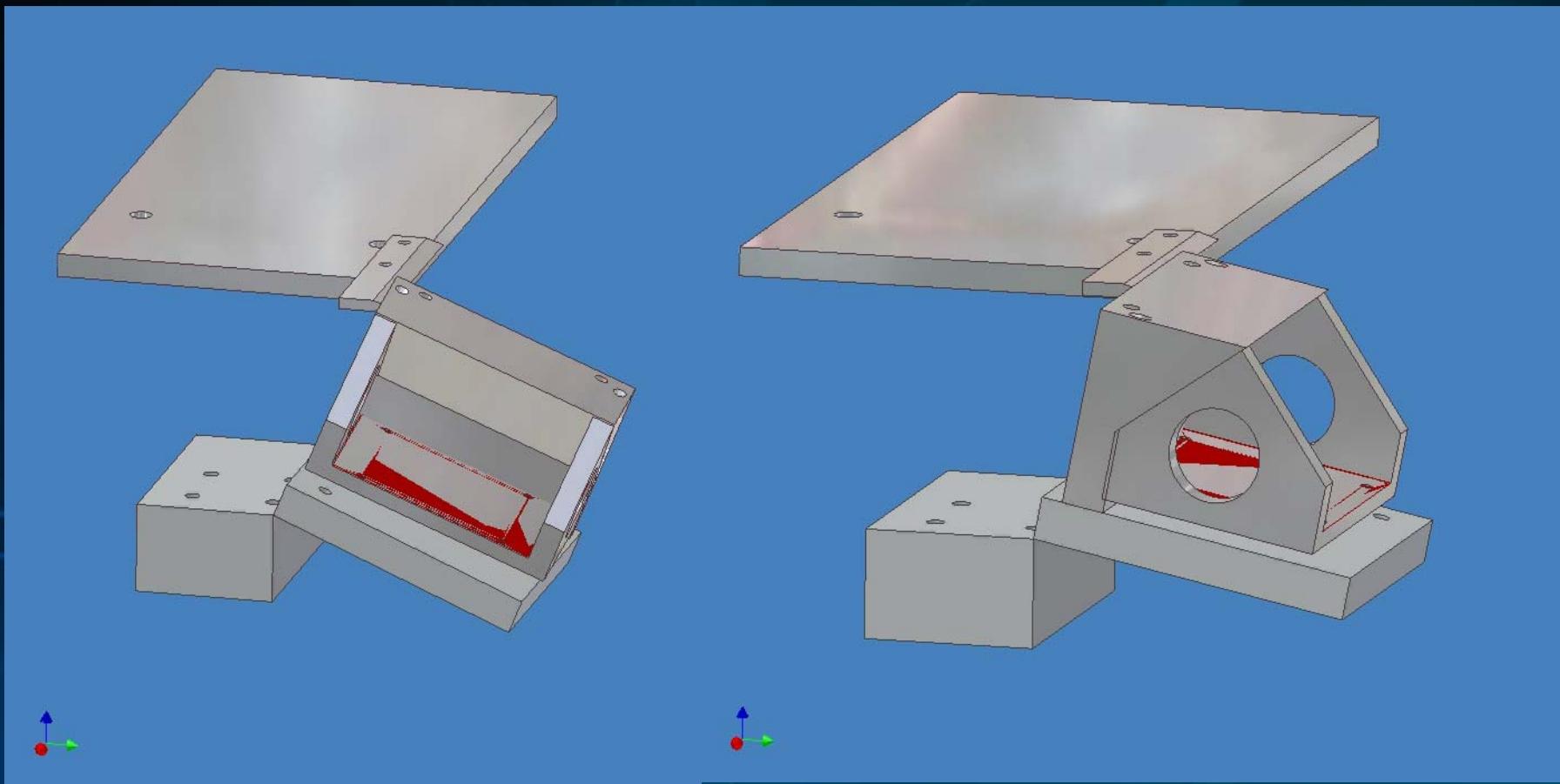
Adapter

Mounting
plate

Tilting base

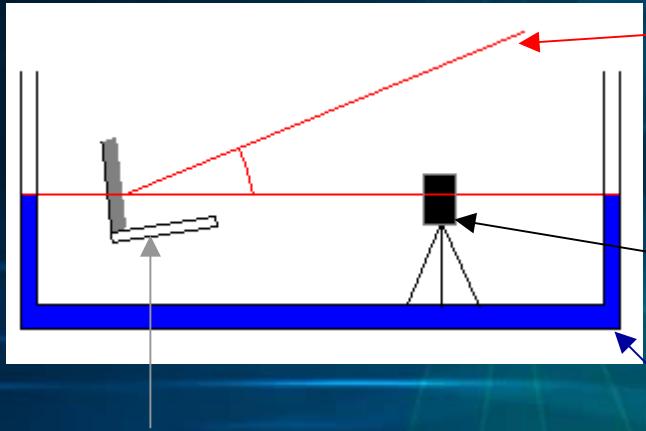


Adaptable base plate



Laser 0 degree measurement

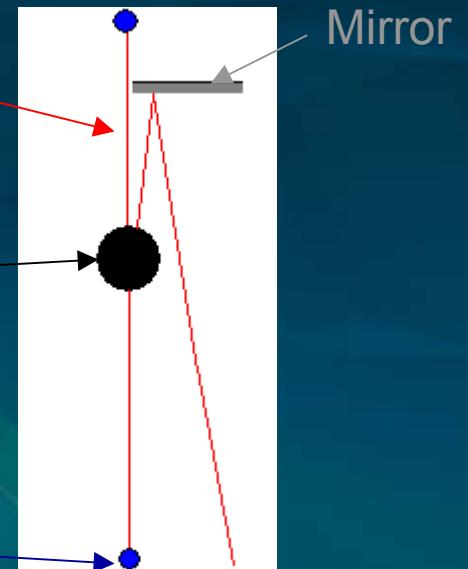
Side view of the installation



Plane that needs to be horizontal (with a mirror fixed perpendicularly)

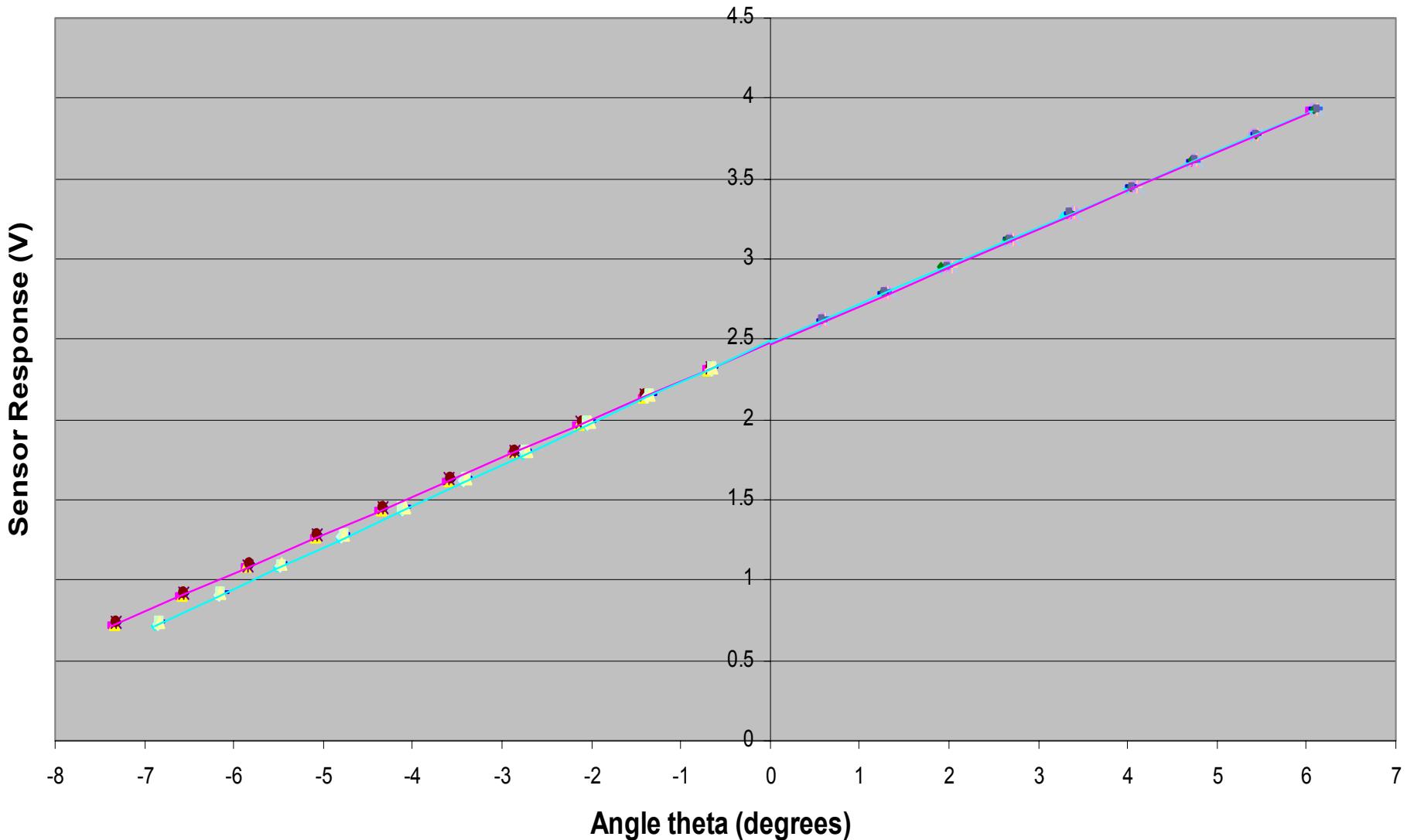
Laser beam
Rotary laser level
Tube filled with colored water

Above view



Mirror

Sensor Response vs. Angle theta



References

- CERN web page: <http://www.CERN.ch>
- Dr HOLMANN web page:
<http://my.fit.edu/~hohlmann/>
- FIT PSS web site: <http://pss.fit.edu>