GE alignment- status, proposal

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The general concept - recap

The aim of the GE-alignment:

to locate the strips of the read-out boards in the CMS coordinate system and monitor their movements.

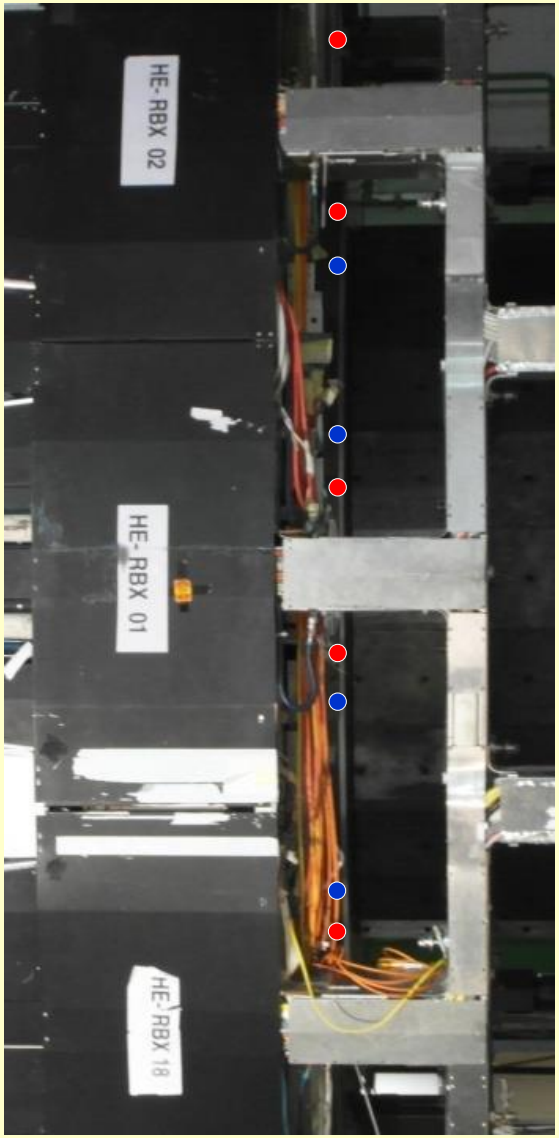
The general alignment concept:

•The strips are sealed during the production and not observable.Therefore the strip positions have to be transferred to the observable (outer) part of the chambers during the construction
•The chamber bodies have to be equipped with the necessary elements for position monitoring.
•The alignment readout+control should provide the operation of the system.
•The opto-geometrical data analysis provides the position data.
•Track-analysis can improve the final accuracy.

Chamber position monitoring - recap

Three levels:

1) **Survey-measurement**
1) **Hardware alignment system**
2) **Integration into the existing HWALI**
3) **Track-based alignment**

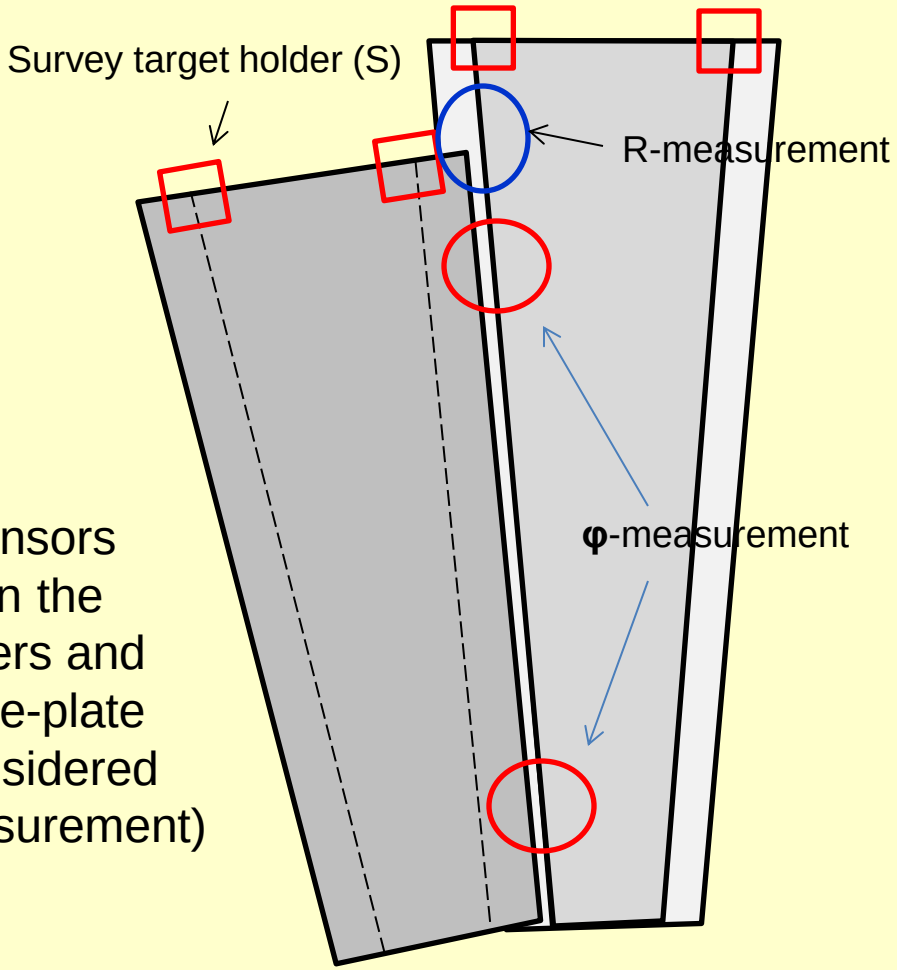


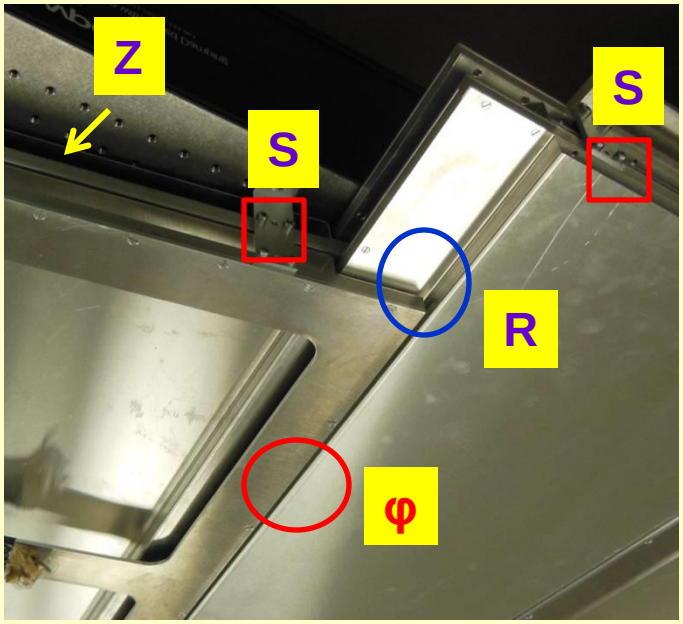
Survey:

Survey-targets mounted on the outer edges of the chambers (see later) are measured by photogrammetry after the installation (red points: short chambers; blue points: long chambers).

This gives a ~1 mm precision information on the relative positions of the chambers (super-chambers) wrt each other and the surrounding CMS-elements.

Alignment elements on the chamber - recap





Also sensors between the chambers and the base-plate are considered (z-measurement)

The total number of align. elements per chamber and their locations are still under discussion

The elements are glued on the chamber.Details (when, on which part) still to be determined.

Internal Calibration of a GEM chamber - recap

Calibration:

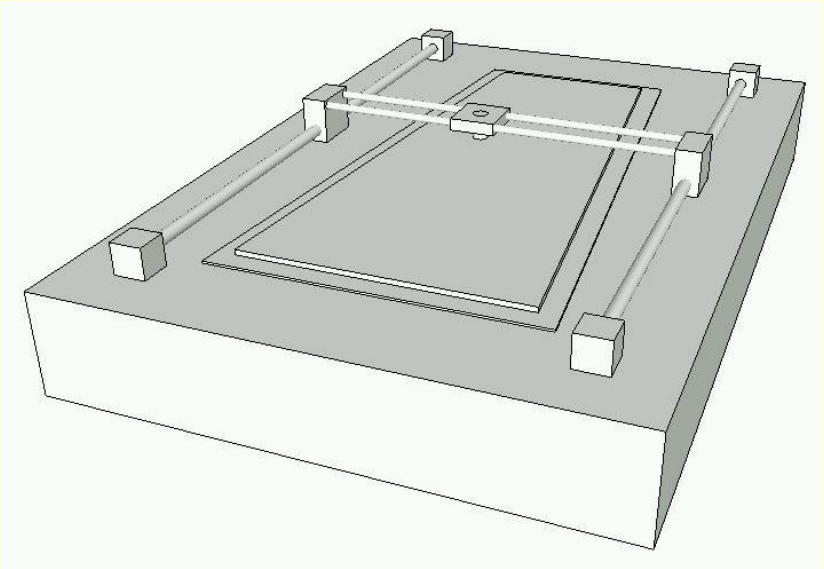
Determination of the positions of all the alignment-related elements in the chamber coordinate system.by survey and proximity-measurements performed on the calibration bench

Two steps are considered:

Step 1 – Scan the assembled chamber (determination of the via holes and part of the alignment elements)

Step 2 – Measure the rest of the elements (e.g. frames used as target for the cpcitive sensors) by Coordinate Measuring Machine (CMM).

Scanning table



„Fantasy” picture

The device can be home-made or purchased on the market

Scanning table

GE1/1, Wigner news:

An estimation of the cost of the design and production of the scanning table is in the range of 25-30 kEUR. This is for internal information only, for an official quotation a request letter is needed.

A recently built small (200x200 lateral movement) 3D-table. A similar bigger one is in work. The design is different from what we need but the difficulties and their solutions are the same.

An example for the high res camera

A possible camera type:

Baumer LXG200-C

- 35 mm CMOS
- 5120 x 3840
- 11 fps
- GigE connection
- F- or C-mount lenses

View area:

- ~10-20 µm x <resolution> ~ 50 x 40 mm
- probably outer edge needs to be subtracted due to geometrical distorsions
- all pixels will be positioned in the moving table's coordinate system and
- successive images then can be stored

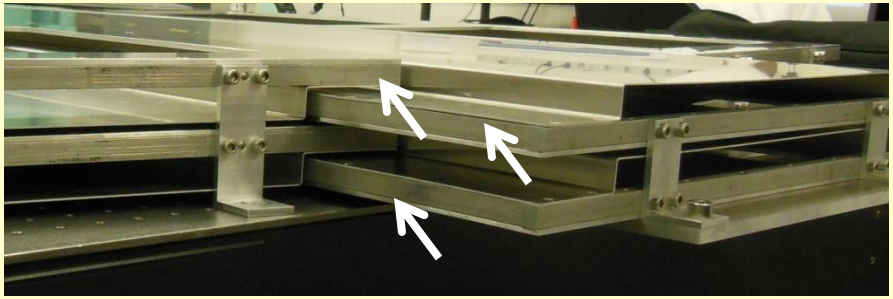
(http://www.baumer.com/de-en/products/identification-image-processing/industrial-cameras/lx-series/)

Calibration step 2 – CMM*

* CMM: Coordinate Measuring Mchine

A machine similar to this to locate the frame surfaces in the chamber or super-chamber coordinate system:

(Illustration, taken from the net)



Approximate price: 15-20 kCHF

This device can then be reused in all the GEM projects (GE1/1, ME0 and GE2/1 alignment)

Opto-geometrical model

COCOA*: CMSSW software package that can be used to simulate the expected accuracy of the measurement of the position monitoring.

For that the opto-geometric model of the system has to be defined: positions of the alignment-related elements, the calibrated data and their errors, the measuring elements (sensors) and the accuracy of the sensor-measurements.

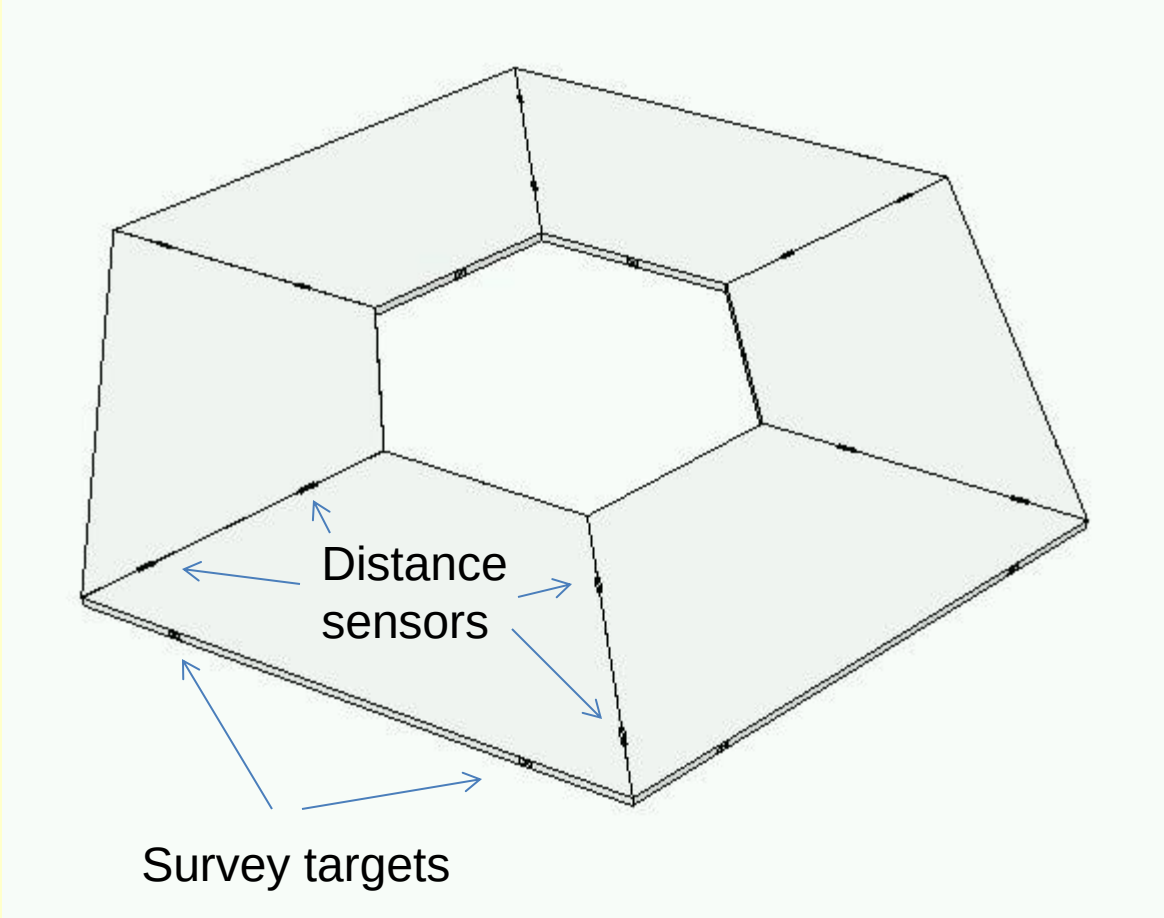
The same model **can be used later to analyse** the real data by simply introducing the results of the sensor measurements.

* **C**MS **O**bject-oriented **C**ode for **O**ptical **A**lignment

Study with simplified model

A s the first step a simplified arrangement (see on the picture) has been studied to gin experience with such a system. The „chambers” contain survey targets and a pair of distance sensors on both edges.

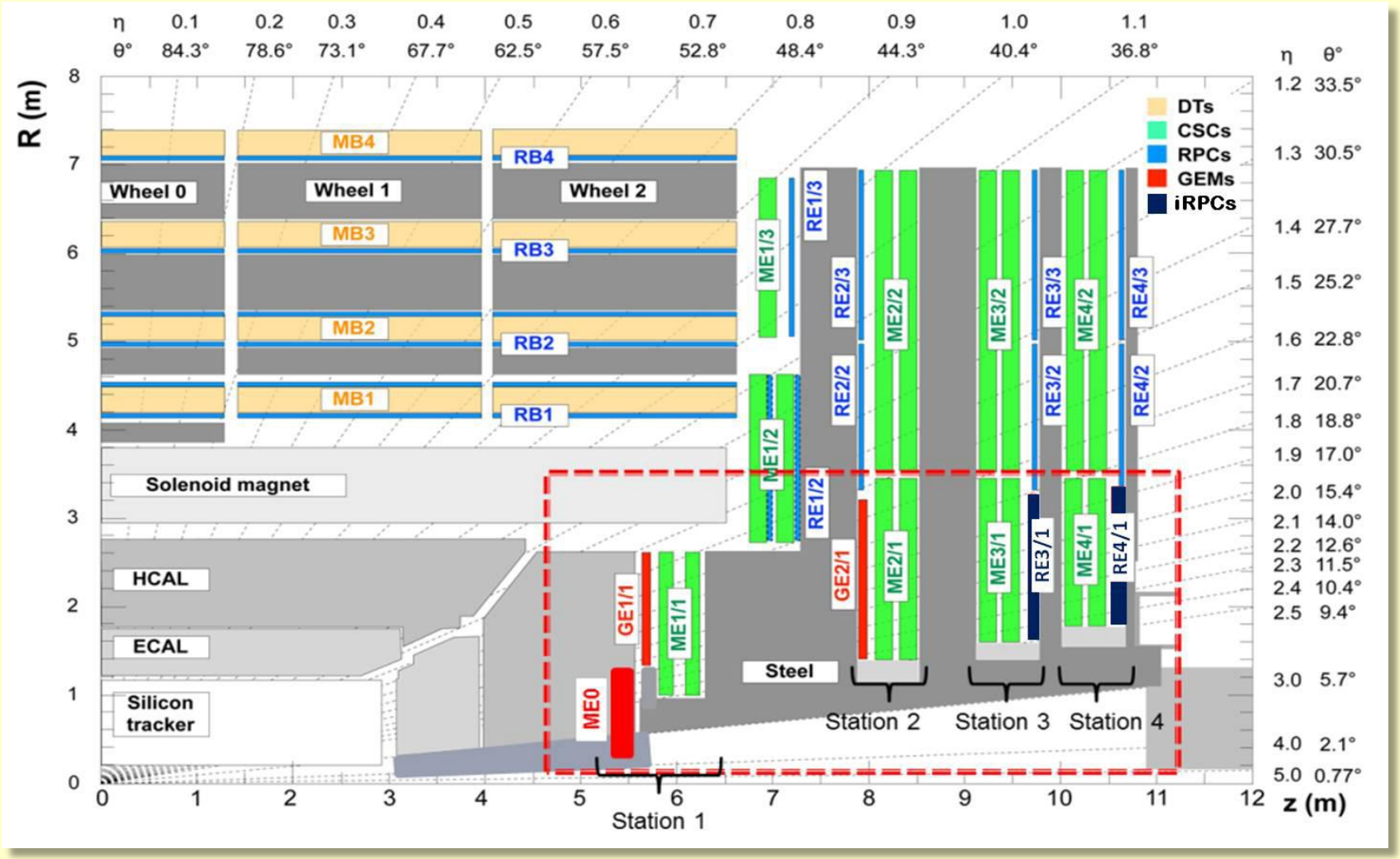
The model seems to work and converge to correct results. The next step is to describe the real system and substitute the survey measurement by the R and Z measurements.



The opto-geometrical modelling will give the final answer to the question of the achievable alignment precision and helps to optimize the configurtion of the alignment elements on the chambers (super-chambers).

Connecting the GE2/1 into the existing HW Alignment system

Phase II MU EndCap

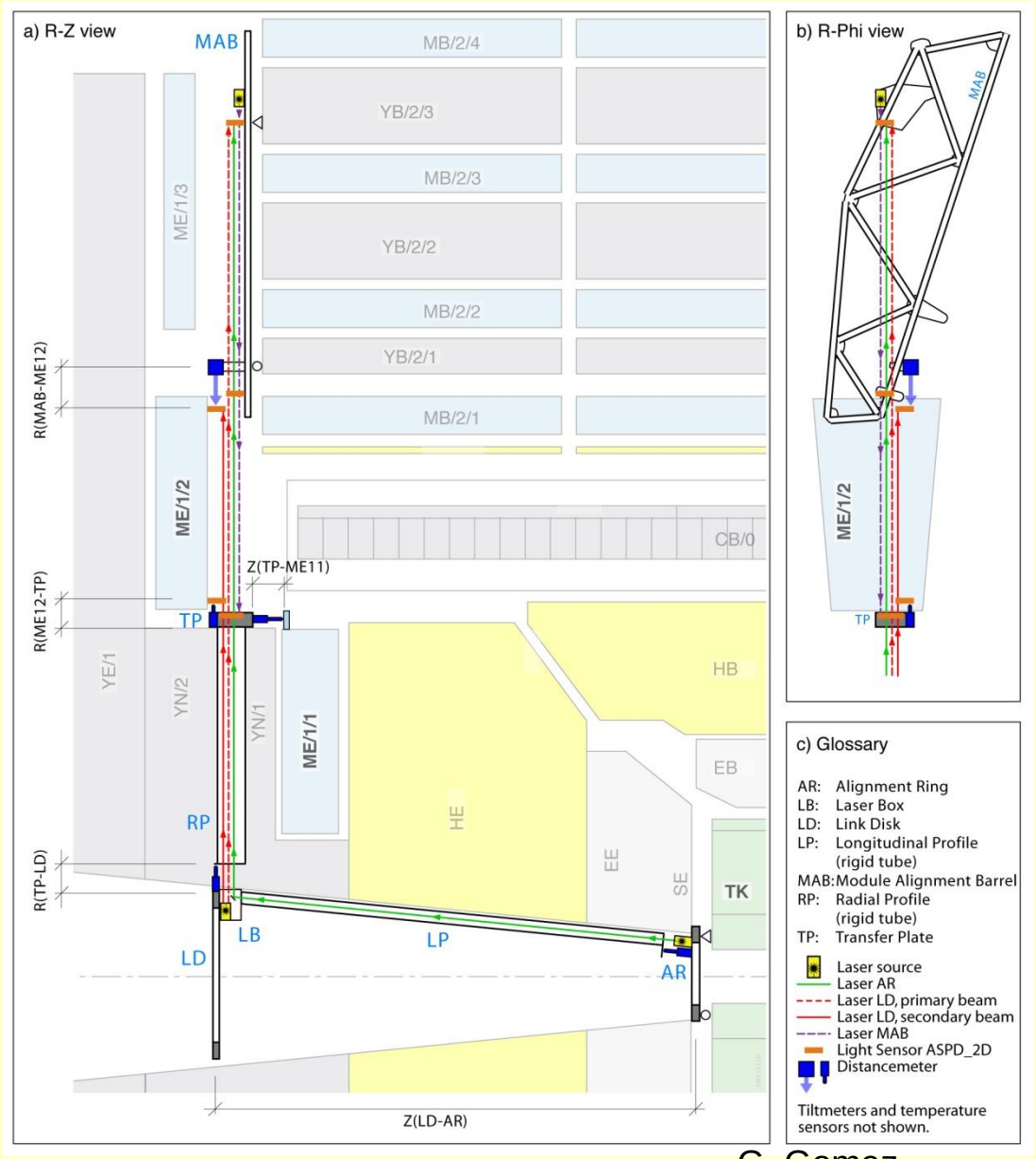


G. Gomez

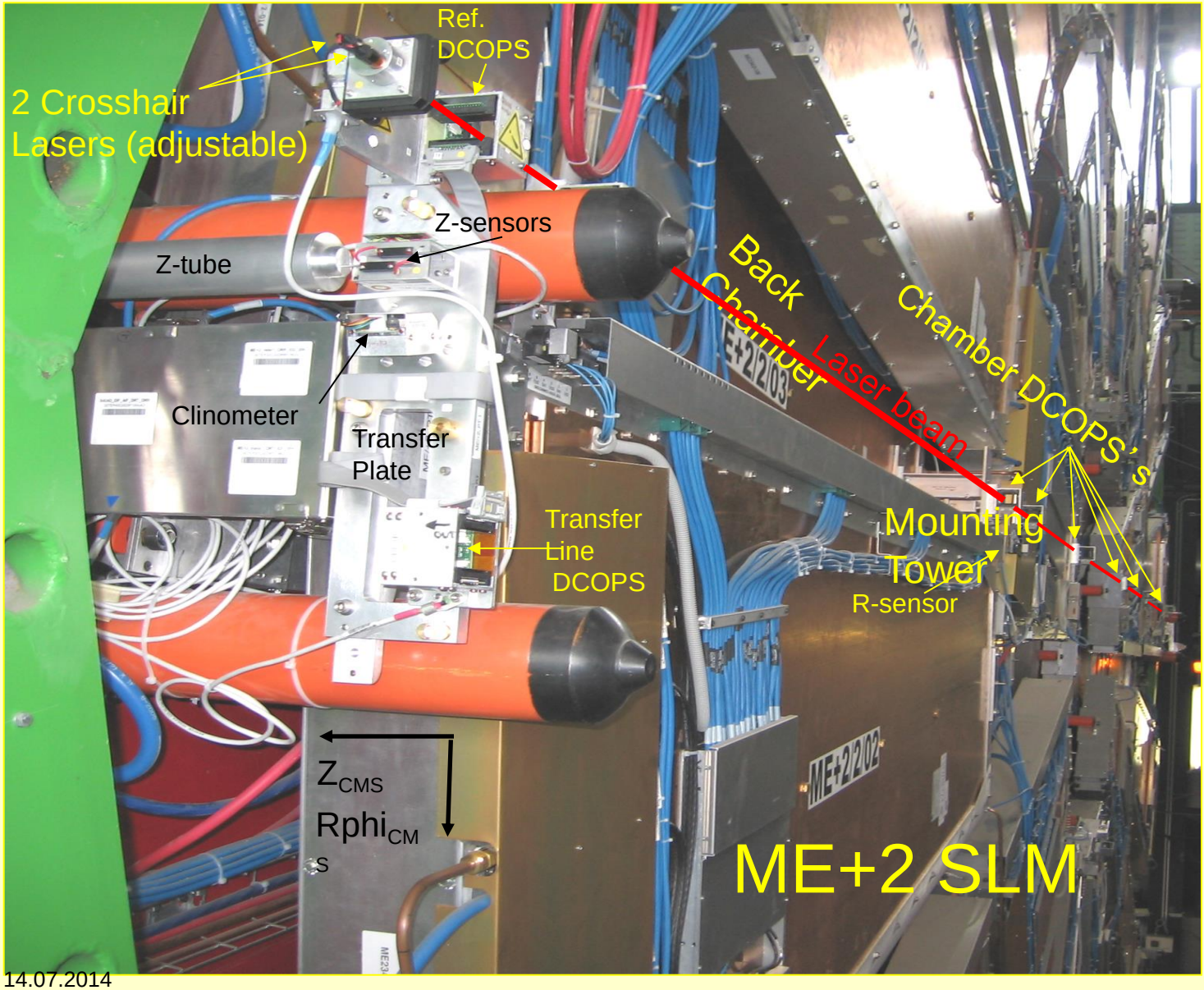
Must be aligned to precision ~ spatial resolution

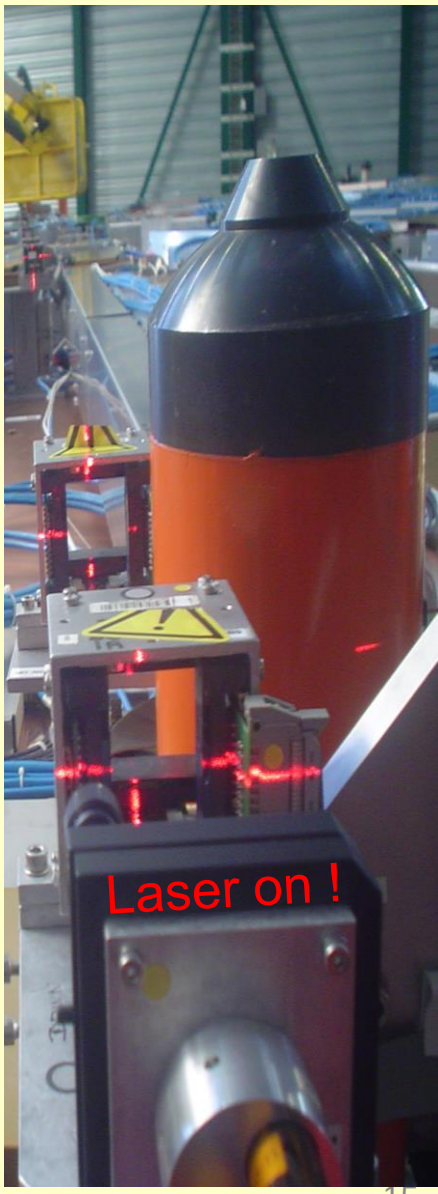
The Link Alignment System

- LD wrt AR (wrt TK)
- MAB wrt LD
- ME1/2 wrt LD
- ME1/1 wrt LD (less precise)
- ME1/2 wrt MAB
- Endcap deformation
- ~1/6 of endcap monitored
- Barrel wrt TK ~1mm
- Fast check of relative movements

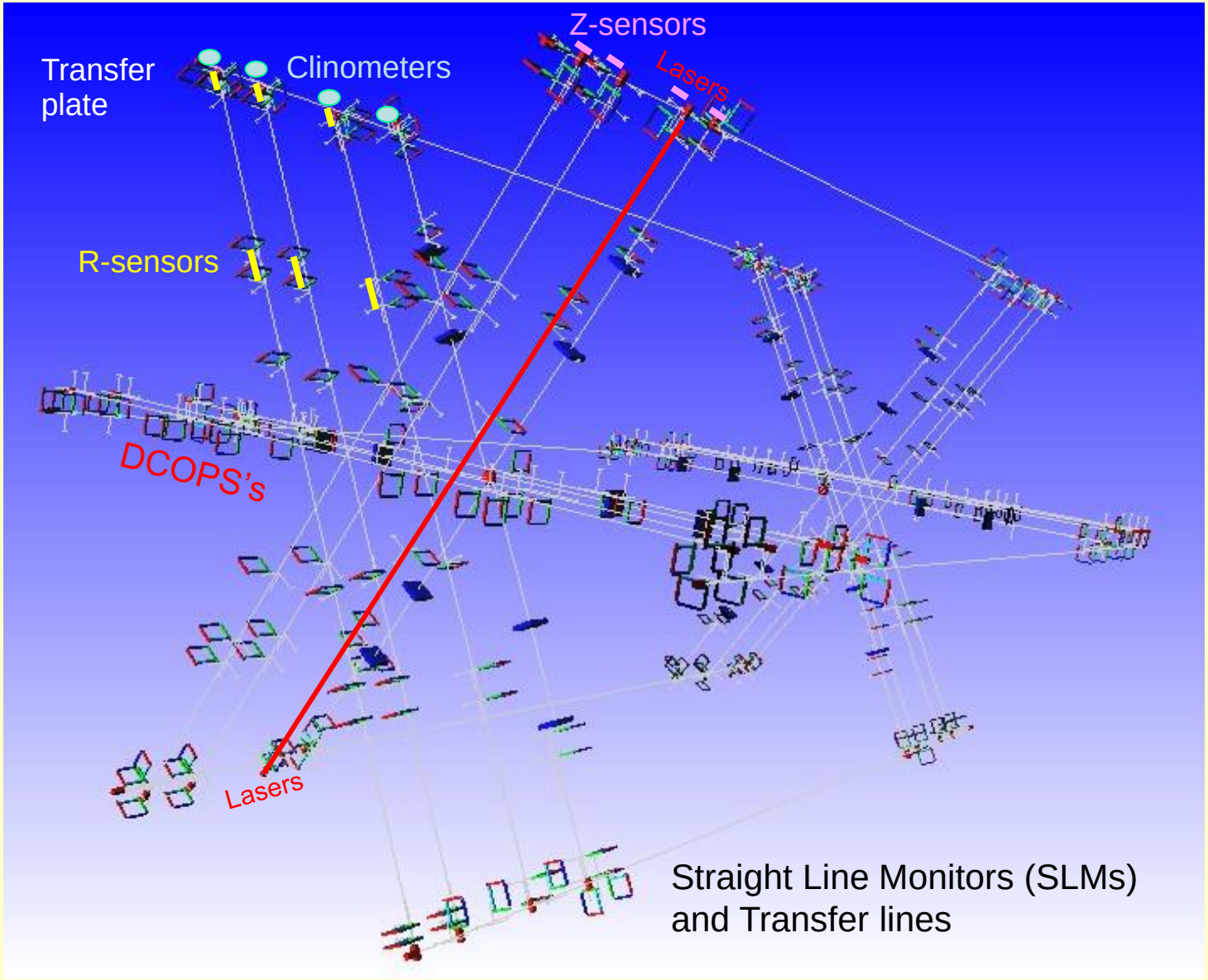


HW EndCap Ali of CMS





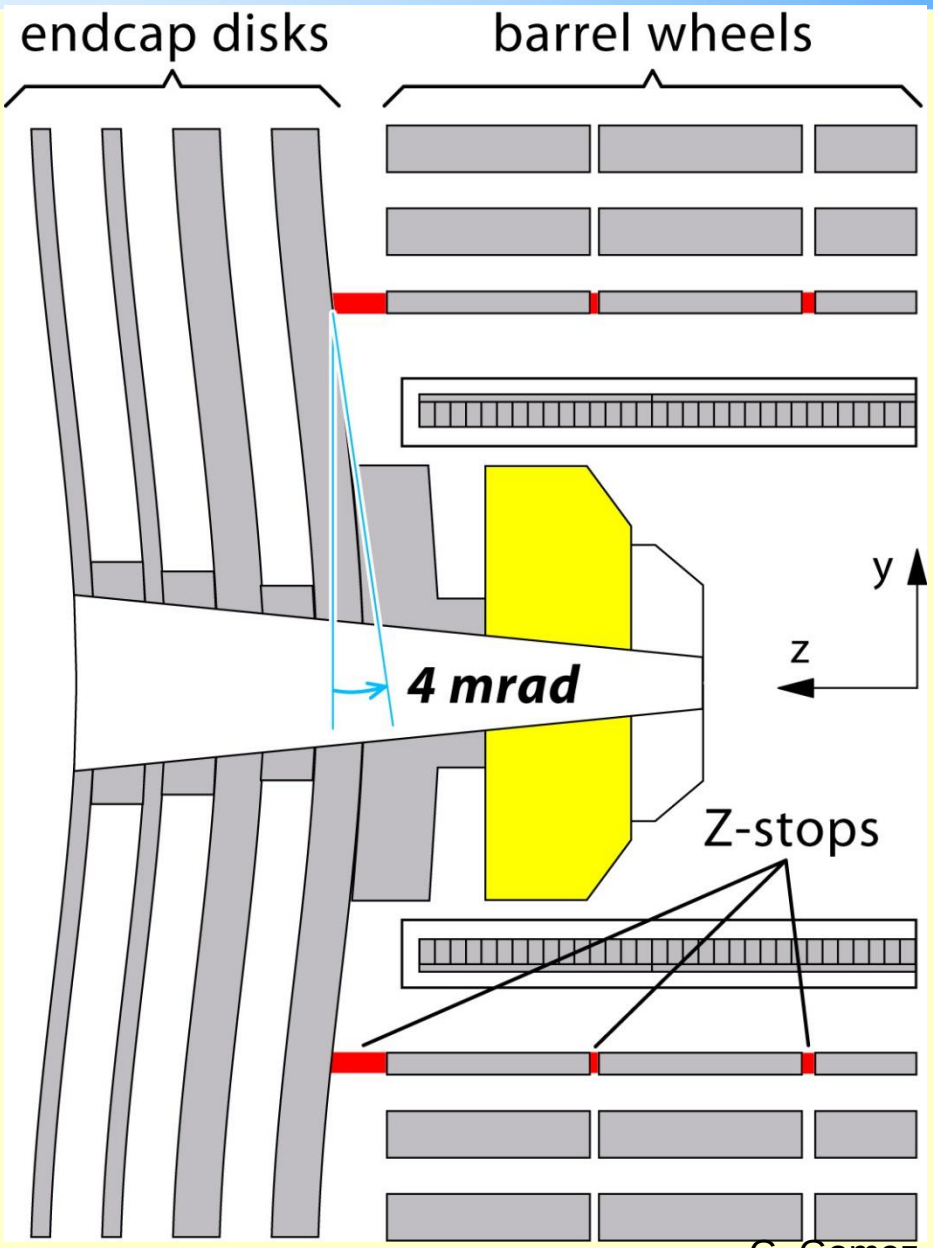
Full HW Ali Structure



Straight Line Monitors (SLMs) and Transfer lines

EndCap Deformation

- Disk movement along z
- Disk deformation
- Tracks marginally sensitive
- Physics marginally sensitive
- Link only YE1
- Need endcap SLMs for others

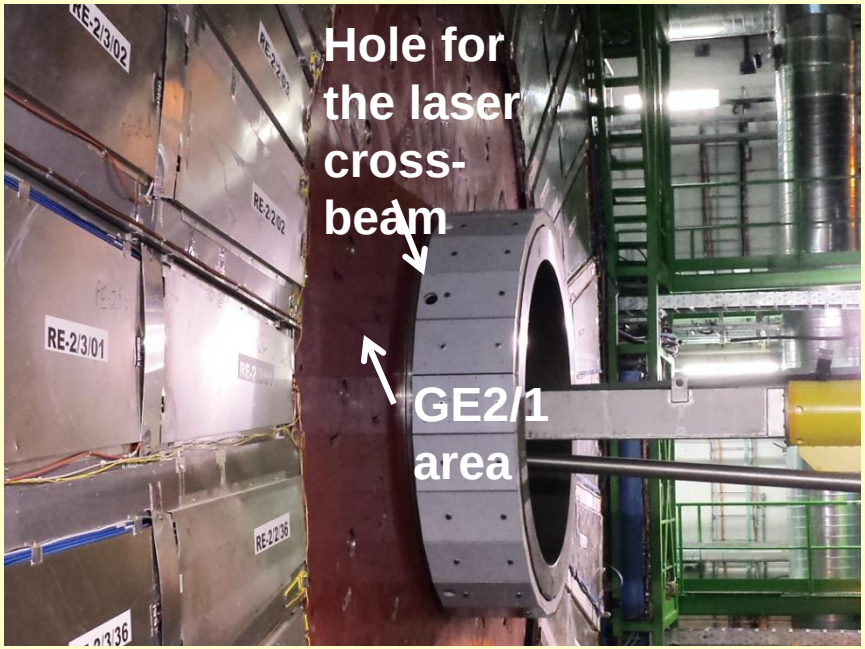


HW-alignment of the GE2/1 detector

Concept:

- Internal alignment of the chambers of the GE2/1 disk by capacitive sensors similarly to GE1/1
- Connection of the GE2/1 disk to the existitng Muon Endcap Alignment system to locate the disk in CMS. For this step the proposal is to mount 6 DCOPS sensors (developed and used by the Muon Endcap Alignment system) on the GE2/1 disk in a way that they can be seen by the laser cross-beams. Their positions can be measured wrt the Muon Endcap in CMS-phi and CMS-Z. The 6 measurements can locate the GE2/1 disk in CMS.

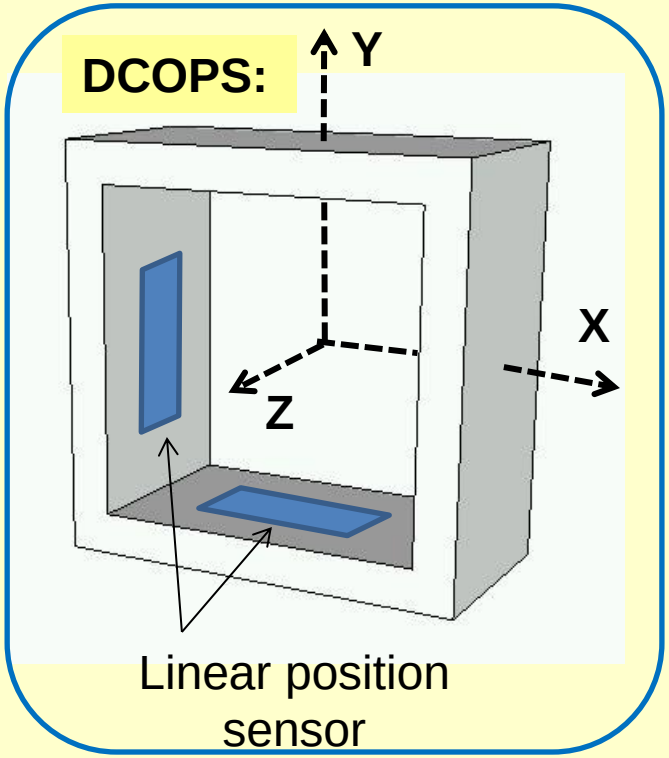
Muon Endcap Alignment elements in the GE2/1 area

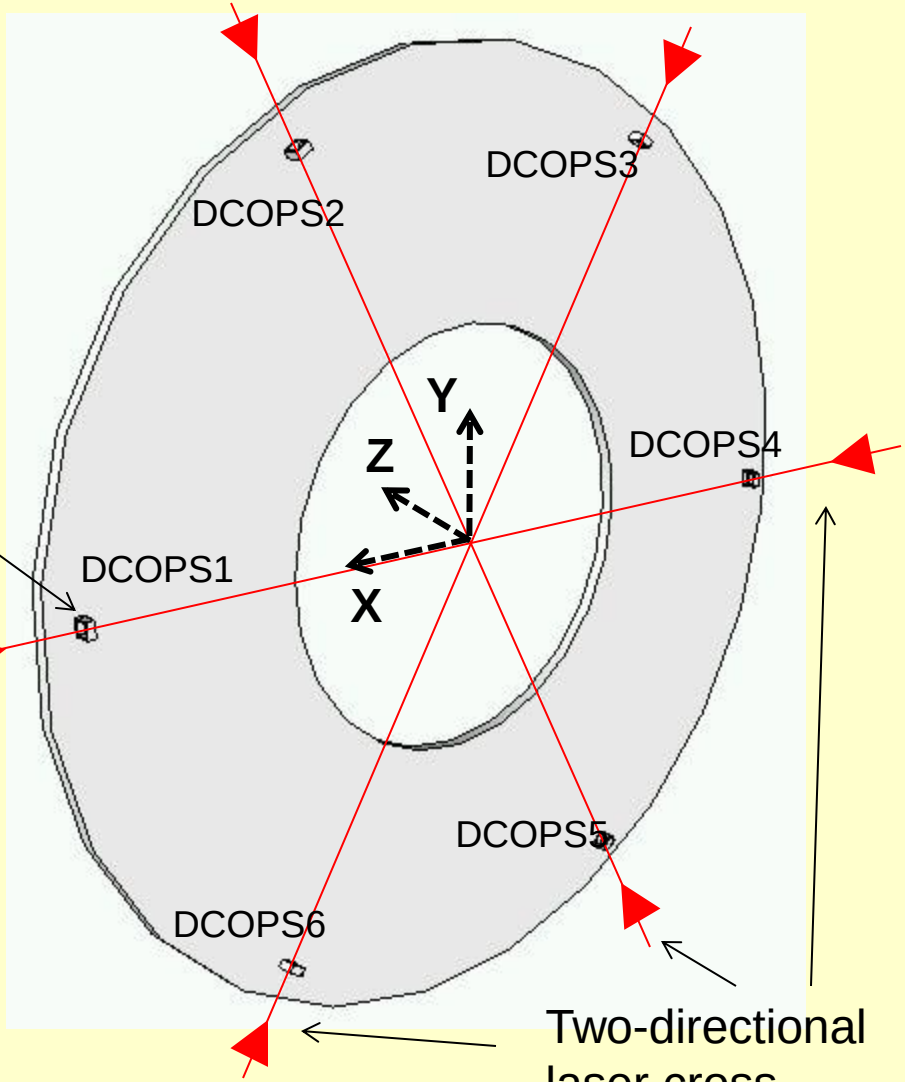


Back-side of the YE1 disk

IP-side of the YE2 disk

Very schematic drawing of the „connection to CMS” concept:





Simulations show very good positioning!

An issue to deal with!

The Hungarian Cluster wouldn't have enough manpower and resources to

- modify and operate the Link
- modify and operate the EndCap alignment

We need new collaborators!!!