Silicon sensor probing and studies of the muon p_T scale uncertainty at CMS

Presentation, 22 nd September 2015

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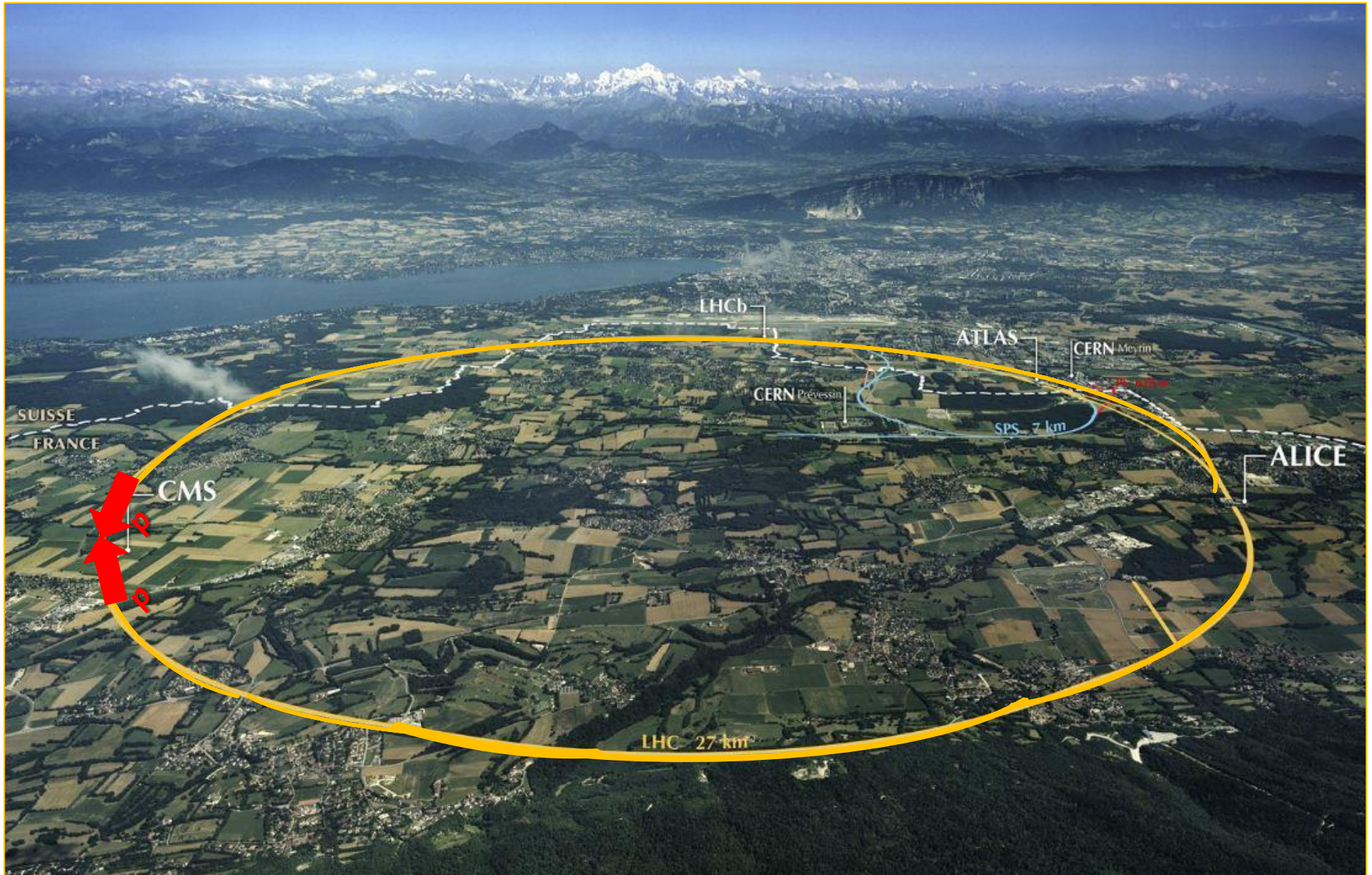
Italian Summer Internship

Istituto Nazionale di Fisica Nucleare

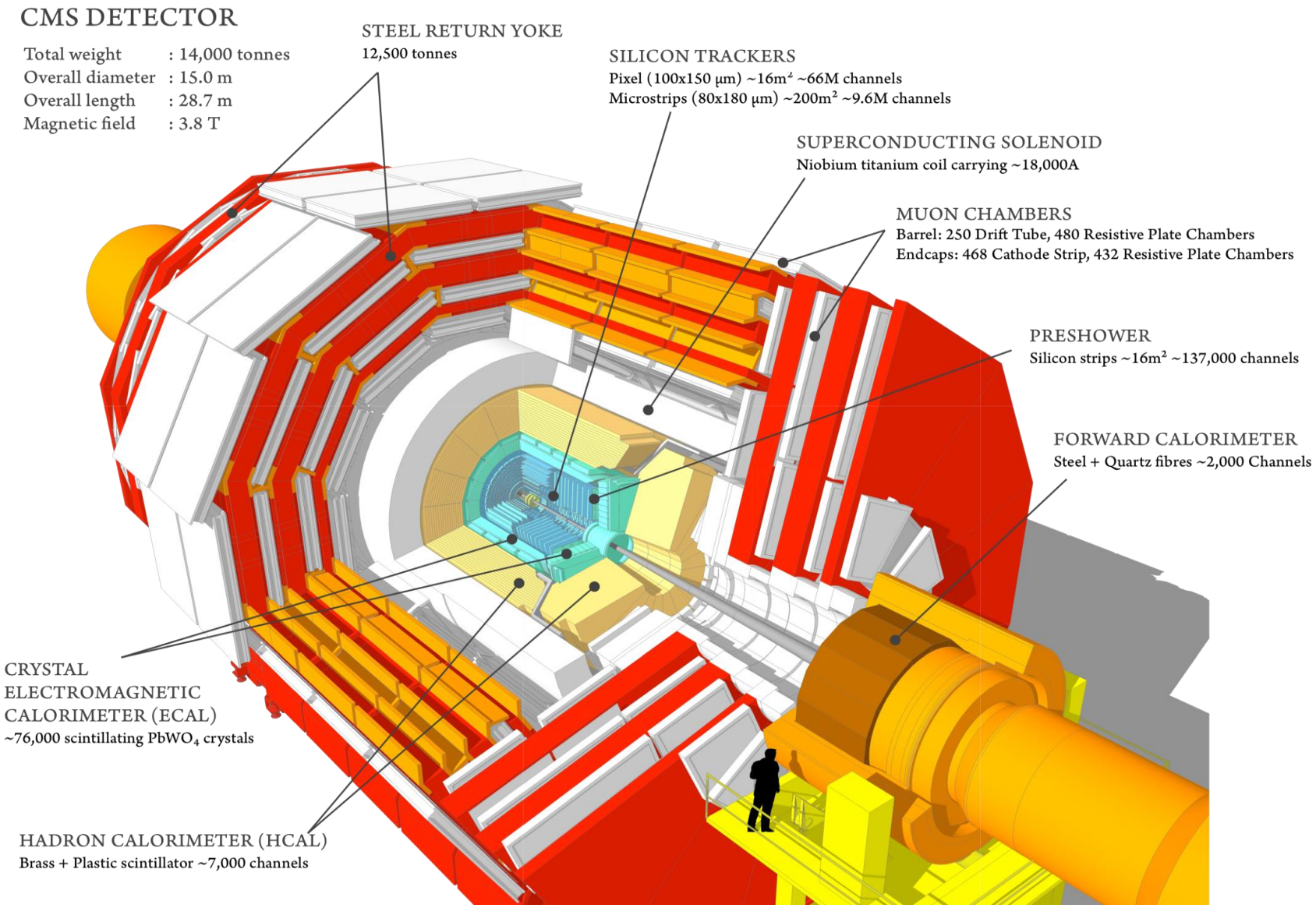
Outline

- LHC and CMS
- Tracker
- Silicon sensor probing
- Studies on p_T scale
- Tracker/Muon System Alignment

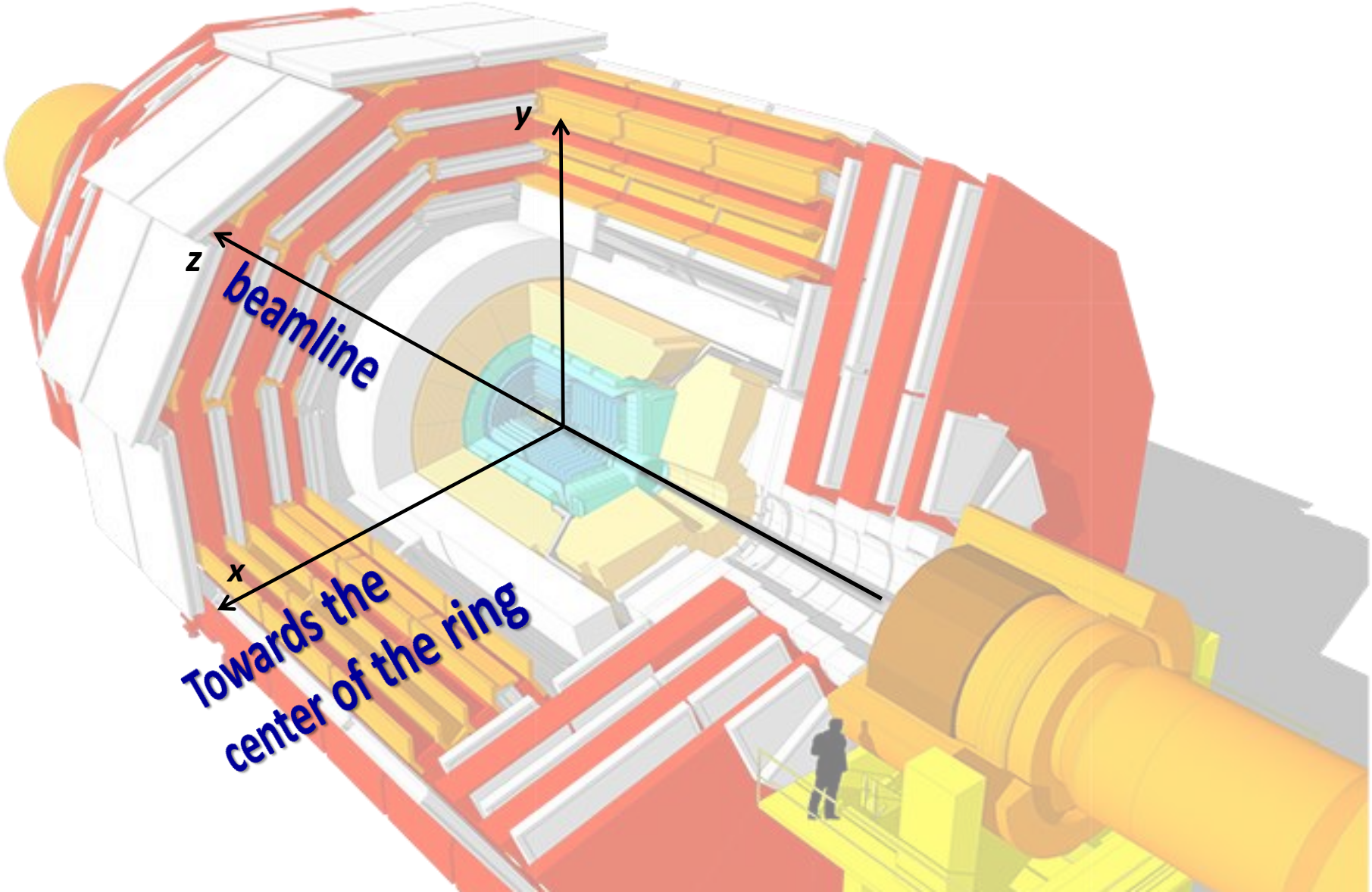
Large Hadron Collider



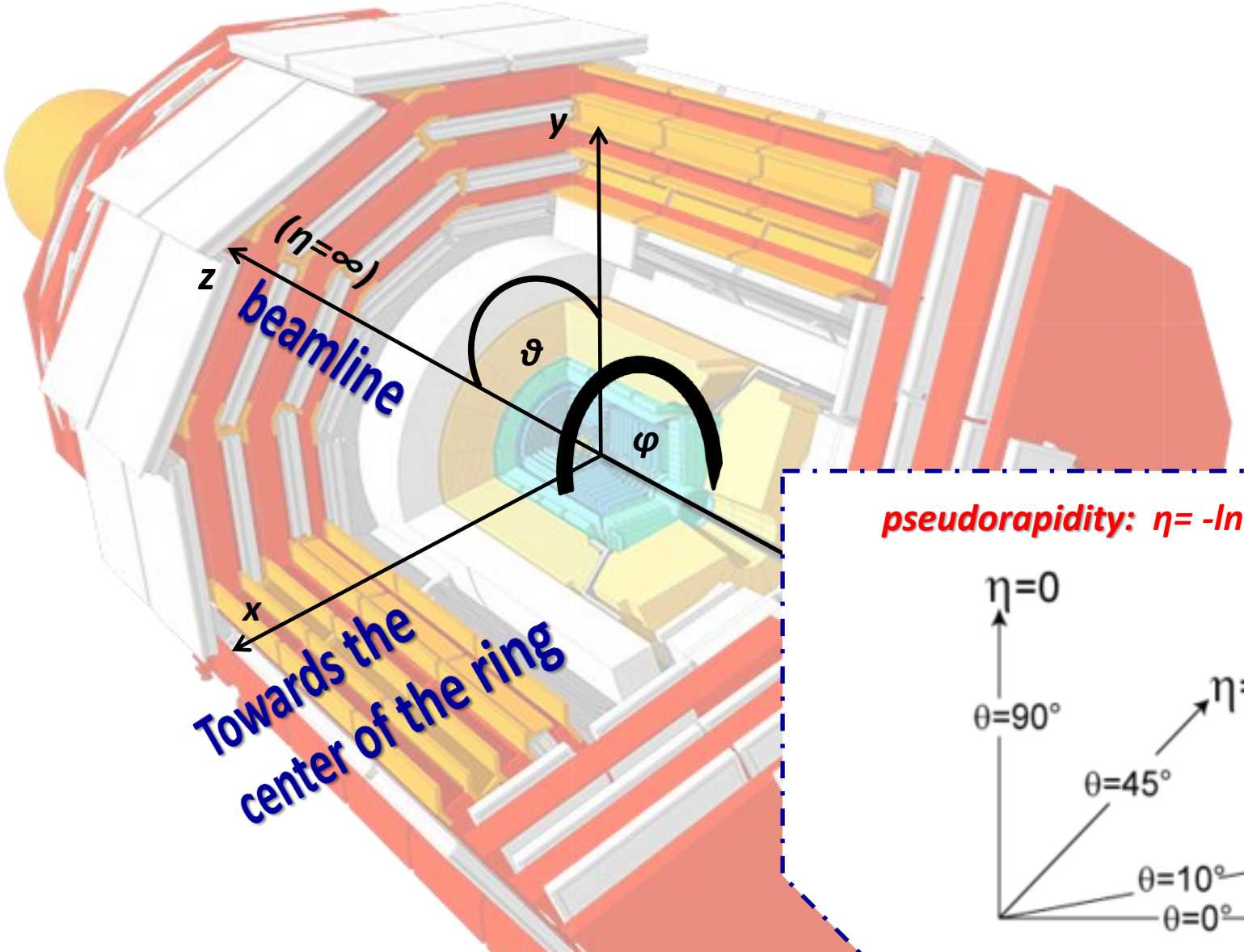
Compact Muon Solenoid



CMS Coordinates

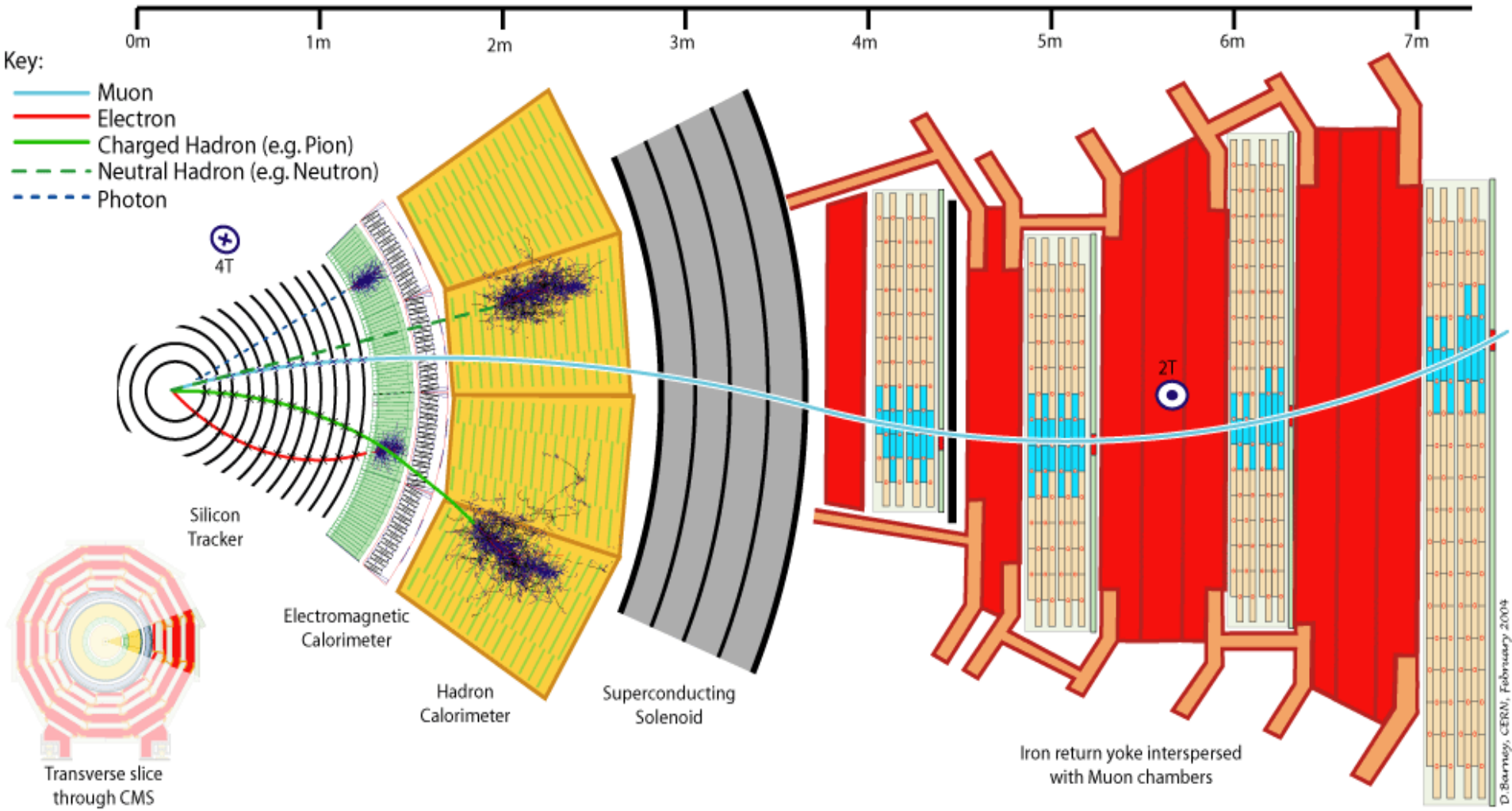


CMS Coordinates

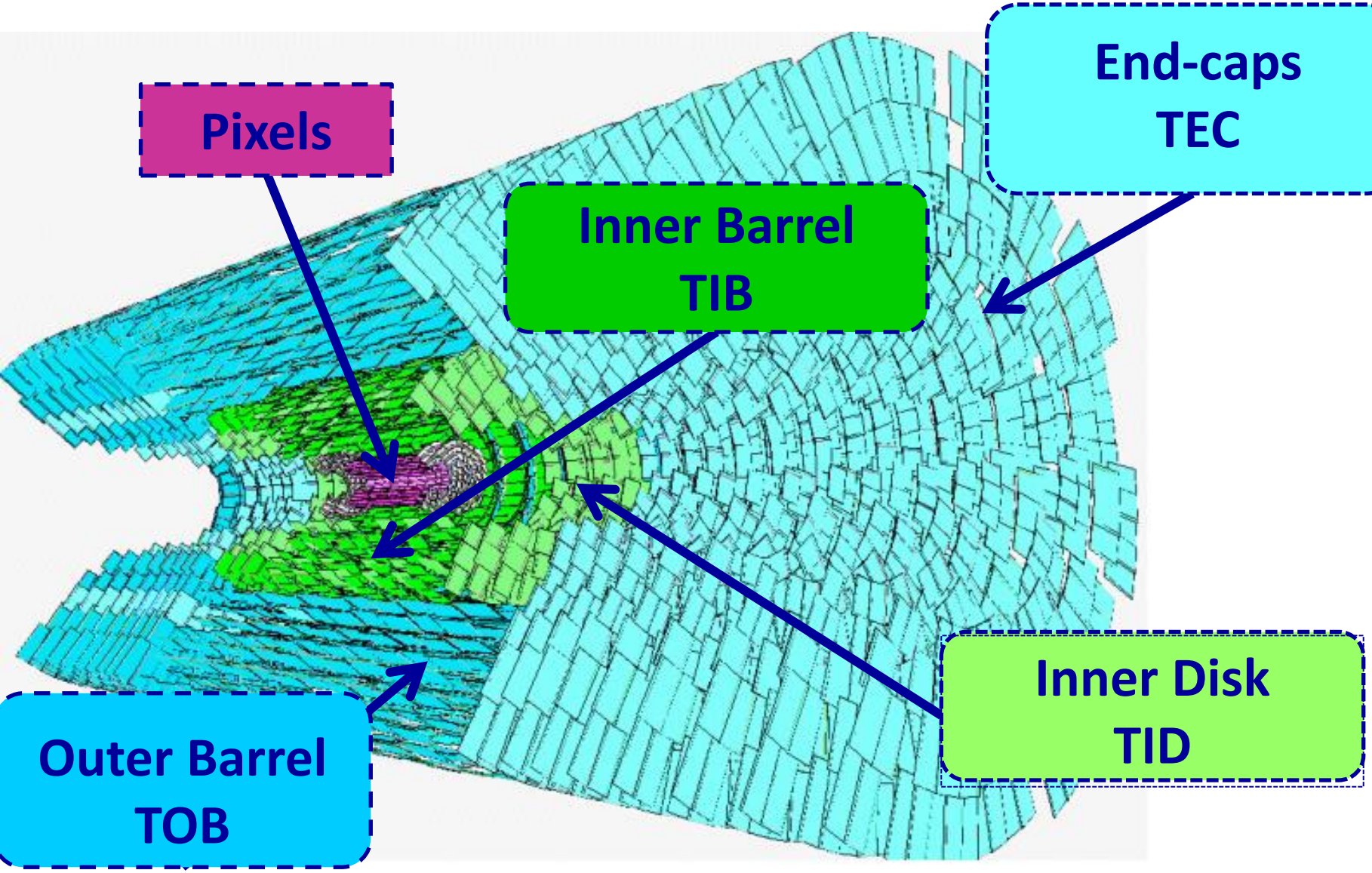


pseudorapidity: $\eta = -\ln \tan(\vartheta/2)$

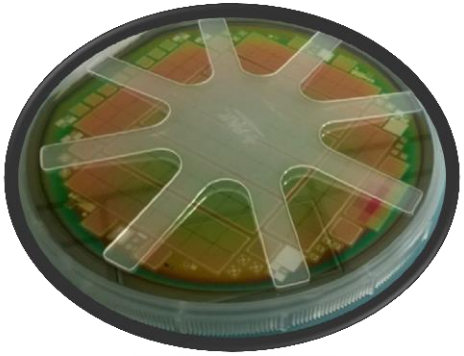
A CMS transverse slice

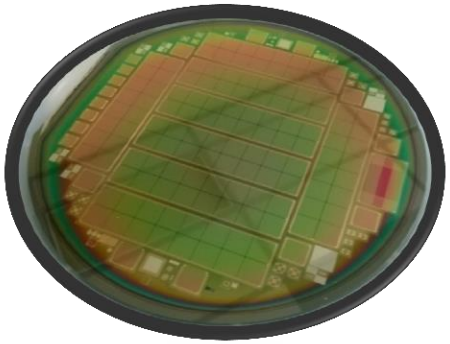


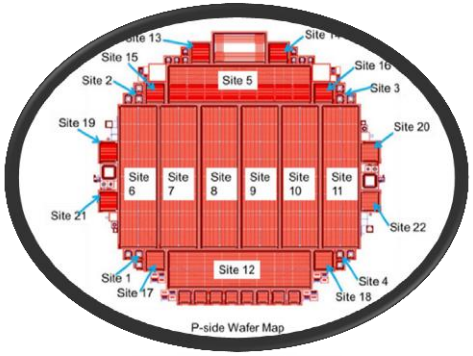
The CMS Silicon Tracker



FPIX upgrade Silicon Pixel



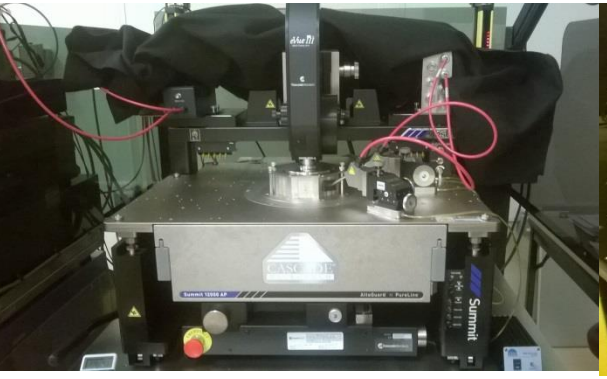


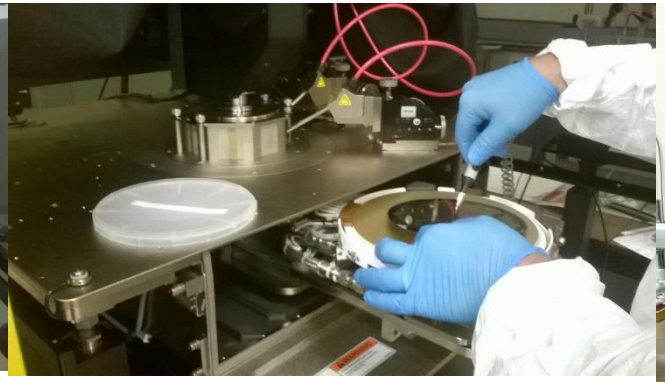


Keep FPIX documentation on the CMS docdb (private server):

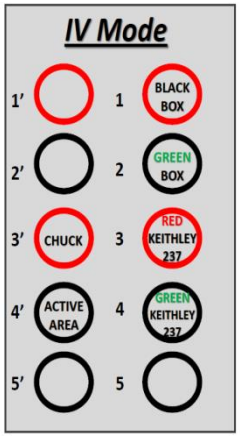
https://cms-docdb.cern.ch

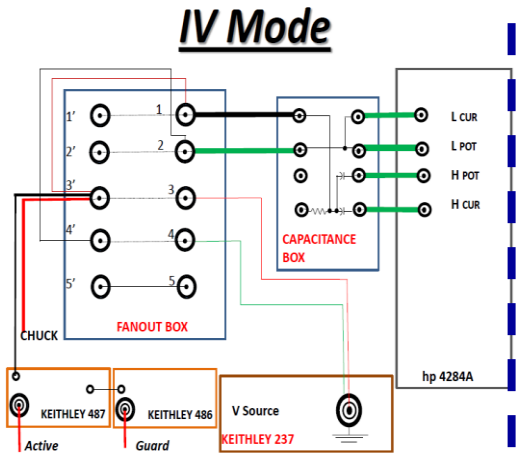
We made IV and CV measurements on wafers provided by Sintef using an automated probe station at SiDet.

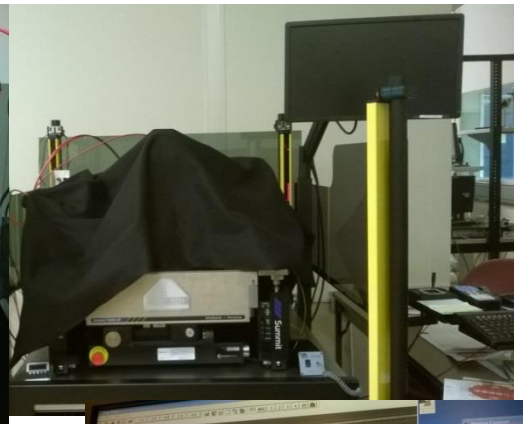


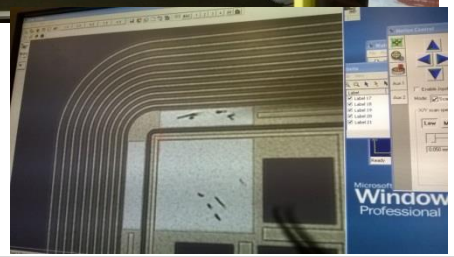


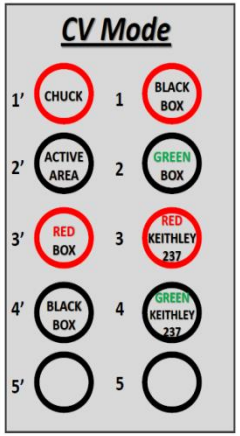
IV and CV Measurement

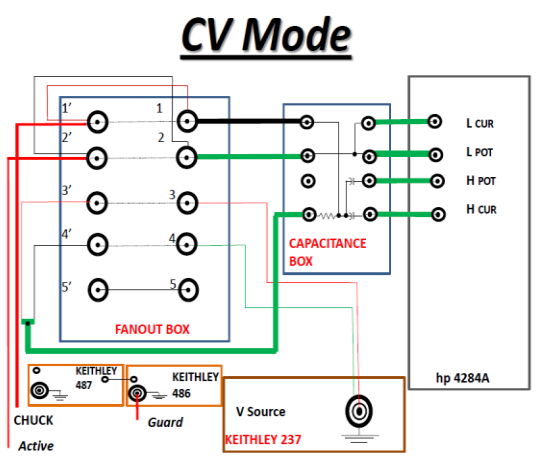


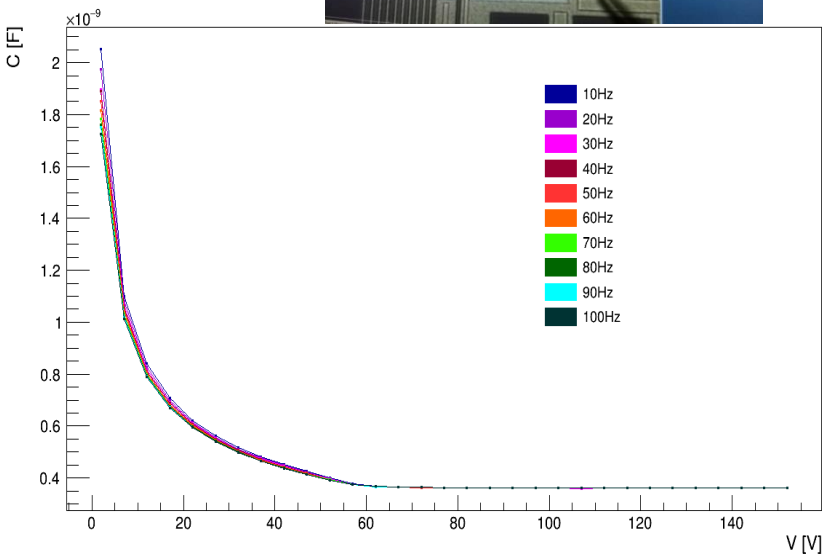






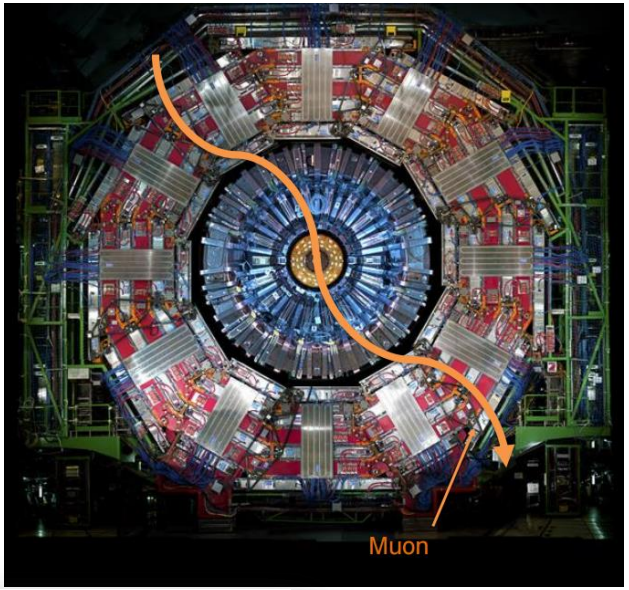




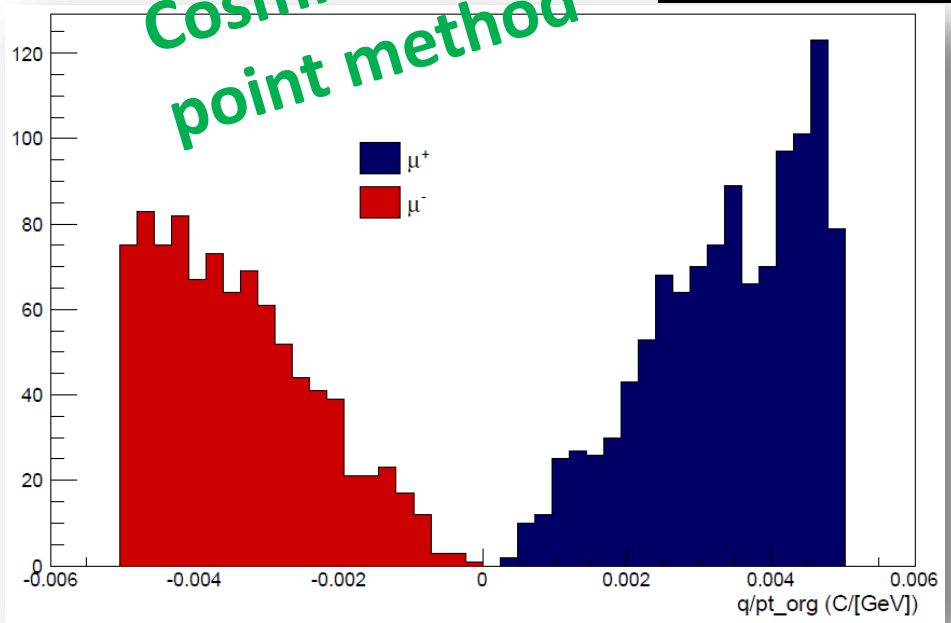


Muon p_T scale study

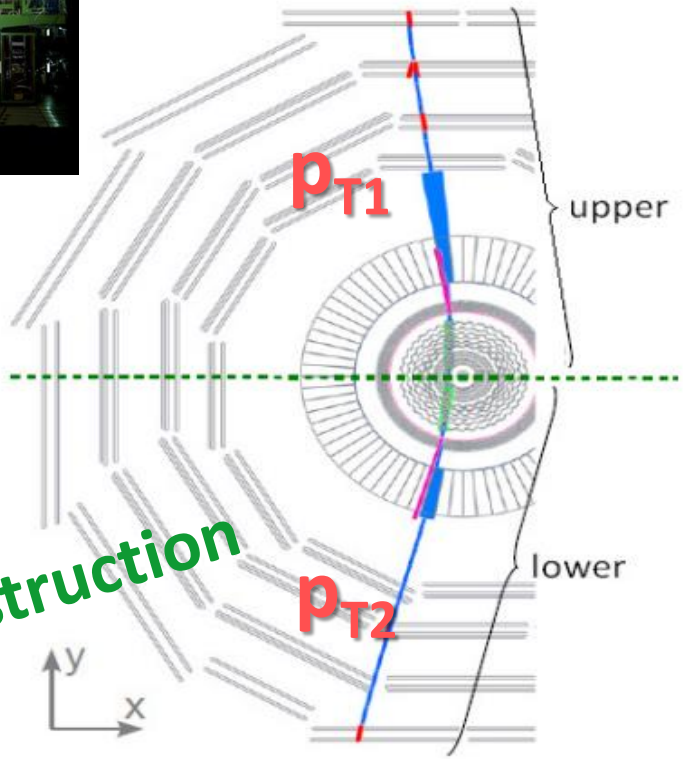
- Cosmic muons



Cosmic end point method



2-leg reconstruction



P_T Dependence?

https://twiki.cern.ch/twiki/bin/viewauth/CMS/MuonReferenceResolution

- **end point method gives 5% uncertainty on momentum scale at 1 TeV;**
- **Searches BSM & for massive new particles (e.g., Z');**

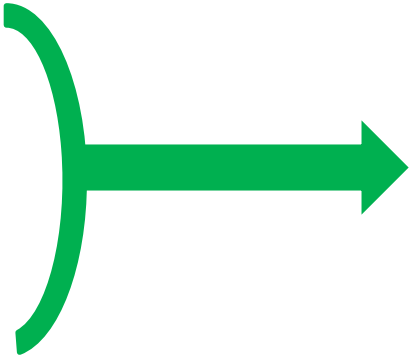
$$p_T = p_T^* \left(1 \pm 0,05 \left(\frac{p_T^*}{1000}\right)\right) ?$$

- **Study the p_T difference between upper and lower parts of cosmic muons at high p_T.**

Workflow 1…

- We started with the CMS Alignment Validation workflow

- **Easy**
- **Fast**
- **Parallelized**



Validation and comparison of any set of alignments

lxplus at CERN

- We studied the **Run2015B cosmics** using different conditions to fit the tracks.

PCL alignment

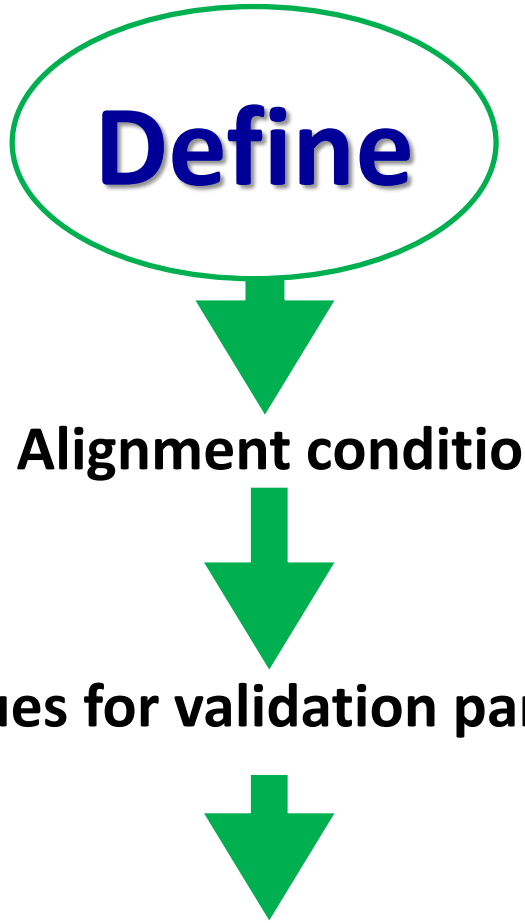
36 total degrees of freedom for 6 structures

automatic process that aligns the most important DOF as data comes in

hp1368

aligned all the pixel modules

Workflow 2…


Define
Alignment conditions
Values for validation parameters
which of the defined validation to run on which of the defined alignments

The general procedure:

- *Log into lxplus*

```
ssh user@lxplus6.cern.ch
```

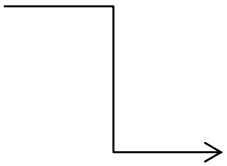
- *Create a release area*

```
cmsrel CMSSW_7_4_6
cd CMSSW_7_4_6/src
cmsenv
```

- *Check-out*

```
git cms-addpkg Alignment/OfflineValidation
scram b -j 12
cd ../..
```

NOW: Run2015B cosmics



cosmics previous packages

- *Copy the package into Alignment/OfflineValidation/python i.e.:*

```
cp /afs/cern.ch/user/h/hroskes/public/tracksplitting/Dataset_CRAFT_cff.py
```

After putting dataset there:

- *Copy the config file*

```
cp /afs/cern.ch/user/h/hroskes/tracksplitting/new/test.ini .
```

The configuration file is the central point to define properties of the validation session!

- *Then the command to run is:*

```
validateAlignments.py  -c test.ini  -N <name of the folder where the output goes>  -m
```

- *This creates a root file on eos*

```
/store/caf/user/$USER/AlignmentValidation/<name specified with -N>
```

- ***It is also possible to run:***

```
validateAlignments.py  -c test.ini  -N <name of the folder where the output goes>  -n
```

This command just creates the files, and then you can run them manually.

- ***Run all the validation jobs:***

***.sh files besides TkAlMerge.sh**

i.e.:

```
./TkAlTrackSplitting.test.hp1368.sh
./TkAlTrackSplitting.test.PCL.sh
./TkAlMerge.sh
```

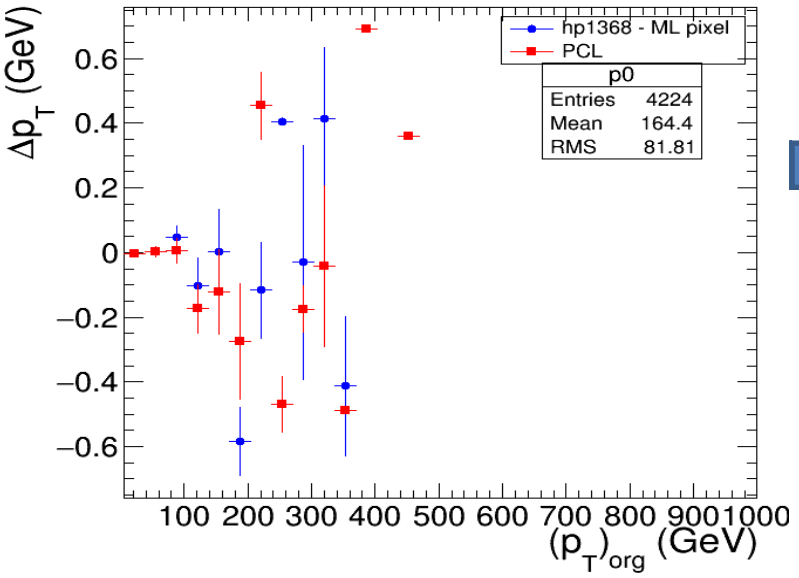
The last one creates the plots!!!

- *If you do not have access to eos:*

Change all the paths!

Workflow 3…

- extended the range of the p_T;



Few Data!

- Tried to extend the analysis to include pre-2015 cosmic ray runs.

- Find datasets:

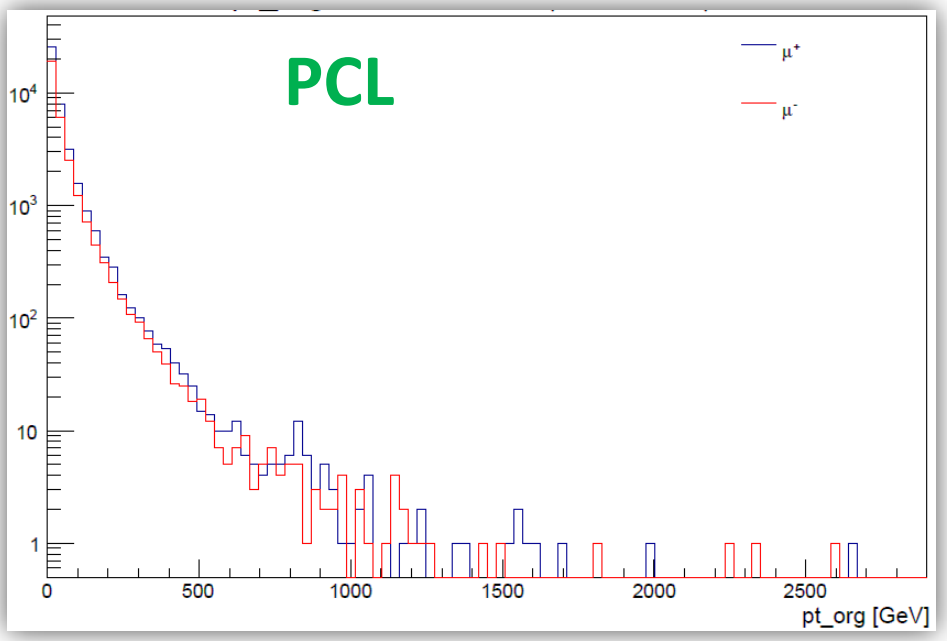
https://twiki.cern.ch/twiki/bin/view/CMS/TkAlignment

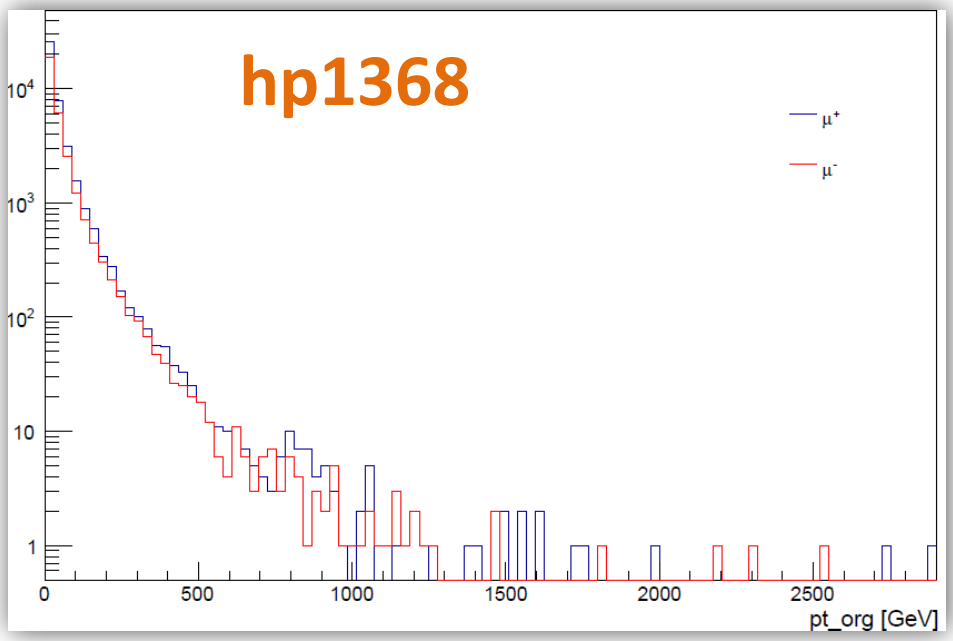
- How to choose?
  - AOD Format
  - RECO CRAFT
  - Last version
  - Exclude smaller dataset

year	Site	Dataset	N. Of Events	globalTag	Runs
2009	https://twiki.cern.ch/twiki/bin/view/CMS/CRAFT09AnalysisInfo	/Cosmics/CRAFT09-v1/RAW	500 M	GR09_31X_V5P::All	108479-111146
2010	https://twiki.cern.ch/twiki/bin/view/CMS/GlobalRunTrackerAlignment2010#CRAFT10_February_2010	/Cosmics/Commissioning10-v3/RAW	300 M	GR10_P_V2COS::All	127476- 127764
2011	https://twiki.cern.ch/twiki/bin/view/CMS/TrackerAlignment2011#Summary_of_CRAFT11_Datasets	/Cosmics/Commissioning11-TkAlCosmics0T-v1/ALCARECO	1 M	TrackerAlignment_GR10_v5_offline	158028-158383
2012	https://twiki.cern.ch/twiki/bin/view/CMS/TrackerAlignment2012#COSMICS_DATASET_during_2012_coll	/Cosmics/Commissioning12-TkAlCosmics0T-v1/ALCARECO	2 M	GR_P_V30	186785-189146
2014	https://twiki.cern.ch/twiki/bin/view/CMS/TkAl2014Datasets	/Cosmics/Commissioning2014-TkAlCosmics0T-PromptReco-v4/ALCARECO	0.6 M	GR_P_V30	229514-229713
2015	https://twiki.cern.ch/twiki/bin/viewauth/CMS/TkAl2015Datasets#CRAFT15_3_8_T_cosmics	/Cosmics/Commissioning2015-TkAlCosmics0T-04Jun2015-	10.9 M	FT_R_74_V15B	238443-239517

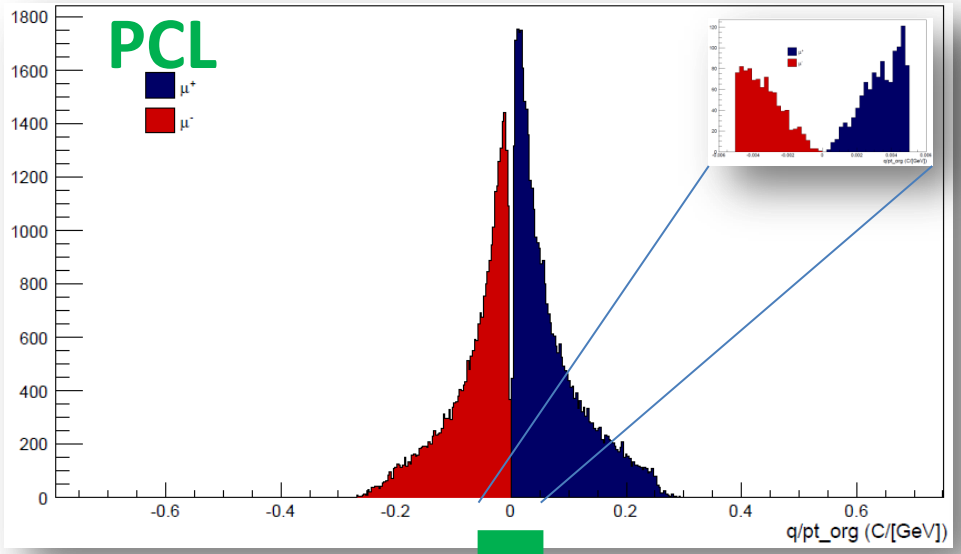
year	Site	Dataset	N. Of Events	globalTag	Runs
2009	https://twiki.cern.ch/twiki/bin/view/CMS/CRAFT09AnalysisInfo	/Cosmics/CRAFT09-v1/RAW	500 M	GR09_31X_V5P::All	108479-111146
2010	https://twiki.cern.ch/twiki/bin/view/CMS/GlobalRunTrackerAlignment2010#CRAFT10_February_2010	/Cosmics/Commissioning10-v3/RAW	300 M	GR10_P_V2COS::All	127476- 127764
2011	https://twiki.cern.ch/twiki/bin/view/CMS/TrackerAlignment2011#Summary_of_CRAFT11_Datasets	/Cosm /C issio 11-TkAlC hics0T-v1/AL FCO	1 M	TrackerAlignment_GR10_v5_offline	158028-158383
2012	https://twiki.cern.ch/twiki/bin/view/CMS/TrackerAlignment2012#COSMICS_DATASET_during_2012_coll	/Cosmics/ issioning12-TkAlCosmics0T-v1/ALCARECO		GR_P_V30	186785-189146
2014	https://twiki.cern.ch/twiki/bin/view/CMS/TkAl2014Datasets	/Cosmics/Commissioning2014-TkAlCosmics0T-PromptReco-v4/ALCARECO	0.6 M	GR_P_V30	229514-229713
2015	https://twiki.cern.ch/twiki/bin/viewauth/CMS/TkAl2015Datasets#CRAFT15_3_8_T cosmics	/Cosmics/Commissioning2015-TkAlCosmics0T-04Jun2015-	10.9 M	FT_R_74_V15B	238443-239517

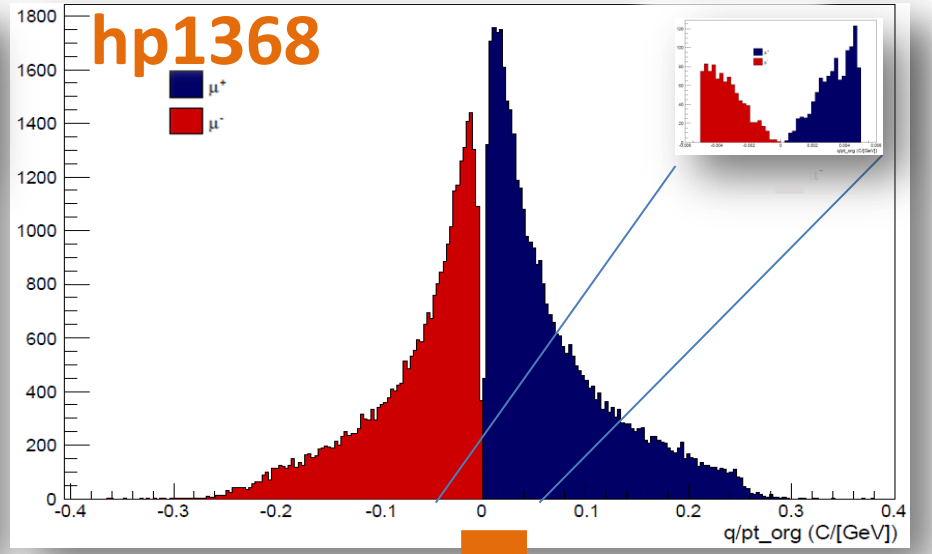
Look at the p_T distribution…

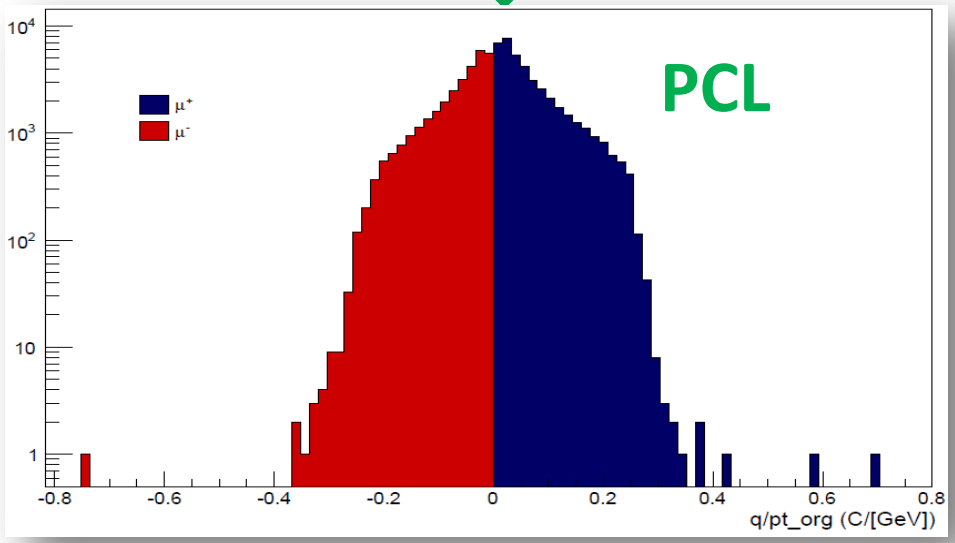


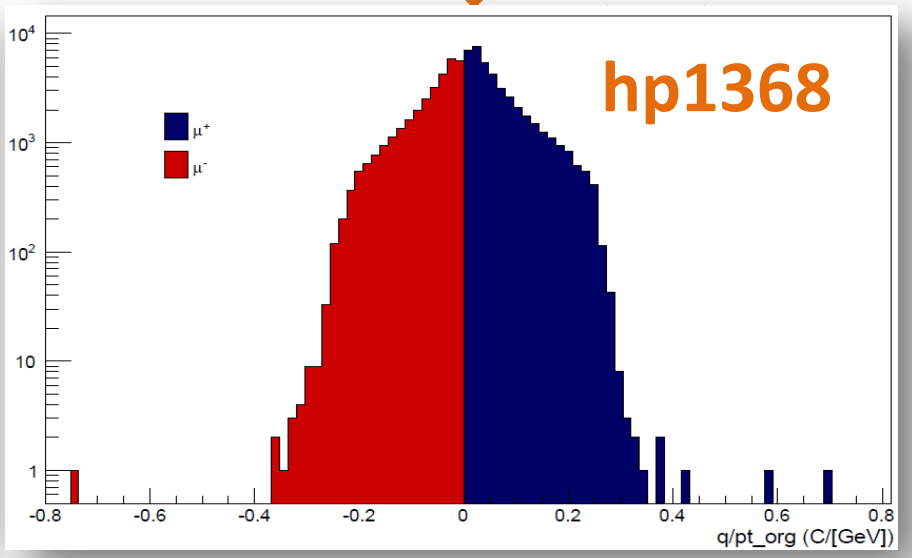


Look at the q/p_T distribution…





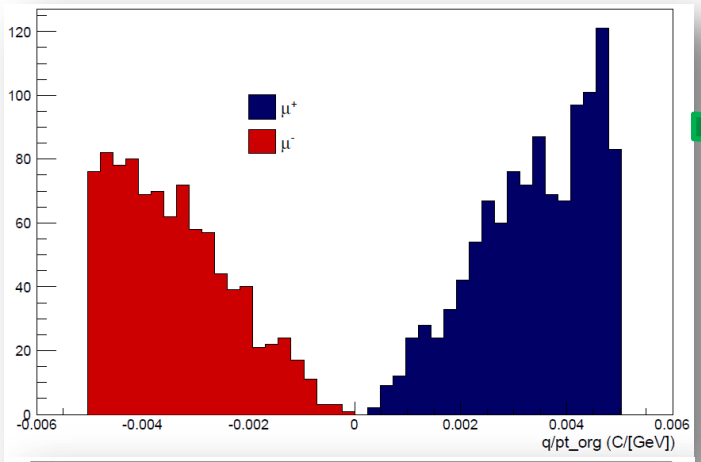


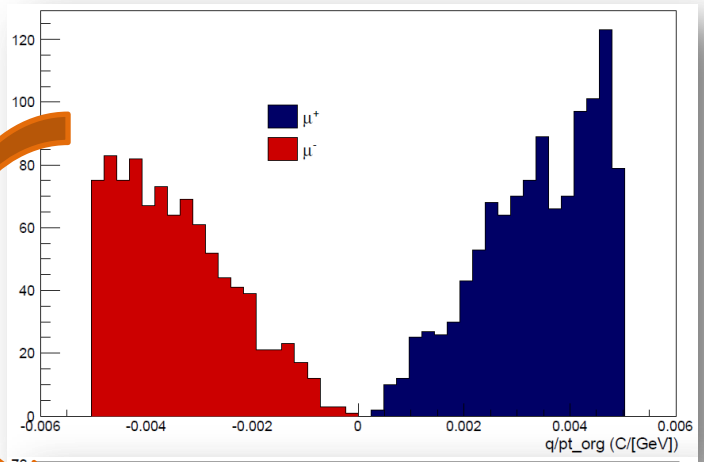


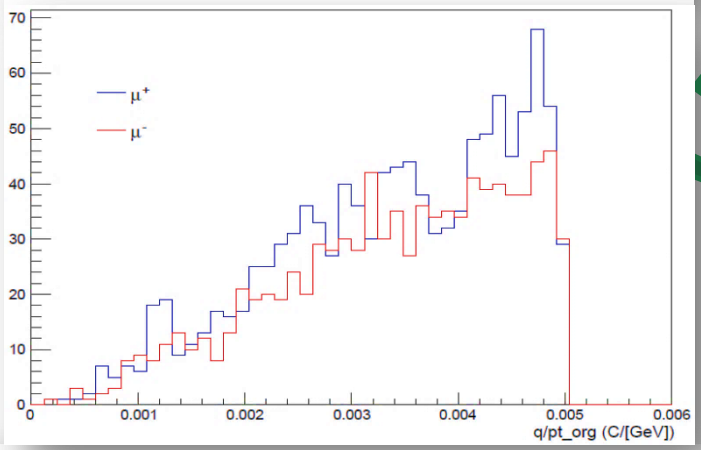
PCL

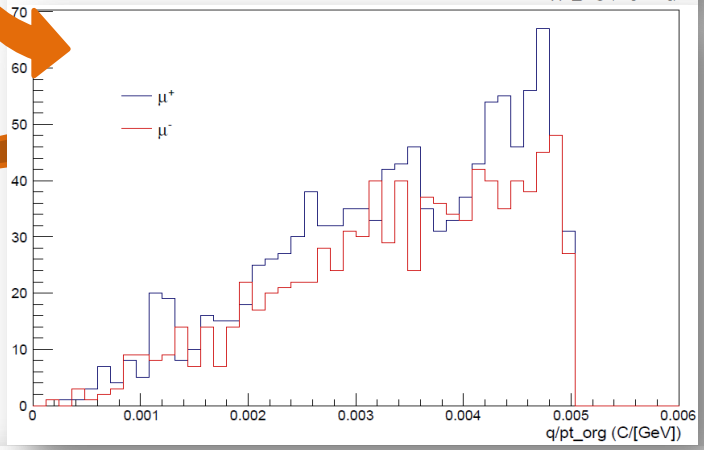
hp1368

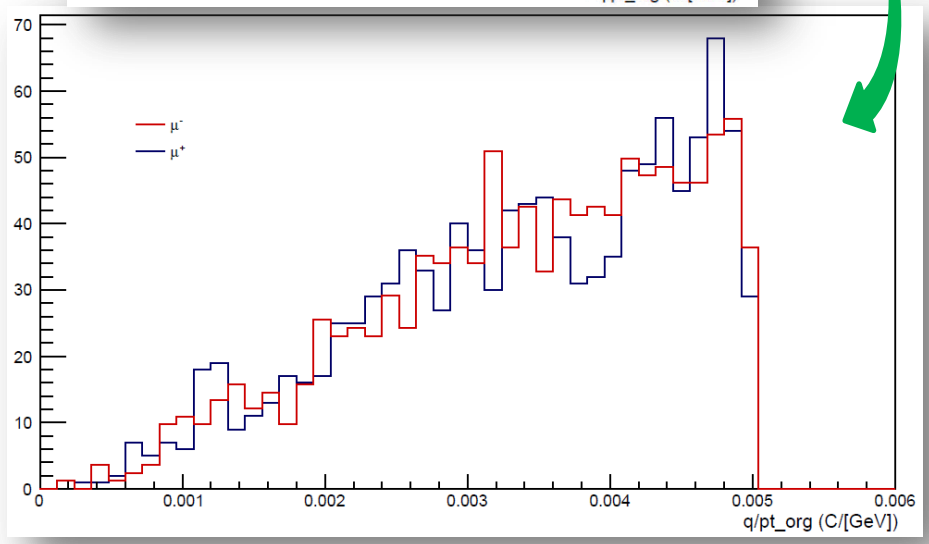
p_T>200 GeV

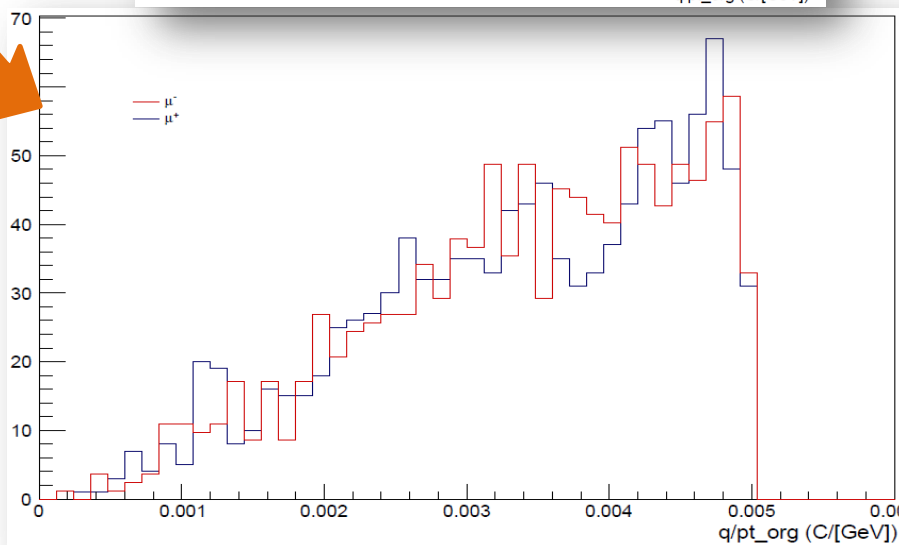




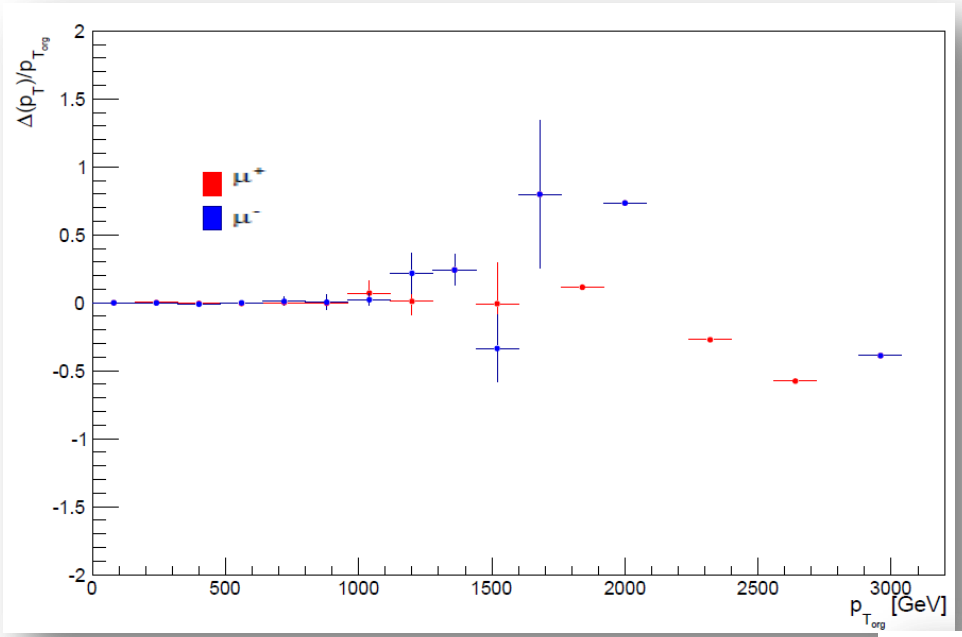




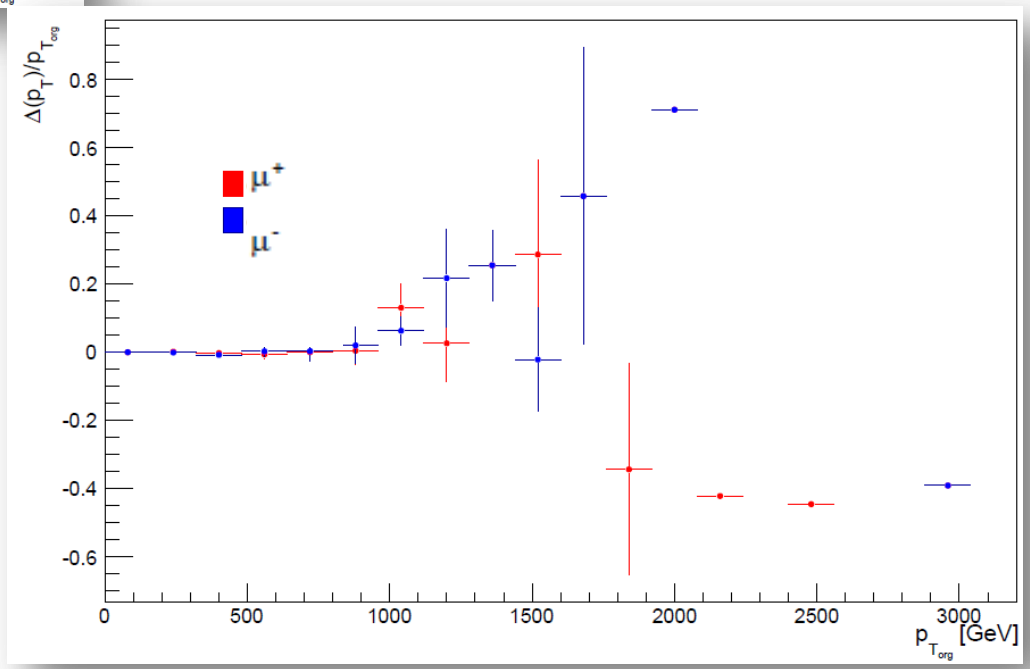




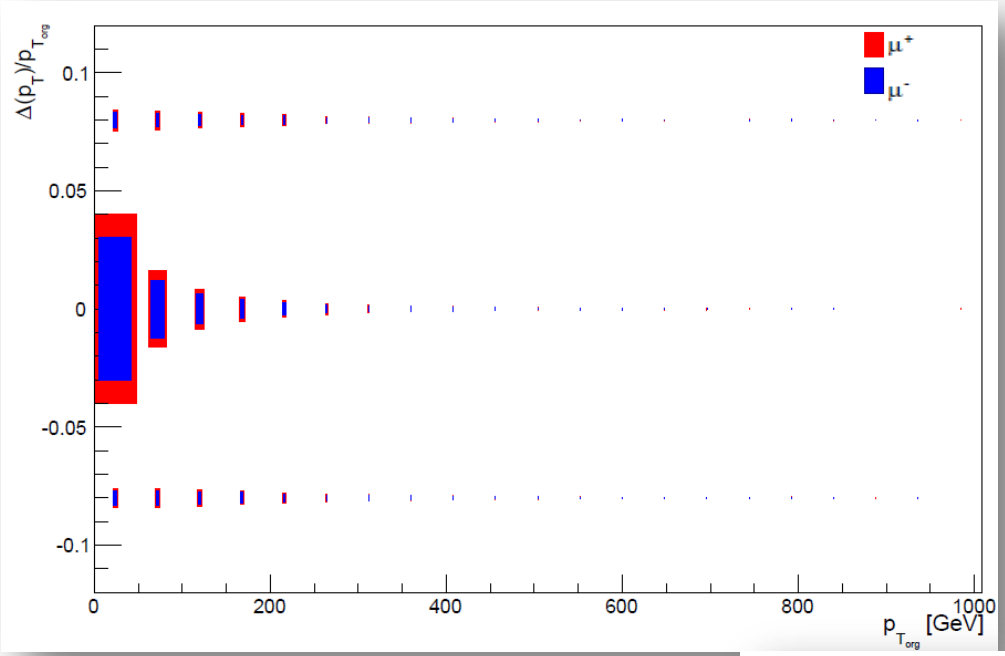
Look at the delta(p_T)/p_T distribution…

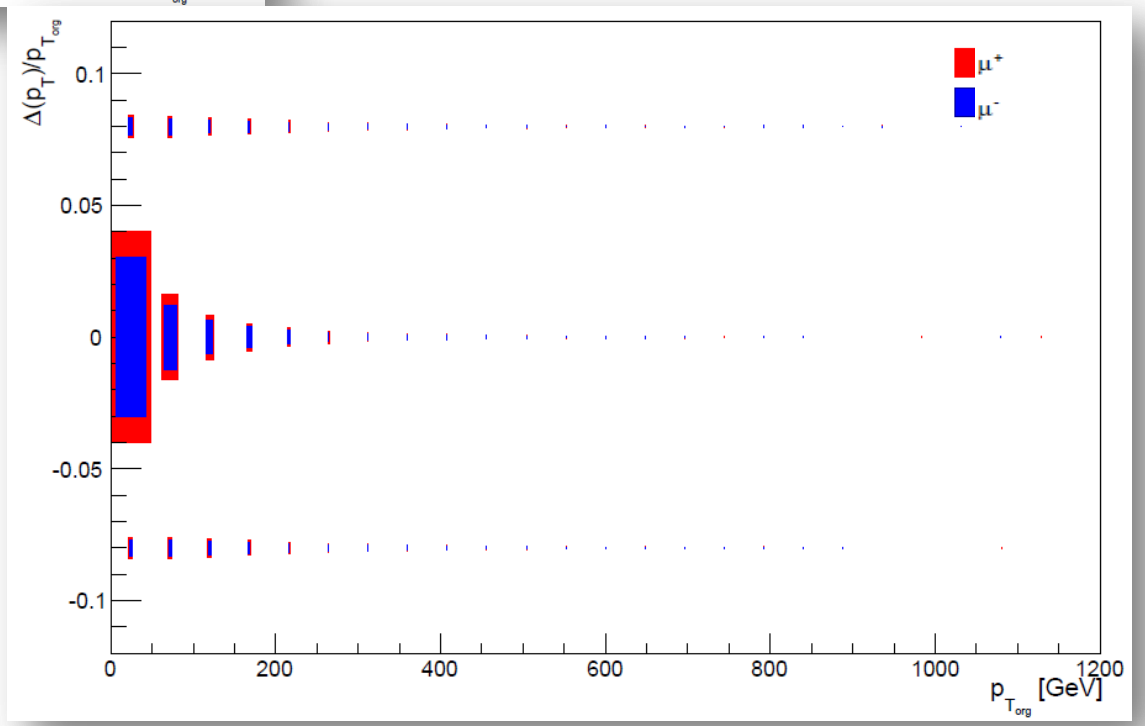


$$\frac{\Delta(p_T)}{p_T} = \frac{p_{T1} - p_{T2}}{p_T}$$



Box_plot…


$\Delta(p_T)/p_{T_{org}}$
0.1
0.05
0
-0.05
-0.1
0
200
400
600
800
1000
$p_{T_{org}}$ [GeV]
μ^+
μ^-

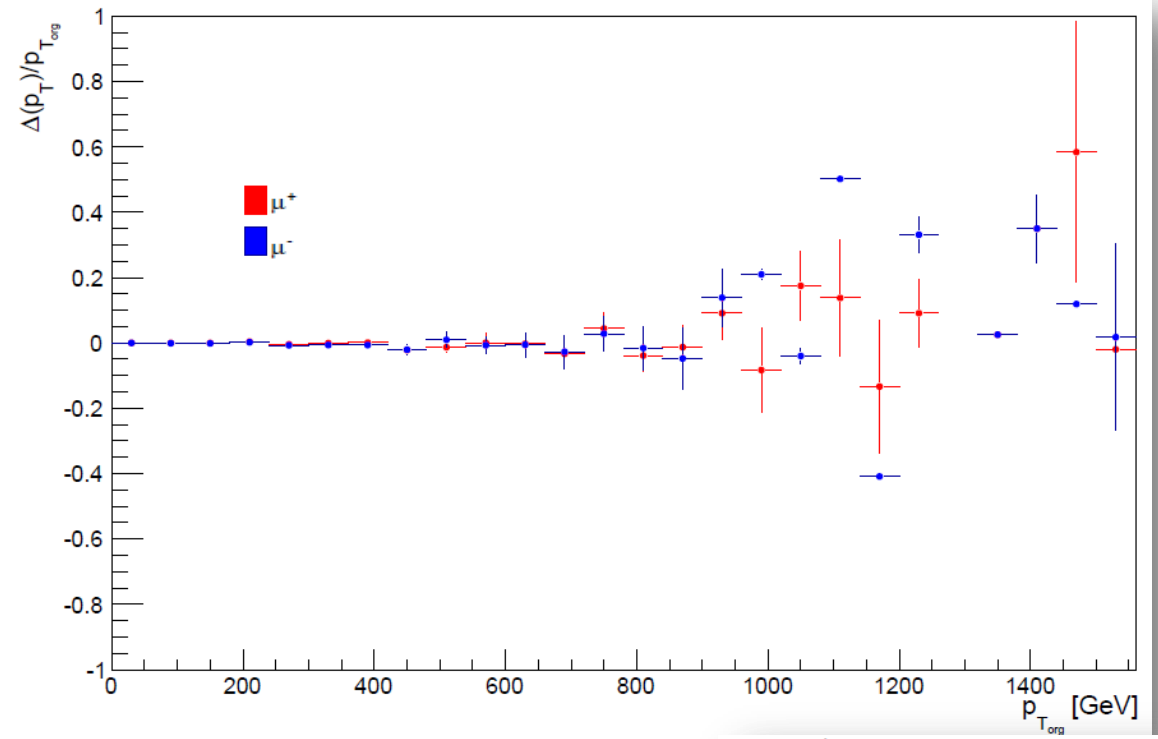

$\Delta(p_T)/p_{T_{org}}$
0.1
0.05
0
-0.05
-0.1
0
200
400
600
800
1000
1200
$p_{T_{org}}$ [GeV]
μ^+
μ^-

Next steps

- CRAFT data study
  - Still looking for help with Processing reco/AOD data from pre-2015 CRAFT runs;
  - Moving from tracker-only to global pt To meet with G. Benelli, Carlo Battilana, and Daniele Trocino.


Thanks for your attention!
Thanks for your attention!

Backup slides



zoom…