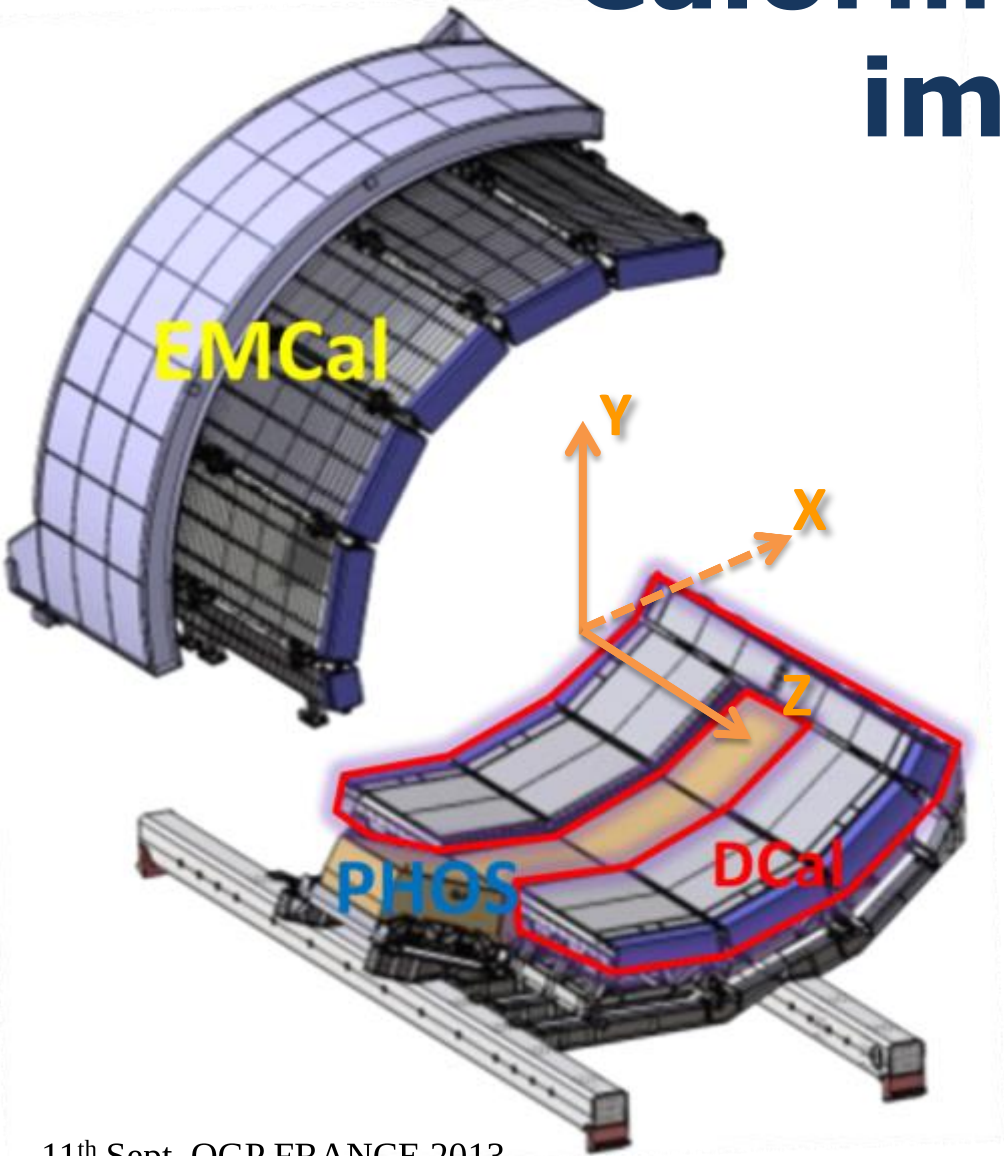
Status of the ALICE Di-jet Calorimeter (DCal) and implementation of its geometry



Mengliang Wang

11 September, 2013

Outline

1. Motivation

2. DCal in concrete terms

3. DCal implementation in AliRoot

4. Summary

5. Plans for future

Outline

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   - 1.1 Jets and the QGP
   - 1.2 Jet physics at LHC
   - 1.3 Detection of jets in ALICE
   - 1.4 DCal Physics
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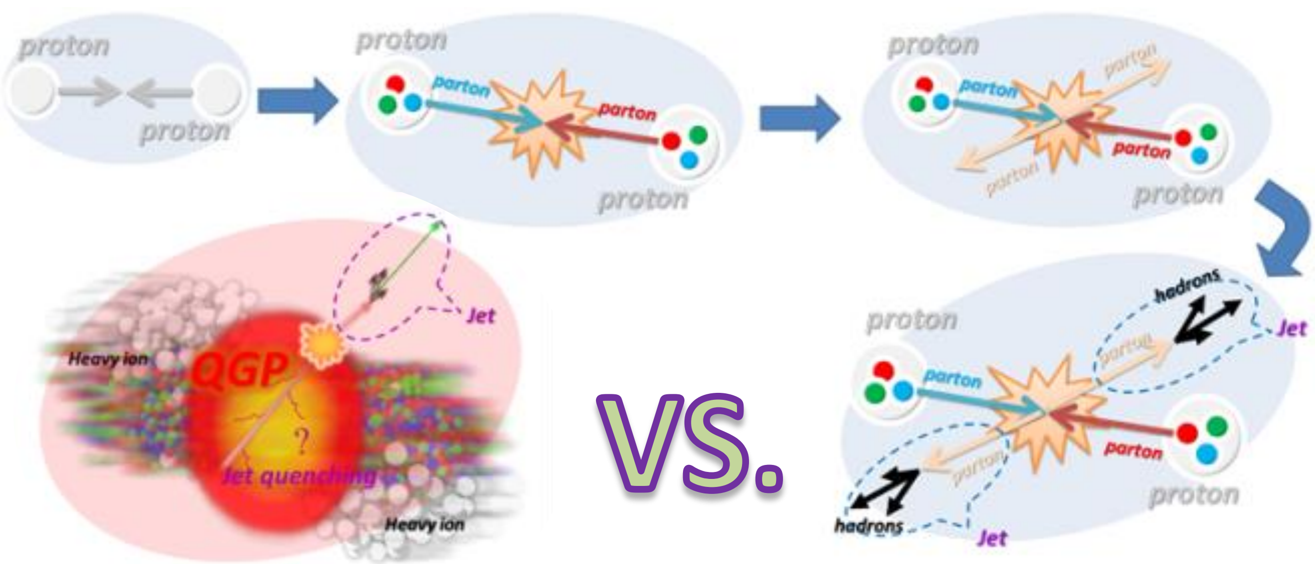
1.1 Jets and the QGP



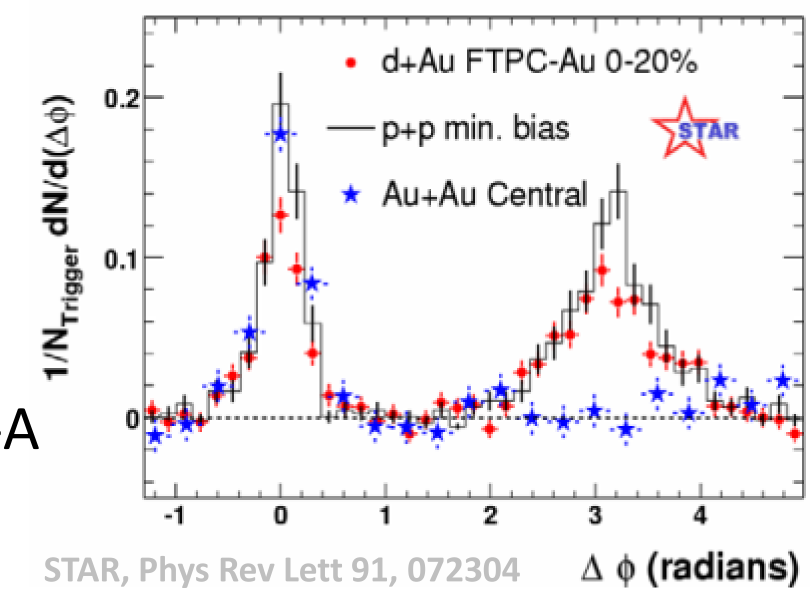
sketch of collisions in p-p collision and in A-A collision

The 2→2 hard process in p-p/A-A collision creates 2 outgoing partons. These hard partons will firstly radiate soft gluons, creating parton shower, then hadronize as collinear hadron shower, the final jets be "seen" experiment.

Results from RHIC:

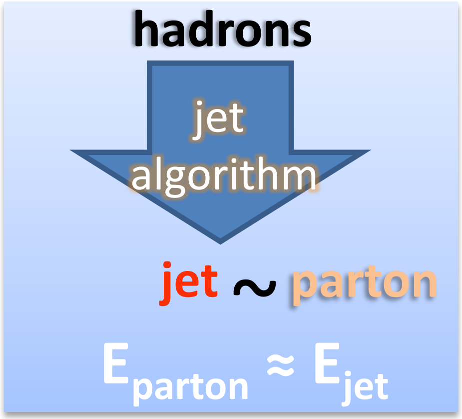
E.g., hadrons suppression on away side from the correlation study (see right fig.).

Signal of these hot, dense medium is considered as QGP (where the deconfined quark-gluon phase created) created in the A-A collision.



STAR, Phys Rev Lett 91, 072304

1.2 Jet physics at LHC



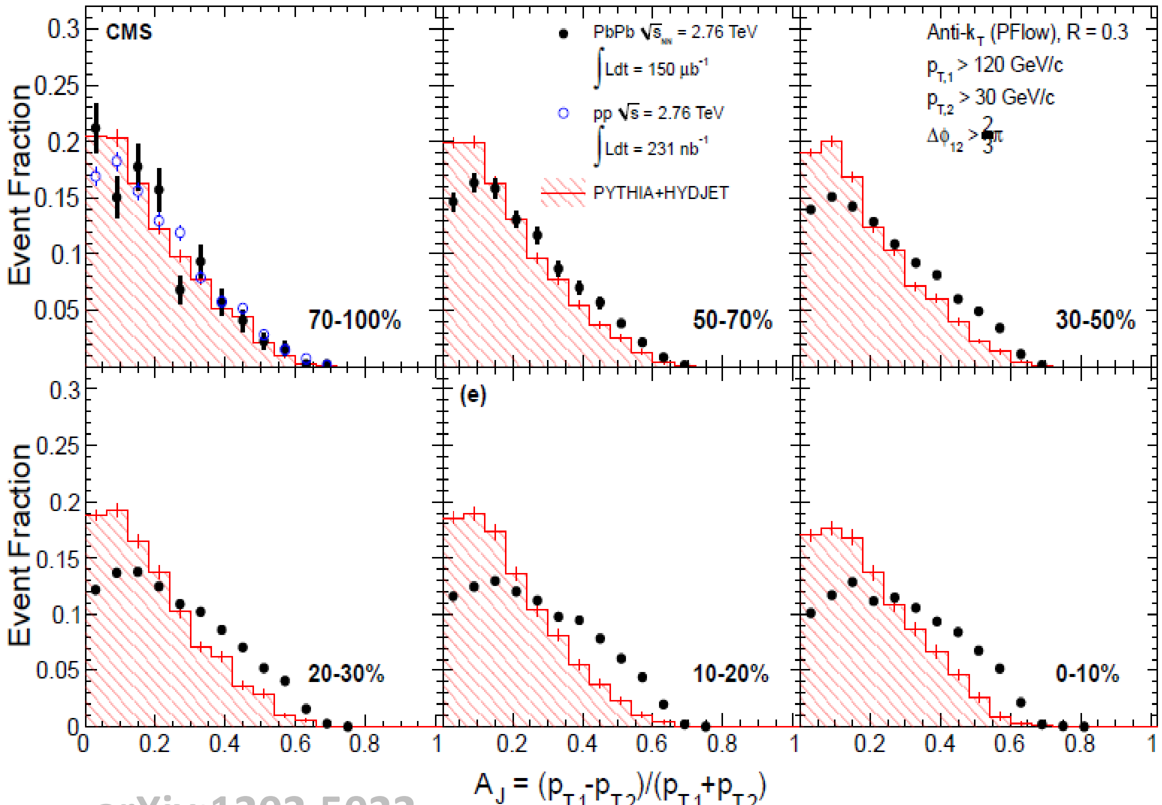
Because LHC runs at a high collision energy, with $\sqrt{s}$ = 14 TeV for p-p and $\sqrt{s_{NN}}$ = 5.5 TeV for Pb-Pb, we have harder outgoing parton. And in Pb-Pb collision , we can have longer life and larger volume of QGP to be studied.

So we can study the medium property at LHC via jets.

E.g., we can see the full single jet measurement. The jet R_{AA} results from ALICE and CMS.

And also, we can do di-jet asymmetry study.

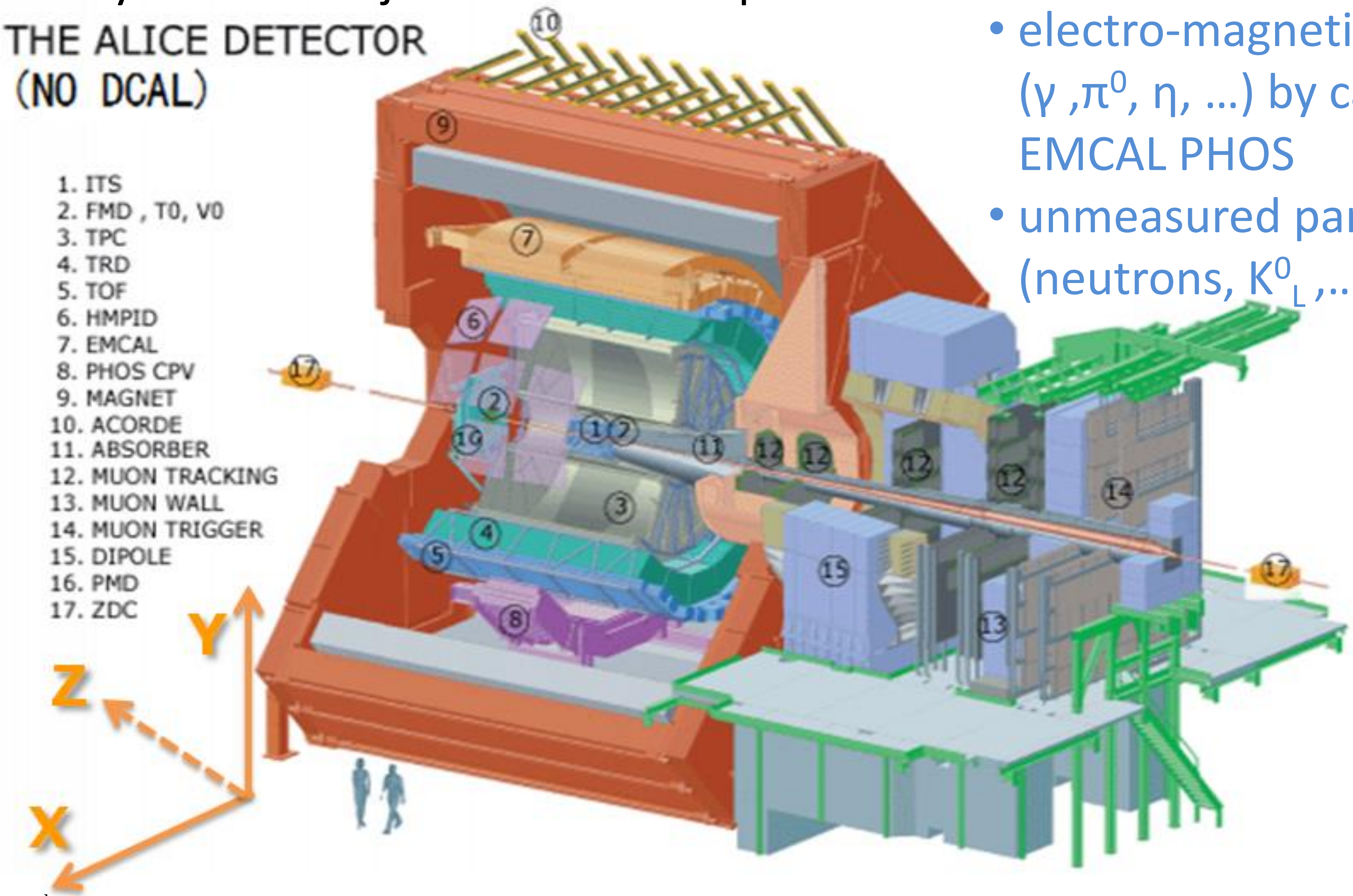
E.g. full jet results from CMS in right fig.



arXiv:1202.5022

1.3 Detection of jets in ALICE

With the detectors in ALICE now, we can do the jet analysis on charged jet or the analysis with full jet in EMCal acceptance.



For jets study:

- charged particle by tracking system, ITS TPC
- electro-magnetic particle (γ ,π^0, η, …) by calorimeter, EMCAL PHOS
- unmeasured particle (neutrons, K^0_L ,…), missing

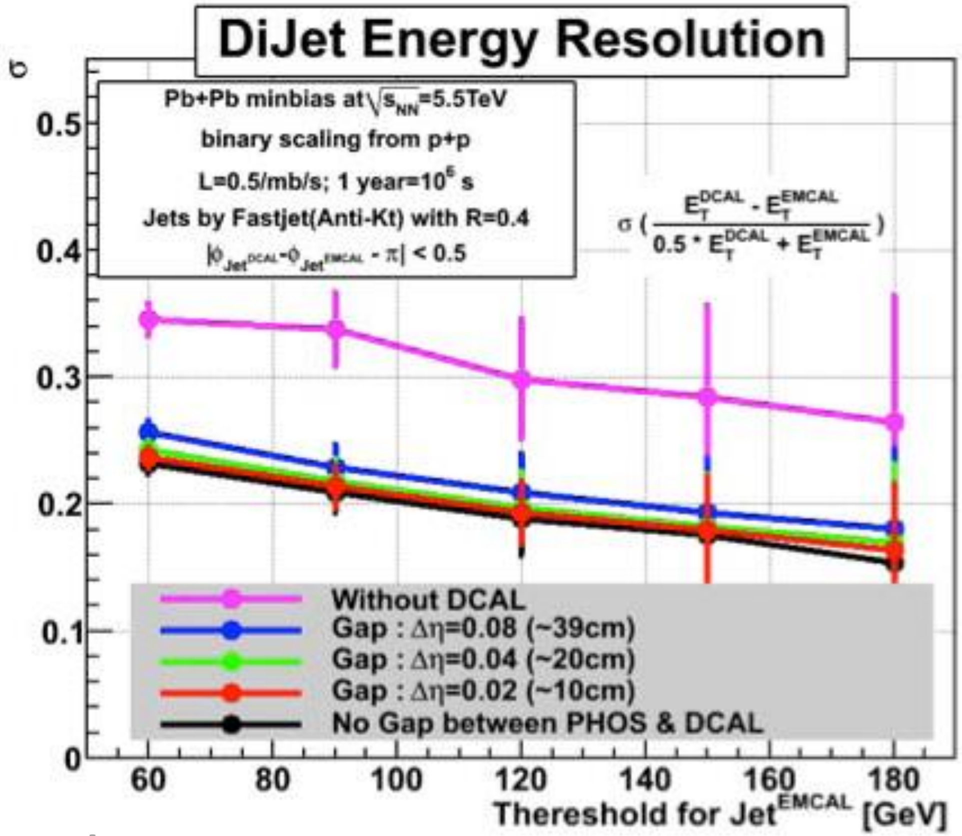
1.4 DCal Physics

ALICE has decided to add the Di-jet Calorimeter (DCal), back-to-back in azimuth to EMCal in the calorimeter system, to achieve correlation analysis. Especially for jet-jet or high p_T γ/π^0-jet study.

Basic parameters of calorimeters

	EMCal	DCal
Phi range	80º ~ 187º	260º ~ 327º
Eta range	|η|<0.7	0.22<|η|<0.7
Technology	"Shashlik" sampling Electro-magnetic calorimeter	
Energy Resolution	$\sigma(E)/E = 11.1\%/\sqrt{E} \oplus 1.7\%$*	

* from beam test result of EMCal, NIM A615 (2010)6-13



DCal TDR, ALICE-TDR-014-ADD-1

Left fig: the di-jet energy resolution achieved with DCal, and the effect of the gap between DCal and PHOS.

DCal provides:

- higher statistics and p_T range (by γ/jet trigger and acceptance)
- better the energy resolution (for γ/π^0/jet-jet)

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2. DCal in concrete terms

- 2.1 The DCal collaboration
- 2.2 Status of DCal installation

3. DCal implementation in AliRoot

4. Summary

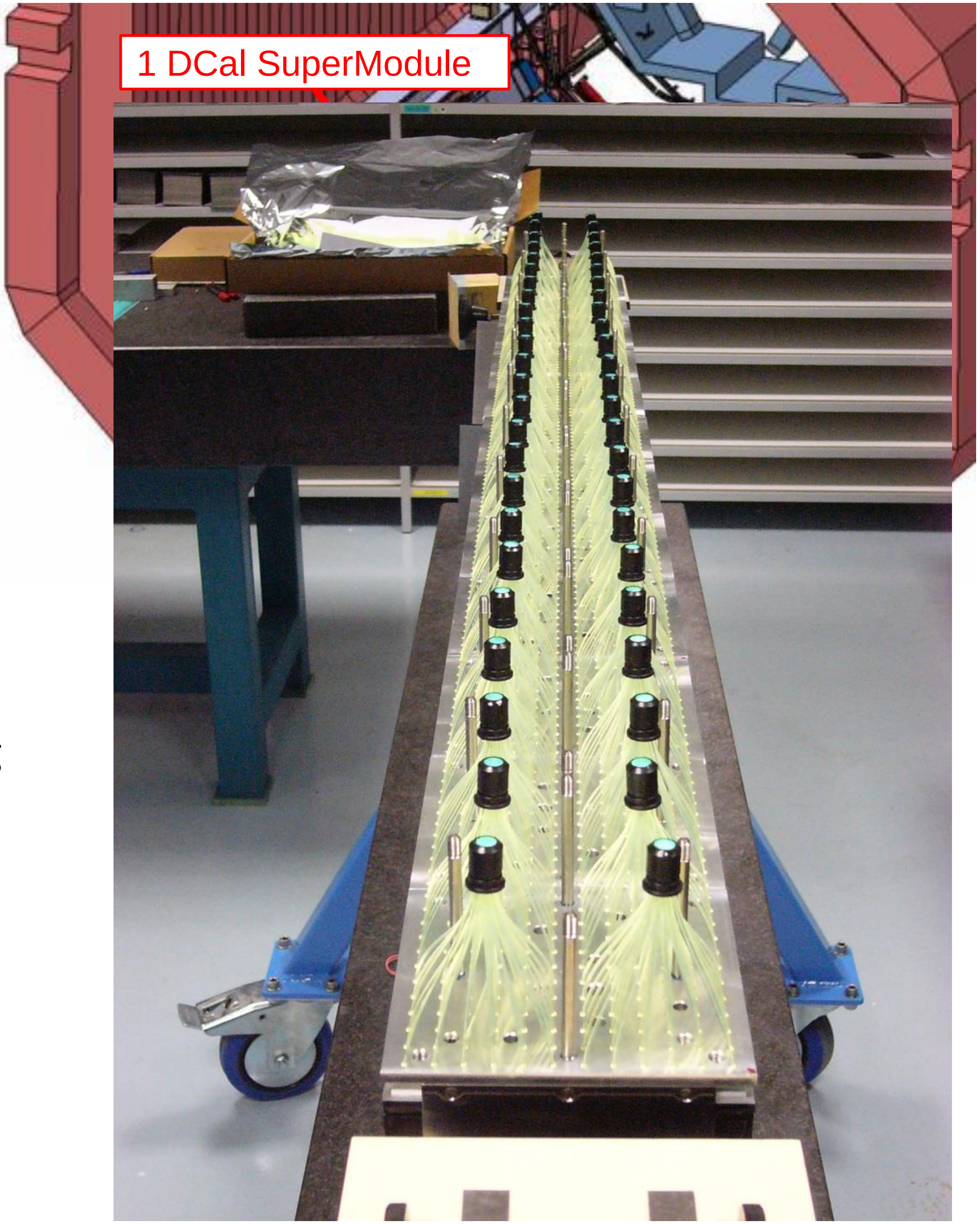
5. Plans for future

2.1 The DCal collaboration

- Electromagnetic calorimeter:
  ✓ Same technology as EMCal (Shashlik)
  ✓ 6 Super Modules (SM) + 2 small SM as extensions

- Collaboration:
  ✓ Project between China (1SM), France (see below), Italy (APD tests, SM crates, tools), Japan (1.5SM) and US (modules for 3SM+2*1/3) born in spring 2009

- French contributions:
  ✓ Engineering of support structure, rails common to 3 subsystems & insertion tooling
  ✓ Production of ½ SM
  ✓ Production follow-up and production of 24 Stripmodules and of 48 mini-Stripmodules (a total of 480 modules) at Subatech together with the Chinese, Japanese & Italian teams
  ✓ SM assembly and calibration of the whole project



2.2 Status of DCal installation

- Done so far:
  - ✓ Dummy assembly of the DCal-PHOS support structure (SS):
    2x12m long beams + 6 ribs
  - ✓ Loading test of the SS: successfully loaded at 1.35 x nominal load (1.35 x 62t = 84t)
  - ✓ PHOS removed from L3
  - ✓ Dummy insertion test of DCal and PHOS with insertion tooling
  - ✓ Insertion of rails in L3
  - ✓ Insertion of DCal-PHOS support structure in L3 + rail alignment

- October 2013
  - ✓ Insertion of 3 DCal C side super modules + 2 DCal extensions.
- End of 2014
  - ✓ Insertion of 4 PHOS modules with DCal insertion tooling.
  - ✓ Insertion of 3 A side DCal super modules.

Outline

1. Motivation

2. DCal in concrete terms

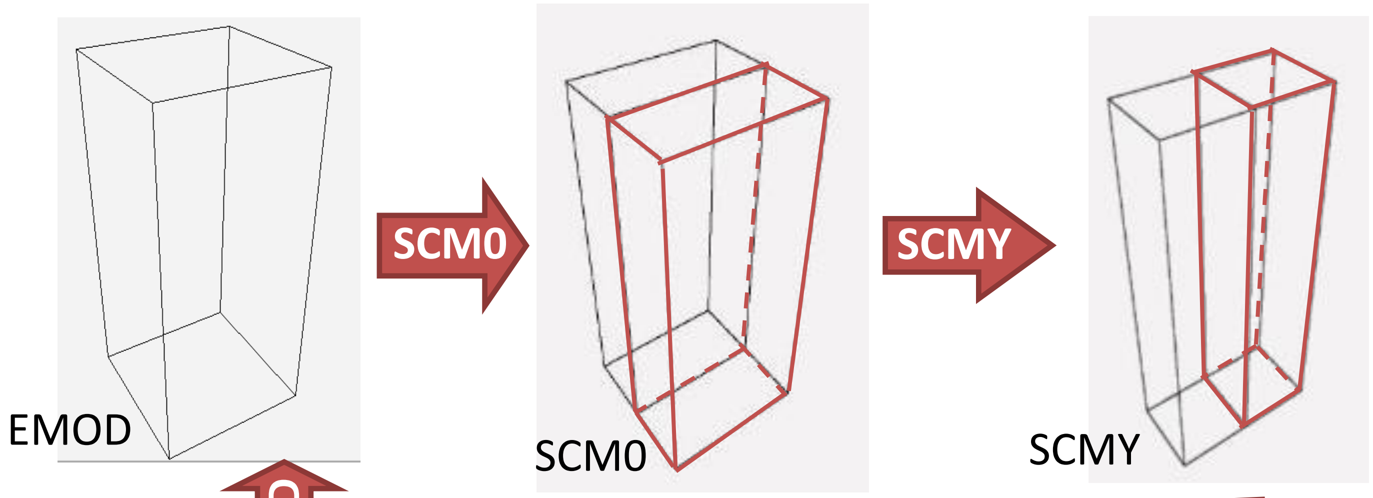
3. DCal implementation in AliRoot

- 3.1 DCal detailed structure
- 3.2 Implementation of the DCAL geometry
- 3.3 Simulation test: mapping and response
- 3.4 Other checks

4. Summary

5. Plans for future

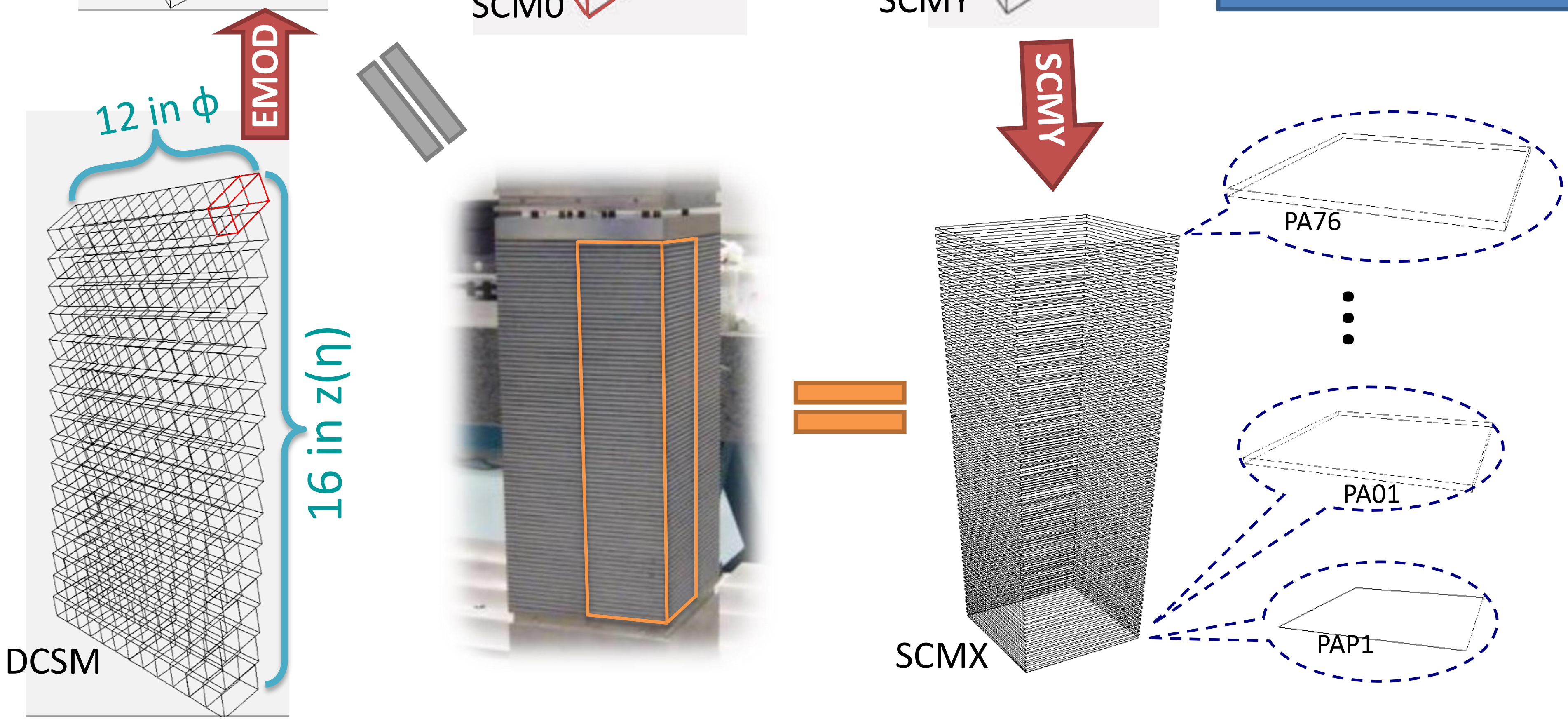
3.1 DCal detailed structure



76 layers of Pb

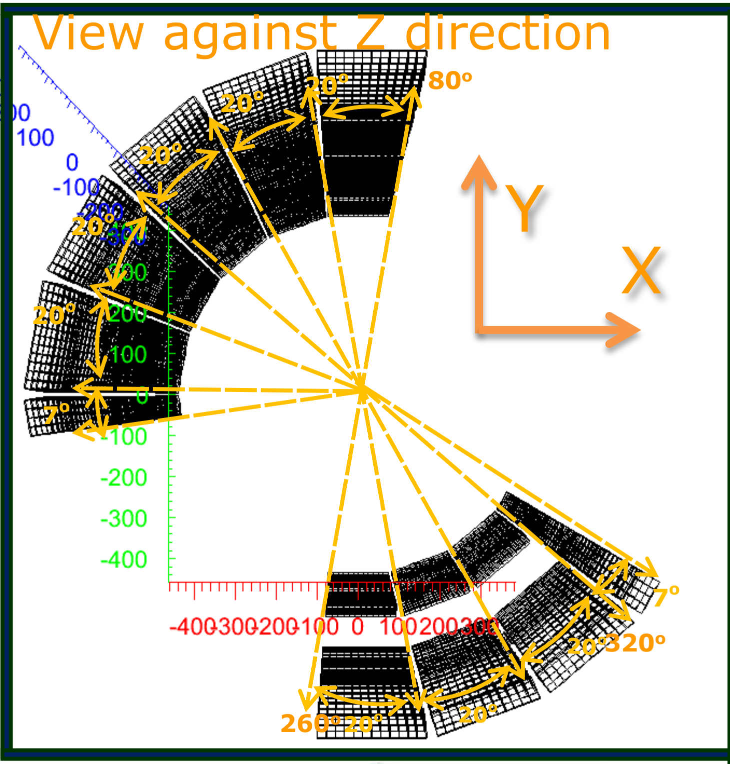
77 layers of scintillators

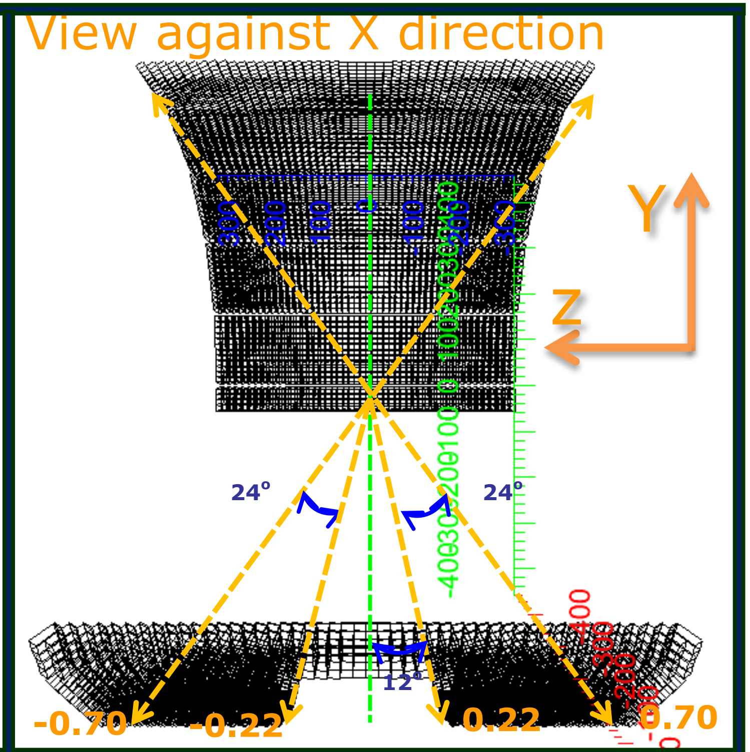
papers in between

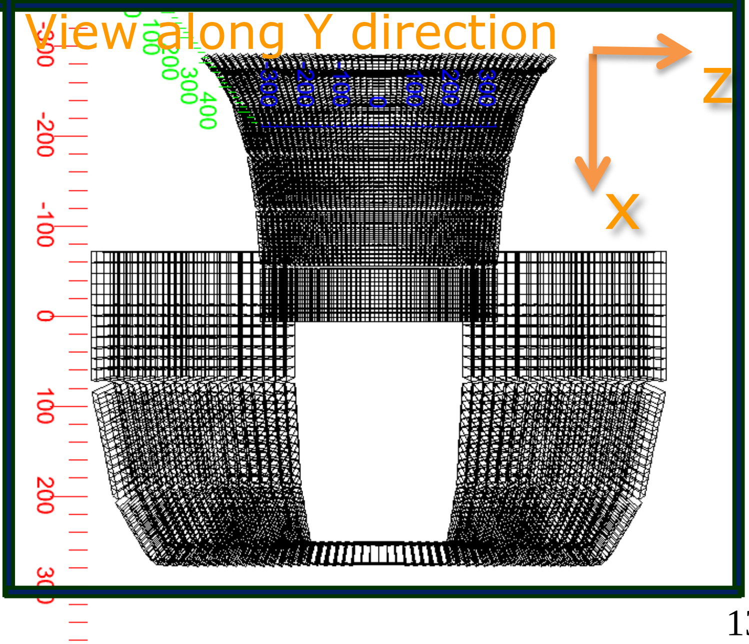


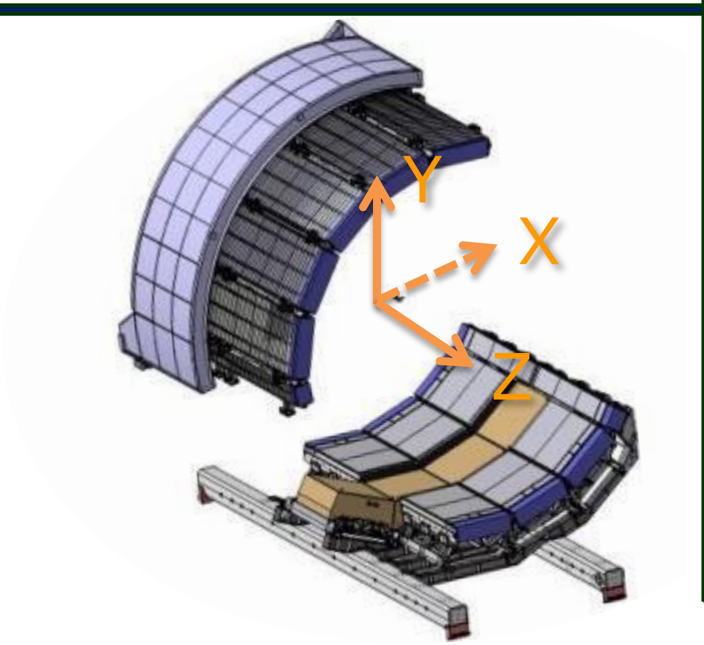
3.2 Implementation of the DCal geometry (1)

- EMCAL + DCAL in AliRoot.
- 12 EMCAL SM (10 + 2*1/3 SM)
- 8 DCAL SM (6 + 2*1/3 SM)









EMCal and DCal after the installation

3.2 Implementation of the DCal geometry (2)

DCal (6 SM)

Name: “EMCAL_COMPLETE12SMV1_DCAL”

- Structure: EMCAL and 6 DCAL Super Modules

DCal (8 SM)

Name: “EMCAL_COMPLETE12SMV1_DCAL_8SM”

- Structure: EMCAL with 6 DCAL Super Modules and 2*1/3 SM (extension)

DCal (10 SM)

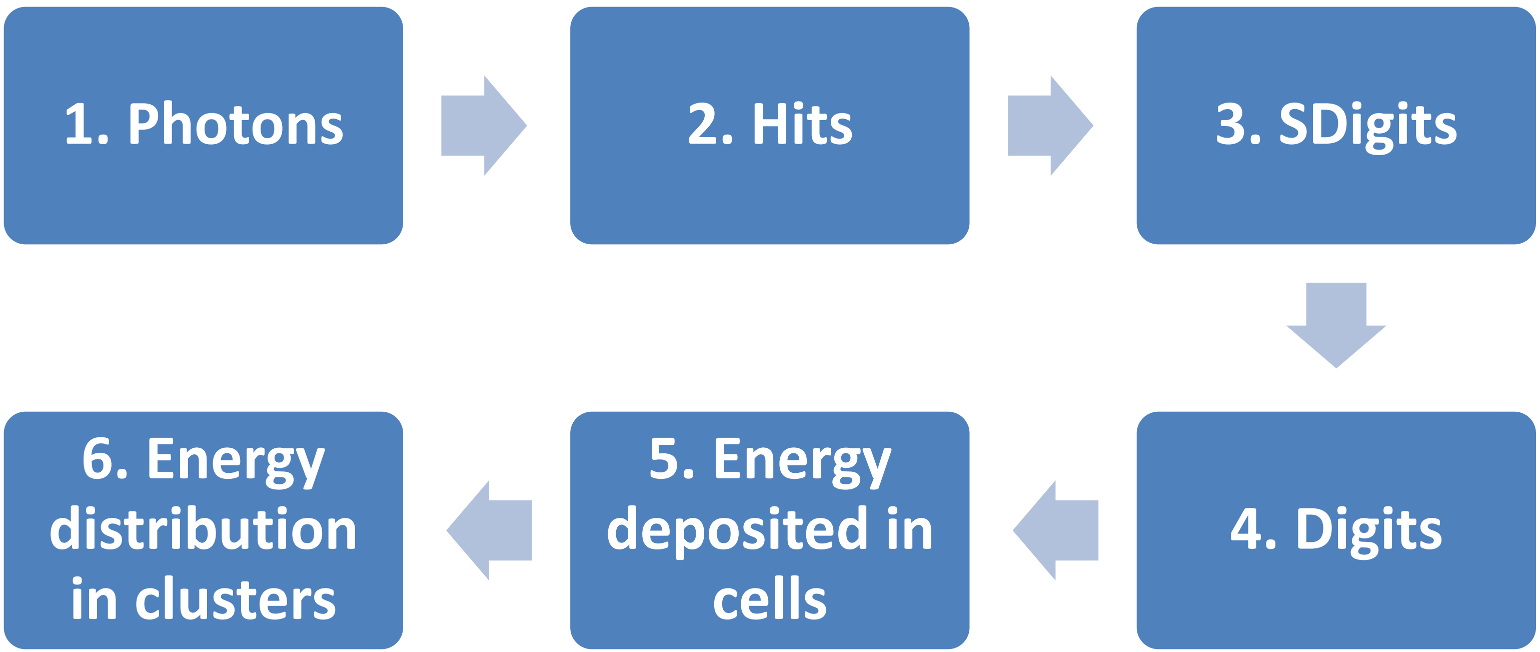
Name: “EMCAL_COMPLETE12SMV1_DCAL_DEV”

- Structure: A possible future geometry :10 DCAL Super Modules (shift of EMCAL position in phi direction).

We also added Trigger Region Units (TRU) for DCal and its mapping

3.3 Simulation test: mapping and response (1)

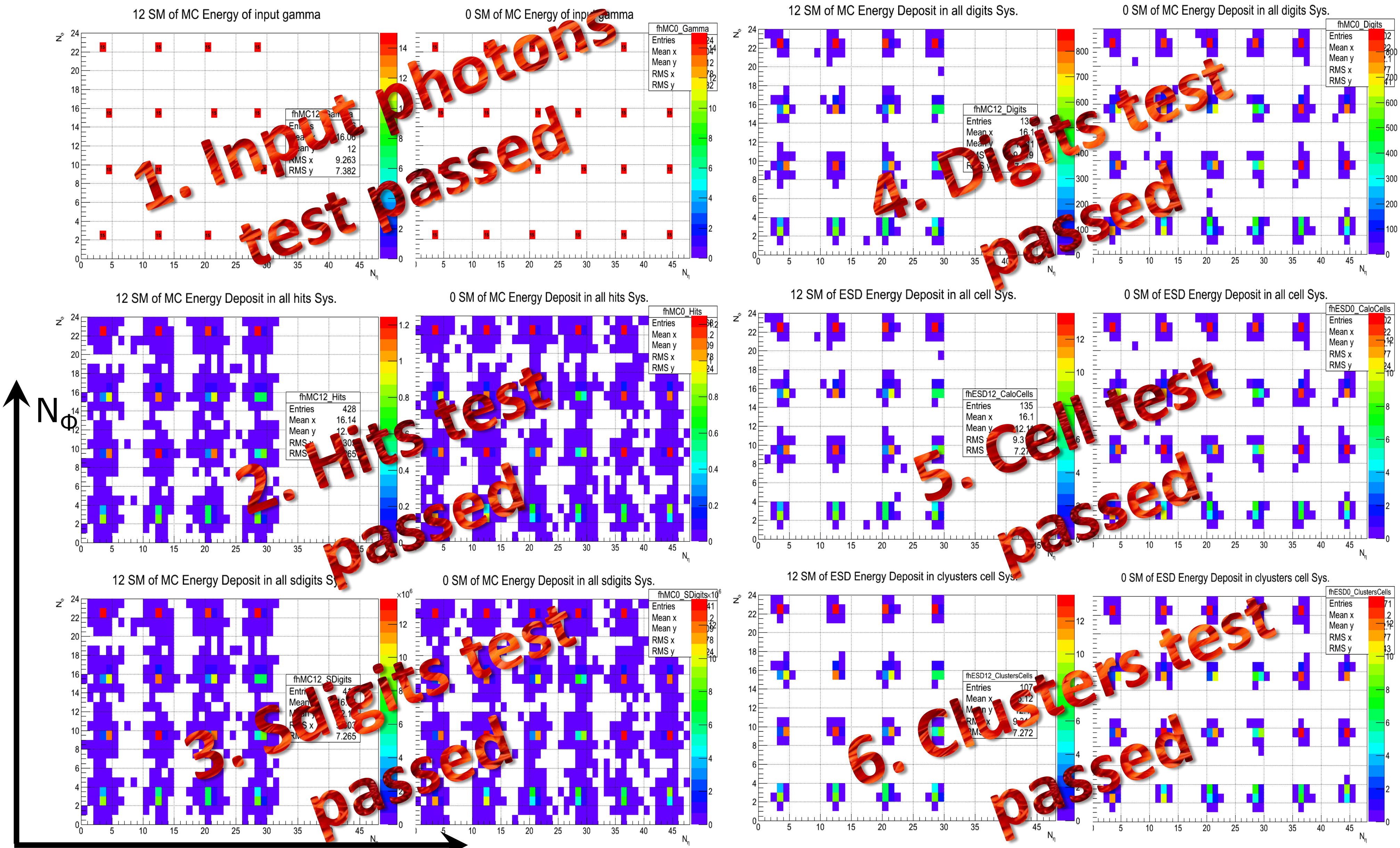
We shot an array of photons with an energy of 15 GeV in the EMCAL and DCAL acceptances.
Then we checked the results step by step:



We show the results next slides
We will take the example of SM0 and SM12 (first SM of EMCAL and DCAL).

3.3 Simulation test: mapping and response (2)

Reconstruction comparison between DCal and EMCal



3.4 other checks

- Position and cell/tower AbsId, TRU id
- Energy resolution
- Inner edge clusterizer
- Compatibility checks with existing EMCal geometry (new code vs. old code)
  - ✓ simulation and real data 2010 - 2012

4. Summary

- Installation of DCal is ongoing (in the cavern)

DCal geometry implementation (my service work):

- The implementation of the DCAL geometry is completed
- General tests were successfully performed

5. Plans for future

Now I am planning to focus on jet analysis for the next two years.

- General analysis and jet tools currently under study.
- Observables of interest:
  - ✓ jet structure with PID
  - ✓ fragmentation function in jet with PID

Thank you