LHCf Status Report

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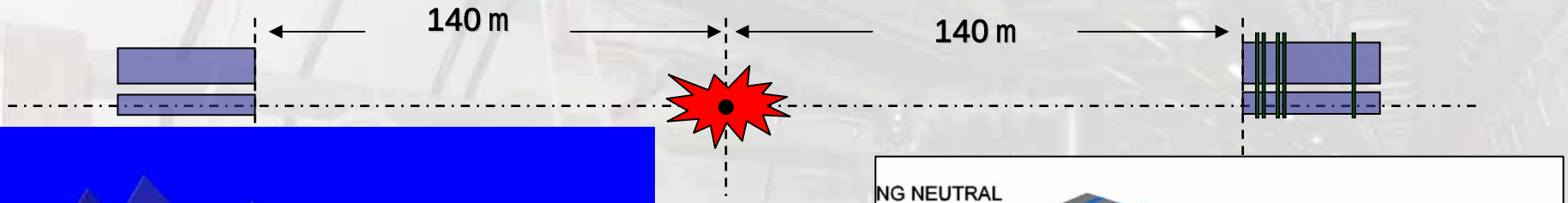
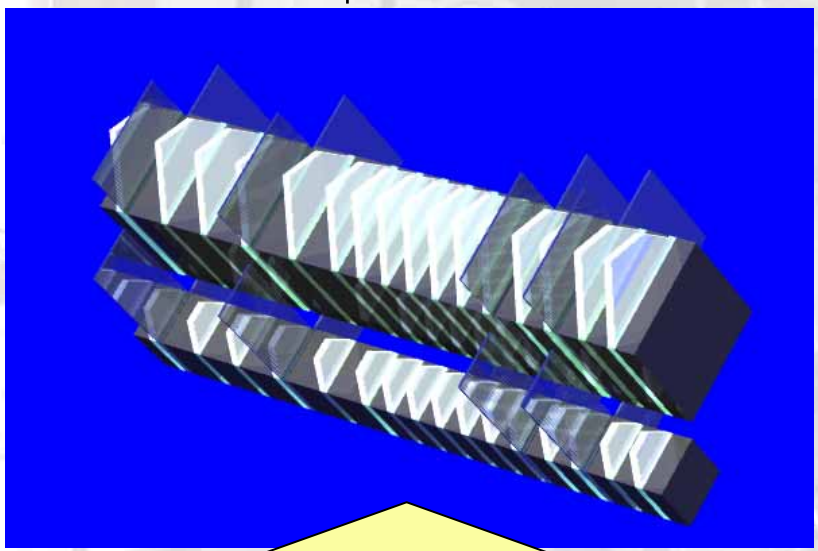
LHCf: detector overview

Detector I
Tungsten
Scintillator
Scintillating fibers

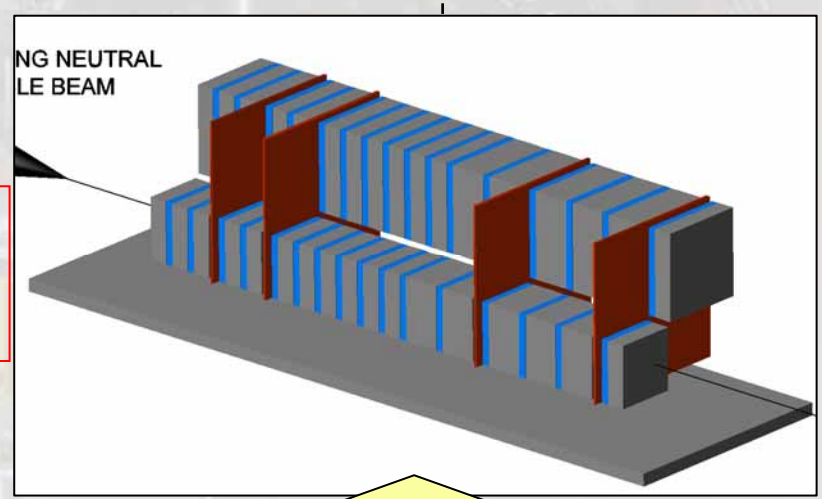
INTERACTION POINT
IP1 (ATLAS)

Detector II
Tungsten
Scintillator
Silicon μstrips



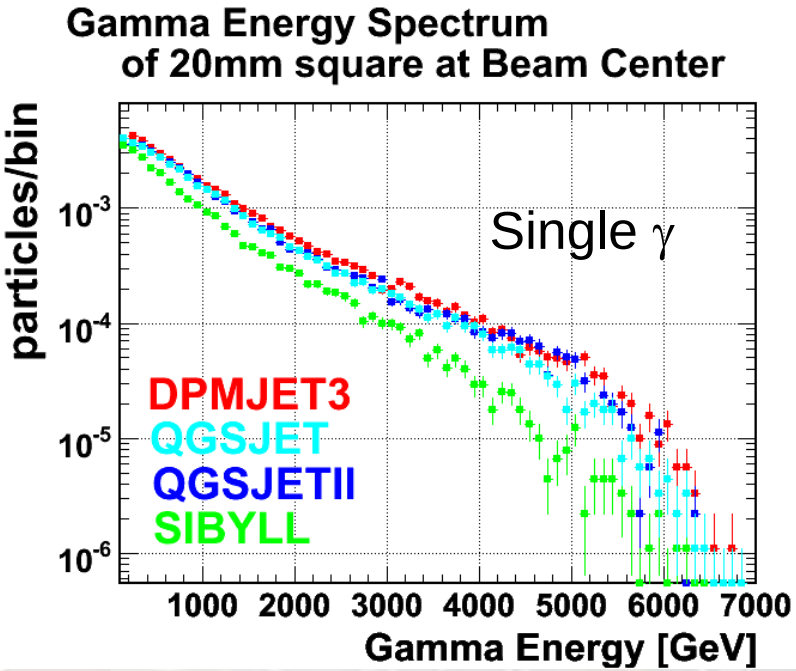


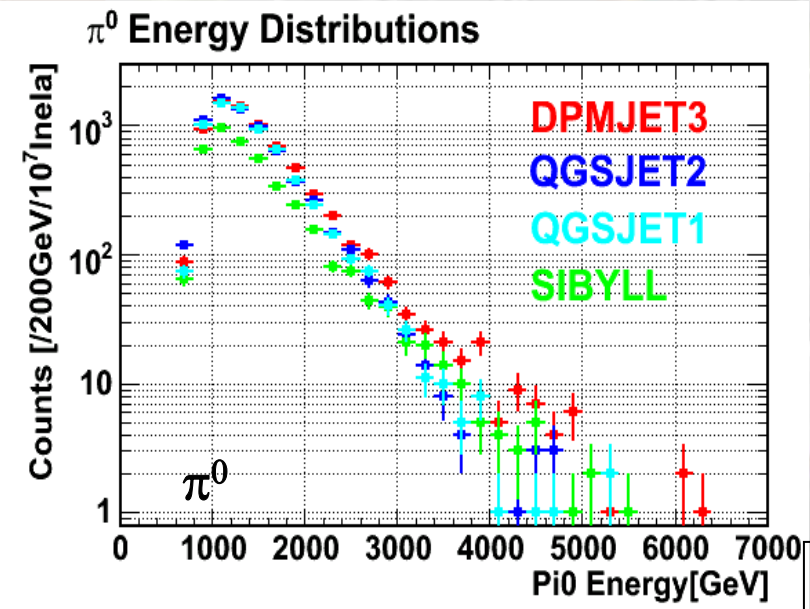
$44X_0$,
$1.6\ \lambda_{int}$



Arm#1 Detector
20mmx20mm+40mmx40mm
4 SciFi tracking layers

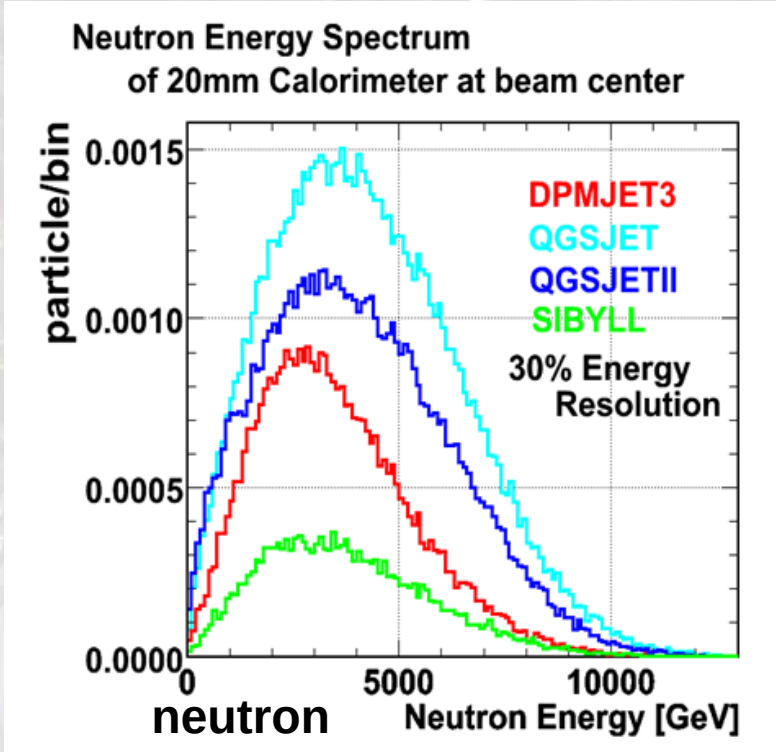
Arm#2 Detector
25mmx25mm+32mmx32mm
4 Silicon strip tracking layers





Calibrate cosmic ray interactions for very forward energy spectra at LHC energy

- Discriminate a good model
- Input data for model building

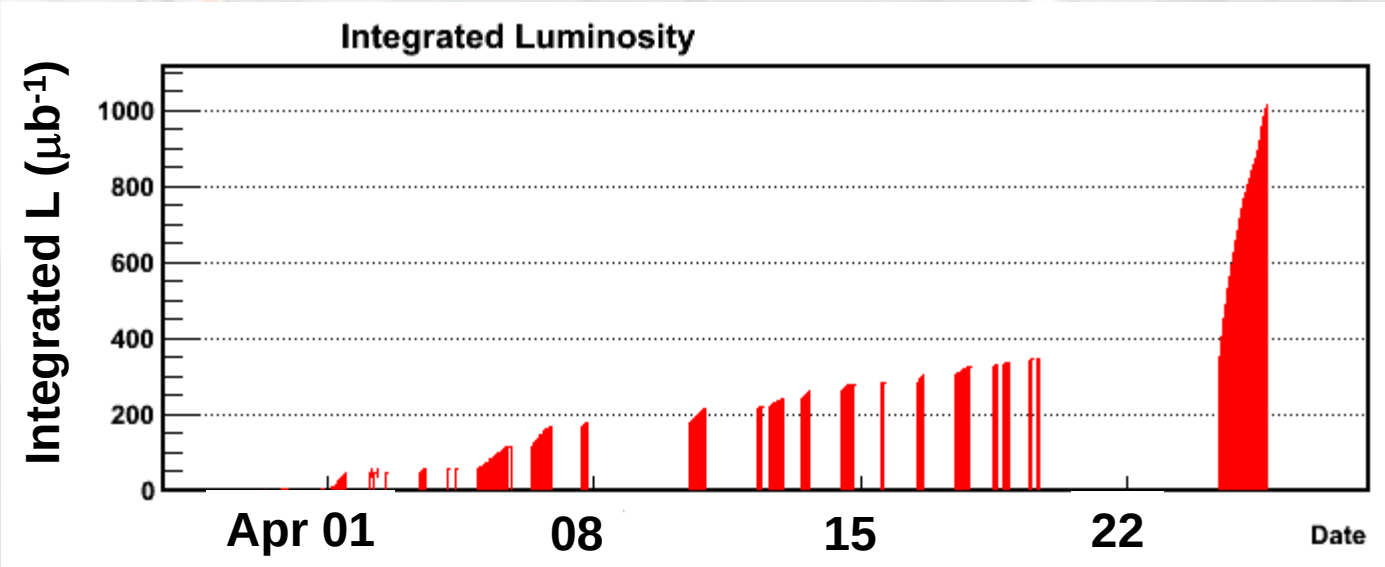


Model difference in very forward at 14TeV

LHCf 2010 runs

- Successful data taking at 7TeV collisions is ongoing.
  - Integrated Luminosity ~ $1nb^{-1}$ before Apr Tech.Stop.
  - ~10M showers and 35K π^0s obtained (arm1+arm2).
- Detector shows good performance with stable quality.
  - Energy scale calibration with a π^0 peak.
  - Good stability < ±1% level. Yet no radiation problem.

LHCf 7TeV run in Apr2010



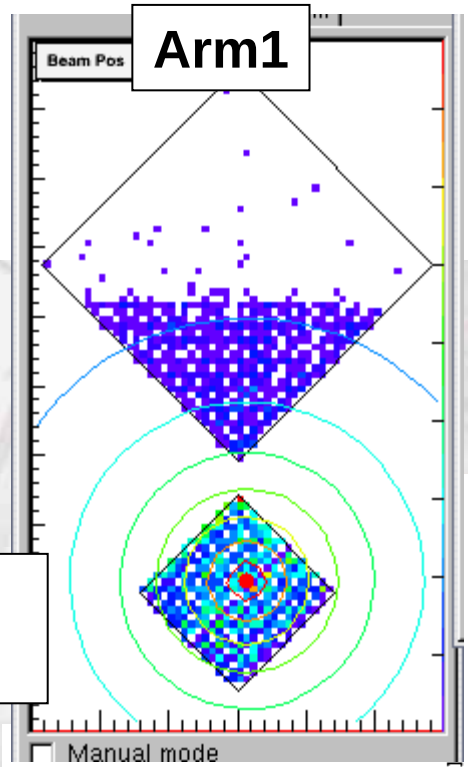
← 1nb^{-1}

Total Stats in Mar30th – Apr 26th 117 hours
(Detector at beam center / Nominal Gain)

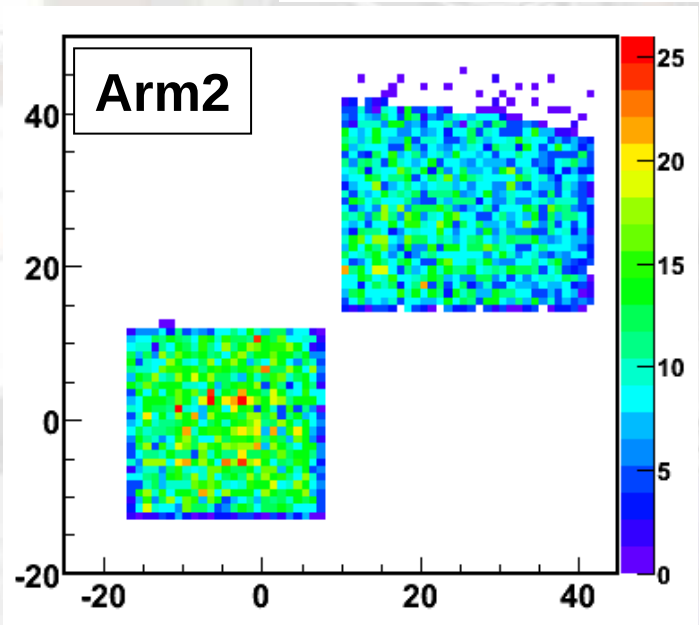
	γ-like	had-like	π^0	Livetime(*)
Arm1	1.6e6	2.8e6	10 K	96%
Arm2	2.0e6	4.0e6	25 K	93%

(*) Deadtime mostly due to detector moving into beamline

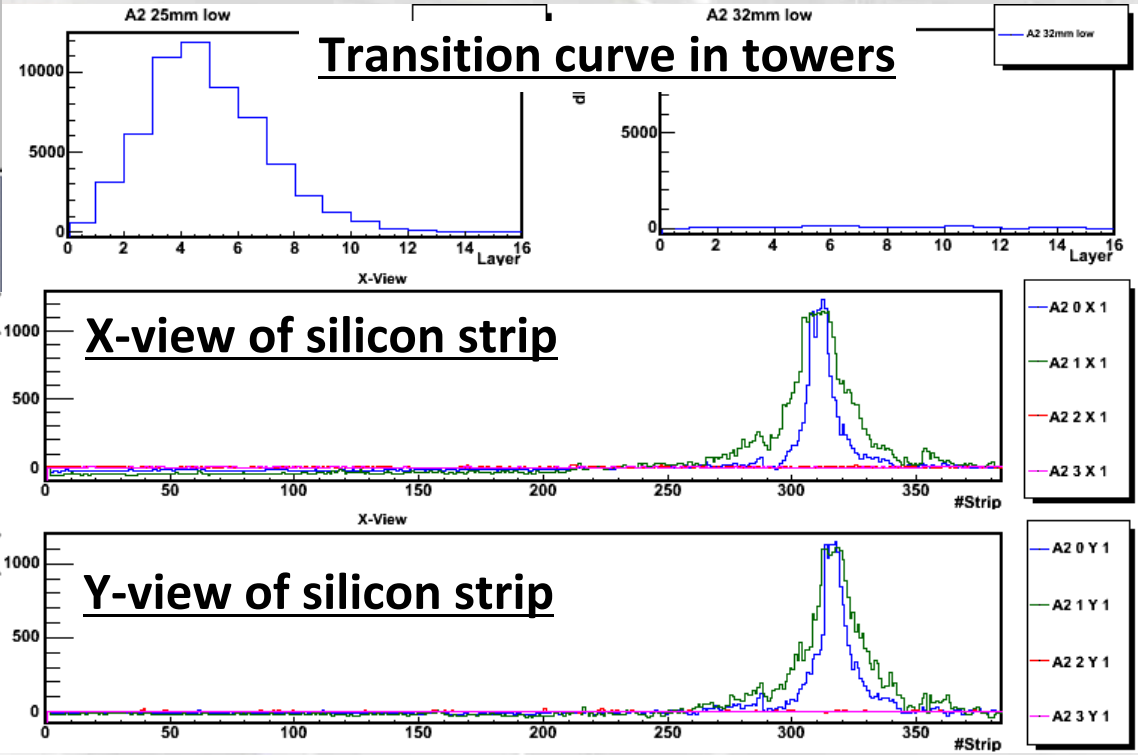
LHCf observed 7TeV collisions at 0-degree



Particle Hit maps

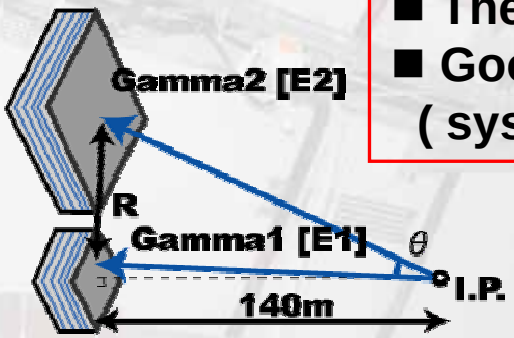


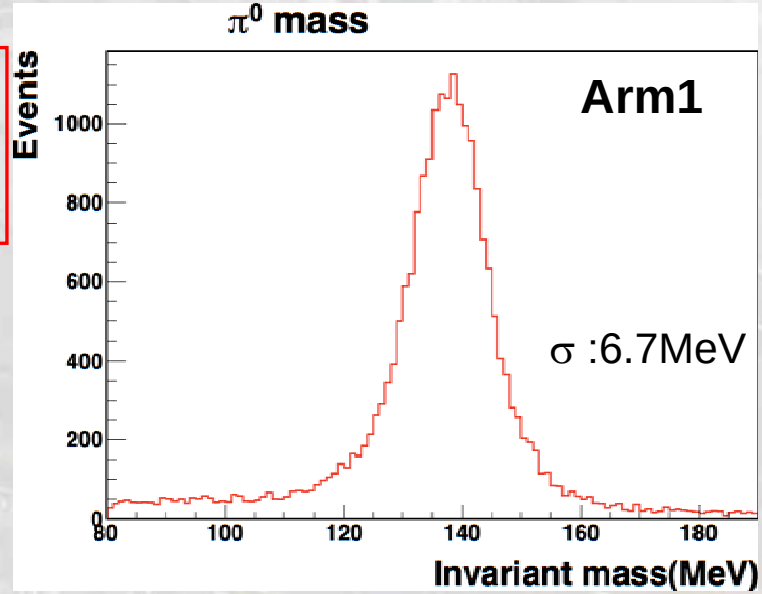
1 TeV gamma-ray shower @ Arm2



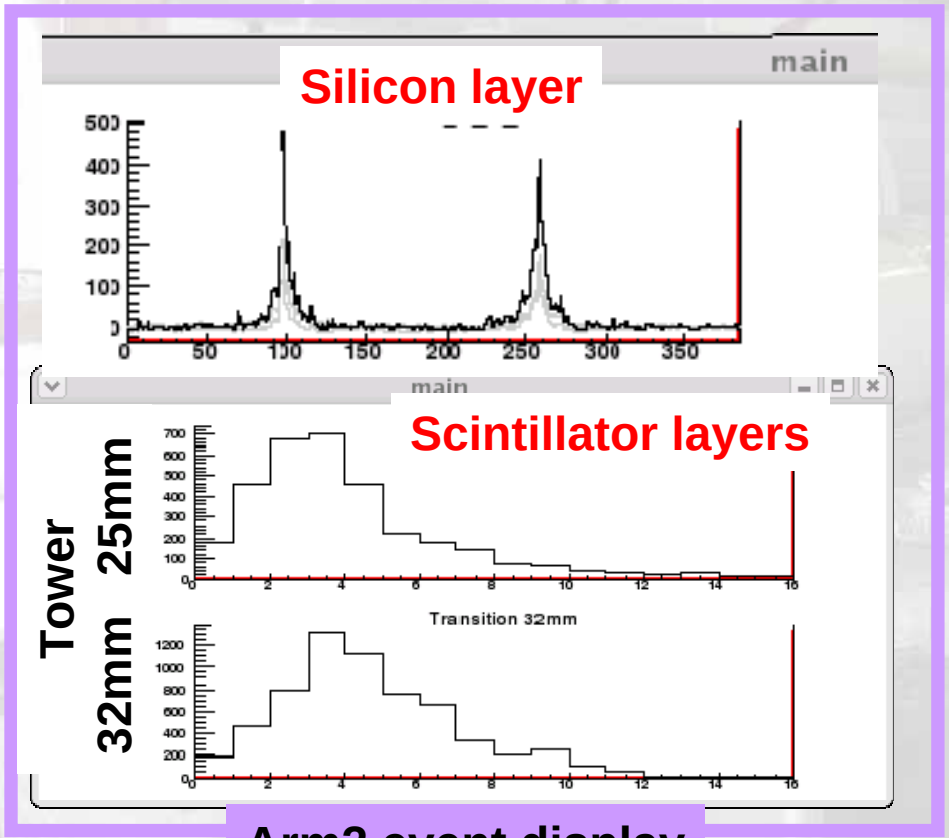
The π^0 peak at 7TeV

- The robust sample
- Good energy calibrator
  (sys err so far +10% -5%)

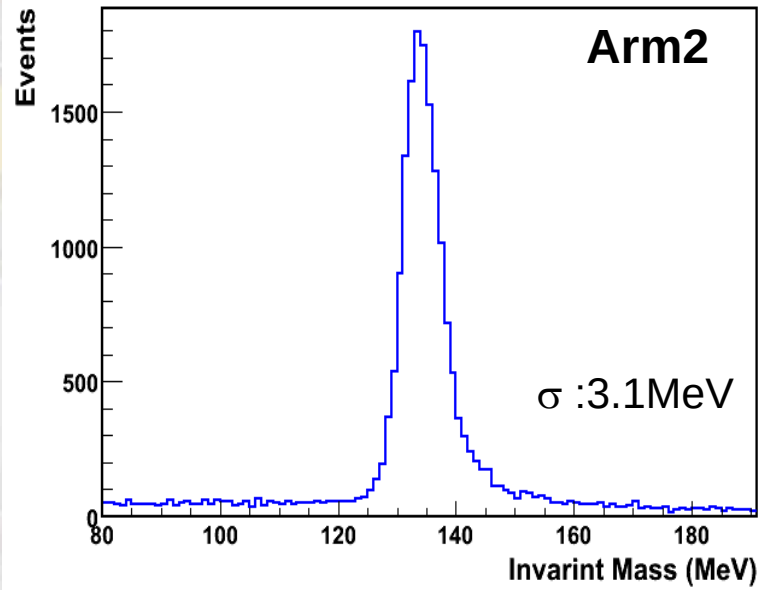




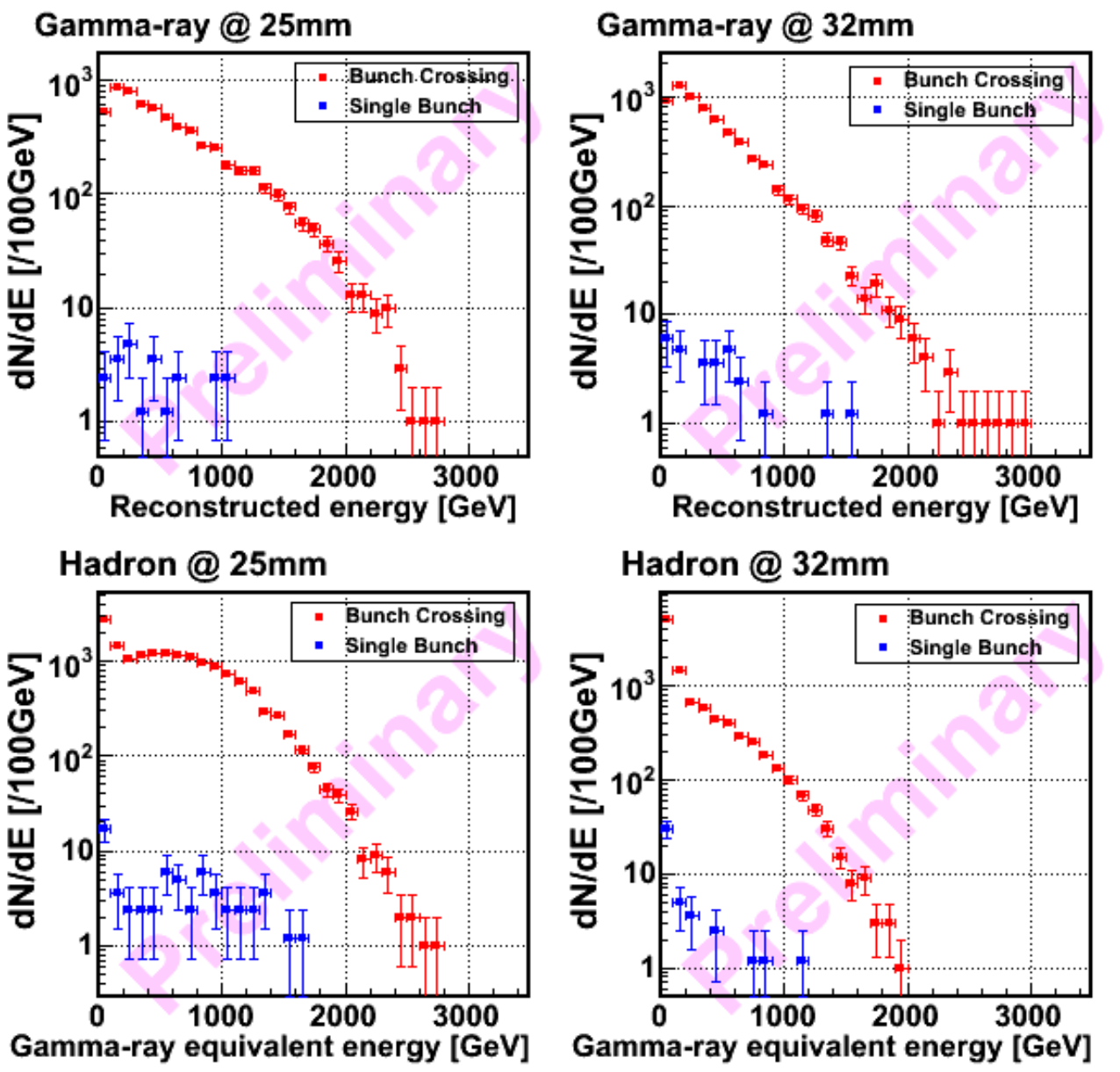
Expected mass resolution 5% and 3%



Arm2 event display



Quick look at 7TeV collisions (Arm2)



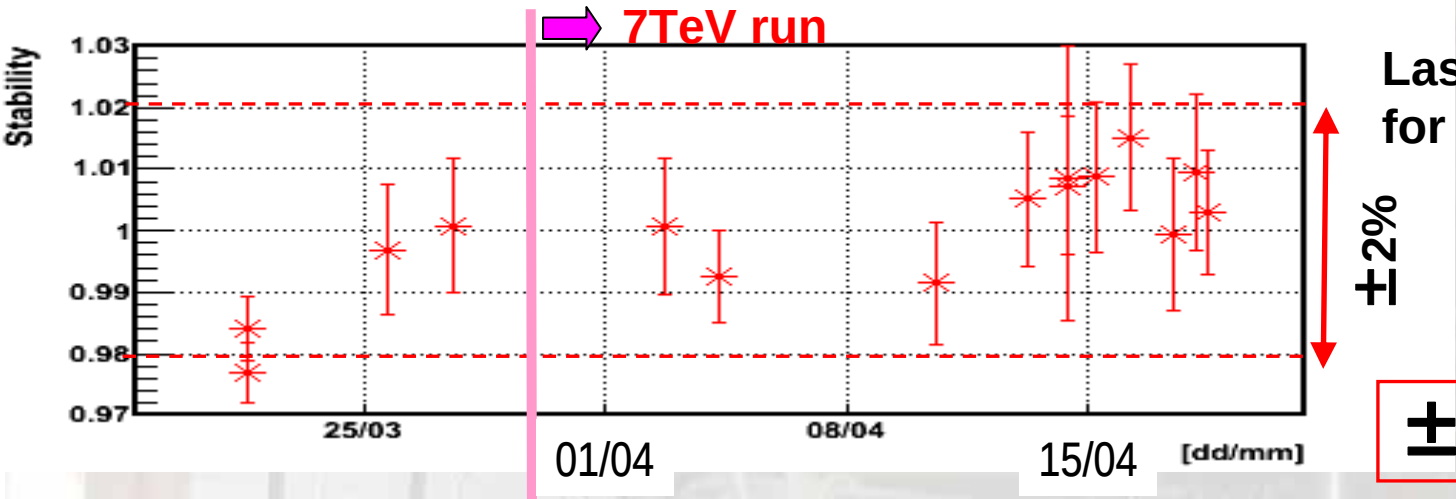
Colliding bunch

Non-colliding bunch

High statistics !!
Only 1.5% of total data are used

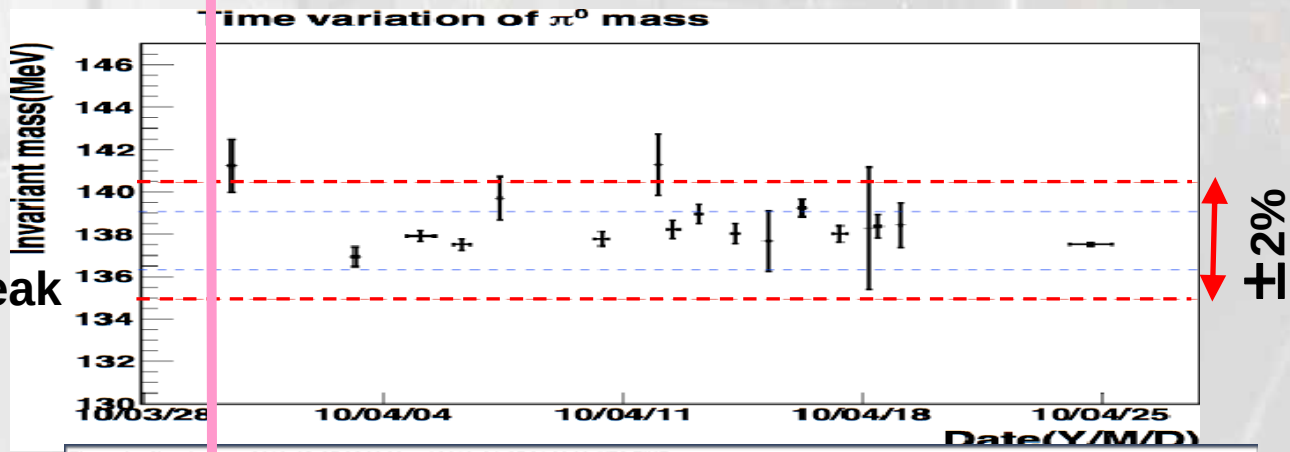
Very clean data!!
BKG due to beam-gas collisions is ~ 1%

Detector gain stability in Apr 2010

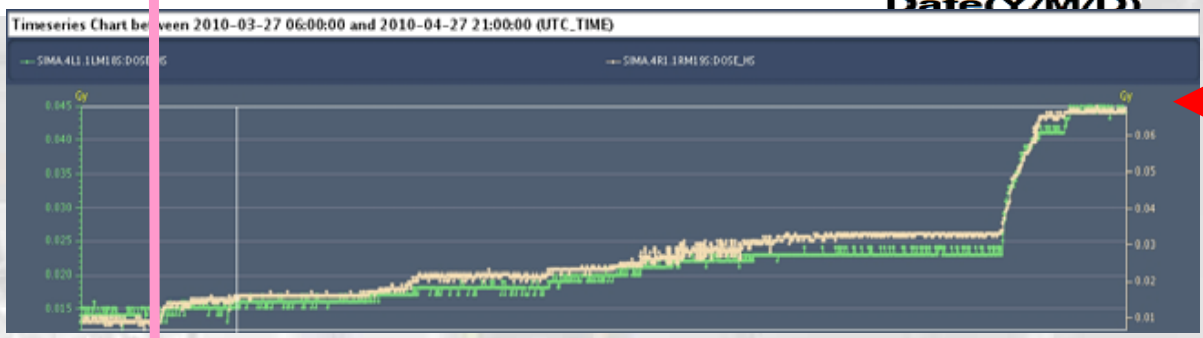


Laser gain calibration for scintillator layers

±1% level stability !



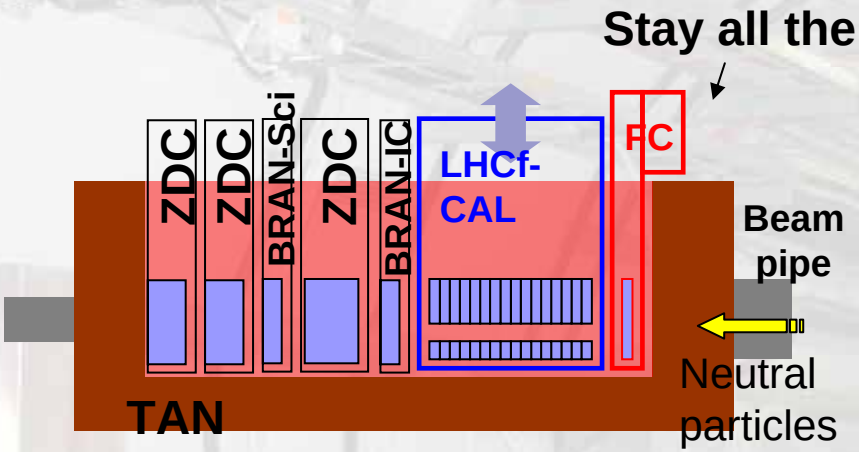
π^0 mass peak

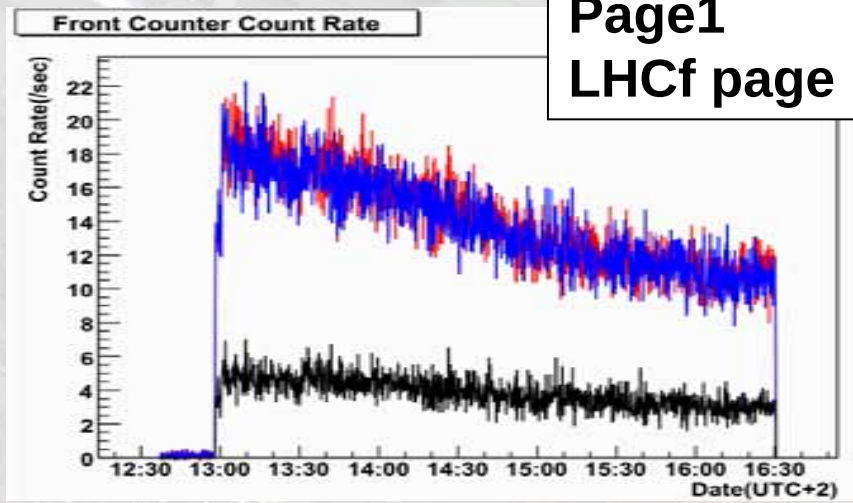


cumulative dose

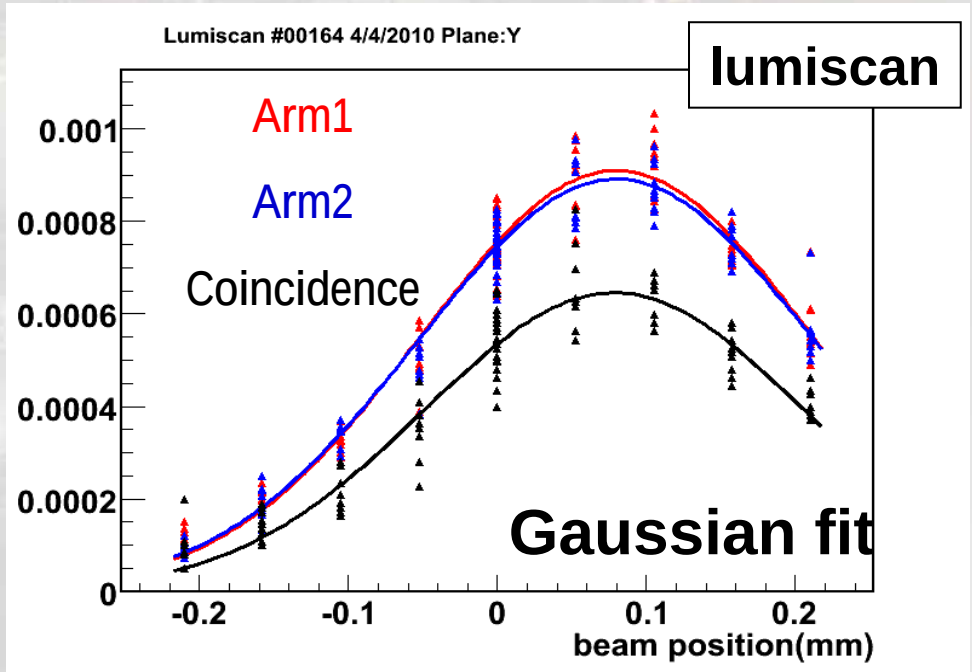
0.045Gy

FrontCounter as a good luminosity monitor





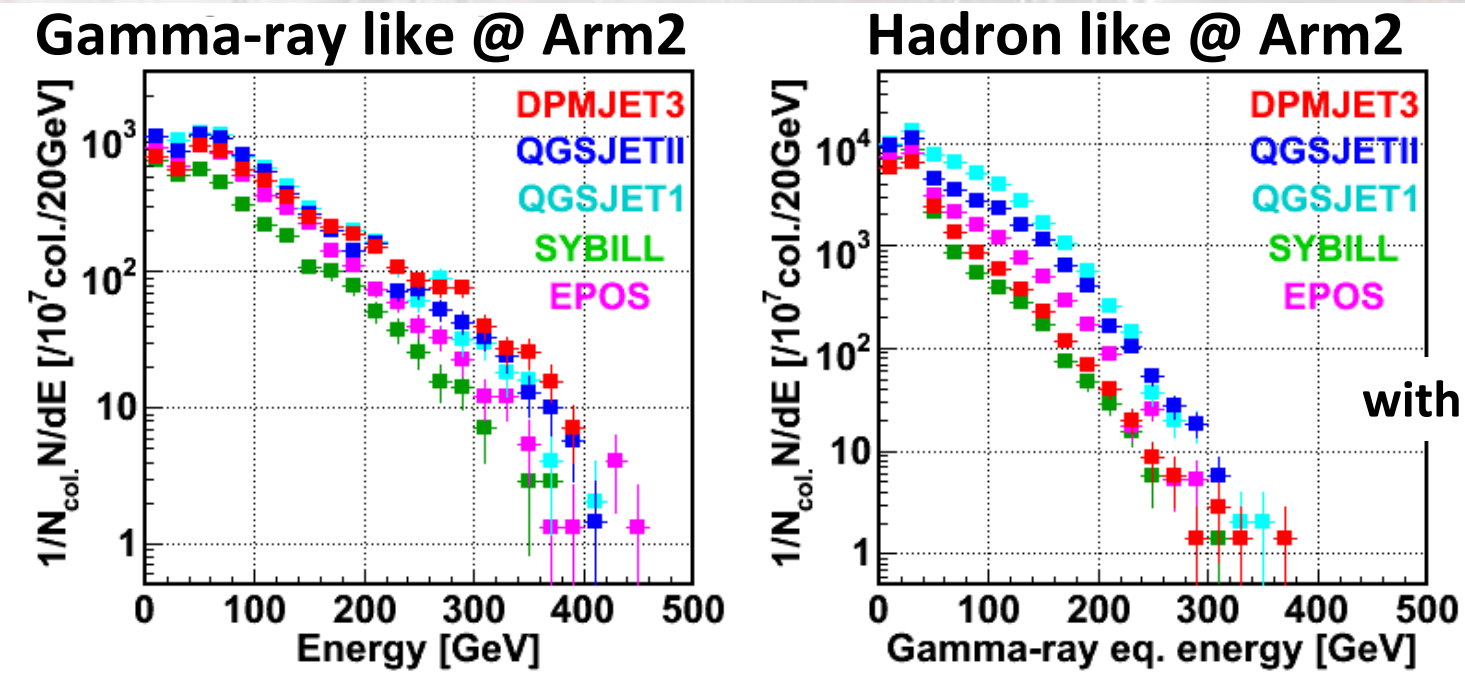
- FC is working very well for luminosity monitoring
- Continuous monitoring w/ independent DAQ now available. See Page1 “LHCf experiment”
- Conversion to “luminosity” from FC rate is now under study by MC



Analysis of 900GeV runs in 2009

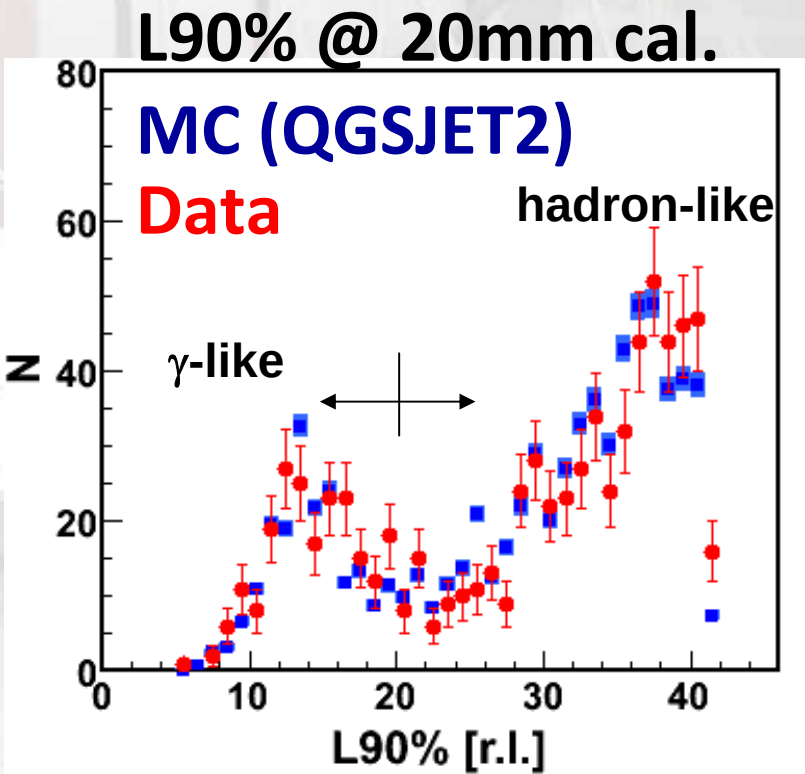
- Stable beams at 900GeV, 06.Dec. – 15.Dec (27.7 hours)
  - 2,800 and 3,700 showers in Arm1 and Arm2, for ~5e5 collisions at IP1
- Progress in Analysis since last LHCC
  - Refine analysis tools and fix final data sets for Dec09 run.
  - Absolute energy calibration by π^0 peak at 7TeV

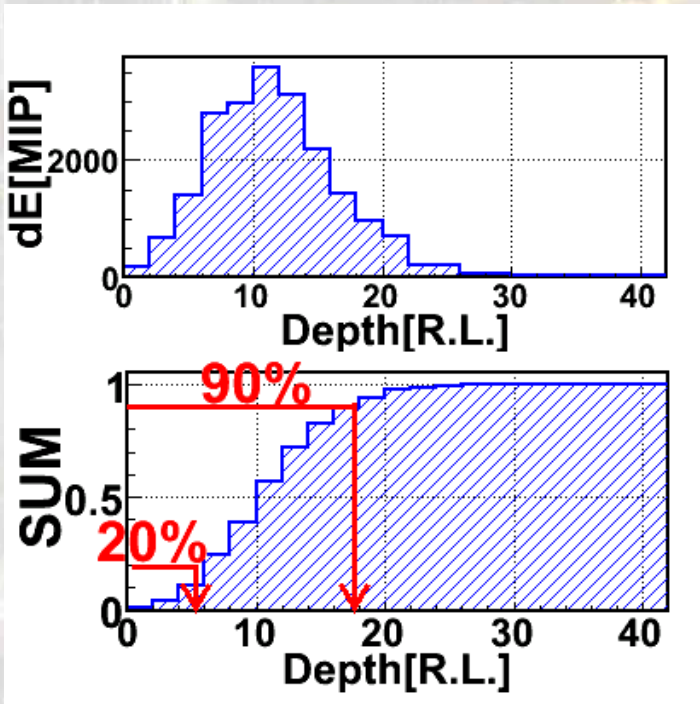
Expected spectra with each hadron interaction model



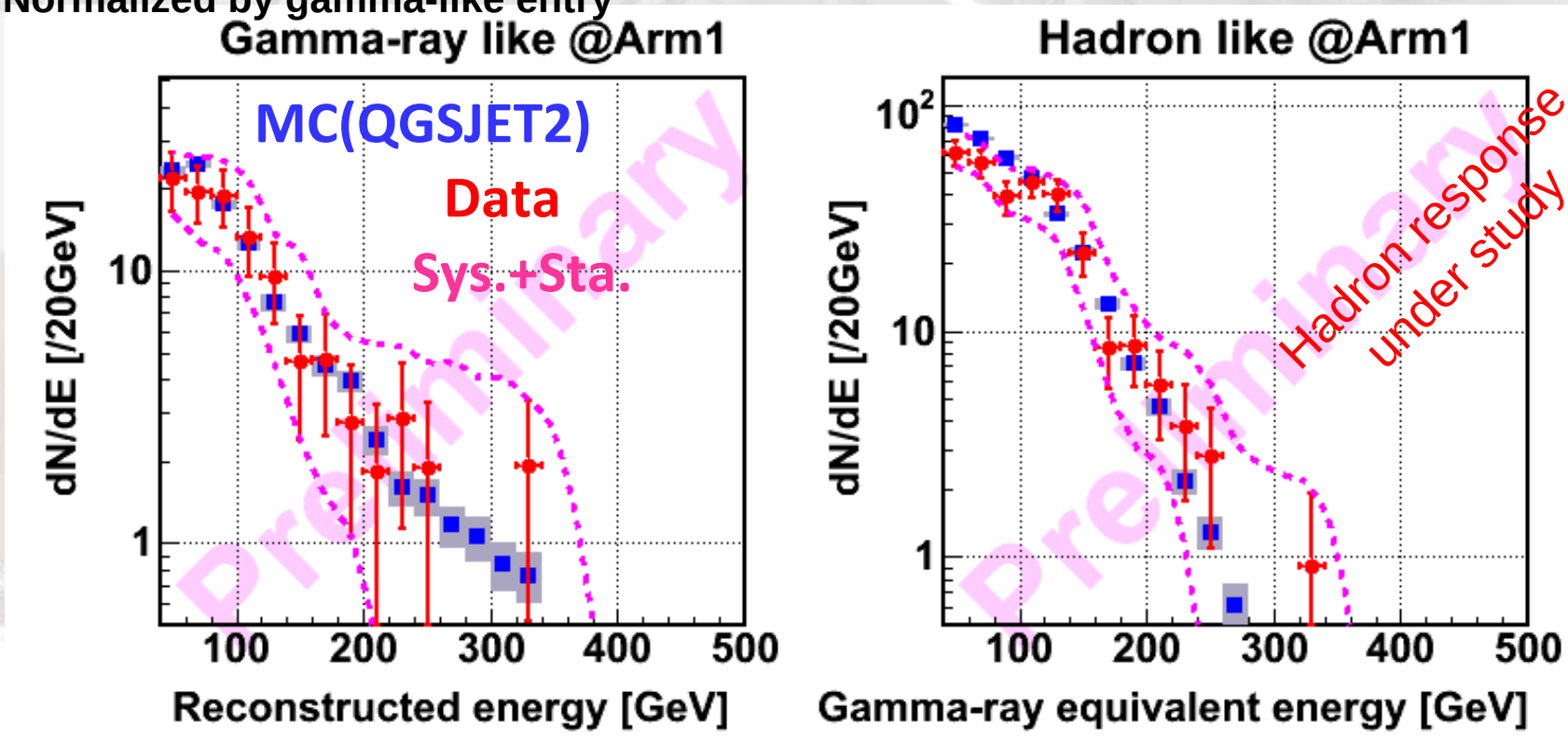
Particle Identification

- Clear discrimination between γ and hadron showers based on shower transition curves.
- Basic agreement in the PID parameter (L90) distribution
- Checking systematics for SPS calibration data (50-200GeV for electrons, 150, 350 GeV for protons)





"Very" preliminary spectra from 900GeV runs in 2009



- Reasonable agreement with MC
- Conservative systematic error for energy scale +10% -4% assigned
- Checking detector response for hadron showers by SPS 350,150GeV p data

Adding May 900GeV runs, 100K showers now (Dec09 x15) !

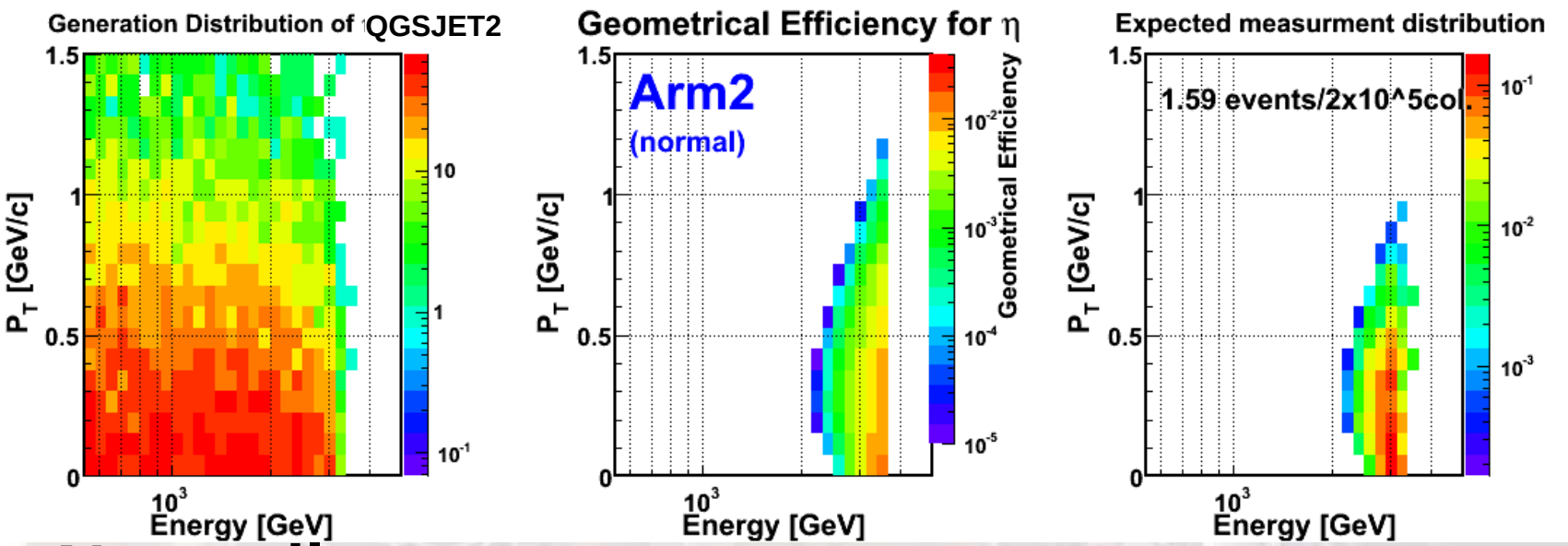
Plan for coming months

- Nominal data taking at 7TeV

  Typical unit 10K π^0 w/ ~1nb^{-1}

  - So far collected ~10K π^0 s at beam center.
  - Another ~10k π^0s will be collected at -10mm below center to cover P_T gap (for arm1 from this May run)
  - Another runs for checking systematics with a few different configuration (HV, trig threshold, etc..)
  - High statistic w/ 1 or 2 settings (for η meson, etc.)
- Possible beam crossing angle run(140μrad) at 7 TeV
  - Enhance rapidity coverage; **η >8.7 → η>8.4**
  - Important to check flux center moving downward w.r.t. crossing angle
- Finally, LHCf de-installation
  - When luminosity reaches too high (>10^{31}cm^{-2}s^{-1}, or 2pb^{-1})

Study of η in a high statics sample

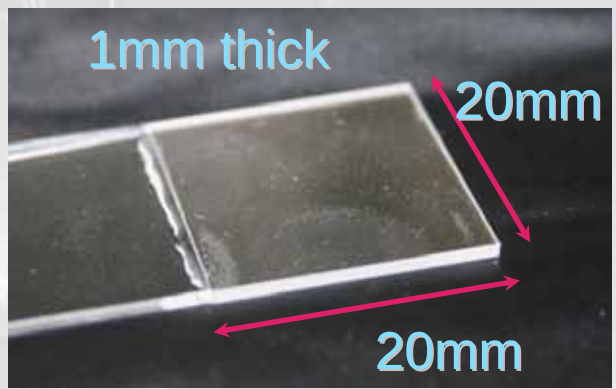


- **Next milestone: η meson**
  - η/π^0 ratio or η production spectra vary a lot among different interaction models. A good handle to probe the models, though irrelevant to air shower development.
  - Another calibration point for more robust energy scale
  - Typical $\eta/\pi^0 = 10^{-3} \sim 10^{-4}$ at 7TeV. Good to collect ~1M π^0 (~100nb^{-1})
- Strangeness production (K^0, Λ) is under study

LHCf removal and toward the phase-2

- When luminosity become too high (>10^{31} $cm^{-2}s^{-1}$, 2 pb^{-1}), LHCf will go out from the TAN (Radiation damage at plastc scinitillator ~1kGy@2pb^{-1} for 20% degradation)
- De-installation work should be quickly done during monthly Technical Stop.
- Probably not earlier than the next Technical Stop in June. We'd like to revisit the scheduling issue when LHC luminosity profile gets clearer in June.
- After removal, beam calibration again by a SPS test beam.
- Revisit LHC at the next energy upgrade. R&D and fabrication of rad-hard GSO scinitillator are on-going for the "phase-2" LHCf detector.

A new GSO scintillator layer →

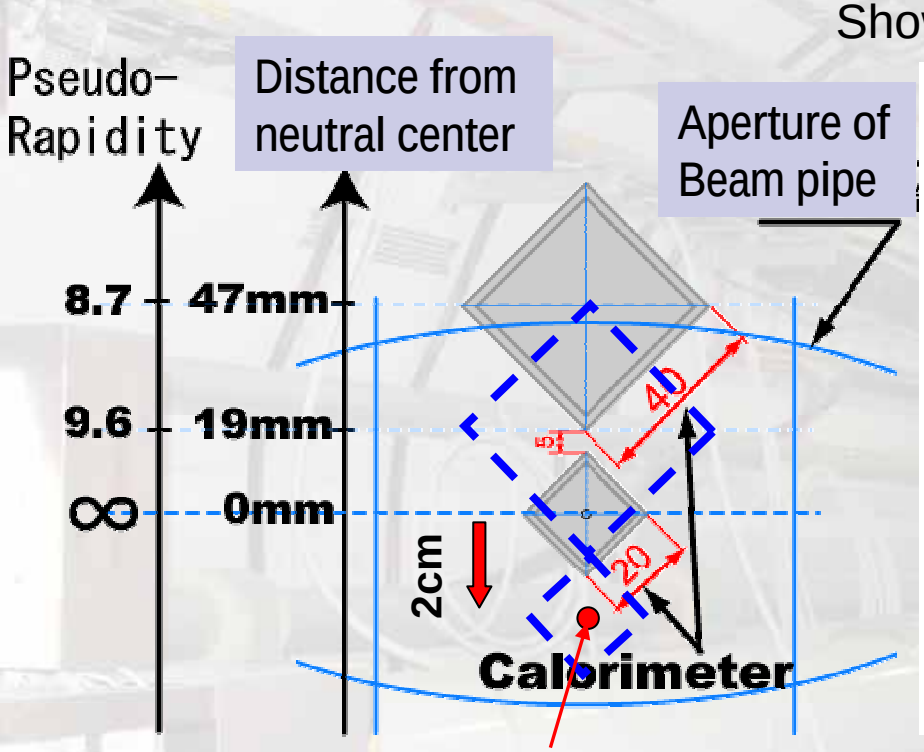


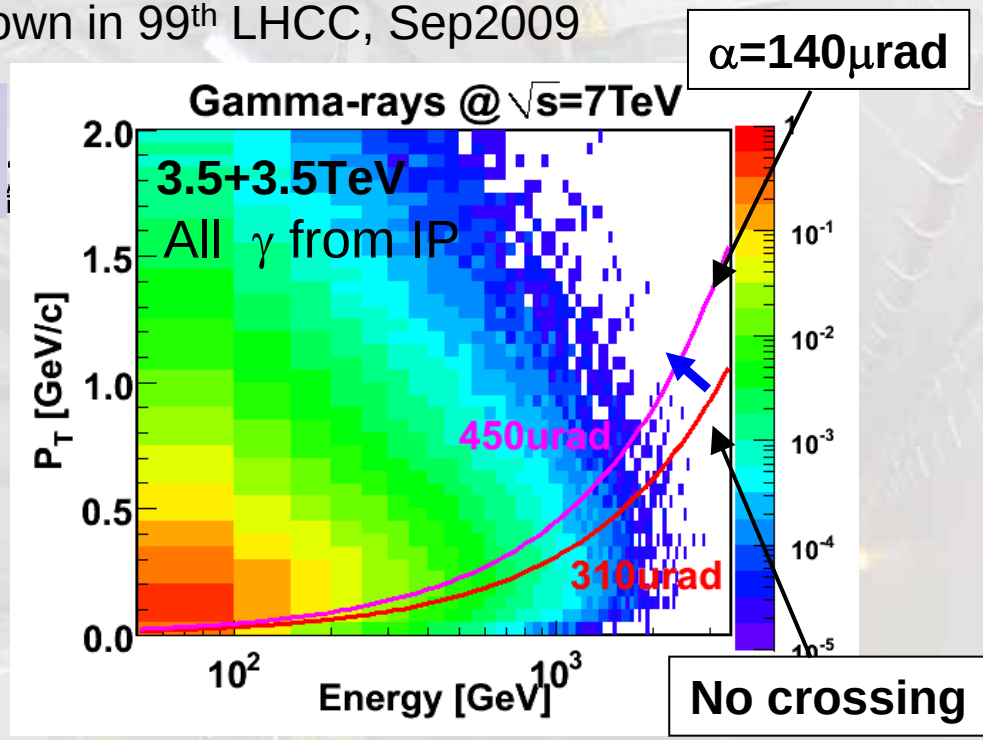
Summary

- LHCf has started physics program quite successfully.
  - 6K showers at 900GeV (now getting 6 times more in May !)
  - 10M showers and 35K π^0 at 7TeV
- Detectors working beautifully without any serious trouble.
  - Very clean ! Negligible beam-gas background
  - The π^0 peak demonstrates good performance as expected.
- As luminosity growing up, high stat run and other optional runs to be discussed
  - High stat run for η mesons
  - Crossing angle commission ← important step to “phase-2”
- Rapid progress in analysis. Almost ready to publish physics !
  - 900GeV results and 7TeV results
  - Finalizing SPS test beam data to confirm energy scale, PID and hadron shower response at a few 100 GeV.

Crossing angle for LHCf 7TeV run

Shown in 99th LHCC, Sep2009





With 140μrad crossing angle,
neutral flux center is lowered by 2cm.
Rapidity coverage: **>8.7 → >8.4**.

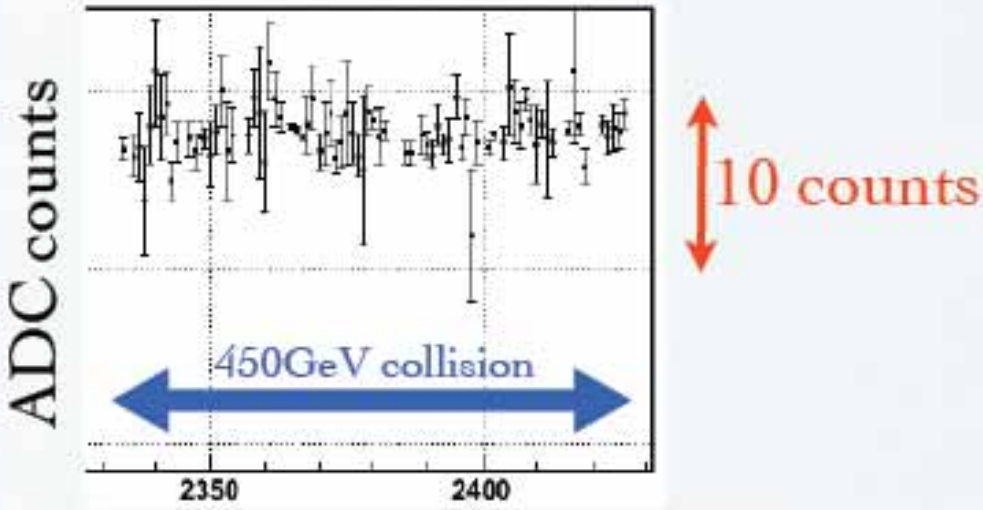
- w/o crossing : 30%acc. @X_f = 0.22
- w/o 140μrad : 50%acc. @X_f = 0.22

- If possible, it is nice to have a crossing angle during LHCf run.
- LHCf can measure crossing angle by fitting shower center
  (ΔY~ 1mm for 100sec@L=10^{29}→Δα~7μrad) to be distributed by DIP.

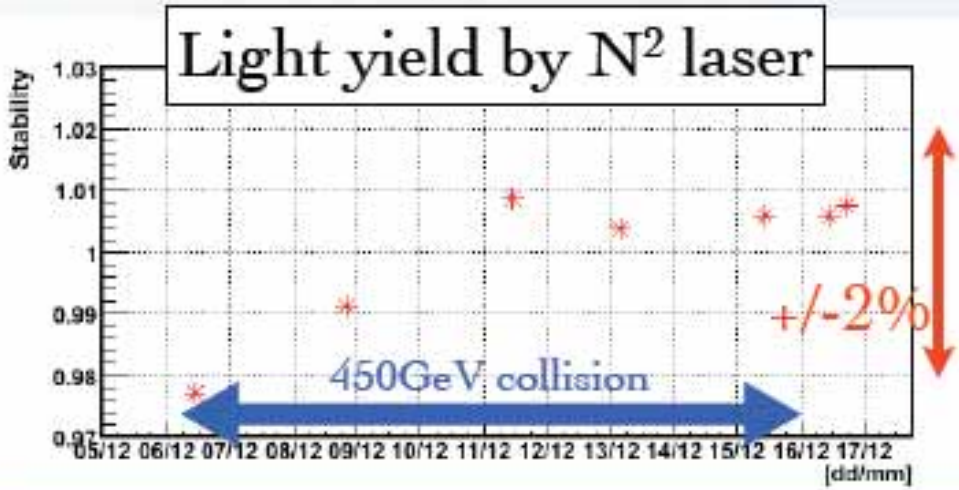
Detector Stabilities (09Dec run)

Calorimeter

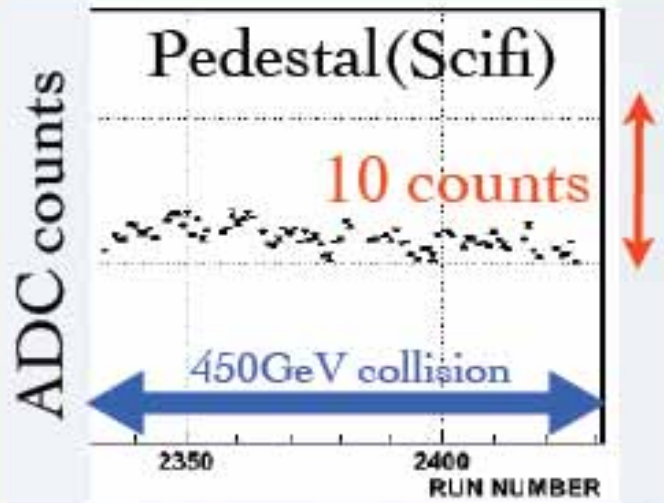
Pedestal fluctuation



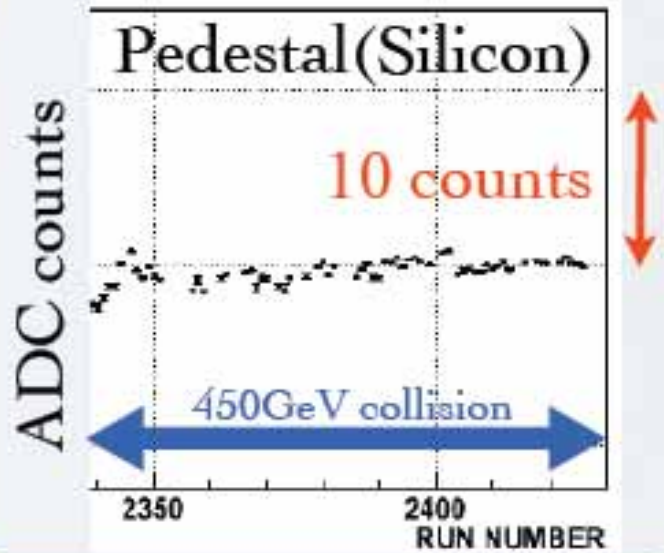
Light yield by N^2 laser



Pedestal(Scifi)

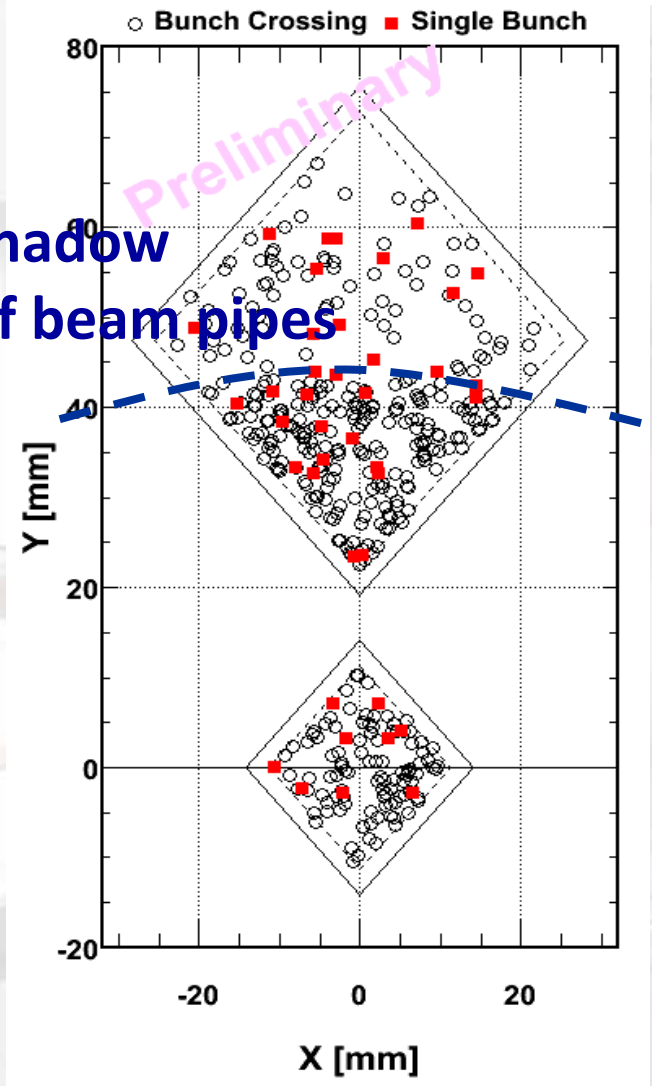


Pedestal(Silicon)



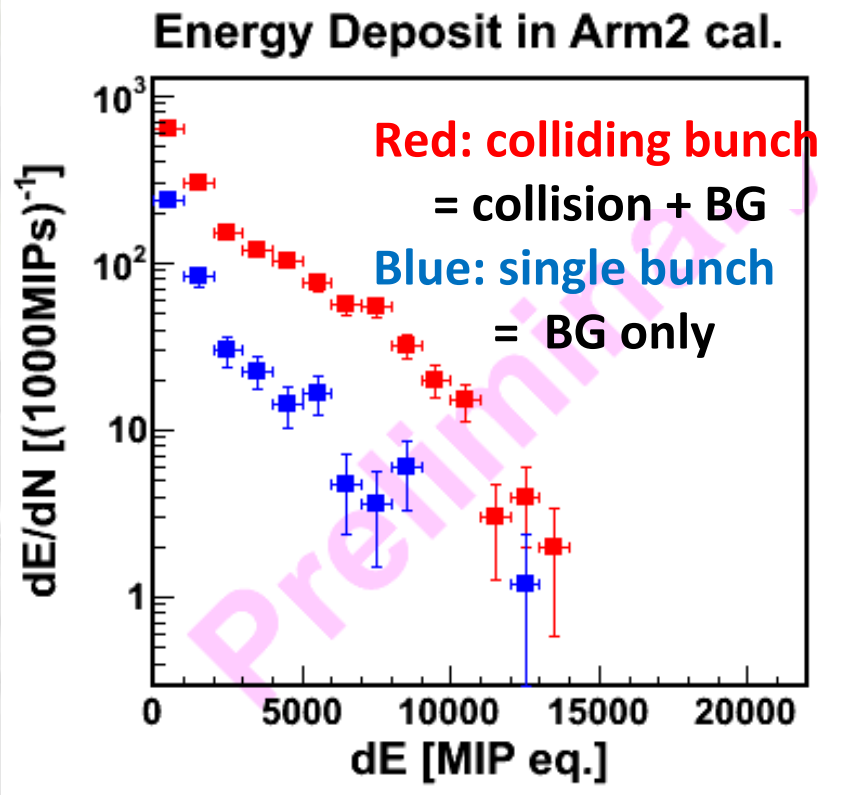
Beam gas BG at Dec09 900GeV runs

Hit map of Gamma-rays

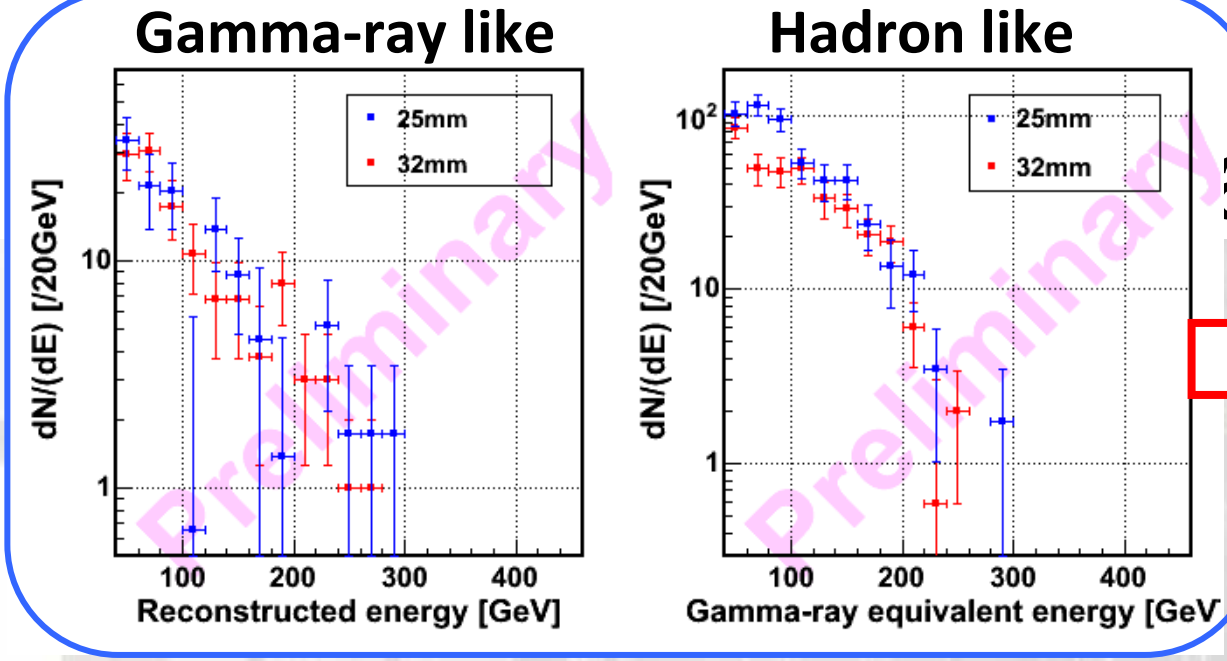


shadow of beam pipes

Background due to beam-residual gas collision is about 10%

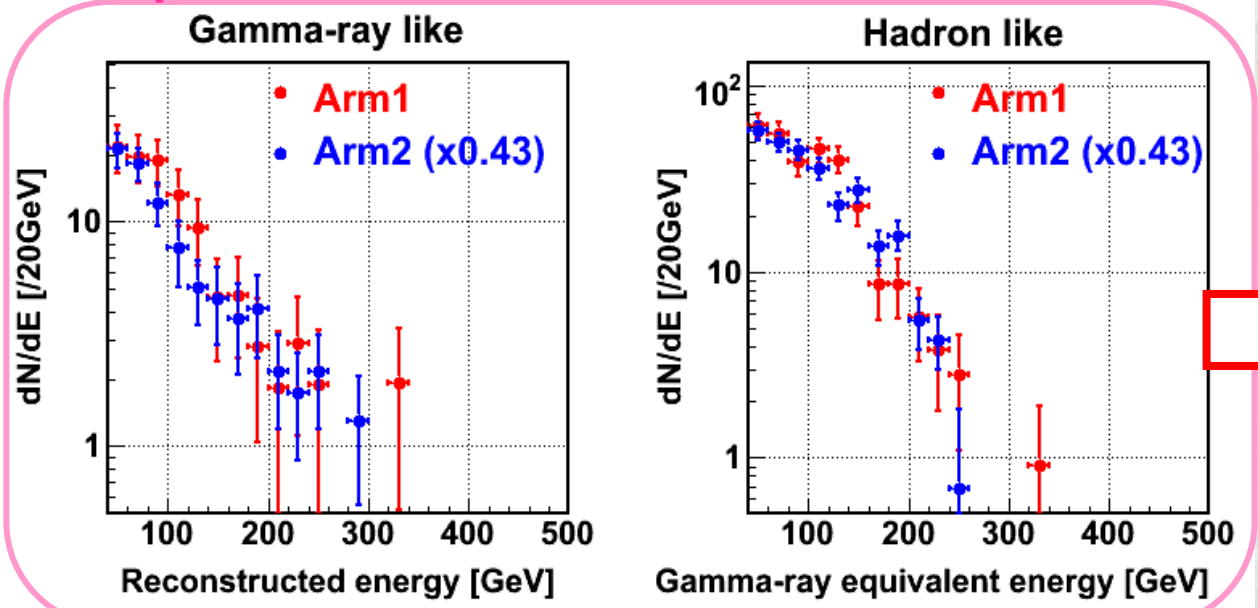


Comparison between tower calorimeter towers of Arm2



Flat spectra in η>8.7 at 900GeV

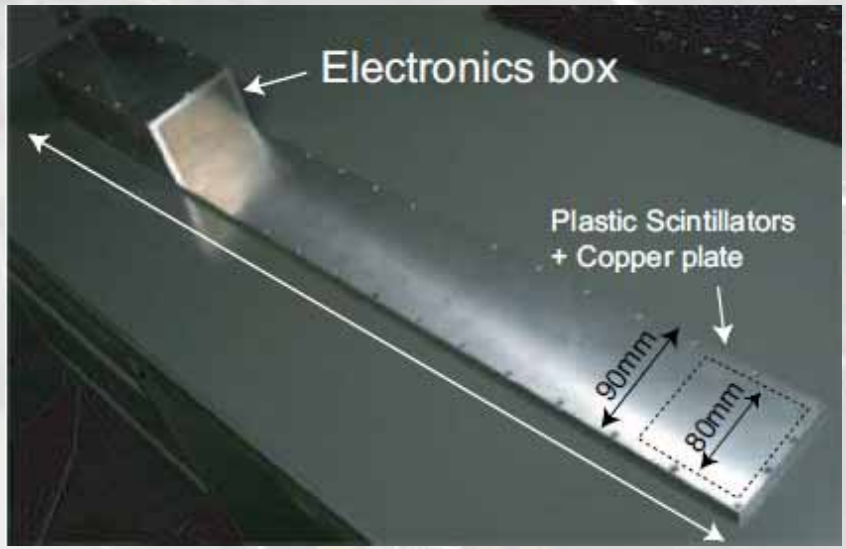
Comparison between two Arms



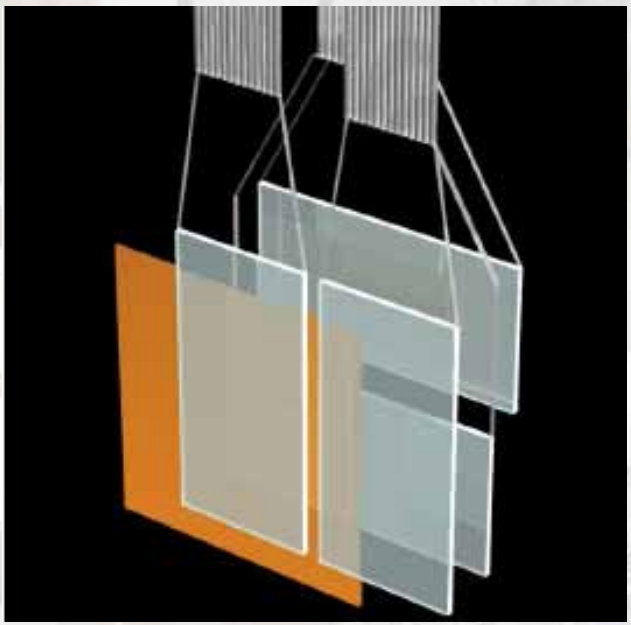
Both detectors working without any biases

-Front Counter-

- Thin scintillators with 8x8cm^2 acceptance, which have been installed in front of each main detector.



Schematic view of Front counter



- **To monitor beam condition.**
- **For background rejection of beam-residual gas collisions by coincidence analysis**