ATF2 Background measurement status and plans for 2011

11th ATF2 Project Meeting, Thursday 13 January 2011 to Friday 14 January 2011, (US/Pacific)

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OUTLINE

- Material status : Detectors, Acquisition
- Analysis status : 2010 data (neutrons from DUMP)
  - Mai run
  - Nov run
- Calibrations data @ KEK
  - Cosmic calibration
  - AmBe source
- Next run plans for 2011

Motivations

- Background studies for ILC/CLIC are carried on with simulation tools
  - eg : Geant4 (through BDSIM ...etc), FLUKA, …
- ATF2 prototypes ILC FF can also give hints on ILC background levels
  - Give hints on how well MC can describe background
  - How well can GEANT4 predict the ATF2 background (neutrons from DUMP, EM)

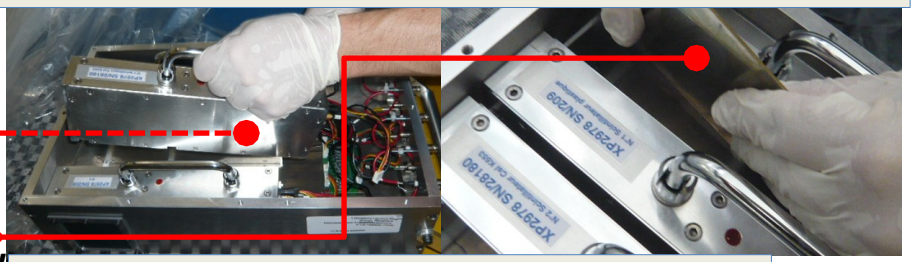
Neutron background measurement

- Activity at ATF2 to address some of the reliability questions of Geant4
  - The approach is to consider a real case situation
  - And "simply" measure, simulate, and compare
- What can be learned at ATF2, where e^- beam energy is 1.3 GeV ?
  - At CLIC/ILC the maximum energy is O(TeV)
    - But in dense materials, this energy rapidly degrades to low energy EM particles
    - With high multiplicity
    - Neutron production through photo-nuclear effects is then dominated by this low energy regime
      - In the beam dump area
      - But also in dense materials close to the IP
    - ATF2 can say something about this neutron production regime
  - An other aspect is to learn and exercise in a real case methods and techniques needed for background simulation
    - As straightforward simulations are inefficient in getting workable statistics
    - This is needed for neutron background simulation
    - But (even if not presented today) should be useful for EM background modeling, in trying to correlate background level with beam parameters

Hardware and acquisition

- Made a set of 8 simple detectors = {scintillator + photomultiplier}
  - That can be used alone
  - Or assembled in boxes to form « mini-calorimeters » with longitudinal segmentation (with W insertion if needed)
- Scintillator = plastic or pure CsI
  - Fast : allows TOF
  - Distinguish background sources
  - Separate (prompt) EM and (delayed) neutron backgrounds
  - Different response to neutrons:
  - Plastic sensitive to fast neutrons
  - Intermediate neutrons for CsI

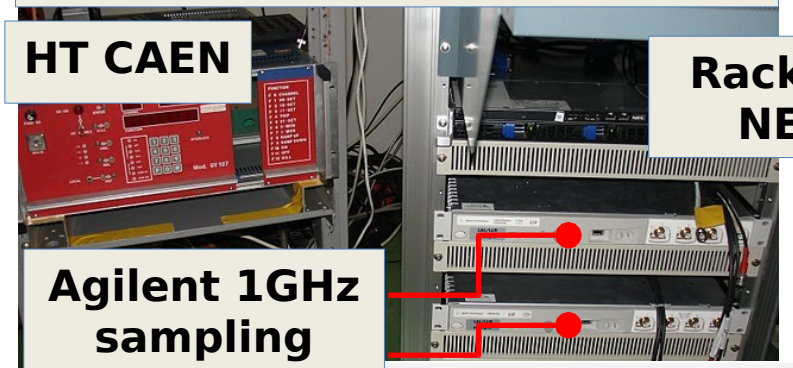
Detectors (example with using a box)



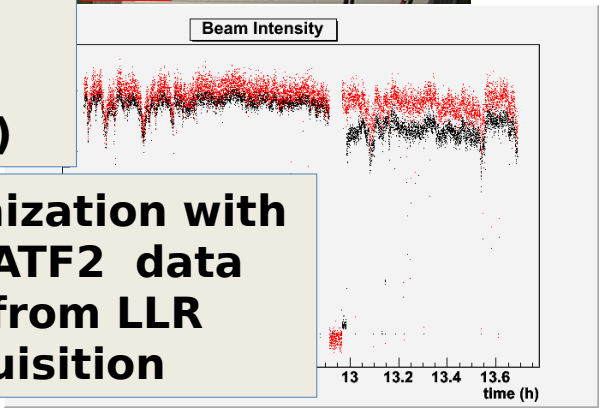
Acquisition

HT CAEN

Rack PC NEC



Agilent 1GHz sampling modules (Philip's kindness)



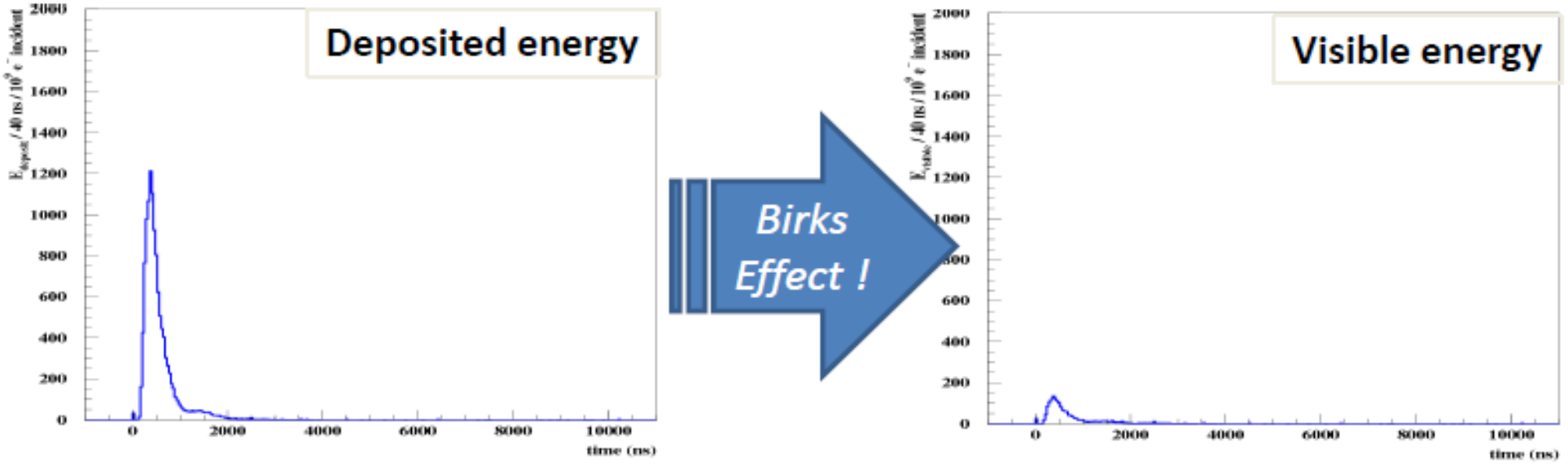
Synchronization with ATF2 : ATF2 data read from LLR acquisition

List of known “systematic effects”

- Calibrations :
  - Done with cosmic rays at different places and conditions :
    - @LLR using RG-58, 20m long cables
    - @KEK using RG-58, ~50m long cables (the one used during normal runs)
    - @KEK with short RG-58 cables (~few meters)
  - Cable attenuations :
    - In particular for 50 m cables and “fast” EM signals
    - Effect small for neutrons having slower signal as average
- PMT saturation :
    - Happened in particular with plastic scintillators when measuring EM background → Need Neutral Densities and better shielding

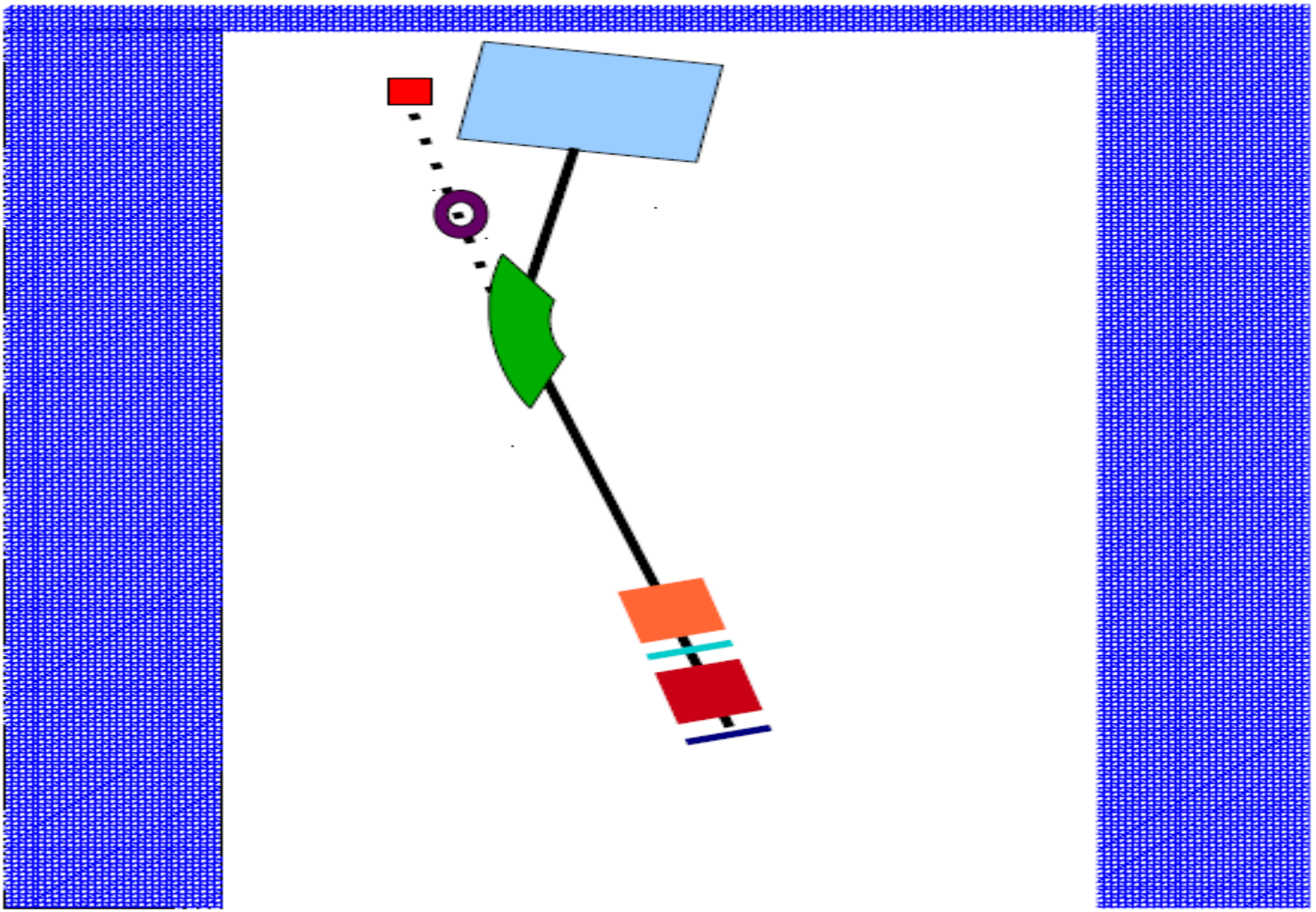
Size of Birks saturation effect

- Birks saturation : $dE_{vis}/dx \sim dE_{dep}/dx \,/\, (1+k_B\, dE_{dep}/dx)$
- Simulated waveform in plastic scintillator
  - Birks constant $k_B = 1.15 \cdot 10^{-2}$ g/cm^2/MeV
    - value in BC-408 plastic, as measured in Chinese Physics C (HEP & NP), 2010, **34**(7) 988-992

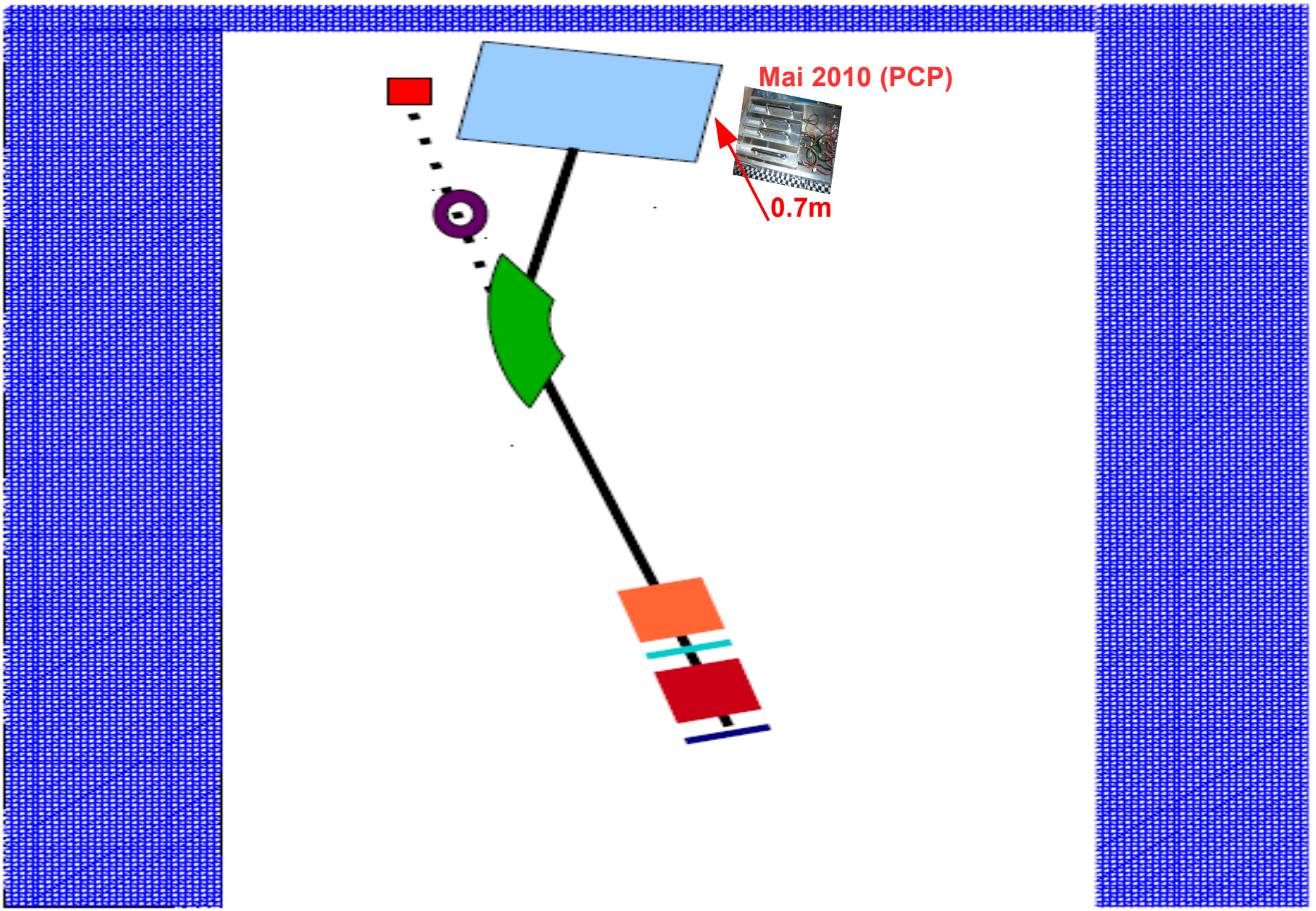


- Very large effect !
- Size of systematic effect on this reduction to be estimated.

Measurements

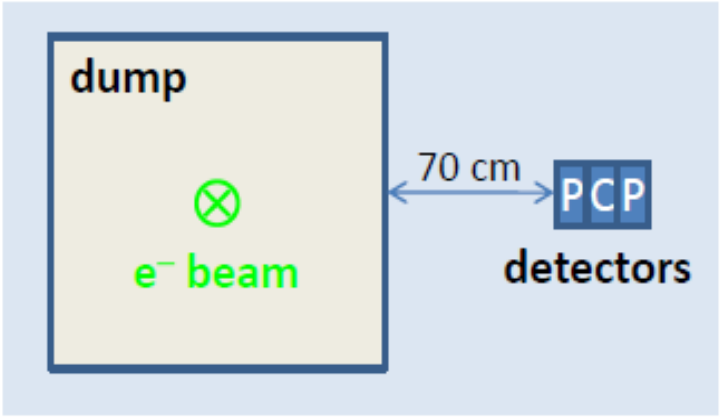


Measurements (BOX)

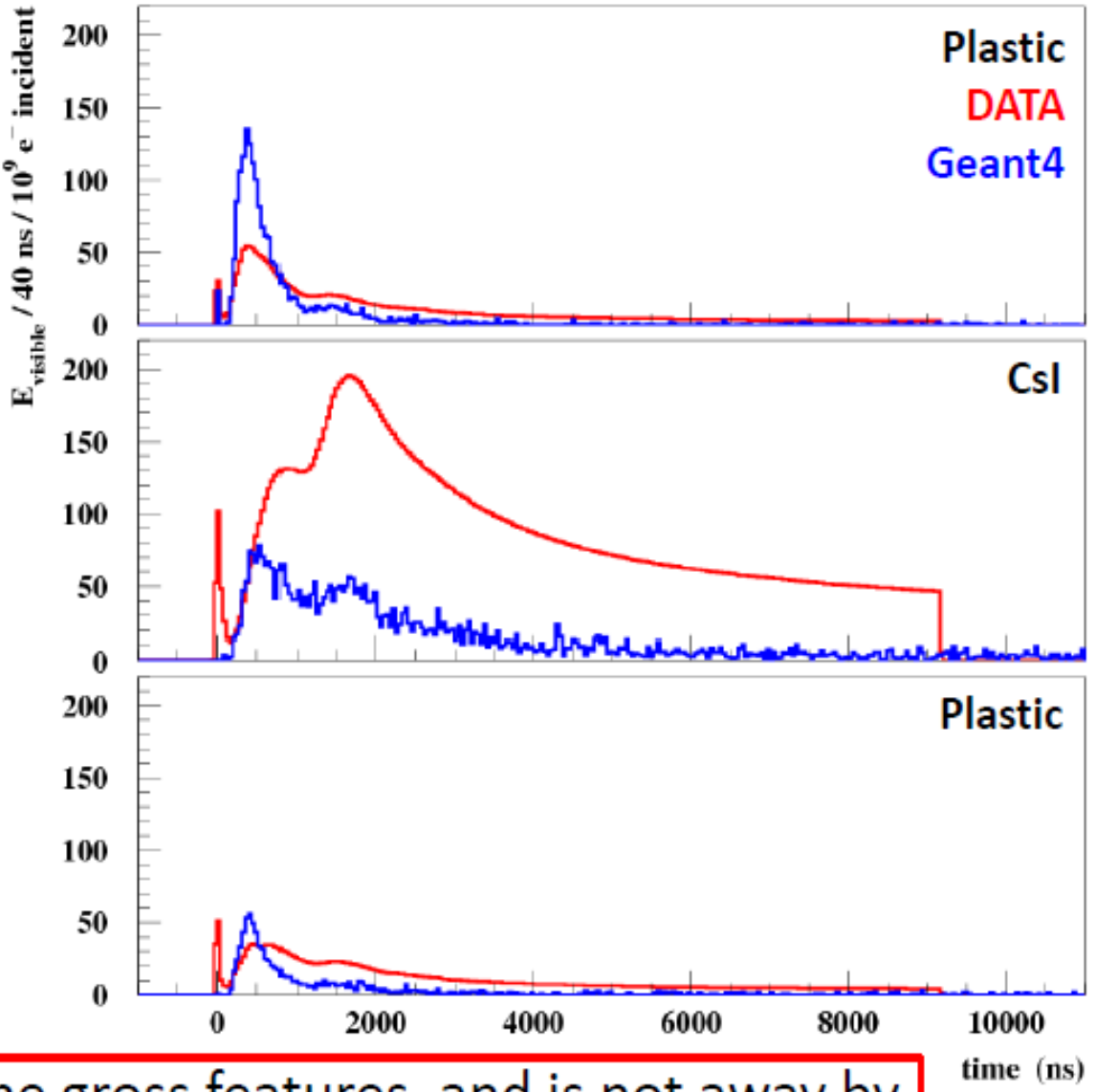


Preliminary Geant4/data comparison

- Experimental setup:
  - Plastic, CsI, plastic
  - 70 cm to dump on lateral side (opposite to Shintake photon detector)

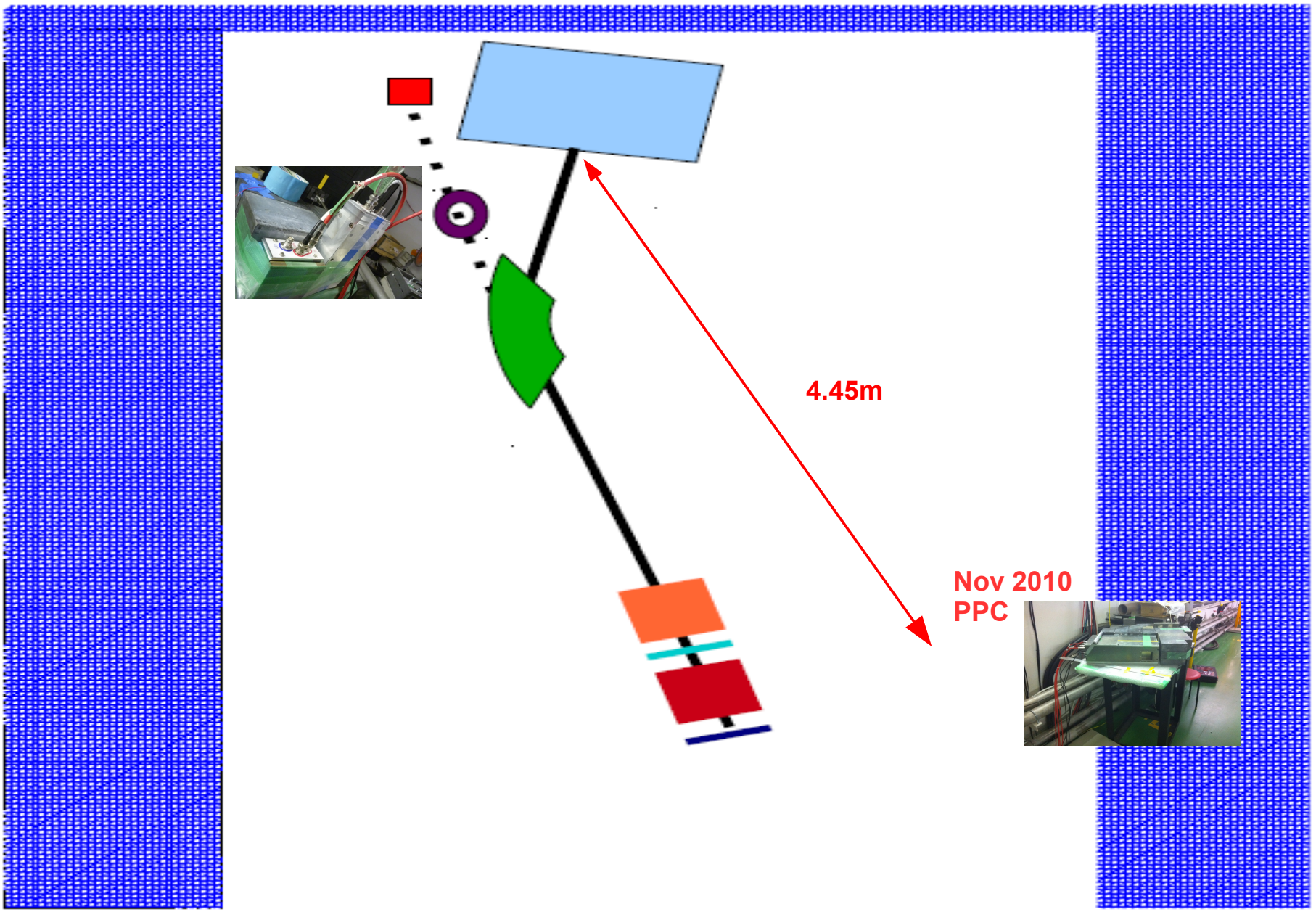


- Plots normalized to 10^9 incident 1.3 GeV e^-.
- Significant differences

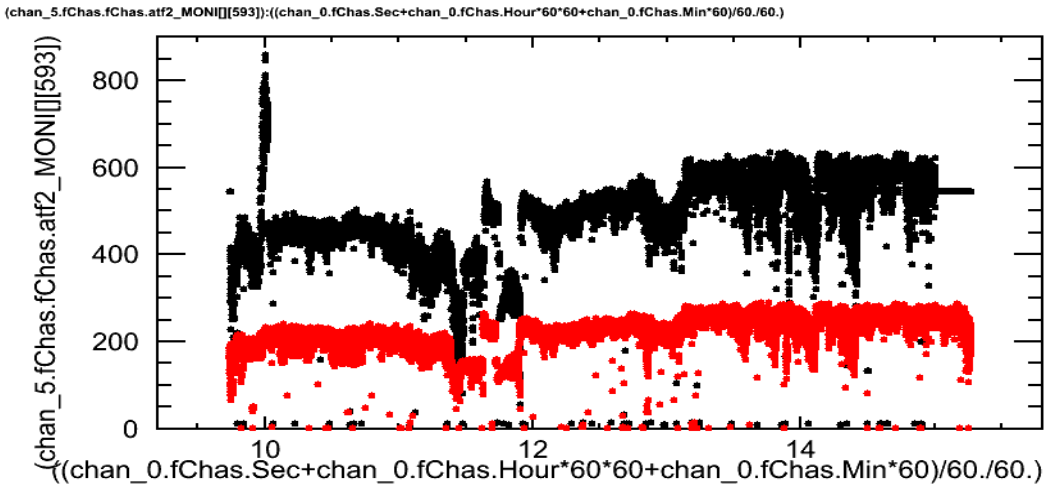


- But Geant4 reproduces the gross features, and is not away by order of magnitudes.

Measurements (BOX)

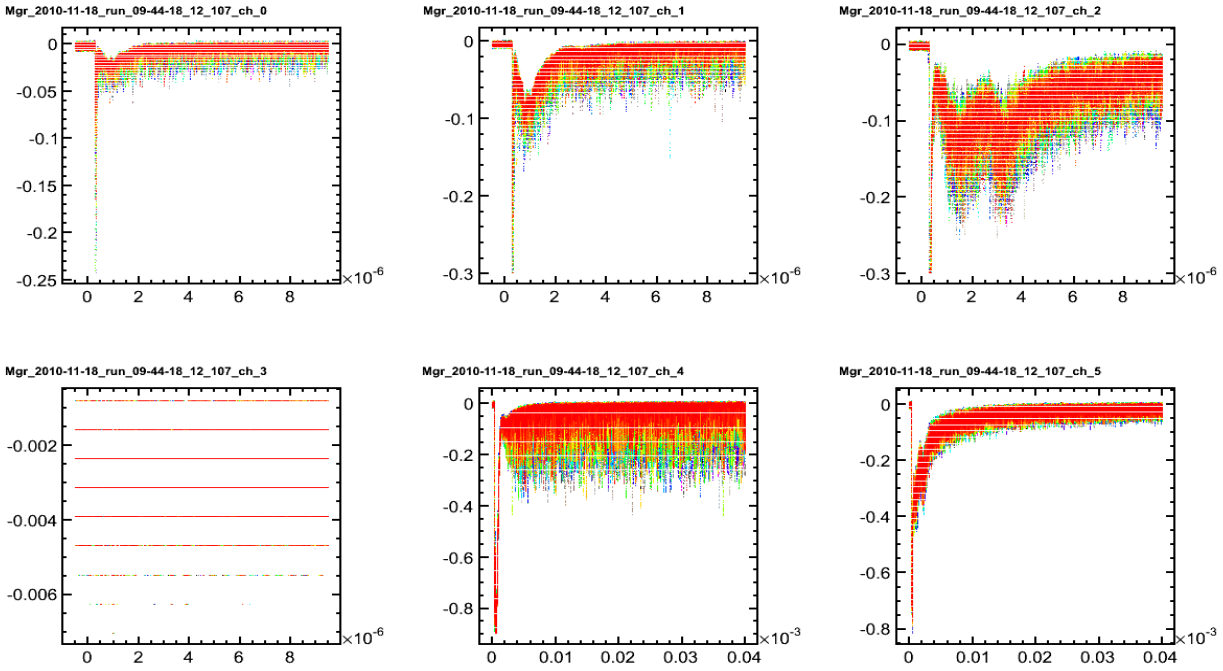


Ongoing analysis (1/2)



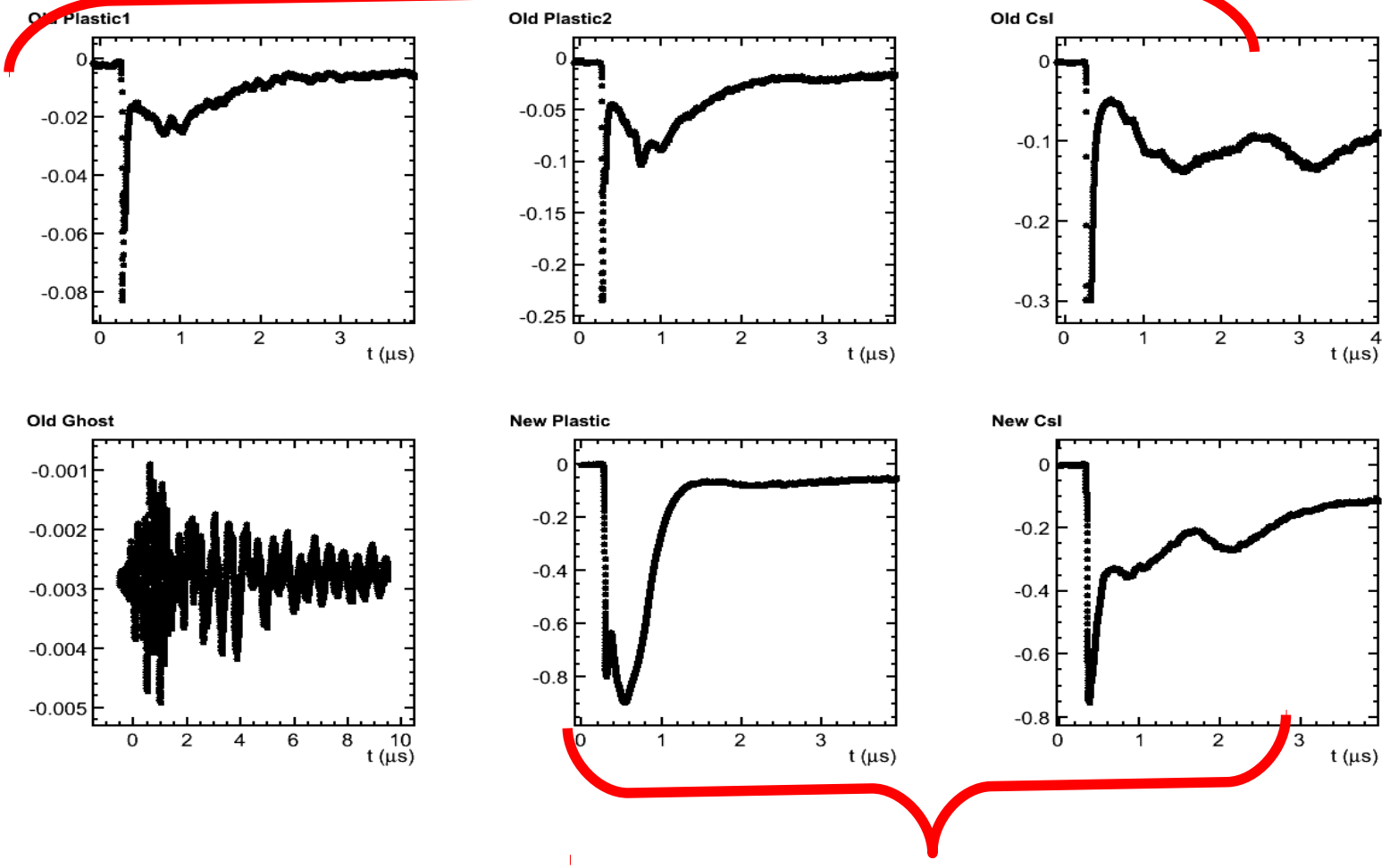
- Epics Machine data synchronized with our signals

- Measured waveforms :
  - 4 Old modules a 4.45 m from DUMP
  - 1 Plastic @ Shintake collimator
  - 1 CsI near beamline @ 1.7 m from dump



Ongoing analysis (2/2)

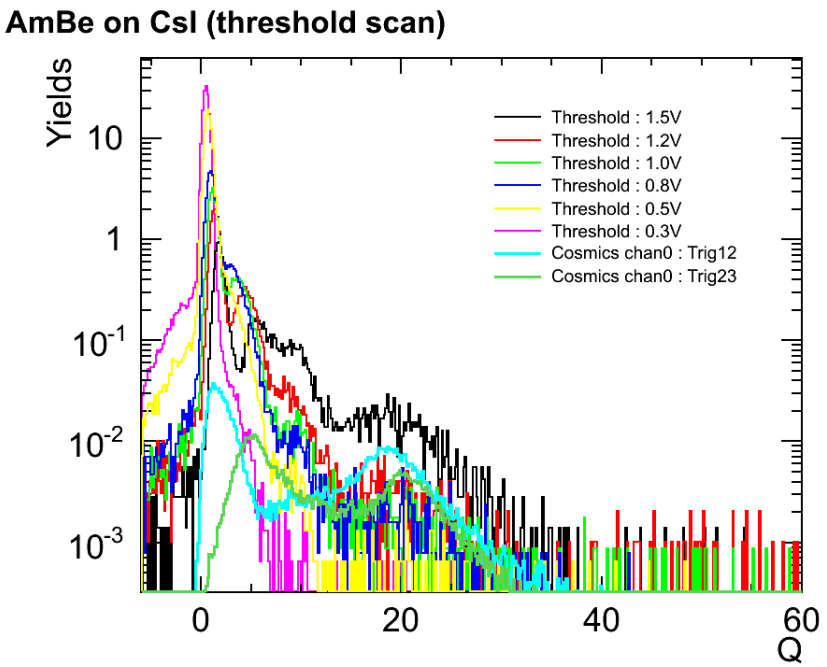
4.45m from DUMP



1.7m from DUMP

November data will provide significant cross check to Mai data dans put more constraints on GEANT4 simulation (use different geometry, biasing … etc)

Calibrations using AmBe source



- Neutrons from AmBe up to few MeV
- Also gamma (4.4 MeV)
- Measured spectrum at different thresholds
- New idea : trig on gamma and measure neutrons
  - Cannot see at the moment :(

Plans for 2011

Continuing with present activities

From the June Meeting

- Neutron background studies
  - Push forward analysis to reach physics goal of assess correctness / limitation of the Geant4 simulation
  - Might require some more data in 2010
  - And possibly no new measurements in 2011
  - We do not anticipate to attack new issues regarding neutrons at the moment
- Electromagnetic background study around the IP area
  - We collected background data before and after IP
  - And collected related beam conditions
  - So we have “on tape” data of interest to (help to) understand background behavior with beam parameters variations
  - But have not gone through serious analysis of them yet, and we need to push forward this analysis
  - Anticipated, is the need for an implementation of an “importance sampling” based biasing for the simulation
  - Problem understood at the principle level
  - Where and how modify Geant4 EM processes identified as well
  - “only” have to do it, but this will be a significant new feature

New measurement ?

- We consider making new EM background related measurements around the IP area
  - ***Preliminary idea at this stage***
  - With no assessment done at this point
- Idea is to measure EM backgrounds, still with TOF based techniques, but being “away” from the beam line
  - Using TOF, and several detectors at a time, it might be possible to do “triangulation” to locate the background source(s)
  - Note that a 1 ns resolution, should allow in principle to locate sources with a 30 cm resolution in position
  - And -with probably a delicate analysis- estimate related source intensities
- A measurement than we should correlate with the PLIC measurement, for cross-checking, and more information extraction
- About the tools:
  - For the hardware, we can reuse our current detectors, they are fast enough
  - For the software, the modeling in the simulation would rely on the “importance sampling” biasing technique, still to get statistics far away from the beam line
- Beyond principles, a first assessment with simulation should be done.