Background measurements and simulation

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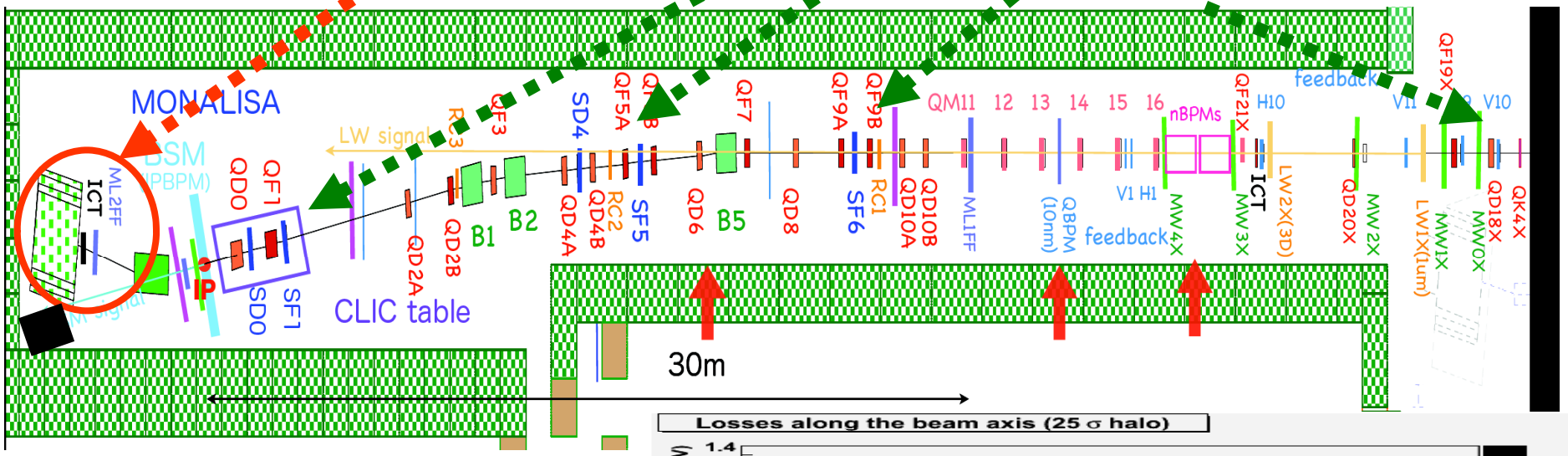
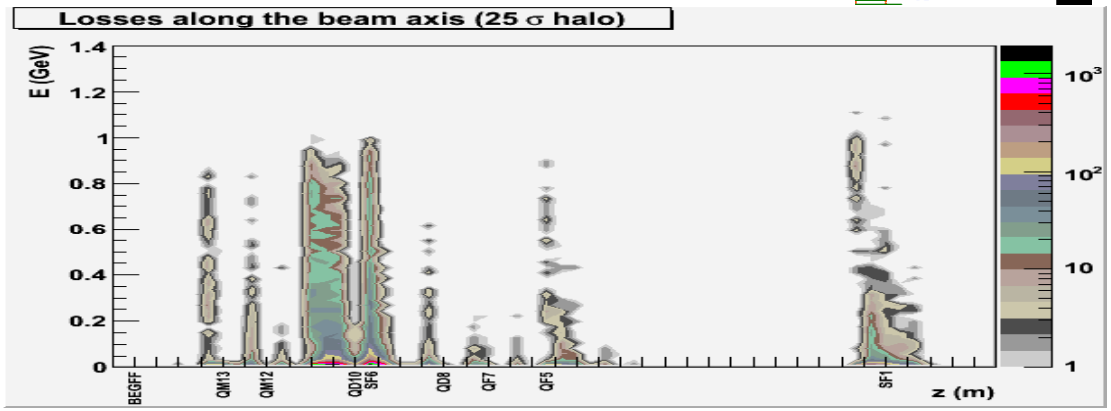
Goals

1. Validate **GEANT4 / BDSIM** beam line modeling tool with controlled measurements
2. Help minimize background in Shintake monitor **Compton photon calorimeter**
3. **Neutrons** and **bremstrahlung photons**





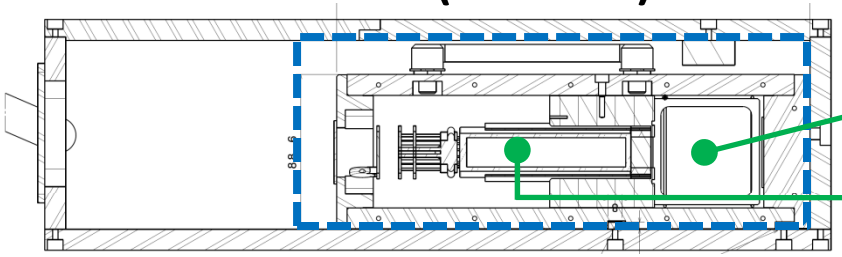
Simulation of beam halo loss along beam line

What we have done so far in 2009 (details coming)

- Complete a detector design and built it at lab
- Develop related simulation
- Take cosmics data for calibration
- Perform neutrons measurements at CEA/Saclay
- Perform electrons measurements at DESY
- Come to KEK in may for first measurement on the line, close to the dump

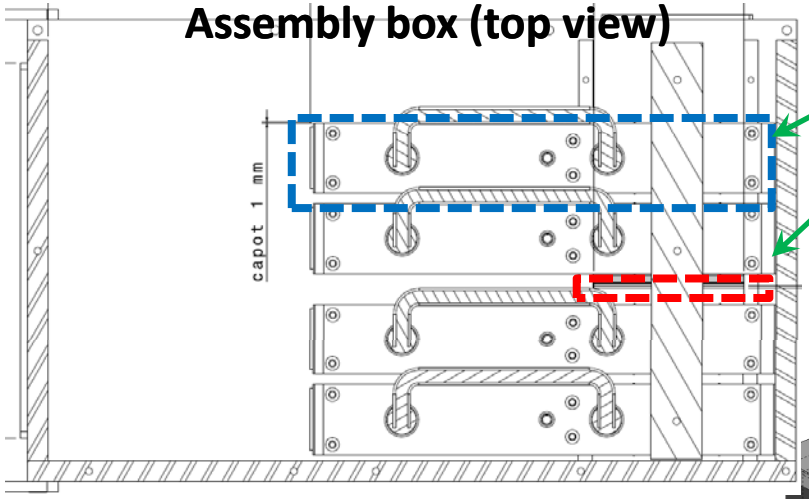
Detector/modules

Module (side view)



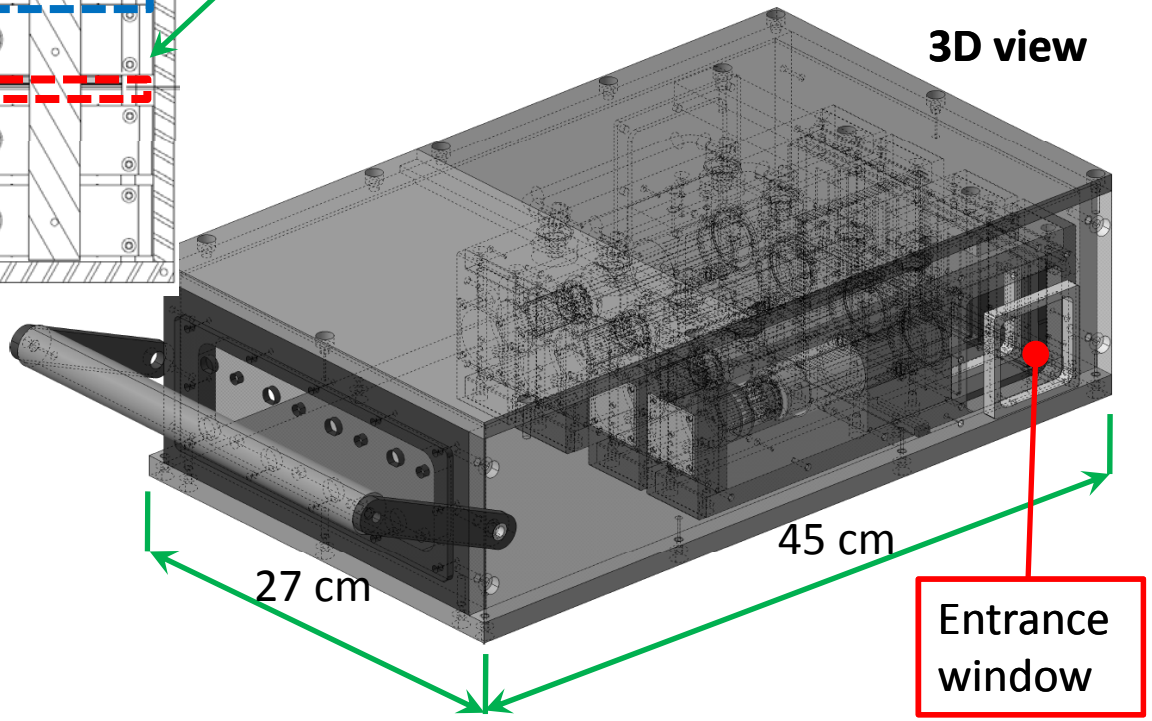
- Scintillator (plastic or CsI)
- Photomultiplier

Assembly box (top view)



- Modules are assembled at will
- Radiator slabs (tungstene) can be inserted at any place

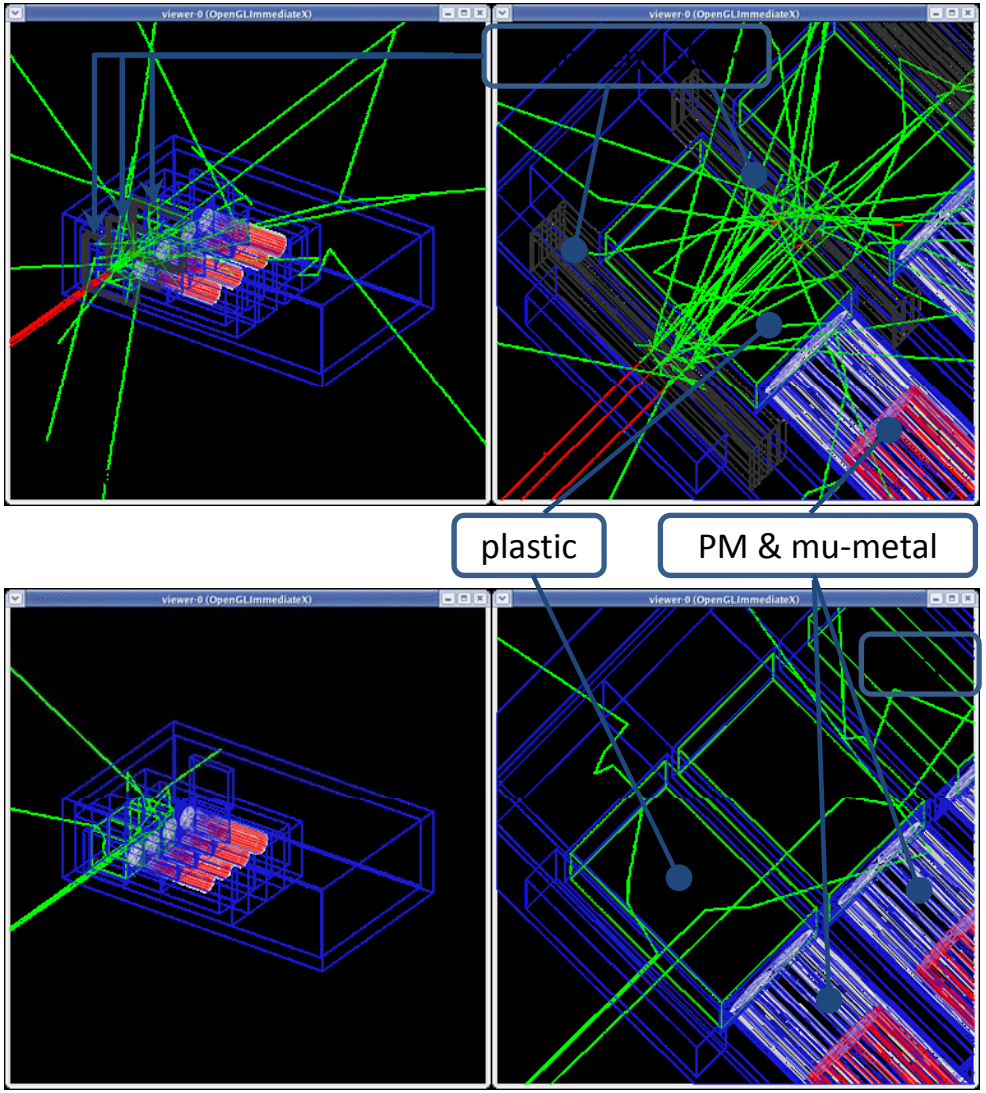
3D view



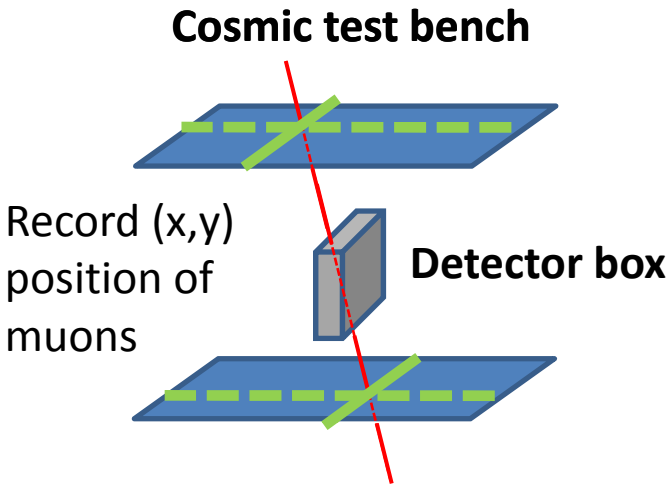
- Modules can be assembled off beam in desired configuration
- And then carried like a suitcase
- Modules for now :
  - 2 plastic (60×60×38 mm)
  - 1 CsI (60×60×20 mm)
- **Acquisition = oscilloscope**

Simulation tool

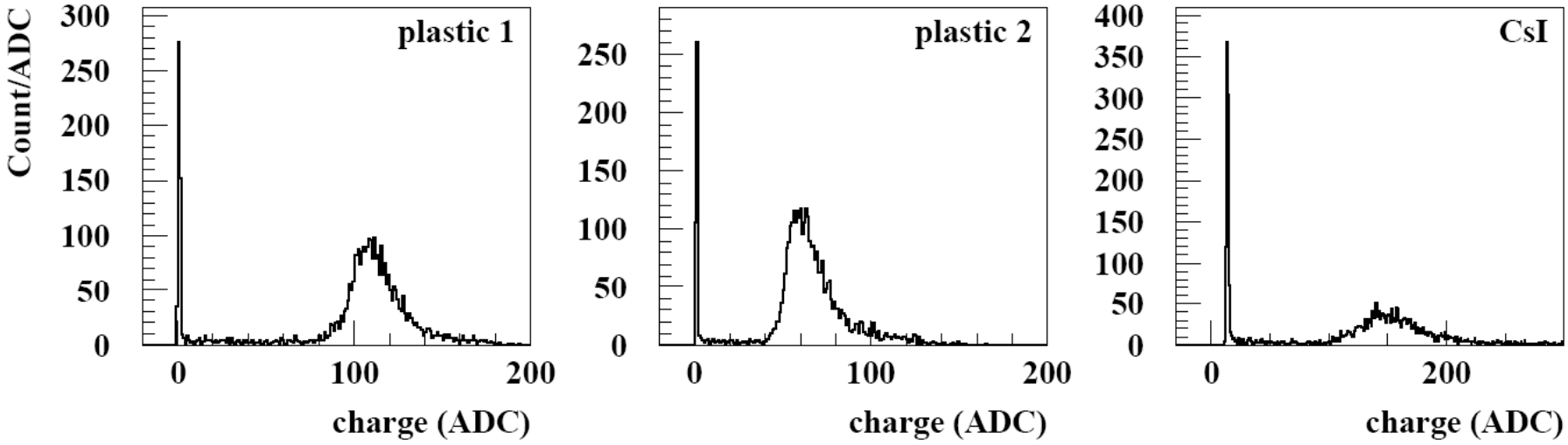
- Develop a simulation application Geant4-based which allows to easily change the detector configuration with macro files.
  - Of course, underneath Geant4 features, as to change the “physics list” for example, are used.
- Work going on to include PM/scintillator response to further compare with data.
  - Ie : no calibration in subsequent plots here
- Detectors description will be interfaced with BDSIM.



Cosmic test bench @ lab.

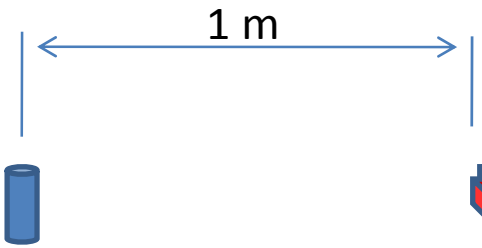


- Cosmic bench test used at lab wich records impact points and direction of incident muons.
- Allows to measure unbiased mips for PM intercalibation, and absolute calibration wrt simulation.

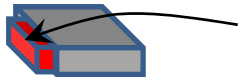


Light collection as function of muon impact point on scintillator is extracted, and then, will be passed to the simulation of the detector response.

Neutron test bench @ Saclay



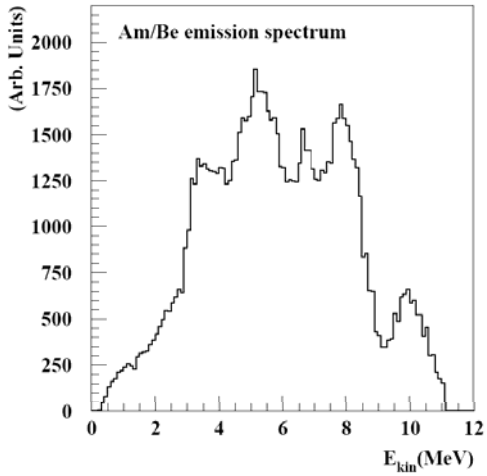
Detector box
Config : plastic; plastic;CsI



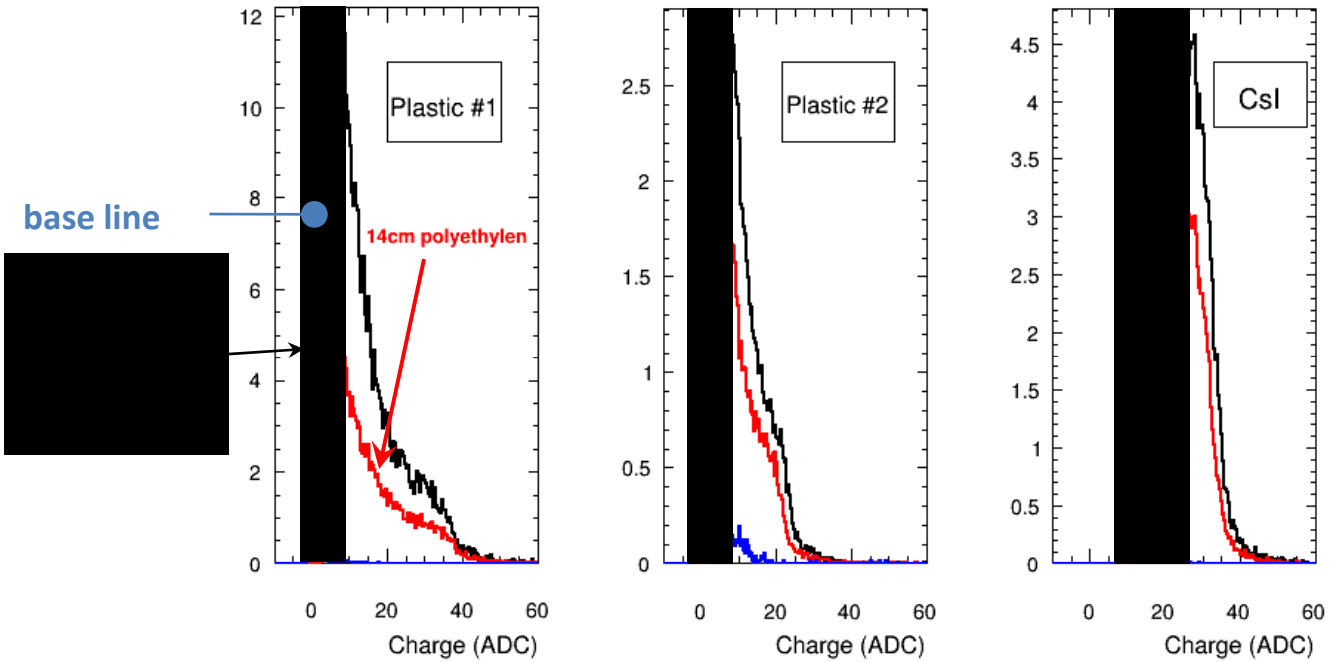
Polyethylene bricks added to moderate neutron

Am/Be neutron source
5×10^6 n/s

~40 Hz/cm^2 @ 1m
Config. : plastic;plastic;CsI



Interest of Am/Be source : highest neutron energy comparable to that of neutrons from ATF2 beam dump.

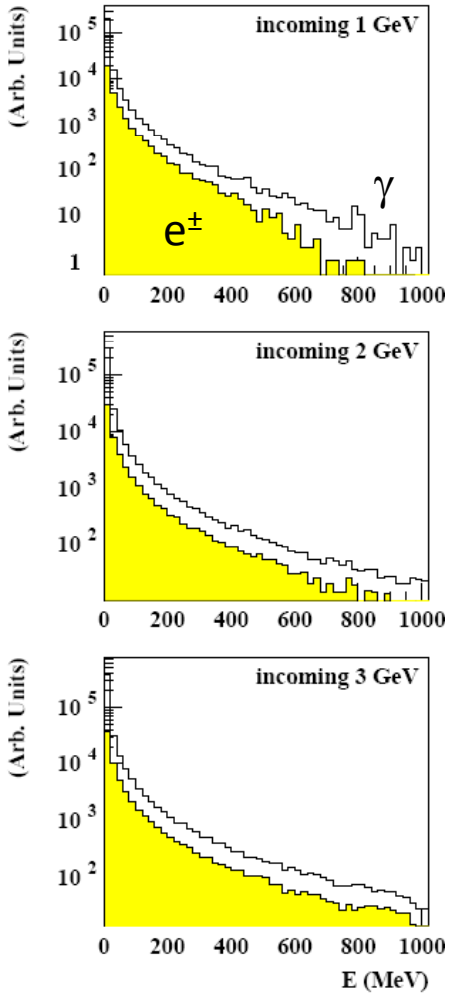


Full simulation of these data will require to simulate the effect of trigger/threshold.

e^+ beam test @ DESY (1/2)

- ATF2 EM background is always made of a burst of particles
- Measuring the energy deposit longitudinal profile « à la Shintake » may help to get information on photon spectrum
  - To further compare with simulation
- Sample the profile at:
  - $1X_0$: more low E sensitive
  - $4X_0$: mostly E insensitive : gets mean energy
  - $10X_0$: more high E sensitive
- Mimic a particle burst by degrading incoming energy with some X_0

Simulation

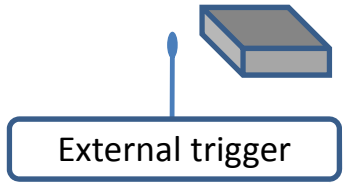


Energy spectra after $3X_0$ for incoming electron

e^+ beam test @ DESY (2/2)

e^+ beam

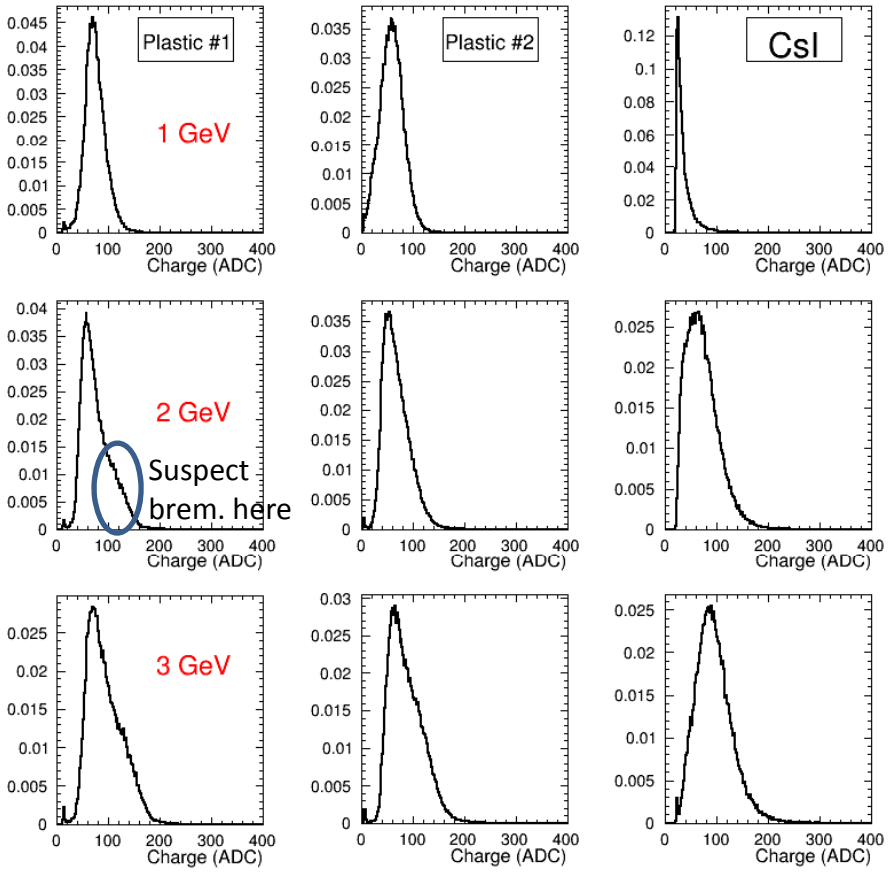
1,2,3 GeV



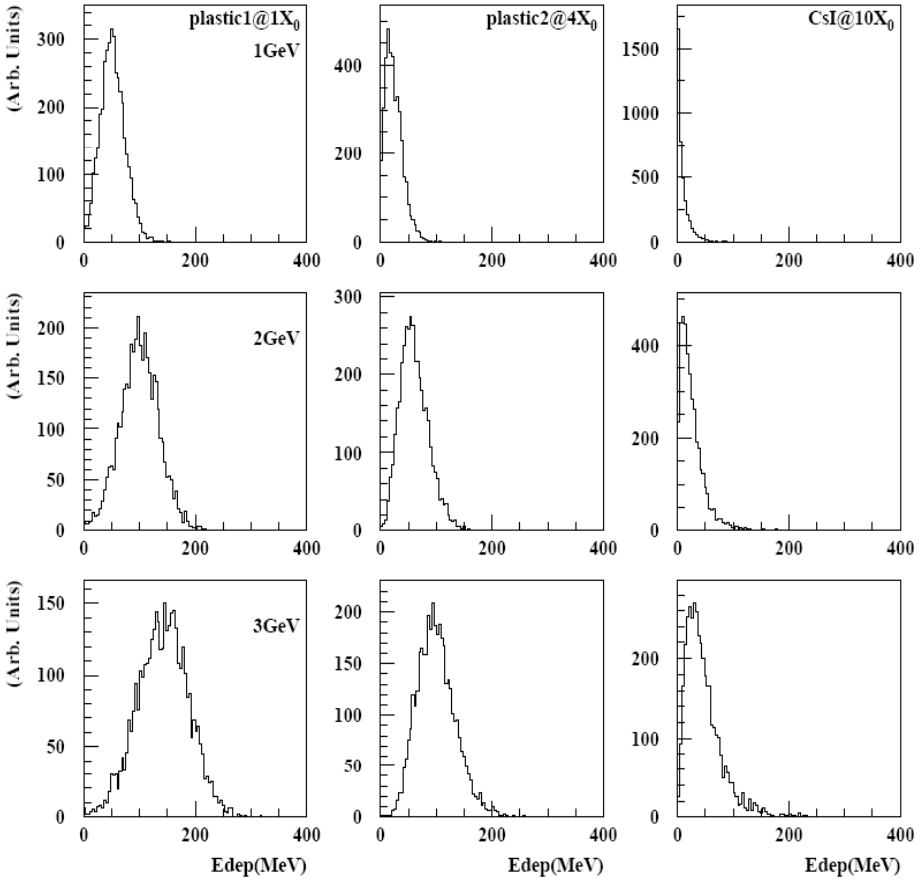
Detector box

$1X_0$ plastic $3X_0$ plastic $6X_0$ CsI
With $3X_0$ in front to degrate incoming energy

Test beam data

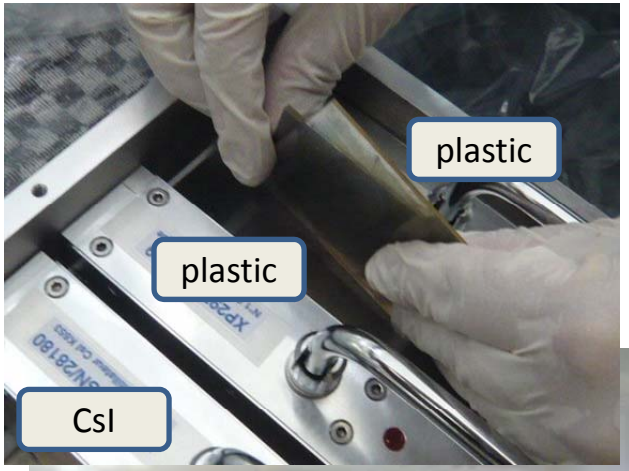


Simulation

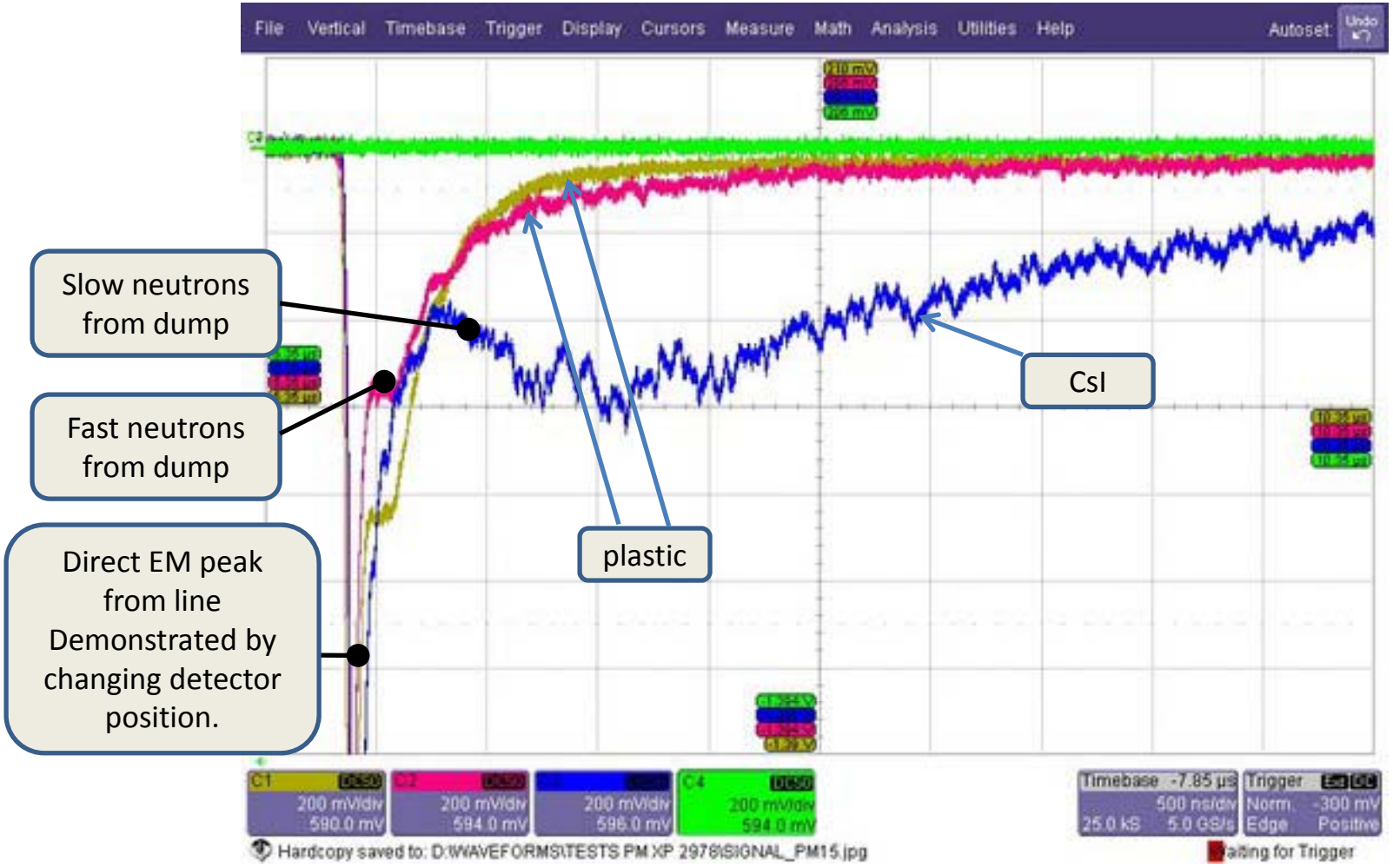


More work needed, but brut force simulation reproduces the gross features of the data.

@ KEK installation in May



Examples of observed signals
(trigger = kicker)



Detector installed on may 19th, and left on site up to the end of the ATF2 run.
Data on the way back to Paris (budget sooo limited that we need to scope to get back).
Intense off line data analysis in July.

What we experienced with May measurements

- What we are happy about:
  - Time of flight is a key feature to disentangle background sources
    - Direct or back shinned from dump
    - EM vs neutrons
      - And surprise of a very delayed component in case of WS use, that we suspect to be from neutrons produced all along the line elements
  - Detector mobility is
    - Not that easy in practice (lead shielding !)
    - But still very interesting because
      - Allowed an half an hour installation
      - Allows to exploit TOF, by measurements at various positions
  - Different detection systems seems (ie plastic vs CsI) to be interesting
    - Neutrons response clearly different in plastic (fast neutron signal) and CsI (more complex)
      - But no time to analyze our data yet

- What we need/should improve :
  - Synchronizing with information about ATF/ATF2 status and activity is essential
    - As things are going fast in practice
    - Ie, we need to be inserted into the EPICS system
    - Will allow to correlate measured background with machine activity (eg WS or screen use) and beam status
  - Dedicated shifts
    - To allow to change any machine or detector configuration/position
    - Kind of “active” measurement mode
  - In situ detectors and electronics for long term data taking
    - When off site
    - Kind of “passive” measurement mode
      - Deeply relying on the EPICS integration
  - Several measurement systems at different positions might be interesting

Next steps for year 2009

- Improve on the previous points
  - Suggestions and help welcome !
- Early thoughts:
  - Insert a TDC module in the acquisition system to acquire modules signals ?
  - Build other modules (we have spare scintillators and CsI) and other boxes ?
- Target November run for installation
  - And some dedicated shifts

Thank you !