JINR, DUBNA
Student Practice

SIMULATION OF SOFT PHOTON CALORIMETER

2011

Participant list

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Physics goals

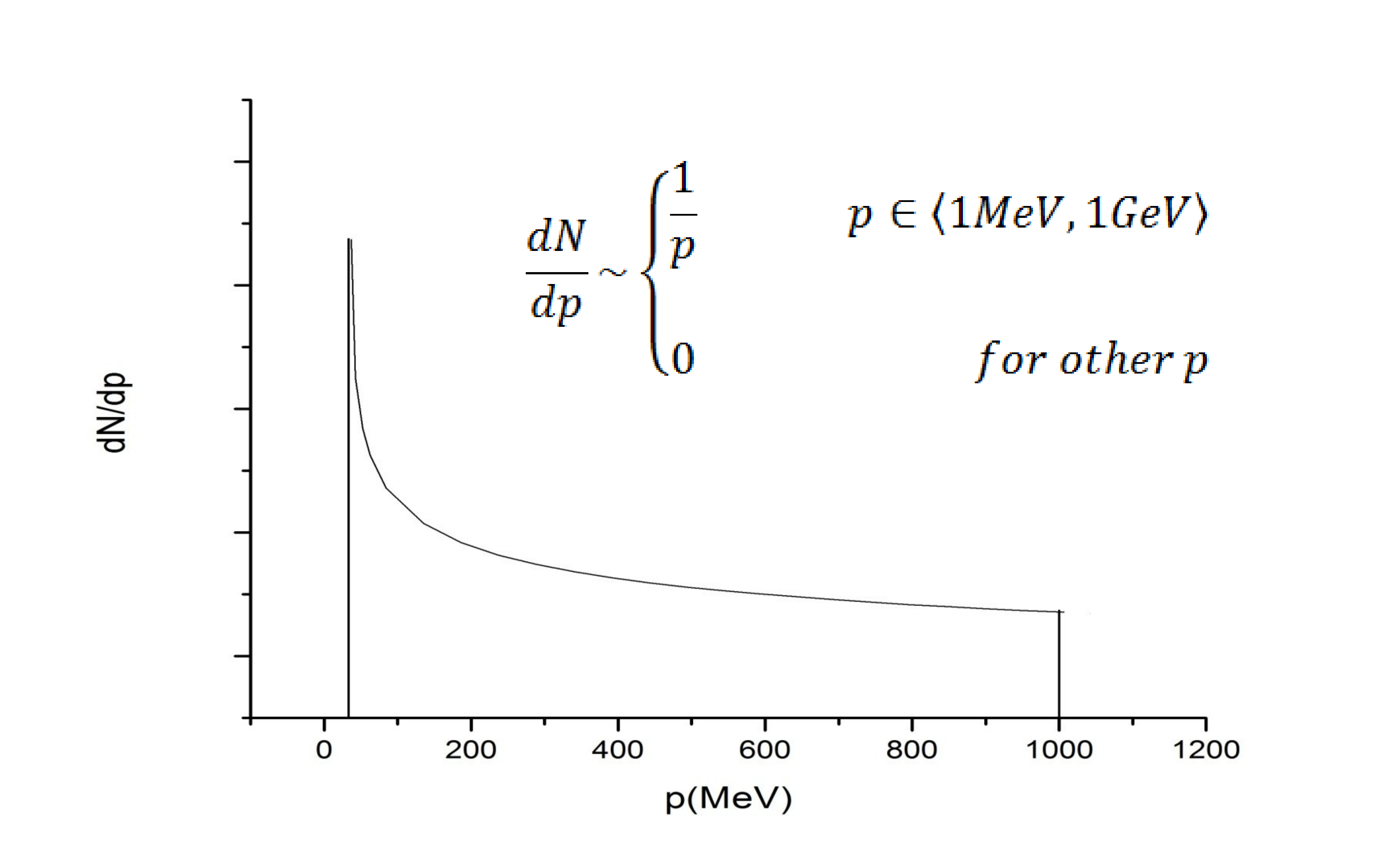
- To understand photon production and it’s importance for collective phenomena explanations.
- To get familiar with GEANT, PYTHIA, PAW
- To simulate the spectra of photons produced in high energy collisions
- To understand how a electromagnetic calorimeter works.
- To simulate the energy deposition spectra of photons in a calorimeter.

Study of anomalous soft photons

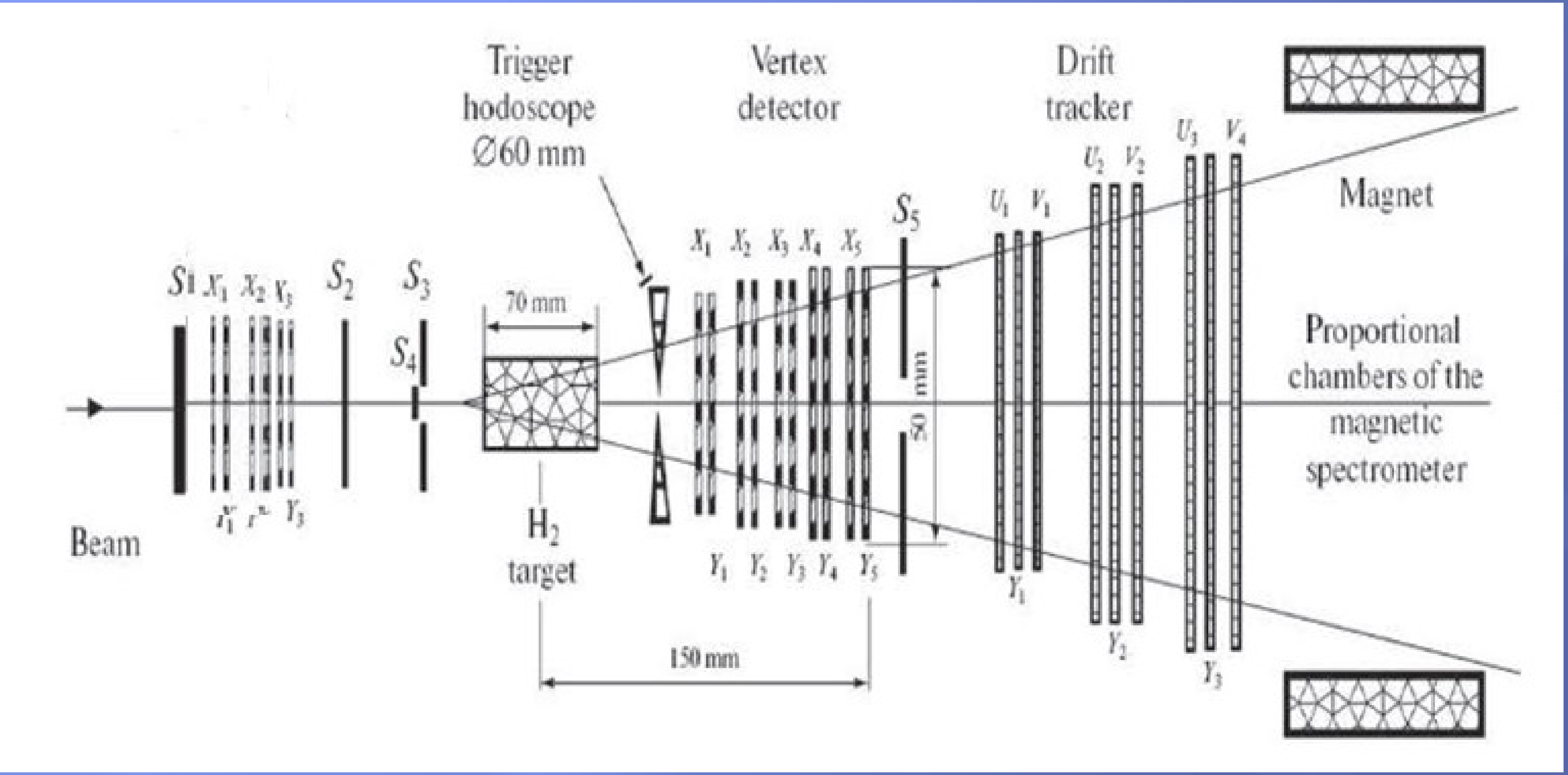
- Soft photons: $p_{\gamma}(transverse) < 50\text{MeV}$ in pp, pA or AA collisions
- Expected sources: hadronic bremsstrahlung radiation and annihilation
- Problems: excess of soft photons for high energy collisions
- Importance: study of collective behavior of particles in high energy collisions.

Soft photon distribution in CMS

- Isotropical with energy distribution:

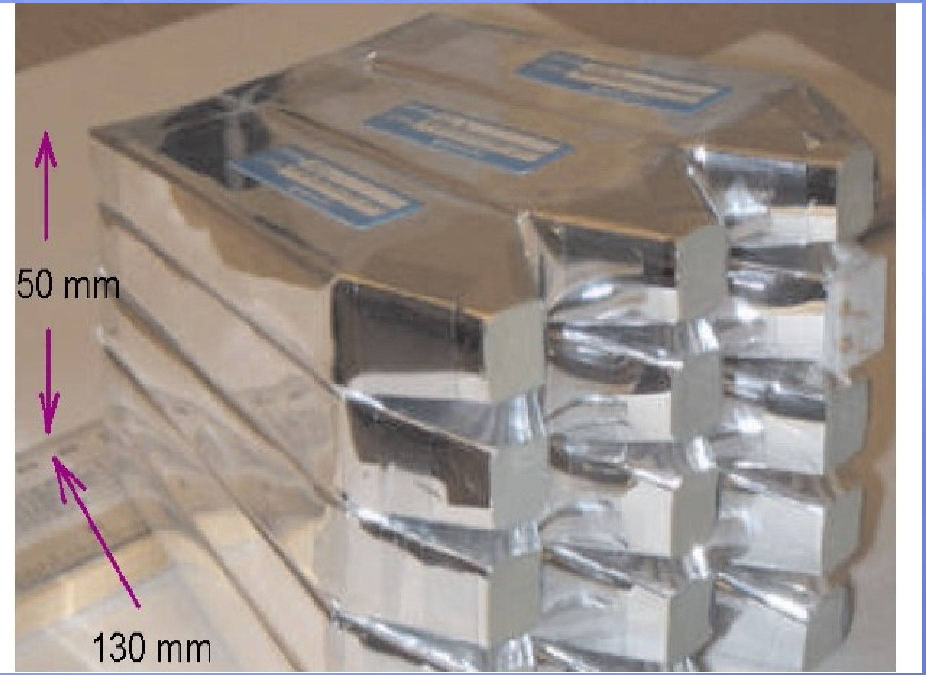


SVD setup



Trigger
hodoscope
Ø60 mm
Vertex
detector
Drift
tracker
Magnet
Proportional
chambers of the
magnetic
spectrometer
70 mm
150 mm
50 mm
Beam
H2
target
S1
S2
S3
S4
S5

BGO crystals



- capability to measure low energy deposit

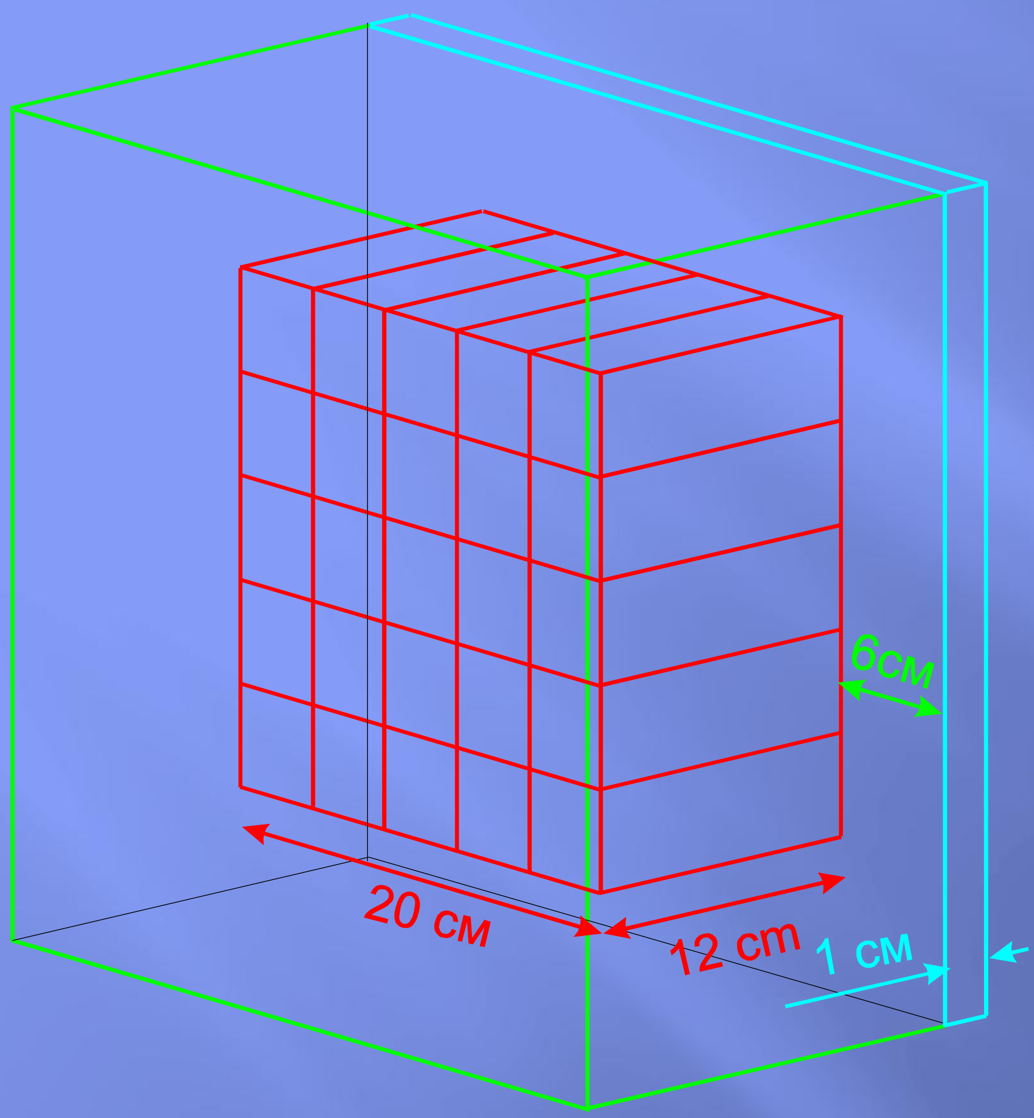
$E_{min} < 5MeV$

- the dimension of one cell

$4 \times 4 \times 120\ cm^3$

- localization of photon $\sigma < 2$ cm.

The electromagnetic calorimeter



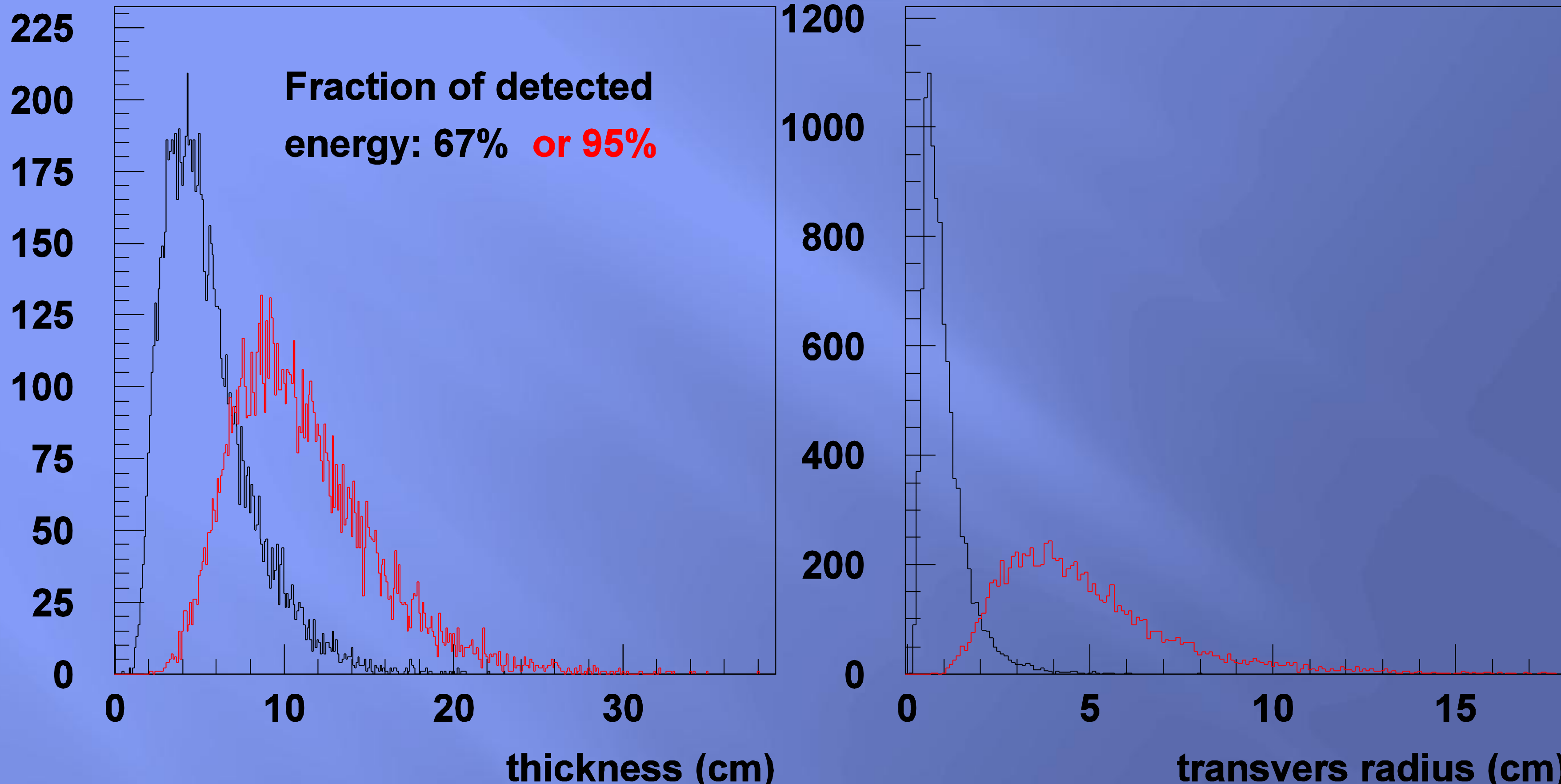
Red - BGO crystals

Blue - organic scintillator - cutting the charged particles

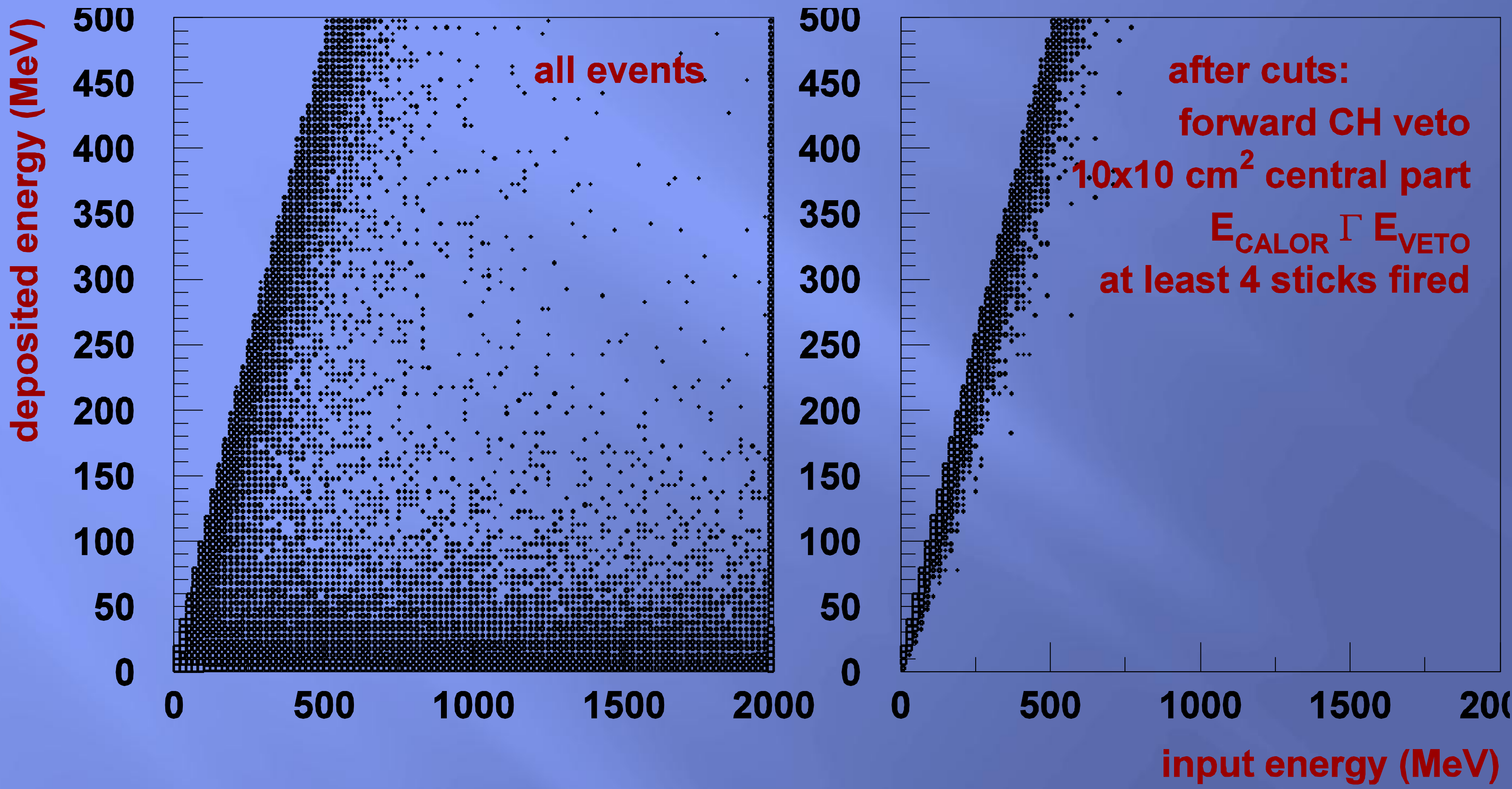
Green - Veto - energy leakages

From GEANT

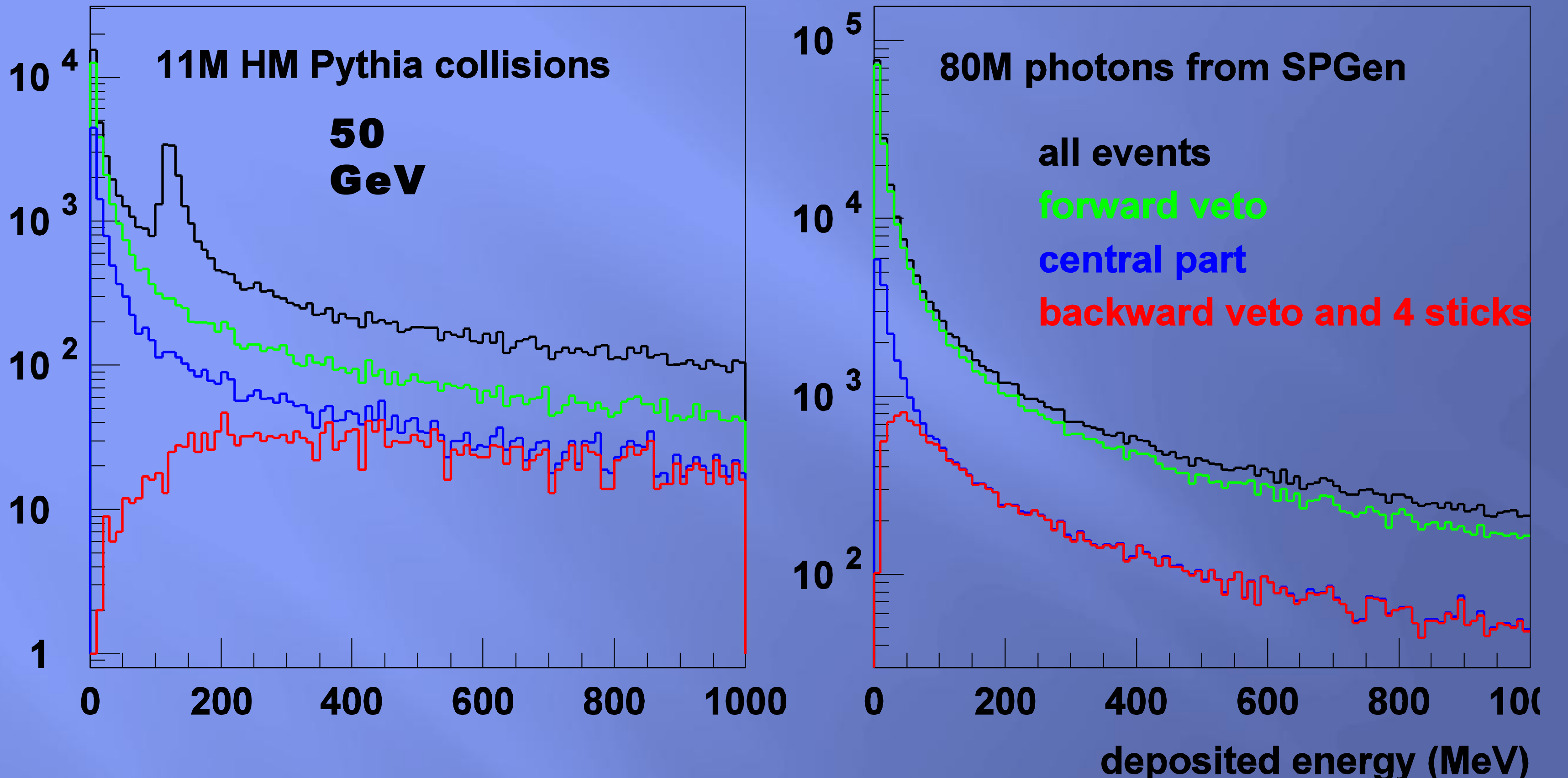
Estimation of dimensions of crystals, $E_\gamma = 100$ MeV



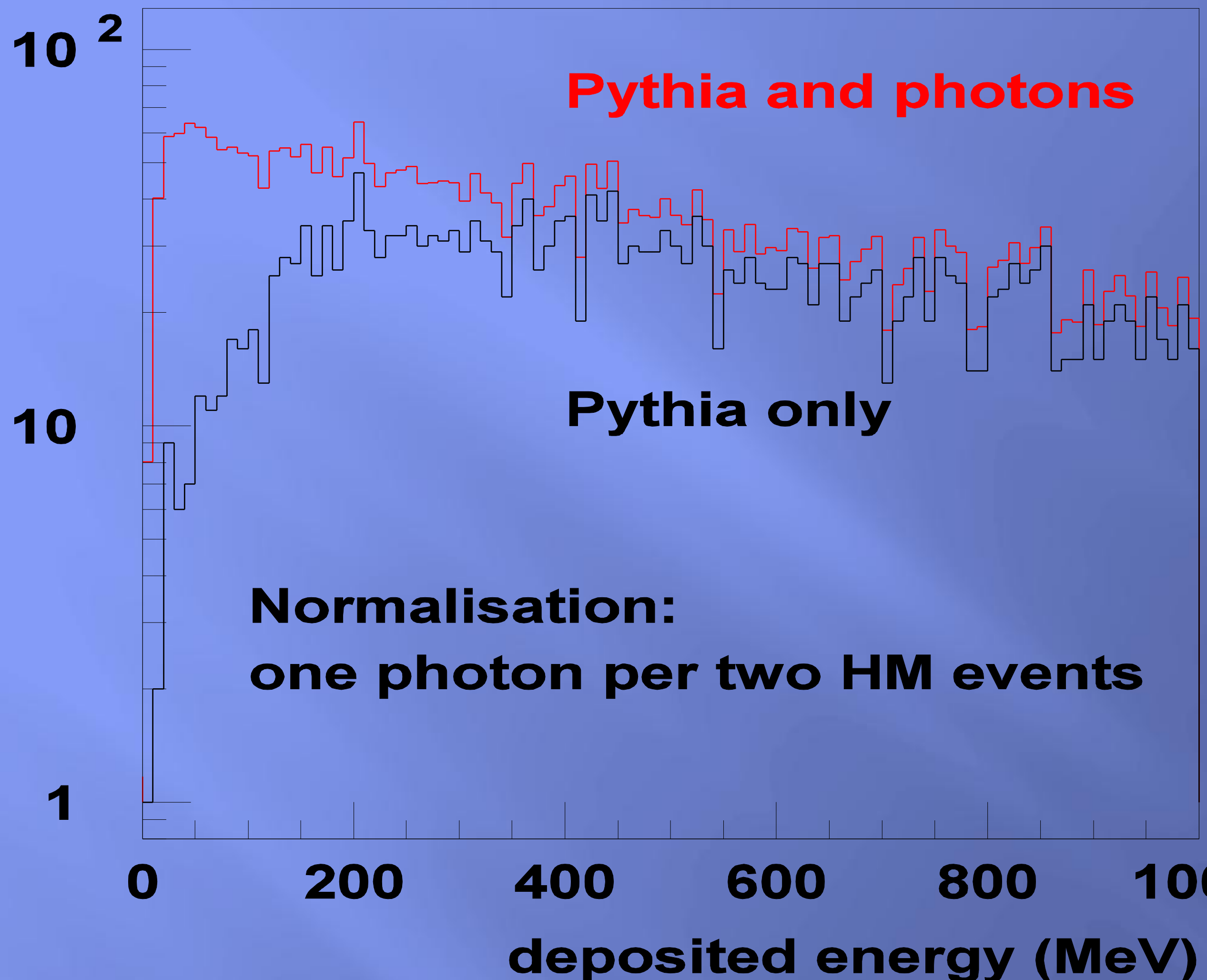
Energy response of the calorimeter



Detections of photons by BGO detector



Signal and background



Conclusion

- In spite of small dimension of detector it allows one to detect low energy photons with small background contribution from high energy particles.
- This is achieved due to VETO detector and measurement of location of incoming photons.
- Signal of soft photons is detectable for cross section of several mb, according to the simulation.

Thank you!

Our SPG (soft photons generator) code

- Generate total momentum of photons in CMS

$$p = p_0 \exp(rand(0)/A)$$

- Generate the direction of photons in CMS

$$x, y, z = 2*(rand(0) - 0.5) \qquad r = \sqrt{x^2 + y^2 + z^2}$$

$$p_{CMS} = p * x / r$$

- Calculate the photons momentum in LS

$$p_{LS}(1,2) = p_{CMS}(1,2) \qquad p_{LS}(3) = \gamma(\frac{p * z}{r} + v_{CMS} * p)$$

- Calculate energy of photons in LS

$$E_{LS} = \sqrt{p^2_{LS}(1) + p^2_{LS}(2) + p^2_{LS}(3)}$$