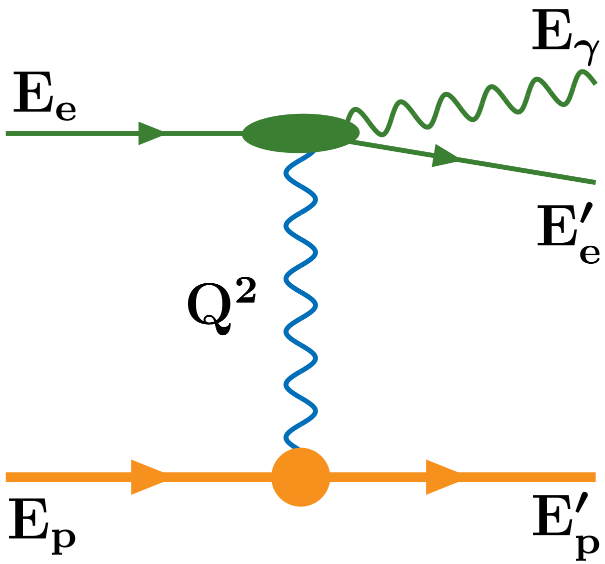
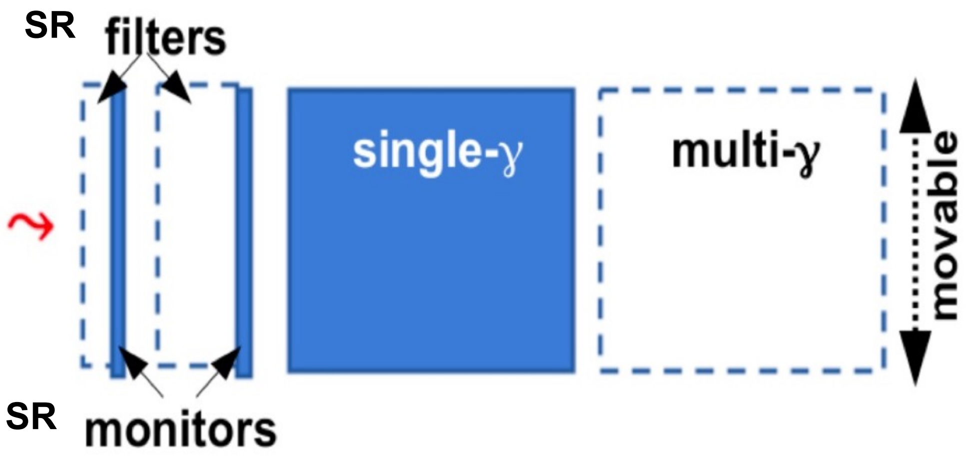
High Rate Calorimeters – update after Warsaw

Krzysztof PIOTRZKOWSKI



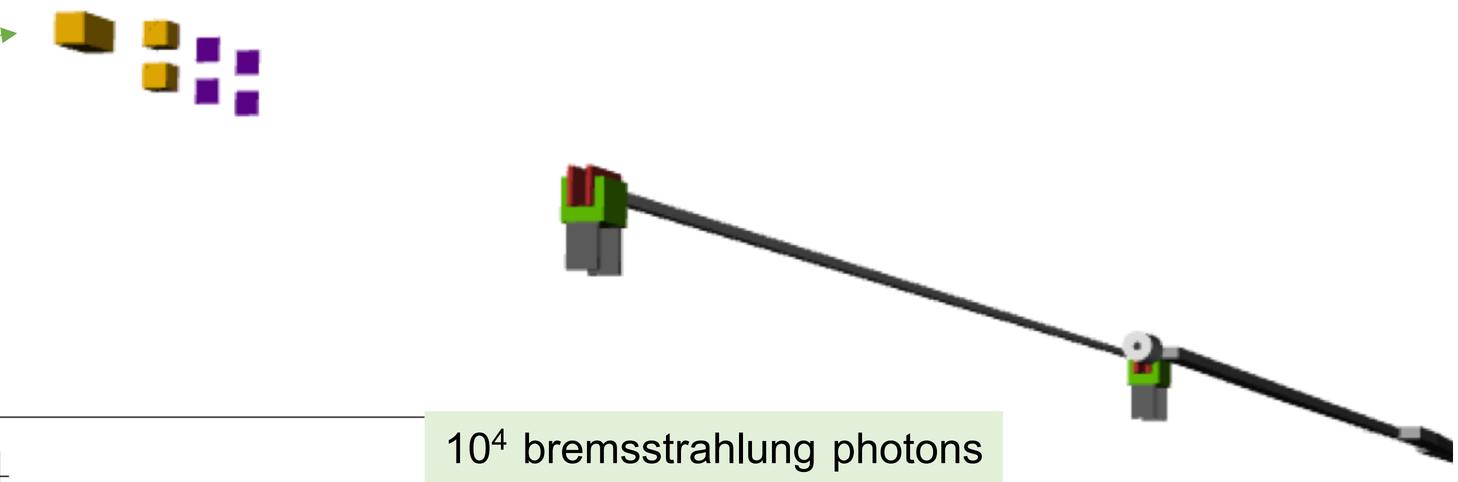


Lumi Meeting, 28/11/2023

HRC “working conditions”

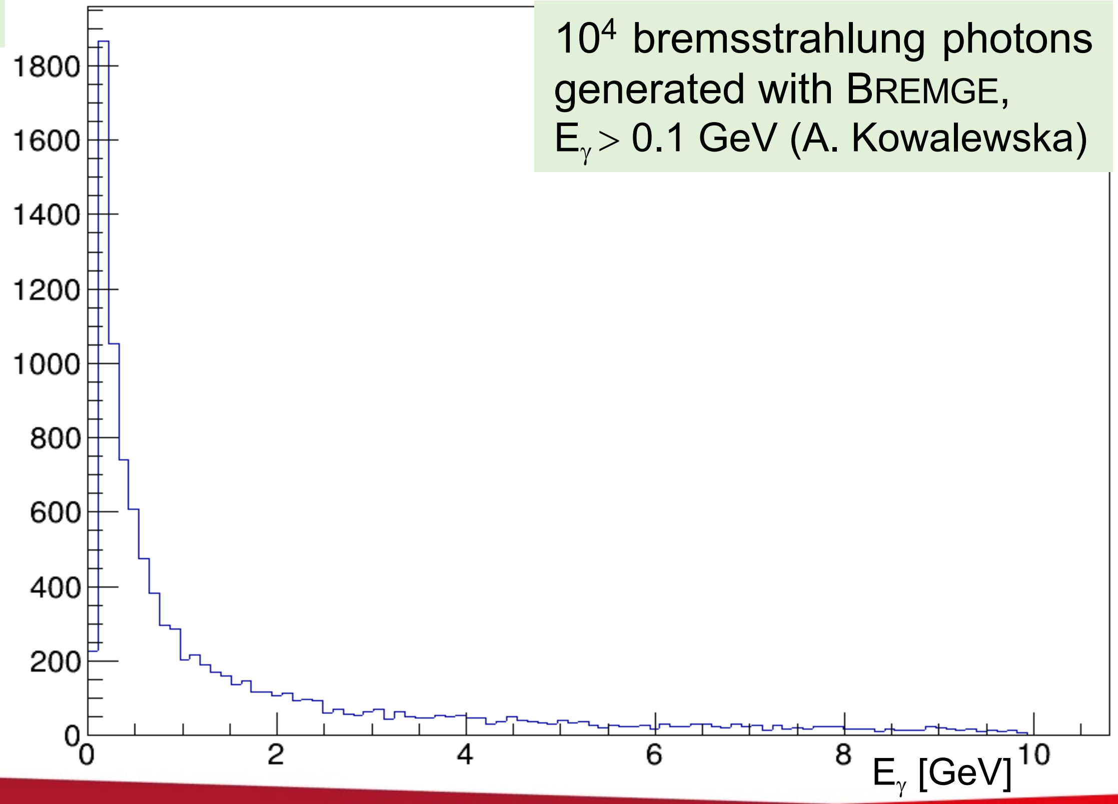
Monte Carlo “warm-up exercise”:

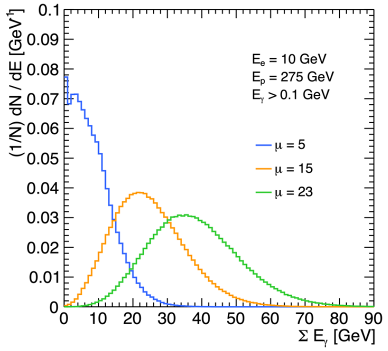
Simulations of a $PbWO_4$ calorimeter – one crystal block 10 cm x 10 cm x 20 cm, placed just behind PS, for studies of (unavoidable) bremsstrahlung energy deposits



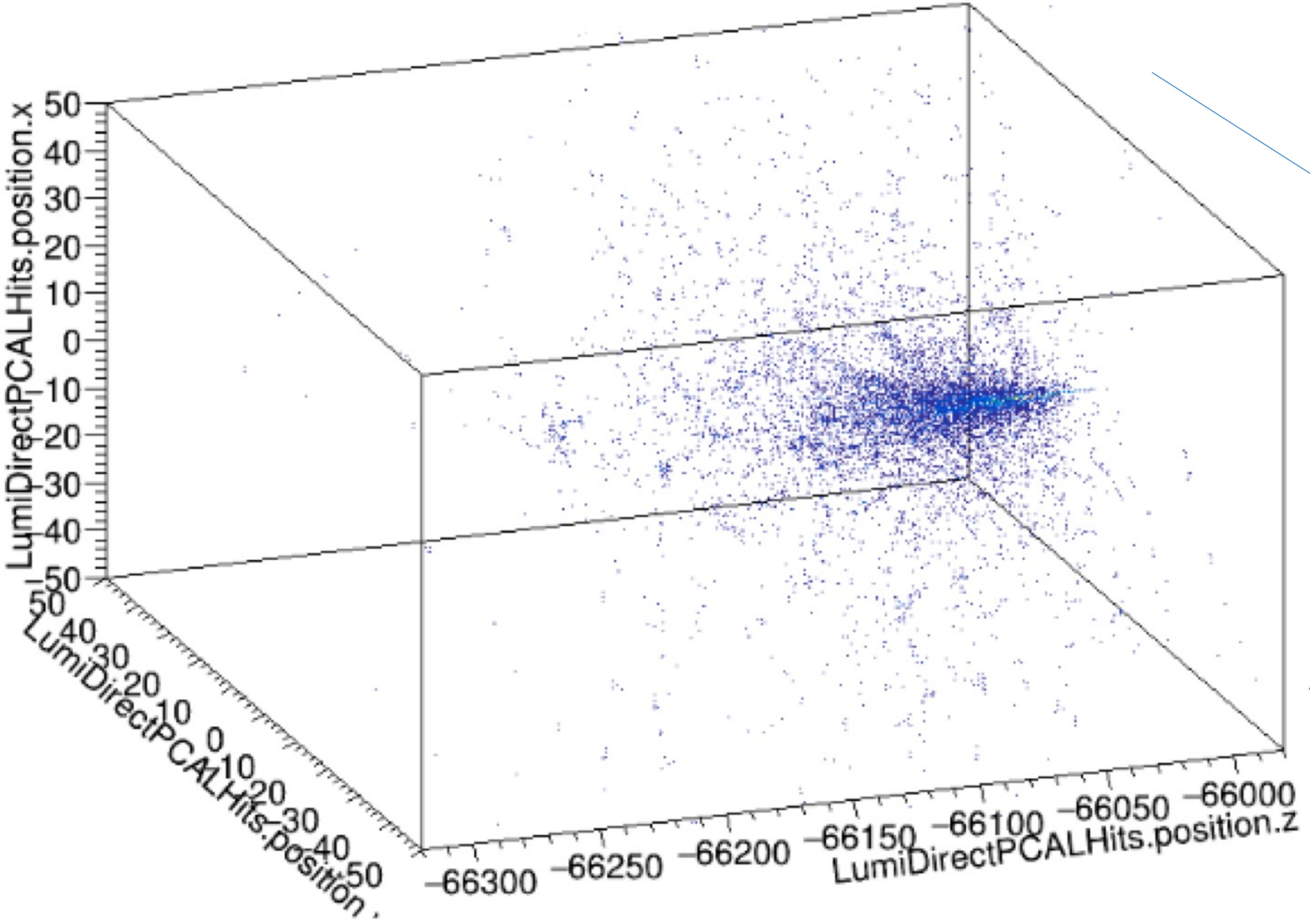
Photon hit position was “gaussian-smeared” laterally (with **σ = 1 cm**, both horizontally and vertically) to account for beam divergence and varying beam tilts over long time periods (+ possible calorimeter “lateral shifts”, from time to time)

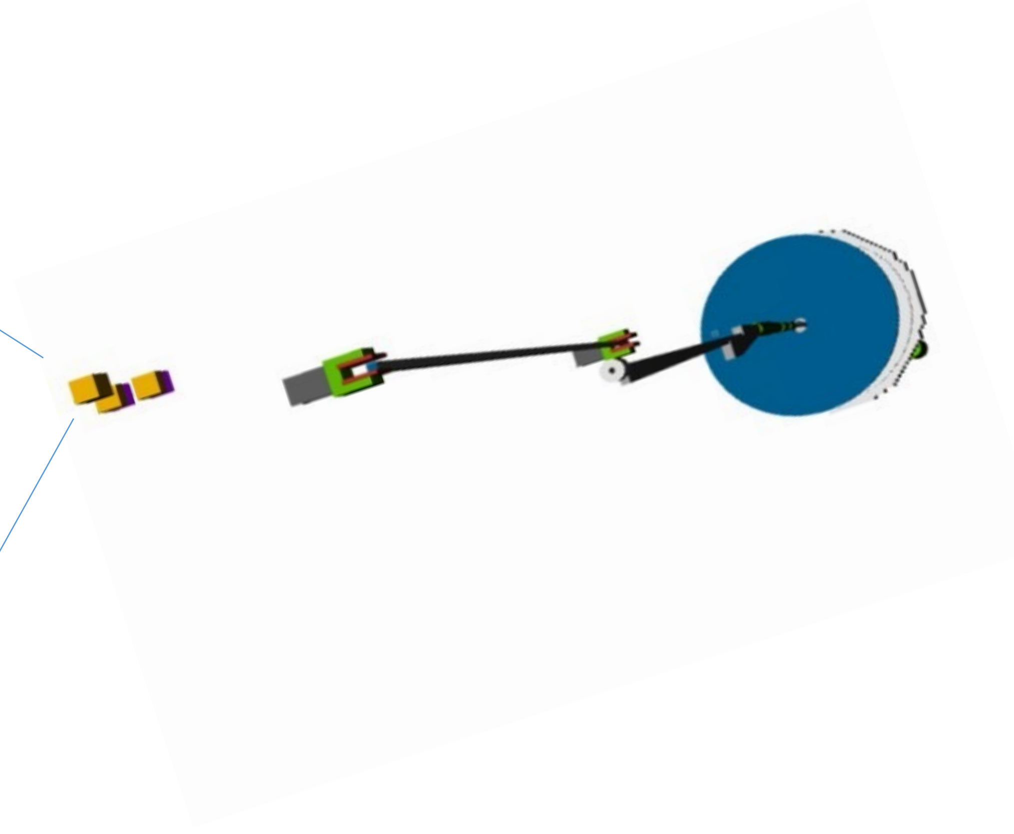
10^4 bremsstrahlung photons generated with BREMGE, $E_\gamma > 0.1$ GeV (A. Kowalewska)





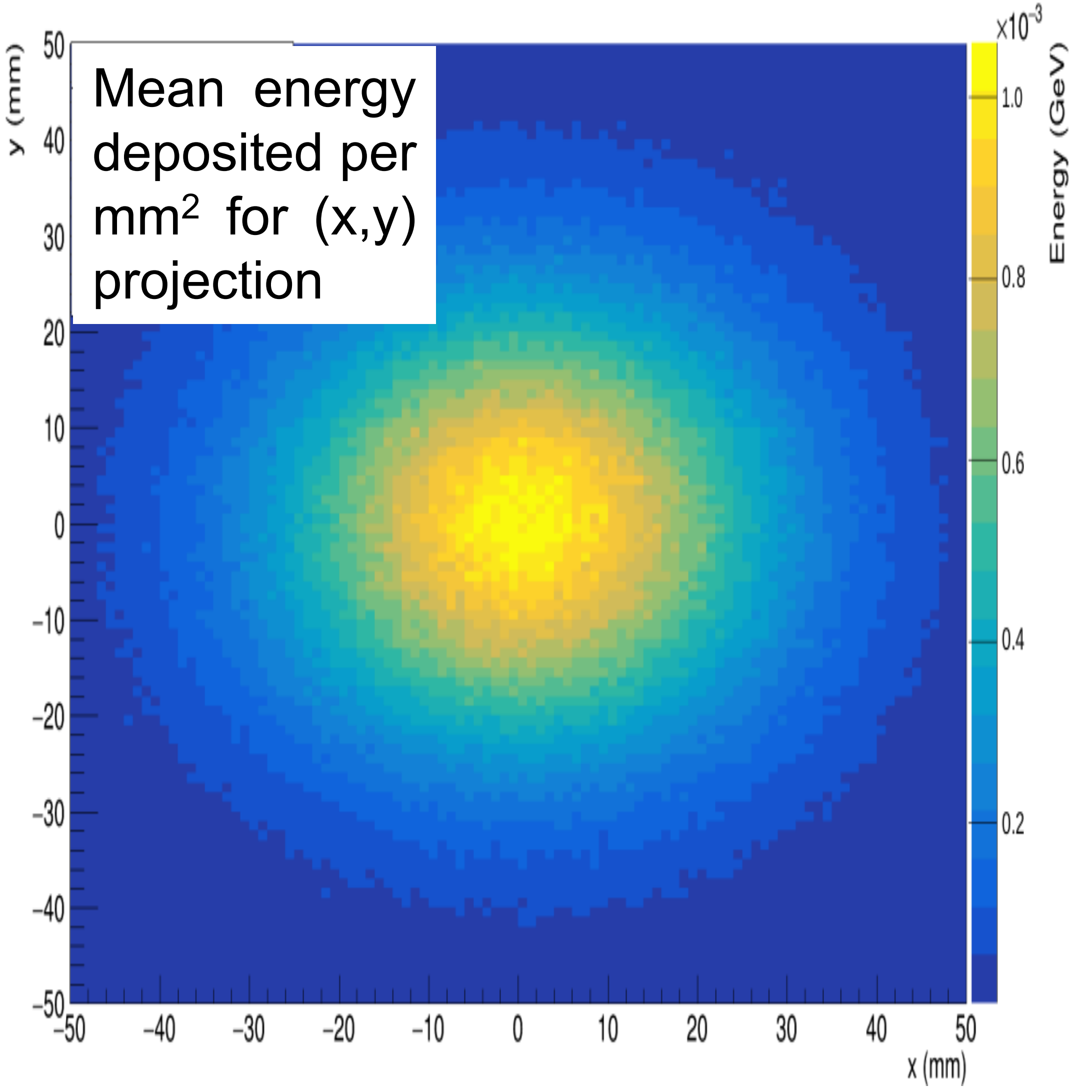
Reminder: Simulations for $PbWO_4$ by Yasir ALI

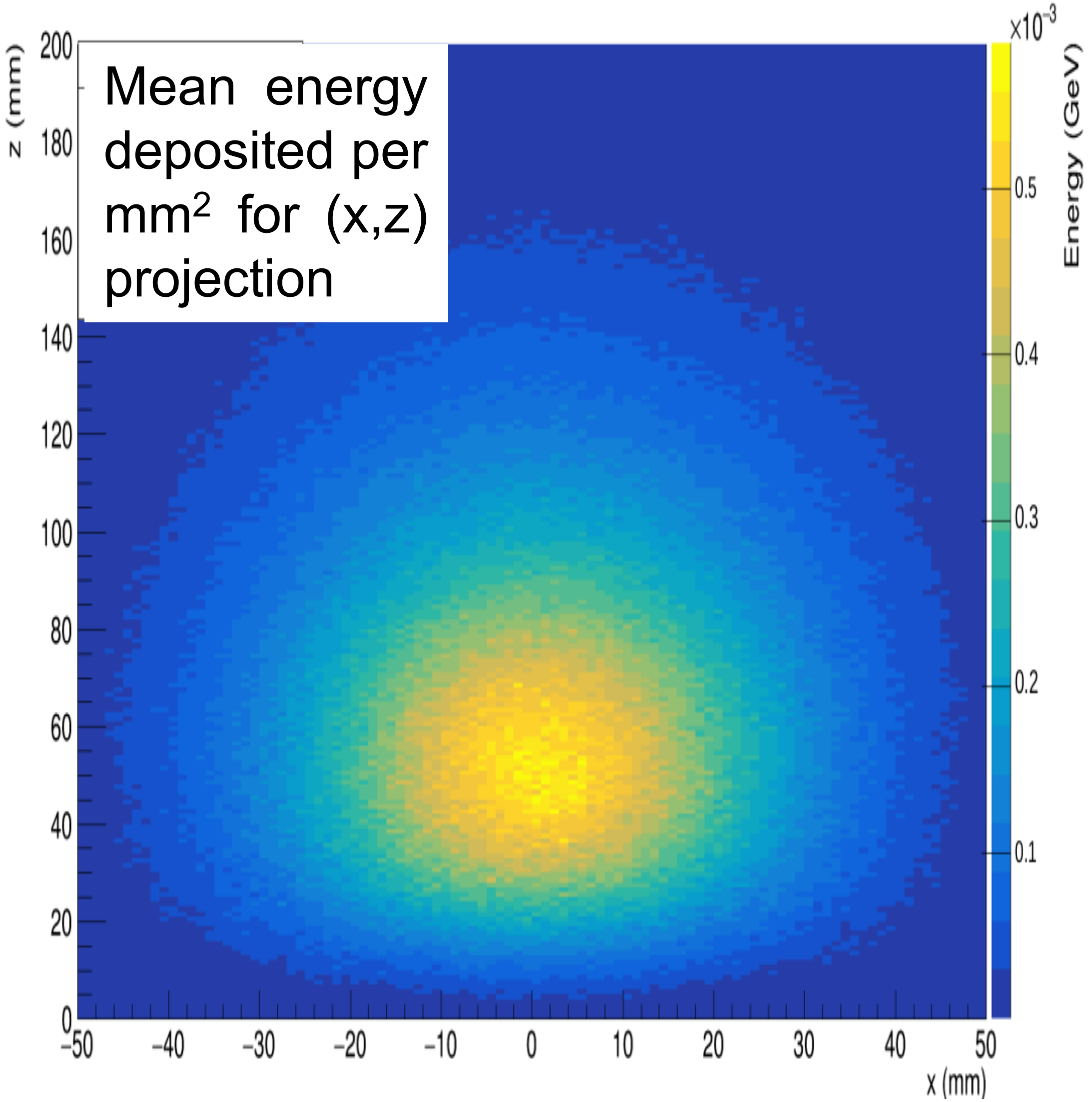




Absorbed doses for $PbWO_4$

10 GeV x 275 GeV

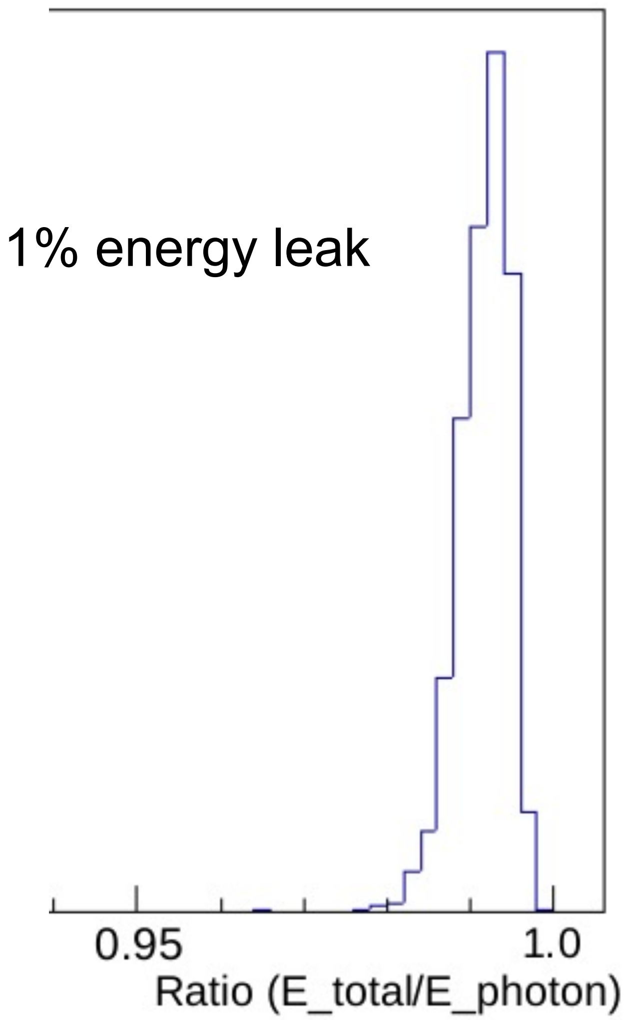




Y. Ali

Absorbed doses for $PbWO_4$

Y. Ali



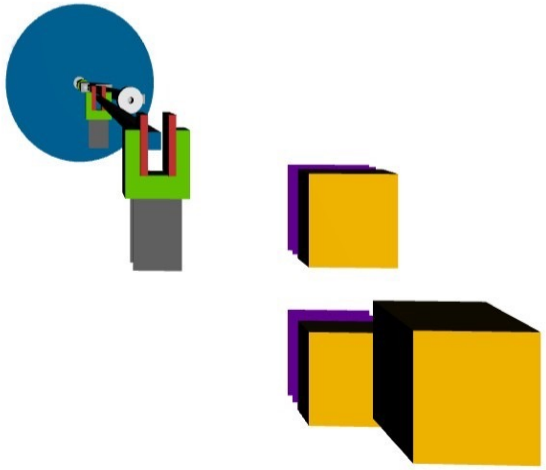
Mostly lateral energy leaks can be easily fixed by making a larger detector, but the highest average density of deposited energy reaches **12 MeV/cm^3** per event which results in maximal absorbed dose of **550 Mrad** for 100 fb^{-1} of *ep* collisions

Conclusion: $PbWO_4$ is an option only for short calibration runs at (very) low luminosity – note the heat of about **0.6 W** generated inside the crystal, for *ep* collisions at 10^{34} cm^{-2}s^{-1}, and above **10 W** for *eAu*

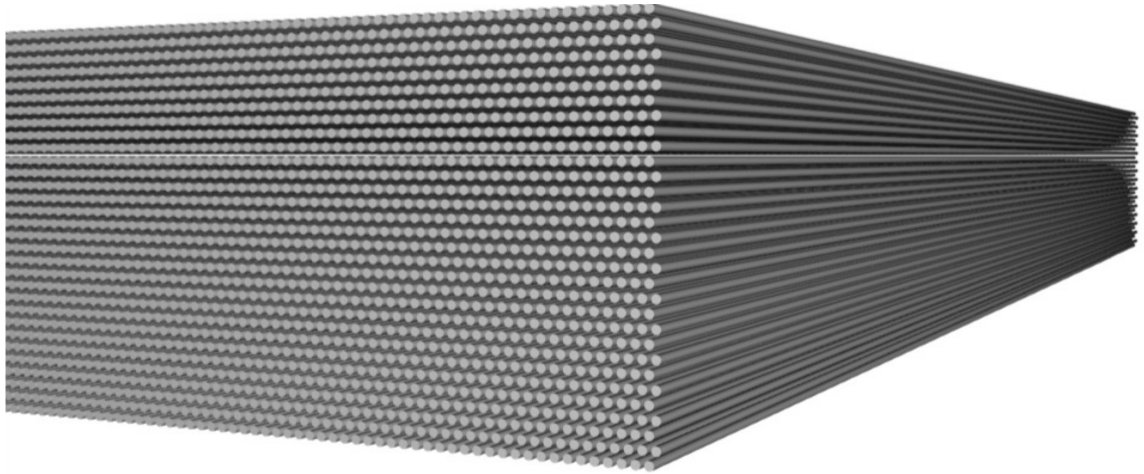
News

Bogdan Pawlik has joined the Krakow effort – he has already indepenently confirmed Yasir's result for the crystal calorimeter. More to come next week.

Fiber calorimeters



Underway:
Simulations of 12 cm x 12 cm x 24 cm (tilted) fiber calorimeters to study bremsstrahlung energy deposits for quartz and scintillator cases



Also next week…

BREMGE

Monte Carlo generator of high energy electron-proton and electron-nucleus bremsstrahlung events

K. Piotrzkowski
Deutsches Elektronen-Synchrotron DESY,
Notkestrasse 85, D-2000 Hamburg 52 [1]

L. Suszycki
Institute of Nuclear Physics and Techniques,
Academy of Mining and Metallurgy,
al.Mickiewicza 30, 30-059 Kraków, Poland

1 Basic Facts

Version: BREMGE 1.0, from December 1991.

Computer type: IBM 3090 300S under MVS/XA operating system and VAX under VMS.

Authors: Leszek Suszycki (author of the algorithm)
F1PSUS@DHHDESY3.BITNET,
Krzysztof Piotrzkowski
(contact person, implementation of beam-size effect)
F1PKRP@DHHDESY3.BITNET.

Program size: 180 lines.

2 Introduction

In both experiments at HERA, H1 and ZEUS, fast luminosity monitoring will be based on measurement of the small angle electron-proton bremsstrahlung $ep \to e\gamma p$ event rates [1,2]. The bremsstrahlung of electrons on nuclei $eN \to e\gamma N$ of the rest gas atoms is expected to be the main source of background. Its contribution will be measured with those electron bunches which will traverse the interaction region alone, without proton bunch. Electron-proton bremsstrahlung events with low energy photons will be suppressed due to limited transverse beam sizes (an effect first observed at Novosibirsk [3]).

[1] On leave from Institute of Nuclear Physics, Kraków, Poland

BREMGE can generate e-p as well as e-N bremsstrahlung events. Optionally beam-size effect can be also included.

For electron-proton collisions the events are generated according to ultra-relativistic differential cross section calculated in the Born approximation and small angle approximation [4] . Higher order diagrams and inelastic ($ep \to e\gamma X$) contributions are well below 1% [5,6] and have been neglected. The energy transfer to a target (proton or nucleus), which is of the order of m_e^2/M_N, has been also neglected therefore the sum: $E_\gamma + E'$ always equals the energy E of primary electron.

For electron-nucleus bremsstrahlung events the screening of the nucleus field by atomic electrons according to the Thomas-Fermi-Moliere form factor [7] was taken into account. Beam-size effect is implemented in BREMGE by suppressing events with small momentum transfer (transversal to direction of primary electron) from proton, which corresponds to large impact parameter values - comparable with transverse beam sizes.

3 The structure of the generator

The generator was written as a FORTRAN 77 package containing the subroutine BREMGE and the blockdata LUBLDT. Generator parameters can be set by attaching in the main program to the following common block:

```
      COMMON/BREMPA/  PI, EMASS, PMASS, EEO, EPO, EGMIN,
     &                EGMAX, XEP, YEP, TGMAX, MODEBR, ZETGAS, FGEGP,
     &                EEOM, EHL, DSDUMA, DMIN, DMAX, DMIN2, DMAX2, DU3
```

where:

- PI - 3.14159...., EMASS - electron mass, PMASS - proton mass
- EE0 - electron beam energy, EP0 - proton beam energy
- EGMIN, EGMAX - photon energy interval ($0. < EGMIN < EGMAX < EE0 - EMASS$)
- XEP, YEP - transverse beam sizes defined as: XEP=$\sqrt{\sigma_{x,e}^2 + \sigma_{x,p}^2}$, YEP=$\sqrt{\sigma_{y,e}^2 + \sigma_{y,p}^2}$
- TGMAX - maximum photon angle ($0. < TGMAX << 1rad$)
- MODEBR - type of process:
  0 - e-p bremsstrahlung, no corrections
  1 - e-p bremsstrahlung+beam-size effect
  2 - e-gas (=e-nucleus) bremsstrahlung
- ZETGAS - Z of nucleus

Workshop on Physics at HERA, Proceedings, 29-30 October 1991 – Hamburg, Germany (C91-10-29)

Janusz Chwastowski (+ Bogdan Pawlik) have translated **BREMGE** from Fortran to C++ and Janusz is putting it now on GitHub