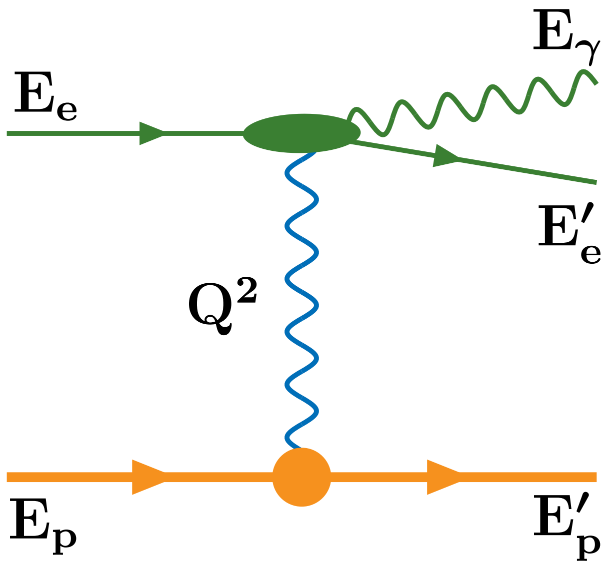
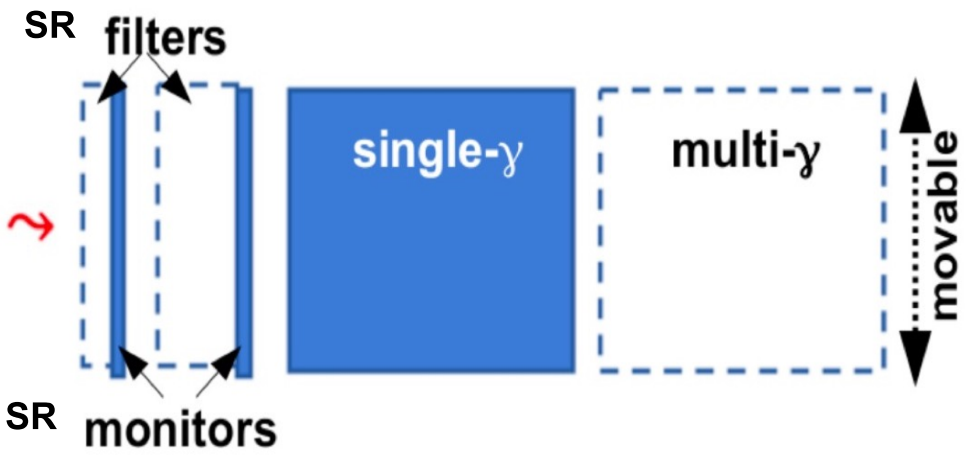
High-Rate Calorimeters – an update

Krzysztof PIOTRZKOWSKI





Lumi Meeting, 5/12/2023

BremgeC is available

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

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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)
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Krzysztof Piotrzkowski
(contact person, implementation of beam-size effect)
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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 $ep \rightarrow e\gamma p$ event rates [1,2]. The bremsstrahlung of electrons on nuclei $eN \rightarrow e\gamma N$ 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]).

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 ($ep \rightarrow e\gamma X$) 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, EE0, EP0, EGMIN,
&                EGMAX, XEP, YEP, TGMAX, MODEBR, ZETGAS, FGEGP,
&                EE0M, 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

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

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

In short – **BremgeC** is:

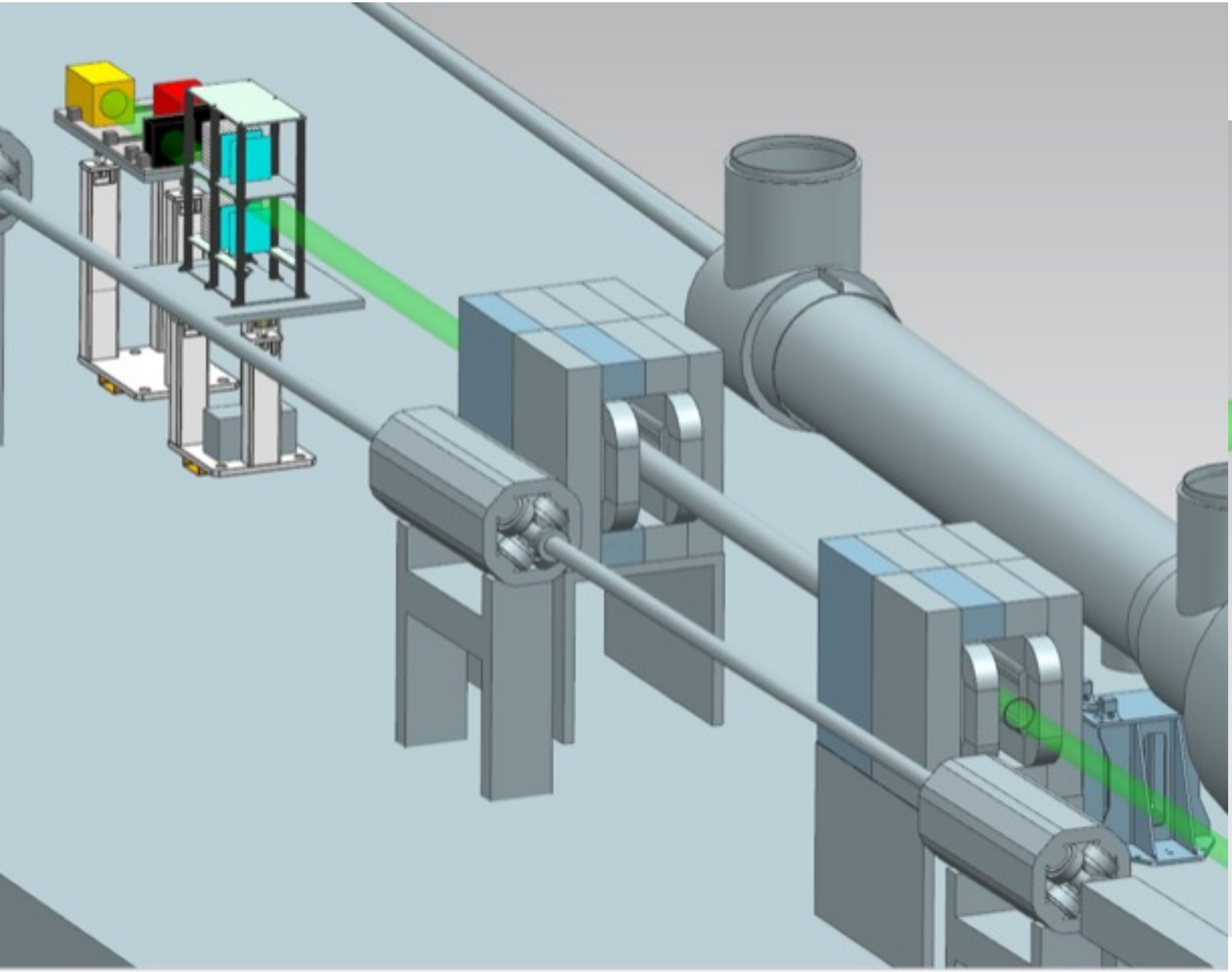
- generating bremsstrahlung according to Bethe-Heitler **fully 4-differential cross-section** ($E\gamma$ + 3 angles)
- having outgoing photon, electron and proton momenta **properly correlated**
- modes: ***ep(A)*, w/BSE included, *e-gas***
- very fast

BREAKING NEWS

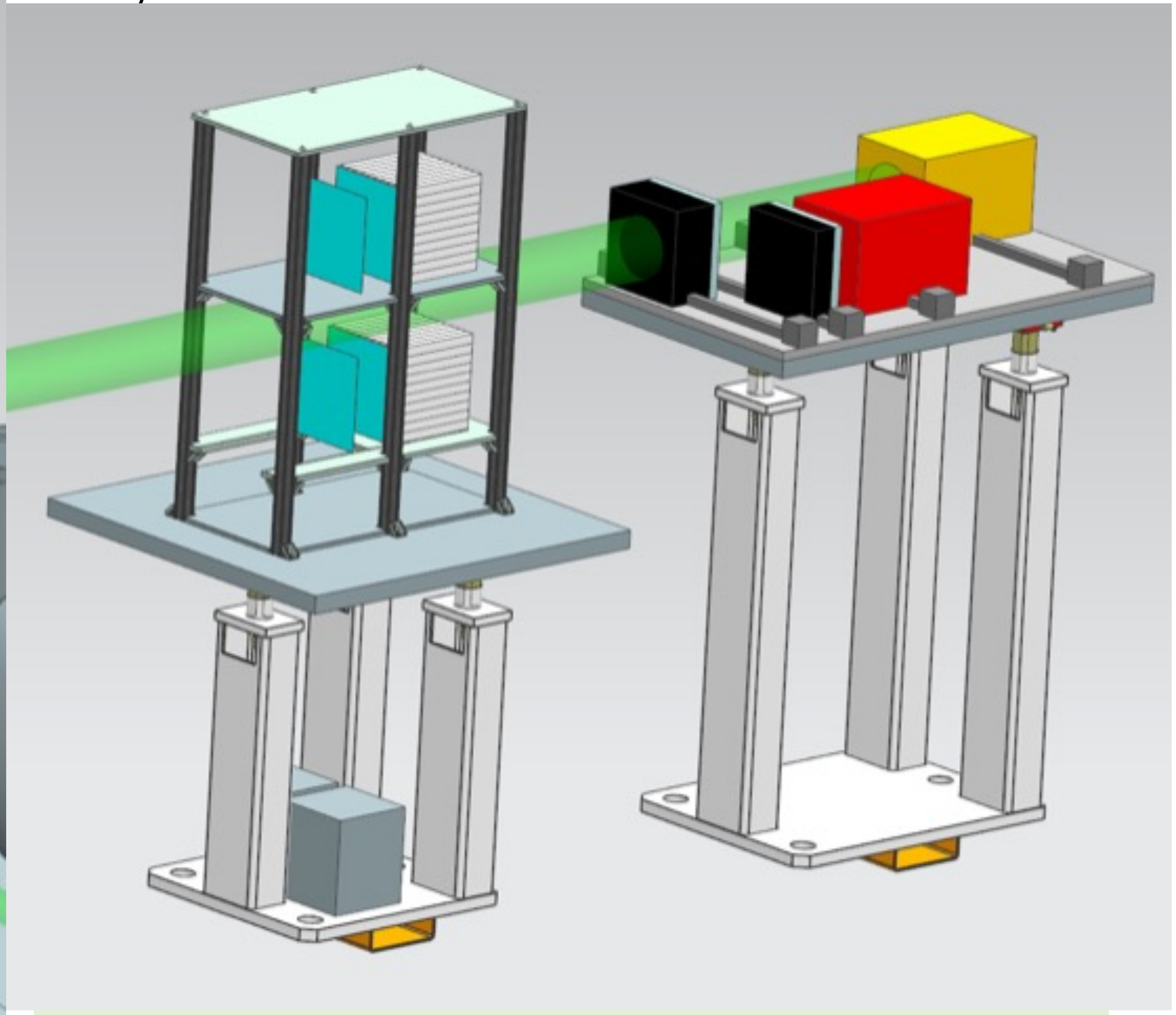
https://github.com/jchwastowski/BremgeC

Next week Janusz will give a proper BremgeC intro

HRC is (finally ☺) in Project CAD

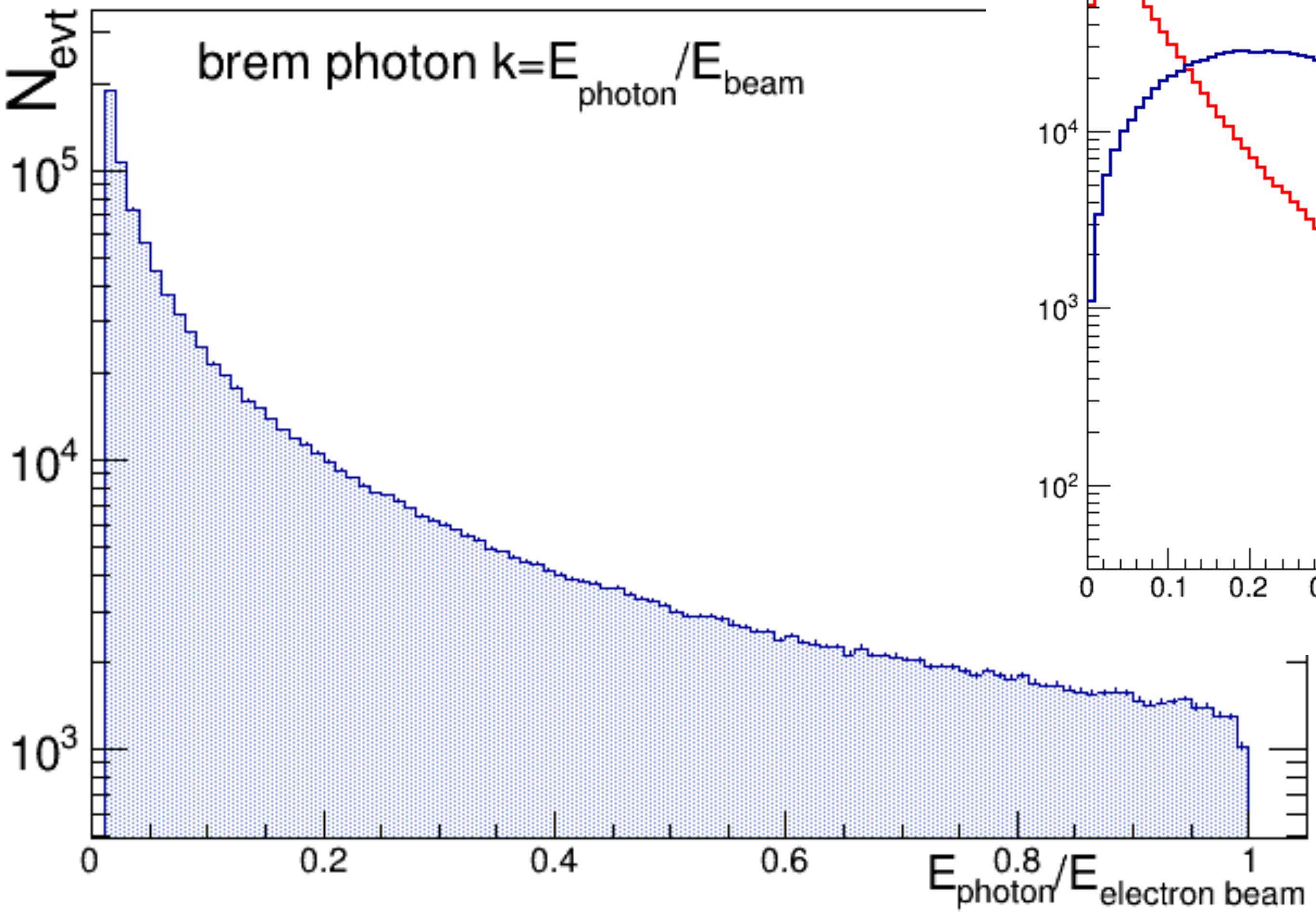


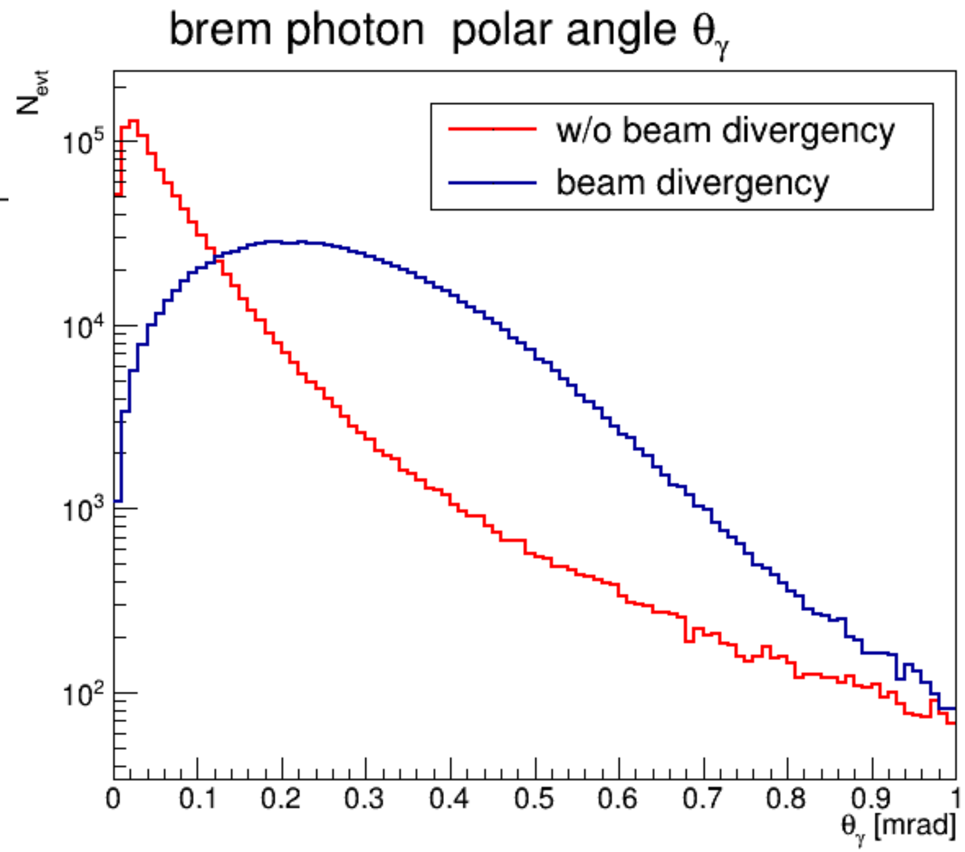
Mariusz Przybycien made a simple CAD model of HRC system

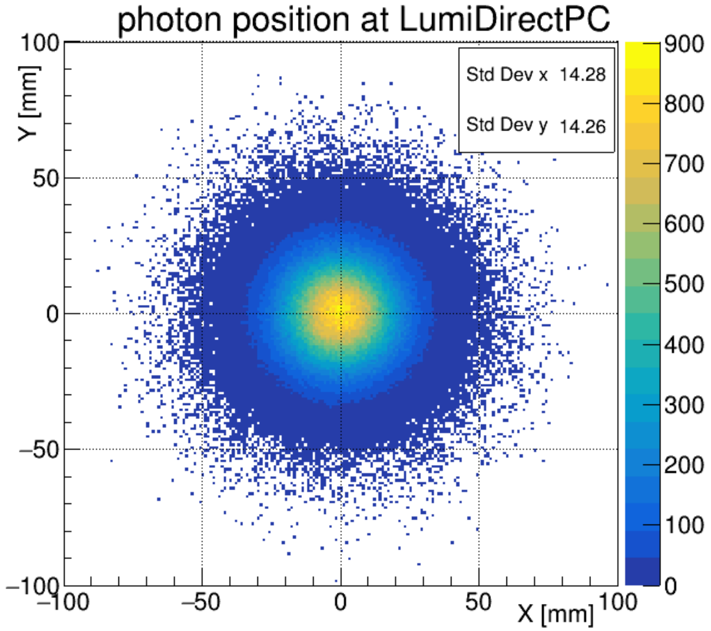


Yulia, thank you for helping to put it in Project CAD!

BremgeC in action – by B. Pawlik

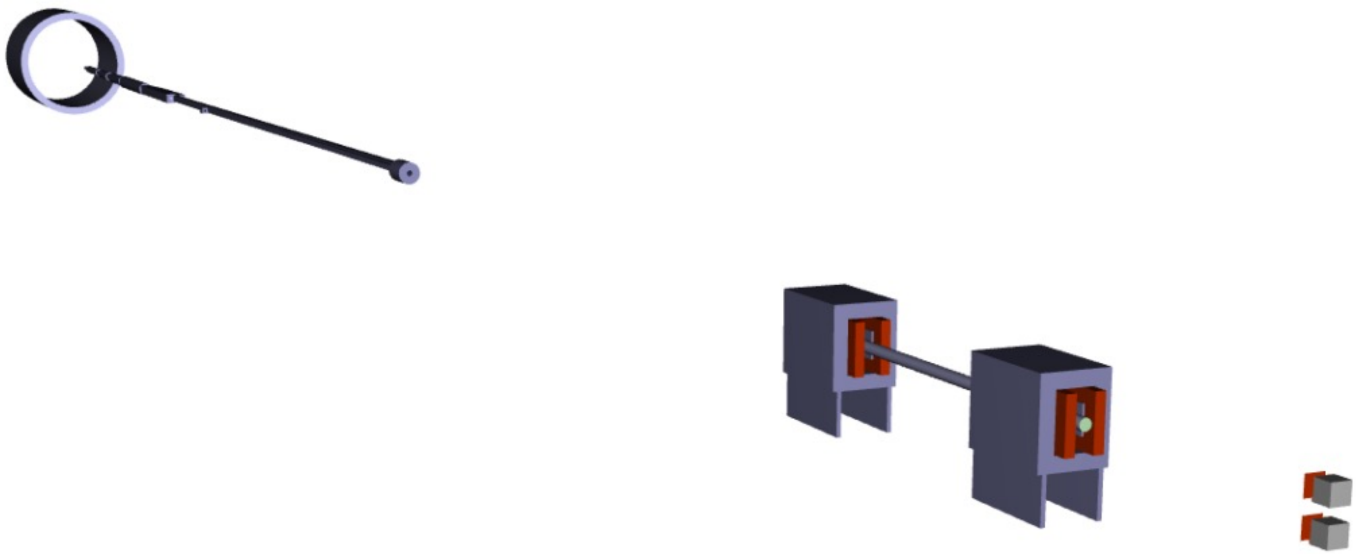




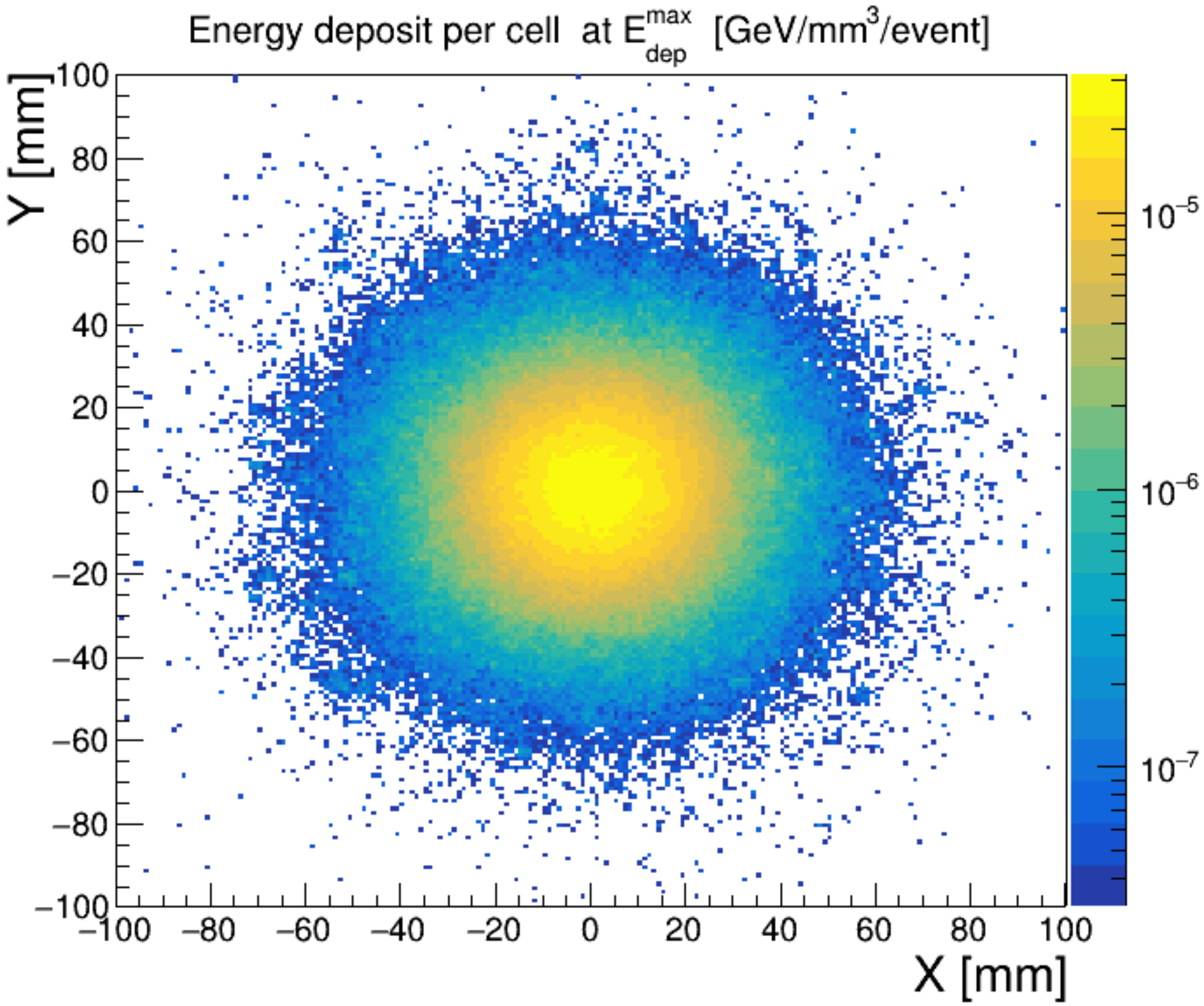


Large beam divergence, $\sigma_{\theta x} = \sigma_{\theta y} = 200\ \mu rad$ to accommodate variations of beam tilt etc.

Simulations for $PbWO_4$ calorimeter

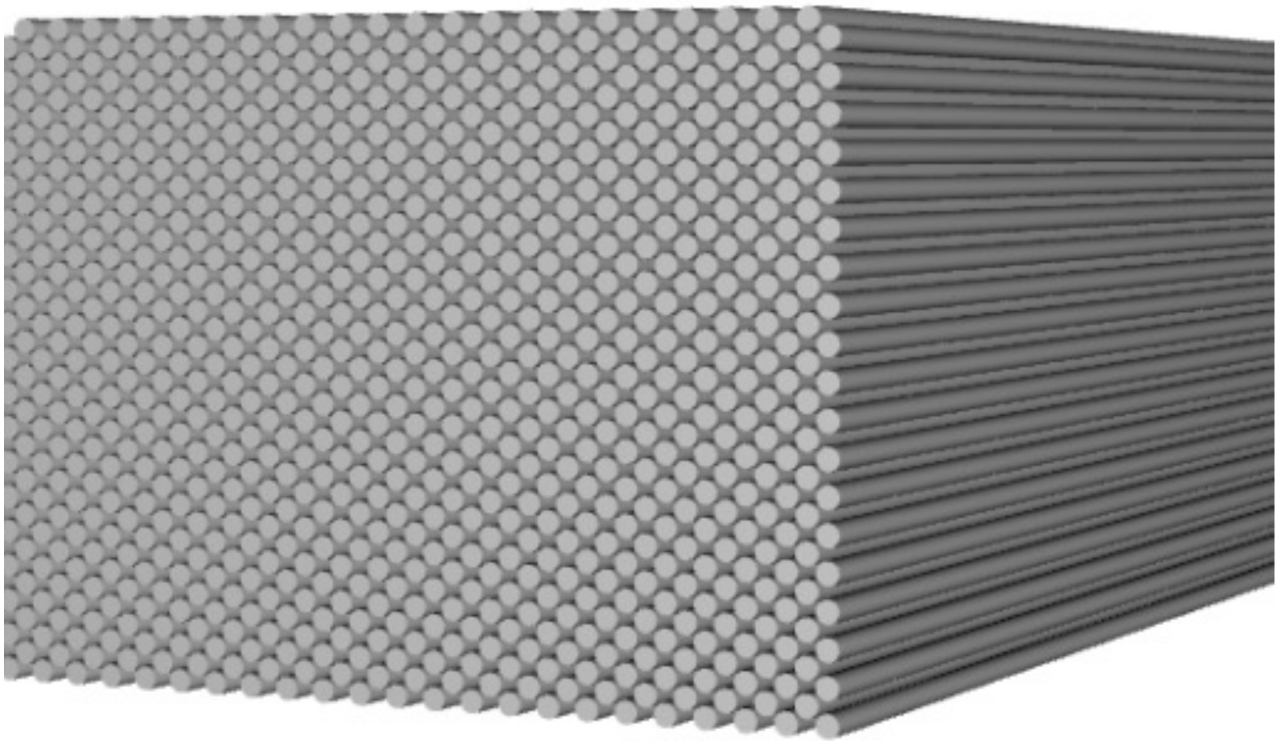


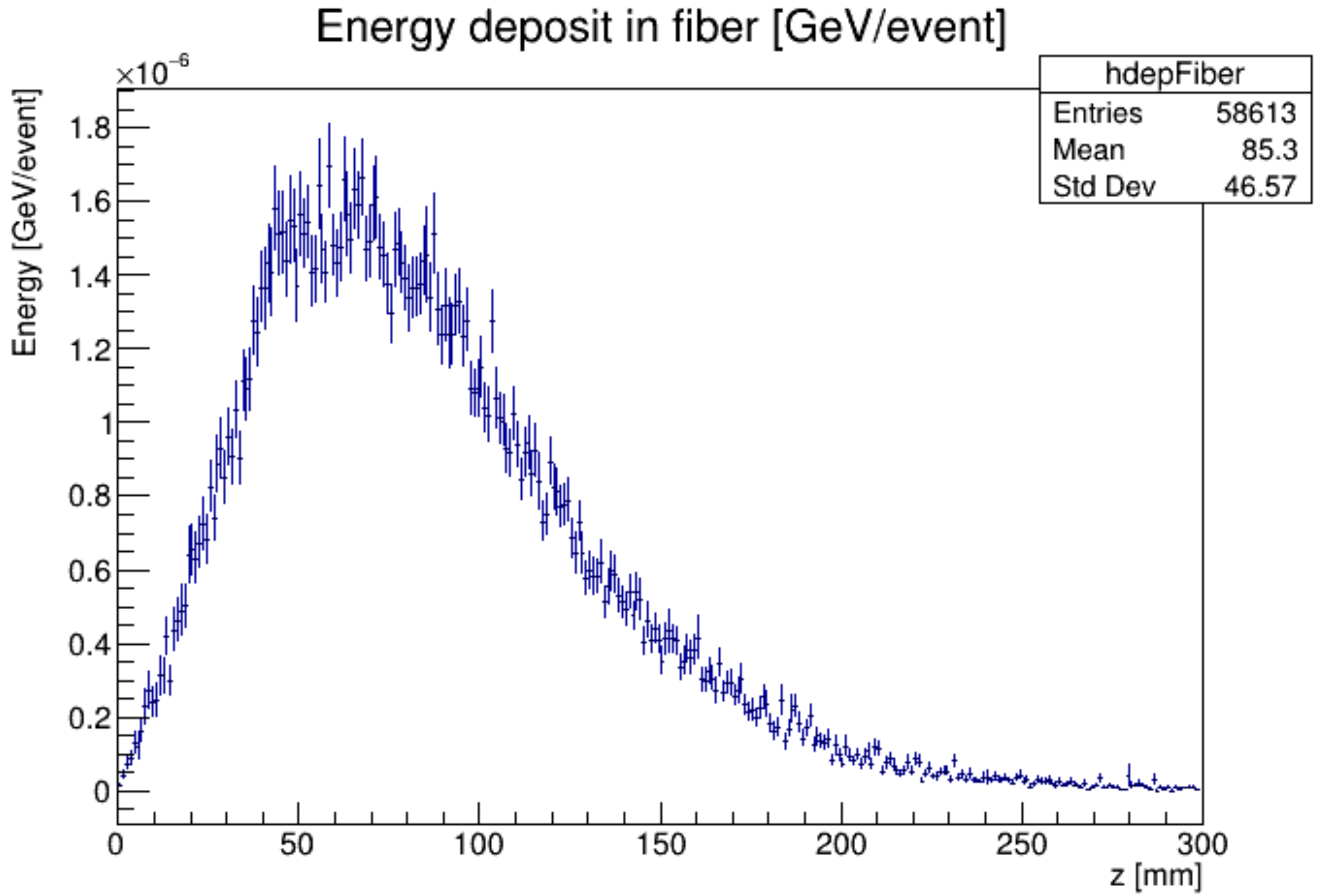
Bogdan's maximal, average irradiation density of **16 MeV/cm³** about 1/3 higher than obtained by Yasir, difference possibly due to different divergence/smearing used



Simulations for SciFi calorimeter

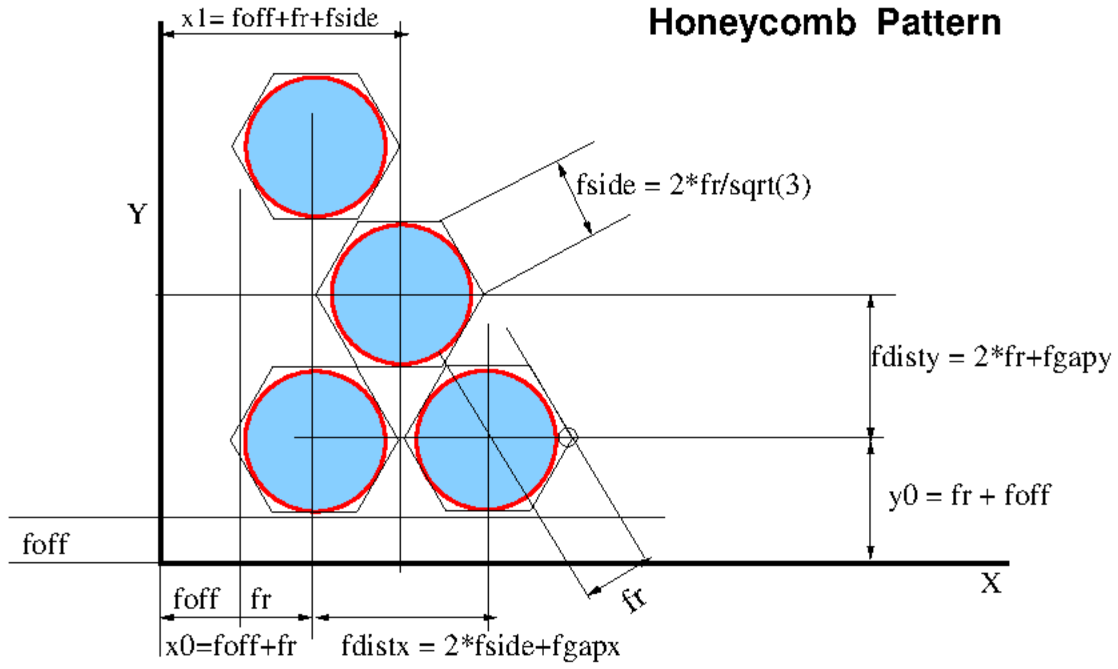
For now, assumed densest, 64% filling, **honeycomb** configuration with **32592 1mm plastic fibers** in a 20cm x 20cm x 30cm volume.





Similar maximal irradiation density to wrt crystal case

Next steps…

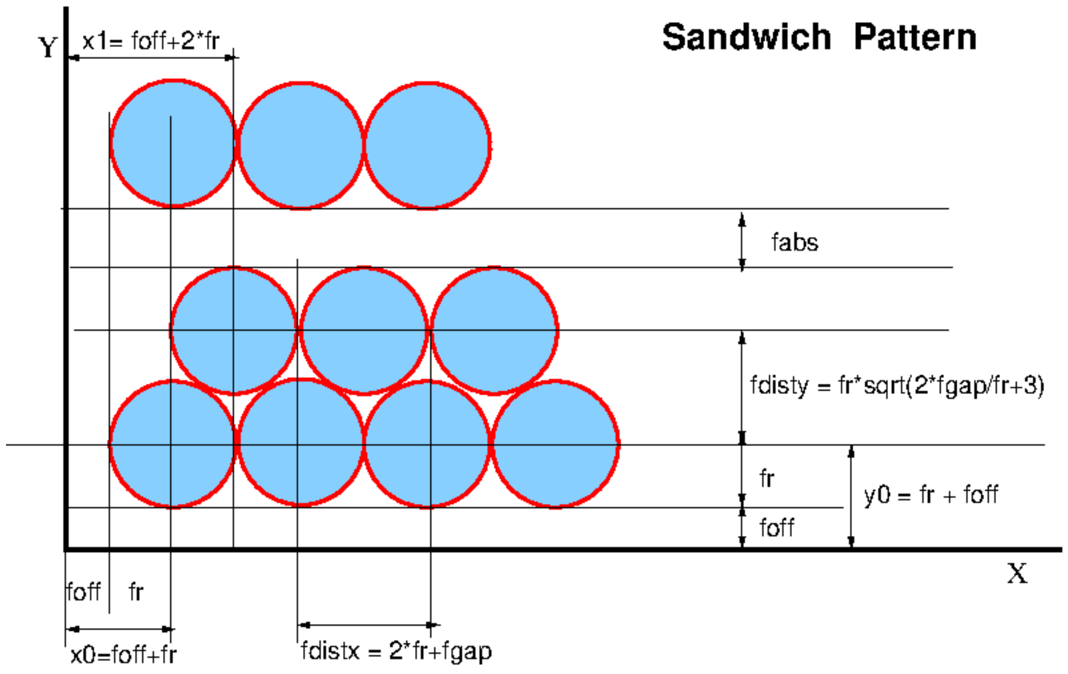


max number of cells:

nx = (sizex–2*foff)/(2*fside+fgapx)

ny = (sizey–2*foff)/(2*fr+fgapy)

vs.



max number of cells:

nx = (sizex–2*foff)/(2*fr)

ny = (sizey–2*foff)/(2*fr+fdisty+fabs)

Honeycomb is x-y asymmetric hence our preference for Sandwich