

Hybrid target simulation

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Outlook

- Introduction
- Simulated hybrid source
- Fot : a simulation for channelling radiation
- Some results with 5 GeV e-
- Conclusion & prospects

Foreword

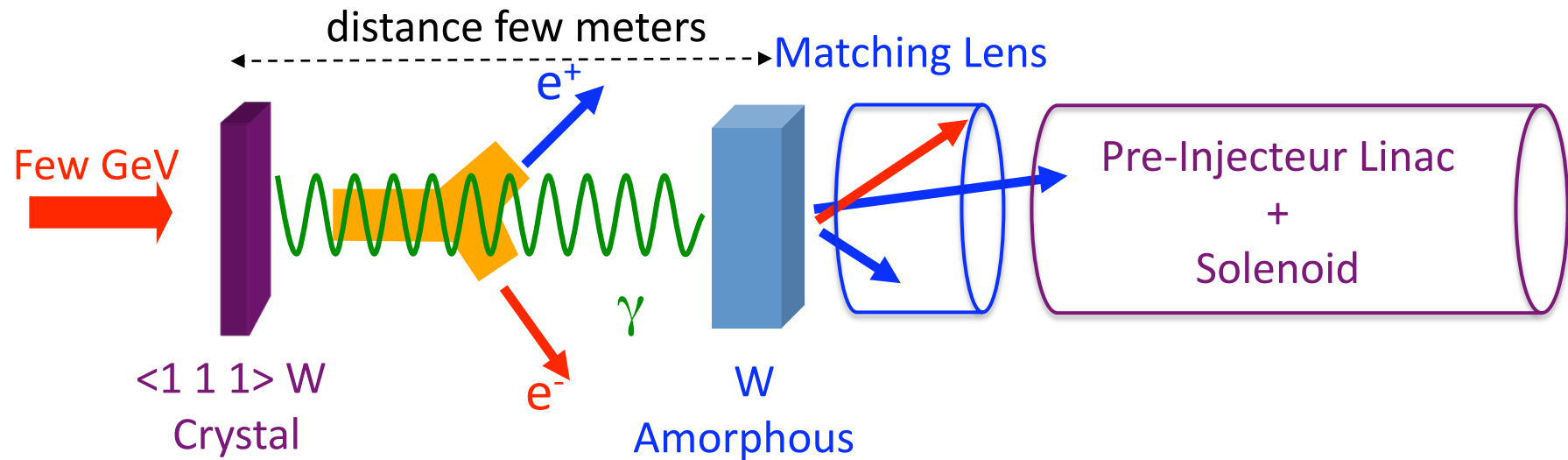
- Since the amorphous target simulation are “under control” my talk is focused on the crystal simulation



This don't mean that there isn't works to do

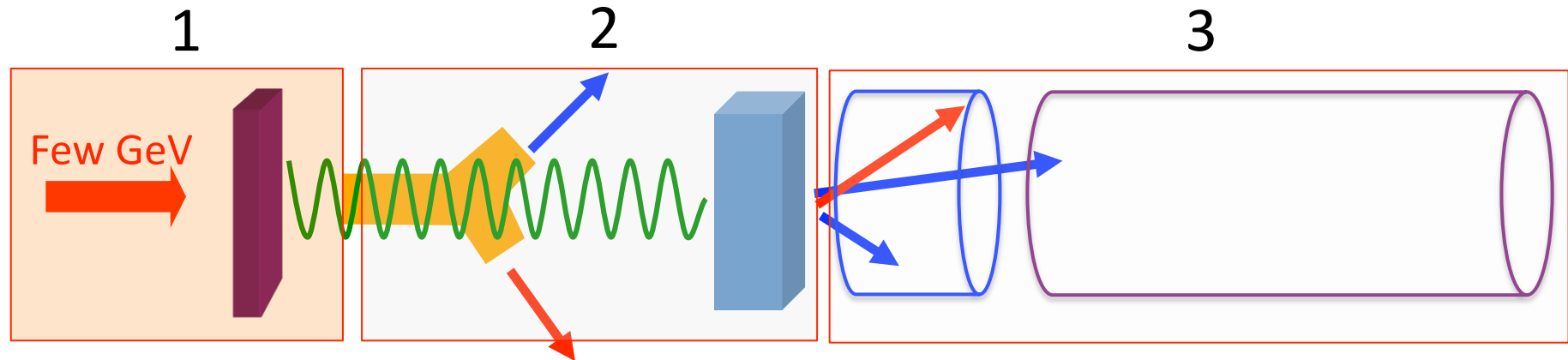
- Start this work few weeks ago, the results shown here are very recent
- Unfortunately difficulties to contact Strakhovenko last few weeks, I don't have the whole details of his crystal simulation
- Not familiar with the physics in the crystal
 - Specialists are present in the room
 - Xavier would give a presentation during a positron phone meeting
- Talk is more technical and concerns results obtain with the X. Artru's simulation which was obtained recently after 12 years of “hibernation”

Introduction



- Hybrid target is the positron baseline for CLIC (L. Rinolfi's talk)
- Study in progress : hybrid solution for ILC (R. Chehab's talk)
 - At the IP : $5 \times$ the requested e^+ for CLIC
 - Time structure modification (A. Variola)
- Results @ KEK Linac (T. Takahashi's talk)
- How to simulate the hybrid source ?

Simulated hybrid source



1. V. Strakhovenko's simulation
2. Geant4, EGS, Fluka ... (PPS-Sim A. Ushakov's talk) ✓
3. Geant4, Astra, Parmela ... (Capture optimization A. Vivoli's talk) ✓

LAL Geant4 simulation : amorphous + flux concentrator + pre-accelerator

➔ Let us say that step 2 & 3 are OK

➔ **Crystal simulation** : step 1 is a critical point



I know 2 (now 3) simulations : V. Strakhovenko, X. Artru & S. Dabagov

Xavier Artru's simulation : Fot history

- NA33 experiment was made at CERN, using 150 GeV γ or e^- impinging on a Germanium crystal, 185 μm thick, aligned in the $\langle 110 \rangle$ axis [Belkacem et al]
 - With γ beam, it confirmed the strong field QED mechanism of pair creation
 - However, with the e^- beam, radiation was much more intense than calculated with an unexpected peak, $x=(\text{radiated energy})/(\text{incident energy})=0.8$
This peak has been explained as an effect of transverse energy loss which accompanies channelling radiation (V. Tikhomirov, X. Artru, V. Baier, V. Katkov and V. Strakhovenko)
- While other authors described the channelling radiation in strong field using the uniform field approximation, X. Artru built a MC simulation code (FOT) using the Baier-Katkov formula for synchrotron radiation in non-uniform field [X. Artru, NIM B48(1990)]
- The code FOT [X. Artru, M. Chevallier, Rad. Eff. Def. in Solids 130 (1994)]
The code have been used to present a proposition of positron using channelling (PAC 1989)
This code has been used also to simulate the proof of principle experiment at Orsay (1992-93)
 - Reproduce the results of a channelling radiation exp. at 10 GeV [E.N. Tsyganov et al(1989)]
 - It was used to interpret another CERN exp. on pair creation [Phys. Lett. B313 (1993)]
- Later on, the simulation of V. Strakhovenko, based on the uniform field approximation, was used. A comparison at one crystal thickness showed no strong difference between the predictions of the two codes ...

Fot simulation

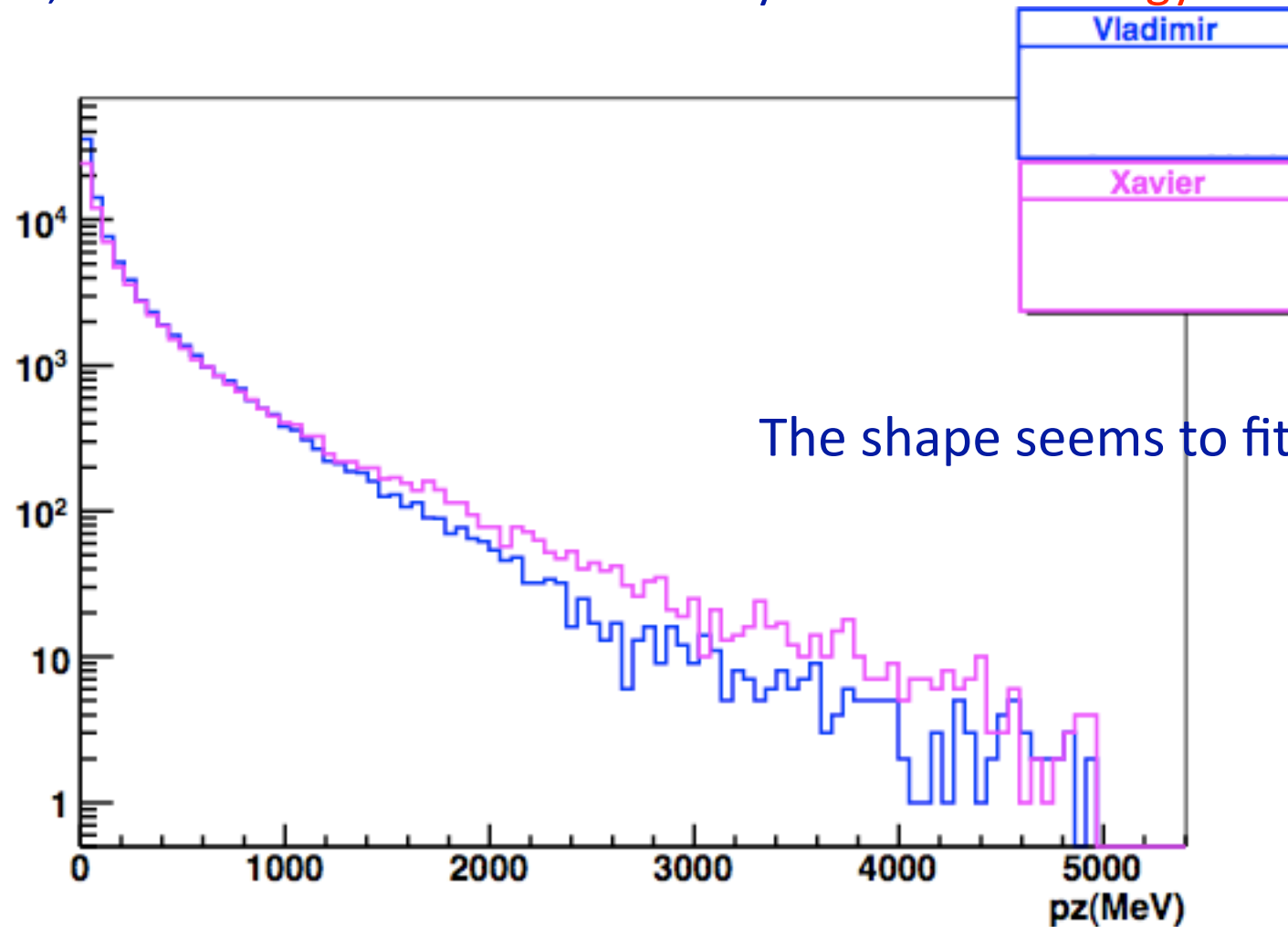
3 different Fortran codes

- LOT (50 lines)
 - Beam preparation
 - e+ or e-
 - Energy of the initial beam
 - Spatial and angle distribution
- POT (260 lines) 
 - Crystal preparation
 - Material, temperature
 - Potential calculus
- FOT (2000 lines) 
 - Crystal thickness
 - Number of particles
 - Energy Cut off ...
- Time to fix some bugs (problem of variable initialisation ...)
- Makefile using gFortran

Gamma at the exit of the crystal

In the following the parameters are:

5 GeV, 1.4 mm of $\langle 111 \rangle$ oriented W crystal 10 MeV energy cut off



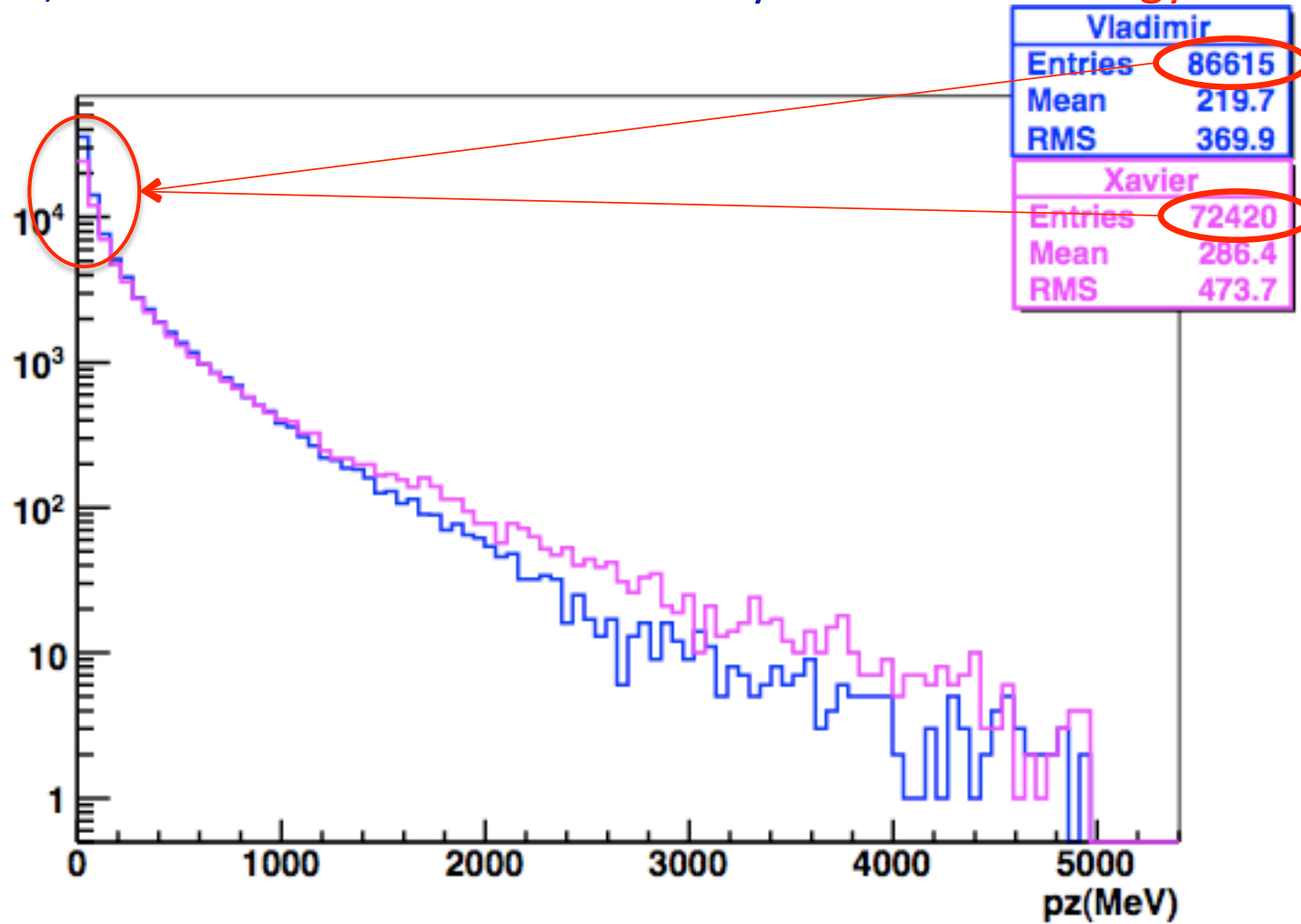
The shape seems to fit but

6 000 e- took ~ 15 mn on a recent intel machine

Gamma at the exit of the crystal

In the following the parameters are:

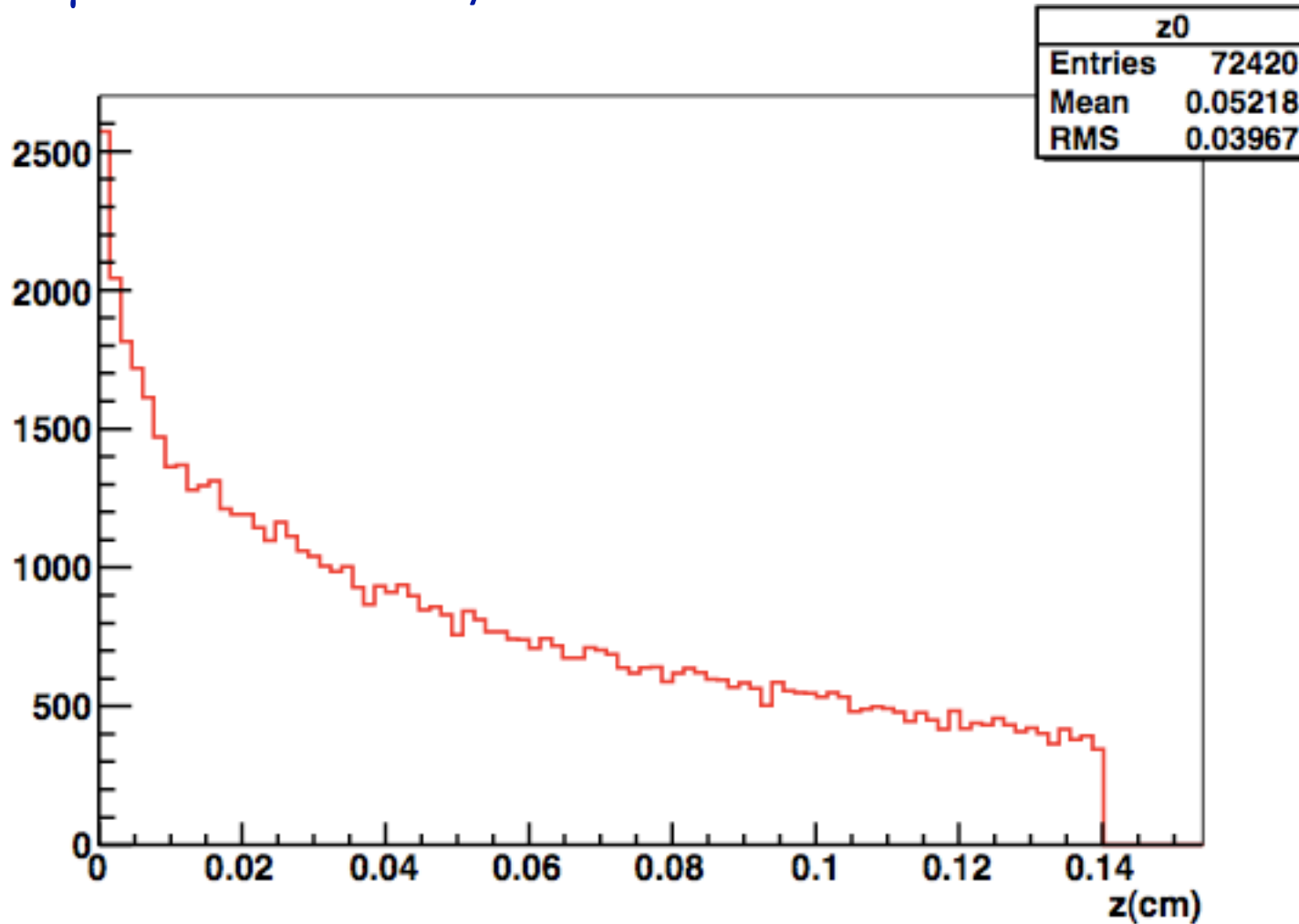
5 GeV, 1.4 mm of $\langle 111 \rangle$ oriented W crystal 10 MeV energy cut off



Yes but no pair creation in the simulation

Gammas at the exit of the crystal

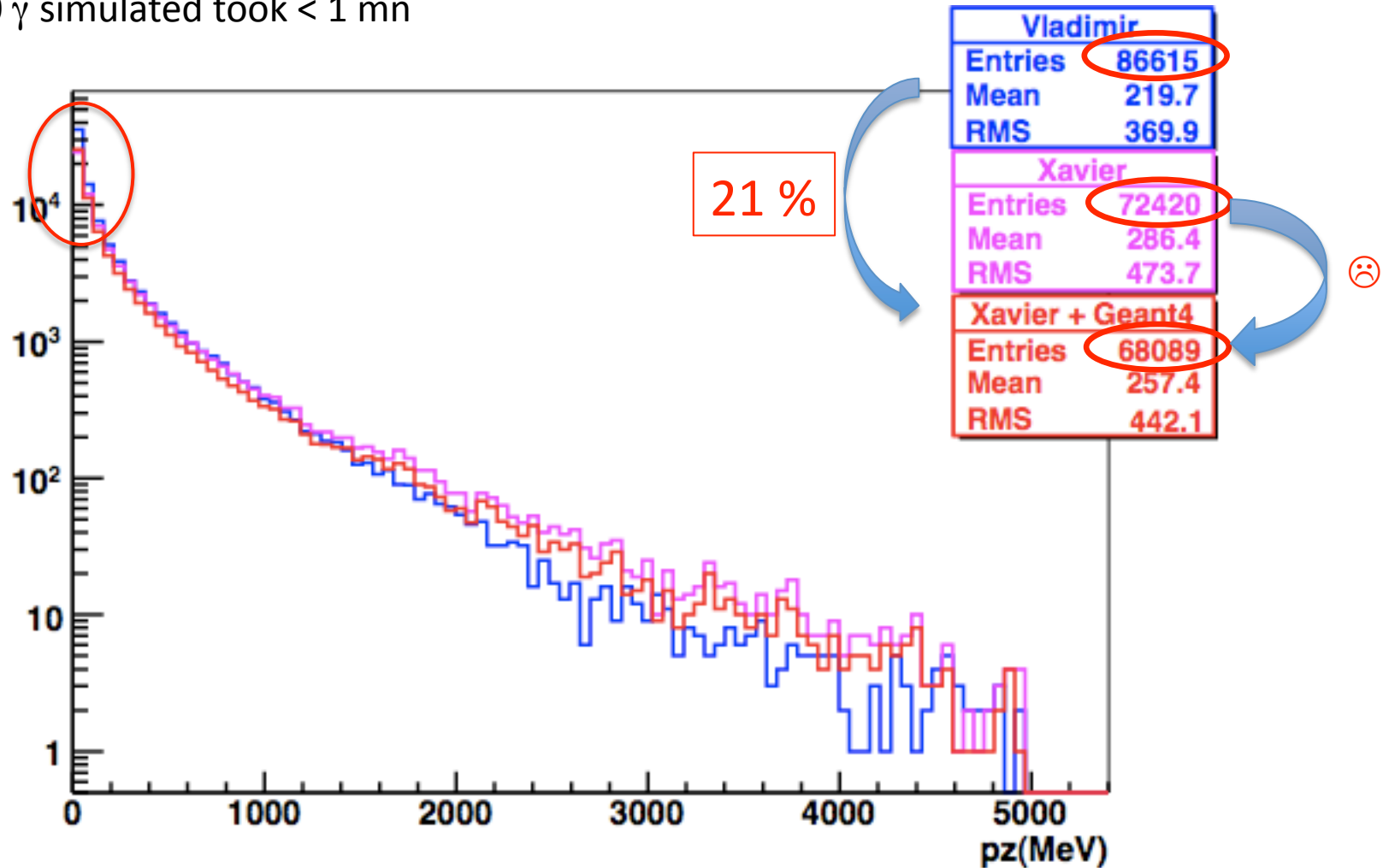
- Emitted γ location in the crystal



- Use the momentum and z_0 as an input of Geant4

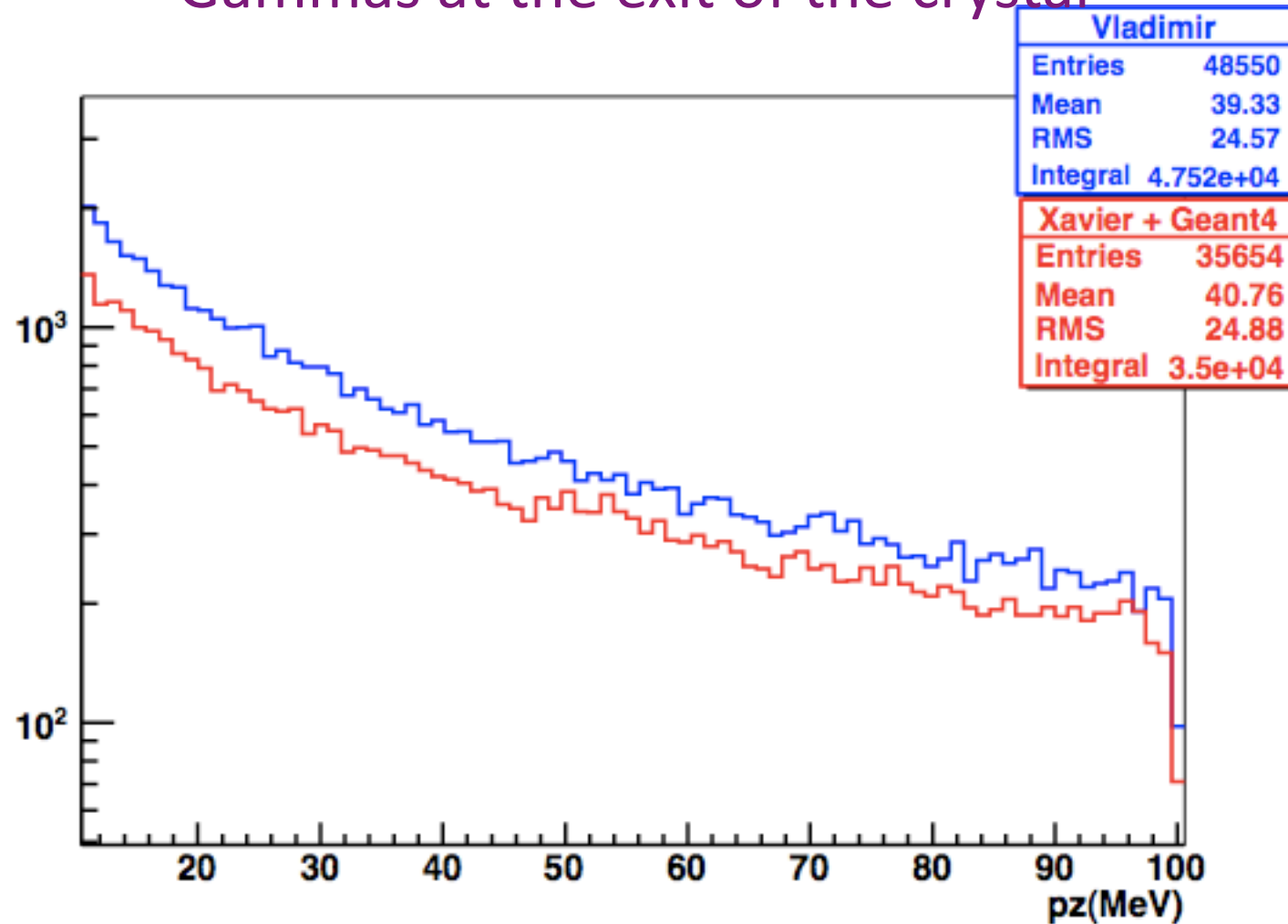
Gammas at the exit of the crystal

72420 γ simulated took < 1 mn



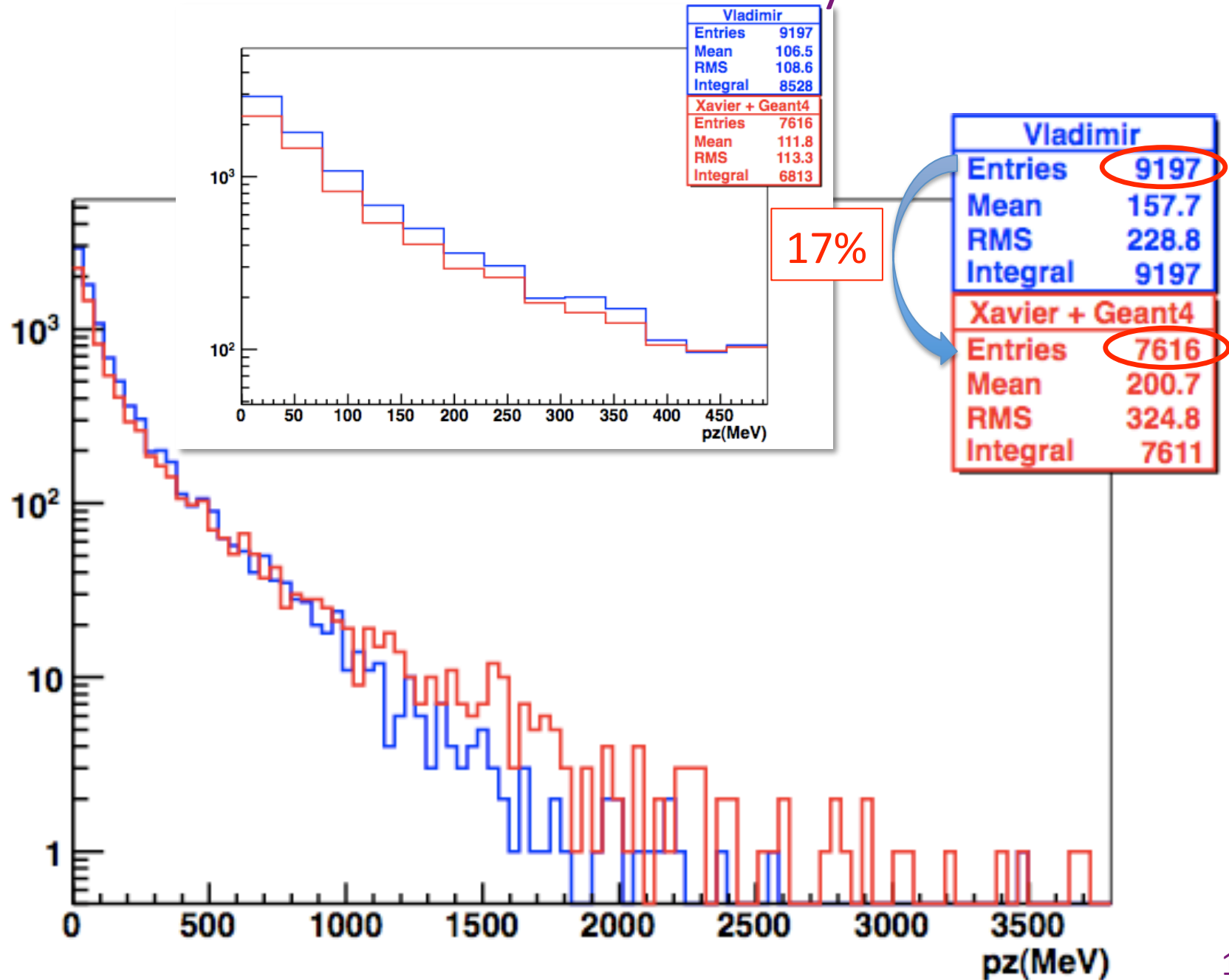
Let check more carefully at low energy

Gammas at the exit of the crystal

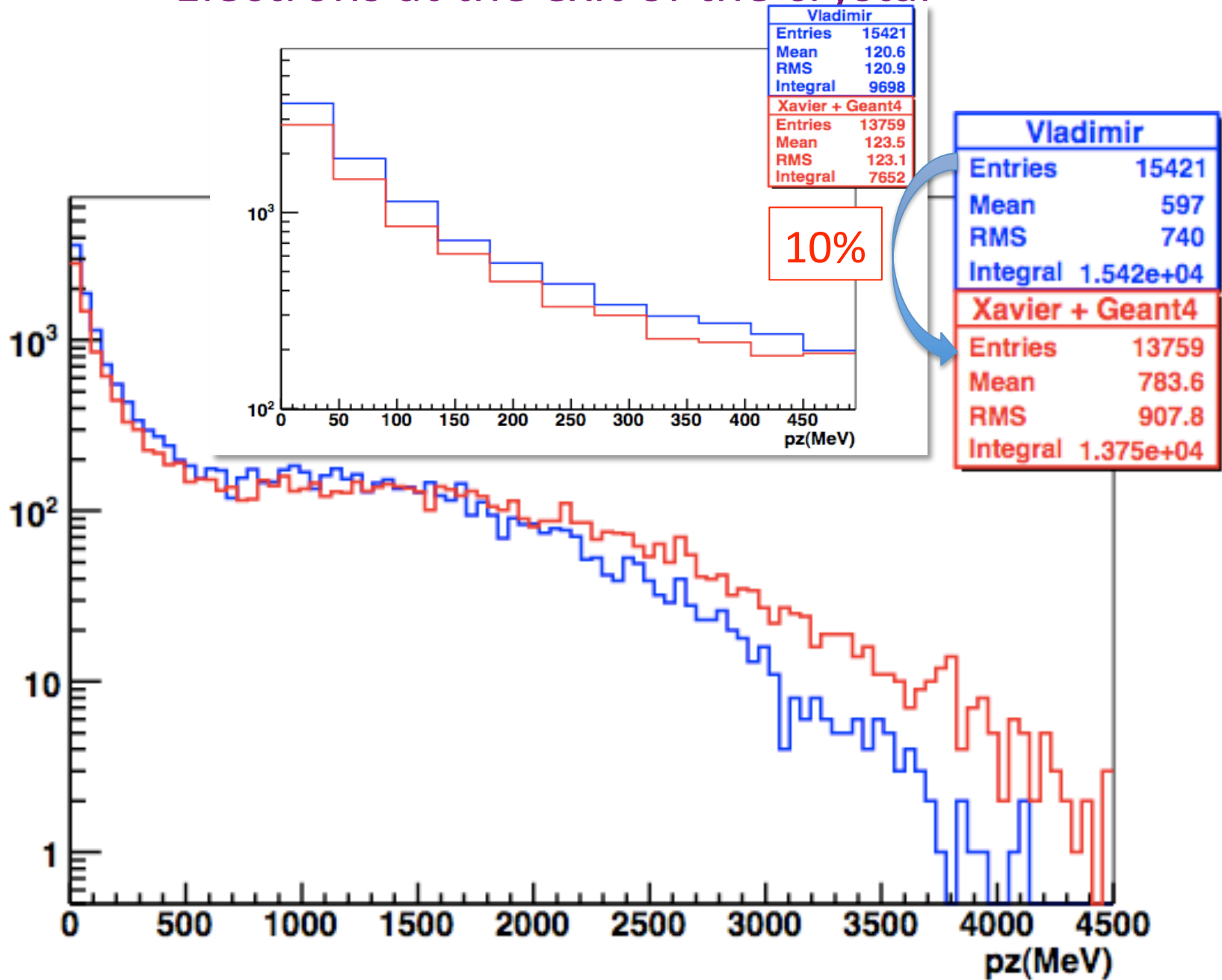


- Xavier + Geant4 **seems** under estimate the γ flux compare to V. Strakhovenko's simulation
- What about the e^+e^- ?

Positrons at the exit of the crystal



Electrons at the exit of the crystal



Conclusion & prospects

- Need to understand the difference between both codes
 - γ : 20 %
 - e^+ : 17 %
 - e^- : 10 %
 - Use different incident electron beam
(from Strakhovenko we have 10, 8, 5, 4 & 3 GeV)
 - Decrease the energy cut off down to few MeV
 - Compare with a third code ?
- Our goal is to add the crystal simulation inside Geant4
 - Rewrite the simulation as a C++ code or encapsulate the Fortran ?
 - Add new classes in Geant4 (G4Channelling...)
Like polarization/depolarization classes (A. Schaelicke Desy-Zeuthen)
G4PolarizedCompton, G4PolarizedGammaConversionModel ...
 - Make an other material : G4_W → G4_W_X ?