

# Simulation update

E. Baracchini<sup>1</sup>, G. Cavoto<sup>2</sup>, A. Cortez<sup>1</sup>, G. D'Imperio<sup>2</sup>, F. Di Clemente<sup>2</sup>, E. Di Marco<sup>2</sup>,  
G. Dho<sup>1</sup>, D. Marques<sup>1</sup>, E. Marconato<sup>2</sup>, D. Pinci<sup>2</sup>

<sup>1</sup>GSSI L'Aquila

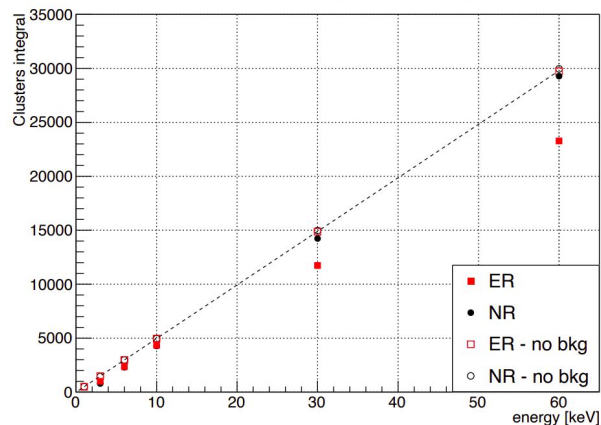
<sup>2</sup>Università La Sapienza e INFN Roma

CYGNO general meeting 07/05/20

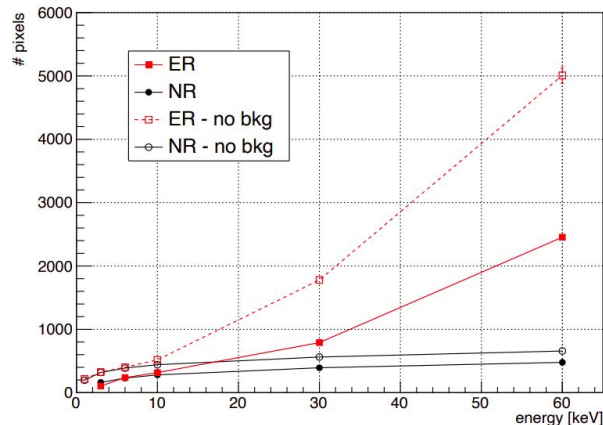
# Reconstruction of simulated ER and NR

- Simulation + digitization no noise → no reconstruction, just count the active pixels and sum the energy
- Reconstructed energy (SC) < true energy, especially for ER at higher energies
- Number of reconstructed active pixels < true active pixels

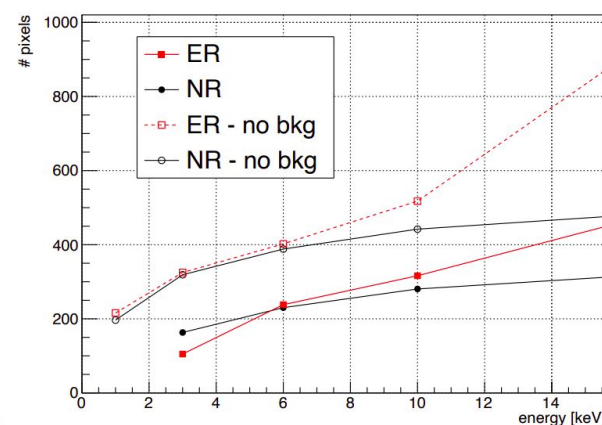
Clusters integral vs energy



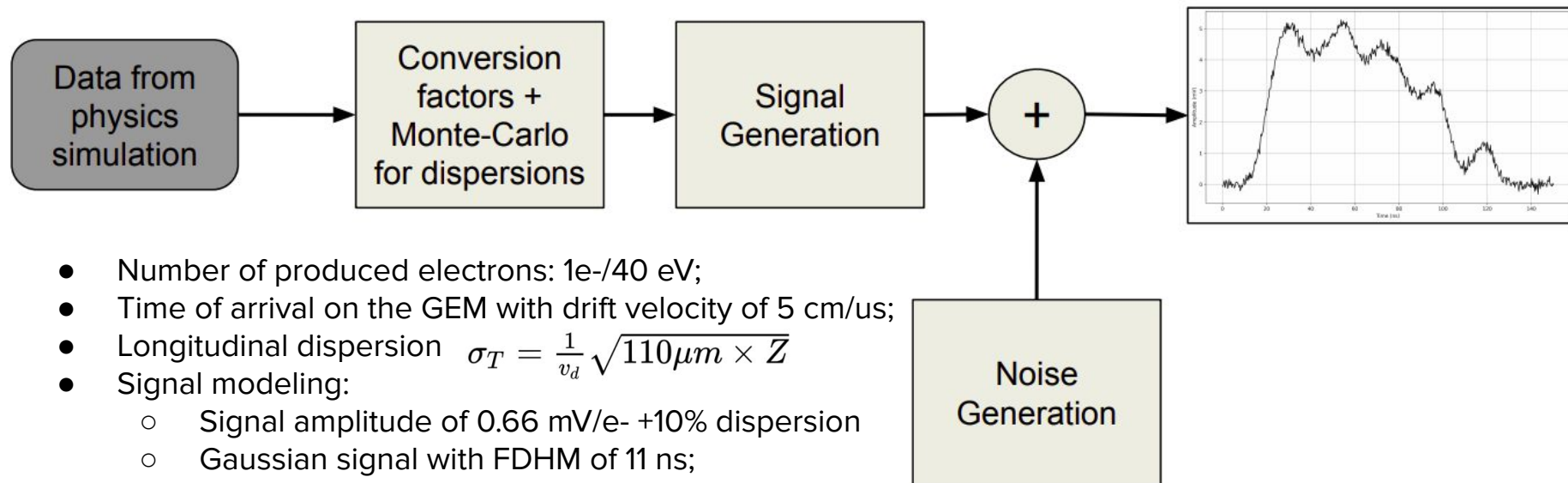
Clusters # pixels vs energy



Clusters # pixels vs energy



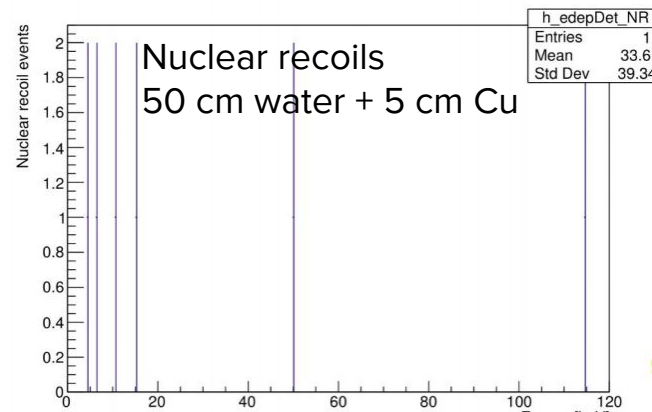
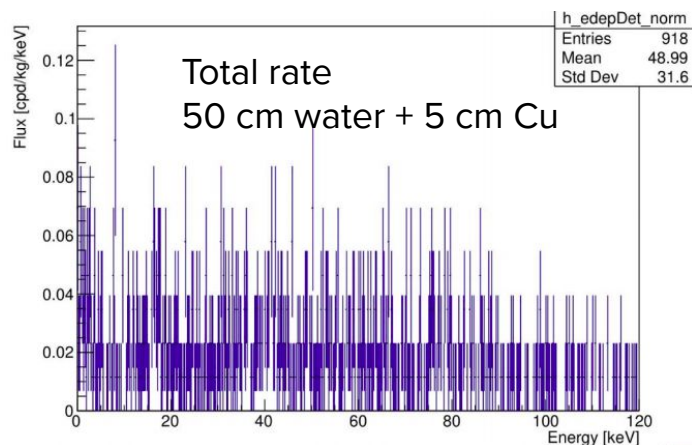
# Simulation of PMTs



- Number of produced electrons:  $1e-/40 \text{ eV}$ ;
- Time of arrival on the GEM with drift velocity of  $5 \text{ cm/us}$ ;
- Longitudinal dispersion  $\sigma_T = \frac{1}{v_d} \sqrt{110\mu\text{m} \times Z}$
- Signal modeling:
  - Signal amplitude of  $0.66 \text{ mV/e-}$  +10% dispersion
  - Gaussian signal with FDHM of  $11 \text{ ns}$ ;
  - Mean: time of arrival of the respective cluster + time of dispersion calculated for each electron;
- Gaussian noise
- Sample rate:  $0.4 \text{ ns/sample}$ .

# LIME simulations

- External neutrons simulation with different shielding options
- 5000M events → 340 days equivalent time
  - 25 cm water + 5 cm Cu → 98 cts/yr in LIME (includes also ER from secondary gammas)
  - 50 cm water + 5 cm Cu → 27 cts/yr in LIME
  - 75 cm water + 5 cm Cu → 3 cts/yr in LIME
  - 100 cm water + 5 cm Cu → 0 cts/year in LIME
- Neutron simulations done, WIP gamma simulations
- Need a more careful cross check with CYGNO simulations



# Summary

- Tested reconstruction code on simulated ER and NR
  - some energy is systematically not included in the SC, especially for ER of higher energies
  - cross-checked with simulation without noise → feature of the reconstruction (not due to bugs in simulations)
- PMT simulation by brazilian group
  - characterization of the real PMT can be given as input to have a realistic simulation
  - important ingredient to develop the 3D reconstruction using MC
- LIME simulation code is in place and shielding study is in progress
  - external neutrons simulation done for 3 options of shielding, need to cross-check the results with CYGNO
  - 50 cm water + 5 cm Cu look sufficient to have a nuclear recoil rate of few counts/year in LIME
  - external gamma simulation is in progress
- Started discussing the feasibility of solar neutrino measurement
  - CYGNO should be sensitive to the pp component of solar neutrinos
  - expected ~50 evts/year in CYGNO Phase-2
  - study our realistic angular and energy resolution, plus diffusion during drift and digitalisation
  - we have all the ingredients from simulation point of view → this work could become a paper