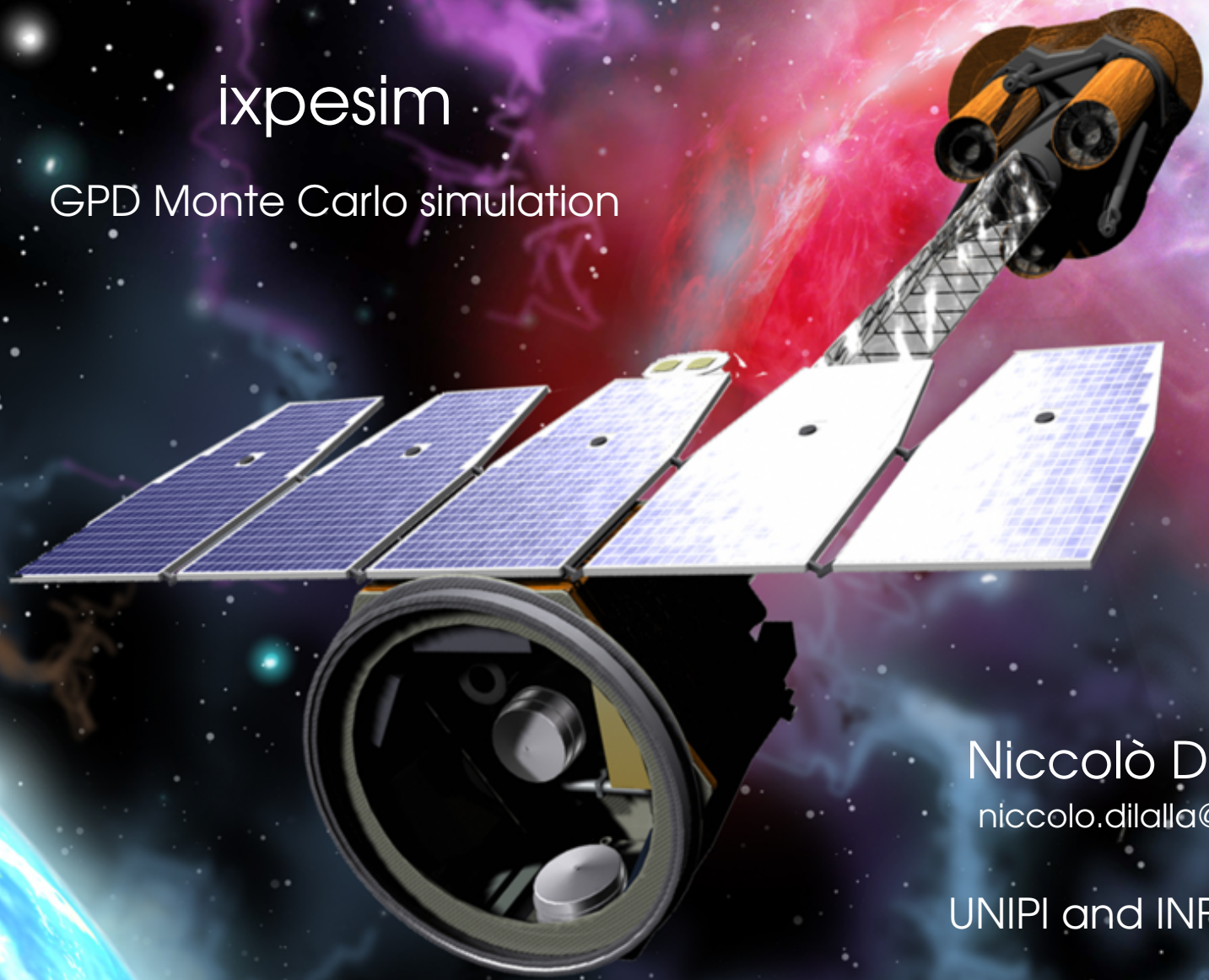
ixpesim

GPD Monte Carlo simulation



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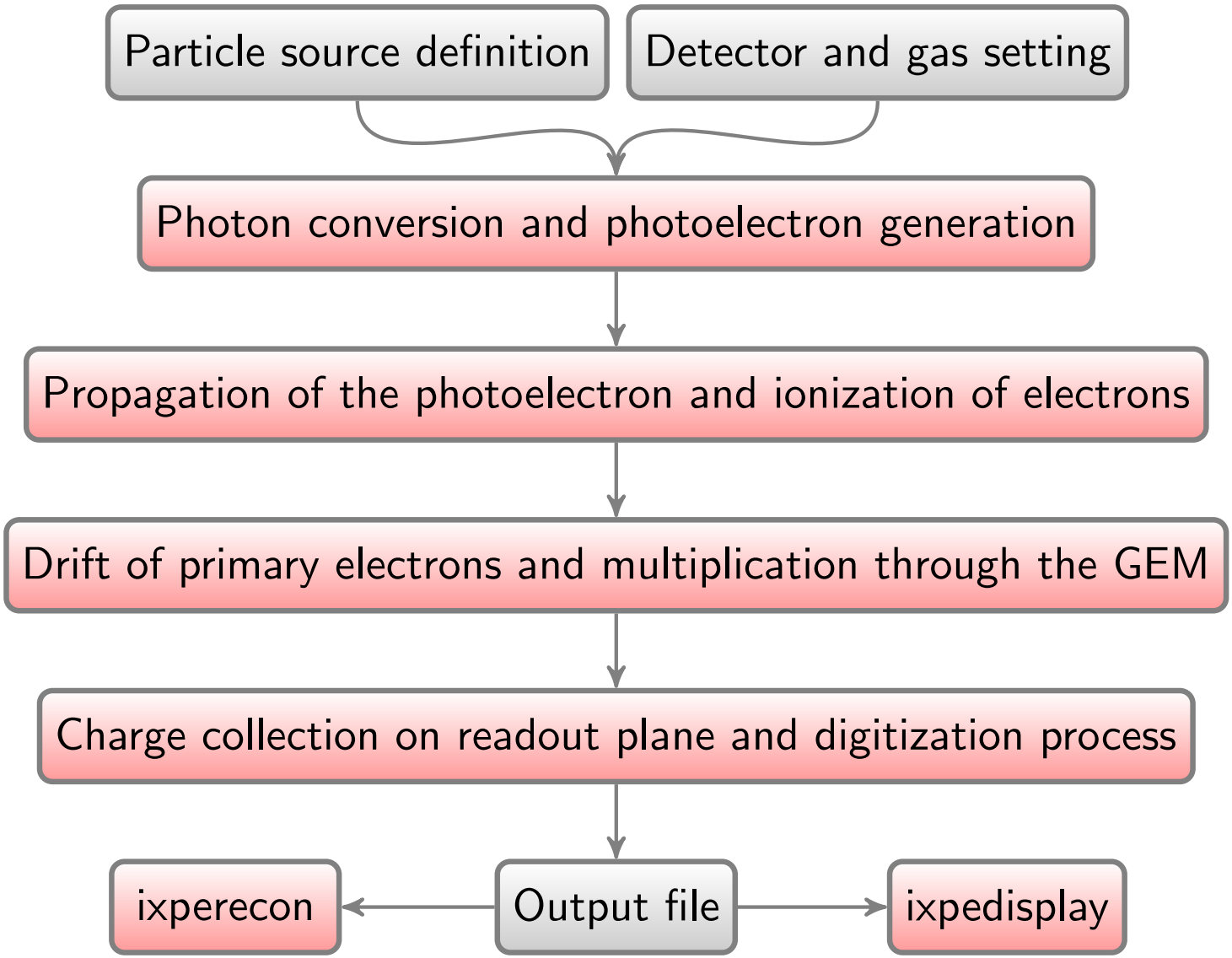
Introduction

- Main purposes:
  - simulate the response of the GPD to a generic particle source;
  - produce output files virtually identical to those produced by the actual hardware (Monte Carlo truth information aside).
- Written in C++ and based on the Geant4 framework:
  - uses a joint combination of the physics processes provided with Geant4 and some custom parameterization.
- Fully integrated in `gpdsw`.

Simulation flow



A large number of simulation options (1)

```
General options:
  -h [ --help ]                         print this help message and exit
  --output-file arg (=sim.fits)         path to the output file
  -n [ --num-events ] arg (=100000)     maximum number of events
  --log-terminal-level arg (=0)         terminal sink logging level
  --log-file-level arg (=0)             file sink logging level
  --log-file arg (=sim.log)             path to the log file
  --buffer-capacity arg (=50000)        Capacity of the write buffer (n. of
                                        events)
  --random-seed arg (=1)                random seed for the simulation

Source options:
  --src-particle arg (=gamma)           source particle [gamma, proton, alpha]
  --src-morphology arg (=gauss)         source morphology [gauss, flat]
  --src-pos-x arg (=0)                  x position of the source centroid [mm]
  --src-pos-y arg (=0)                  y position of the source centroid [mm]
  --src-pos-z arg (=20)                 z position of the source centroid [mm]
  --src-sigma arg (=0.25)               source 1-sigma extension [mm]
  --src-theta arg (=-180)               source beam polar angle [deg]
  --src-phi arg (=0)                    source beam azimuthal angle [deg]
  --src-spectrum arg (=Fe55)            source spectrum [line, Fe55, powerlaw,
                                        user]
  --src-energy arg (=4)                 source energy [keV]
  --src-index arg (=-2)                 source spectral index
  --src-spec-file arg                   path to the source spectrum file
  --src-polarized arg (=0)              source is (100%) polarized?
  --src-pol-angle arg (=0)              polarization angle [deg]
```

A large number of simulation options (2)

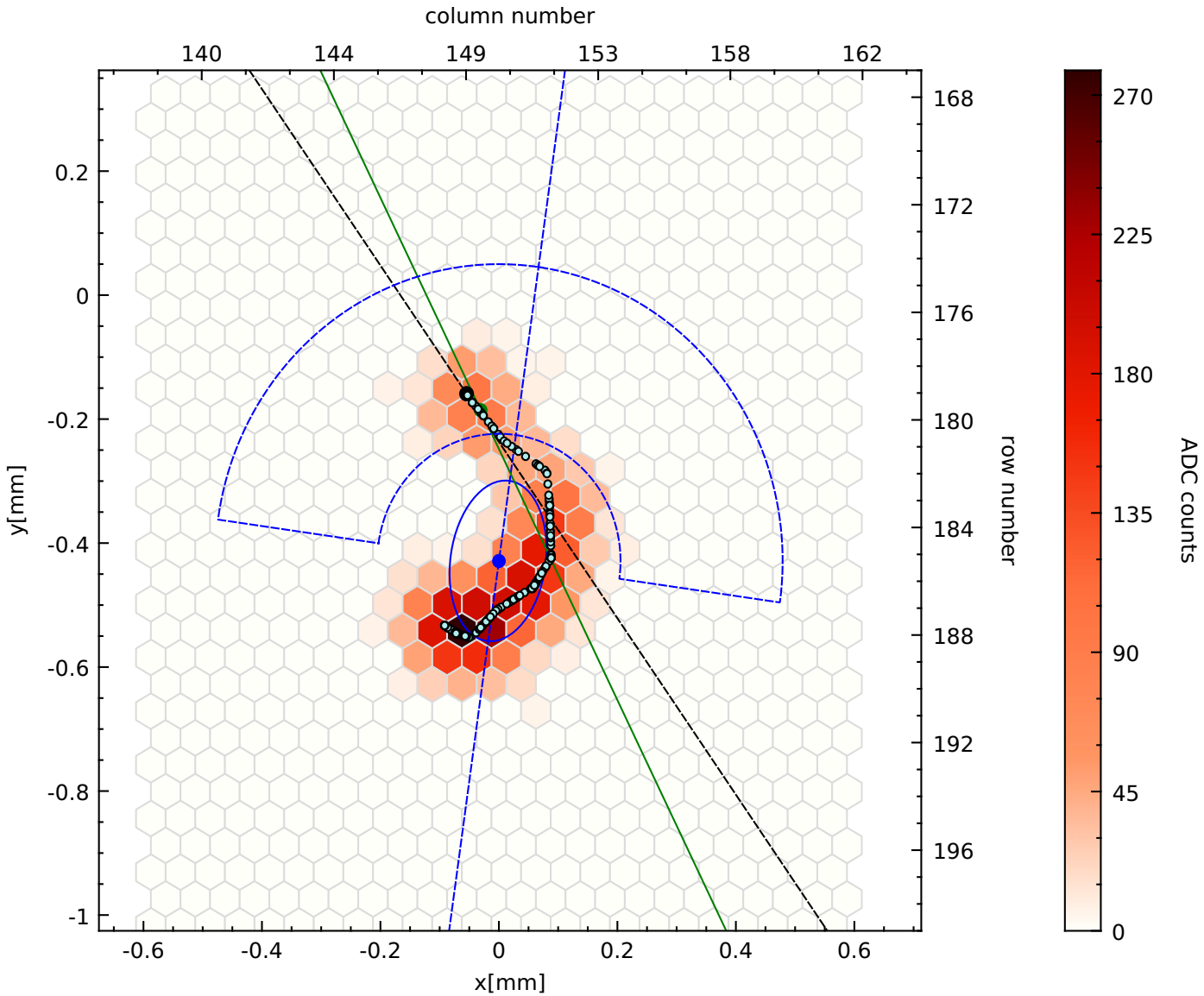
```
Gas-mixture options:
  --excitation-energy arg (=160)        mean excitation energy [eV]
  --ionization-energy arg (=24.567900000000002)
                                        mean ionization energy [eV]
  --fano-factor arg (=0.29999999999999999)
                                        Fano factor
  --abs-diff-sigma arg (=73)            diffusion sigma in the absorption gap
                                        [um/sqrt(cm)]
  --abs-attach-coeff arg (=0)           attachment coefficient in the
                                        absorption gap [1/mm]
  --transf-diff-sigma arg (=150)        diffusion sigma in the transfer gap
                                        [um/sqrt(cm)]

Detector options:
  --gem-eff-gain arg (=150)             GEM effective gain
  --gem-capture-prob arg (=0.75)        Capture probability for GEM events
  --num-pac-electrons arg (=1)          number of electrons per packet
  --trg-threshold arg (=35)             trigger threshold [mV]

Calibration options:
  --calib-xpol-noise arg (=/home/ndilalla/work/ixpe/gpdsw/CALDB/gpd/xpol_noise_vanilla.fits)
                                        path to the XPOL noise calibration file
  --xpol-noise-scale arg (=1)           xpol noise scaling factor
  --calib-xpol-gain arg (=/home/ndilalla/work/ixpe/gpdsw/CALDB/gpd/xpol_gain_vanilla.fits)
                                        path to the XPOL gain calibration file
  --calib-gem-gain arg (=/home/ndilalla/work/ixpe/gpdsw/CALDB/gpd/gem_gain_vanilla.fits)
                                        path to the GEM gain calibration file
```

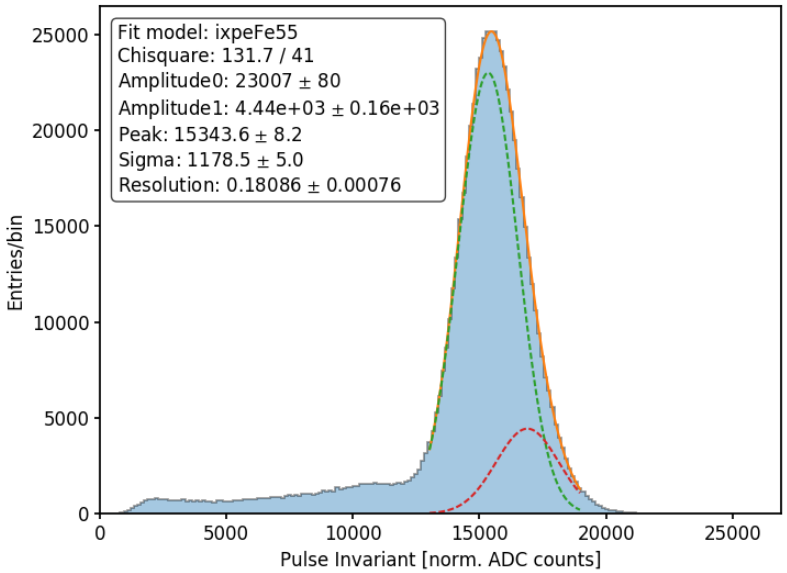
Simulation output

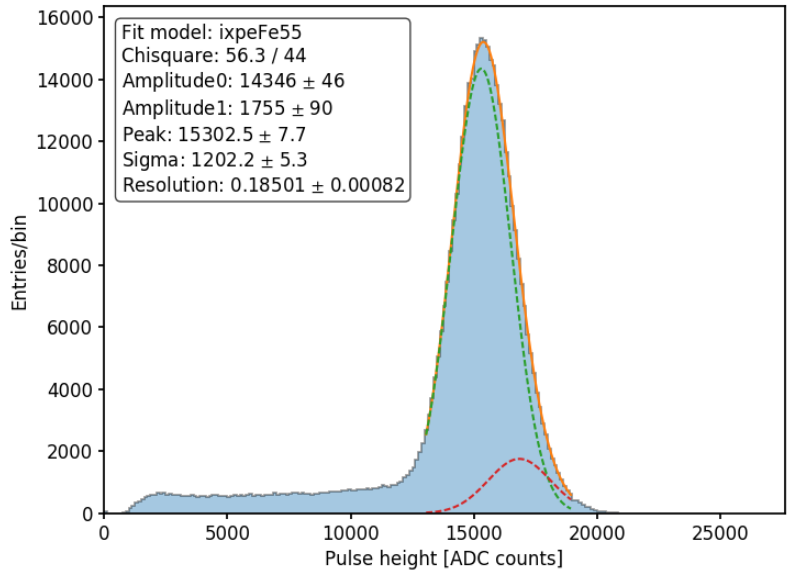
ixpedisplay



Data/MC comparison

Fe55 spectrum





Conclusions

- ixpesim is up and running.
- Extensively used and tested to study:
  - Inclined beam (attachement);
  - Systematics in polarization measurements;
  - Effect of change in gas mixture;
  - Modulation factor.
- Large flexibility in terms of input source and detector setting;
- Many works still in progress:
  - Change the gas mixture composition (almost done);
  - Assign event times and trigger ids;
  - Simulate polarization degrees;
  - Simulate the effect sample-and-hold discharge during readout.