

Steps towards realistic Straw Tracker simulation

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on behalf of the JINR/PNPI straw TB & simulation team

Physics Sensitivity and measurement precision

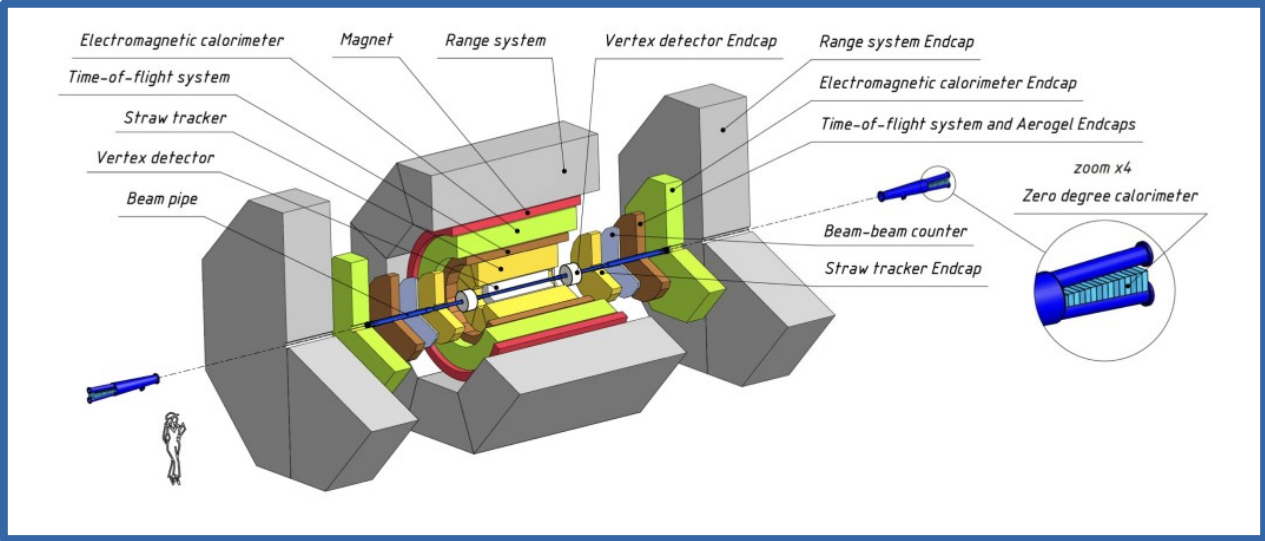


detector+readout + reconstruction

realistic simulation



Final Design and Cost



=

prototyping and performance studies

“A detector and its electronics should be considered as a whole” - Sasha Solin :)

Straw response simulation : detector VS detector + readout

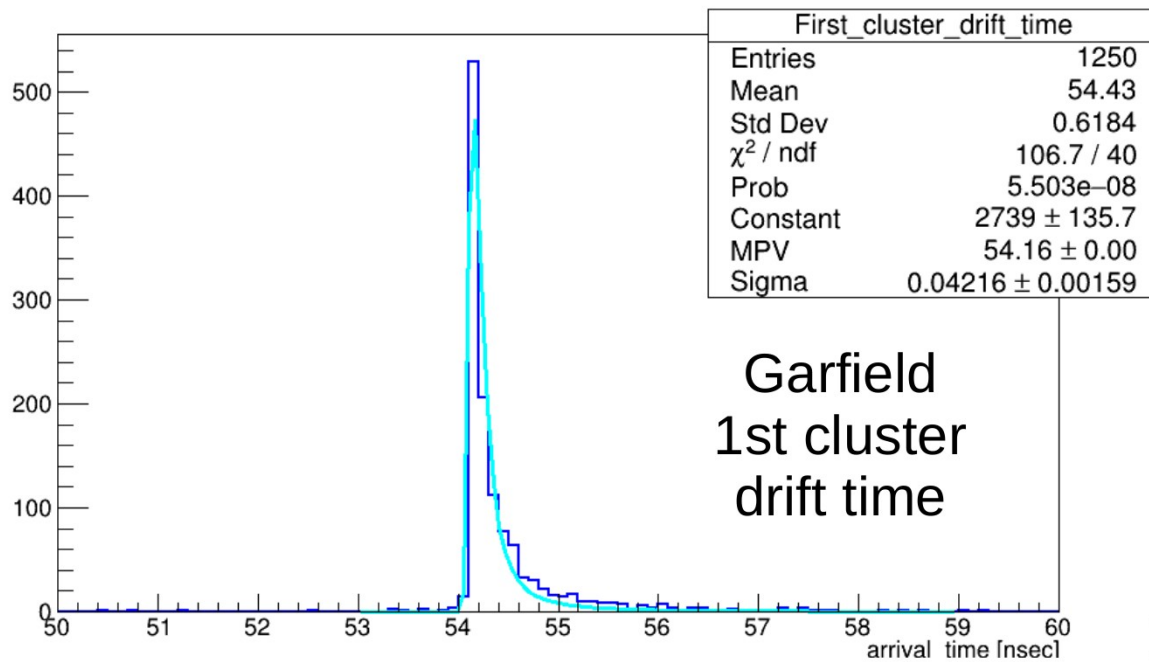
Simulation dedicated for SPDroot straw signal
parametrisation started in the spring:

Straw response – Garfield/Garfield++

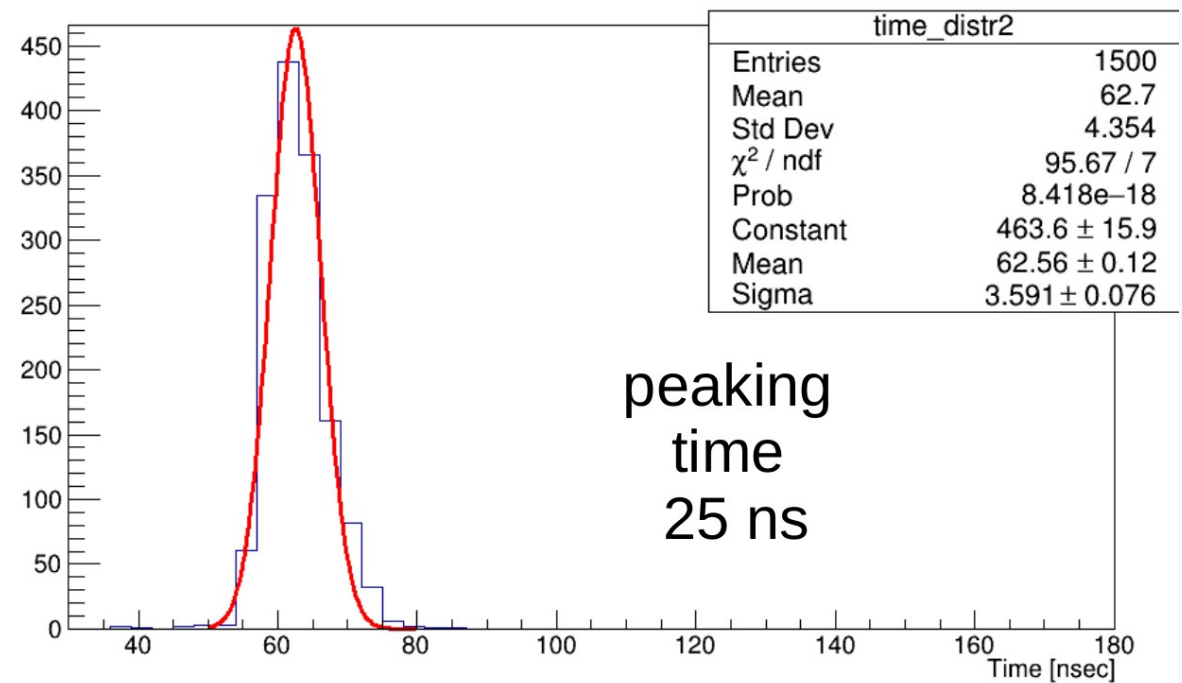
Electronics (VMM3) – LTSpice

In more details presented at SPD Ph&MC March22 ([link](#))

first cluster drift time



Time of low threshold crossing



Realistic simulation / reconstruction

Garfield/LTSpice
straw signal
simulation with
realistic electronics
models

TB measurements
with different
readout solutions

Signal
parametrisation
in SPDroot*
simulation part

Realistic
reconstruction
in SPDroot*

realistic tracker
simulation/reconstruction

- garfield+LTSpice / TB -based
signal parametrisation
- realistic noise description
(TB experience)
- readout
(t, ADC, something else?)
- pattern recognition???
- T0??
- geometry??

Simulation studies
with different tracker
(geometry+readout)
models

- realistic spacial resolution
- realistic PID performance
- influence of the different
electronics models and
noise levels on **sensitivity
to physics processes**

choice of the tracker readout
= requirements for the electronics/DAQ development

we are here

* portable modular code adoptable
for any SPD simulation software

Straw Tracker readout parameters and available models

Readout is defined by the requirements of simultaneous time and charge measurements (coordinates + PID)

Analogue part => achievable time and charge resolution, efficiency (bandwidth, thresholds...)

Noise and x-talk => pattern recognition efficiency, resolution

realistic estimate? TB experience, expert input

Dynamic range => flexibility, PR and reconstruction efficiency, resolution

studies are needed

Digitization => resolution

studies are needed

Frontend ASIC models:

- existing readout solutions being studied are based on:

- VMM3a – rejected with October21 TB + JINR lab studies

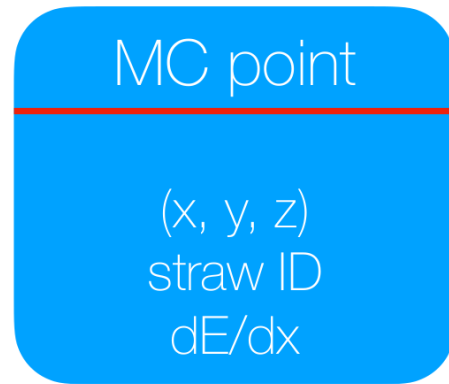
- VMM3 – May22 + July22 TBs – data analysis ongoing

- TIGER – preparation started in July, measurements scheduled for October22 TB

- available readout allows test in magnetic field (tbc)

- other options (incl. Idealistic for reference)

The principal scheme of Simulation → Reconstruction procedure in Straw Tracker



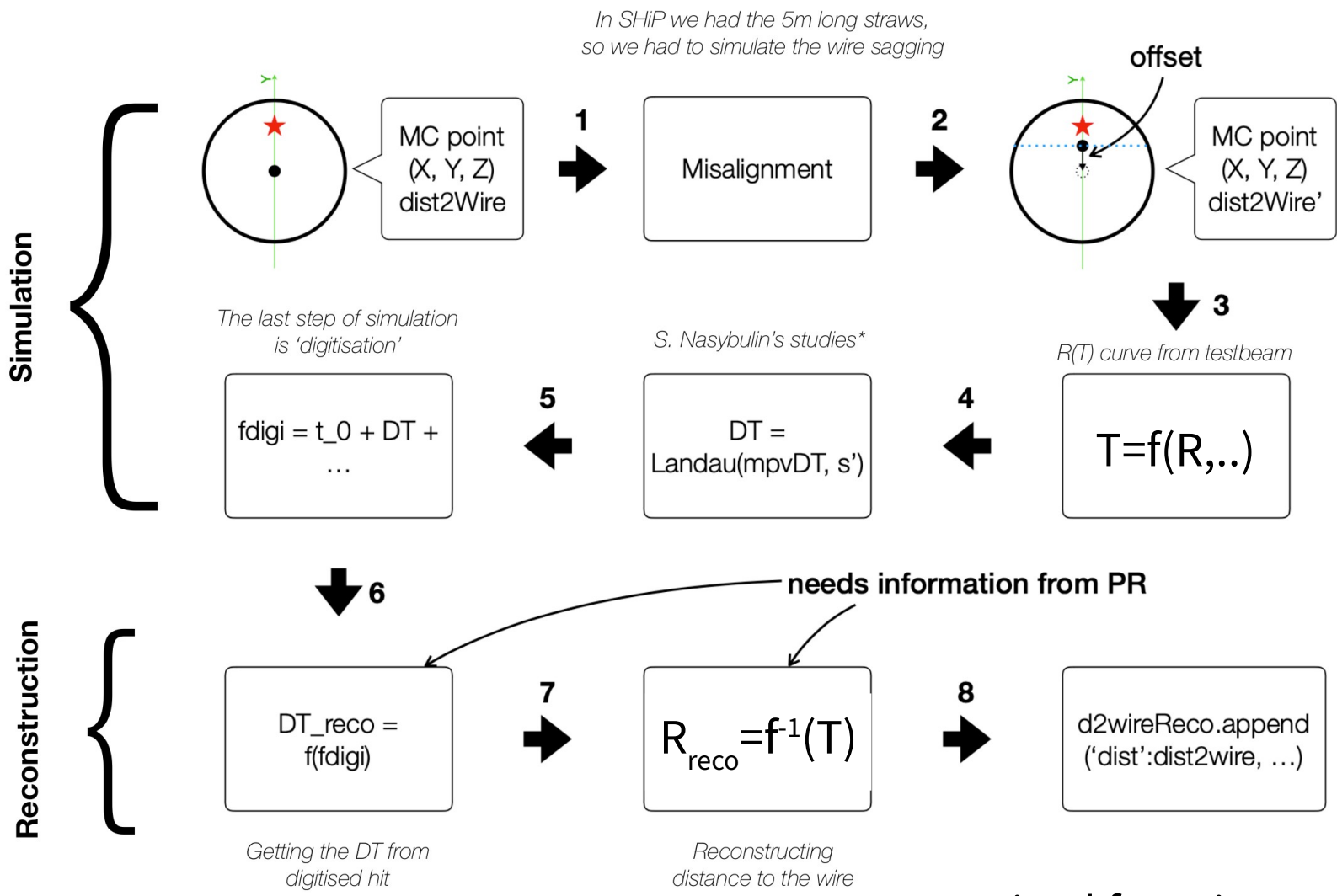
strawID only

Reconstruction part should be well separated and unique for MC and real data



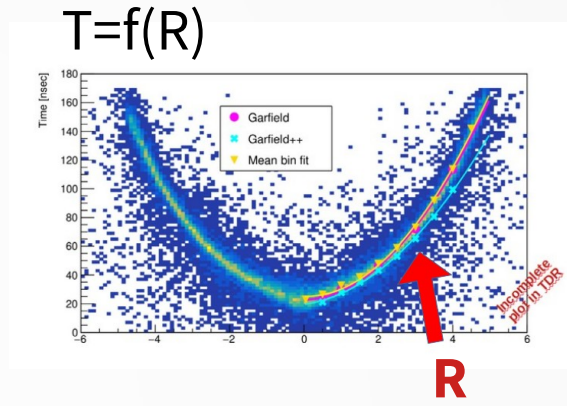
Example: DEV implementation in FairSHiP (A.Zelenov)

Vonelez/FairShip strawtubesDigi branch

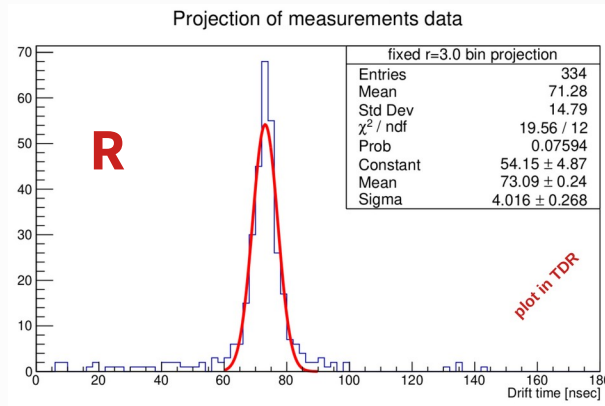


Input:

1) RT – calibration



2) width $DT=P(R, \text{par}(R, \mathbf{x}, \mathbf{y}, \alpha))$



Input: parametrized function or tabulated data from simulation and/or TB measurements

Summary

- realistic simulation is necessary for reliable prediction of the detector performance and, in turn, for predictions of the physics sensitivity
- realistic simulation is necessary for proper choice of detector parameters. In case of SPD straw tracker those are mainly for the geometry optimisation and readout electronics choice
- reliable predictions should be done before fixing the final design
...otherwise will be needed before an upgrade... :)
- technically the realistic signal emulation be relatively easy implemented in the general simulation/reconstruction software
- but it requires a lot of work to provide proper parameters (detector/electronics expertise, measurements with prototypes, external simulation studies like GARFIELD+LTSPICE)
- details on the ongoing work on GARFIELD/LTSPICE and TB measurements are in the talk tomorrow