

SHiP Software / FAIRSHIP Status



OUTLINE

- Framework
- Simulation
 - ◆ Geometry
 - ◆ Generators
- Reconstruction

■ Mailing list

- ◆ ship-software@cern.ch (SHiP Collaboration mailing list dedicated to software)
- ◆ Archive: <https://groups.cern.ch/group/ship-software/default.aspx>

■ Biweekly meetings, Thursday 11am

■ Web page

- ◆ <http://ship.web.cern.ch/ship/FairShip/default.html>
- ◆ Updated instructions for obtaining a SHiP account: http://ship.web.cern.ch/ship/FairShip/HowTo_SecondAccountCreation.pdf

Framework

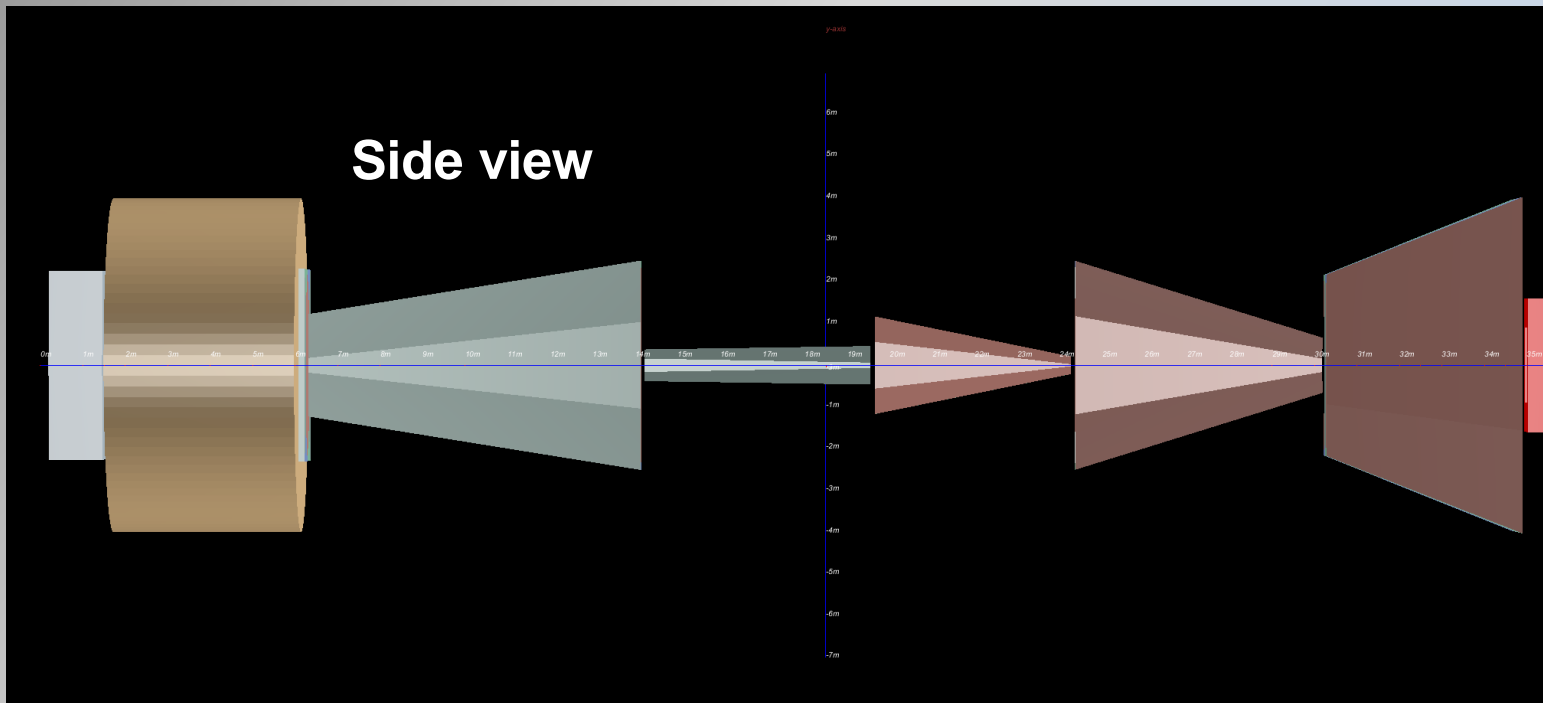
- FairSHiP is a lightweight simulation, reconstruction and analysis framework based on FairRoot (<https://fairroot.gsi.de/>)
- There are three pillars:
 - ◆ FairSoft: contains most of the external tools, root, boost, geant4, pythia6/8, Genie, ...
 - ◆ FairRoot, the framework: interaction with root, geant4, provides run manager, data persistency, ...
 - ◆ FairSHiP: geometry, generators, reconstruction (trackfit using genfit), analysis, ...
- Overall philosophy: Keep it simple.
 - ◆ Use Python as the glue between all the available tools and packages (FairSHiP specific).
- Latest major updates, August 2016
 - ◆ Move to gcc5.4.0 (except for lxplus, SLC6)
 - ◆ ROOT 6.06/08, XrootD 4.4.0

Software Distribution

- The three software packages, FairSoft, FairRoot and FairShip are available on <https://github.com/ShipSoft>
 - ◆ Download with `git clone` <https://github.com/ShipSoft/XXX.git>
 - ◆ Install with `configure.sh`
 - ◆ Basic instructions are available at above link
- Compiled software for usage on lxplus, gcc49/python2.7, also available on afs, </afs/cern.ch/ship/sw/ShipSoft/XXX>
- Soon, </cvmfs/ship.cern.ch>
 - ◆ Offers the possibility to provide versions for different operating systems
 - ◆ Will replace afs in future
- Also possible, via virtual machine container using Docker
 - ◆ <https://github.com/ShipSoft/FairShip/wiki/Linux:-Building-&-Running-FairShip-using-Virtual-Machine-container> (contact Andrey Ustyuzhanin)

Simulation / Geometry

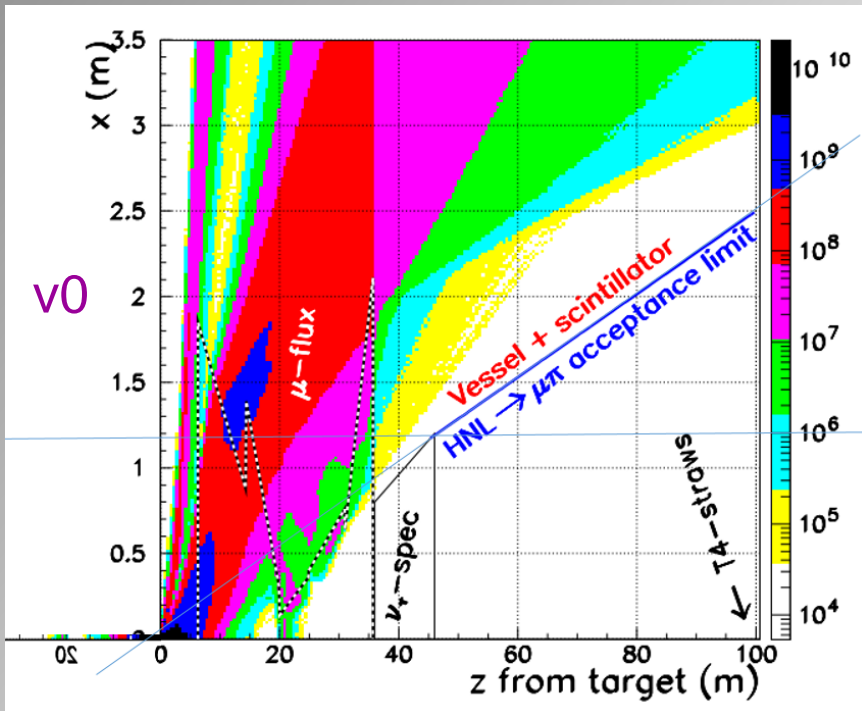
- Short Muon Shield, including magnetized hadron absorber
 - ◆ Implemented by Iaroslava, see <https://indico.cern.ch/event/474896/>



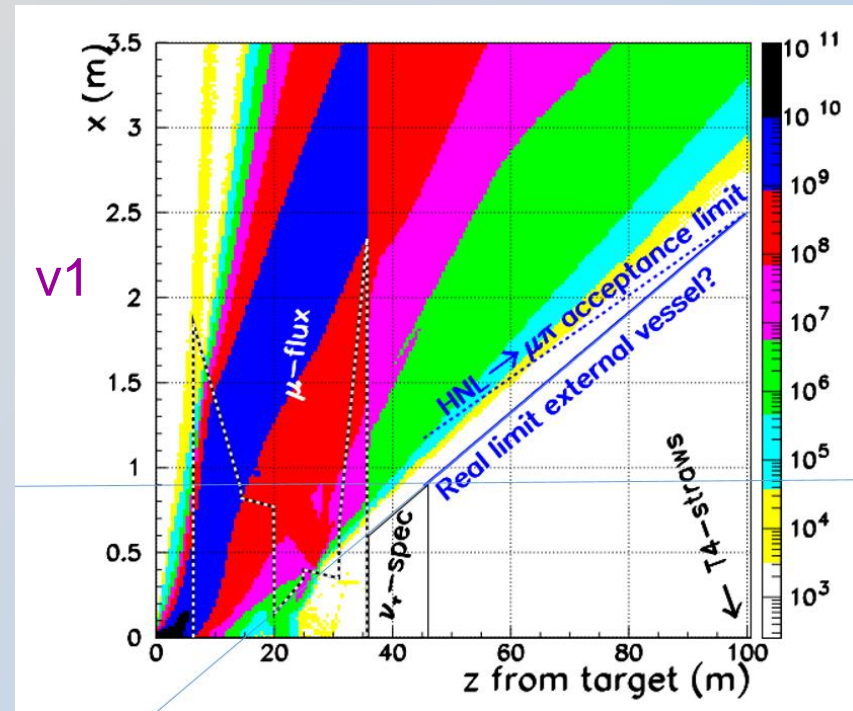
- ◆ End of muon shield now 35m after target, before 54m.
- ◆ Weight, now 1845t, before 2900t.

Simulation / Geometry II

- Muon free region (Hans, [8th SHiP collaboration meeting](#))



muons only from charm



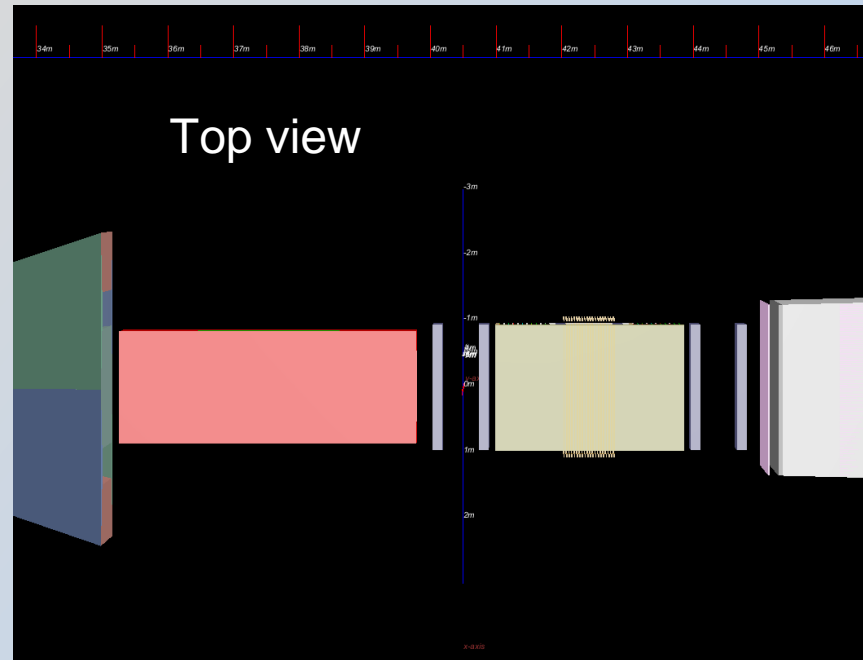
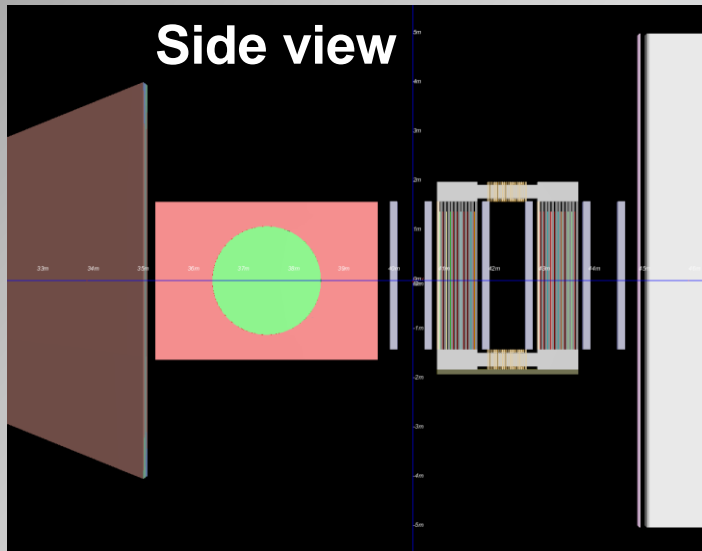
+ muons from non-charm: π/K decays, vector resonances: $\rho, \omega, \Phi, J/\psi, \Upsilon$

- For the moment, use envelope given by v0
- Waiting for next iteration including ν_τ detector constraints, (Oliver)
- Important decision to take: focus point upstream or downstream of target

Simulation / Geometry III

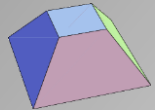
■ Tau Neutrino Detector

- ◆ Implemented by Annarita, see <https://indico.cern.ch/event/575686/contributions/2329628/>

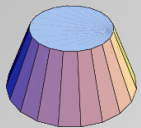


Simulation / Geometry IV

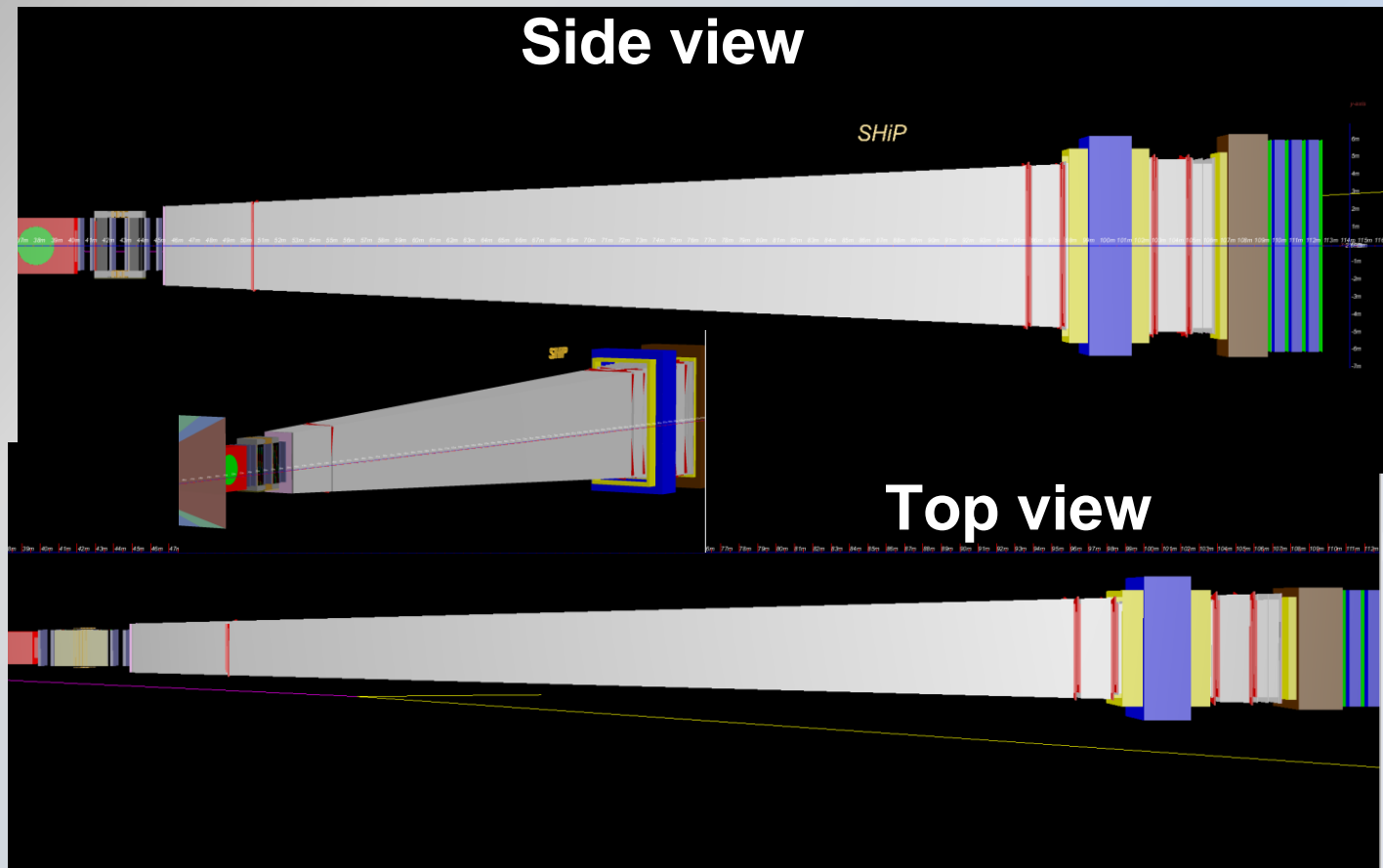
- HNL decay volume and spectrometer
 - ◆ see <https://indico.cern.ch/event/474900/>
 - ◆ ~~Conical up to straw tracking station 4~~



The truncated square pyramid is a special case of a pyramidal frustum for a square pyramid.

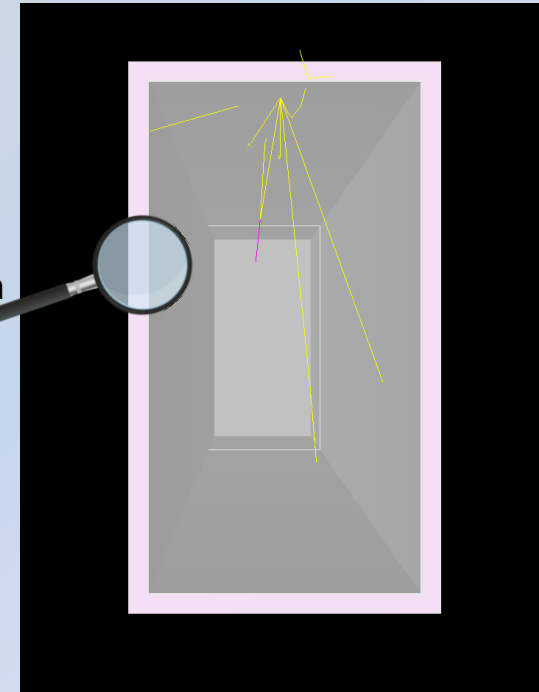
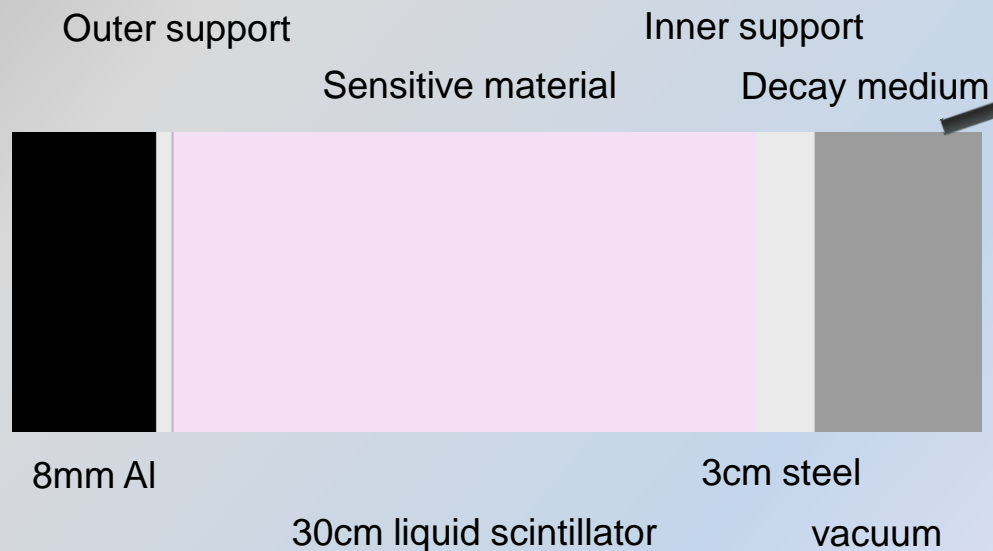


conical frustum



Simulation / Geometry IV

- Options: `run_simScript.py --tankDesign 5 --muShieldDesign 7 ...`
 - ◆ Focus points for pyramid design defined in `geometry_config.py`
 - ◆ $c.zFocusX = -5 \cdot u.m$ and $c.zFocusY = -5 \cdot u.m$, = 5m upstream of proton target
- Generic description of decay vessel
 - ◆ Thicknesses and material can easily be changed
 - ◆ He vessel, concrete tank, ...
 - ◆ (Medium of cavern now set to air, vacuum for TP)



Simulation / Generators



- Charm and beauty production in thick targets
 - ◆ Primary proton interaction with Pythia6, followed by Pythia6 simulations of secondary particles in the cascade. Pythia6 tuned to fit experimental data. [CERN-SHiP-NOTE-2015-009](https://indico.cern.ch/event/474890/)
 - ◆ makeCascade.py, msel = 4(charm), 5(beauty).
 - ▶ Option to keep all particles produced with charm for “charm cross section” studies with emulsion, <https://indico.cern.ch/event/474890/>
- HNLPythia8Generator:
 - ◆ Standard simulator for HNL decays, template for other exotic particles
 - ◆ Mass and couplings are free parameters, one default setting with $M = 1\text{GeV}/c^2$
 - ◆ Branching ratios are calculated, decay channels can be chosen
 - ◆ HNL produced in charm and beauty decays
 - ▶ /eos/ship/data/Charm/Cascade-parp16-MSTP82-1-MSEL4-76Mpot_1.root
 - ▶ /eos/ship/data/Beauty/Cascade1M-Beauty.root
- Dark Photons, under construction, Anne-Marie Magnan
 - ◆ see <https://indico.cern.ch/event/569715>
- Low energy SUSY, under construction, Konstantinos Petridis
 - ◆ see <https://indico.cern.ch/event/569715>

Simulation / Generators II



■ Muon and neutrino background:

- ◆ Non-charm: primary proton interaction with Pythia8, followed by Geant4 simulation of target and hadron absorber (CPU intensive, done by Yandex).
- ◆ Charm: semileptonic decays of prefabricated charm hadrons
- ◆ Merging of both productions: /eos/ship/data/Mbias/pythia8_Geant4-withCharm_onlyMuons_4magTarget.root, with weights corresponding to 5×10^{13} pot.

■ Neutrino interactions: GENIE, NuageGenerator

- ◆ Input to GENIE, neutrino momentum from above, /eos/ship/data/Mbias/pythia8_Geant4-withCharm_onlyNeutrinos_4magTarget.root
 - ▶ Latest production has energy threshold at 10 GeV. Older productions exist with lower thresholds, but with other issues, see also [NuMuProdFlow](#)
- ◆ Prefabricated neutrino scattering events with different materials are used as input for the neutrino background simulation in SHiP, GenieGenerator

■ CosmicsGenerator, Martin Franke (Berlin)

Reconstruction

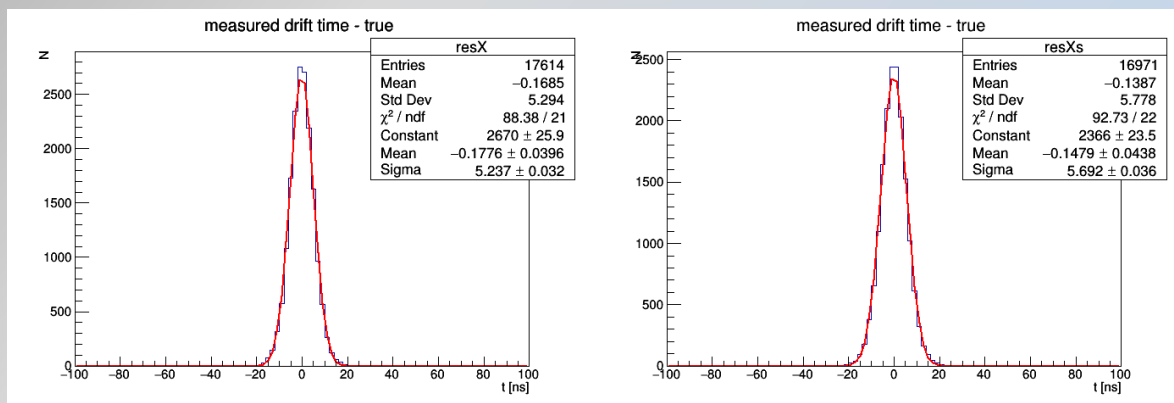
- For particle ID, see talk by Behzad Hosseini
- For new pattern recognition algorithm, see talk by Mikhail Hushchyn

- VETO: combining info of SBT, UVT, SVT and RPC
 - ◆ shipVeto task needs update to latest geometry changes (Plamenna Venkova, Berlin)
- Proper vertex reconstruction with covariance matrix (Ievgen Korol, Berlin)
- Open areas: photon reconstruction, π^0 reconstruction with mass constraint, ...

Reconstruction

Other developments:

- ◆ T0 for the strawtracker, see <https://indico.cern.ch/event/474895/>
- ◆ New class for digitized hits, ShipHit. First use case: strawtubesHit with digi value = TDC
- ◆ TDC = t_0 (random number: 0 - 1000 ns)
+ ToF
+ drift time (distance to wire * 30ns/mm) with Gaussian smearing of 120 μ m
+ signal propagation (5m - X position of hit) / c
- ◆ From digitized information back to t_0
 - ▶ Using TDC of all hits or t_0 for each track. Correct for ToF, signal propagation along wire:



- ▶ Straw resolution including t_0 error = 170 μ m compared to 120 μ m intrinsic resolution.
- ▶ Room for improvement, add t_0 to trackfit as free parameter (NOMAD: <https://cds.cern.ch/record/412374/files/9912034.pdf>), use t_0 from external source, timing detector.

Weak Points

- Documentation, update of tutorials. Help appreciated!
- Also, bookkeeping of data sets. How to organize it? Support welcome!
- EOS storage (10TB)

```
# ==> Quota Node: /eos/ship/
#
# .....
group      used bytes logi bytes used files aval bytes aval logib aval files filled[%] vol-status ino-status
z5         7.35 TB   3.68 TB   46.90 k- 20.00 TB   10.00 TB  100.00 k- 36.77      ok         ok
```

2 replicas

- ◆ Starts to become a bit chaotic

```
[truf@lxplus124 ~]$ ls eos/ship/
data muonTestBeam skygrid sw TestBeam user
[truf@lxplus124 ~]$ ls eos/ship/data
AcceptanceStudies      cosmicBackground  na61              nuDataTP-DOCA-Repro
antinuAdditionalProduction  DAFreco          na61 MuonBack-Thomas_orig_ToFF  nuDataTP_raw
antinuDataReprocessingAugust2015  Elena            neutrinoBackground  Oliver
antinuDataTP            GenieEvents      ntuplesUsedAddendum  Pythia8
antinuDataTP-DOCA-Repro  Iaro             nu-antinu-ntuples    Richard
Archive                 lxbatch          nuData-2015-06-08    signal
Beauty                  Mbias            nuDataAdditionalProduction  trackingstudies
BigProductionAugust2015  muonBackground  nuDataReprocessingAugust2015
Charm                   muonDIS          nuDataTP
```

- ◆ Propose to populate user data below eos/ship/user/xxx, testbeam data below eos/ship/TestBeam/xxx.
- ◆ Please add README files for a minimum of documentation

Next Steps

- CVMFS: new place for ShipSoft code and libraries (SLC6, ...)
- Integrate changes from detector optimization exercise
- Improve reconstruction, adding new algorithms, creation and use of digitized data