Muon flux measurement status

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26 july 2018

SHiP

Target (14 λ)

Active Muon Shield

Muon Filter

Magnet

~115m

Vacuum Vessel

10^{-3}bar vacuum:
remove $\sim 2 \times 10^4 \nu$ ints

Electromagnetic Calorimeter

Spectrometer Timing Detector

Spectrometer Magnet

B=0.65 Tm

Hadron absorber

Neutrino Emulsion Target and Target Tracker

$N_{2,3}$

5m

10m

e, π, γ

μ^-

π^+

Surround Background Tagger (SBT)

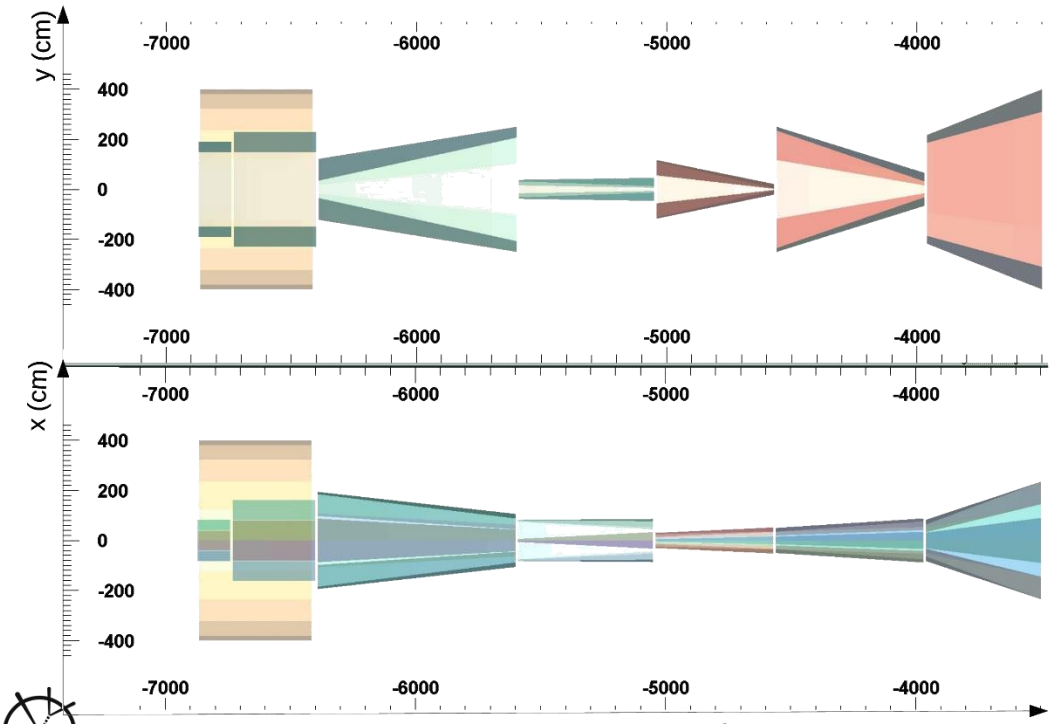
Spectrometer Straw Tracker

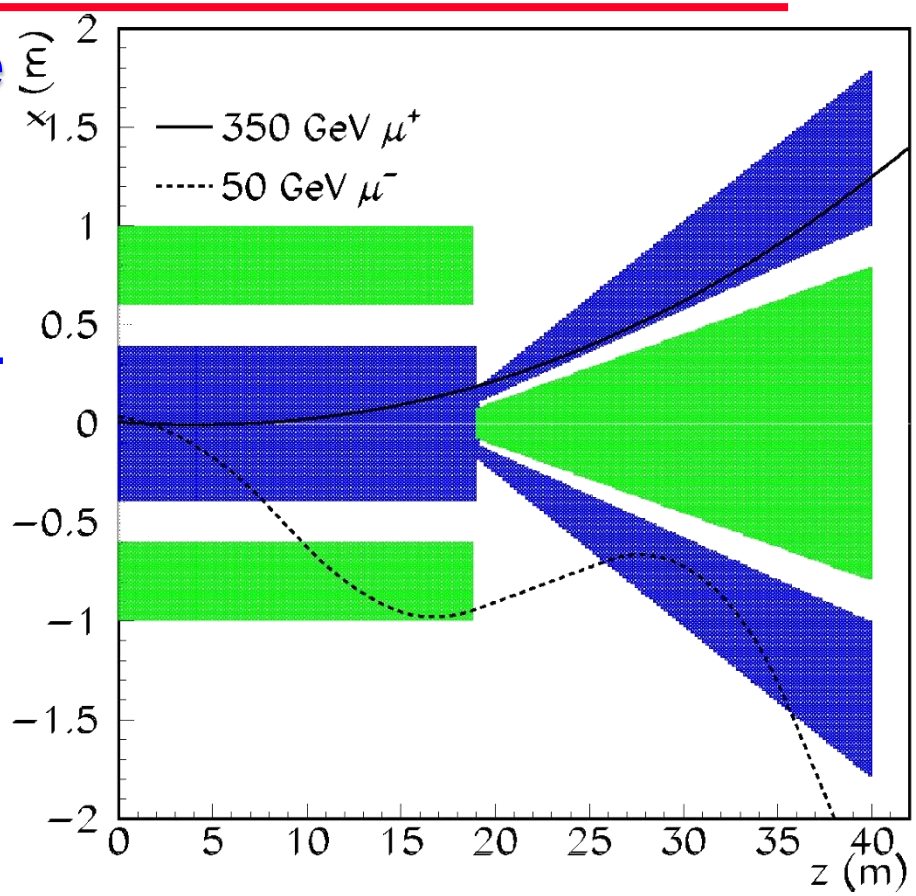
Muon Detector

Straw trackers: measure p for decay vtx reco
NA62 straw tubes, 2cm diameter, 5m long horizontal straws
$\sigma_x = 120\mu m, \frac{\sigma_p}{p} \sim 0.5\%$
EM calo: e, π^0, γ
Upstream Veto: μ, ν, K, Λ

Active Muon shield optimization

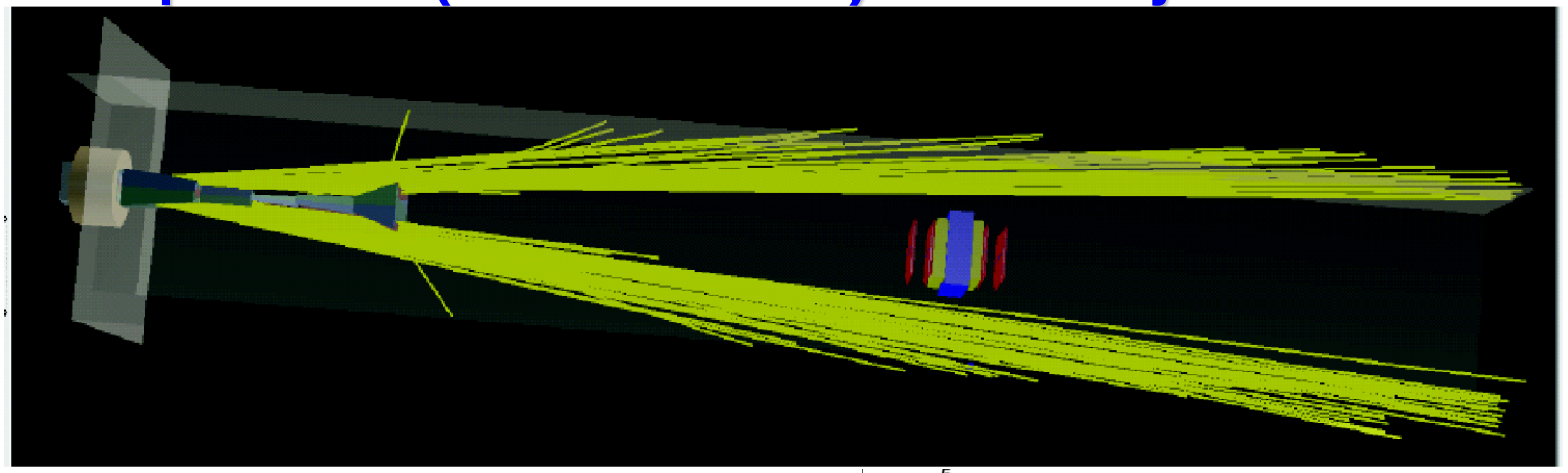
- Per spill: 10^{10} $\mu^{+/-}$ in acceptance
- Large phase space of μ's
- Active μ shield (1.8 T in Fe)
- Details 2017_JINST_12_P05011



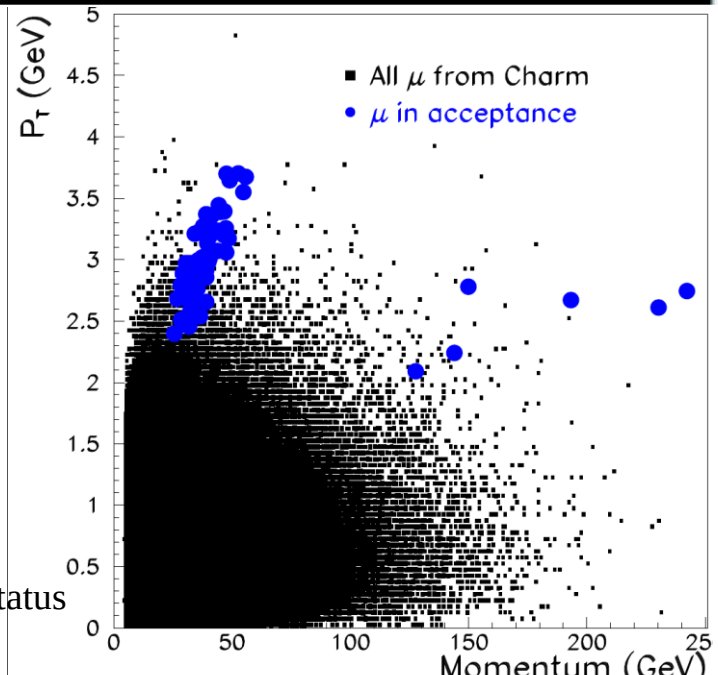


Muon shield performance

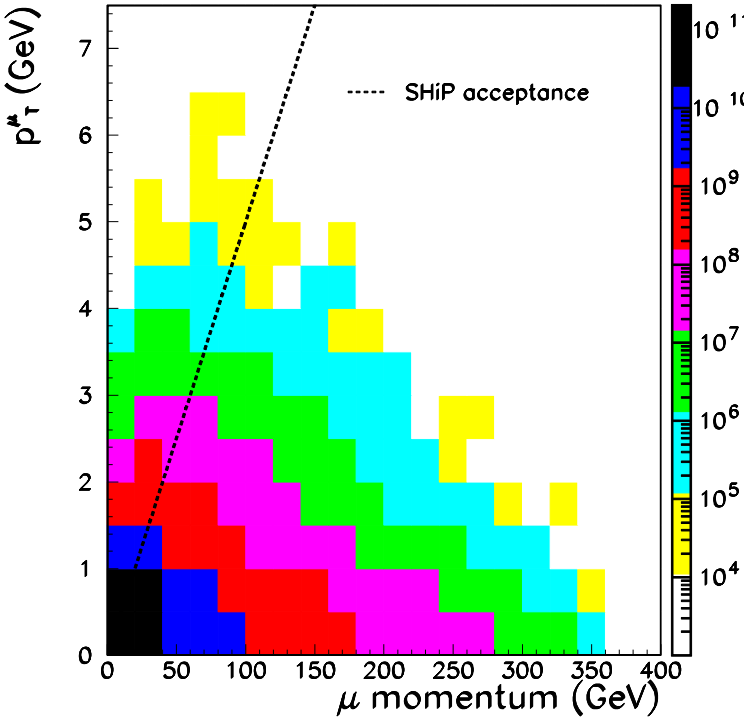
- **$3x10^5$ μ/s in T4 (reduction 10^4) Muon trajectories:**



- **However, depending on the magnet configuration, some muons can still get through**



Muon flux measurement



Expected μ phase space for 1 spill (4x10^{13} pot)

4x10^{13} POT/spill; 2x10^{20} POT during 5 years running

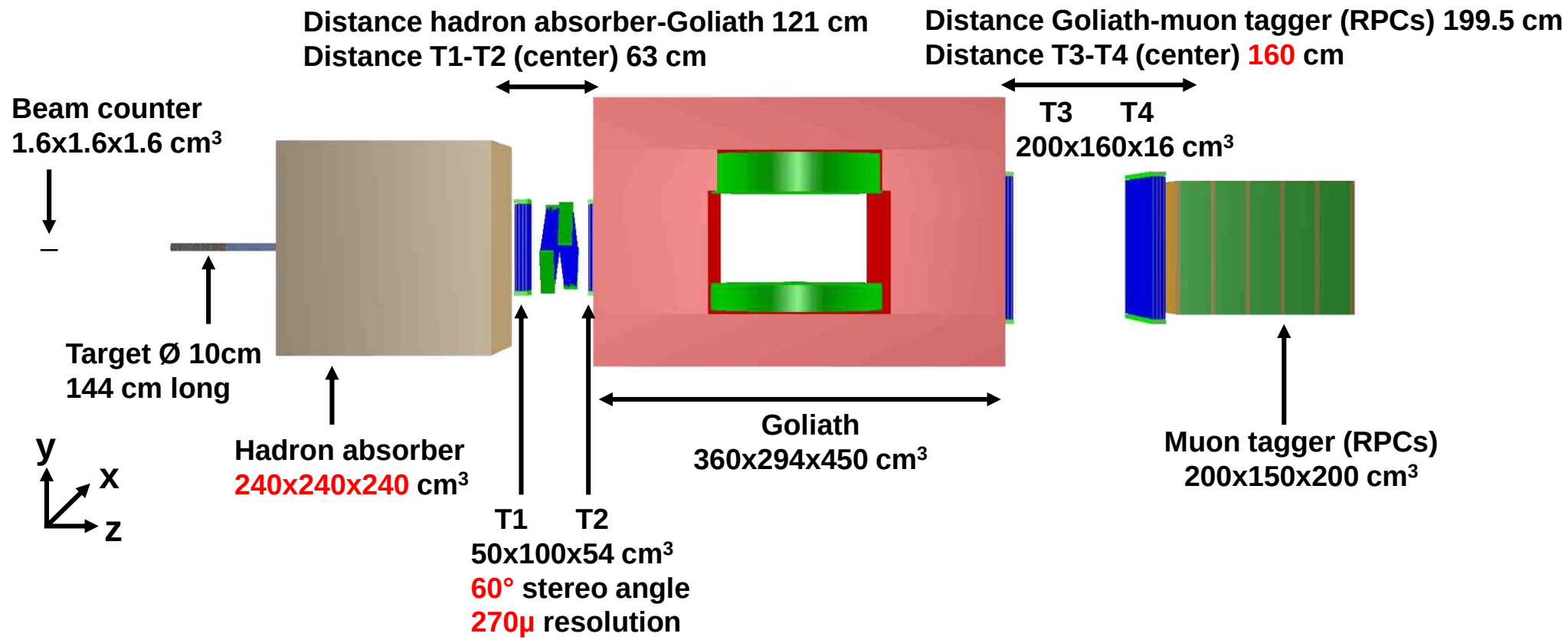
~2.6x10^{10} μ's/spill in SHiP acceptance
~4x10^{8} with p>100 GeV

In 10^{10} simulated pp ints: 166 muons with p>100 GeV, p_T>3 GeV, too small!

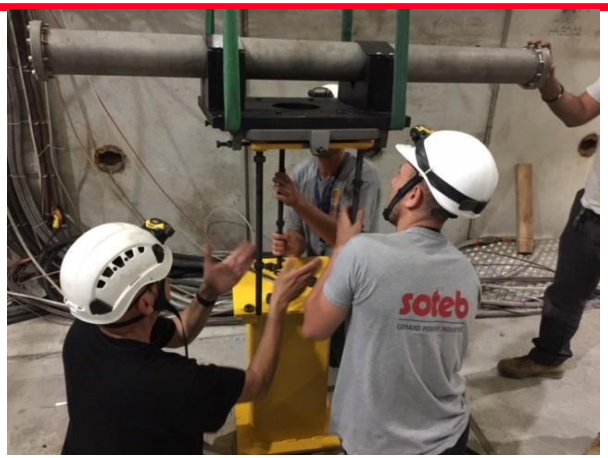
Measure the (p, p_T) spectrum to make sure the design of the muon shield is good

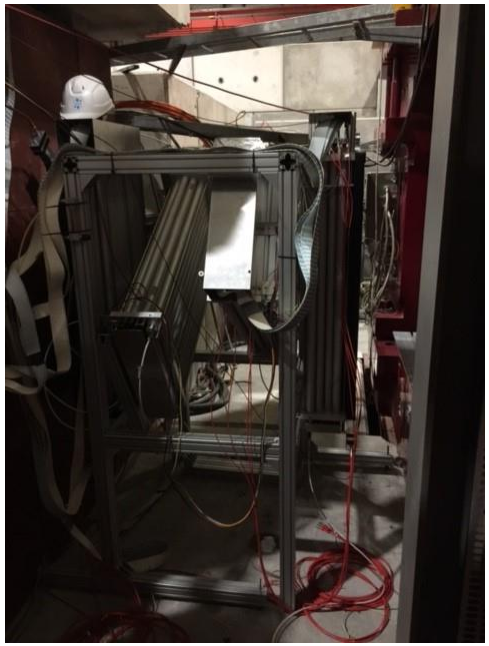
SPSC-EOI-016: accumulate ~10^{11} pot using charm cross section inspired spectrometer

Spectrometer for muon flux measurement

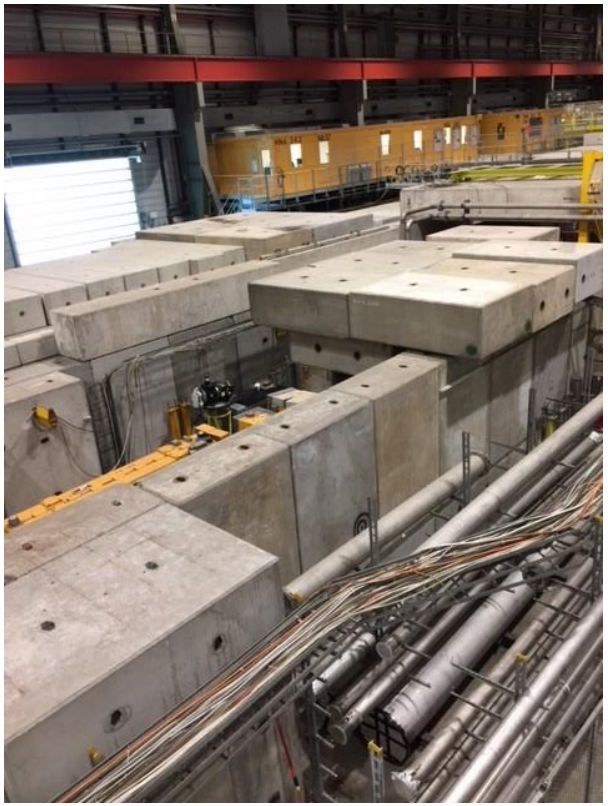


Installation wed-thu 4-5 july

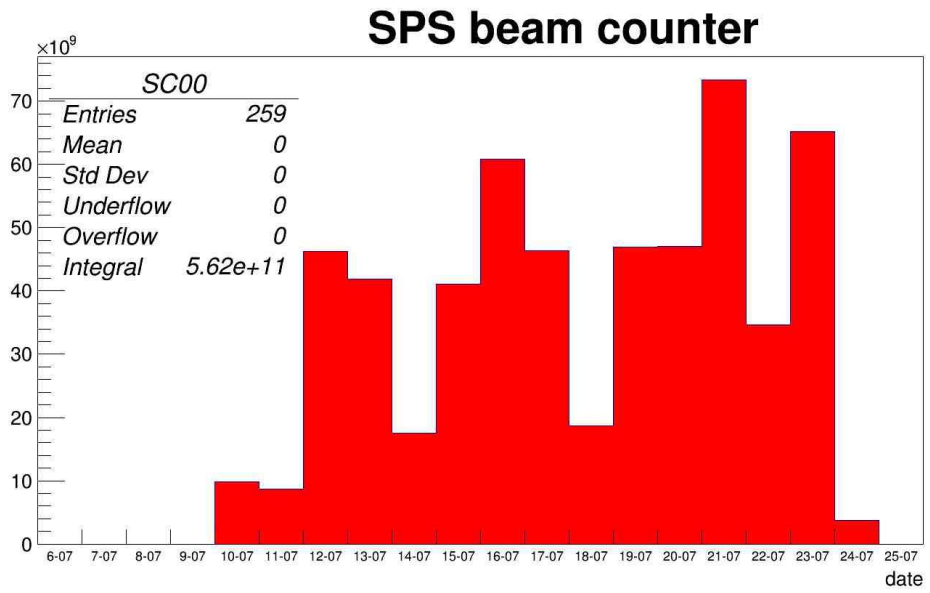


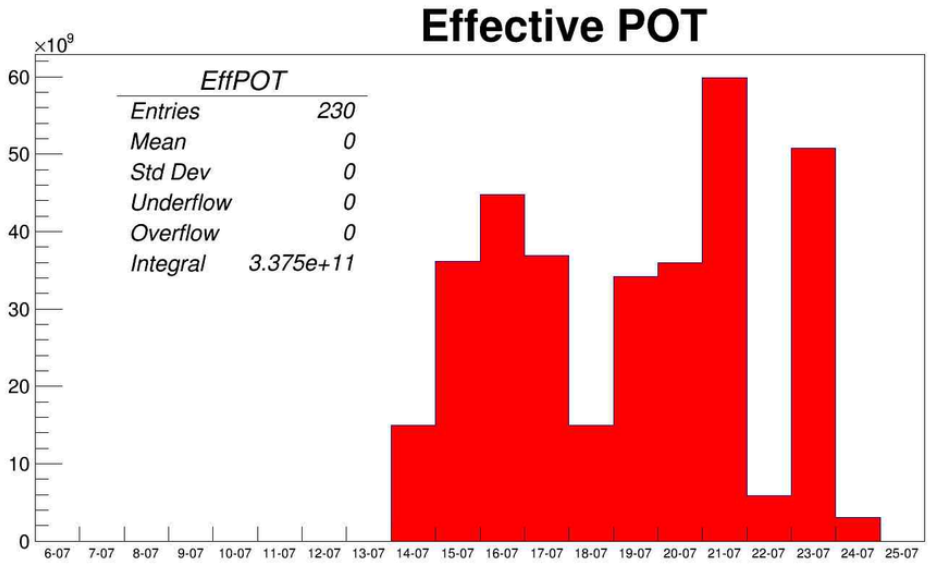


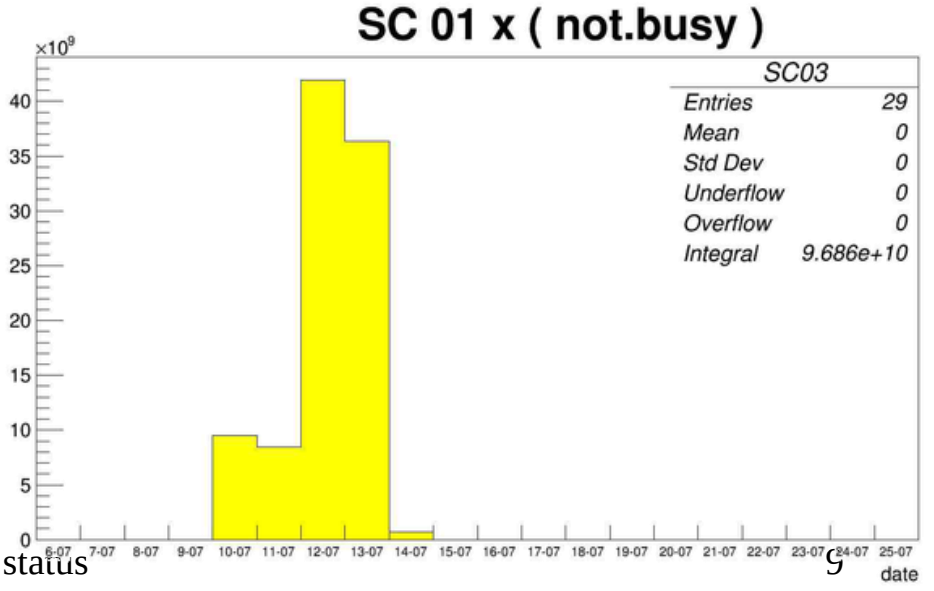
Installation fri 6 july



Amount of data taken in 3 weeks

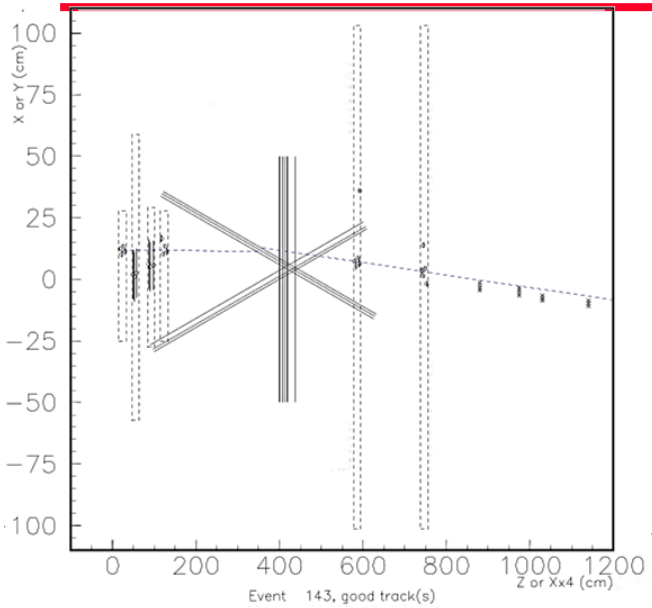


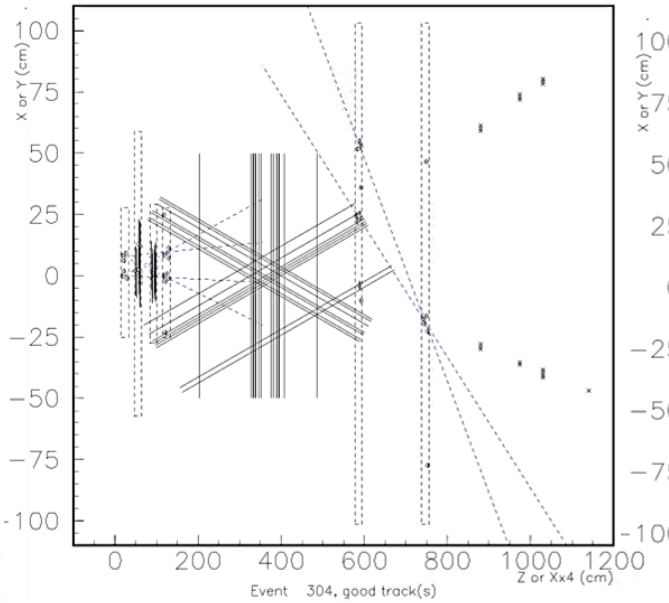


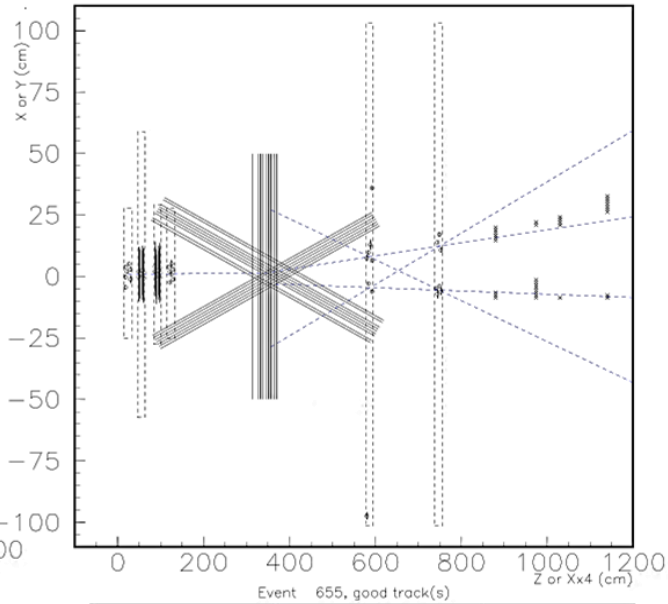


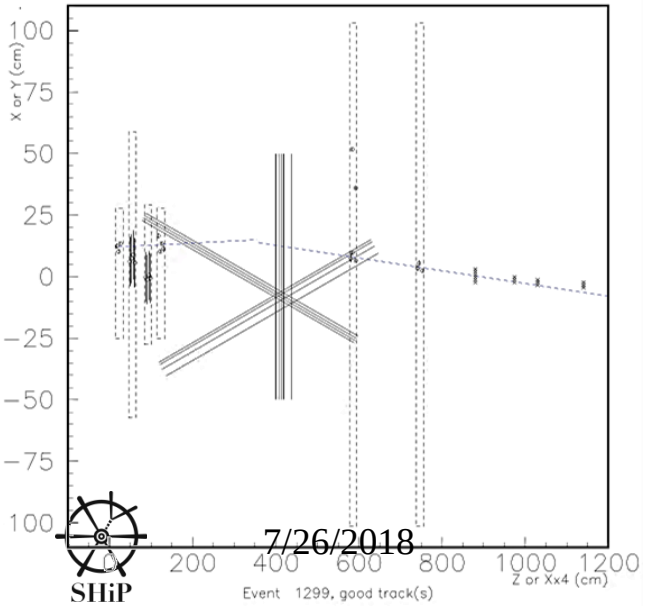
- **~4.2e11 recorded POT**

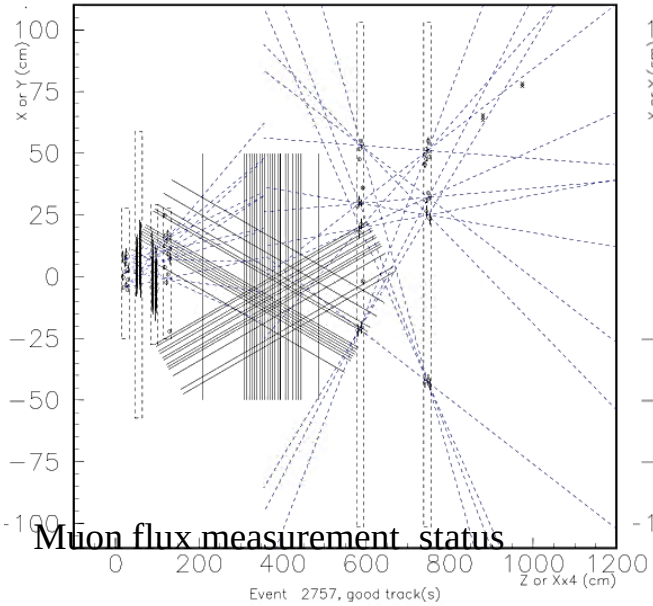
Event display

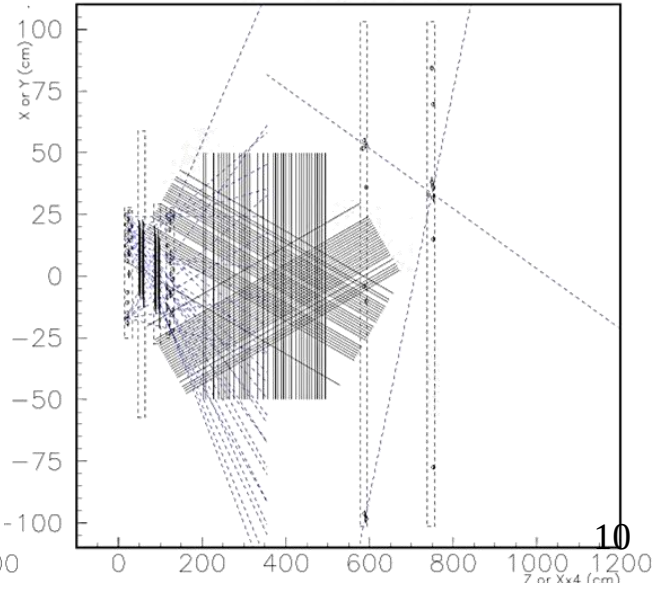




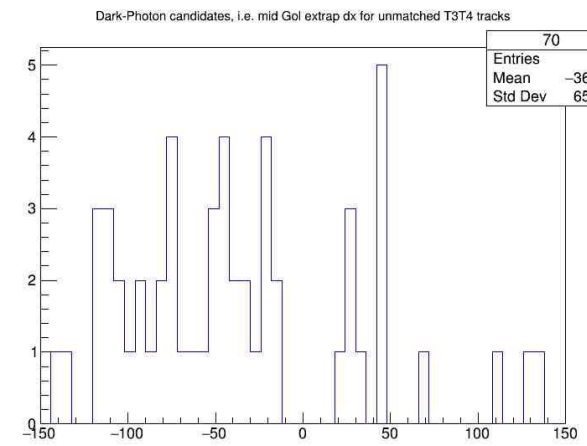


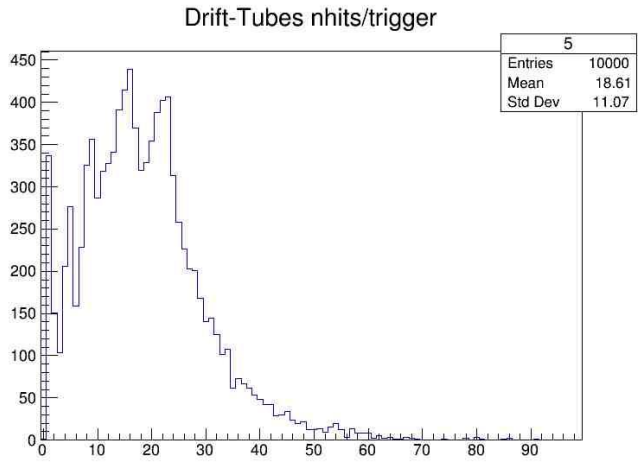


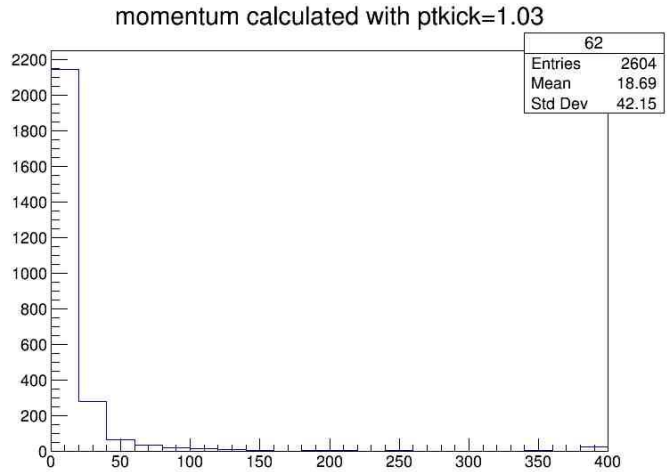


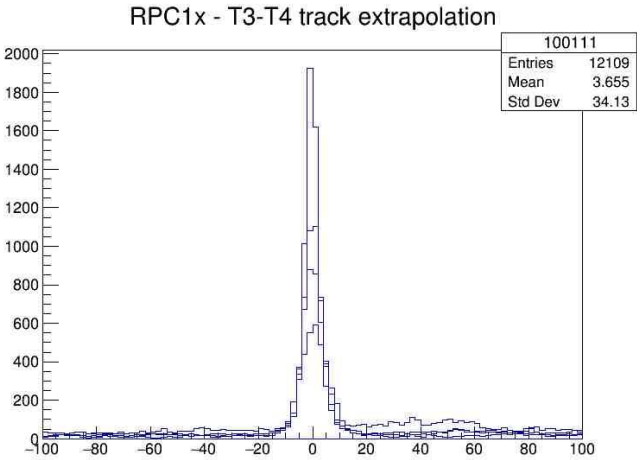


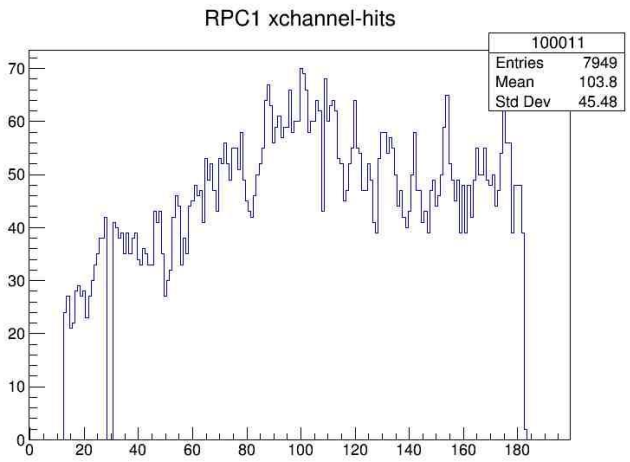
Monitoring histograms

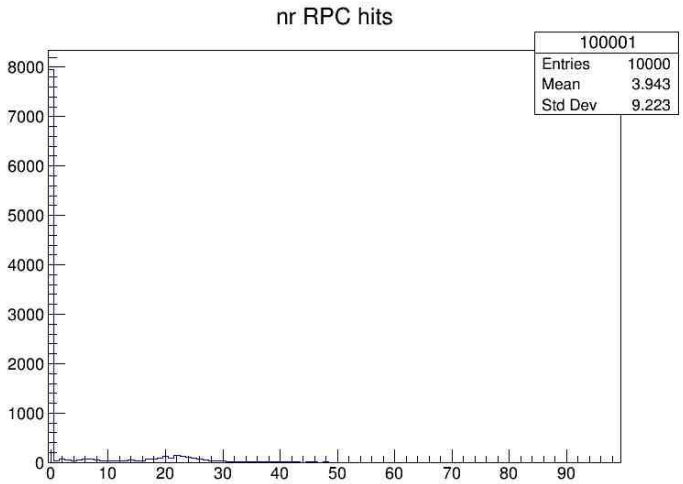




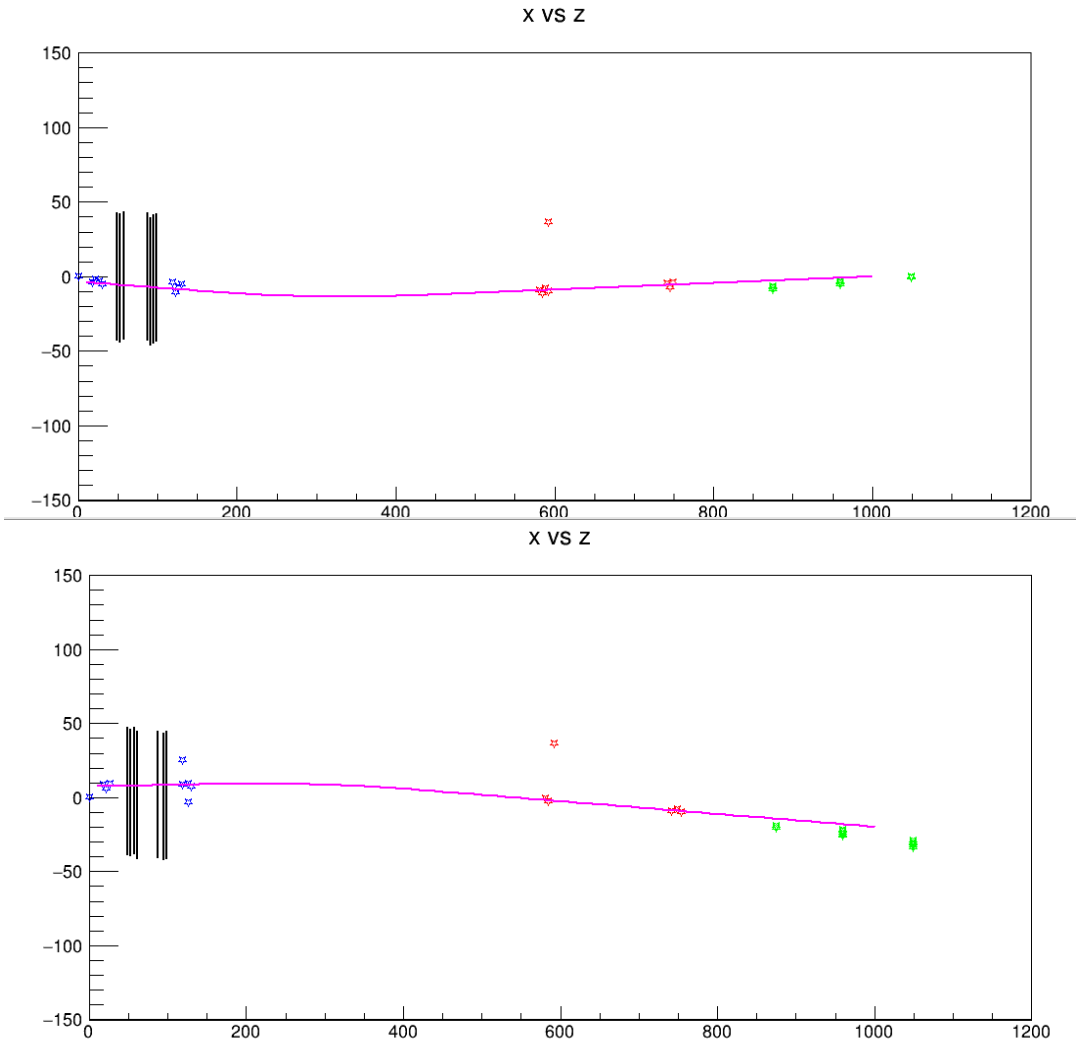






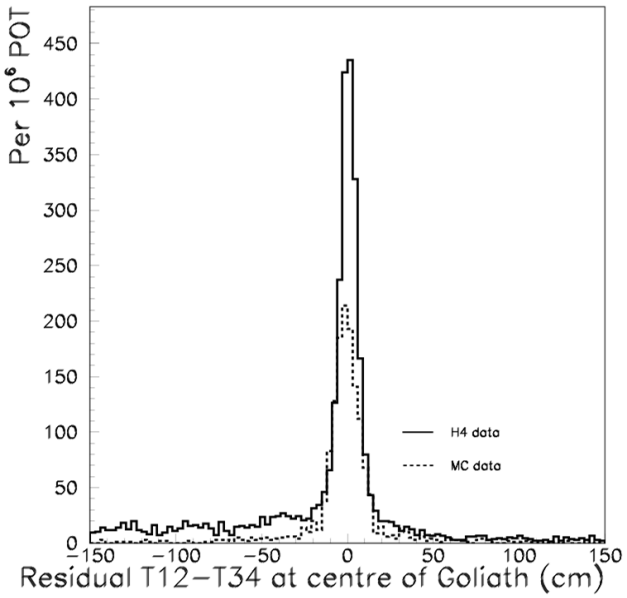


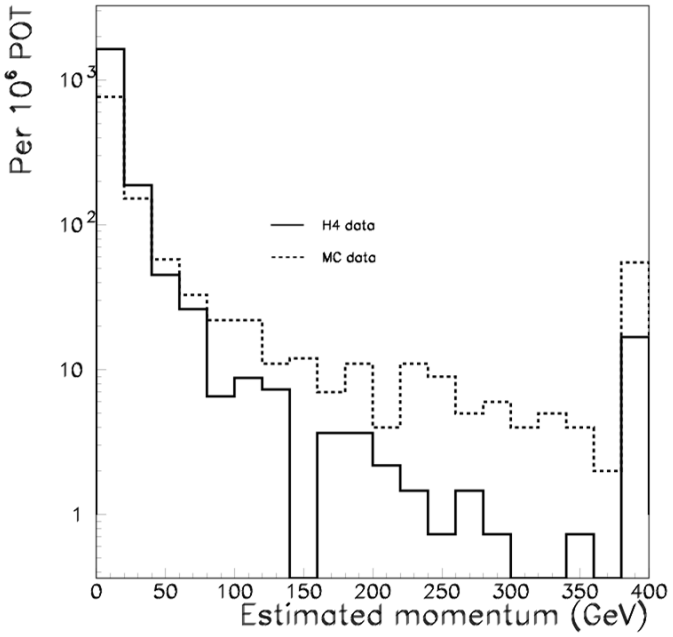
Reconstruction (fitted tracks)



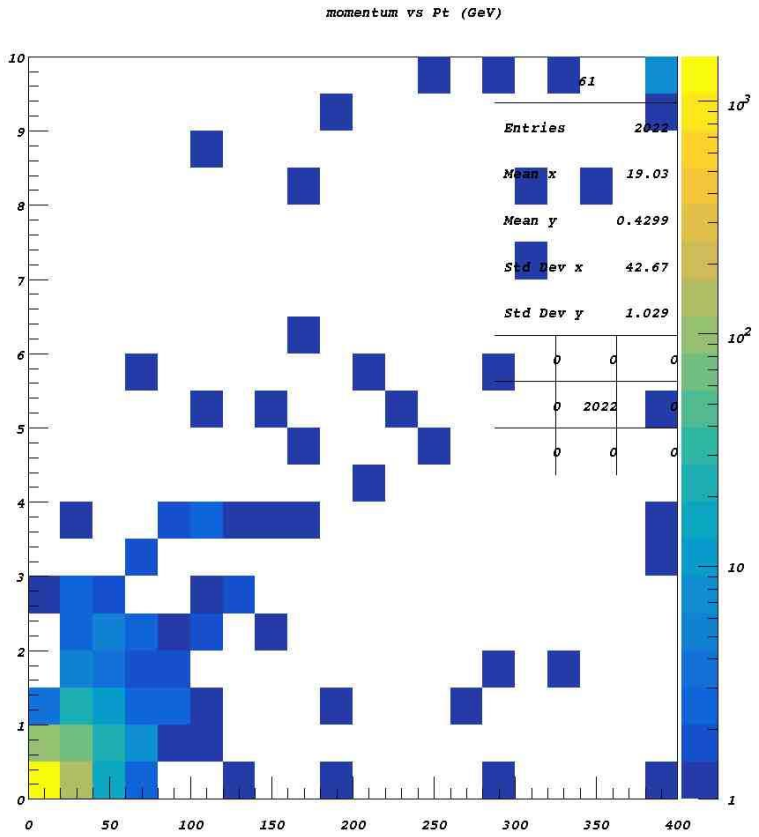
Preliminary comparison with MC

- **MC: 0.338 % hit in T1/POT; data: 0.73% trigger/POT**
- **More than factor 2 higher trigger rate**
- **Factor 1.6 more muons/pot. However:**
  - **MC no noisy/dead channels, hence finds all tracks**
  - **MC perfectly aligned, hence momentum distribution different due to this, especially different for larger p=smaller angular difference before/after Goliath**

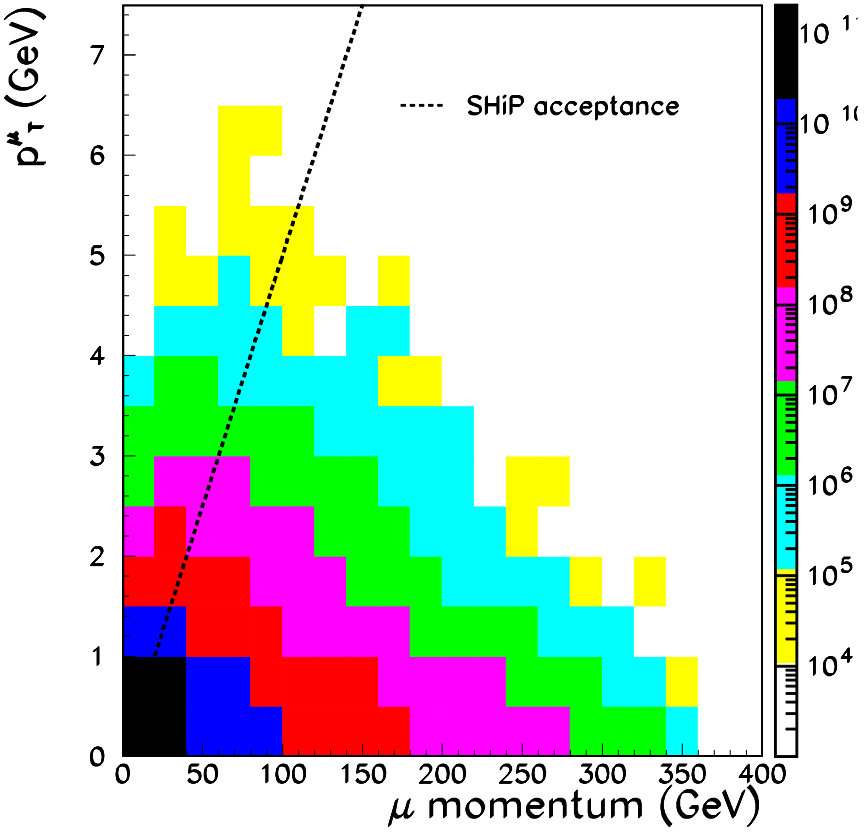




p/pT



1 spill, 1.6 10^7 POT

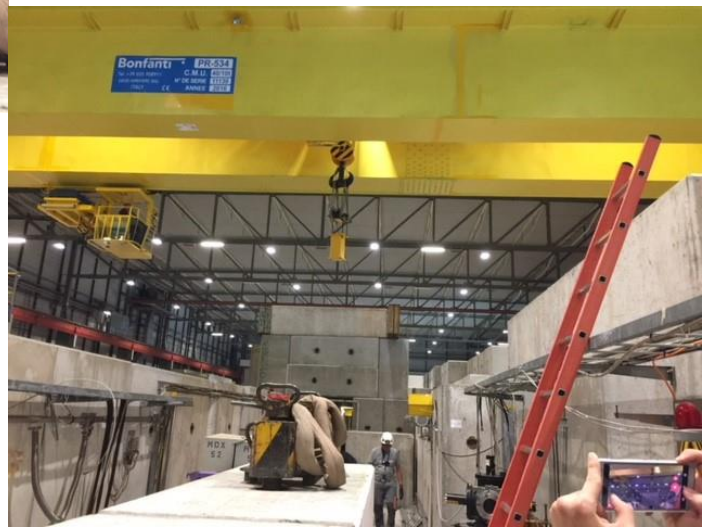


EOI, 1 SHiP spill, 4 10^{13} POT
Based on 10^{10} MC POT

Conclusions

- **43 shifters/experts**
- **3 weeks to understand the detector, the trigger and the data.**
- **Muon flux measurement over. We have accumulated ~4x10^{11} POT**
- **Continue with the charm cross section measurement**
- **A big THANK YOU to:**
  - **Our fabulous colleagues from RP and EN for their advice, help and enthusiasm**
  - **all shifters and experts for their enthusiasm and help to make this measurement a success!**

Good bye! (see you in 2022…)



Backup

Stable running conditions

- **Beam, new optics: focus on beam counter**
  - 1 sigma in spot: 2mm
  - SPS beam scintillator: 20ns stretching
  - Our beam counter: 30ns
  - 10 ns time difference: expect to loose (depending on rate) ~ 7%
  - Optimal conditions: $1.8*10^{7}$ /spill(SPS); master trigger (raw): 130k/spill
- **Trigger:**
  - Drifttube PMT close to Goliath (-1.5T) dies in mag field. Came back by lowering the discriminator threshold.
  - (2/4 T1&T2 coincidences).and.(beam counter)
- **Drifttubes:**
  - Some dead channels
- **RPCs:**
  - Station 4 dead (since Sunday 15). Came back by changing the HV power supply.