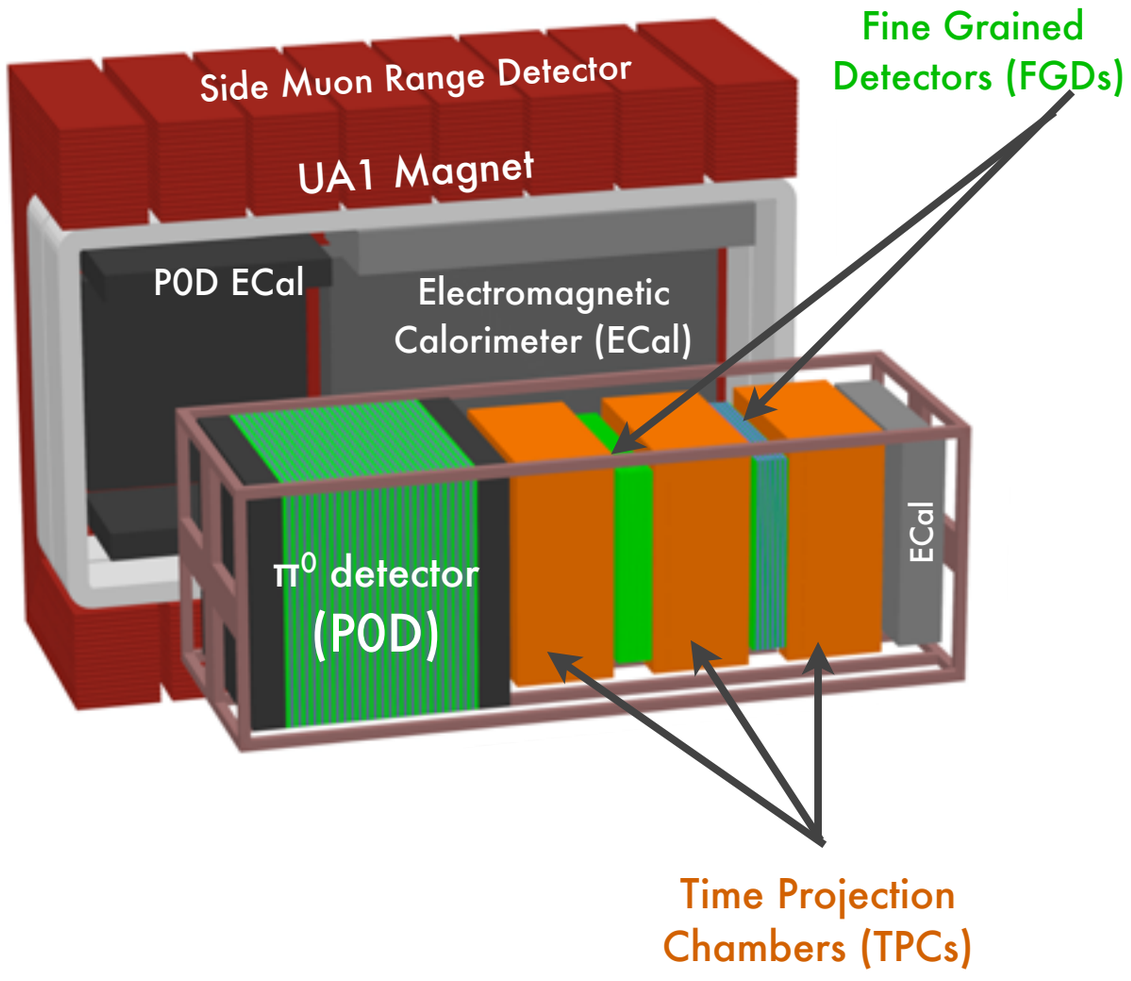
Lessons from ND280 and Future UK Plans

Asher Kaboth

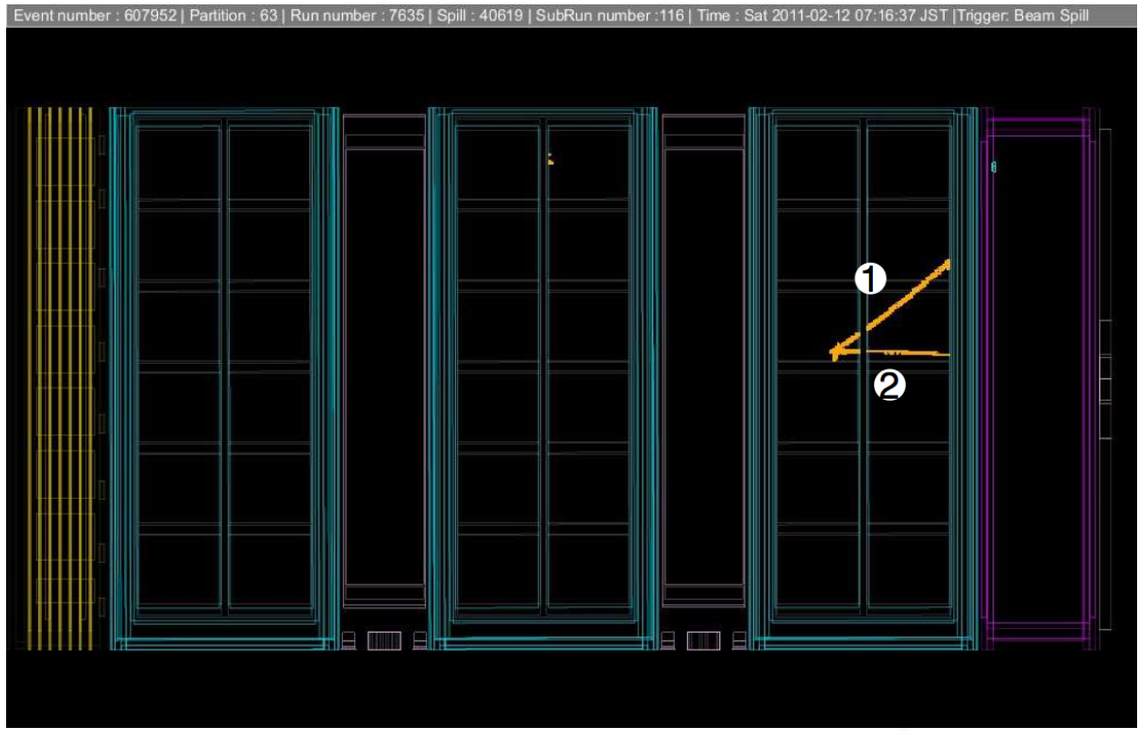
16 July 2015

Imperial College London

ND280



Ant Hillairet was on shift and happened to see this event on the display



ND280 has three TPCs, surrounded by solid detectors

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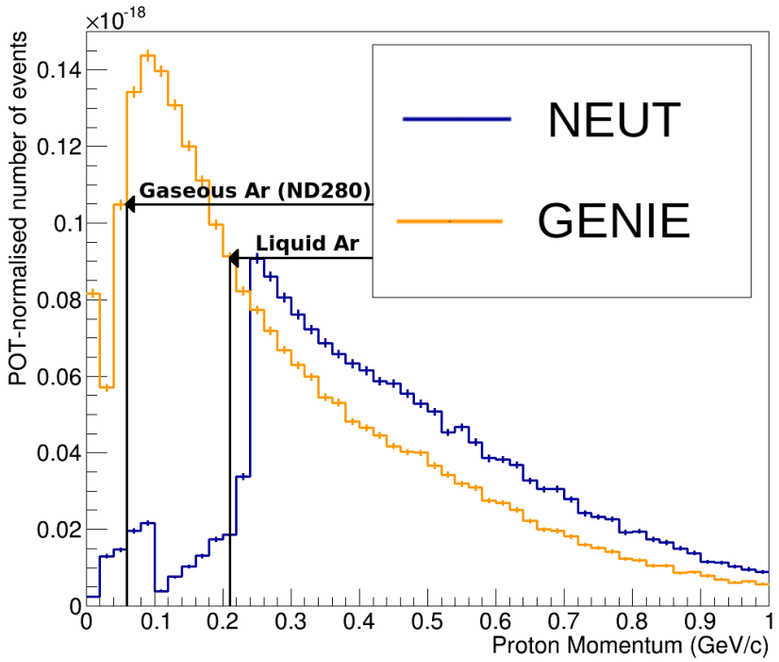
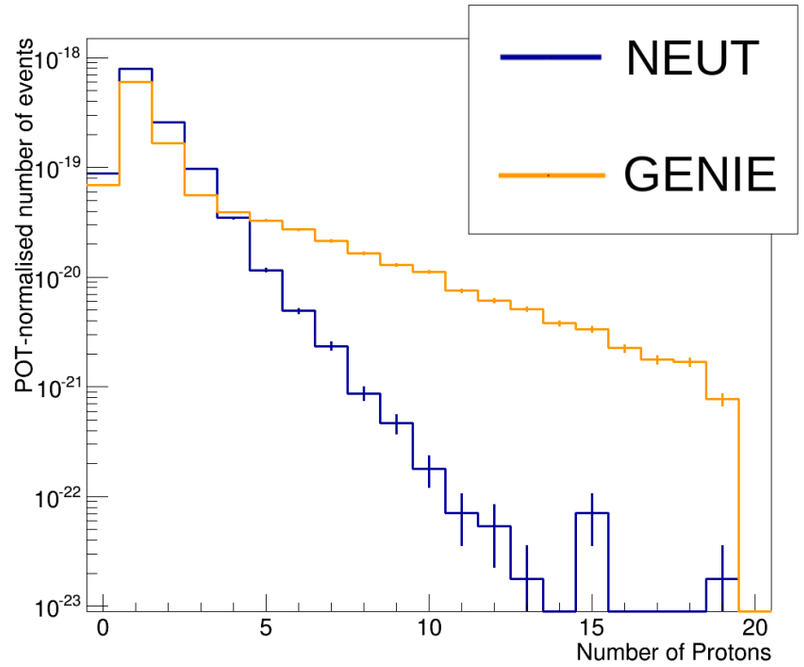
ND280 Gas Analysis



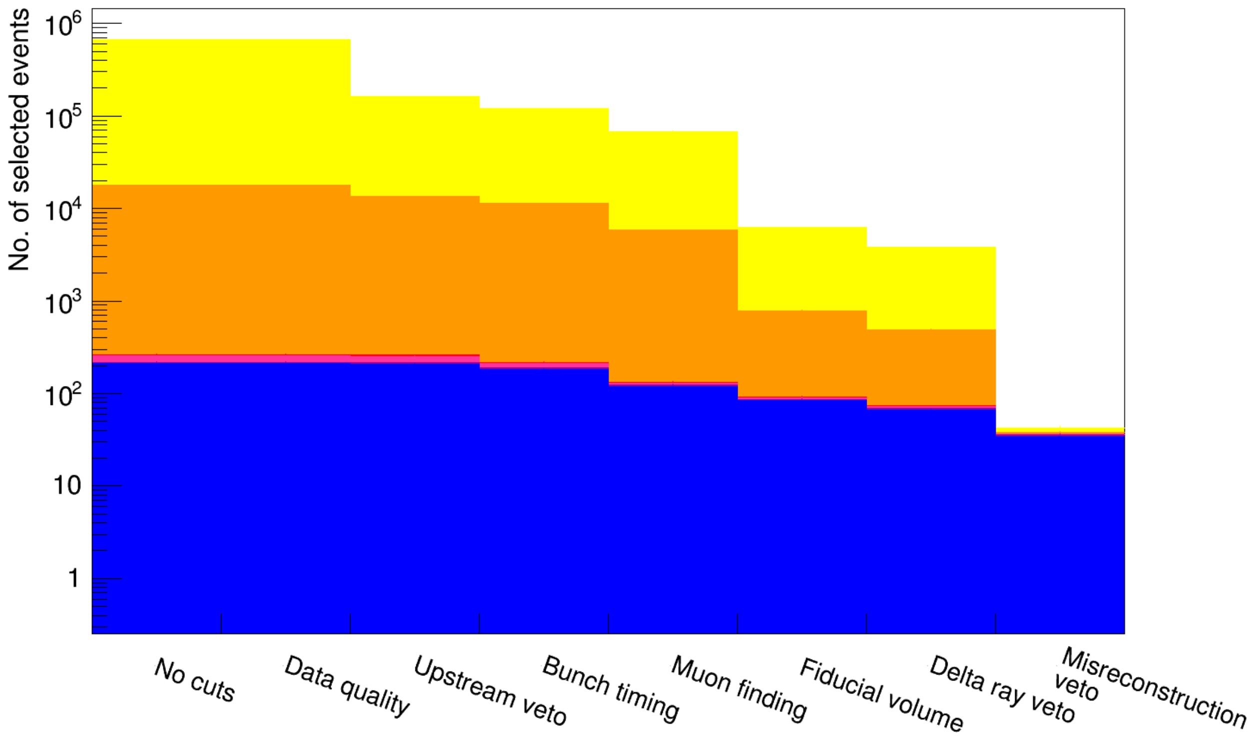


- Further motivated by discrepancies we saw between generators
- The ArgoNUTs group was formed to investigate a gas analysis
- Pip Hamilton successfully passed his viva yesterday with this analysis! Congratulations, Pip! (Plots in the first half of this talk are blatantly stolen from his thesis.)

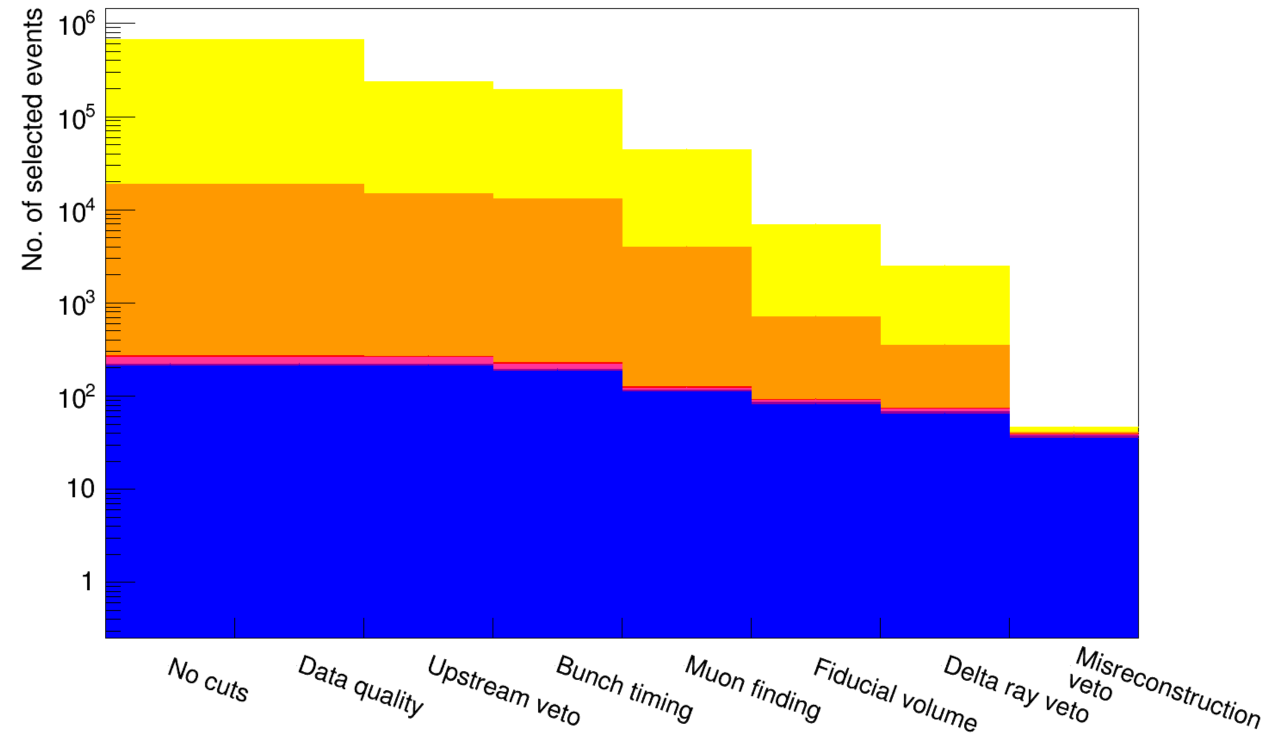
New Tools Developed

- Dedicated tracking for TPC vertex events (TPC Reconstruction Extension, or TREx)
  - Isotropic hit clustering
  - A new method of pathfinding, using the A* algorithm to trace path between points of interest.
    - Careful handling of secondary interaction products, e.g. delta rays from muon tracks.
    - A new output structure of connected paths.
- Preselection to take a hayfield to a haystack (Saves processing time for TREx)
- Selection to find the needle in the haystack

Selection



No. of selected events
10^6
10^5
10^4
10^3
10^2
10
1
No cuts
Data quality
Upstream veto
Bunch timing
Muon finding
Fiducial volume
Delta ray veto
Misreconstruction veto



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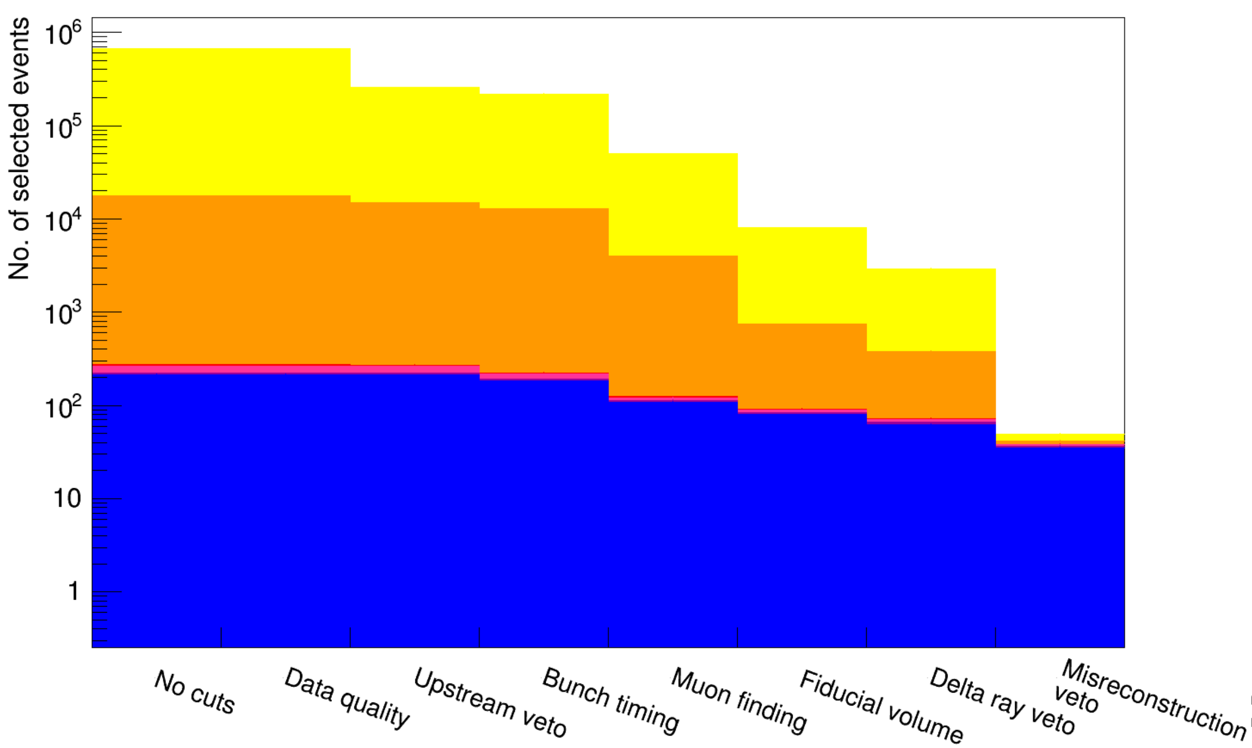

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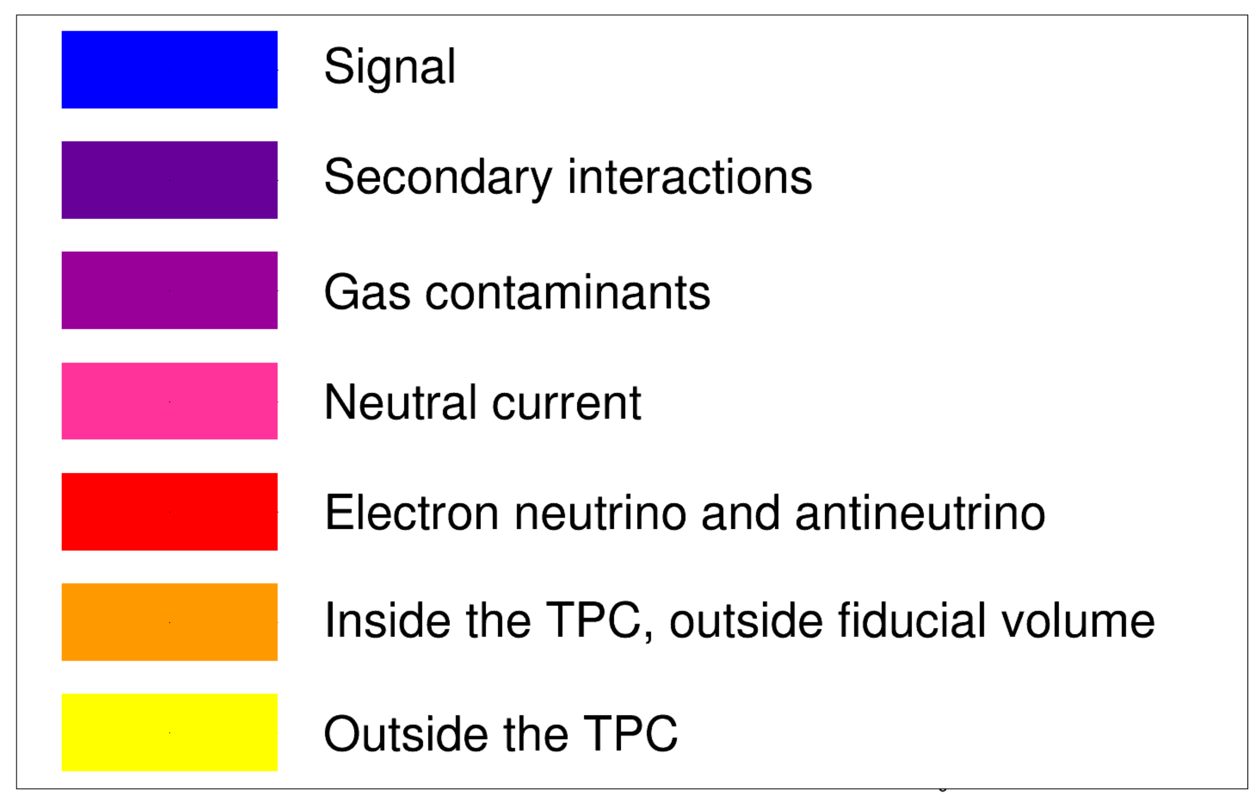
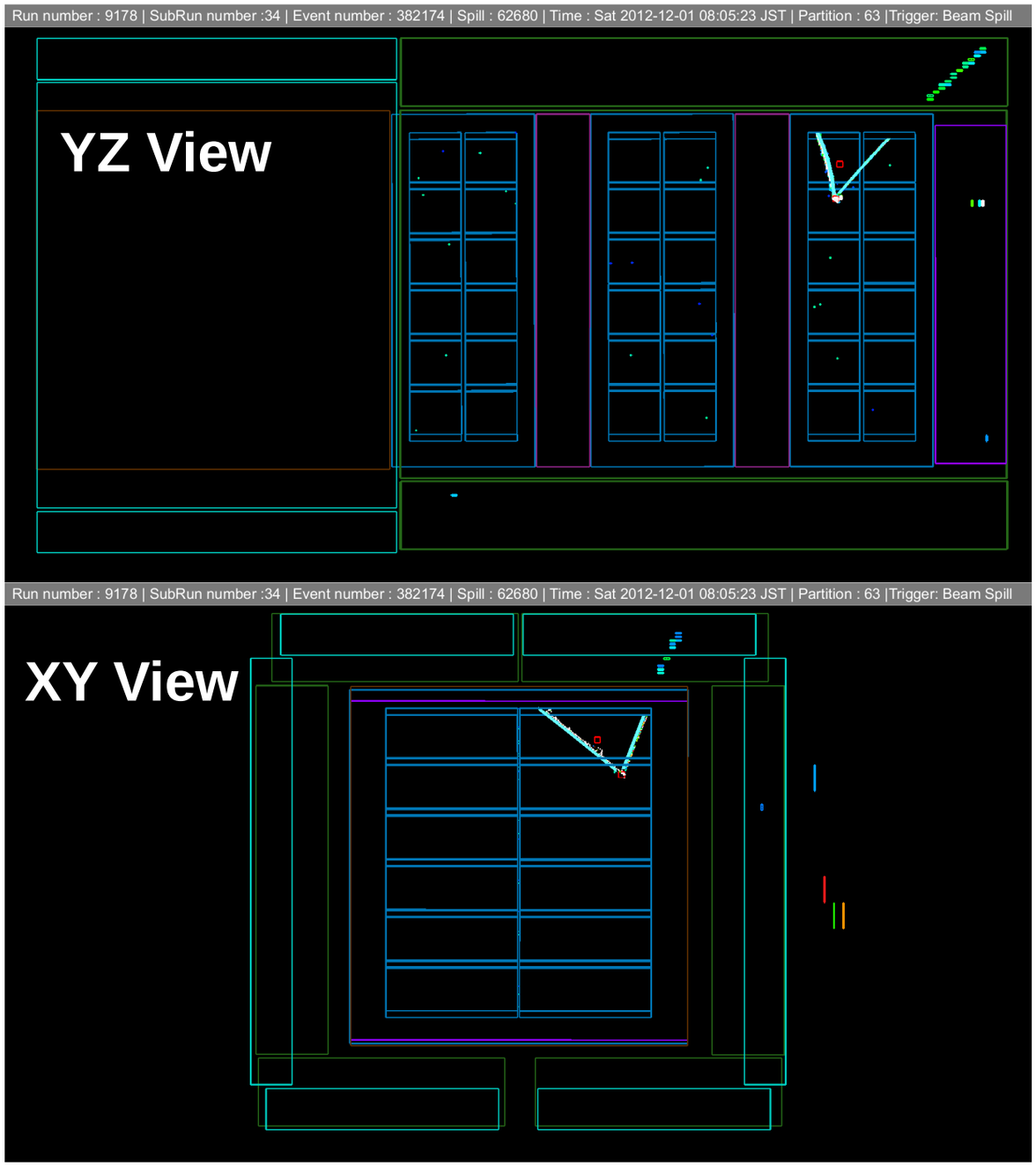
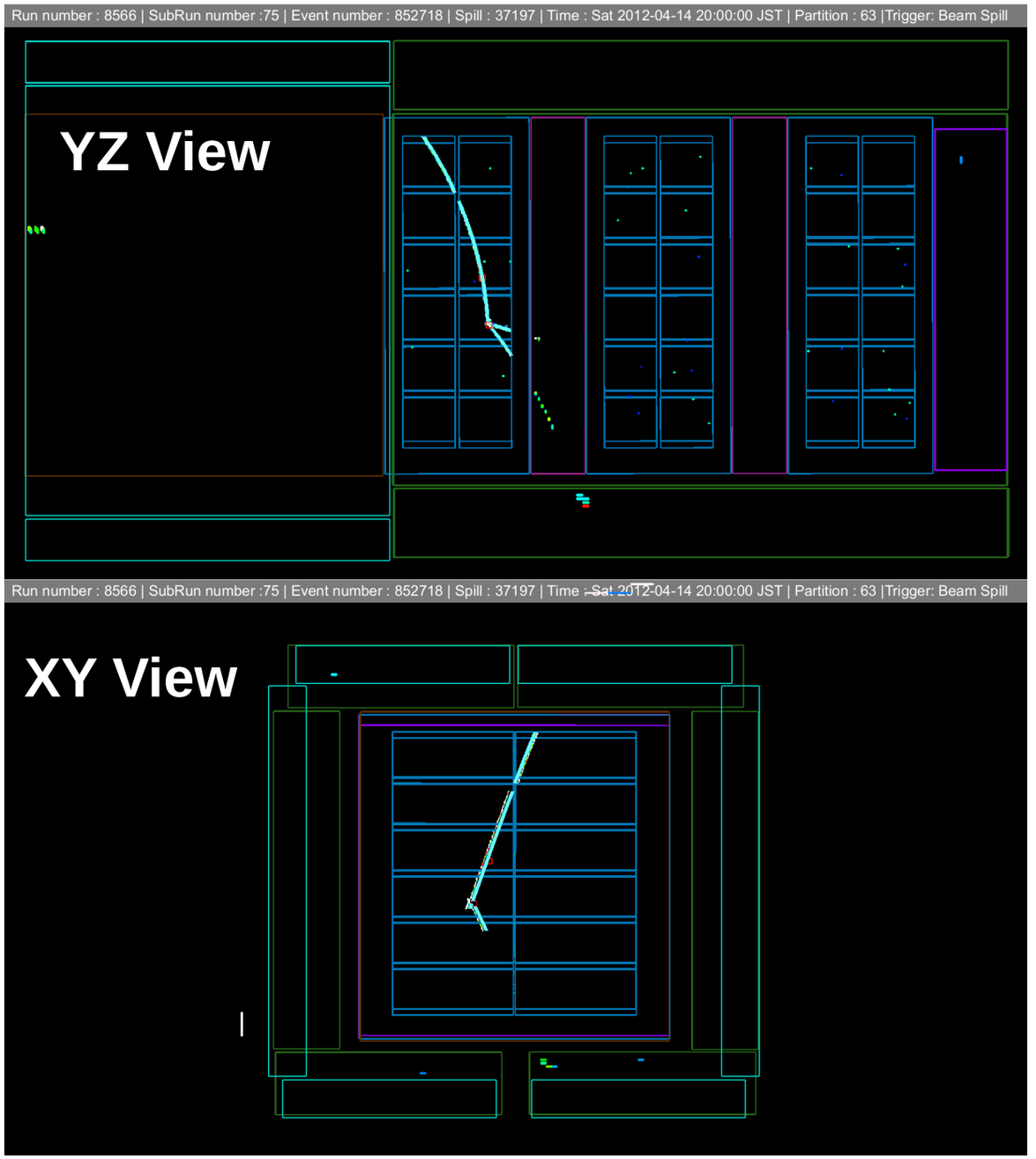


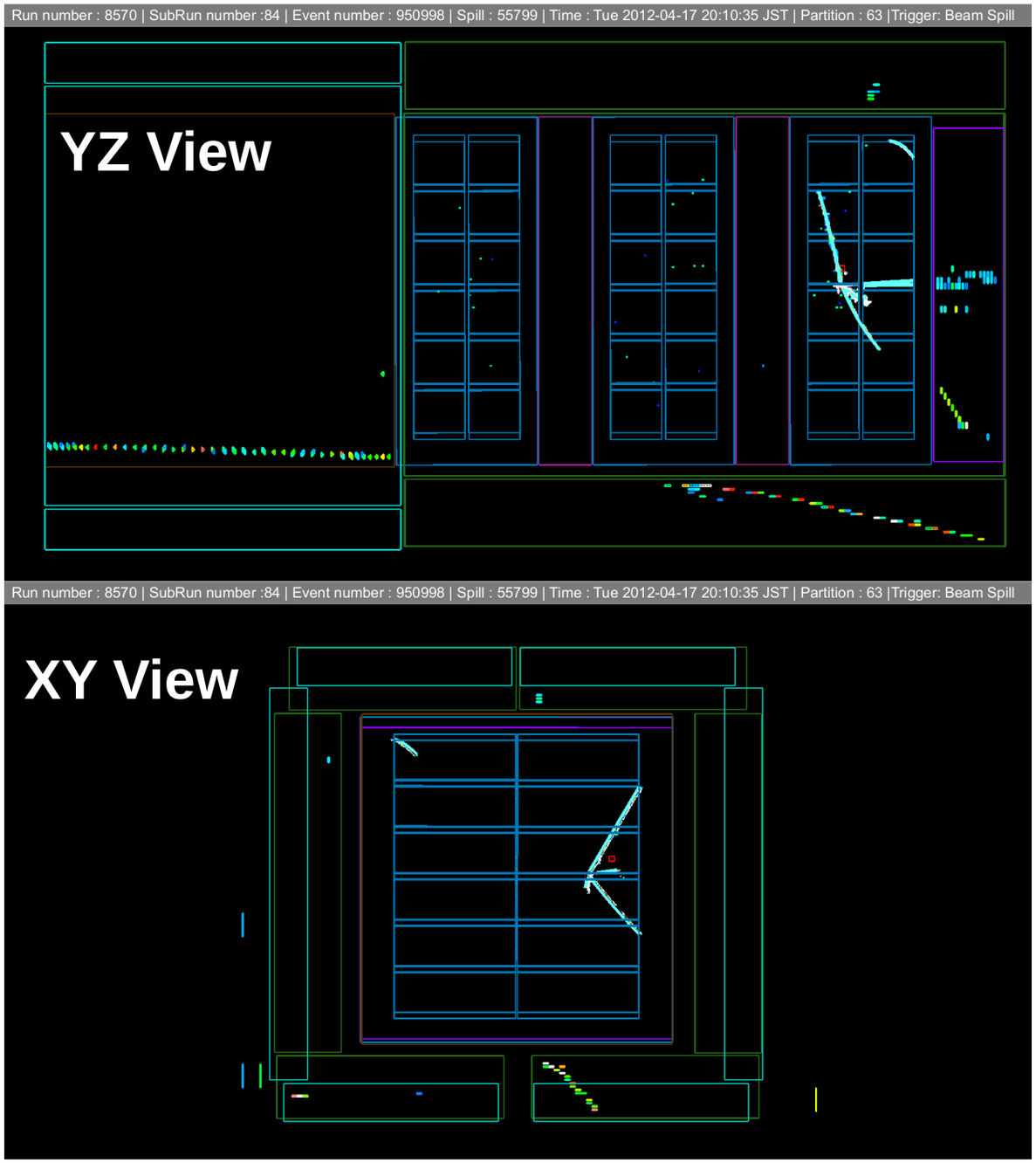
Signal
Secondary interactions
Gas contaminants
Neutral current
Electron neutrino and antineutrino
Inside the TPC, outside fiducial volume
Outside the TPC

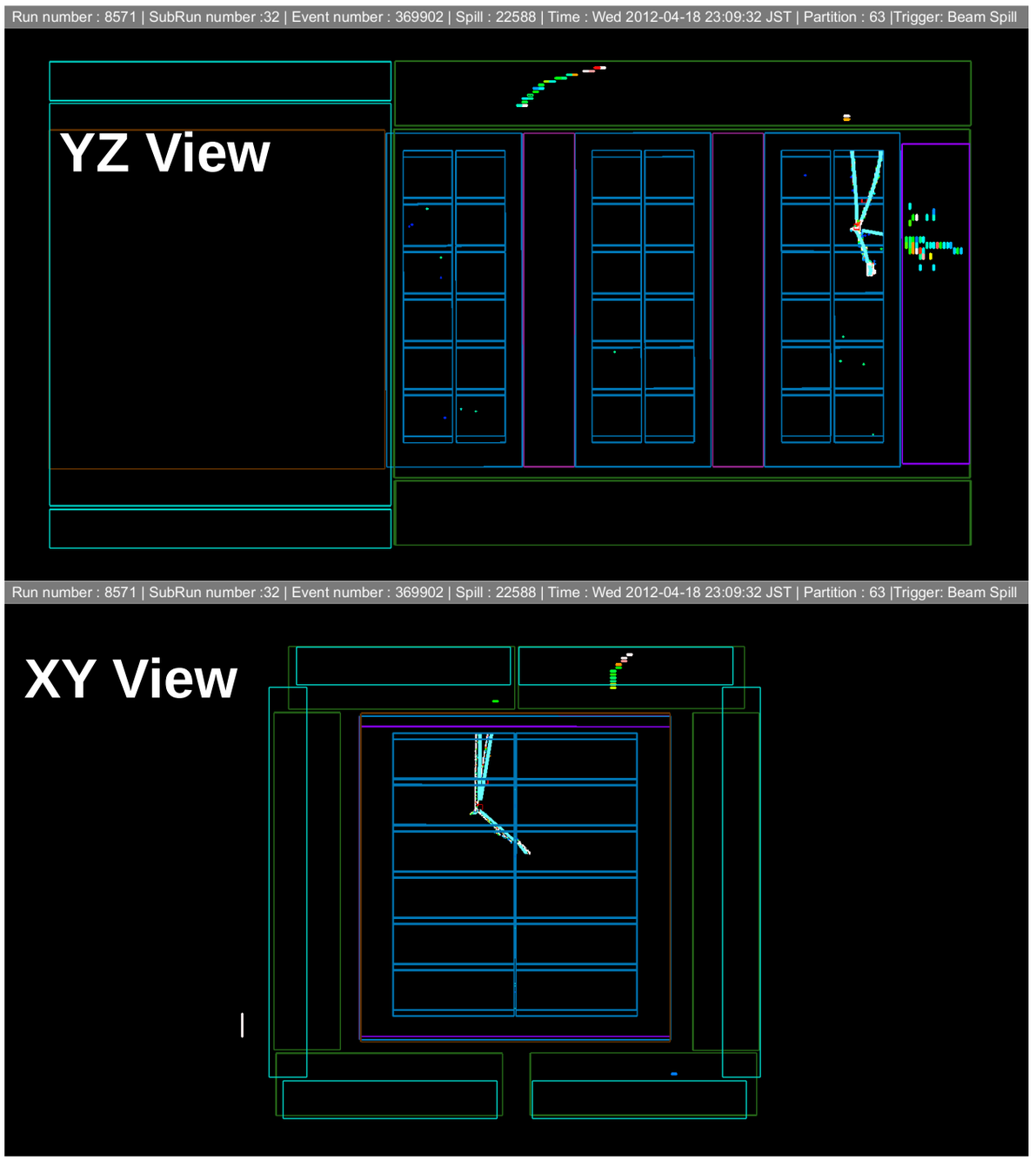
Data!


Run number : 9178 | SubRun number :34 | Event number : 382174 | Spill : 62680 | Time : Sat 2012-12-01 08:05:23 JST | Partition : 63 |Trigger: Beam Spill
YZ View
Run number : 9178 | SubRun number :34 | Event number : 382174 | Spill : 62680 | Time : Sat 2012-12-01 08:05:23 JST | Partition : 63 |Trigger: Beam Spill
XY View


Run number : 8566 | SubRun number :75 | Event number : 852718 | Spill : 37197 | Time : Sat 2012-04-14 20:00:00 JST | Partition : 63 |Trigger: Beam Spill
YZ View
Run number : 8566 | SubRun number :75 | Event number : 852718 | Spill : 37197 | Time : Sat 2012-04-14 20:00:00 JST | Partition : 63 |Trigger: Beam Spill
XY View

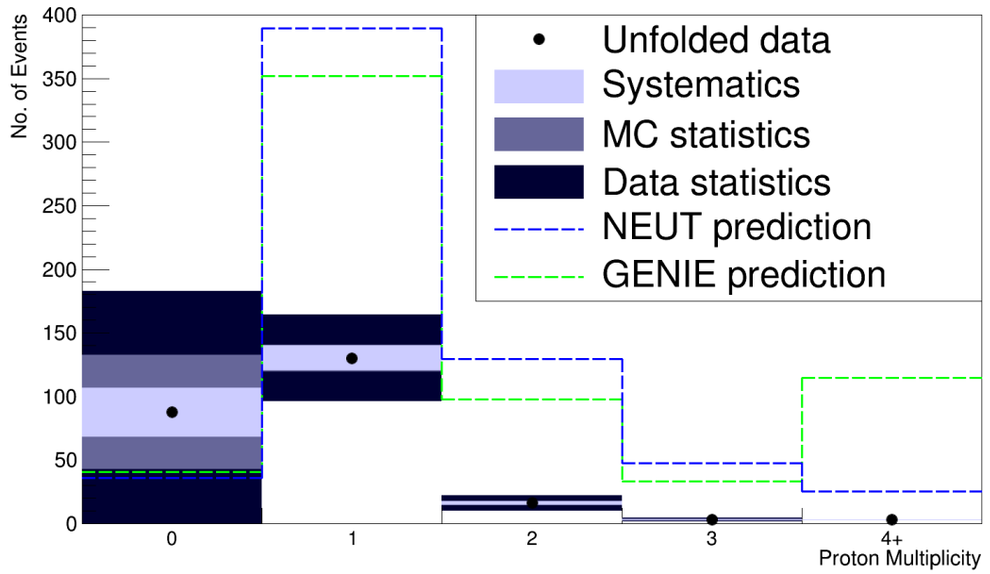
Data!

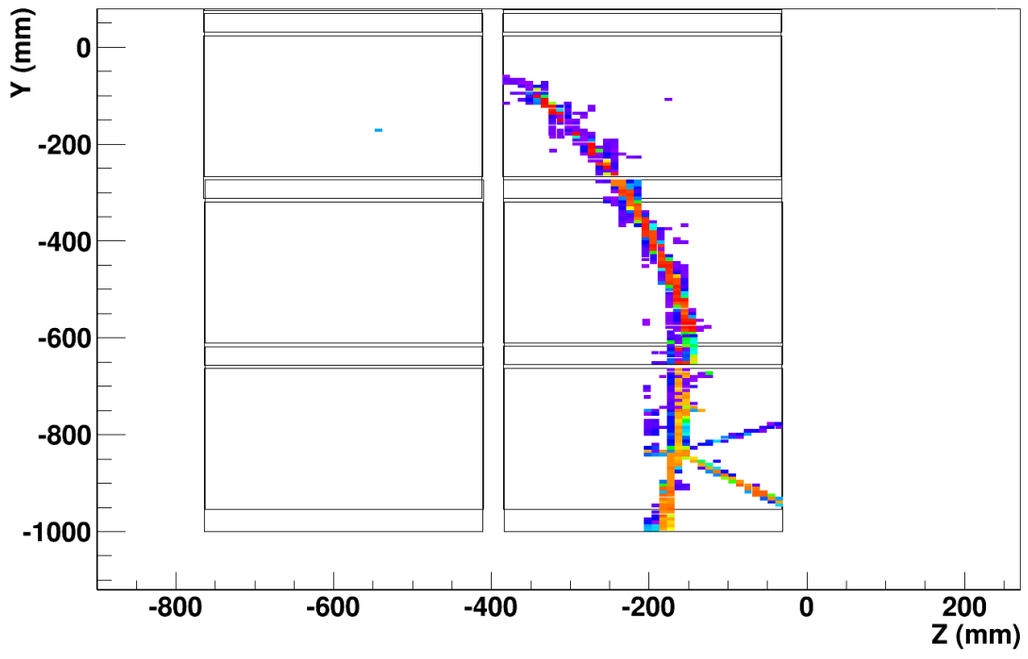

Run number : 8570 | SubRun number :84 | Event number : 950998 | Spill : 55799 | Time : Tue 2012-04-17 20:10:35 JST | Partition : 63 |Trigger: Beam Spill
YZ View
Run number : 8570 | SubRun number :84 | Event number : 950998 | Spill : 55799 | Time : Tue 2012-04-17 20:10:35 JST | Partition : 63 |Trigger: Beam Spill
XY View


Run number : 8571 | SubRun number :32 | Event number : 369902 | Spill : 22588 | Time : Wed 2012-04-18 23:09:32 JST | Partition : 63 |Trigger: Beam Spill
YZ View
Run number : 8571 | SubRun number :32 | Event number : 369902 | Spill : 22588 | Time : Wed 2012-04-18 23:09:32 JST | Partition : 63 |Trigger: Beam Spill
XY View

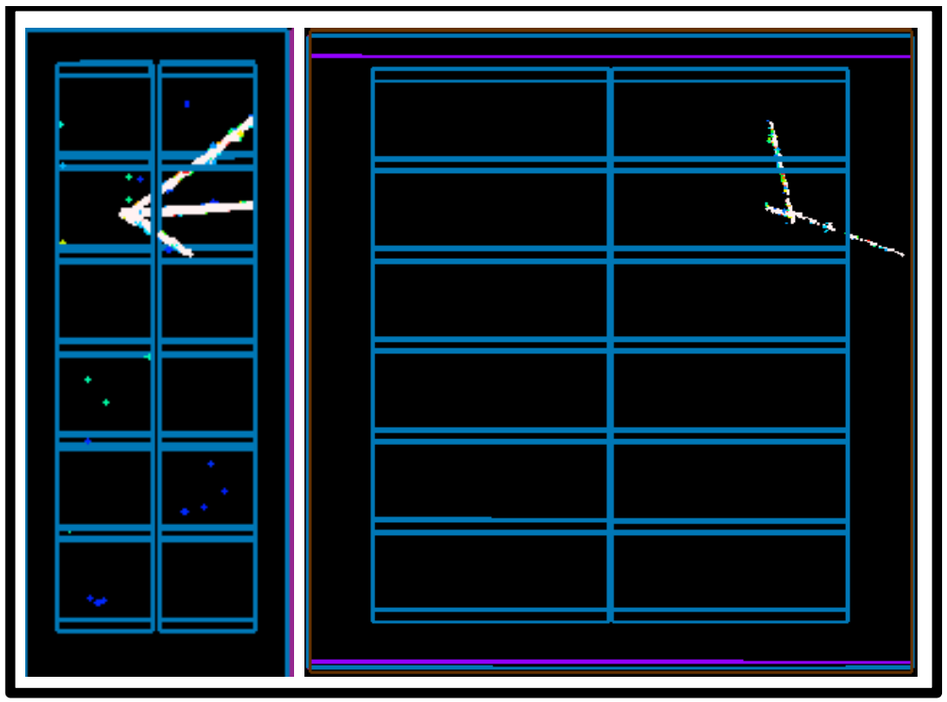
Challenges

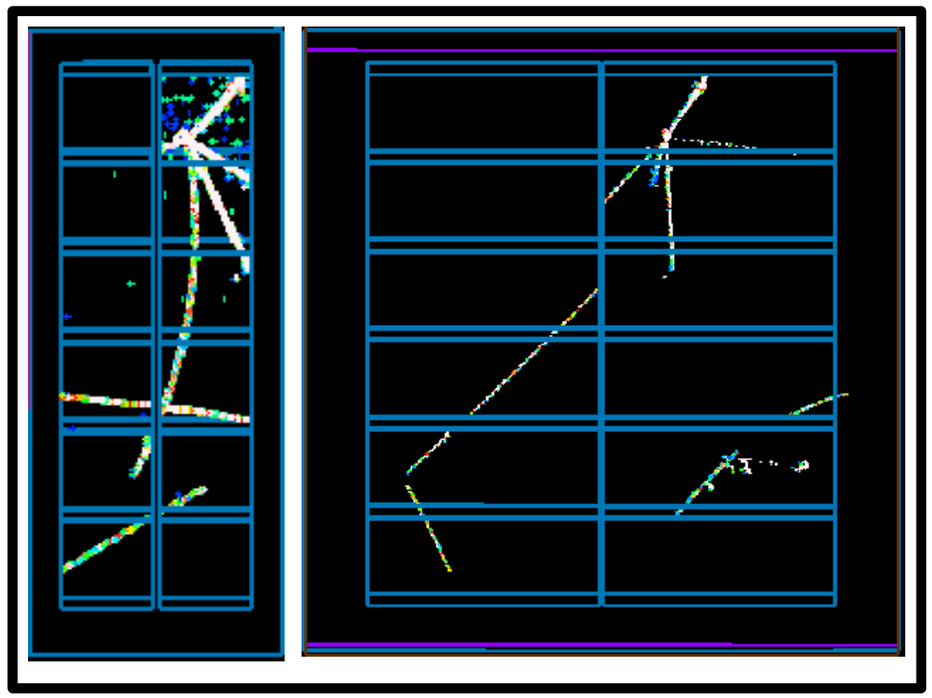
- Saw many fewer events than expected…
- Problem has been traced to "hairy" tracks, which are predominantly protons that saturate the readout, create crosstalk between pixels and screwup the reconstruction
- This behavior isn't currently modeled by the MC, so it's difficult to develop reconstruction strategies to compensate

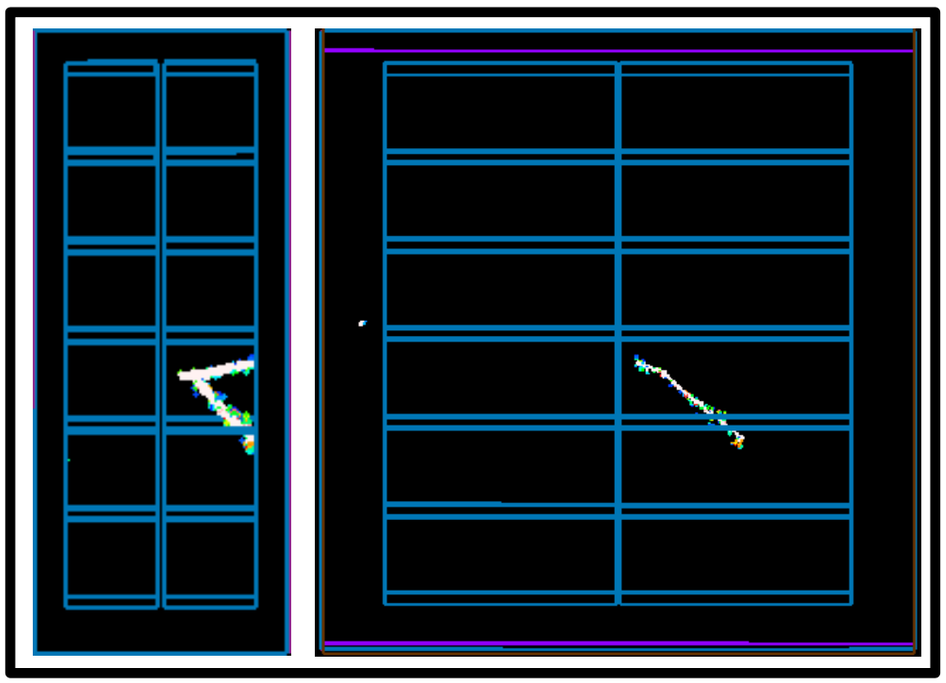


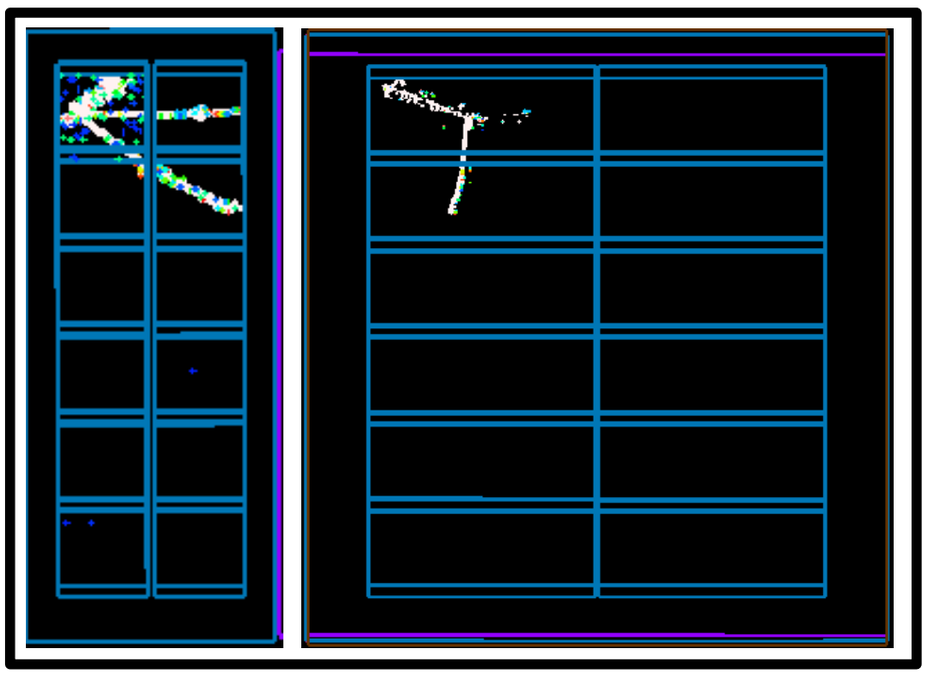


"Hairy" Tracks









Thoughts

- We can find events in TPCs, even surrounded by "heavy" detectors
- ...but heavy detectors are a serious detriment!
  - Reconstruction of high multiplicity events is not easy, but is possible
  - Readout which can handle charge cascades from protons is crucial

Plans in the UK

Morgan Wascko: "Tell them we're up for anything!"

Institutions Interested

- Imperial College (Morgan Wascko, Pip Hamilton, ACK)
- Oxford (Alfons Weber, Dave Wark)
- Royal Holloway (Jocelyn Monroe)
- Warwick (Gary Barker, Steve Boyd)
- Plus students! (Imperial has two full time summer students working on HPTPC this year.)

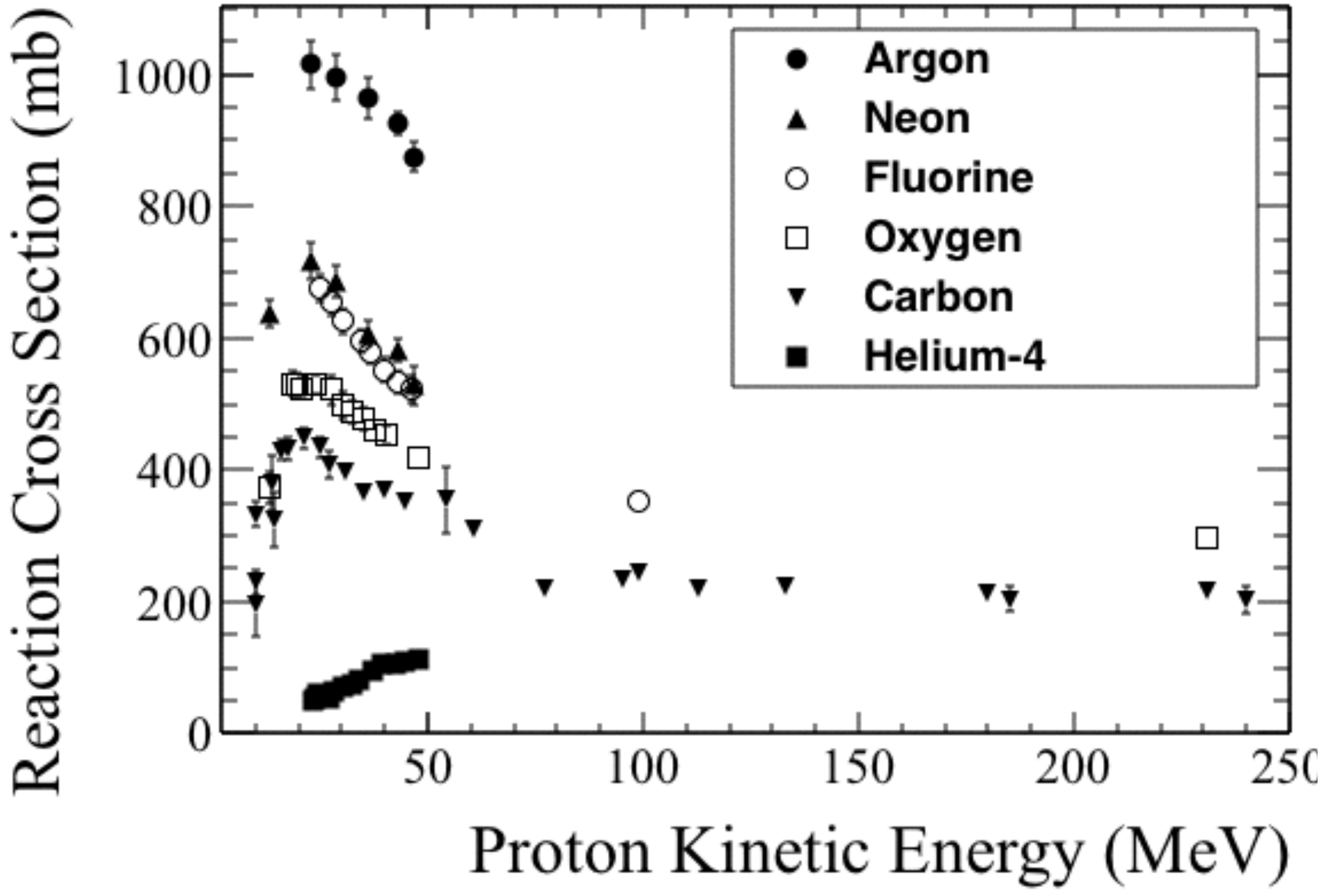
Plans in the UK

- The UK initial Long Baseline Neutrino Grant includes funding for
  - 1 postdoc for two years (shared Imperial and Royal Holloway)
  - Equipment funds to rehab a small TPC at RHUL and do gas property studies
  - Commitment to building a simulation for use for detector optimization

Plans in the UK

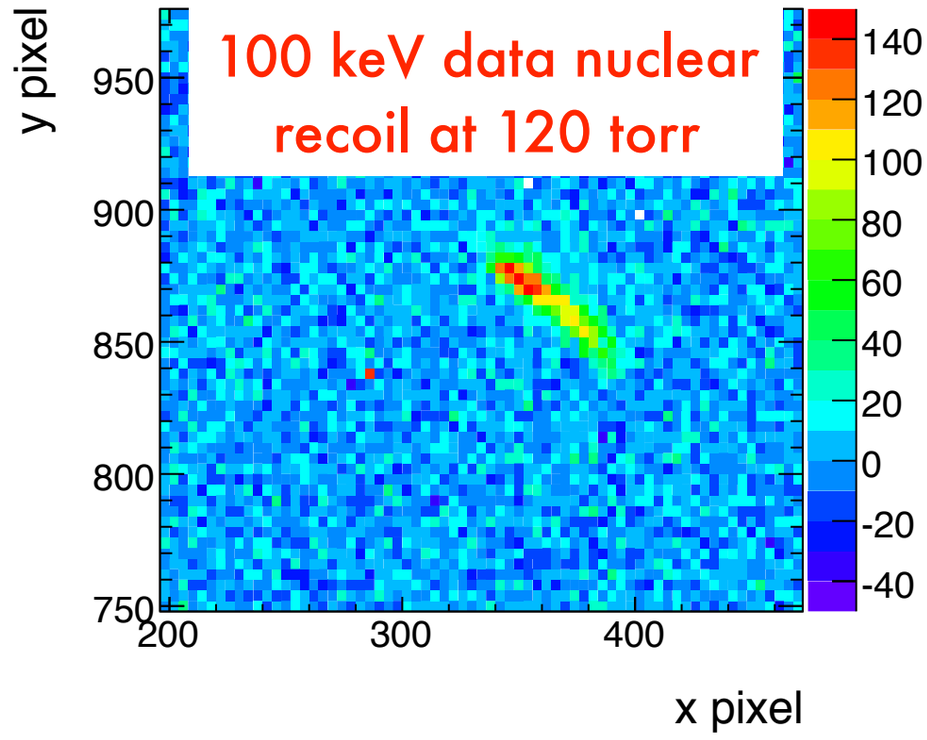
- Imperial, RHUL, and Warwick are submitting a proposal to the Projects Research and Development Scheme in the UK
  - Physics goal: build something to put in a proton/pion test beam at CERN to measure p/π
  - Physics goal: do the ν generator and simulation development to evaluate impact on future experiments
  - Detector design: (0.5 m)^3 to (1 m)^3 TPC with optical and charge readout
  - Proposal is due 29 July

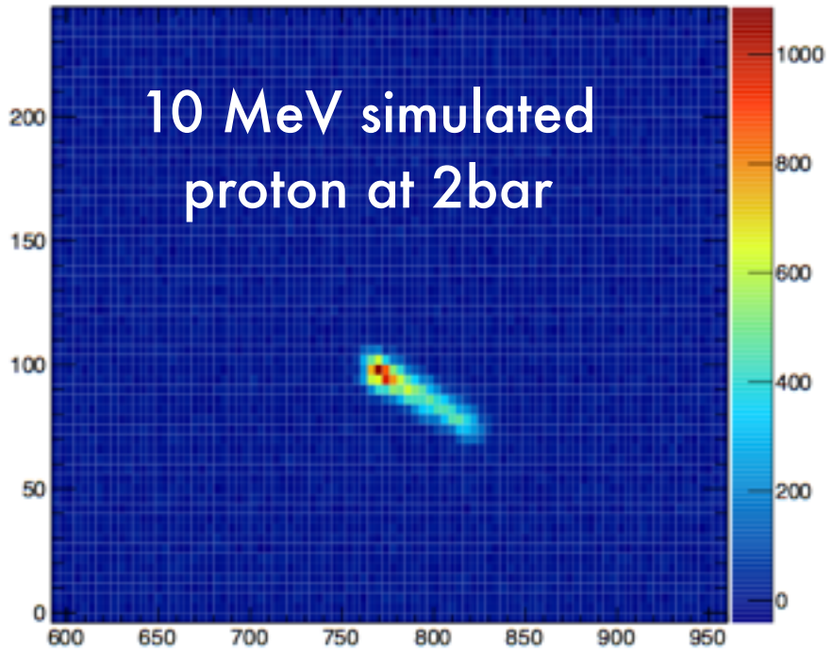
Proton Cross Sections



Optical Readout

- Big problem is how to instrument a large gas volume
- I worked for five years on using CCD cameras to read out a gas TPC for dark matter
- Pressures & energies scale correctly so that HPTPC can build on this work—if we can make it fast enough





Conclusions

- We have an existing TPC analysis which is going to second generation students–lots to be learned here!
- In the UK, there is a wealth of experience and interest and we want to be part of this European effort!