

Persisting slices in Pandora's output

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What is a *slice*?

- Pandora uses the concept of *slice* internally since its (LAr) beginning:
 - They represent topologically distinct collection of hits
 - They become a *candidate* neutrino or beam-particle interaction in the pattern recognition
 - They are produced *after* the unambiguous cosmic-rays have already been identified
- Now that the appropriate object exists in the LArSoft EDM, they can be persisted and used downstream:
 - As topologically distinct collection of hits that represents any particle hierarchy
 - Which could be from a cosmic-ray, a neutrino interaction or a test-beam particle interaction.
Added a method to also create a slice of unambiguous cosmic-ray hierarchies
- The new LArSoft objects are `recob::Slices`, available in `lardataobj/RecoBase`:
 - For the moment they contain only an ID, i.e. they are just a number
 - For more info: http://nusoft.fnal.gov/larsoft/doxsvn/html/classrecob_1_1Slice.html



What's in a `recob::Slice`?

- With the latest updates...

In Pandora's consolidated output, the following are persisted as `recob::Slices`

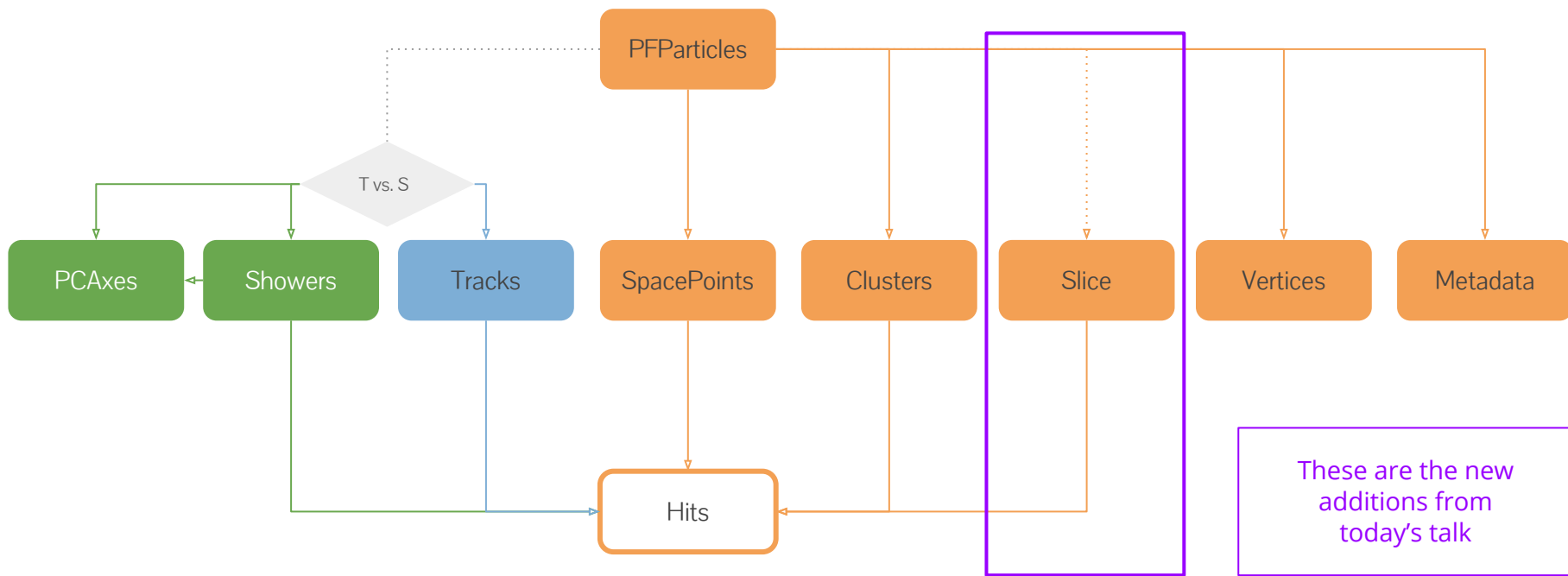
- All unambiguous cosmic-ray hierarchies - one `recob::Slice` per hierarchy
- All Pandora internal slices

- Every `PFP`Particle belongs to exactly one `recob::Slice`
- `recob::Slices` can contain multiple `PFP`Particles
- Every Hit belongs to exactly one `recob::Slice` - even if it wasn't added into a `PFP`Particle
(apart from a few subtle and expected cases - such as those with negative charge - see backup for more details)
- All other reconstruction options (e.g. just the cosmic hypothesis, aka `pandoraCosmic`) are also handled (see also backup for more details)



Pandora output structure

NB. Can have multiple PFParticles associated to one Slice





The code itself

- The code is available in larpandora feature branch: [feature/asmith_persistRecobSlicev07_11_00](#)
- **New products:**
 - `std::vector<recob::Slice>`
 - `art::Assns<recob::Slice, recob::Hit, void>`
 - `art::Assns<recob::PFParticle, recob::Slice, void>`
- **Behaviour:** Checked, hit-by-hit, that the output to `recob::Slices` matches exactly what we expect from inside Pandora
- **Profiling:** The additional collections mean only a small increase in file size for MicroBooNE (<0.1%) & protoDUNE (<1%), and no significant change in memory usage
- **Unit tests:** “mrb t” tests and CI build tests pass for all experiments (except failures in SCE specific test unit in uboonocode, unrelated to us)



Summary

- Code adding `recob::Slices` to Pandora output to LArSoft is now available in larpandora feature branch: [feature/asmith_persistRecobSlicev07_11_00](#)
- We would like to request these changes to be added to the release next week
- Meanwhile, work is ongoing to persist `recob::Slices` by the “pandora” producer (spoofing module, only relevant for MicroBooNE) to match the “PatRec” modules, and to update external event building module



Pandora for MicroBooNE

Pandora is an open project and new contributors would be extremely welcome.
We'd love to hear from you and we will always try to answer your questions!

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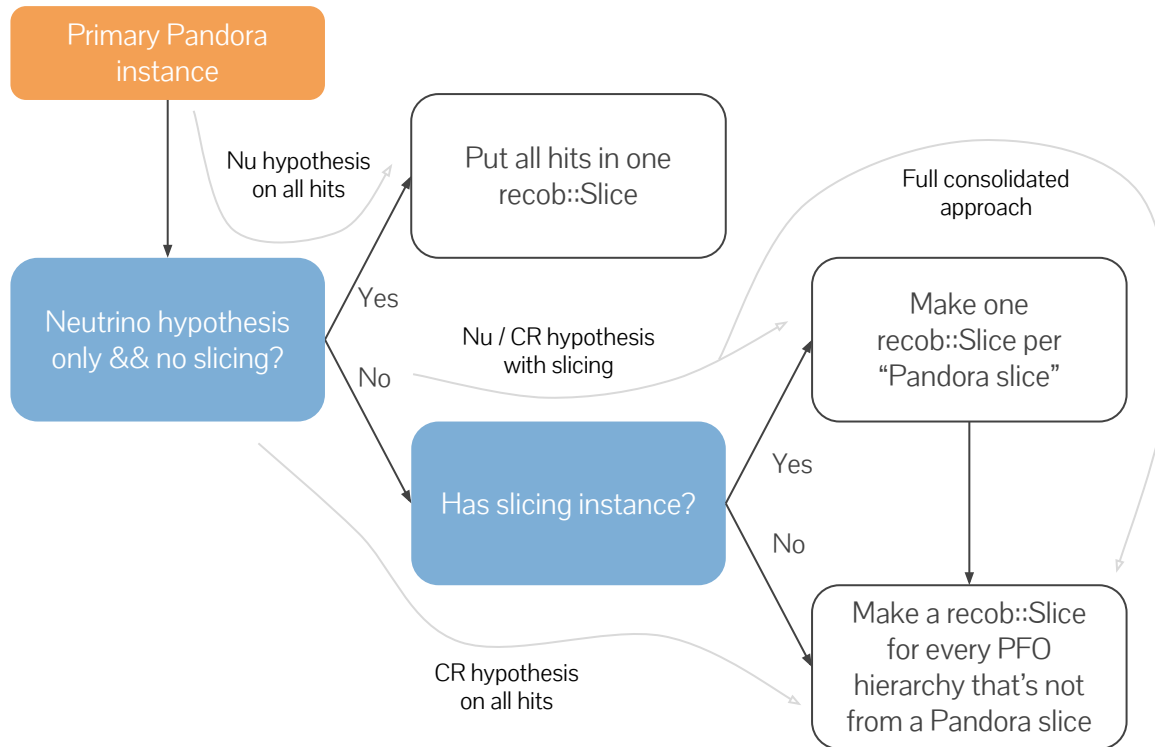
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Logic for recob::Slice production



- Pandora offers multiple reconstruction options
 - With / without slicing
 - Cosmic / neutrino hypothesis
 - With / without unambiguous cosmic-ray tagging
 - With / without neutrino (or beam particle) identification
- The logic shown is used to give the user the output most consistent with the expected definition of a recob::Slice over all reconstruction options



Which hits don't make it into a slice?

- There are two reasons why a `recob::Hit` will not be associated to a `recob::Slice`
 - The hit wasn't ever considered by Pandora's pattern-recognition
 - Pandora will not consider any hits that have nonsensical information (such as a negative integrated charge)
 - In the consolidated output, the hit wasn't reconstructed into a unambiguous cosmic-ray, AND has a peak-time which puts it outside of the detector volume (i.e. not possible to be from the neutrino or beam-particle interaction)
 - In this case, it is never considered by the slicing algorithm
- The number of hits lost here is small, and we have tested to make sure that in every other case, every hit is added to a `recob::Slice`