Shower Reconstruction

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LArSoft Coordination Meeting

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Overview

- Pandora-based shower reconstruction in LArSoft
  - geometrical variables only
  - no shower energy, dE/dx yet
- Modifications and updates on
  - lardataobj - feature/gp_LArShowerPfoSuggestions
  - larpandora - feature/ gp_LArShowerPfoSuggestions
  - larpandoracontent - since larsoft v06_23_00
  - uboonecode - feature/LArShowerPfo
- Produce recob::Shower in the pandora stage

lardataobj

- recob::Shower object
  - add length and opening angle variables to a shower object
  - if no valid length and opening angle, the variables will be set to -1.
    - add functions has_length() and has_open_angle()
- Enable association between recob::Shower and recob::PCAxis
- Tested the current larreco depending on the modified lardataobj
  - it compiles and works

recob::Shower

```
int fID;
TVector3 fDCosStart;                    ///< direction cosines at start of shower
TVector3 fSigmaDCosStart;               ///< uncertainty on initial direction cosines
TVector3 fXYZstart;                     ///< direction cosines at start of shower
TVector3 fSigmaXYZstart;                ///< uncertainty on initial direction cosines
std::vector< double > fTotalEnergy;     ///< Calculated Energy per each plane
std::vector< double > fSigmaTotalEnergy;    ///< Calculated Energy per each plane
std::vector< double > fdEdx;            ///< Calculated dE/dx per each plane
std::vector< double > fSigmadEdx;       ///< Calculated dE/dx per each plane
std::vector< double > fTotalMIPEnergy;      ///< Calculated Energy per each plane
std::vector< double > fSigmaTotalMIPEnergy; ///< Calculated Energy per each plane
int fBestPlane;
double fLength;                         ///< the length of the shower
double fOpenAngle;                      ///< the opening angle of the shower
```

Newly added

larpandora

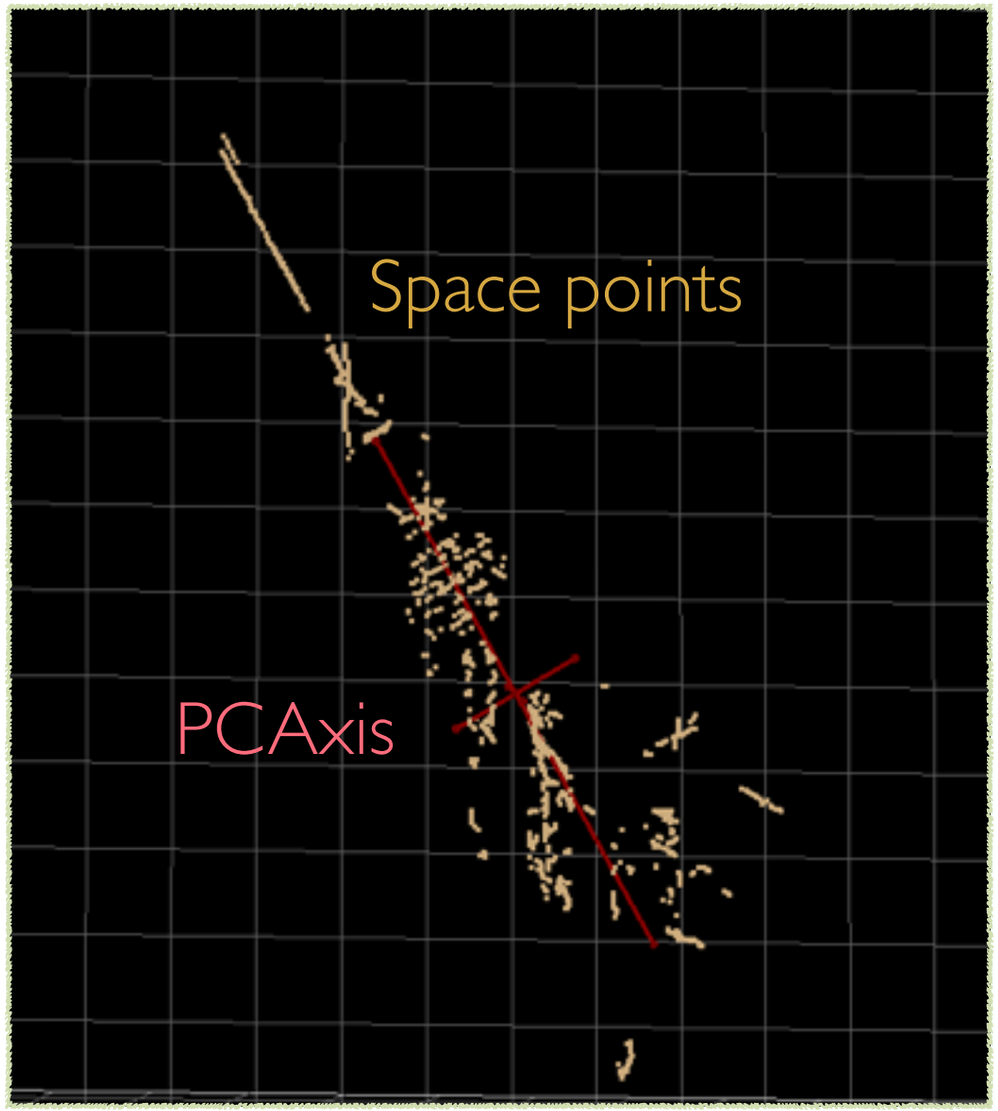
- New module in larpandora/LArPandoraShowers/
  - run a principal component analysis using the Eigen package on the pandora outputs
  - fill the results into a recob::PCAxis object
  - obtain and fill the geometrical parameters of a recob::Shower object
  - each pfparticle corresponds to a shower and a PCAxis objects
  - associations between the three built
  - may be moved into larpandoracontent in the future

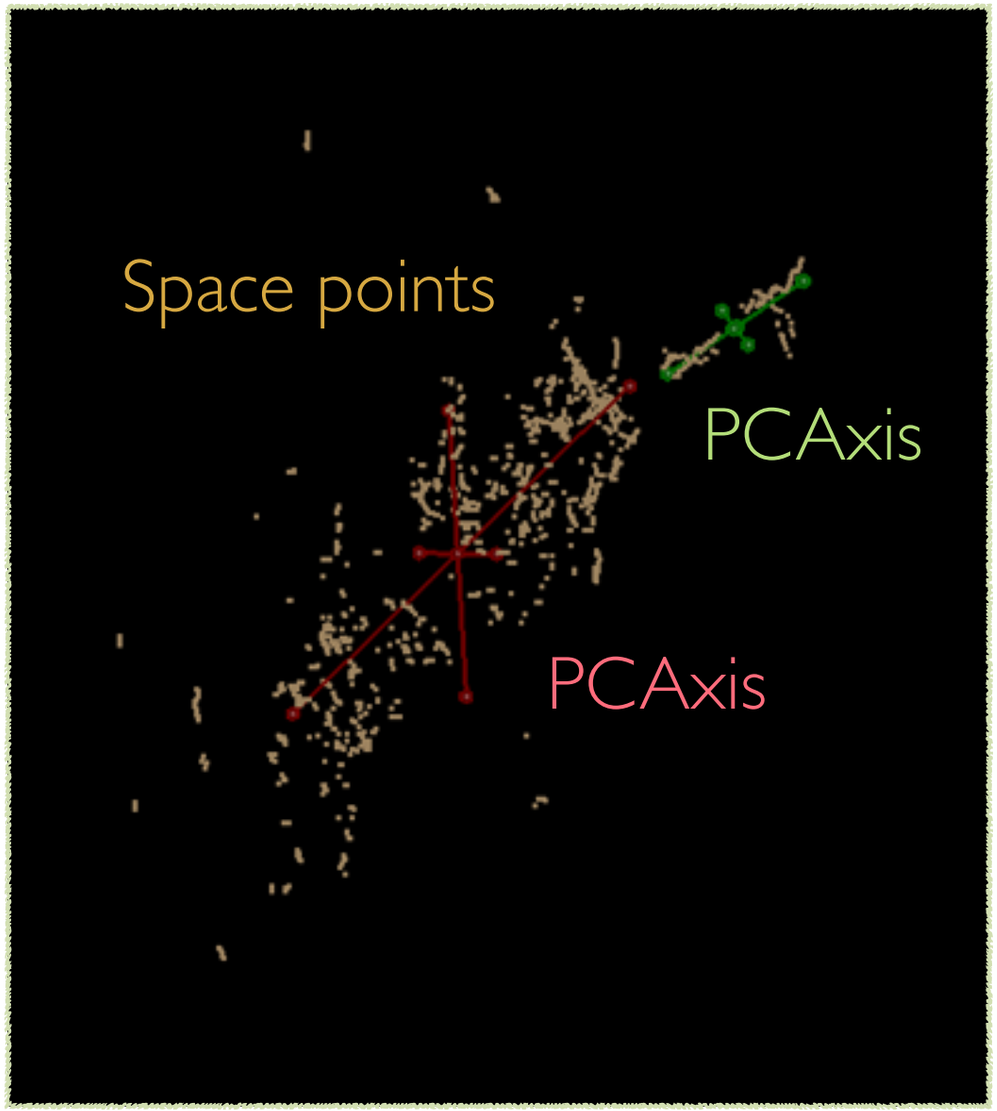
Other Repositories

- larpandoracontent
  - add LArShowerPfo variables, handling the shower parameters within Pandora
- uboonecode
  - update Pandora parameters in uboone/MicroBooNEPandora/scripts/*.xml

Qualitative Validation

- Single electron events
- Three-dimensional event display





Summary

- Pandora-based shower reconstruction algorithms in LArSoft!
  - currently have geometrical parameters
  - will implement calorimetric parameters
- Modify and update lardataobj, larpandora, larpandoracontent, and uboonecode
- Qualitatively validate the outputs
- Have no impact on larreco
- Many thanks to John Marshall, Gianluca Petrillo and Tracy Usher!