

FD1-HD and FD2-VD production validations

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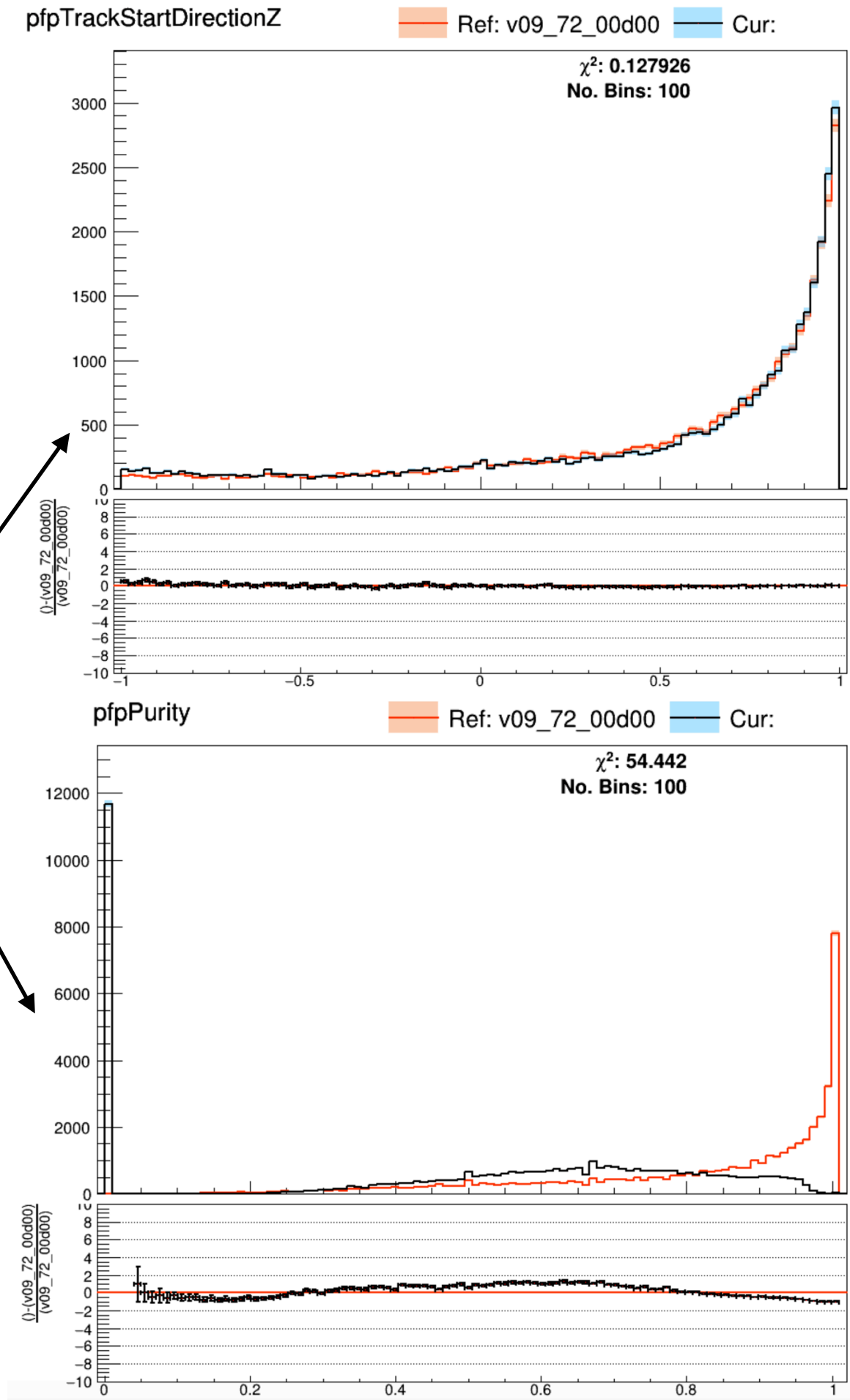
5th June 2023

FD1-HD and FD2-VD production

- We are in the process of gearing up for a new production for both FD1-HD and FD2-HD
- The productions aims:
 - Fold in recent simulation and reconstruction developments to FD1-HD
 - Increase similarity in FD1-HD and FD2-VDs workflows
- The production is split into LBL and Low E samples

Validation

- Relying heavily on the automated validation system
 - Run full workflow using reference and modified software
 - Makes plots automatically
- Reconstruction-level plots look good
- Plots that rely on truth matching do not...

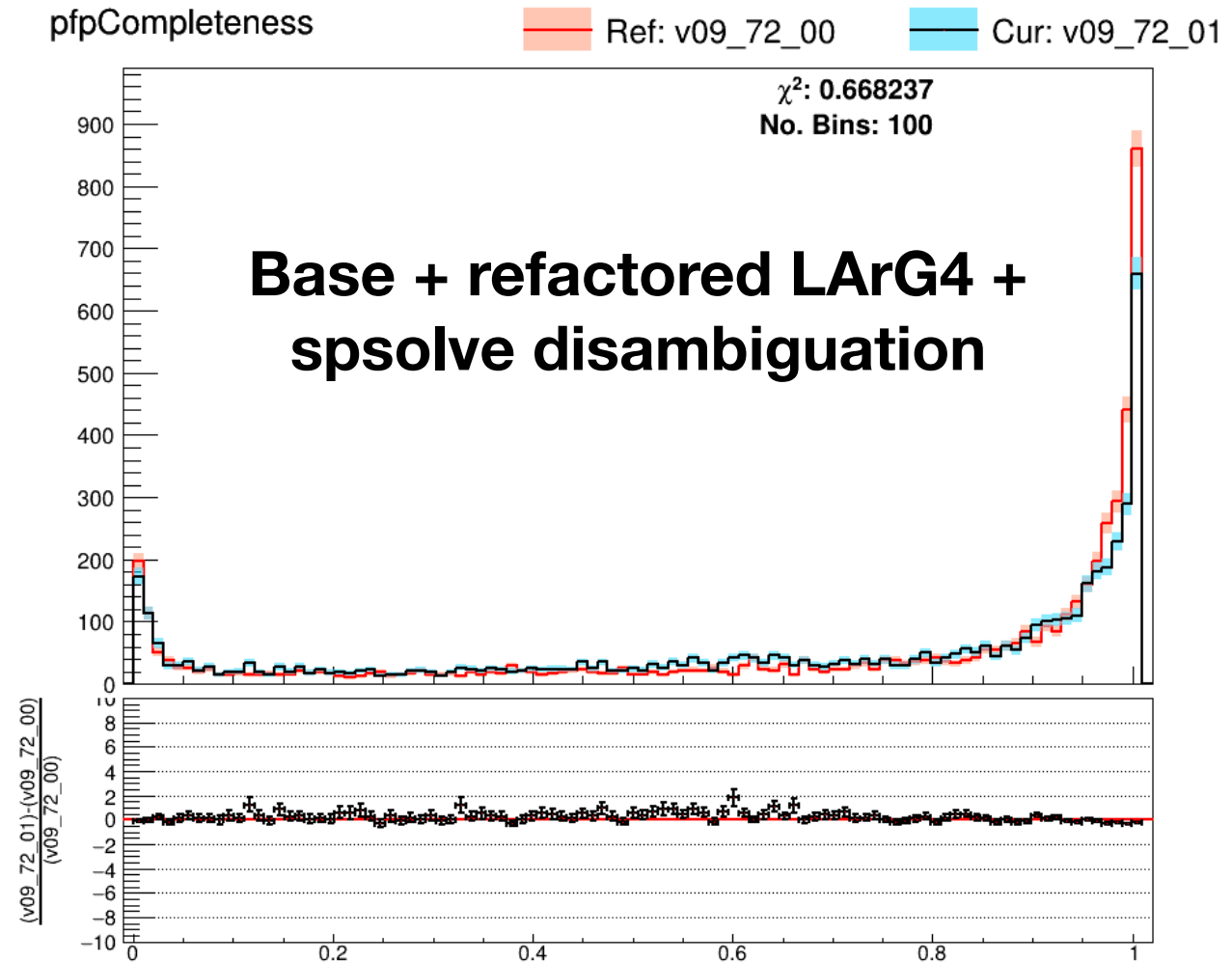
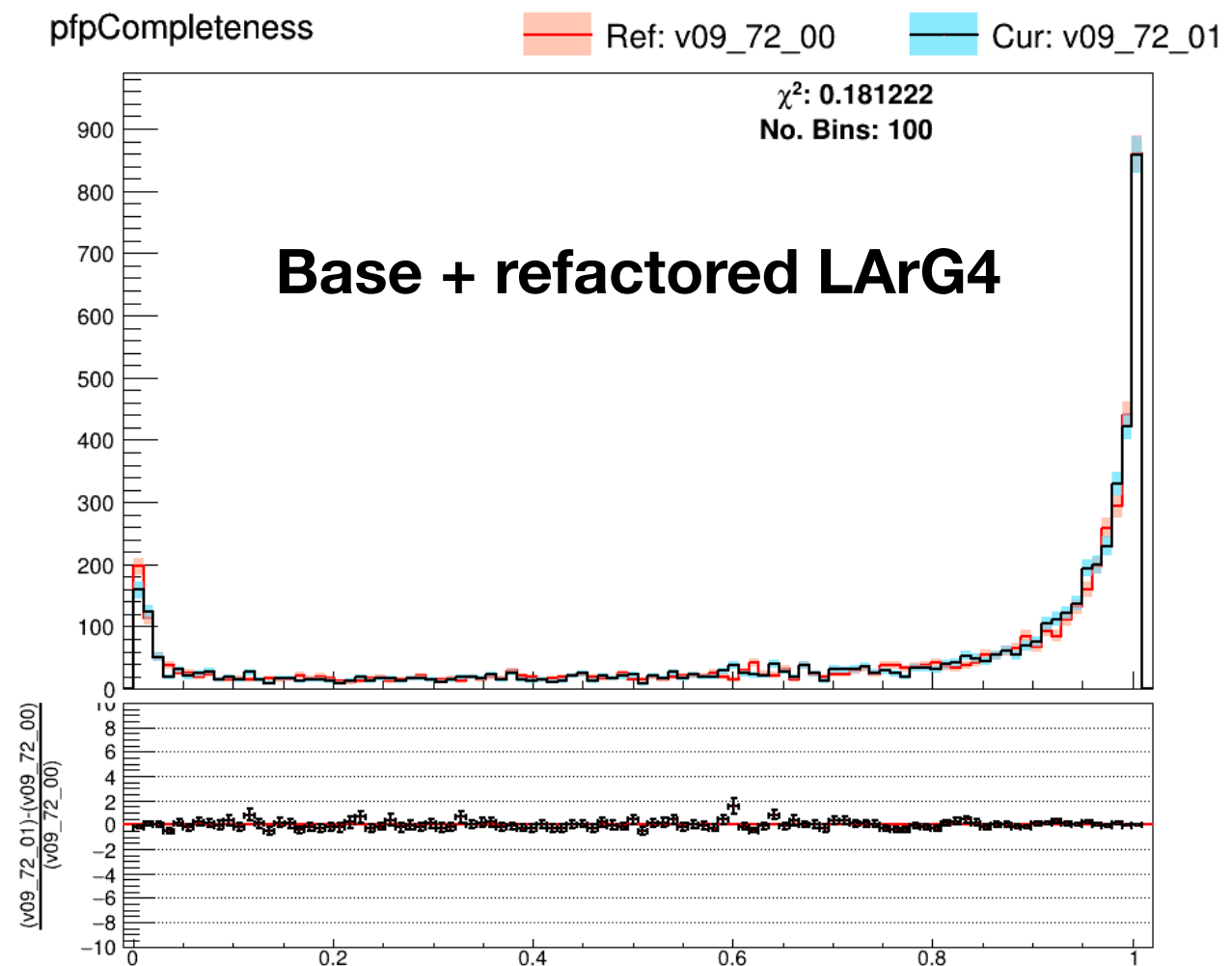


Validation findings

- Testing methodology
 - Incrementally roll back changes from the production branches and run the validation system
 - Incrementally add production changes to the base branches and run the validation system
- Testing is ongoing but three issues have already been found
 1. Wirecell and LArSoft were using different units in FD1-HD
 - PR submitted. Thanks H. Yu!
 2. Space point solver-based disambiguation degrades performance
 3. FD2-VD and ProtoDUNE-inspired gaushit tuning significantly degrades performance

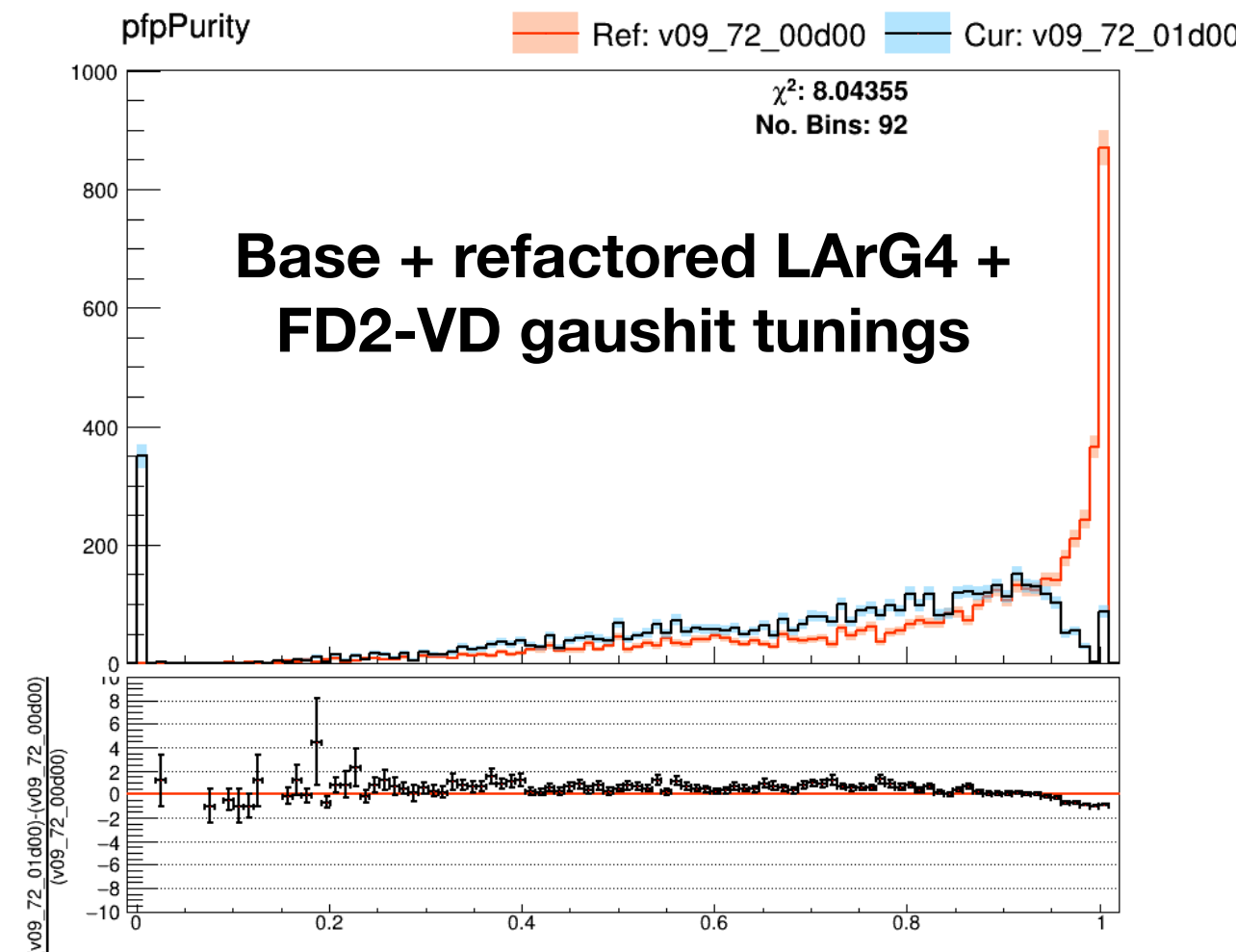
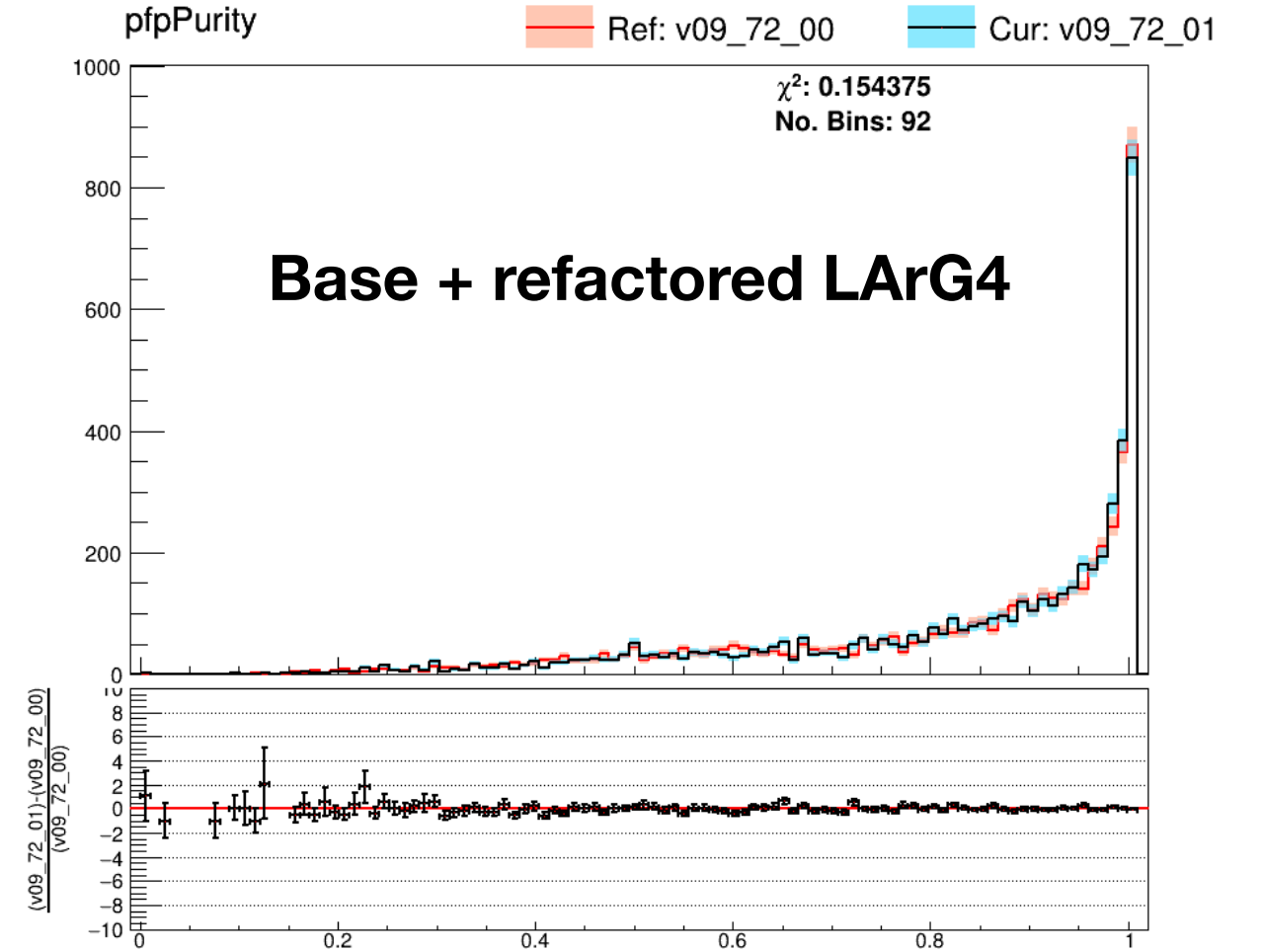
FD1-HD: Space point solver disambiguation performance degradation

- Found by incrementally adding on production changes to the base branches
- The base branch uses a timing-based, triple point disambiguation routine written for the 35t
- Space point solver disambiguation (developed in ProtoDUNE) converts gaushit hits to 3D space points, which are then dissolved into unambiguous 2d hits
- Historically found marginal gains when testing the spsolve disambiguation
- Solution: drop spsolve disambiguation from this production and retain the older 35t disambiguation routine



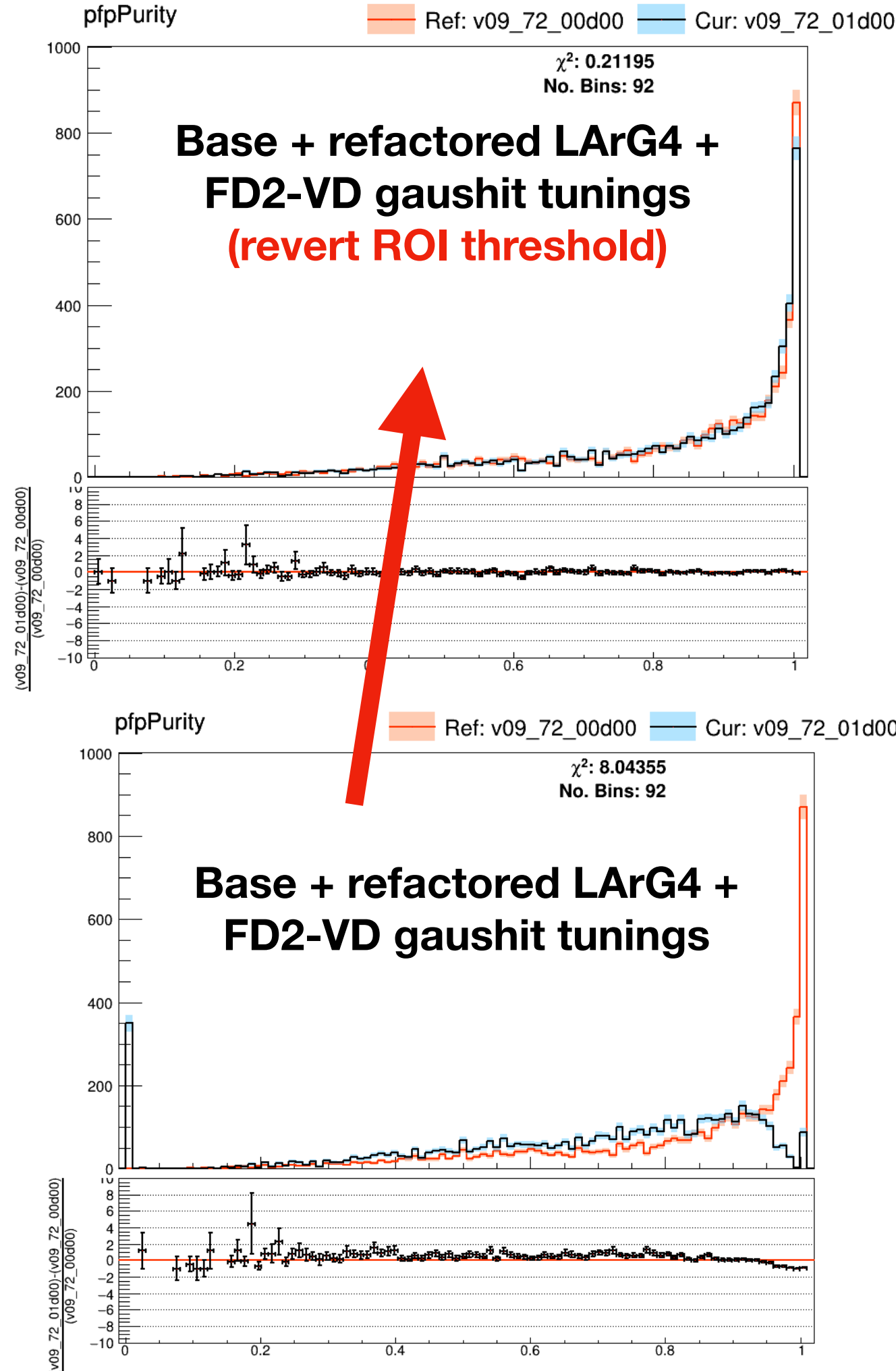
FD1-HD: Gaushit tunings from FD2-VD impacts performance

- Found by incrementally adding on production changes to the base branches
- FD2-VD gaushit tunings based on ProtoDUNE tunings
 - Out of the box the tunings significantly impact FD1-HD performance
- What changes have been made to the hit tuning?
 - Chi2 NDF: 2000 -> 50
 - ROI thresholds: 6 -> 2
 - Peakfitter: Gaussian -> Mrqdt



FD1-HD: Gaushit tunings from FD2-VD impacts performance

- Reverting hit parameters does recover performance
 - RHS top plot shows reverting ROI thresholds to 6
- Solution
 - Temporarily remove new gaushit tunings from production
 - Validate the entire production workflow
 - Re-enable and tune the hit reconstruction

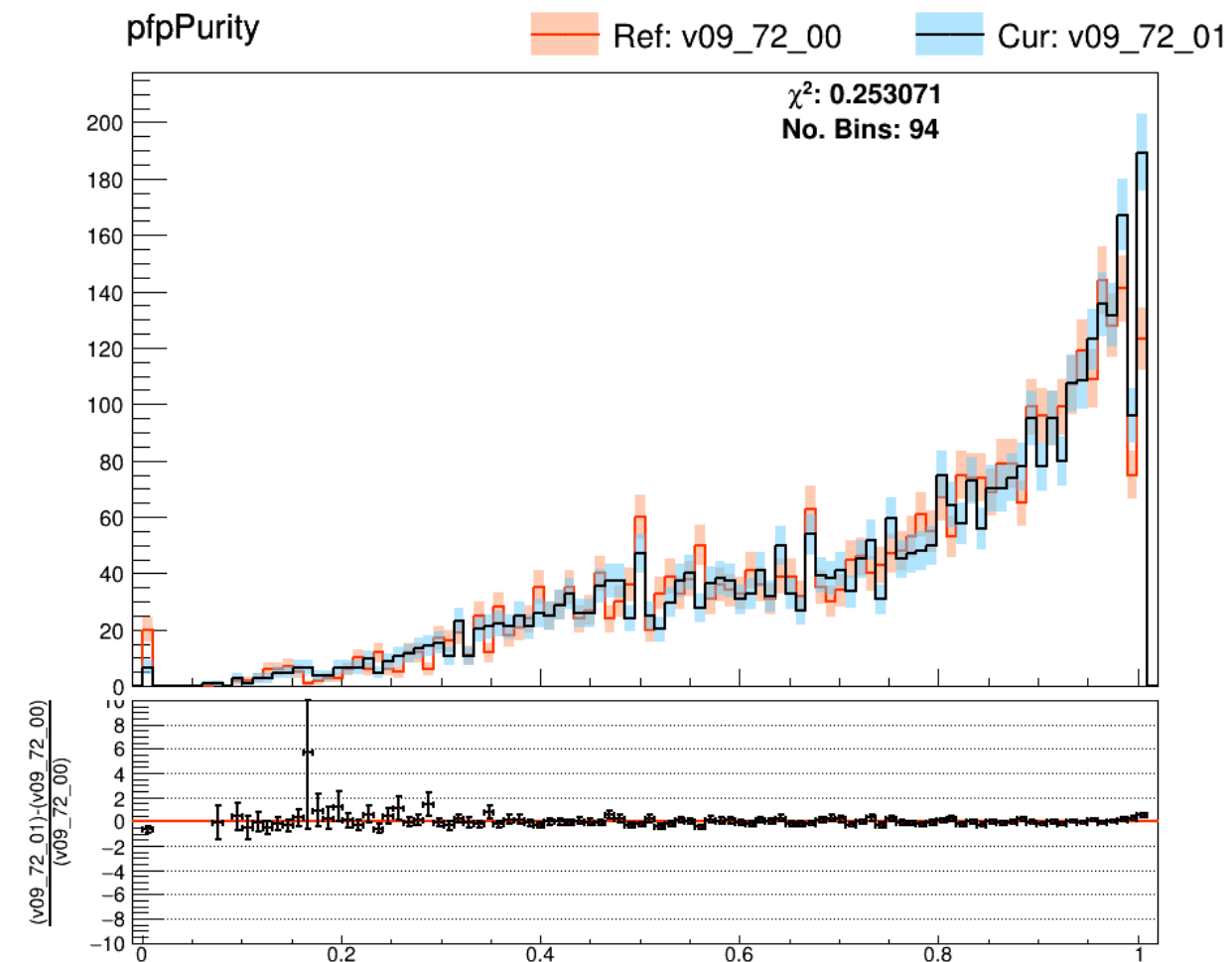
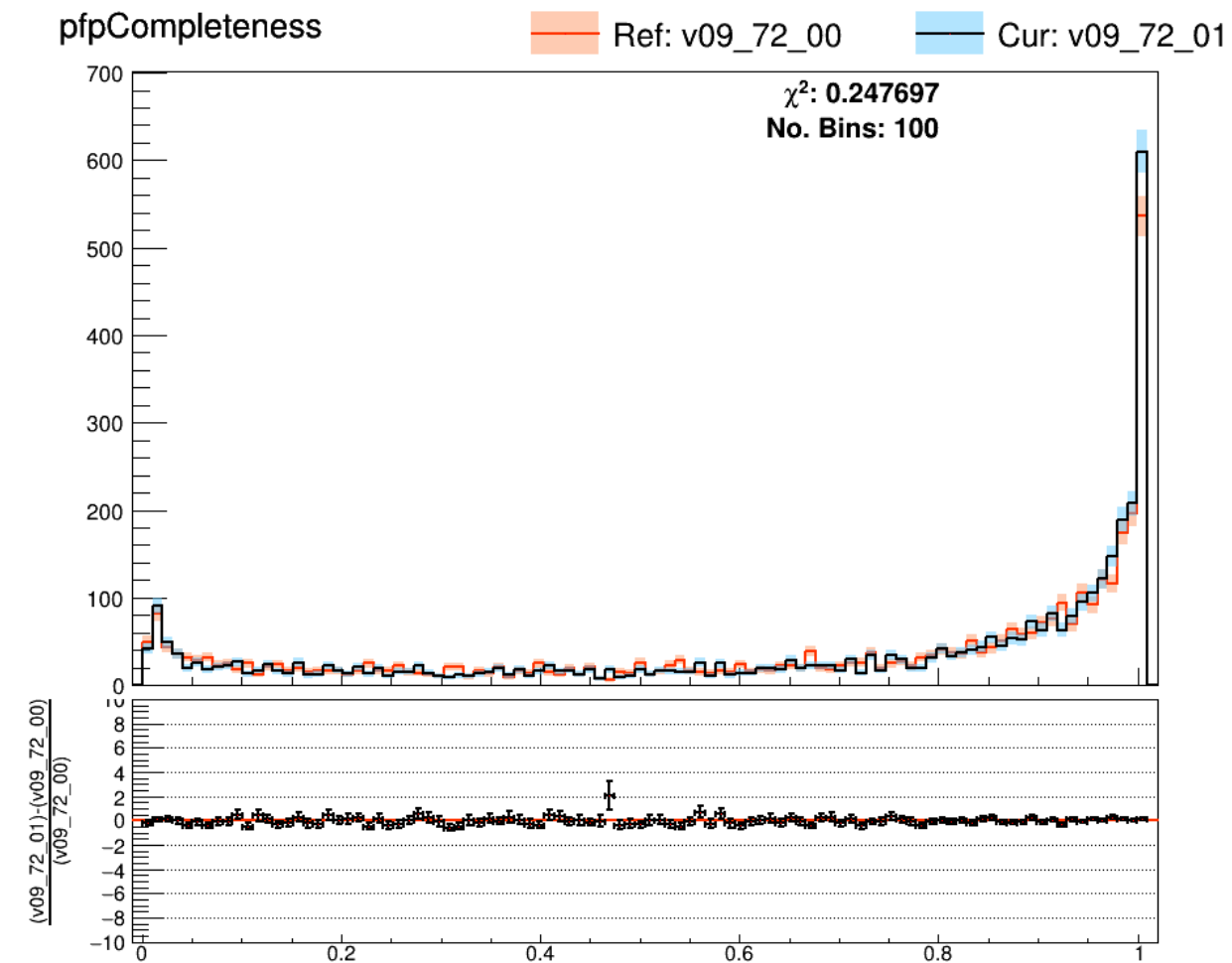


Other validations

- Simulation-level changes (diffusion and lifetime): **DONE**
- Structural changes to promote the refactored workflow to be the standard workflow: **ONGOING**
- Wirecell: **ONGOING**
- Low E: **ONGOING**

FD2-VD validations

- Generally good news here
- The validations look decent
- Relatively minor changes compares to FD1-HD
- No longer chopping up long pulses into multiple hits
- Lowering diffusion



Timeline

- LBL
 - **Validations:** ~1.5 weeks (*completes the week beg. June 12th*)
 - **Production phase 1**
 - Processes gen, g4, detsim, reco1 (hit reconstruction)
 - ~1 month (*completes July*)
 - **Tuning campaign**
 - CVN (N. Nayak), Pandora (A. Chappell, M. B. Brunetti), calibration constants (R. Jones)
 - 1 month (*completes in August*)
 - **Production phase 2**
 - Processes tuned reco2 (high level reconstruction)
 - ~1 month (*completes September*)
- Low energy
 - **Development and validations:** ~1 month
 - **Production phase 1:** 1 month
 - **Production phase 2:** 1 month

Summary

- FD1-HD and FD2-VD production is being validated now
- The validations are significantly relying on the automated validation system
- Validation findings so far
 - *FD1-HD wirecell/LArSoft units mismatch: **fixed***
 - *Space point solver disambiguation degrades performance: **drop from production***
 - *FD2-VD/ProtoDUNE hit finding params significantly degrade performance: **retune once the production workflow is validated***
- First production tickets expected to be submitted week beginning June 12th

Backups

Improvement highlights

- 2D signal simulation/processing via wirecell (BNL team)
- ProtoDUNE's data driven noise simulation (D. Adams)
- Refactored LArG4 (H. Wenzel)
- ProtoDUNE-style disambiguation using space point solver (R. Sulej)
- Assorted Pandora pattern recognition improvements (A. Chappell, M. B. Brunetti)
- Reorganisation of dunesw's fcl structure to more easily migrate to the refactored LArG4
- A paradigm shift to make any 'standard' workflow use the refactored larg4 with 'legacy' workflows now running the older simulation
 - `standard_g4_dune10kt_1x2x6.fcl` #runs the refactored larg4
 - `legacy_g4_dune10kt_1x2x6.fcl` #runs the old simulation
- Identical hit reconstruction for both FD1-HD and FD2-VD
- Updating detector simulation parameters based on ProtoDUNE
 - Lifetime: 10.4 ms
 - D_L and D_T : $4e-9$ cm²/ns and $8.8e-9$ cm²/ns respectively

Improvement highlights: low energy

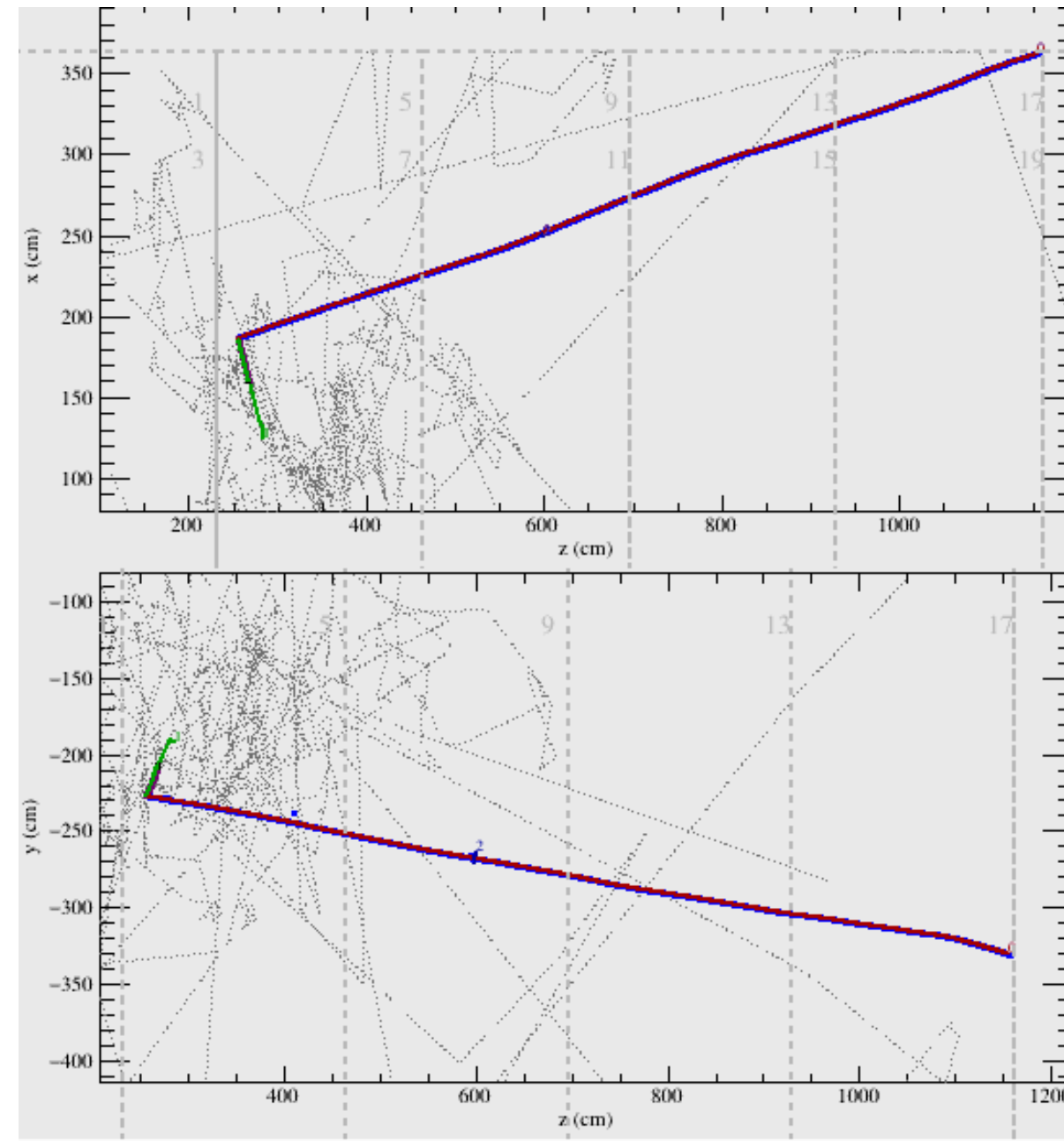
- Decay0 radiological model (T. Bezerra with updates from G. Sinev, J. Reichenbacher)
- Dedicated pandora workflow (M. Osbiston)
- New light generation model (Correlated - W. Foreman, LArQL - F. Marinho)
 - alpha LY will be checked next week
- New fast optical sim
 - semi-analytical model for HD (P. Green)
 - computable graph for VD (Muve)
- New single PE (with undershoot) and signal deconvolution for HD (M. Delgado, S. Manthey, D. Guffanti)

Production samples

- LBL: 24 million neutrinos equally split between FD1-HD and FD2-VD
 - 2M unoscillated + 2x 2M fully oscillated events
 - FHC and RHC
- Low energy: requests are still evolving, also split between FD1-HD and FD2-VD
 - 2M Marley events (SN and solar analyses)
 - 2M background events
 - 6M Marley + background

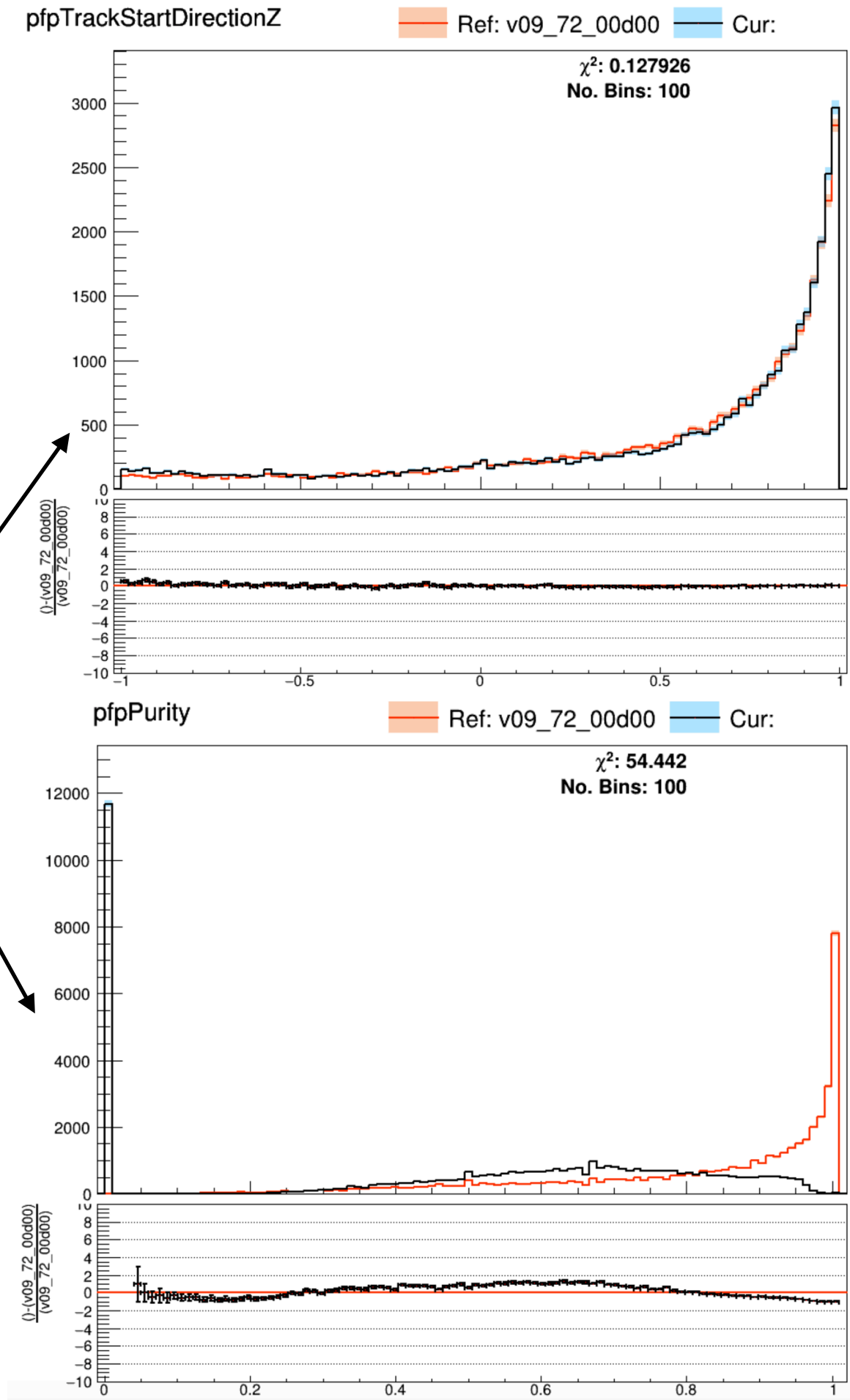
Production status

- LBL
 - All pull requests have been issued to github
 - Validation tests are now ongoing
 - You are able to help with testing: checkout '***dbrailsf_integration***' in ***dunecore***, ***dunesim***, ***dunreco***, ***dunesw*** and simulate a few events
 - The automated validation system (A. Chappell, R. Cross, V. Di. Benedetto) has started returning plots
 - We are expecting to submit the production tickets the week after the collaboration meeting **pending validations**
- Low E
 - Expecting further updates to:
 - Radiological simulation
 - Geometry
 - We are expecting to submit the production tickets in mid-June
- Documentation is starting to appear on the wiki: https://wiki.dunescience.org/wiki/2023_FD1-HD_and_FD2-VD_production_fdsimreco



Validation

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 - Run full workflow using reference and modified software
 - Makes plots automatically
- Reconstruction-level plots look good
- Plots that rely on truth matching do not...
 - Reconstructed hits not matching to true particles, possibly due to some truth timing offset
 - Being investigated now



Timeline

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 - *~1 month (completes July)*
 - **Tuning campaign**
 - CVN (N. Nayak), Pandora (A. Chappell, M. B. Brunetti), calibration constants (R. Jones)
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 - **Development and validations:** *~1 month*
 - **Production phase 1:** *1 month*
 - **Production phase 2:** *1 month*

Summary

- We are going to run a new MC production in both FD1-HD and FD2-VD
- The production is separate into LBL and Low energy samples
- Expected production start dates
 - LBL: week beginning 28th May but dependent on validations
 - Low energy: Mid June