

ND Physics Simulation and Reconstruction

AKA ND Sim/Reco
AKA ND Reco/Sim

Linda Cremonesi and Mathew Muether
DUNE Analysis workshop August 2022

ND Physics Sim/Reco group



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[Bi-weekly meetings -
Wednesday at 10 am Central](#)



[DUNE-ND-SW-INTEGRATION
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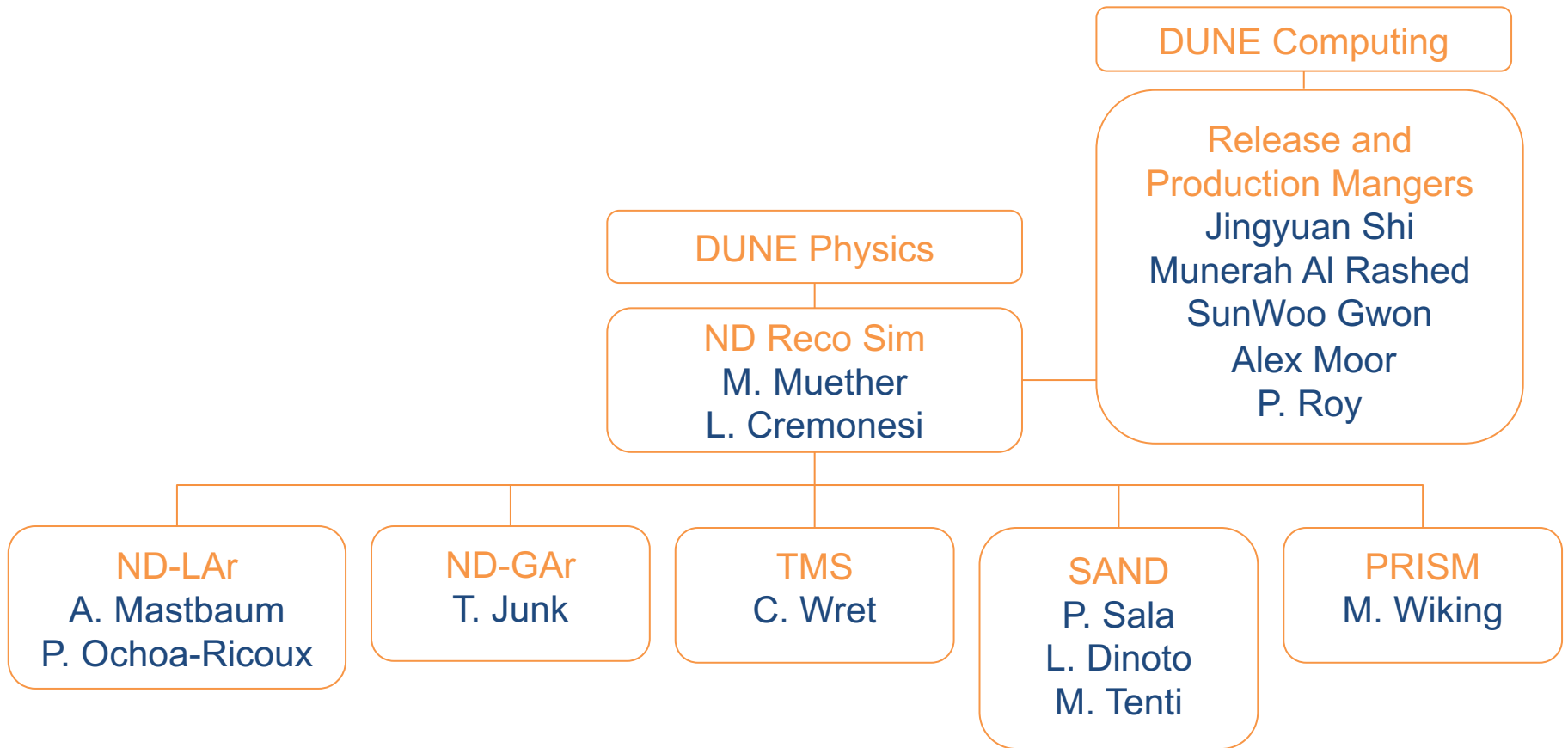


[#nd-reco-sim](#)

What is ND Reco/Sim?

- Physics group that coordinates the development of the ND reconstruction and simulation for physics studies.
- Additional coordination with other physics groups (e.g. LBL, exotics, neutrino interaction, etc), DUNE Computing and FD Reco/Sim.
- Near detector **PHYSICS** studies and plots should get approved by our group before being shown publicly (APB policy is currently being updated accordingly)

DUNE ND Reco/Sim Org.



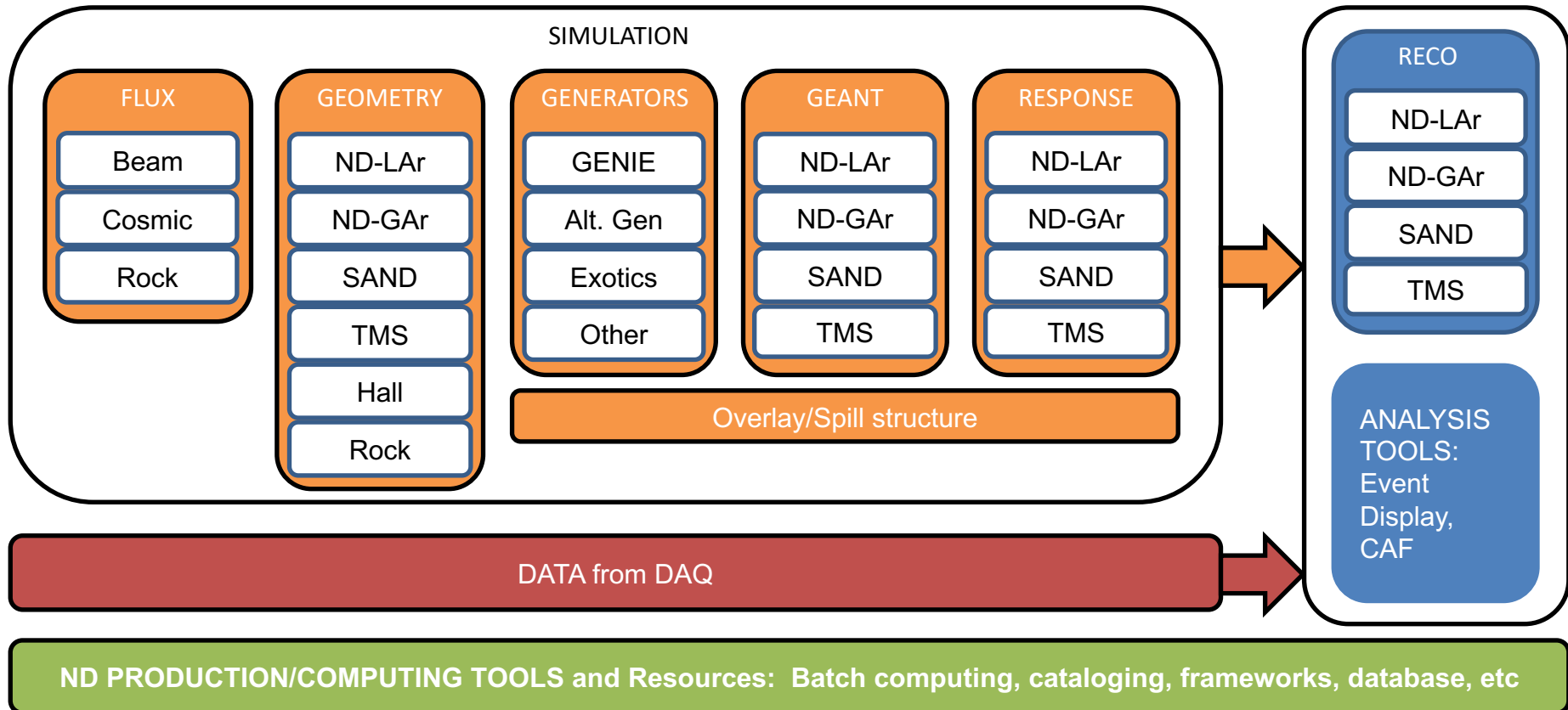
What is not ND Reco/Sim?

- We are **NOT** a production group
 - At the moment we are focusing a lot on production because:
 - the files we need for physics studies have not been produced before
 - Substantial coordination effort is needed to ensure all subdetector simulation and reconstruction can play nicely together
 - Additional effort also towards using the computing infrastructure to allow large numbers of files to be produced
 - We expect that future productions will require a lot less of our coordination effort
- Detector performance studies and plots are still within the sub-detector groups realm

Fuzzy boundaries sometimes between physics performance (DUNE ND Reco/Sim) and detector performance (DUNE ND subdetectors)

ND Software overview

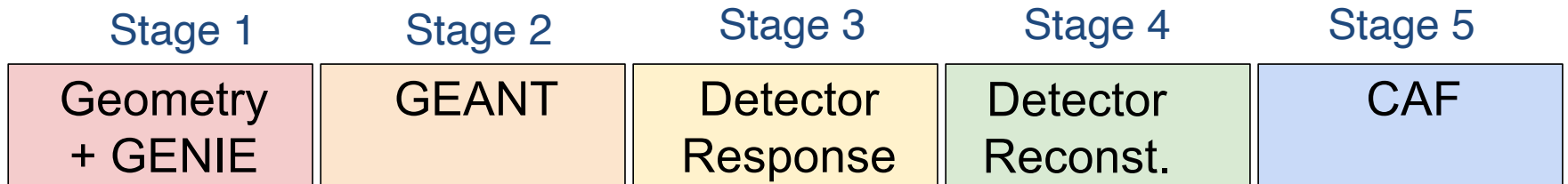
- Working on developing fully-integrated end-to-end production-ready simulation and reconstruction software for the ND detector suite.



Staged Production Process/Status

Stage Steps

Freezes → Mini-Production → Validation → Full Production



Does the software exist?

Written and working
Written and partially working
Work in progress
Not started

	Stage 1 Geo + GENIE	Stage 2 GEANT	Stage 3 Detector Response	Stage 4 Detector Reco	Stage 5 Analysis files
ND-LAr	done	done	full	ML-Reco	CAFs
ND-LAr + TMS	done	done	partial	ML-Reco + Hough/A*	CAFs
TMS Only	done	done	cheated	Hough/A*	CAFs
ND-GAr	done	done	full	GArSoft	CAFs + GArAna
SAND (ECAL, STT, GRAIN)	done	done	full	Fast and full mixed	CAFs

Is it integrated with the production tools?

Written and working
Written and partially working
Work in progress
Not started

GPUs
(see slide x)

	Stage 1 Geo + GENIE	Stage 2 GEANT	Stage 3 Detector Response	Stage 4 Detector Reco	Stage 5 Analysis files
ND-LAr	done	done	full	ML-Reco	CAFs
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SAND (ECAL, STT, GRAIN)	done	done	full	Fast and full	CAFs

Do files exist?

Yes produced officially

Yes in small numbers

Work in progress

Not started

	Stage 1 Geo + GENIE	Stage 2 GEANT	Stage 3 Detector Response	Stage 4 Detector Reco	Stage 5 Analysis files
ND-LAr	Yes produced officially	done	Work in progress	ML-Reco	CAFs
ND-LAr + TMS	Yes produced officially	done	Work in progress	ML-Reco + Hough/A*	CAFs
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ND-GAr					
SAND (ECAL, STT, GRAIN)					

ND Production Status

- Jingyuan has been our Production liaison, producing files up to Stage 2
- Working on integration of Stage 4 (reconstruction) cheating the detector response stage for now
- At the moment we are producing 1e20 POT for FHC/RHC and each geometry:
 - Active volume, topvol: volArgonCubeDetector75,
/pnfs/dune/scratch/dunepro/dune_nd_production_2022_v1/Active_Volume/FHC/
Hall_ND-LAr_TMS_SAND_TDR/edep/FHC/00m/00/
 - Active volume, topvol: volTMS,
/pnfs/dune/scratch/dunepro/dune_nd_production_2022_v1/Active_Volume/RHC/
Hall_ND-LAr_TMS_SAND_TDR_topvol_TMS/edep/RHC/00m/00/
 - Non-active volume, topvol: volArgonCubeDetector,
/pnfs/dune/scratch/dunepro/dune_nd_production_2022_v1/Non-
active_Volume/FHC/Hall_ND-LAr_TMS_SAND_TDR/edep/FHC/00m/00/
- Working on better naming to describe files more effectively (interaction vol, horn polarity, off-axis position etc.). Ideally we would use metadata for this, but this is still work in progress

Reco/Analysis readiness

- ND-LAr:
 - Jeremy W and Andrew M have successfully run the ML-Reco on a small subset of the new files
 - ML reco needs to run on GPU – currently working towards using QMUL GPUs for this
- TMS:
 - Jeffrey has integrated the reconstruction with the production scripts
 - Takes about 10 mins per job
- CAFs:
 - Faiza and Chris M have successfully produced CAFs for LAr+TMS sample for workshop
 - 10 seconds to produce a file
 - Not extensively validated yet

Other news

- Official files have been catalogued with SAM definitions and written to tape
 - Workflow does not take advantage of this at the moment
 - Full SAM integration is work-in-progress
- Jeffrey K also worked on GENIE-3 integration. Current production is still in GENIE-2 while we wait for a GENIE-3 configuration recommendation
- Palash has been working on a more efficient rock interactions generation – almost ready
- New 50TB group disk area available to ND Sim/Reco group: get in touch with me and Mat if you want access to it.

Next Steps

Stage 1

Geo./GENIE

Stage 2

GEANT

- All geometries are now included.
- Move forward to GENIE 3 (J. Kleykamp) (DIRT will provide favored base model soon.)
- Produce mini-production of rock interactions for validation.
 - Rock generation integration in progress (P. Roy)
- Produce overlay sample (Overlay framework, K. Wood)

Stage 3

Detector Response

- Detector response simulation development is in progress for all detector groups.
 - Finalize and Freeze code
 - Integrate into production chain

Next Steps

Stage 4

Detector Reconst.

- LAr reco has been integrated but needs to run on GPUs
- TMS reco integration done
- Other sub-detectors?

Stage 5

CAF

- CAF development is progressing (J. Wolcott, C. Hilgenberg/GArAna, L. Di Noto CAFs for SAND)

We also have a poll of additional production requests (Nu Int., BSM, systematic samples etc) that need integration and manpower.

[Link to production request spreadsheet](#)

Getting involved

- There has been great progress in moving forward on the ND sim/reco production and lots of new effort, but there is still a long way to go.
- Please get involved, don't assume the files will be made/handled by others... jump in and help out.
- We continue to work with the computing consortium to establish ND computing resource requirements and discuss DUNE computing choices (DB, frameworks, etc.)

THANK YOU