# Status of the HerdSoftware framework

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on behalf of the HerdSoftware development team

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# Outline

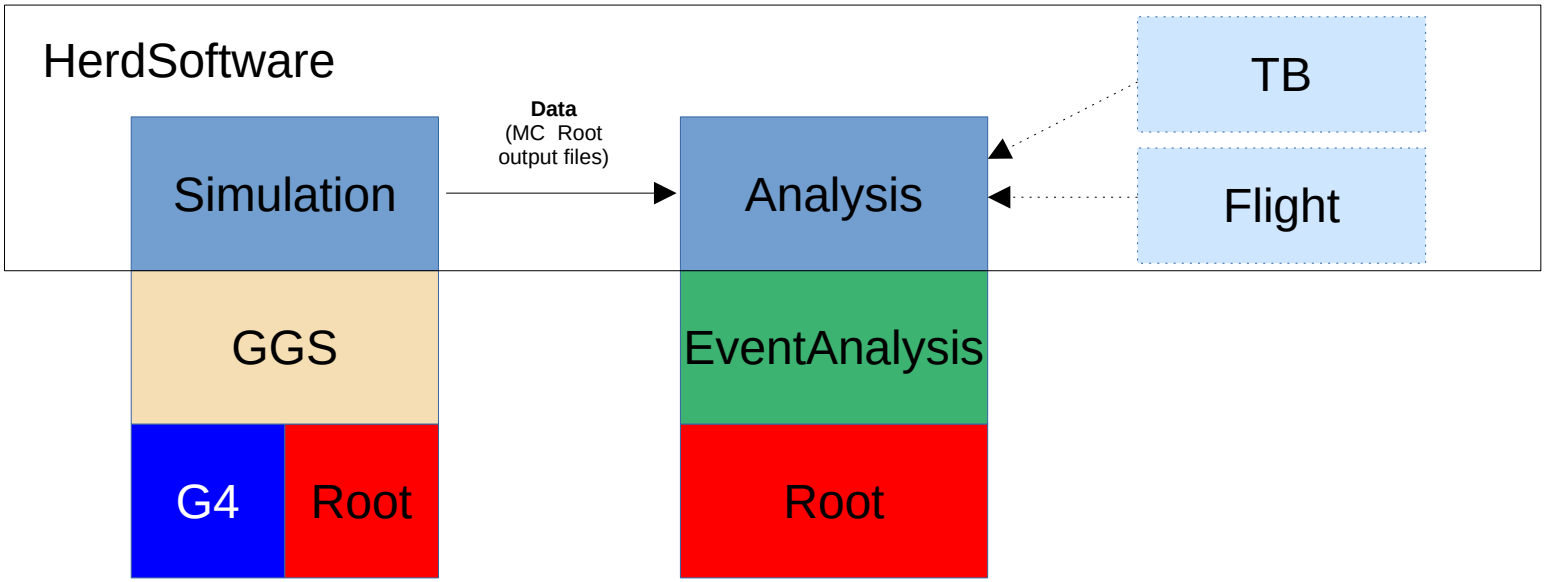
- Introduction
- Status and new features
- Involvement and adoption
- Plans

# Introduction

- HerdSoftware: framework for MC simulation and data reconstruction/analysis
- Designed and implemented from the start to be a common, shared framework for the whole collaboration
- Introduced at the 2019 Xi'an Workshop (link)

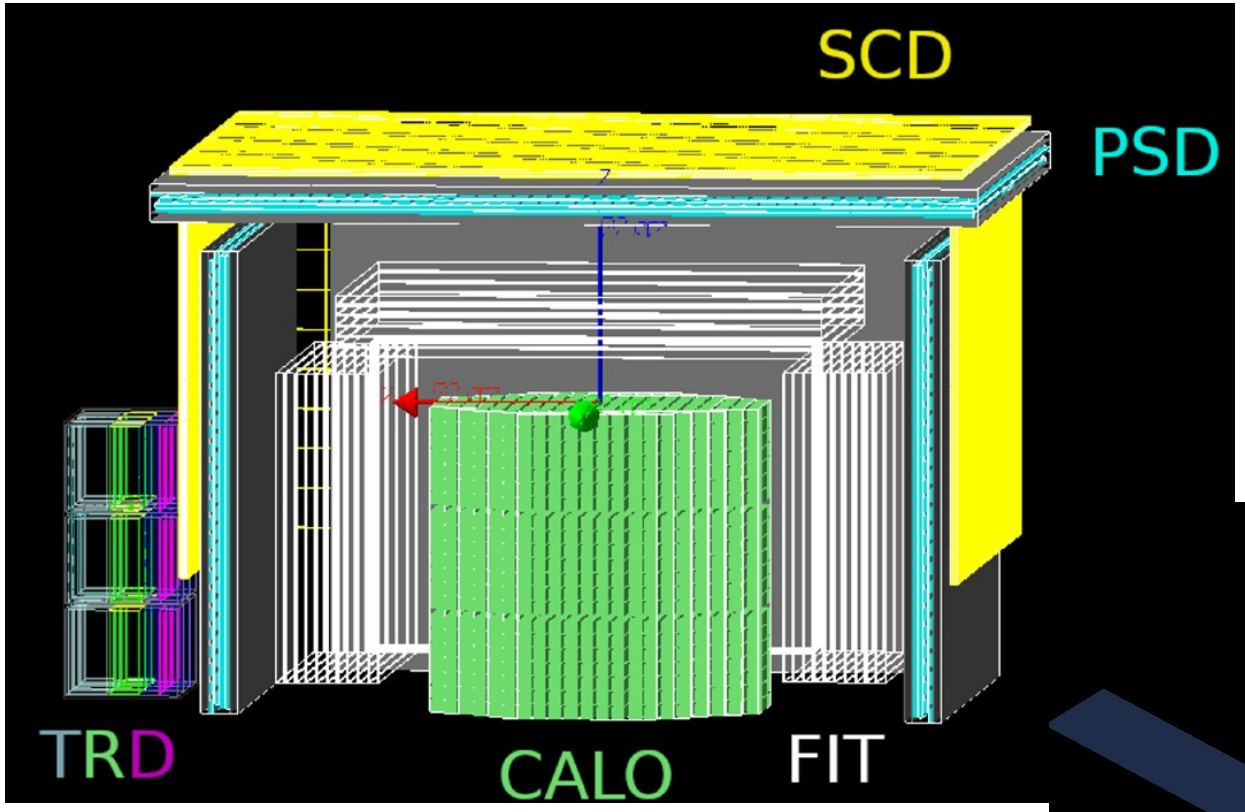
# Introduction

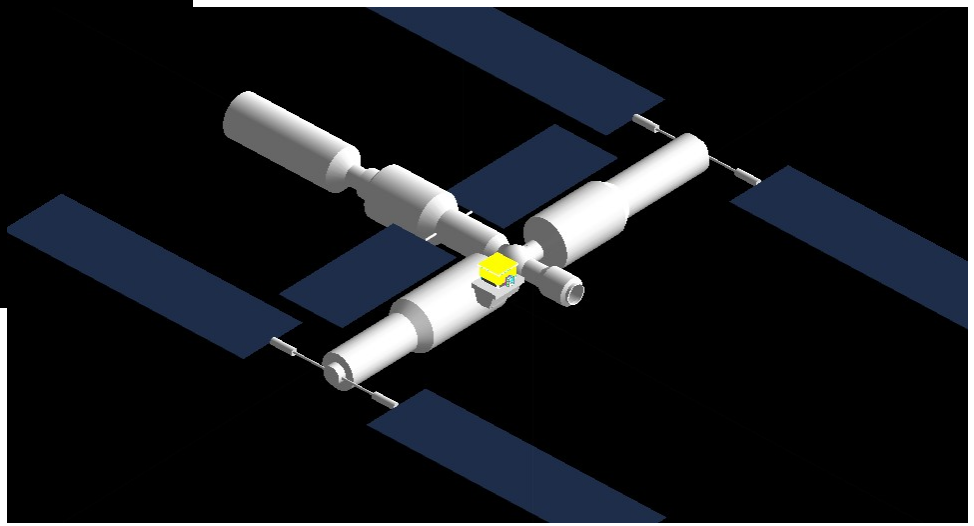
- Two distinct code parts
  - MC simulation
  - Data analysis (incl. reconstruction)



# MC simulation

- Full detector geometry



# MC simulation

- Parametric geometry:
  - Subdetectors (e.g. STK or FIT)
  - Positions
  - Details (e.g. n. of SCD layers, W in FIT etc.)
- Calo:
  - v1
  - v2 (with CF trays)

# MC simulation

- STK:
  - Si tiles + honeycomb structures
  - Optional W on TOP
- FIT:
  - Fiber mats + plastic structures
  - Optional W
- PSD
  - Bars or tiles
  - v1
  - v2 (with carbon fiber structures)

# MC simulation

- SCD:
  - Si tiles
  - Optional support foam
- TRD:
  - Settable number of modules
- Shield:
  - Optional reference external shield
- CSS:
  - Solar panel rotation and revolution angles

# MC simulation

- Custom physics:
  - TR generation and detection in TRD
  - CRMC-G4 interface for simulating hadronic interactions at PeV scale
- All other components (particle generation, output etc.) provided by GGS

# Analysis

- Data model: C++ classes
  - Hits, clusters, tracks, geometry parameters etc.
- I/O: based on Root
- Readout (data providers):
  - GGS simulation files
  - Reconstructed/analyzed files
- Output (persistence services):
  - Reconstructed/analyzed files

# Data processing

- Algorithms:
  - Modular processing procedures operating on data objects
  - Combinable to build full analysis procedures
  - Easily replaceable with alternative implementations
- Digitization:
  - CALO: full (MC GeV → ADC) for PD readout

# Data processing

- Digitization:
  - CALO: full (MC GeV → ADC) for PD readout
    - Parameters from CaloCube, to be updated
  - FIT: full
    - Dark noise, electronics
  - SCD/STK: partial
    - Drift/diffusion, strip bonding, capacitive couplings
    - Electronics to be done

# Data processing

- Calibration:
  - CALO: full (ADC → GeV/MIP) for PD readout
    - Parameters from CaloCube, to be updated
    - Will work also with flight/tb data
- Clustering:
  - CALO: 3D DBSCAN (Density-Based Spatial Clustering of Applications with Noise) algorithm
  - FT/SCD/STK

# Data processing

- Tracking
  - CALO: 3D PCA (Principal Components Analysis) algorithm
  - FIT/STK/SCD: 2D Hough transform
    - Exploits full information from all detectors on all sides
- Offline trigger
  - High Energy, Low Energy Gamma, Unbiased
  - Available soon

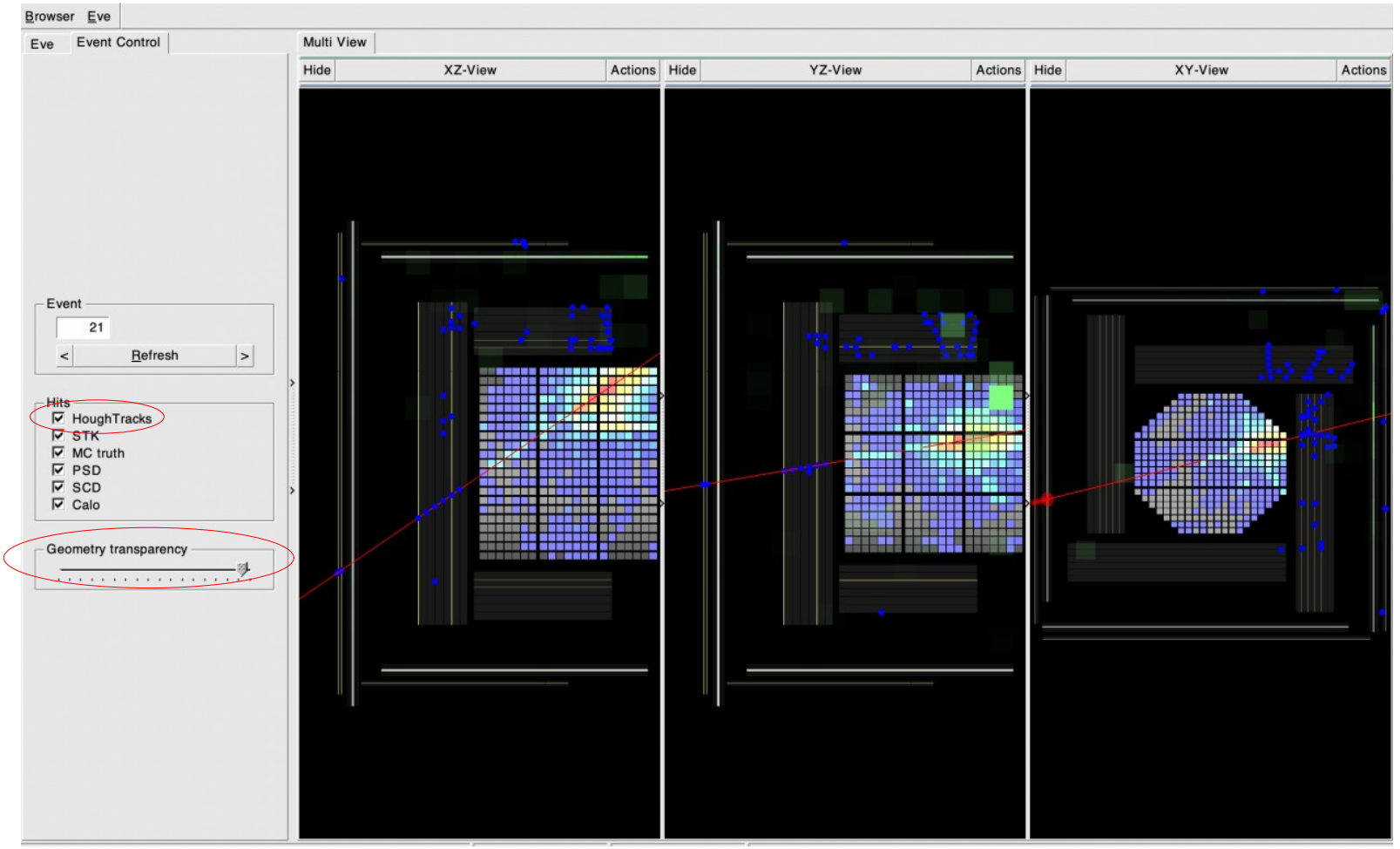
# Data processing

- Geometry
  - CALO acceptance
  - STK intersections with MC track

# Data processing

- Event display

Proton @ 100 GeV



# Infrastructure

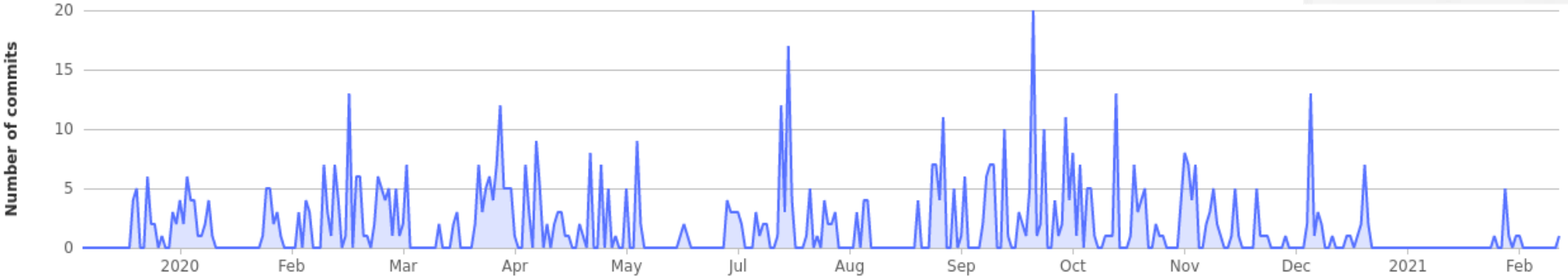
- Gitlab:

  https://git.recas.ba.infn.it/herd/HerdSoftware

- Code
- Wiki (installation, usage, examples, ...)
- Automated tests
- Automated deploy

# Involvement & adoption

- Contributions from all the countries
- Contributors:
  - C. Dai, M. Duranti, V. Formato, L. Jouvin, X. Liu, N. Mori, A. Oliva, L. Pacini, A. Tykhonov, V. Vagelli, M. A. Velasco, M. Xu




- More contributors are welcome!

# Involvement & adoption

- Regular update talks during analysis meetings
- Detector studies:
  - Geometrical factor (L. Pacini) ✭
  - Backscattering on PSD (P. Hu) ✭
  - FIT/STK performance with gamma rays (L. Jouvin, L. Fariña) ✭
  - Trigger (J. Casaus, M. Xu et al.) *
  - CALO reconstruction and performance (V. Vagelli et al.) *
  - CALO readout effects (S. Bottai) *
  - SCD charge ID performance (A. Oliva, L. Quadrani) *
  - ...

* Presented at this workshop

✭ Presented at this previous workshop / analysis meeting

# Plans for future

- Implementation of CERN test beam features
  - Geometry etc.
  - The majority of the existing algorithms will work also on TB data
- Digitization of CALO IsCMOS readout
  - Need help from Chinese colleagues
- Implementation of STK/SCD electronics effects
- Continue to work on reconstruction
  - CALO (energy of the primary particle etc.)
  - Tracking
  - …
- ...

# Summary

- The framework has grown in features since Xi’an meeting
  - Almost all the presented features were added during last year
- Well-established and robust concurrent development workflow and tools
  - Many contributors, but more are needed!
- Successfully in use for many detector performance studies
  - Happy to support other use cases
- Challenging and exciting roadmap for the future