

# FOOT software status

MAECI-MOFFITS meeting

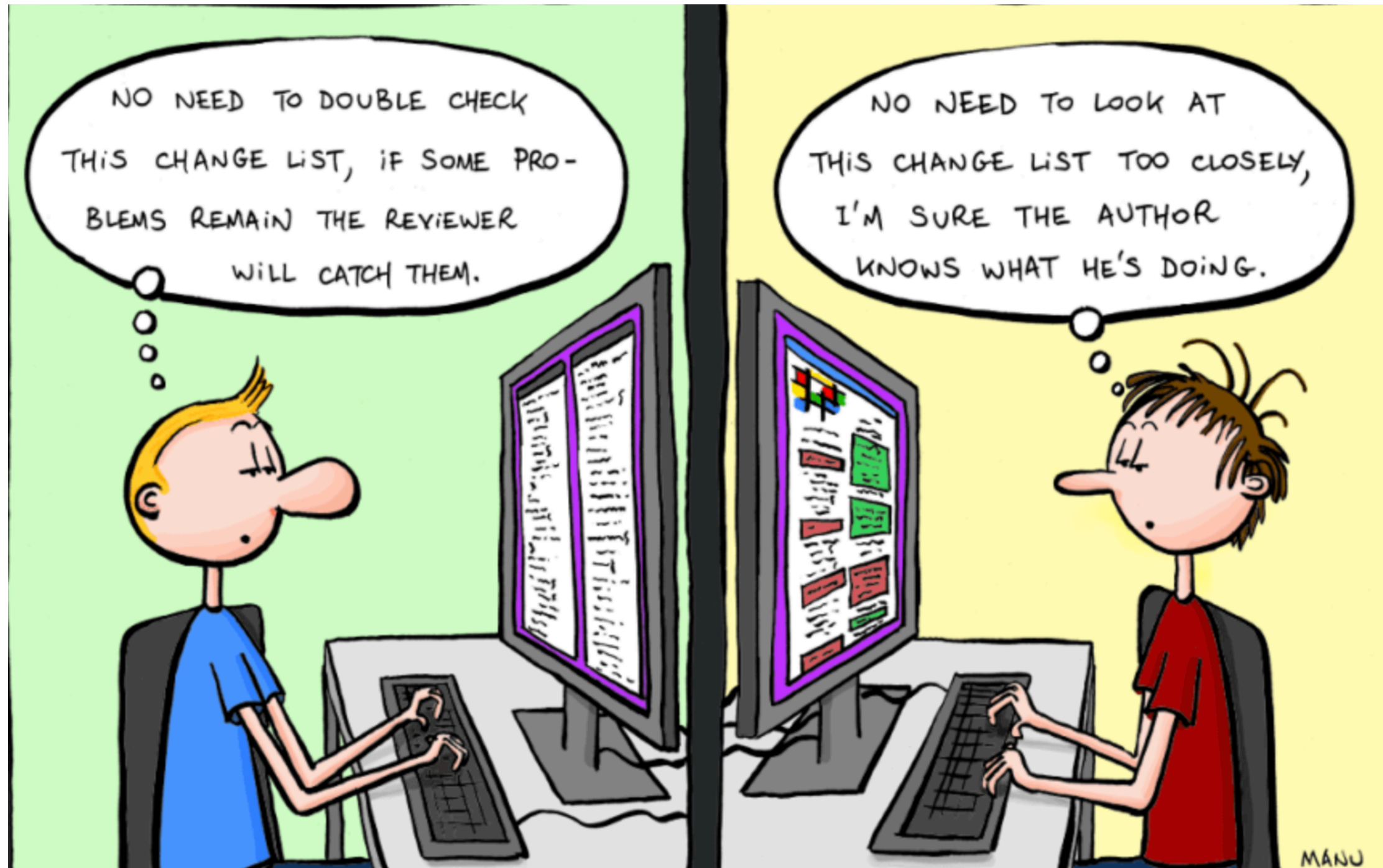
Y. Dong & R. Zarrella  
27/05/2025

# Outline

- Code development: New Guidelines
- SHOE 25.0
- Wiki
- Software tutorial
- Doxygen
- Pipelines
- Campaign viewer
- Other developments
- Software tasks and organization
- Current software development
- To do list

# Code development: New Guidelines

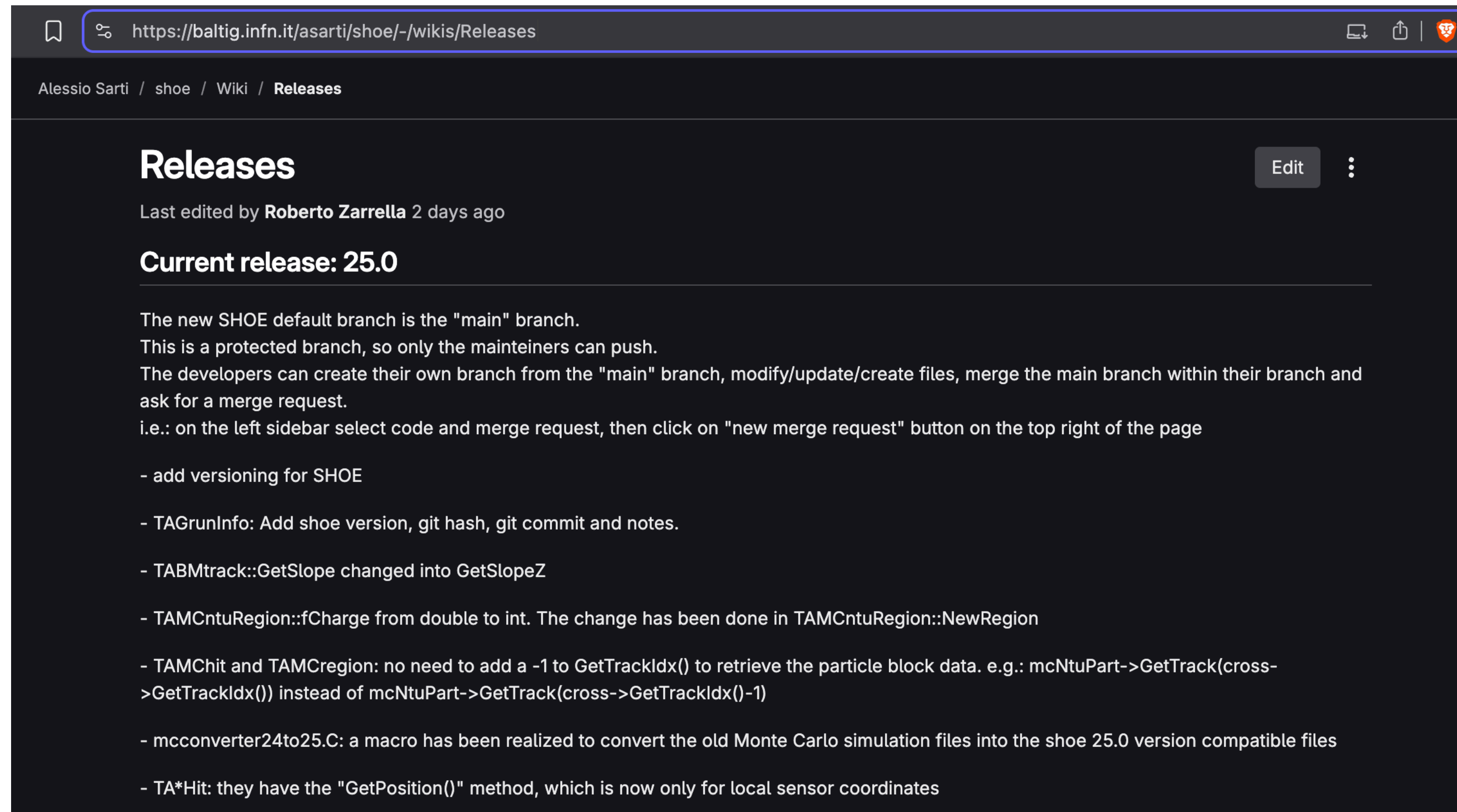
Since December 2024 we changed the push policy for the SHOE software



Probably this will happen... but we should avoid this as much as possible

- The SHOE main branch is called “main” and it is protected (aka: only maintainers can directly push into the branch (Battistoni, Dong, Finck, Toppi, Zarrella))
- Other developers are invited to create their own branch from the main, develop the code complying the coding conventions, **stay updated with the main branch** and, eventually, request a merge.
- The former newgeom\_v1.0 branch has been renamed to SHOE\_24.0 and is now locked to prevent further modifications.

# SHOE 25.0



- Current release is 25.0, we'll change the version name probably before CNAO2025
- Different methods name has been changed and new features has been added, **you can track the changes here: <https://baltig.infn.it/asarti/shoe/-/wikis/Releases>**



## Wiki pages

Access to Tier 1

Analysis Cuts

Available Simulation

Beam Monitor

Campaign\_details ▾

CNAO2024

gsi2021

Data location on Tier 1

FOOT campaigns

HOME

HTCondor

Reconstruction

Releases

SHOE

Simulation

Software Tasks

\_sidebar

## CNAO2024

Last edited by **Benedetto Spadavecchia** 1 month ago

Edit ⋮

### CNAO2024 campaign

The CNAO2024 campaign has been conducted at CNAO in November 2024 with the following sub-detectors: SC, BM, VT, IT, DI, MSD, TW and CALO.

### Useful links

- The geometry survey of CNAO2024 campaign is [here](#)
- The elog page is [here](#)
- The summary of the runs is [here](#)
- Data, Simulations and reconstructed files are stored on tier1

### Alignment

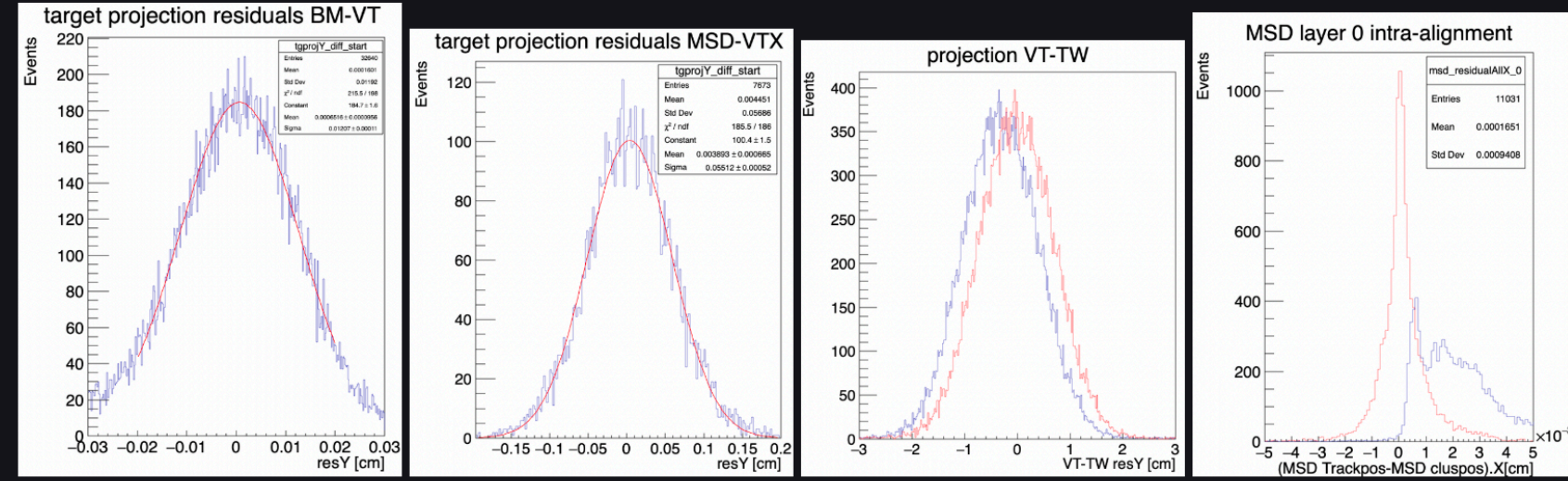
#### Alignment strategy

For the proton runs, the BM has been aligned with the VTX during the data taking using the AlignFOOTMain.C macro and selecting only the events with 1 BM track and 1 VTX vertex that have only 1 associated track.

The alignment of the detectors during the run: 6917-6961 has been conducted with the AlignFOOTMain.C macro with the following steps:

1. All the detector Z position have been fixed using the geometry survey
2. For run 6957: the TW has been placed in (-11,0) as measured in the geometrical survey. In this way the beam is centred on the two central bars when the magnetic field is present.  
For run 6917, the TW position has been evaluated using run 6925 (C @ 200 MeV/u without target and TW centered in (-1,-1)) projecting the VTX tracks to the TW plane and checking the residuals between the VT tracks and the TW hits positions. This procedure has been done **after** the alignment of the VTX detector described below.
3. On each event: the BM track is selected if there is only 1 BM track; VTX track is selected if the event is synchronized and there is only 1 VTX vertex and the vertex has only 1 associated track; MSD track is selected if there is only 1 MSD track; TW point is selected if there is only 1 TW point and the reconstructed charge is equal to the beam charge.
4. The VTX XY position has been fixed so that the beam reconstructed with the VTX tracks and projected on the Target is in (0,0).

### Example of detector alignment residual plots



- In the MSD intra-alignment plot, the blue curve is the residual between the MSD stand alone tracks with the selected MSD cluster before the alignment conducted with the VTX tracks. The red curve is the residuals after the intra-alignment procedure.
- In the VT-TW residual plot, the blue curve is the plot of run 6959 before adding the 3mm shift and the red curve is after the correction.

### Detector status

#### Beam Monitor

- The BM space time relation has been computed using the VTX tracks
- The number of events with one BM reconstructed track is of about 87%
- The mean number of hits per track is of about 9.6
- The hit detection efficiency has been evaluated, propagating the VTX tracks in the BM cell and checking the presence of a BM hit or not
- The BM spatial resolution has been computed using the residual distribution of the BM tracks and hit measurements
- The evaluation of the BM performances has been done using the run 6925

#### Inner Tracker

The Inner tracker is under study; currently, there are mapping and geometry issues.

#### Microstrip Silicon Detector

The MSD is under study. At present, no signal threshold has been set yet.

- We updated the wiki page and we are trying to keep it updated: <https://baltig.infn.it/asarti/shoe/-/wikis/home>
- New pages has been added to describe the campaign details: detectors and alignment status etc.

# Software tutorial

- We have done the III<sup>rd</sup> FOOT software tutorial in February 2025
- Many many thanks to Chris, Marco, Giuseppe and, of course, to all the participants
- <https://agenda.infn.it/event/44111/>
- **All slides and presentation recordings are uploaded on indico**



# Doxygen

## Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

[detail level 1 2 3]

▸ <b>N</b> checker	
▸ <b>N</b> details	
▸ <b>N</b> gbl	Namespace for the general broken lines package
▸ <b>N</b> genfit	Defines for I/O streams used for error and debug printing
▸ <b>N</b> orientation	
▸ <b>N</b> tag	
<b>C</b> additional_parameters	Additional parameters for particle/track
<b>C</b> baseline_procedure	
▸ <b>C</b> baseline_scorer	
<b>C</b> BaseReco	Base class for reconstruction
<b>C</b> beamtrk	
<b>C</b> BM_struct	The BM acquisition software structure
<b>C</b> caller	
<b>C</b> ChannelData	Channel data
<b>C</b> ChannelDataMeas	Padding suppression
▸ <b>C</b> cluster	Cluster parameters
▸ <b>C</b> computation_checker	
<b>C</b> ConvertNtuple	Base class for reconstruction
<b>C</b> cut_setter	

- We (actually Chris) updated the Doxygen documentation for different SHOE classes
- The Doxygen are updated automatically after each push in the main branch
- Doxygen link:  
<https://asarti.baltig-pages.infn.it/shoe/index.html>
- **For the newcomers:** you have Doxygen, Wiki, tutorial, macro examples, data accessibility (tier1), computational power (tier1+condor) and a full list of software development and analysis task.  
**Don't be shy with this opportunity!**
- **For software developers: Please remember the few simple instructions for writing Doxygen-compliant code.** There won't always be a Chris who does things for you

# Pipelines

The image shows a GitLab CI/CD pipeline interface. At the top, the pipeline is titled "update calo position for cnao2024 run 7005". It shows a status of "Passed" with a green checkmark. The pipeline was created by "Yunsheng Dong" for commit "abec6d5e" 6 days ago. It is currently running on the "main" branch. The pipeline consists of 4 jobs and 0 tests. The jobs are grouped by stage: "build" (compile), "test" (testFluka), and "deploy" (pages, pages:deploy). All jobs are shown with green checkmarks, indicating they passed successfully.

update calo position for cnao2024 run 7005

✓ Passed Yunsheng Dong created pipeline for commit abec6d5e 6 days ago, finished 6 days ago

For main

latest branch 4 jobs 9 minutes 9 seconds, queued for 2 seconds

Pipeline Jobs 4 Tests 0

Group jobs by Stage Job dependencies

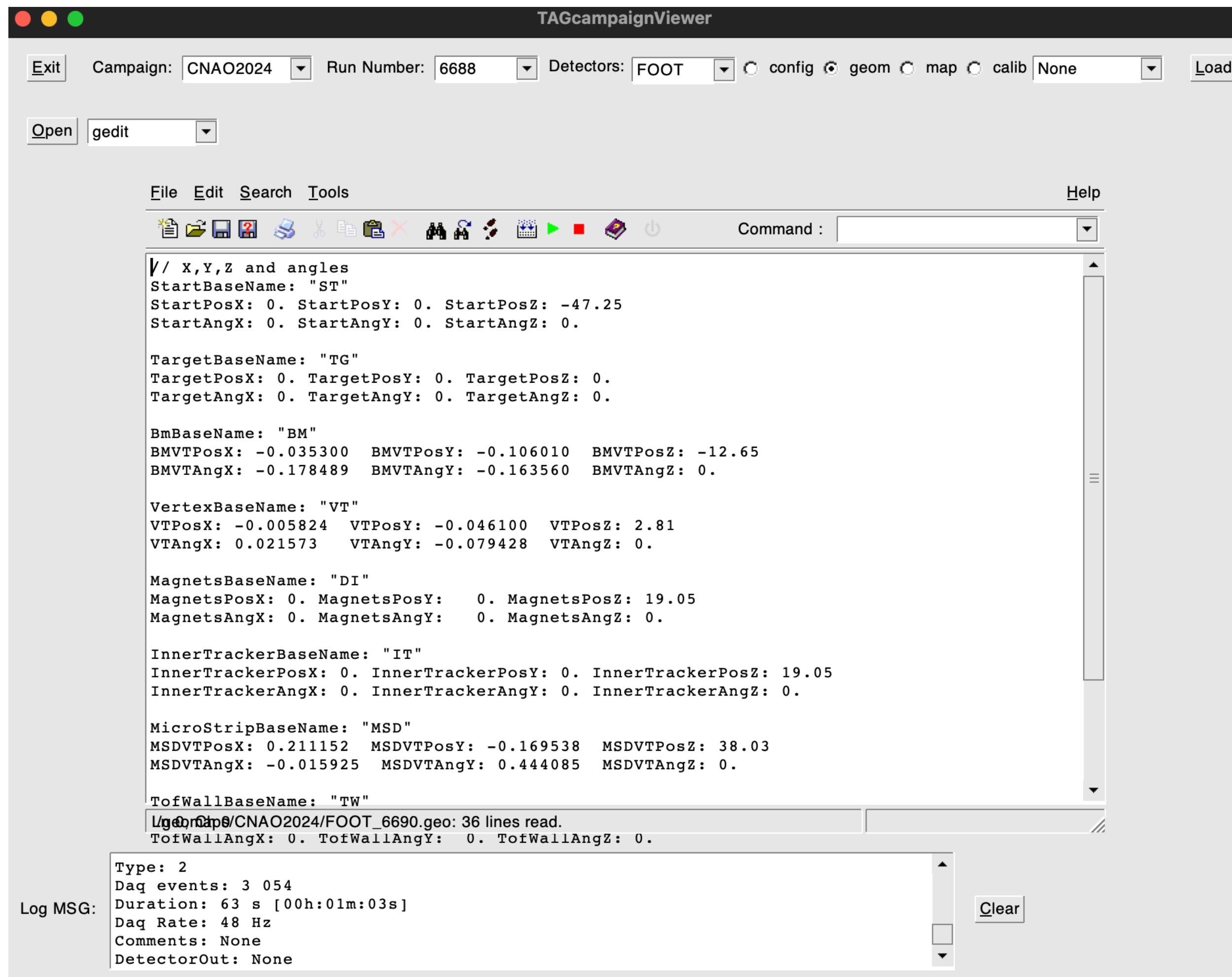
build test deploy

✓ compile ✓ testFluka ✓ pages ✓ pages:deploy

- We started to explore the instruments provided by gitlab
- One of that are the pipelines: at each push of any shoe branch, it builds the whole code from scratch on a linux based machine
- **If the pipeline fails, an email message will be sent. You can click on the Pipeline# link and check the error** (N.B.: sometime there can be false errors due to out-of-memory issues on baltig)
- New branch created from main branch will automatically inherit the compile and testFluka pipeline stages
- This is a useful tool to check the compilation of the code. However, it is good practice to check and test the code before the push

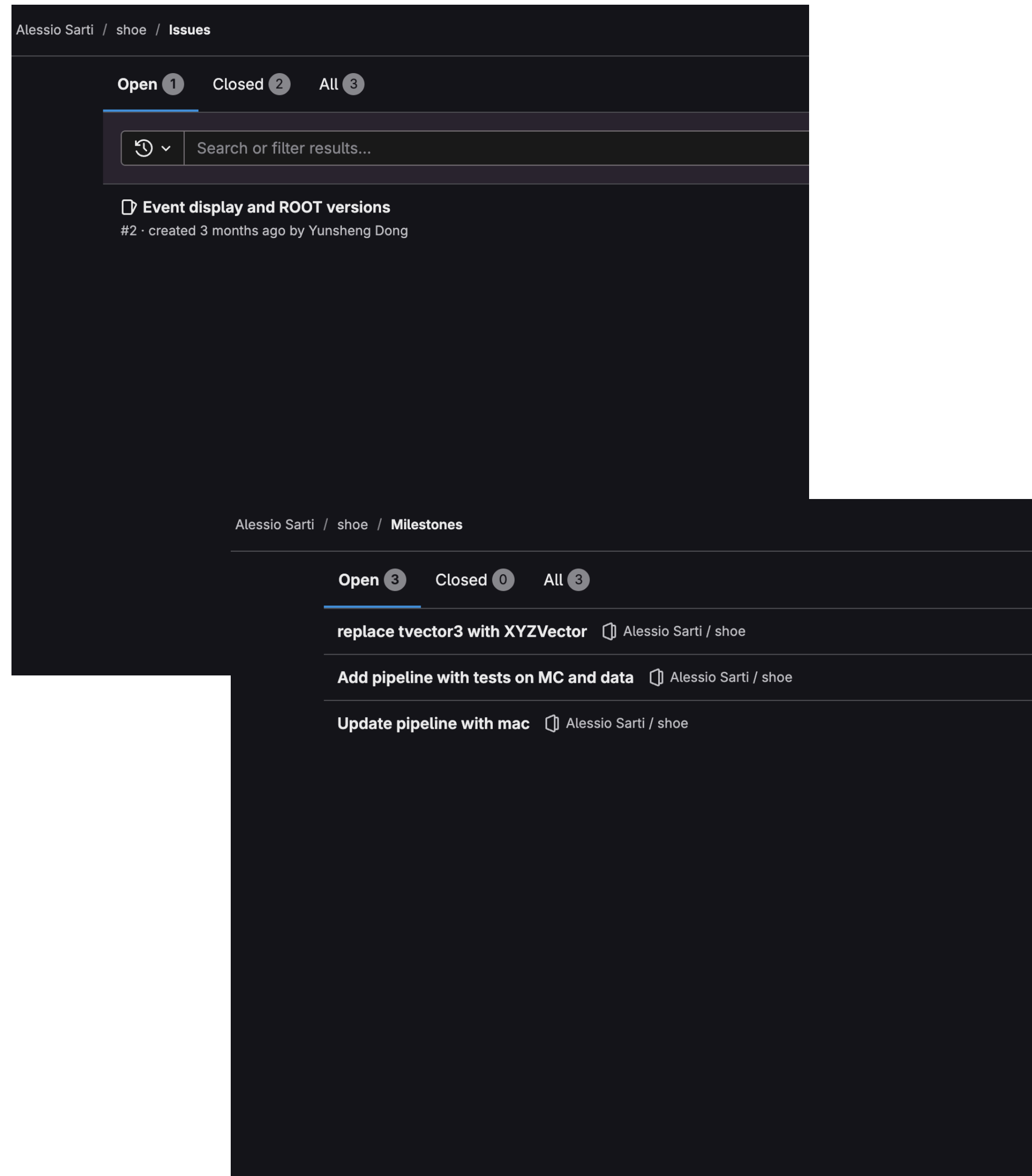


# Campaign viewer



- A campaign viewer tool has been developed by Chris to check and modify all the config/geo/map/calib files of the FOOT main campaigns
- GSI, HIT2022, CNAO2022/3/4, GSI21PS\_MC, HIT22PS\_MC, CNAO22/3/4PS\_MC)
- How to use it:
  - just open root in the Reconstruction folder and type:TAGcampaignViewer::Instance()
  - choose the desired campaign, run, detector, type of file and press the “Load” button
- Possibility to use different external text editors
- **Possibility to directly modify and save the file**

# Other developments



- G4 simulations —> Chris presentation
- Possibility to raise issues on gitlab (<https://baltig.infn.it/asarti/shoe/-/issues>)
- Possibility to add milestones on gitlab (<https://baltig.infn.it/asarti/shoe/-/milestones>)
- Other minor changes listed here: <https://baltig.infn.it/asarti/shoe/-/wikis/Releases>

# Software tasks and organization

Project/task	Contact person(s)	Branch	Work in progress
Framework	Y. Dong, R. Zarrella	main	Merge from other branches
Start Counter	G. Traini		Implementation of waveform analysis: trigger cell correction + fit-less time calculation. Check correct time propagation for global reconstruction studies.
Beam Monitor	Y. Dong		Detector calibration and analysis
Vertex	C. Finck, M. Toppi		Work on alignment strategies + tracking integration. Charge ID capabilities being explored.
Inner Tracker	C. Finck, M. Toppi		(see Vertex)
MSD	A. Sarti, I. Mattei, S. Mazzolani	AleMSDStudies	Pedestals, Common noise, and eta function studies
Tof Wall	A. Kraan, R. Zarrella, M. Morrocchi, M. Toppi, T. Minniti		Working on time and charge calibrations.
Calorimeter	P. Cerello, E. L. Torres, B. Spadavecchia, A. Valetti	bspadavec	Full porting of geometry, clustering and calibration studies
DAQ	M. Villa, R. Ridolfi		DAQ classes developed and stable. No ongoing work.
Global Reconstruction	M. Franchini, R. Zarrella	GlobalGF_dev	Different parallel strategies are being developed in two different branches
Simulation (FLUKA)	S. Muraro, G. Battistoni		
Simulation (G4)	M. Vanstalle		Geant4 simulation
Trigger	G. Traini		Triggering strategies implementation and study will be performed against the simulation.
Analysis	I. Mattei, R. Ridolfi, G. Ubaldi	Ubaldi_temp + GSI2021 + GSI2021_XS	Analysis on GSI2021 cross section measurements
Alignment	Y.Dong	Alignment macro	Alignment of the global setup

- This is an “inclusive” list of people, different people are involved in different tasks and **we still have problem of manpower** (+ concorsone)
- In December Laura Buonincontri joined the CALO team in Turin and asked me instructions about SHOE... But she left few months ago. Now in Torino there is a new post-doc: Bharat
- We have a new Ph.D. student in Perugia for the MSD and she started to learn about coding in C++ and how to use ROOT
- Chris have a master student dedicated to IT



# Current software development

- Regarding software development, different detectors are in a “good shape”: SC, BM, VTX, TW, Simulations
- IT: Chris and his student developed a new tracking algorithm for IT alignment that can work w/o magnetic field. A lot of work had been done to fix the decoding issues and to perform efficiency analysis. Still working on debugging, mapping, geometry etc.
- MSD: Ilaria and Sofia developed different macros to evaluate pedestals, common noise and dead strips. Currently working on the physics runs. Need to evaluate the detector performances, analyse the clustering algorithm, ghosts, MC digitiser etc.
- CALO: Benedetto worked on the analysis and calibration of the CALO using different macros. Currently working on data analysis related topics. At some point the analysis code will be included in the SHOE framework
- Global reconstruction: Added a new EnableBMmatch flag in FootGlobal.par so that Genfit or StraightTrack will reconstruct only the tracks of the vertex matched with the BM (y) or all the vtx tracks (n). Useful for high pile up campaigns e.g.: GSI2021.
- Cross section analysis: A lot of work had been done by Giacomo U. to develop the cross section analysis classes (TANA\*). Now the cross sections and different other global analysis tasks can be “easily” done using configuration files to set the cuts and select the type of analysis.

# To do list: towards CNAO2025

- Before CNAO2025:
  - Complete the software required for MSD and CALO and merge them into the main branch
  - Replace all the TVector3 (obsolete) with the new XYZVector
  - SHOE 25.1
- During CNAO2025:
  - Use a dedicated non protected branch
  - Use FastDecode for monitoring and analysis purposes
  - Use Footbol4 or another computer for almost-online monitoring
  - Update the FOOT.geo files**
- After CNAO2025:
  - clean the dedicated branch and merge into main branch
  - update all the detector calib/geo/conf files
  - alignment

# To do list: sooner or later

- Automatised and improve some tasks (e.g.: alignment)
- Check up all the software detector by detector and do a performance evaluation (speed, memory leaks, optimization etc.)
- Review of current “Standard” Genfit global reconstruction algorithm
- Development of further track finding algorithms for cross-check of performance (“outsidein”, “back”)