

ProtoDUNE GEANT4 simulation

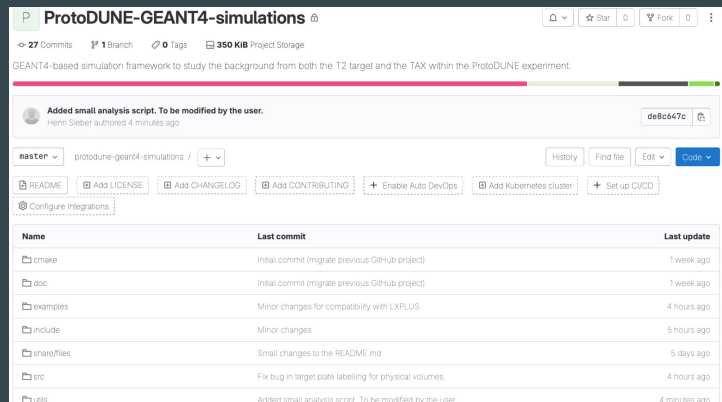


Update on background simulation from T2 and TAX

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08.02.2024

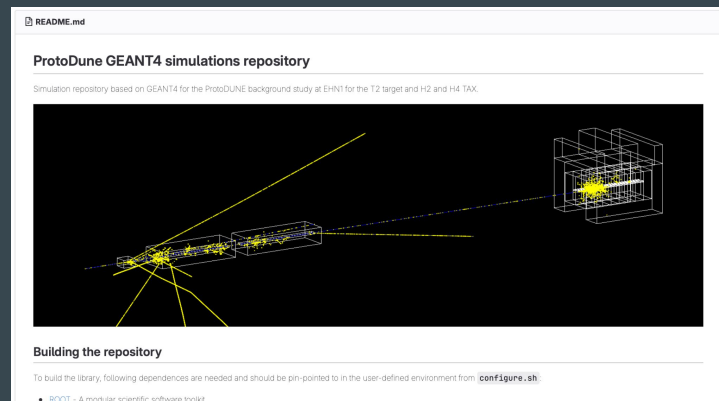
Status

- Full GEANT4-based implementation of the **TCC2 T2 and H2/H4 TAX** area
- Preparation of a dedicated example for the study of particles (i) **production** within the target from primary 400 GeV/c proton interactions and (ii) **propagation** after the **T2 target** and before/after the **TAX**



The screenshot shows the GitHub repository page for "ProtoDUNE-GEANT4-simulations". At the top, it indicates 27 commits, 1 branch, 0 tags, and 350 KiB of project storage. A commit message "Added small analysis script. To be modified by the user." is visible, authored by "Hermi Sobier" 4 minutes ago. Below the commit, there are buttons for "README", "Add LICENSE", "Add CHANGELOG", "Add CONTRIBUTING", "Enable Auto DevOps", "Add Kubernetes cluster", and "Set up CI/CD". A table lists the repository's files and their last commit details.

Name	Last commit	Last update
cmake	Initial commit (migrate previous GitHub project)	1 week ago
doc	Initial commit (migrate previous GitHub project)	1 week ago
examples	Minor changes for compatibility with LXPLUS	4 hours ago
include	Minor changes	5 hours ago
sharefiles	Small changes to the README.md	5 days ago
src	Fix bug in target plate labelling for physical volumes	4 hours ago
utils	Added small analysis script. To be modified by the user.	4 minutes ago



The screenshot shows the README.md file for the "ProtoDune GEANT4 simulations repository". It describes the repository as a simulation repository based on GEANT4 for the ProtoDUNE background study at EHN1 for the T2 target and H2 and H4 TAX. Below the text is a 3D visualization of a particle detector setup with yellow particle tracks. The "Building the repository" section provides instructions on how to build the library, mentioning dependencies and a user-defined environment from a script named "configure.sh".

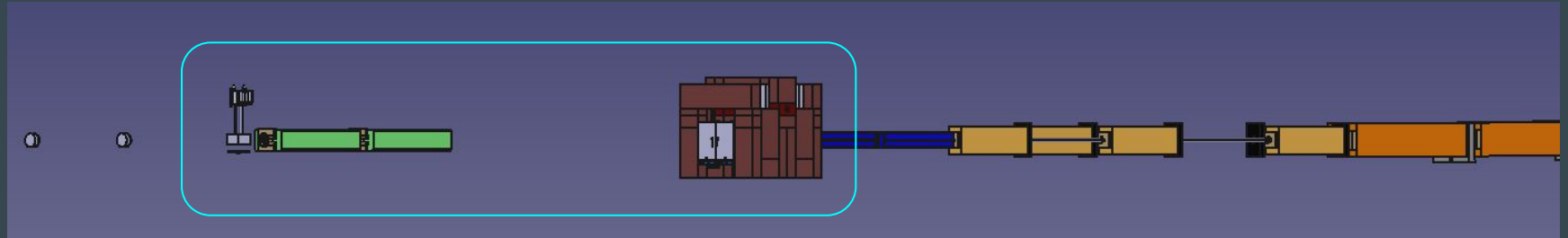
Building the repository

To build the library, following dependencies are needed and should be pin-pointed to in the user-defined environment from `configure.sh`.

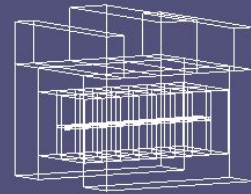
- ROOT - A modular scientific software toolkit

TCC2 T2 target and H2/H4 TAX

Full area translated to **GEANT4!**



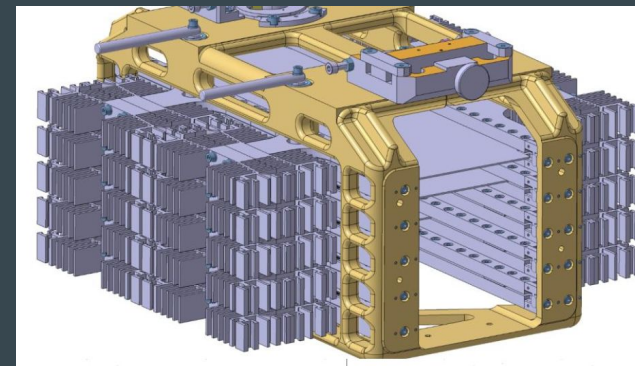
GEANT4



T2 Target

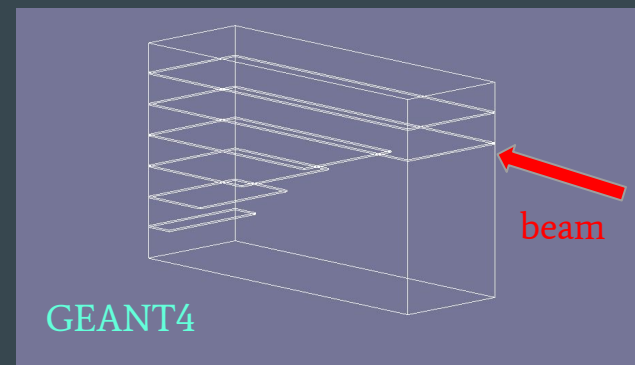
EDMS no. 1267311

- Simplified implementation of T2 target geometry (**only Be plates**, no Al cooling fins)
- Different Be **plates geometry** (5) + one “empty” configuration



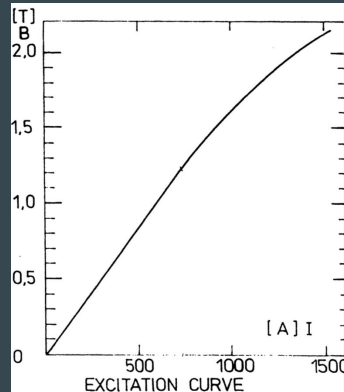
Position	Material	Length (mm)	Height (mm)	Width (mm)
0	Air/OUT	-	-	-
1	Be	500	2	160
2	Be	300	2	160
3	Be	180	2	160
4	Be	100	2	160
5	Be	40	2	160

5x plates, 40 mm inter-plate distance

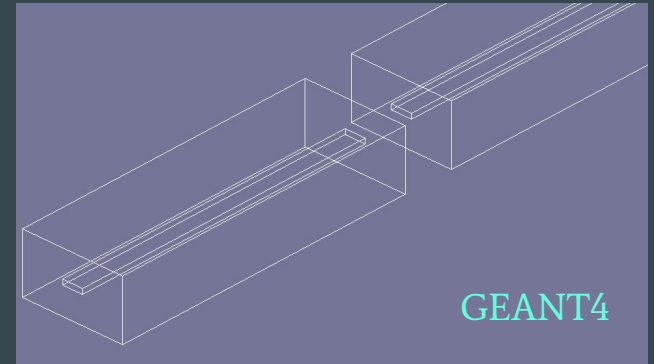
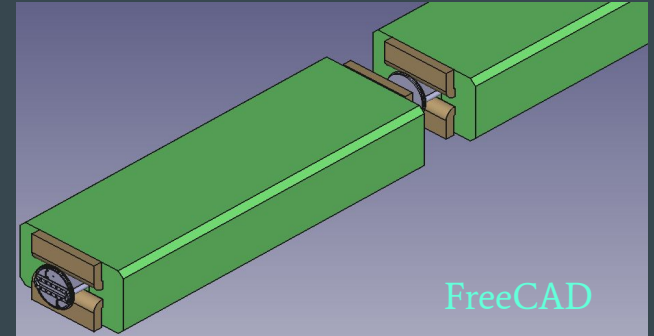


MTN bending magnets

- Simplified implementation of MTN magnets **without epoxy coil** structure
- **Uniform magnetic field** within the magnet aperture (no fringe effects)
- Field value tunable depending on the **wobbling configuration**



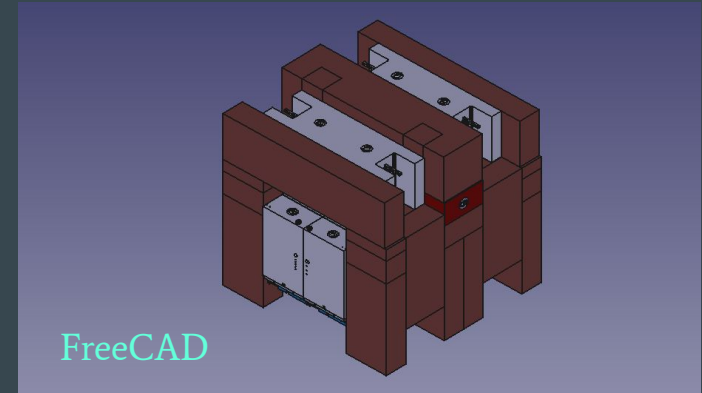
CERN-OPEN-2004-003



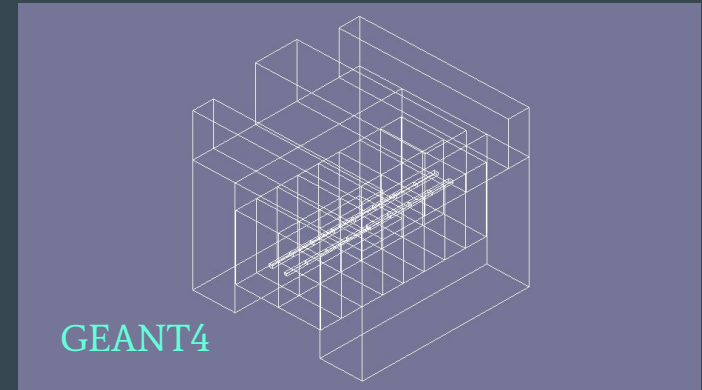
TAX and shielding blocks

EDMS no. 2593676

- Implementation of both TAX for **H4** and **H2 beam lines** and enclosing Fe shield structures
- TAX block structures: (i) **Al-Cu-Cu-Fe** and (ii) **Cu-Cu-Fe-Fe** with hole within the individual blocks



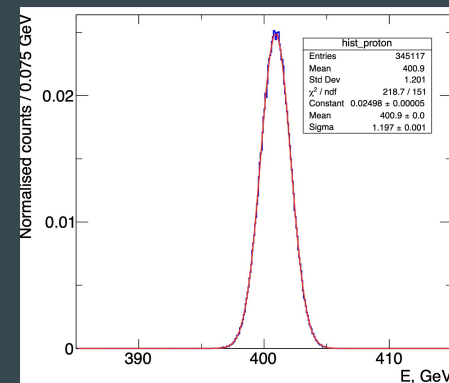
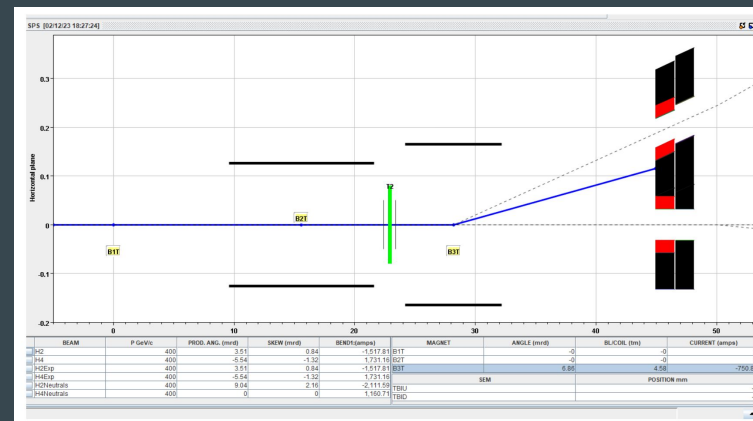
Name	Beam	Taxmot	Reference	Y-position	Hole size	Insert position				TAX range	Composition	Comments	
						Block1	Block2	Block3	Block4				
T2 (checked 26/04/2023)	H2	1	XTAX0210023	143.5	dump	120 cm Be (Ø=12)					small	Al-Cu-Cu-Fe	Negative range limits:
				100						small	Small: +85		
				-20	60x40					medium	Medium: -35		
				-140	48x40					large	Large: -142 mm		
	2	XTAX0210025	142	dump	80 cm Be (Ø=12)					small	Cu-Cu-Fe-Fe	<12 mm holes have W inserts	
			80						small	Negative range limits:			
			20	Ø=4 (W insert)					small	Small: +5			
			-60	Ø=12					medium	Medium: -75			
3	XTAX0220023	142	dump	160 cm Be (Ø=12)					small	Al-Cu-Cu-Fe	Negative range limits:		
		60						small	Small: +45				
		-20	Ø=12					medium	Medium: -35				
		-140	64x50					large	Large: -142 mm				
4	XTAX0220025	143	dump	Ø=4.2 (W insert)					small	Cu-Cu-Fe-Fe	<10 mm holes have W inserts		
		100						small	Negative range limits:				
		60	Ø=6.0 (W insert)					small	Small: +45				
		-20	Ø=5.0 (W insert)					medium	Medium: -35				
		20	Ø=7.2 (W insert)				large	Large: -142 mm					
		-60	Ø=16.0					large					
		-140	64x50					large					



Particle production study

Wobbling no. 133

- Dedicated simulation example to study **particle production** with 2023 wobbling configuration 133 (several configurations used)
 - The 2023 configuration was shared by the beam department and we are waiting the one for 2022.
- Events registered in **MC truth detectors** (T2, before and after TAX)
- Use of **CERN batch submission service** for large statistics (currently running)



Outlook

- Once large statistics simulations terminates, study of the **spectra** (energy, angle, ...) of both mesons and hadrons and **comparison** with previous study (see **JHEP01(2024)134**) and **GENIE** rates per POT
- **Simulation repository** can be made available after the final tests (currently being developed on Gitlab)