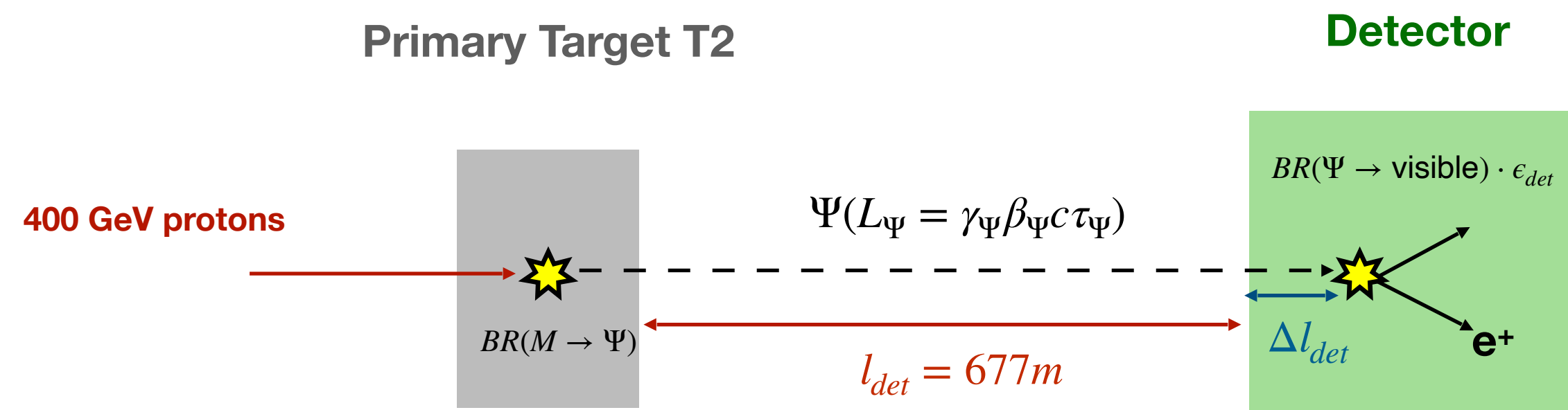


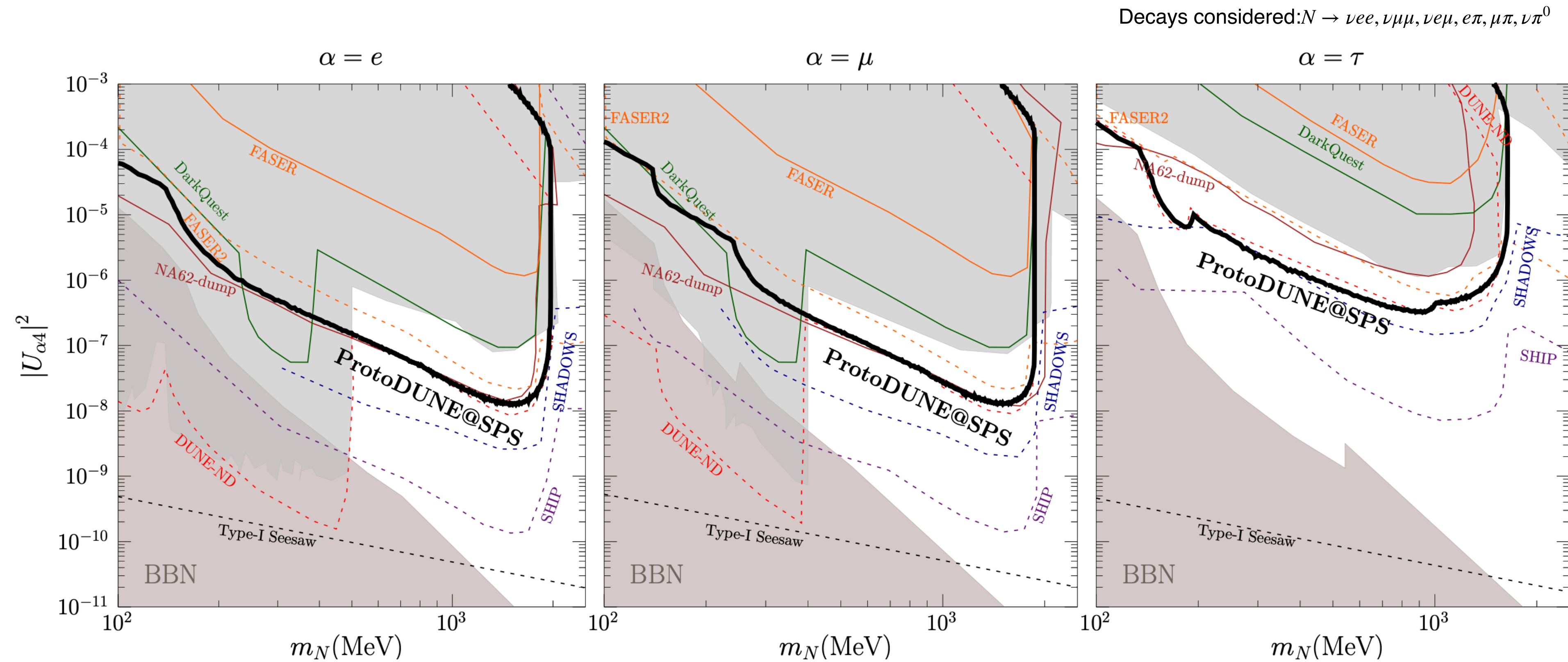
Feasibility studies: where we are

Summary from our last meeting

- Working group created meeting on a monthly basis (different tasks assigned): Animesh, Albert, Ciaran, Hamza, Henri, Jacobo, Justo, Josu and Laura with great feedback and help from Filippo and Giovanna.
- Our main goal was to demonstrate the feasibility of searching for BSM physics using the ProtoDUNE detectors.
 - Are there any showstoppers? Are we able to see such particles? Can we trigger those signatures? What is the background level?
 - We decided to focus on searching for long lived particles which might decay inside the detector (for example HNLs)



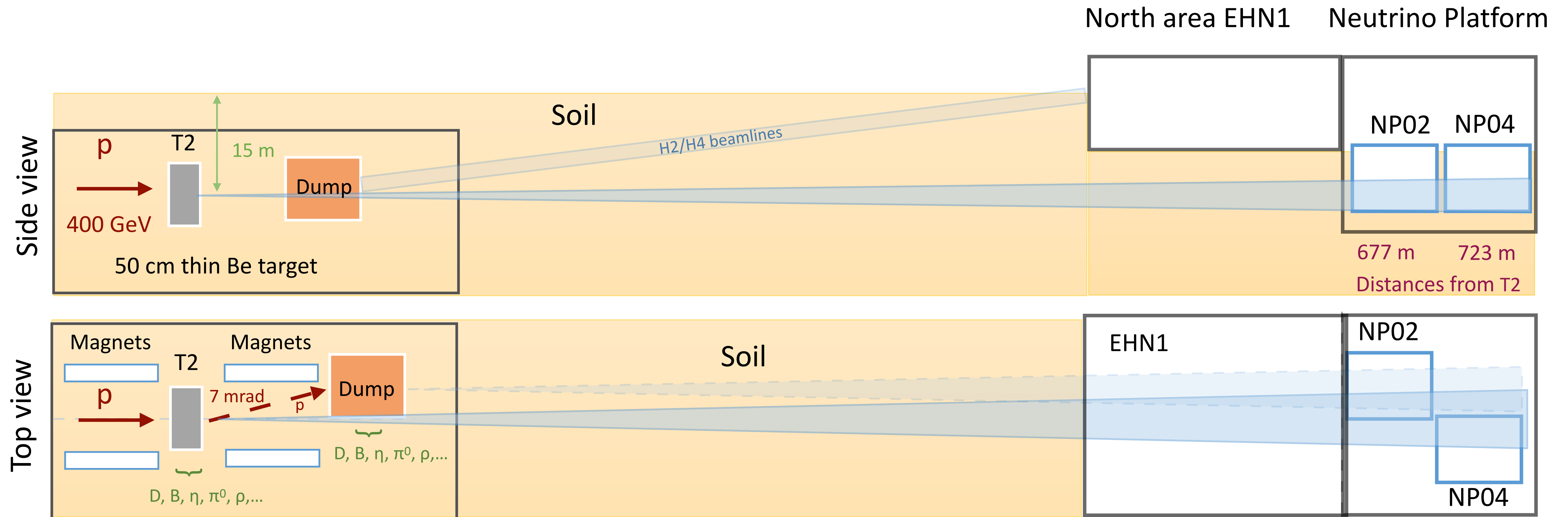
HNL sensitivity



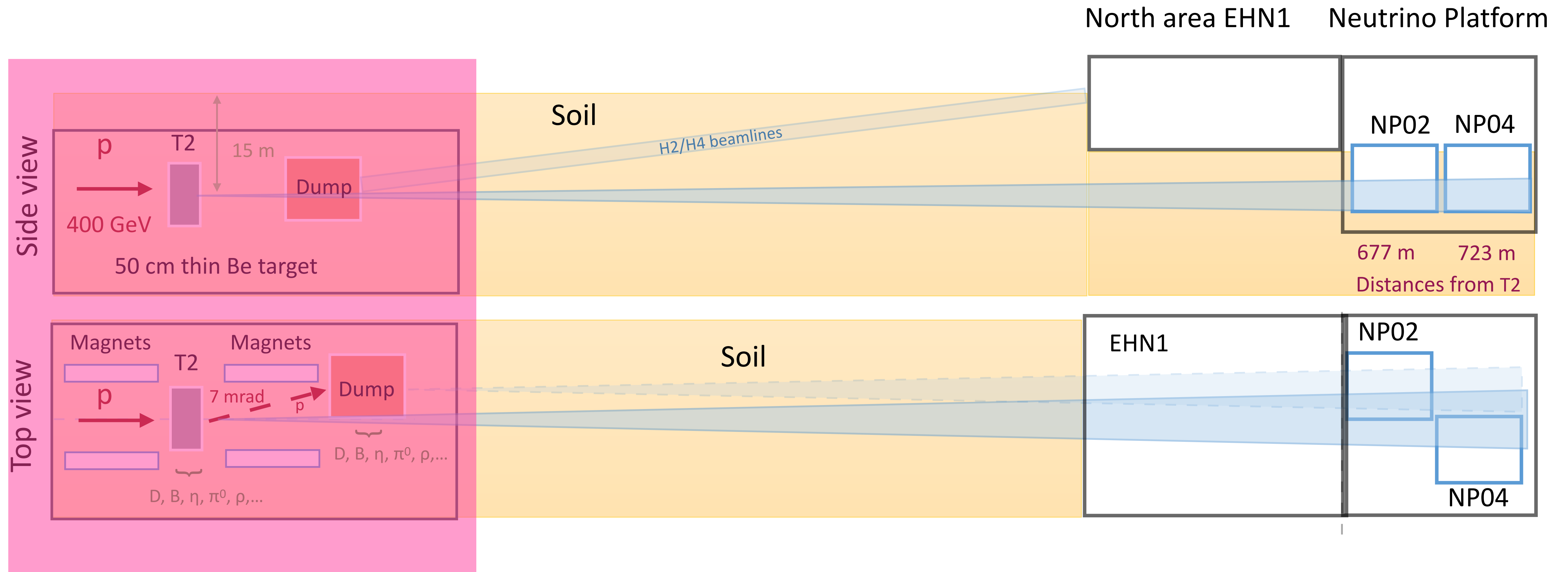
P. Coloma, J. López-Pavón, L. Molina-Bueno and S. Urrea, JHEP 01 (2024), 134 doi:10.1007/JHEP01(2024)134 [arXiv:2304.06765 [hep-ph]].

Important: zero-background considered in this plot
5 years of exposure: 1.75×10^{19} PoT

HNL sensitivity

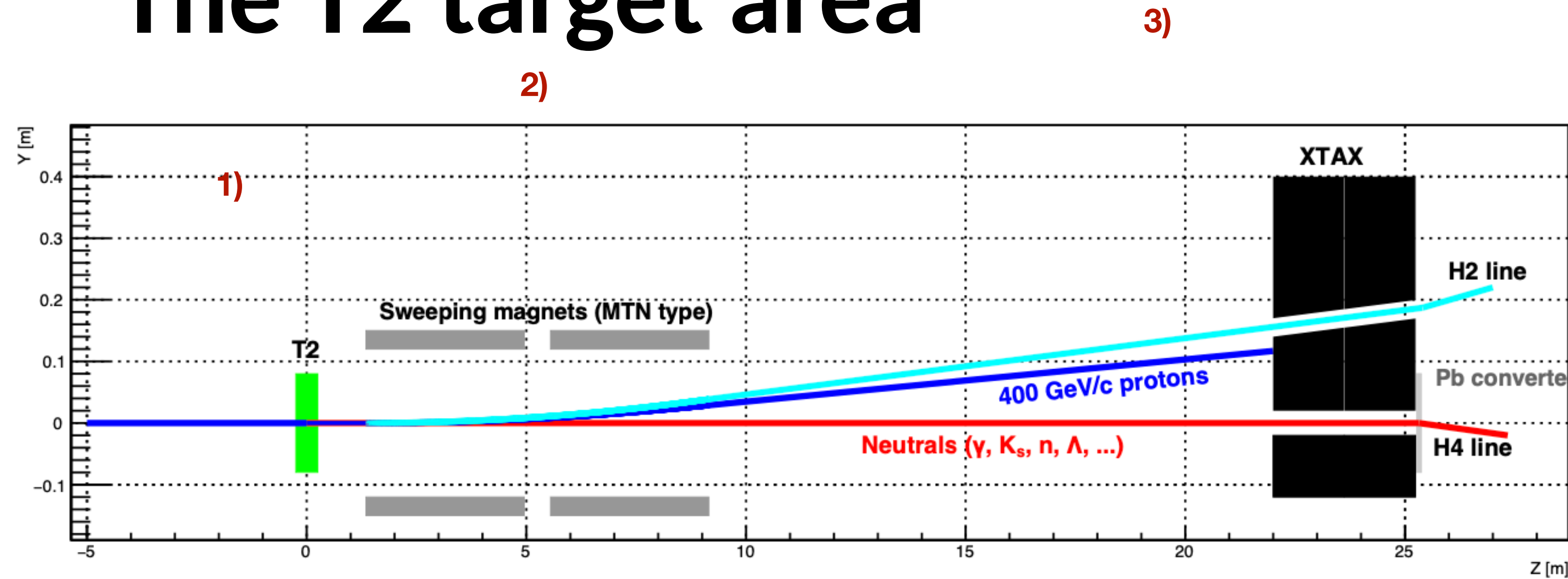


HNL sensitivity: *the setup*



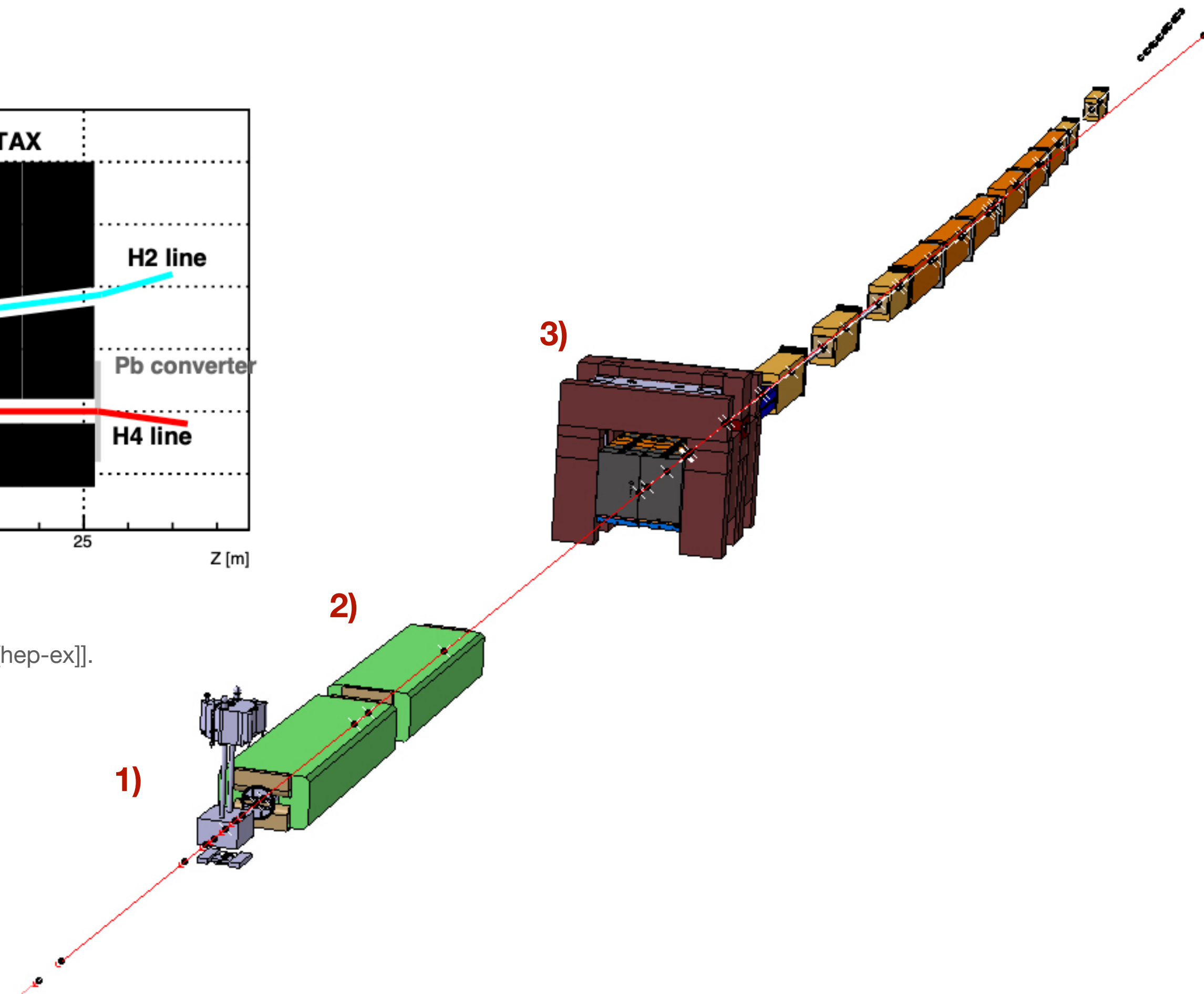
HNL sensitivity: *the setup*

The T2 target area

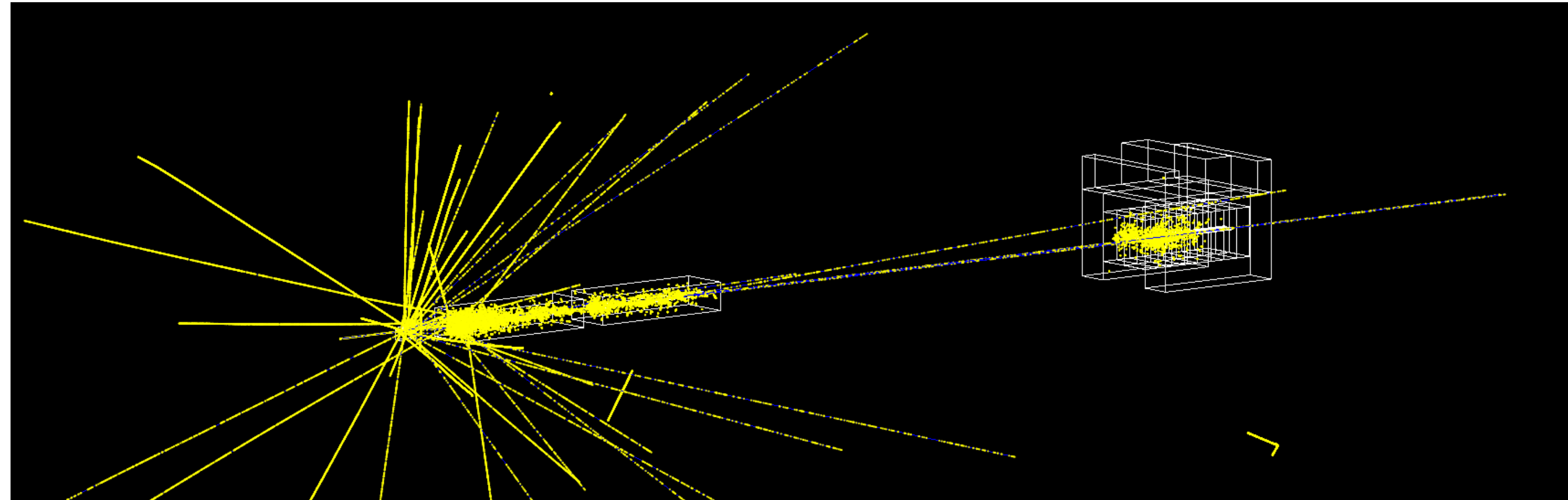


<https://www.sciencedirect.com/science/article/pii/S0168900223007672?via%3Dihub>
NA64 collaboration, Nucl. Instrum. Meth. A 1057 (2023), 168776 doi:10.1016/j.nima.2023.168776 [arXiv:2305.19411 [hep-ex]].

From previous meeting



Realistic Geant-4 based simulation of the T2-target area



- Henri Sieber joined the effort on January 15th and he has developed a detailed Geant-4 based simulation including the T2 Target, TAX and magnets.
- The results of the paper were obtained using Pythia without considering the meson regeneration in the target
 - Ongoing comparison of the fluxes generated in Geant4 and in Pythia
 - Simulation of D and B's not reproduced reliably in Geant4 and is currently under investigation. We will have also feedback from SHIP people (thanks to Albert)
- Detailed information from the magnets and the configuration used along 2022 and 2023 provided by N. Charitonidis
 - *More details in Henri's talk this afternoon*

HNL sensitivity: *signal*

- Most important channels, topologies and kinematics from the signal events studied
 - More details in Salva's talk
- New module in LArSoft developed by Ciaran to have a full simulation of the signal events in the LArTPC
 - Reconstruction effects and selection criteria
 - More details in Ciaran's talk
- Other possible scenarios under study: *inelastic DM, ALPs,...*

HNL sensitivity: *backgrounds*

- Neutrinos produced from neutrals and short-lived mesons in the T2 target and TAX.
 - *Opportunity to study neutrinos in ProtoDUNE?*
 - Detailed study ongoing using GENIE
 - Expected rate in 5 years plus possible ways to attenuated
 - *More details in Salva's presentation*
- Cosmic Ray background
 - Retrieving data from ProtoDUNE-SP-run1
- Other possible sources to be studied

Trigger

- Hamza Amar joined the team in January.
- He got familiarised with the trigger logic, working groups and experts
 - Effort embedded into the DAQ and trigger groups
- Ongoing algorithm developments based on 50l cold box data
 - To be tested in ProtoDUNE-SP-run1: main goal retrieve the expected CR rate
 - *This will be important also for the scattering signal (millicharge particles) as it will be the main background*
- Algorithm to be tested in ProtoDUNE-HD run
- We had also productive discussions with Giovanna: possibility to have access to all Trigger Primitive information acquired during the run and combined with the timing information from the beam.
- *More details on Hamza's presentation*

Summary

- Progress on many items: *simulations, trigger and backgrounds*
- Main goal of the meeting:
 - define where we are
 - identify the critical aspects
 - Next steps (discussion this afternoon)
 - HNL sensitivity with background level by June
- ProtoDUNE-NP04 ready by summer (more details on Filippo's talk)
 - Great opportunity to see if this proposal is feasible!

Back-up

The TCC2 area

The next step will to understand of the surrounding taxes can be a source of additional signal-like events which can be potential background sources

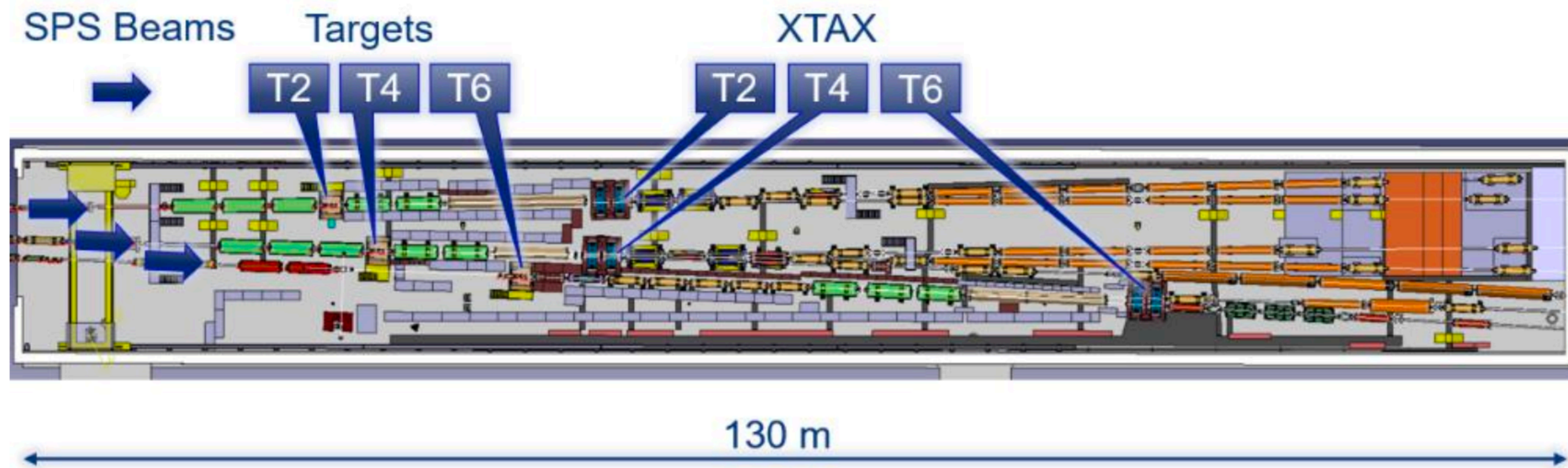


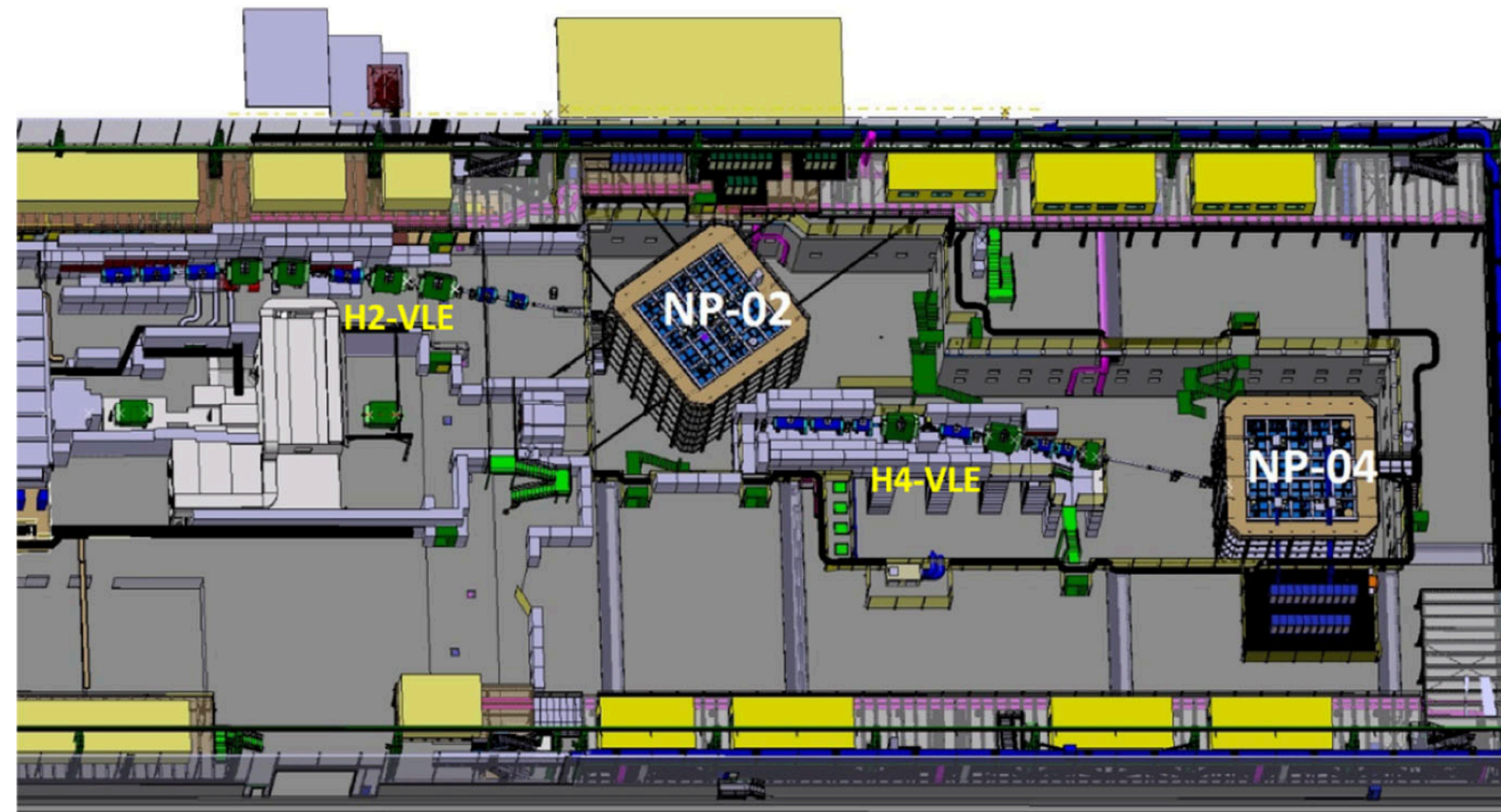
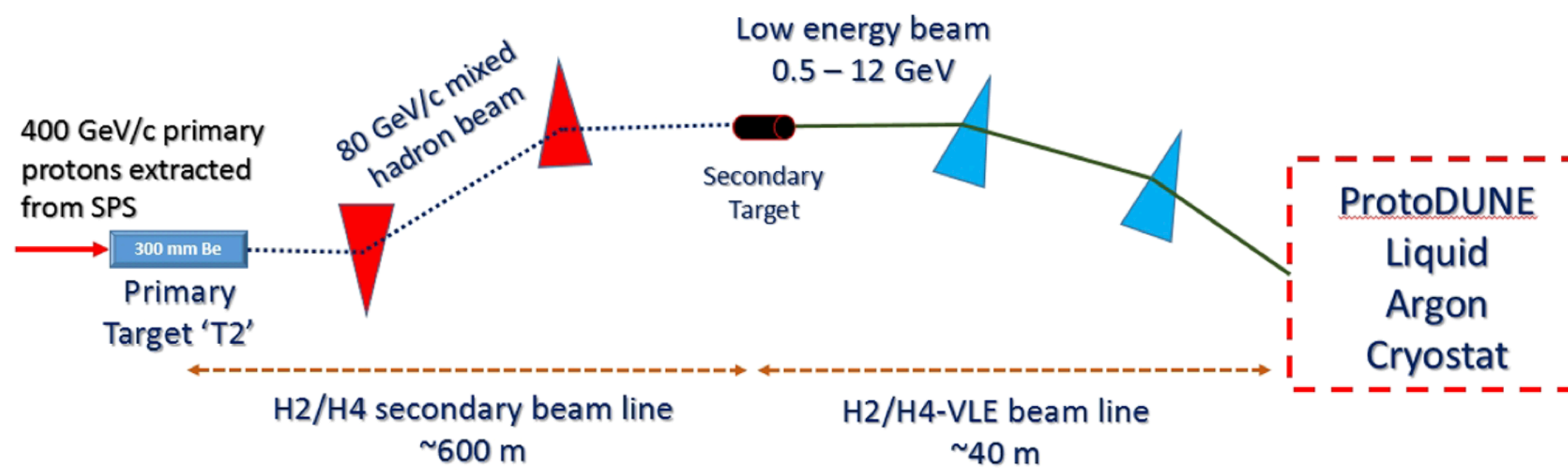
Figure 2 — General layout and location of XTAXs in TCC2

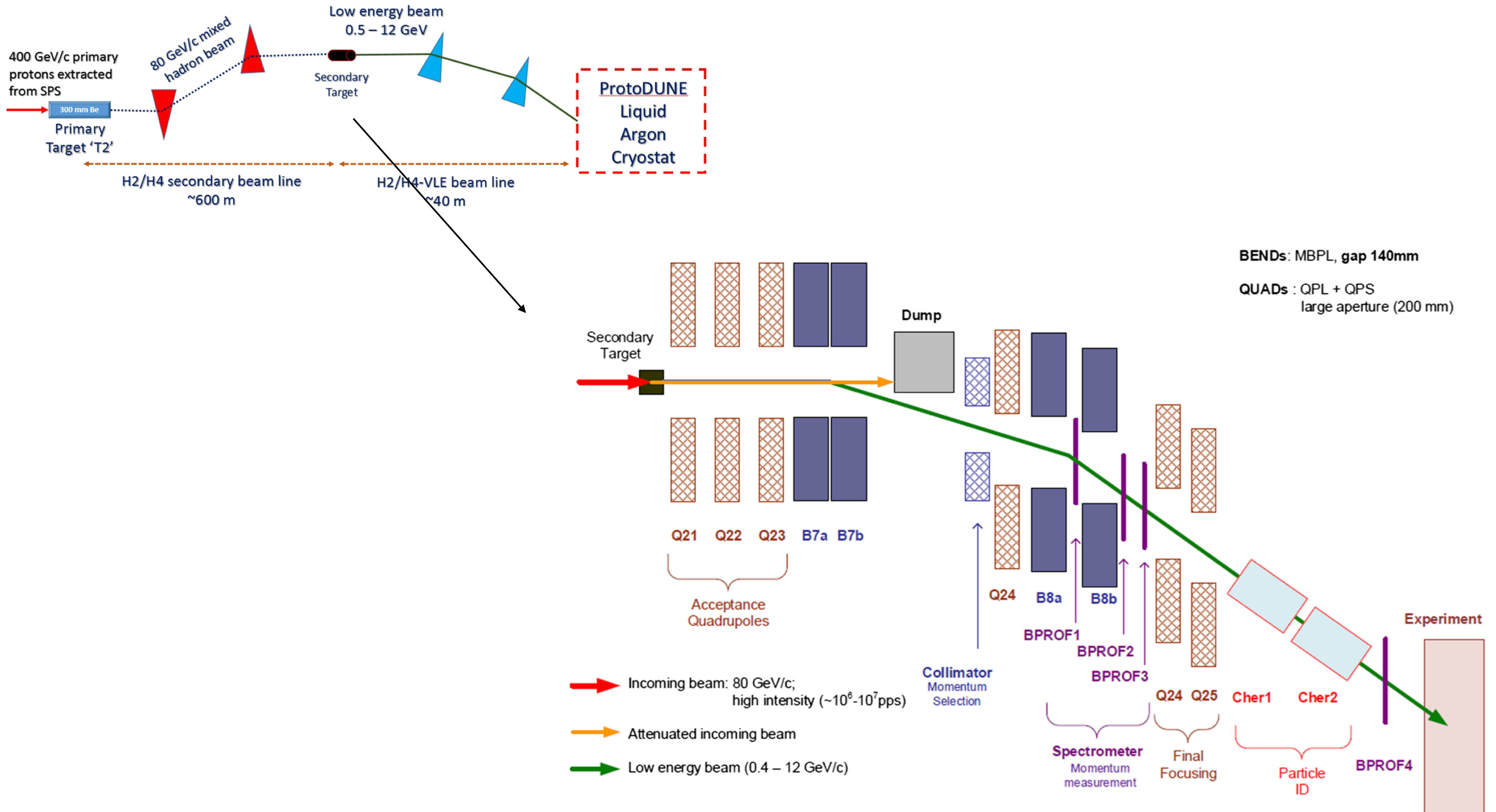
Extracted from internal documentation

ProtoDUNE

- T2 configuration might be different (to be confirmed by Nikos). It should correspond to the worse case scenario

Details about the beam can be find here: <https://journals.aps.org/prab/pdf/10.1103/PhysRevAccelBeams.20.111001>





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