Introduction

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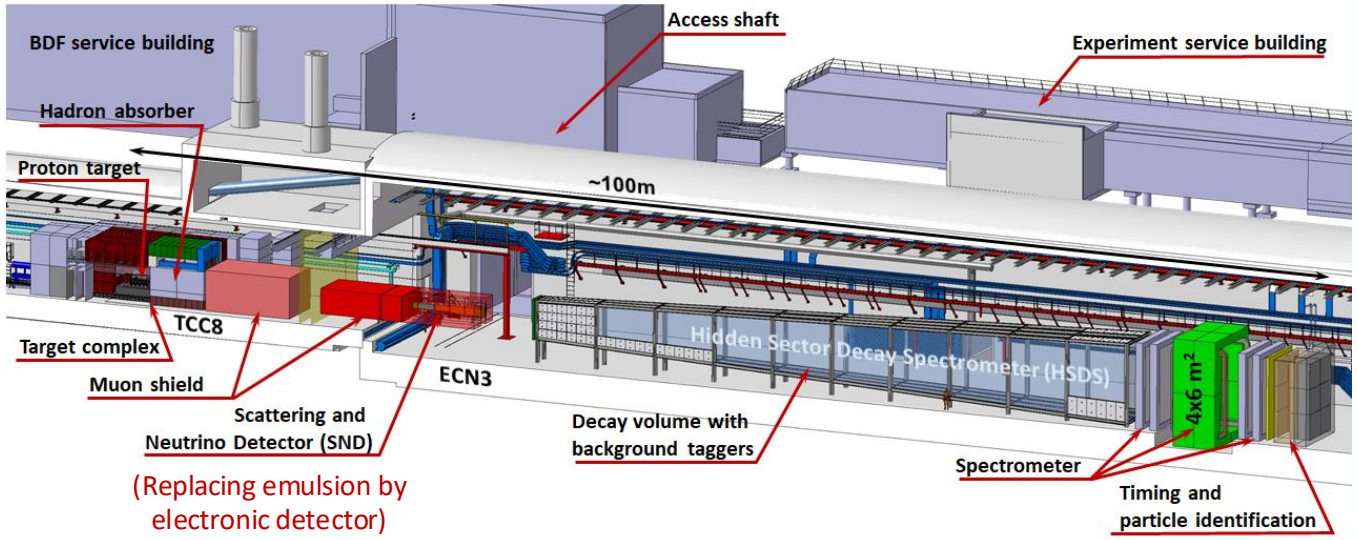
6th October 2025

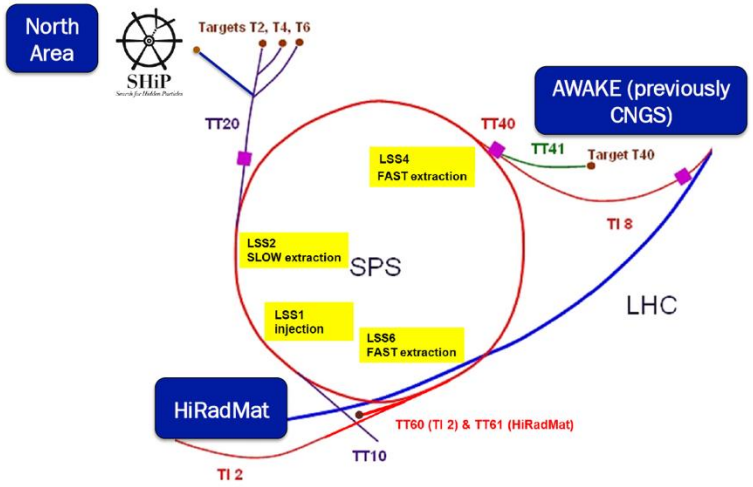
SHiP Liverpool Meeting

UNIVERSITY OF LIVERPOOL

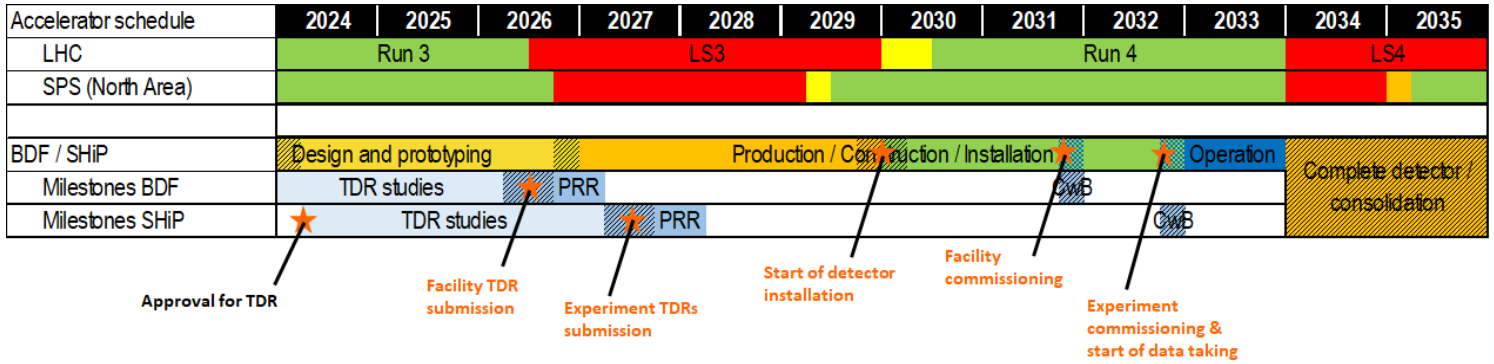
SHiP in a nutshell

- Designed to search for FIPs predicted by hidden sector models and measure SM neutrino
  - Will be built in the upgraded ECN3 facility in the north area using 400 GeV proton beam from SPS





- Aiming to start operation in last year of run 4 (2032) before upgrades over LS4 for run 5
  - Experiment TDR needed in 2027 with construction starting very shortly after



SHiP UK

- SHiP UK currently consists of 4 accepted institutes
  - Bristol, Imperial (Spokes + UK contact), Liverpool, UCL (+ RAL)
  - Currently trying to expand this further with new institutes
  - Spokesperson: Andrei Golutvin
  - UK contact person: Mitesh Patel
- Existing effort currently primarily focused on warm muon shield / magnet
  - Including integration of updated electronic neutrino detector
  - Hopefully with input from UK industry
  - Some previous involvement in spectrometer tracker
- Previously (Dec 2024) put in SoI to STFC for funding of staff + capital for construction
  - Very ambitious given current state of UKRI funding
  - Potential of SHiP recognised but rejected due to lack of funding
  - Encouraged to apply again for less funding, though still not clear if this would be successful

" SB PPAN noted that the SHiP experiment has been recently approved by CERN and will be one of the only major new search programmes at CERN in the short to medium term. The project's timing is driven by CERN's accelerator schedule, and investment is required now to capitalise on the UK leadership in the project. The board also noted the opportunities for UK industry. "

" ... at this point there is insufficient funding in the programme to accommodate a funding request on this scale and so it is not possible to invite a full proposal at this stage. However, the collaboration may submit an SoI in future for a contribution to the experiment that is significantly lower."

SHiP Liverpool

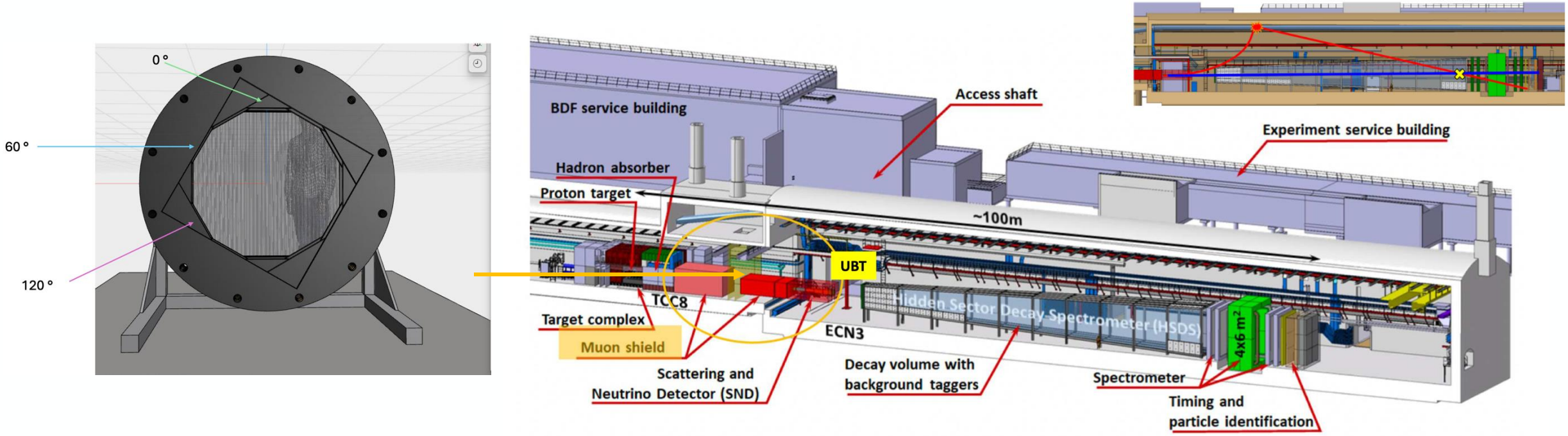
- People: small 10% contributions from
  - Carl Gwilliam: tracking software + FIPs
  - Themis Bowcock: upstream background straw tracker
  - Joe Price: tracking software + tracker QC/QA + physics
  - Saskia Charity: Tracking software / B-field + DQ + physics
  - Eduardo Rodrigues: Overall computing + software
  - Christos Touramanis: Neutrino Physics

- Potential interest also from Tim Jones for straw tracker
  - Maybe able to get small engineer effort for prototyping/studies
  - To actually build a tracker we would of course need to get money for dedicated effort

- Admin/Communication
  - To get indico access etc please register SHiP as a second experiment in EDH
  - Dedicated ship@hep.ph.liv.ac.uk mailing list
  - SHIP and SHIP Liverpool Mattermosts → please sign up
  - Dedicated Liverpool SHiP Meetings

Detector

- Making SND mostly electronic opens up space for an up-stream background tagger (UBT)
  - Main goal is to tag and veto the combinatorial muon background from upstream (details: here and here)



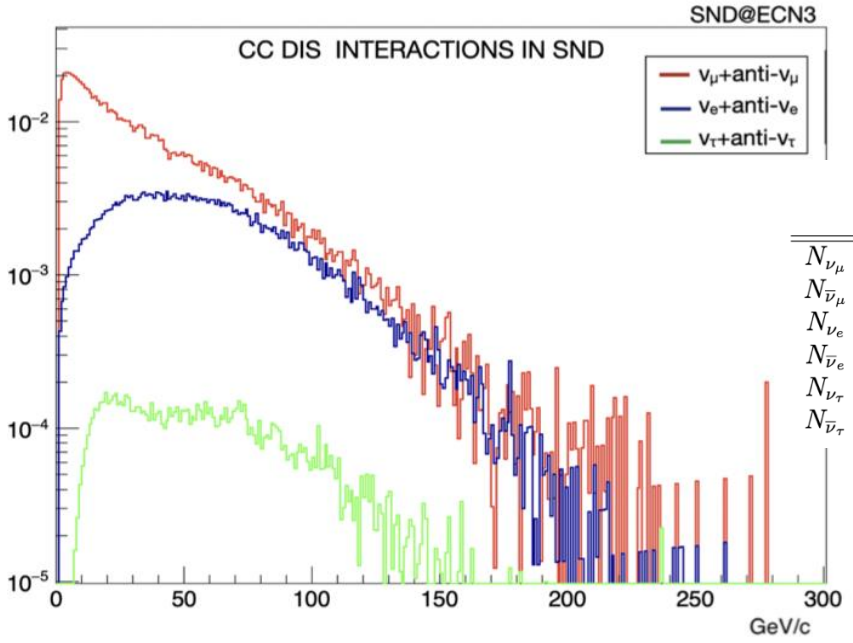
- We would be interested in building a straw-tube based UBT using g-2 tracker expertise
  - Presented by **Themis** in recent Collaboration Meeting
  - Would need to start acquiring straws for prototyping this year
  - Need to study the performance requirement/capabilities of the proposed detector concept e.g. resolution

Software, Tracking and B-field

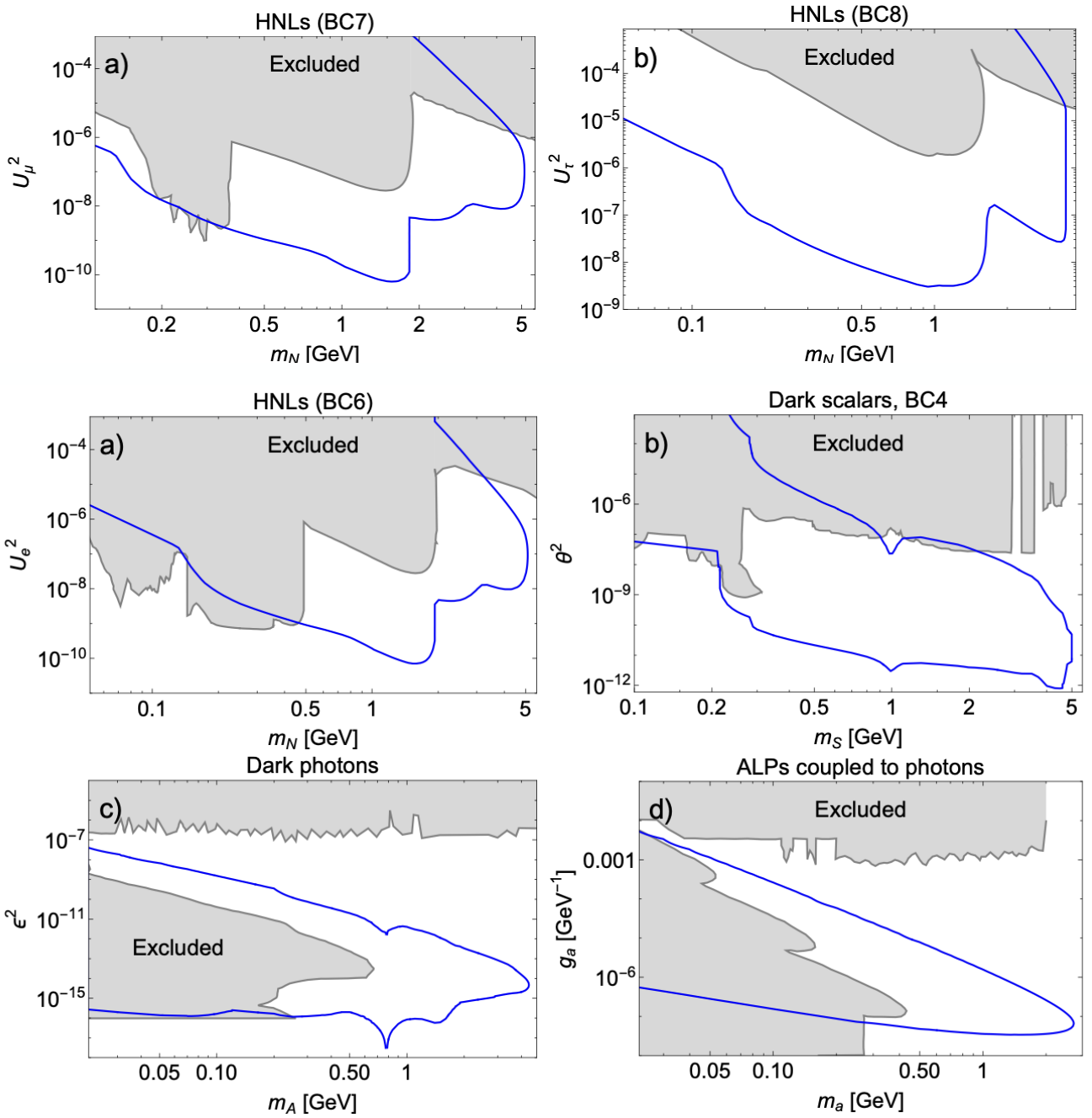
- SHiP software, FairSHIP is based on FairROOT developed by the Alice Experiment
  - I was able to successfully check out and run basic examples at Liverpool following README
- Planning to update some components to HEP software foundation (HSF) tools e.g. DD4HEP
  - Given his involvement with the HSF, **Eduardo** might be well placed to contribute to this
- SHiP tracking has previously been based on GenFit
  - This is essentially no longer supported and tracking has not been running for a while
- In the process of migrating to the common ACTS tracking (used by ATLAS, FASER, …)
  - This has been done for the SND detector but not for the downstream straw tracker
  - **Carl**, **Joe** and **Saskia** talked to SHIP s/w coord and expressed interest in contributing to this
    - Not much progress yet though so need to coordinate to move forwards on this
    - I was able to run standalone ACTS examples
    - Saskia attempted to run SND example but didn't manage
- Also had some email contact about the B-field (since links to UK deliverables)
  - However, not clear what needs doing there at the moment

Physics

- Should also start to think of physics plans
  - And position ourselves equalit
- Huge sensitivity to new FIPs phase space
  - HNL / RH neutrinos one of key goals
  - Also, dark-photon/Higgs, ALPs, ….
- Large numbers of neutrinos, including τs
  - With E in 10 – 100 GeV range



	<E> [GeV]	CC DIS interactions
N_{ν_μ}	40	8.0×10^6
$N_{\bar{\nu}_\mu}$	33	1.8×10^6
N_{ν_e}	63	2.8×10^6
$N_{\bar{\nu}_e}$	49	5.9×10^5
N_{ν_τ}	54	8.8×10^4
$N_{\bar{\nu}_\tau}$	74	6.1×10^4



https://cds.cern.ch/record/2878604/files/SPSC-P-369.pdf

Discussion Items

- Software/tracking
  - How do we get started on the ACTS tracking?
  - What studies do we need to do for the UBT?
- Physics
  - Where do we want to position ourselves for physics?
  - Just FIPs for now or also neutrinos?
- Detector
  - Who can help with straw prototyping?
  - Funding applications?
- Organisation
  - Do we want a deputy Liverpool SHIP TL?
  - How often do we want Liverpool SHiP meetings?
  - Students: might be able to get some fraction of Pawan + can apply for PhD/MPHYS students next year
- Things I've missed?