Summary of FIPs and neutrino TF findings

Federico Meloni (DESY), on behalf of the TF members (Friederike Januschek, Felix Kling, FM, Andreas Meyer, Klaus Moenig, Kai Schmidt-Hoberg, Marcel Stanitzki)

PoF V MU-FPF Retreat
19/06/2025

Key questions

What are the **most interesting physics questions** in this area?

What interesting **opportunities exist in the future** (2027+) beyond continuing ongoing activities?

Where could DESY make an **important contributions**?

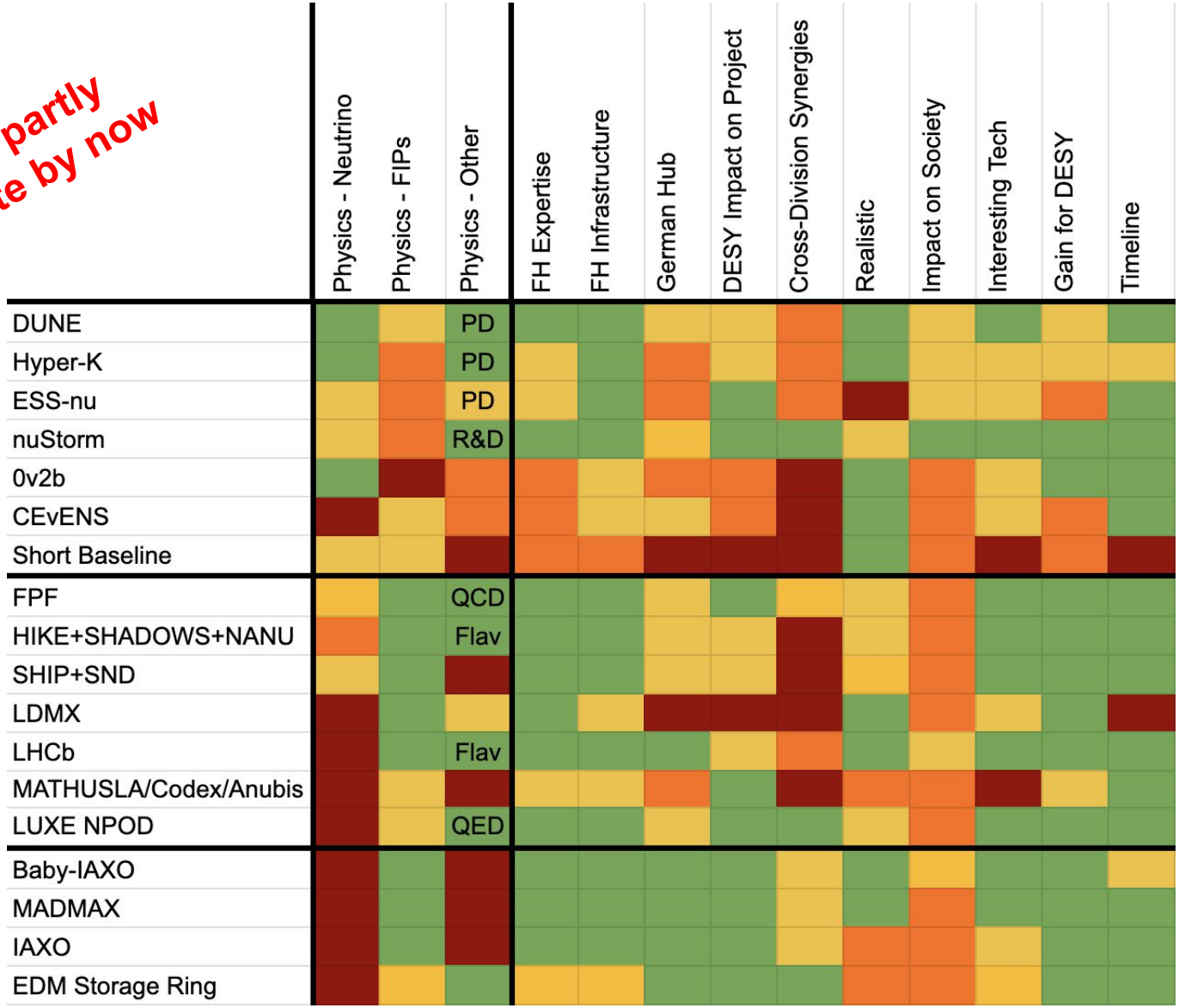
Are there possibilities for dedicated **local experiments**?

Targets and constraints

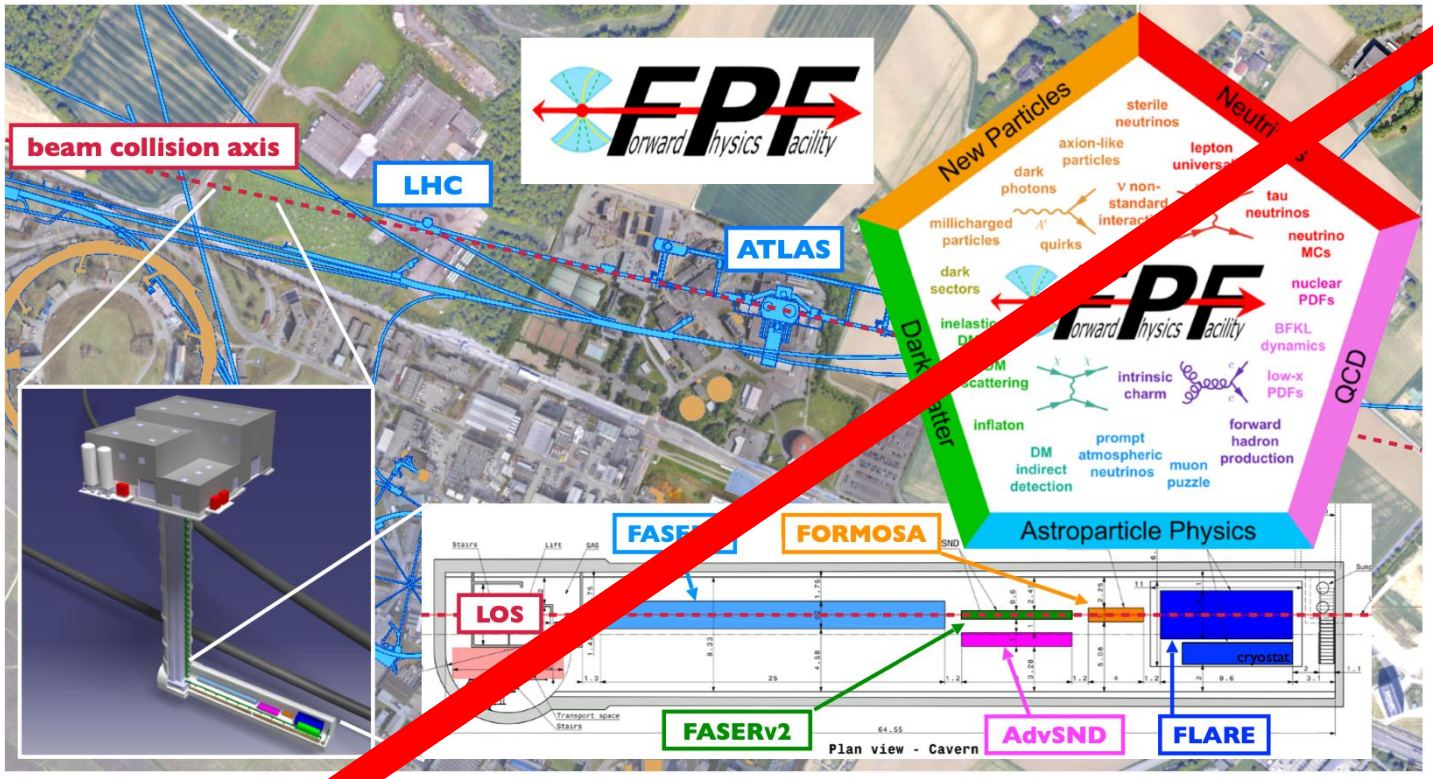
Goal	Identify O(5) initiatives of varying size/technology/physics
Timescale	After LHC Phase 2 upgrades
Size	O(40) people
Expertise	Use DESY's expertise e.g., in detector development and/or axions
Place	DESY would be good, but the main driver must be the physics case
Involvement	Leading role for FH, ideally also in detector design

Bird's eye summary

Beware: partly obsolete by now



The Forward Physics Facility



Broad physics programme

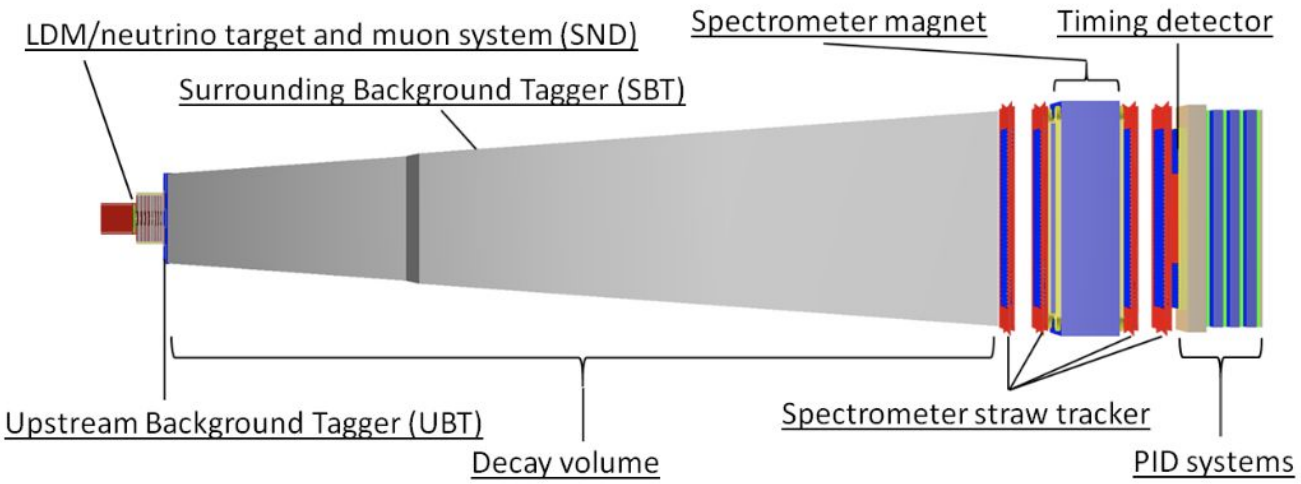
- Neutrino cross sections in unprobed regime (400-1000 GeV)
- QCD and PDFs
  Searches beyond the Standard Model

Timescale 2029+

Detectors Tracking detectors
High-granularity calorimeters

Interesting project FLARE and FASER2

SHiP



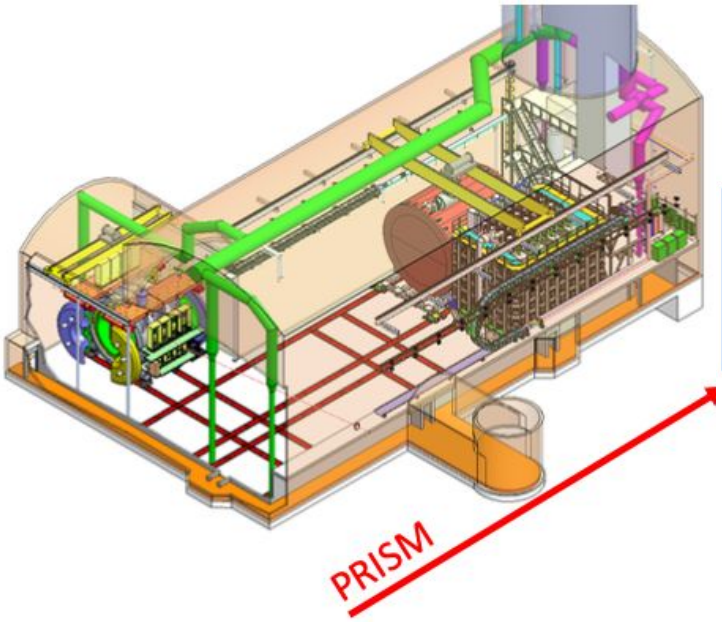
ShiP got selected as potential SPS North area experiment

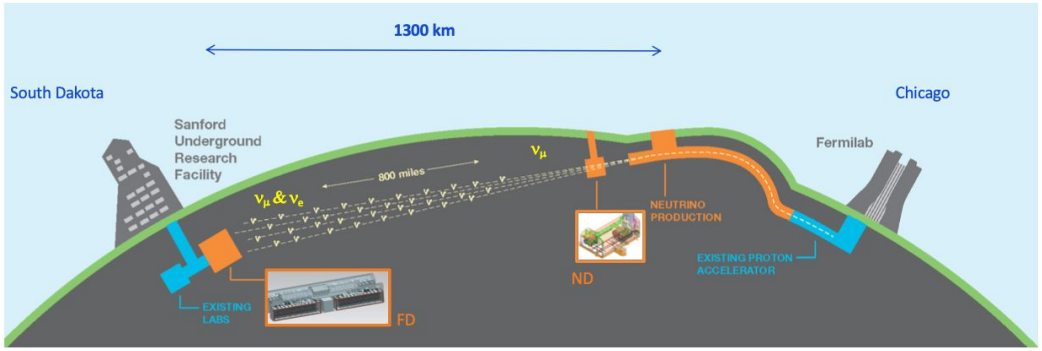
- https://cds.cern.ch/record/2878604?ln=en

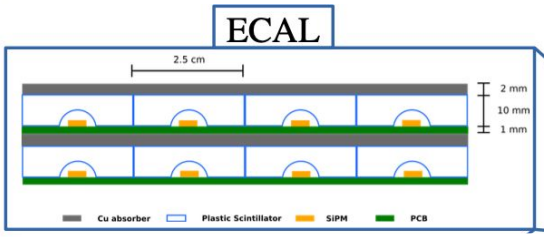
Sensitivity for FIPs is excellent

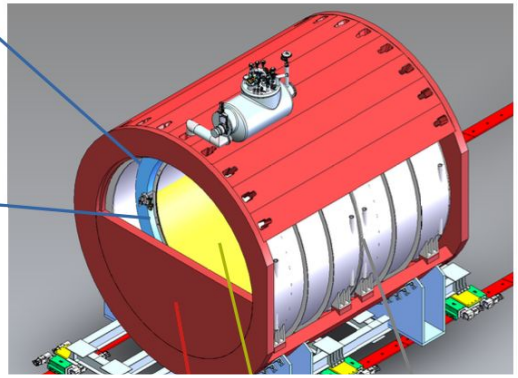
- Event rate goes as coupling^4, the sensitivity with one year data will be within- a factor 2 of the final sensitivity.
- Lots of German University groups interested
- Timeline ~ about fits
- Detector contributions Not well aligned with DESY detector expertise

DUNE









Broad physics programme

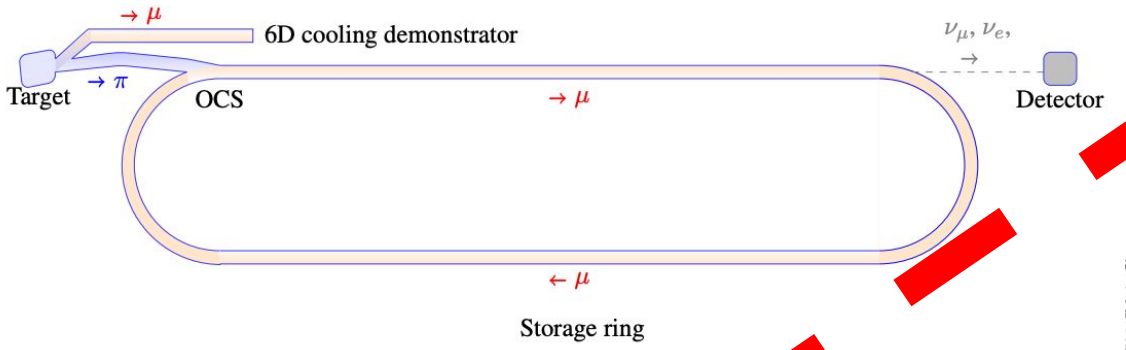
- Neutrino mass ordering
- CP violation in lepton sector
- Unitarity of PMNS matrix
- Neutrinos as astroparticle messengers
- …

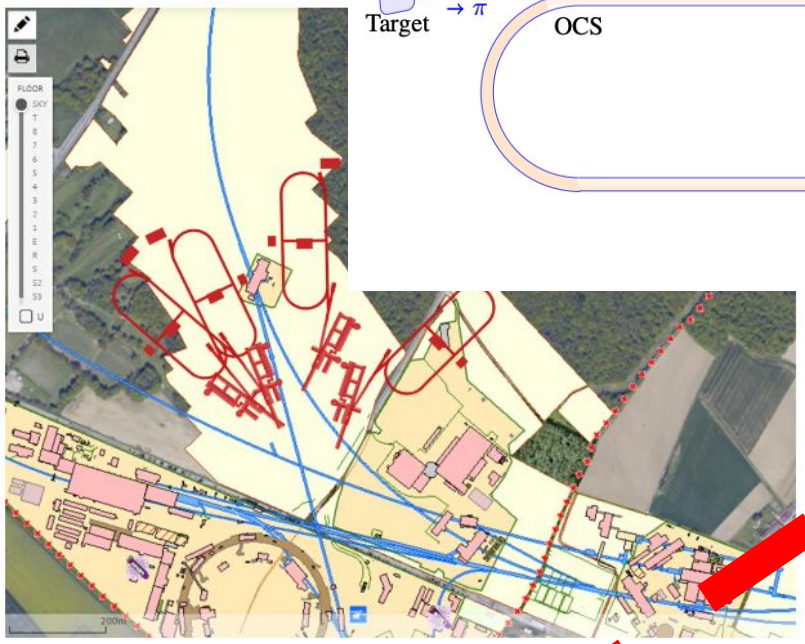
Timescale Phase I - current decade
Phase II - priority for 2030s

Detectors Tracking detectors
High-granularity calorimeters

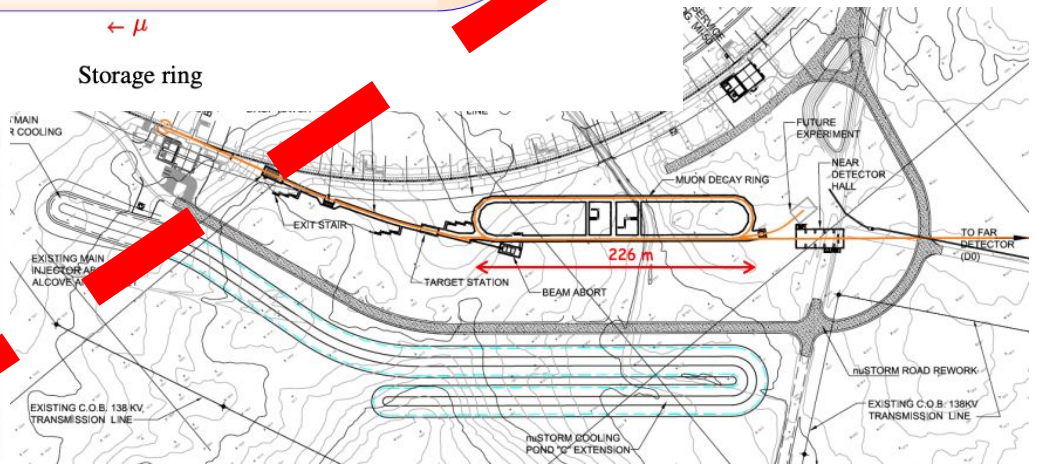
Interesting project ND-GAr (for Phase II)

nuSTORM





nuSTORM at CERN



nuSTORM at FNAL

Broad physics programme

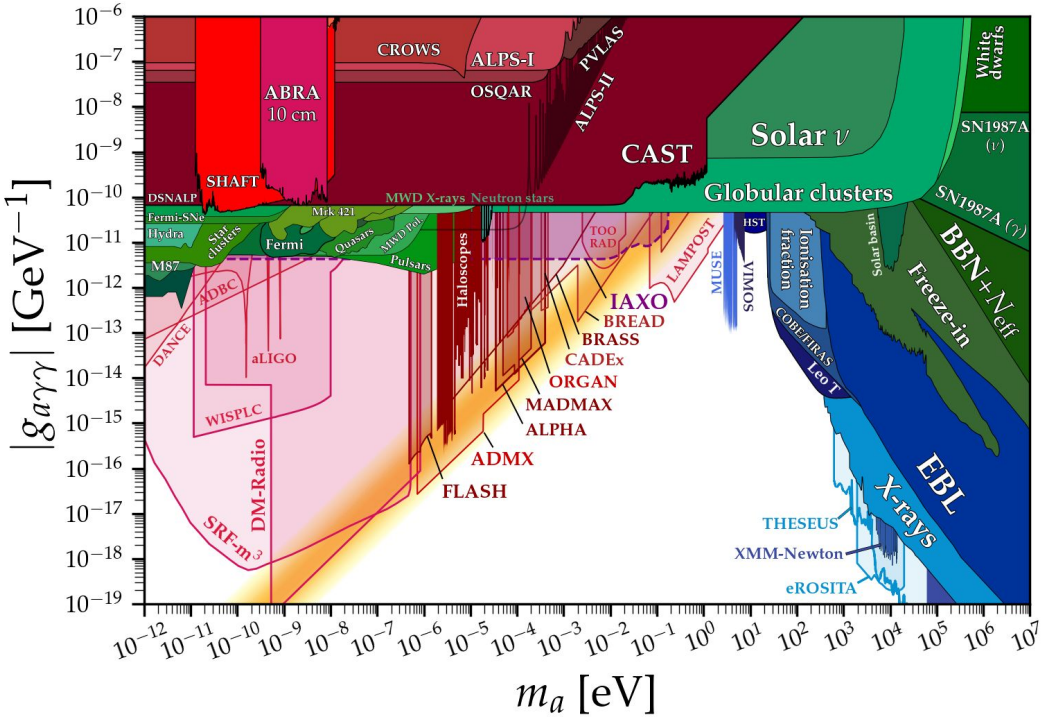
- %-level (νN) cross sections
- QCD
- Searches for new phenomena
- Step towards muon colliders

Timescale 2030+

Detectors Tracking detectors
High-granularity calorimeters

Interesting projects detectors don't have a name yet

The Axion programme



Strategic axion research programme encompassing a planning of several **on-site experiments** as cornerstone

- ALPS II
- (Baby) IAXO
- MADMAX

Timescale	Now to 2030+
Technologies	Cavity optics Cryogenics Cryogenic detectors

Conclusions

Recommendations

- Exploit the full FIPs and neutrino physics potential of the LHC and Belle II
- Pursue the existing axion programme at DESY consisting of ALPS-II, Baby-IAXO and MADMAX
- Join well-motivated, suited, and technologically synergetic upcoming experiments, which we identified as the ~~FPF~~, DUNE, ~~nuSTORM~~
  - SHiP came up in the meanwhile as strong alternative to FPF. Good prospects as hub for German community, but poor fit with detector priorities at DESY
- Also consider FIPs and neutrinos experiments that are independent of the CERN/LHC schedule
- Invest in focused detector R&D (e.g., tracking detectors, high-granularity calorimetry or cryogenic detectors) for FIPs and neutrino experiments
- Continue to monitor the opportunities for local world-leading experiments that might arise from infrastructure available on the DESY campus