Feebly Interacting Particles

Summary of activities

Friederike Januschek, Felix Kling, Federico Meloni, Andreas Meyer, Klaus Moenig, Kai Schmidt-Hoberg, Marcel Stanitzki

FH retreat follow up
14/12/2022

The task force

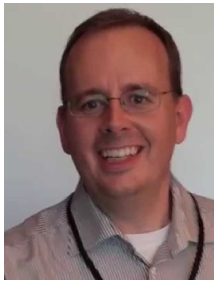
Meet the members

Friederike Januschek

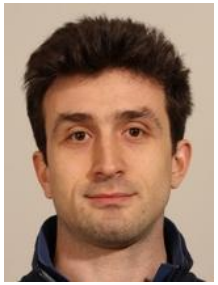
Andreas Meyer

Klaus Moenig

Kai Schmidt-Hoberg



Marcel Stanitzki



Federico Meloni

Felix Kling

Very active participation from TF members and lively discussions (thanks!) since the TF creation (total of 10 meetings).

Key questions

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

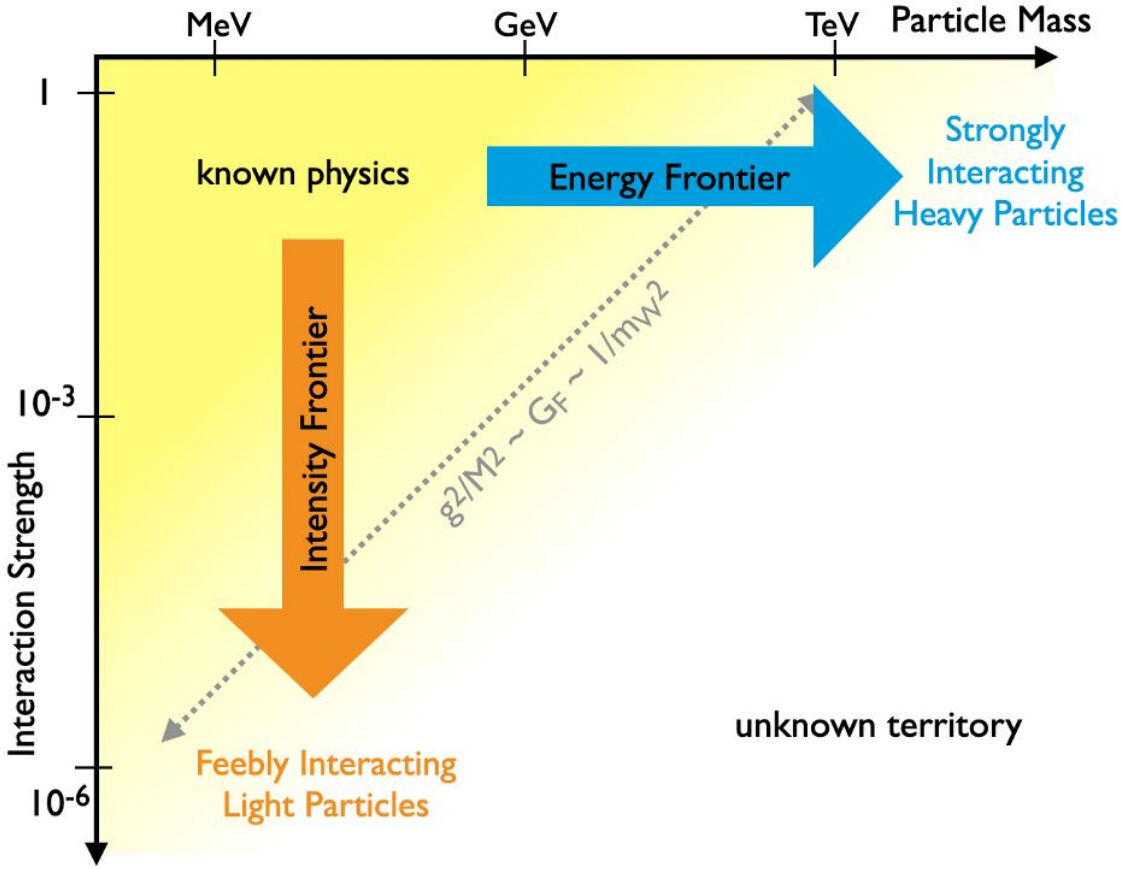
What interesting **opportunities exist in the future** (2027+) beyond continuing ongoing activities?

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

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

The task force

Meet the physics

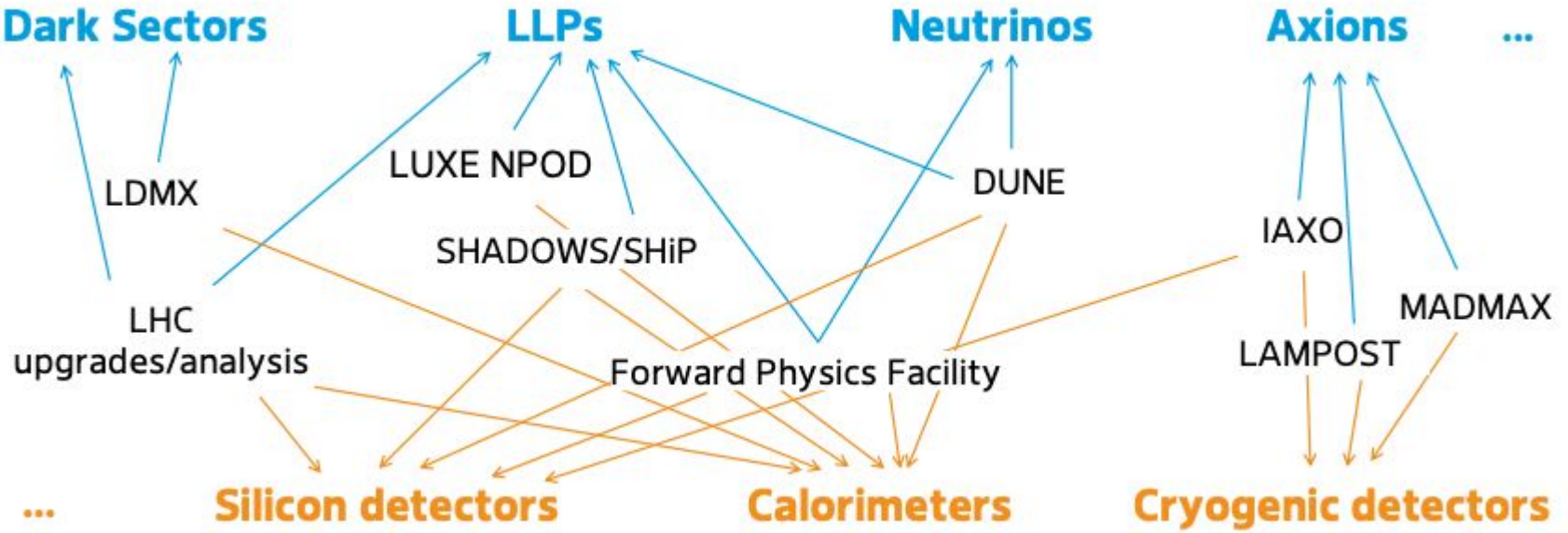


Several **well-motivated targets**: from the determination of key parameters in the neutrino sector, to searches for axions, dark matter, long-lived particles, dark sectors and more…

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

Mapping the opportunity space



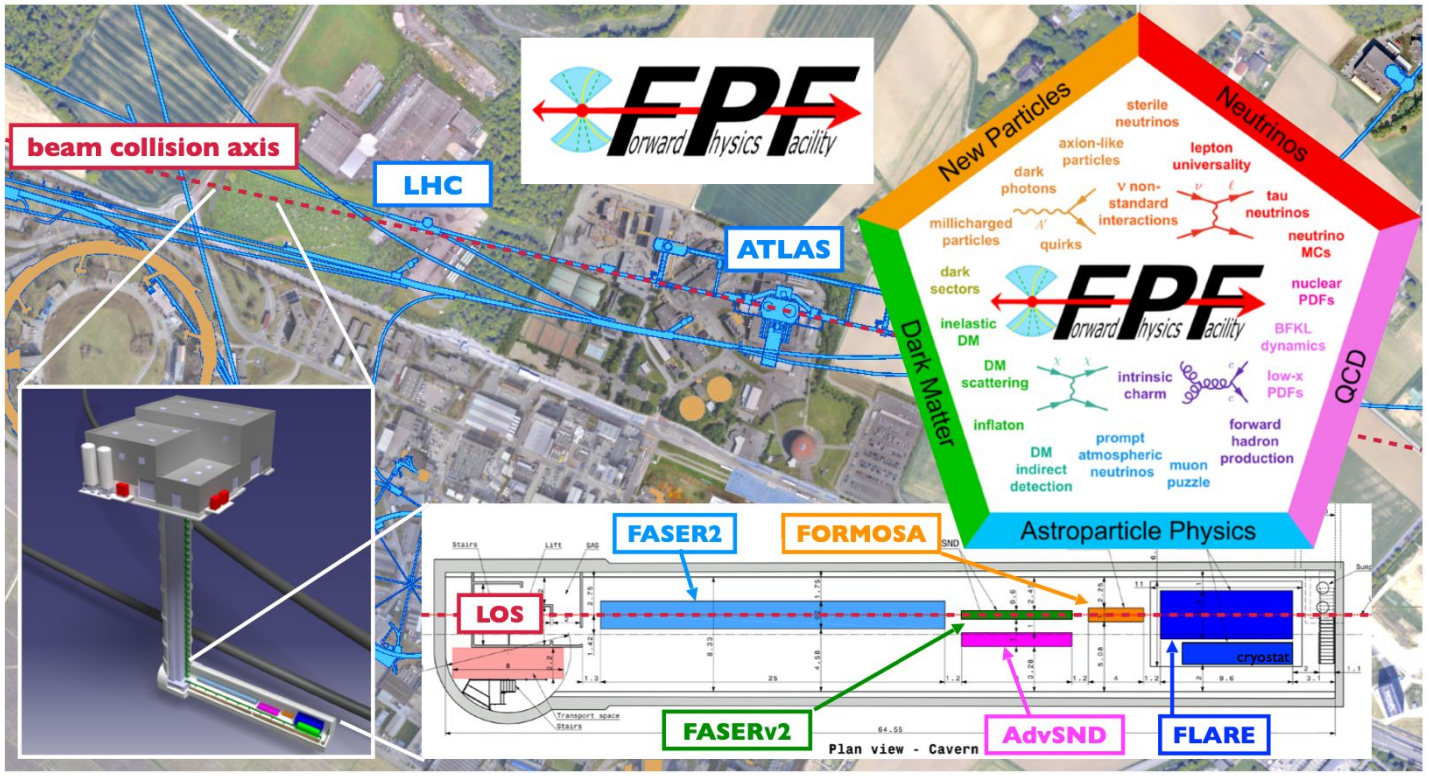
We surveyed the proposed and planned experiments in the realm of FIPs

- Discussed a list of 56 different opportunities

Narrowed down the list by applying our targets and constraints

- Small-scale experiments considered to be “always doable”

The Forward Physics Facility



Broad physics programme

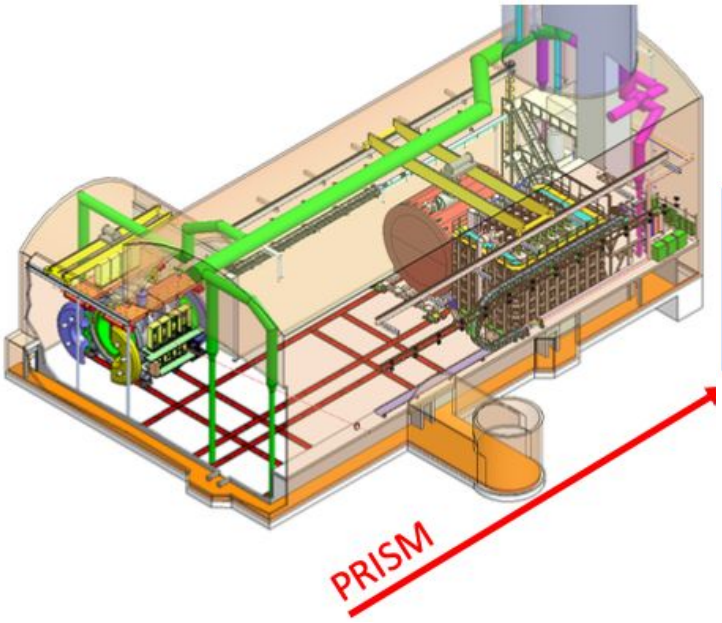
- Neutrino cross sections in unprobed regime (400-1000 GeV)
- QCD and PDFs
- Searches beyond the Standard Model

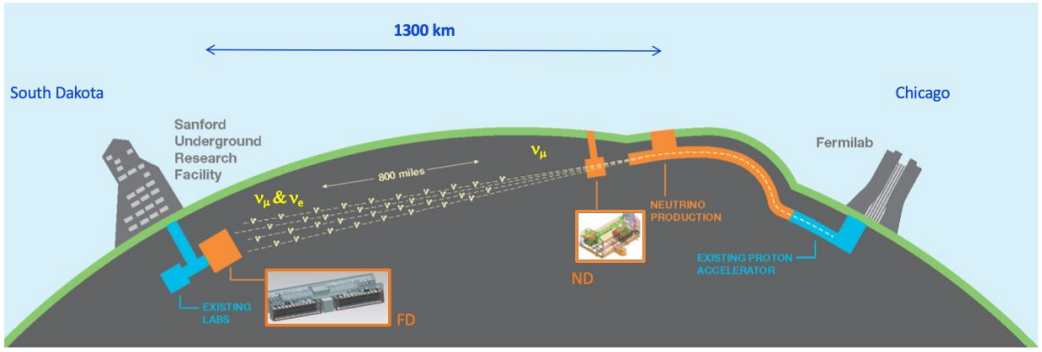
Timescale 2029+

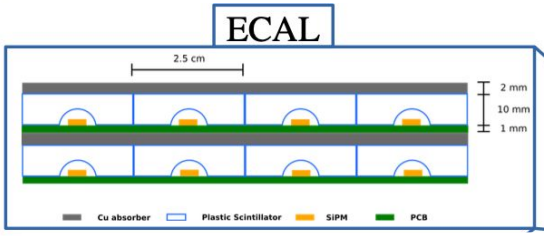
Detectors Tracking detectors
High-granularity calorimeters

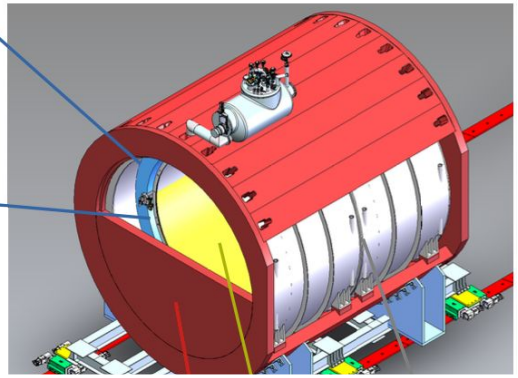
Interesting project FLARE and FASER2

DUNE









Broad physics programme

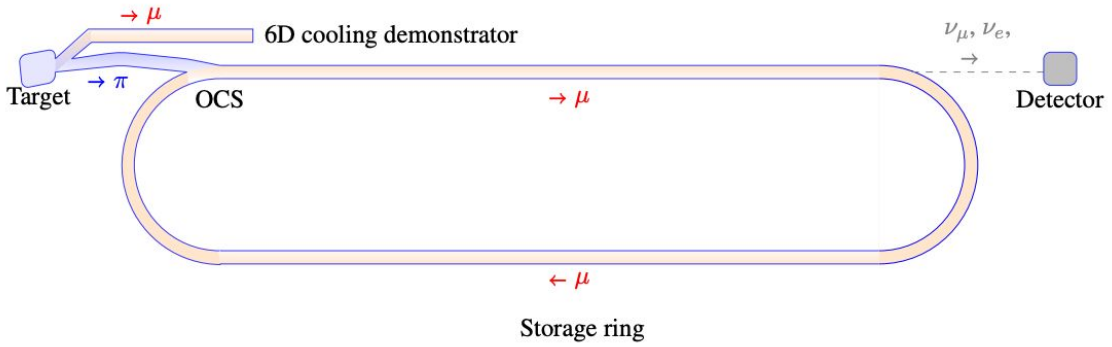
- Neutrino mass ordering
- CP violation in lepton sector
- Unitarity of PMNS matrix
- Neutrinos as astroparticle messengers
- …

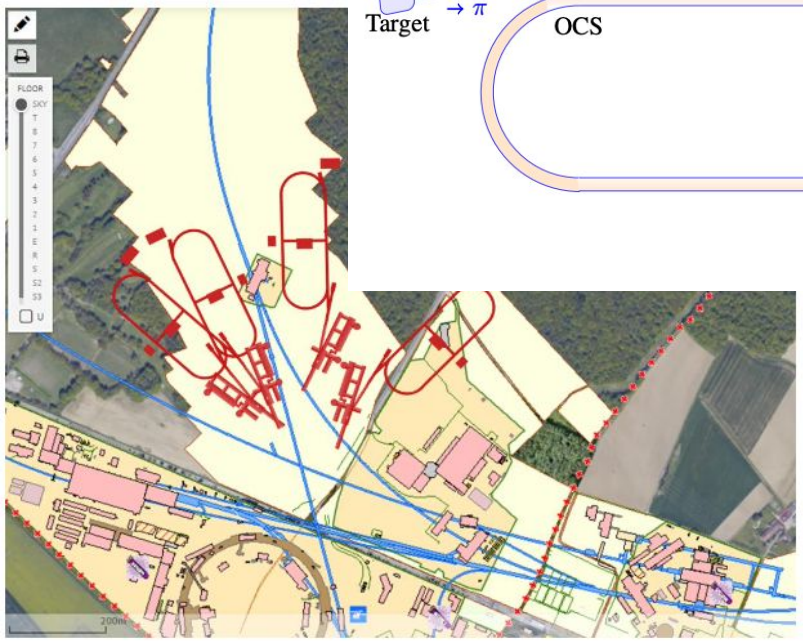
Timescale Phase I - current decade
Phase II - priority for 2030s

Detectors Tracking detectors
High-granularity calorimeters

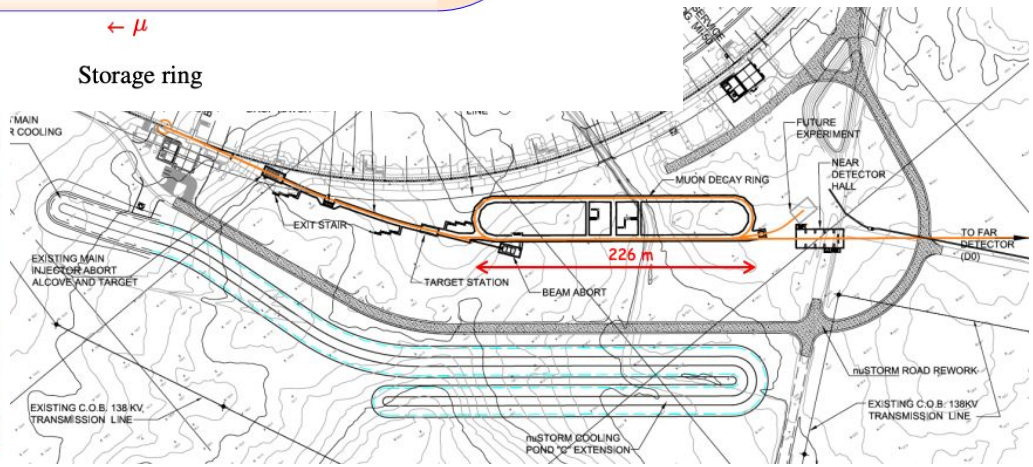
Interesting project ND-GAr (for Phase II)

nuSTORM





nuSTORM at CERN



nuSTORM at FNAL

Broad physics programme

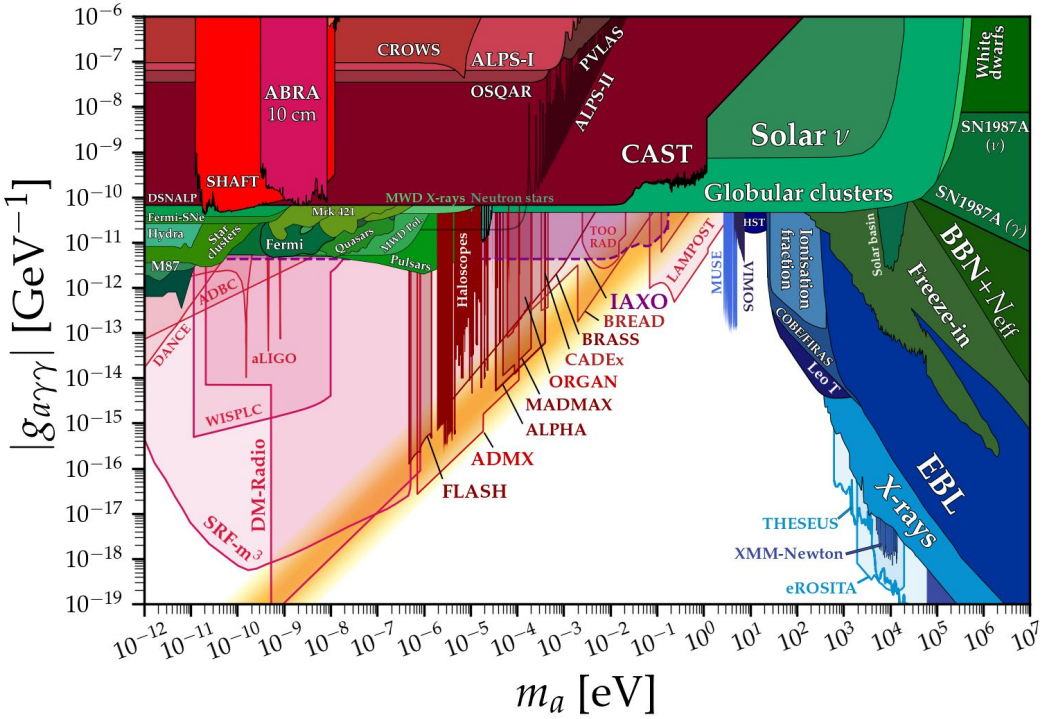
- %-level (vN) cross sections
- QCD
- Searches beyond the Standard Model
- Step towards muon colliders

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

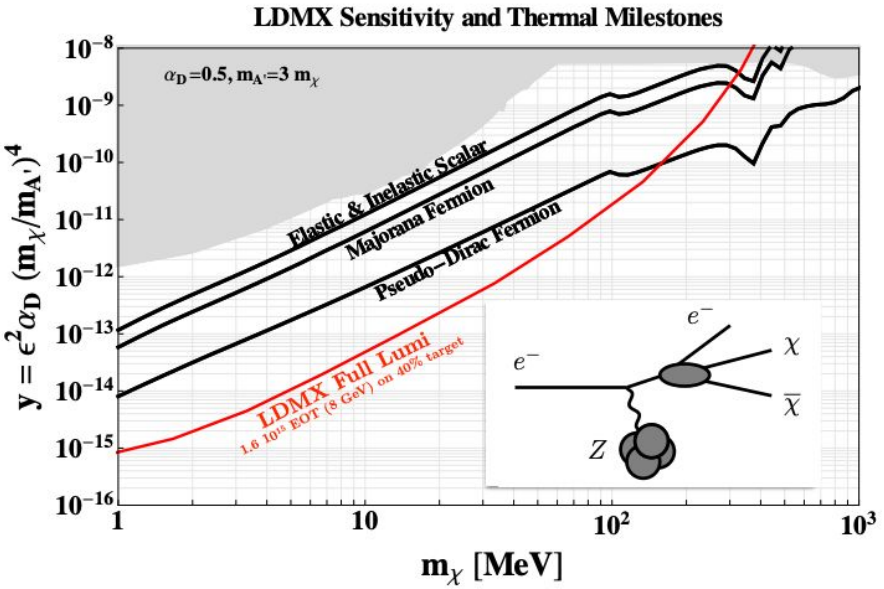
- ALPS II
- (Baby) IAXO
- MADMAX

Timescale	Now to 2030+
Technologies	Cavity optics Cryogenics Cryogenic detectors

Honorable mentions

LDMX small-scale electron beam experiment measuring missing momentum

- Excellent (often the best) coverage of a variety of light dark sector models
- SLAC likely to build it
- In case of a discovery DESY would be in an ideal position to reproduce the results on a short time-scale
- LDMX Phase-3 could be compatible with using fan 2 of the Eu.XFEL (do not dump the beam in the ground)



Connections to Flavour TF many ongoing and proposed flavour physics experiments, also have sensitivity to search for FIPs

More honorable mentions in final TF report

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
- 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