
**Forward Physics Facility (FPF)
Working Group 4 (WG4) - BSM physics
Kick-off meeting**

Brian Batell
Sebastian Trojanowski
(also slides from Jonathan L. Feng, Felix Kling, ...)

November 9, 2022

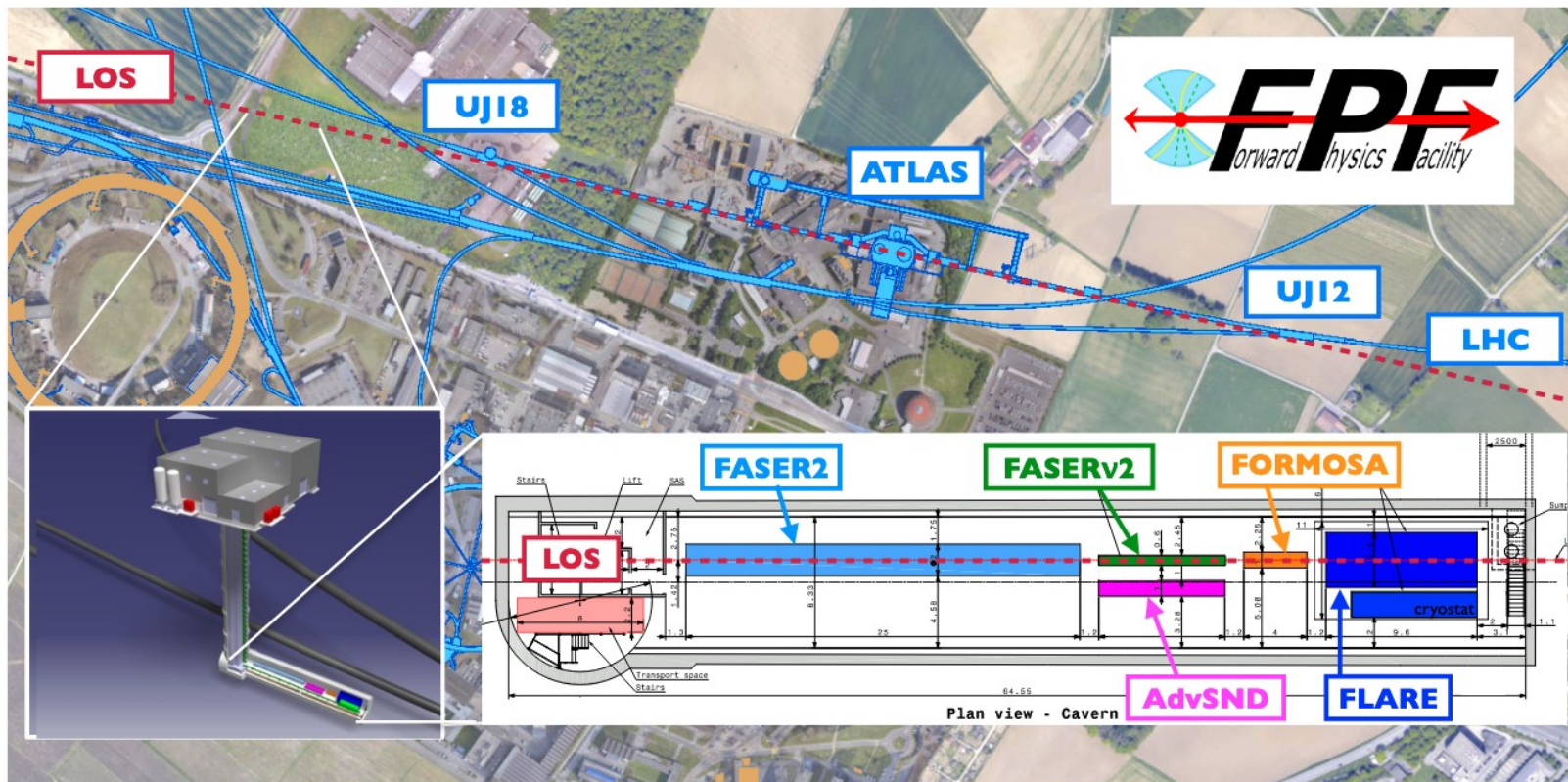
Far-forward searches at the LHC in a bird's eye view



PURPOSE-BUILT FACILITY

Underground facility:

- ~620 m far forward from the ATLAS IP,
- shielded by ~200 m concrete and rock.
- FPF experiments to detect neutrino interactions, energies up to a few TeV,
- and search for new physics
- Several experiments proposed so far (signatures: decay, scattering, ionization)



STATUS

- FASER/FASERv and SND@LHC experiments are currently taking data
- Forward Physics Facility (FPF)

In the U.S. the Snowmass process is concluding. From the Energy Frontier Executive Summary:

- “Our highest immediate priority accelerator and project is the HL-LHC, the successful completion of the detector upgrades, operations of the detectors at the HL-LHC, data taking and analysis, **including the construction of auxiliary experiments that extend the reach of HL-LHC in kinematic regions uncovered by the detector upgrades.**”

Also strong endorsements of the FPF physics case from the Neutrino Frontier, the Rare Processes Frontier, and the Cosmic Frontier.

CERN:

- large progress in facility planning (e.g. make sure that FPF installation and operation will not interfere with the LHC)
- extensive simulations (CERN FLUKA team); BG and radiation safety, **muons**
- first informal discussions with the LHCC chair
- Physics Beyond Colliders (PBC) at CERN allocated 75K CHF for site investigation

WHITEPAPER(S) (hep-ph/2109.10905, hep-ex/2203.05090)

- discuss facility, experiments, and physics case
- ~50% of the recent whitepaper is about BSM physics
(mostly LLPs, but also DM, neutrino BSM, ...)

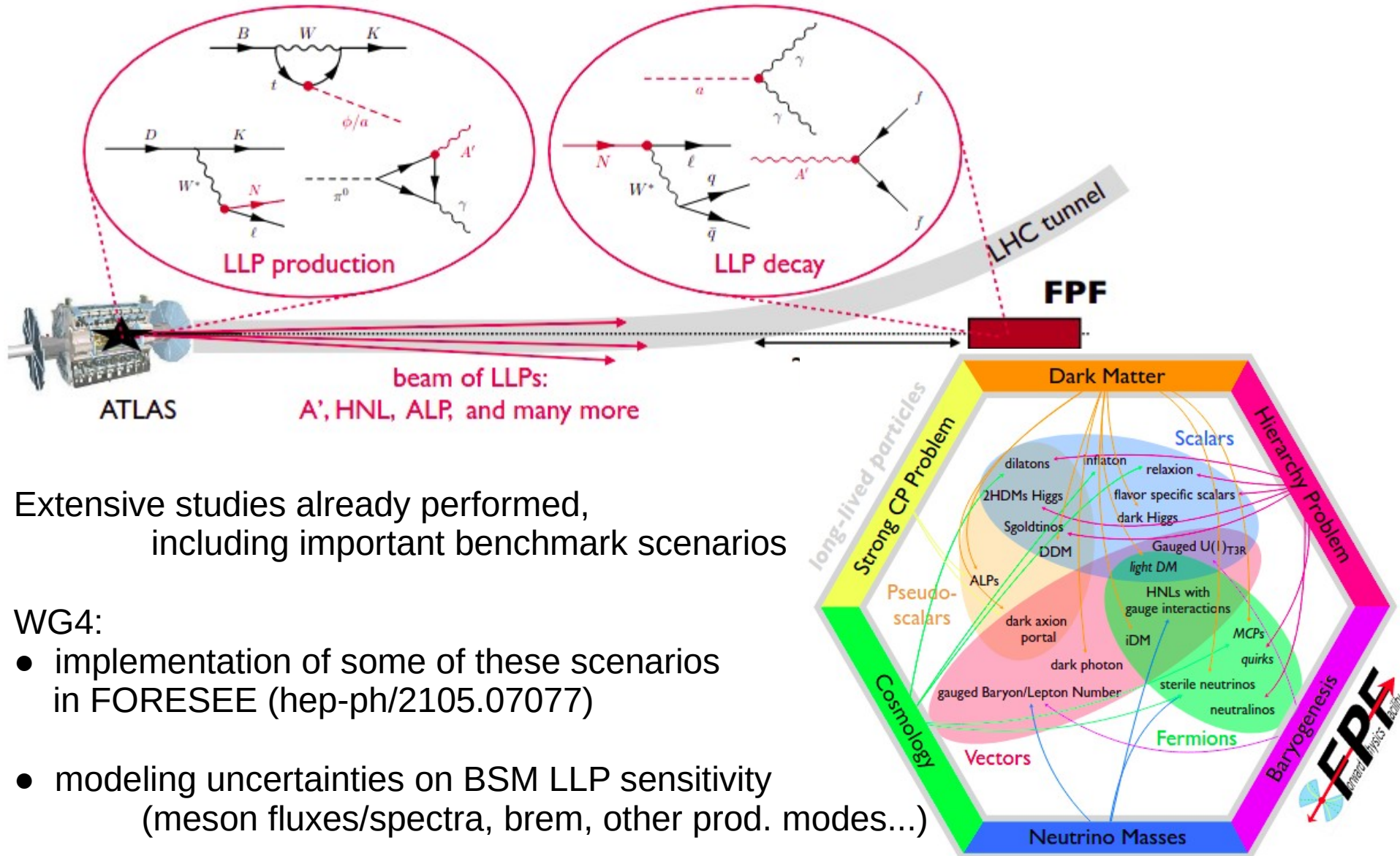
Submitted to the US Community Study
on the Future of Particle Physics (Snowmass 2021)



The Forward Physics Facility at the High-Luminosity LHC

High energy collisions at the High-Luminosity Large Hadron Collider (LHC) produce a large number of particles along the beam collision axis, outside of the acceptance of existing LHC experiments. The proposed Forward Physics Facility (FPF), to be located several hundred meters from the ATLAS interaction point and shielded by concrete and rock, will host a suite of experiments to probe Standard Model (SM) processes and search for physics beyond the Standard Model (BSM). In this report, we review the status of the civil engineering plans and the experiments to explore the diverse physics signals that can be uniquely probed in the forward region. FPF experiments

WHITEPAPER – (MANY) LLP STUDIES



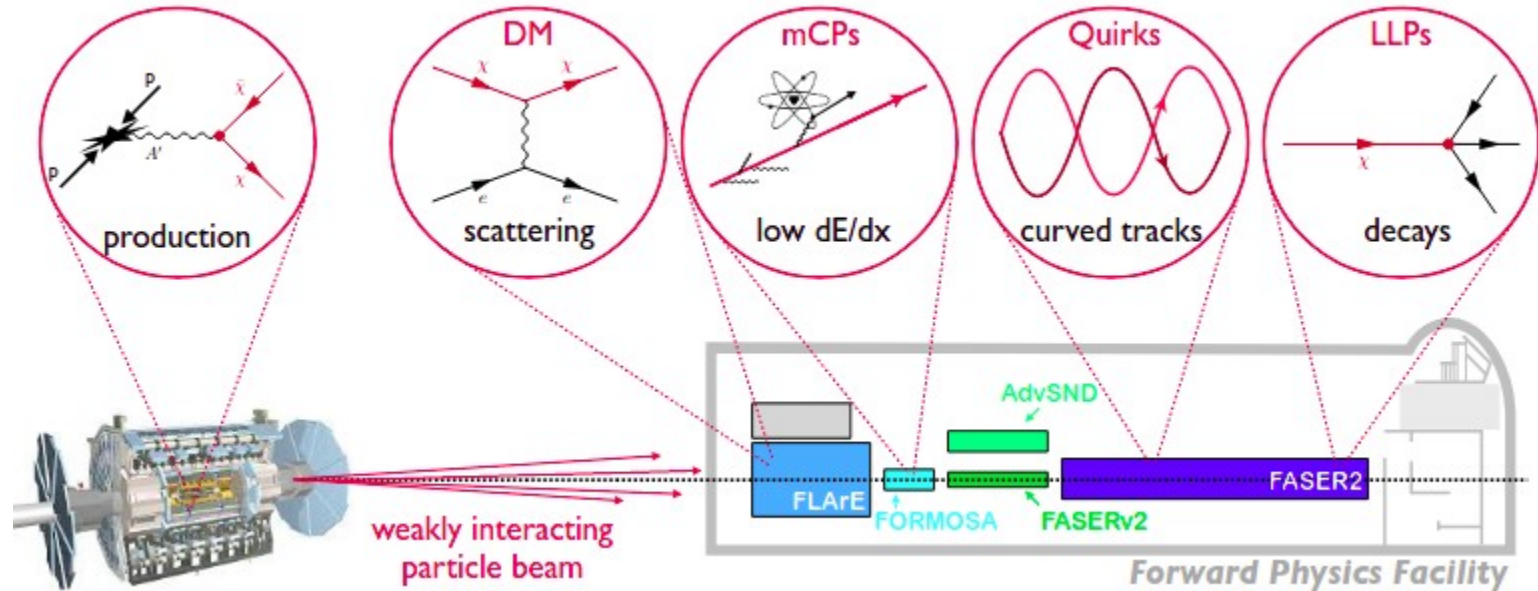
Extensive studies already performed, including important benchmark scenarios

- WG4:
- implementation of some of these scenarios in FORESEE (hep-ph/2105.07077)

- modeling uncertainties on BSM LLP sensitivity (meson fluxes/spectra, brem, other prod. modes...)



WHITEPAPER – OTHER SIGNATURES

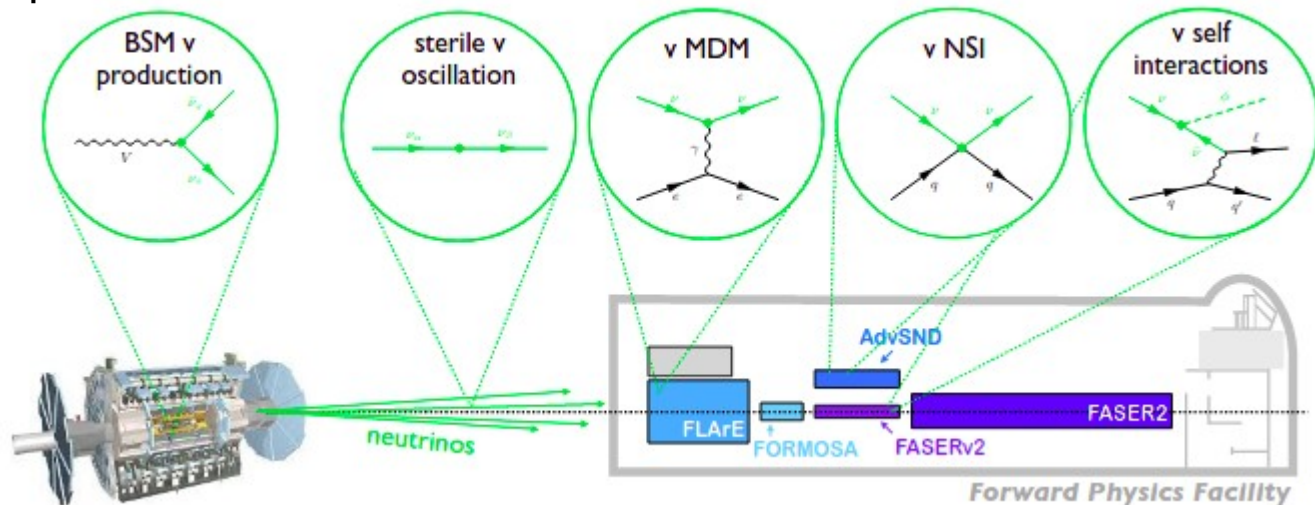


WG4:

- Several dedicated subgroups

- Neutrino BSM effects:
 - Production rates
 - Propagation (oscillations)
 - Interaction rates (different channels)
 - Event characteristics

- Consider capabilities of different FPF detectors



MUONS

Background for other FPF studies but could it also be a source of interesting signal?

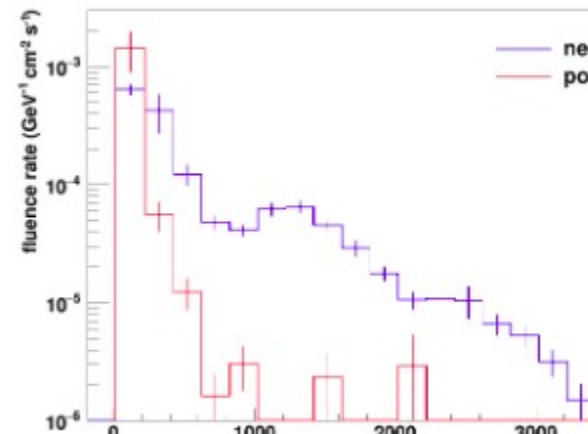
Hard spectrum, up to few TeV energies, not uniform in transverse plane
(can be substantially higher off-axis)

Ongoing simulations for the FPF (flux, spectrum, heat maps, maybe sweeper magnet)

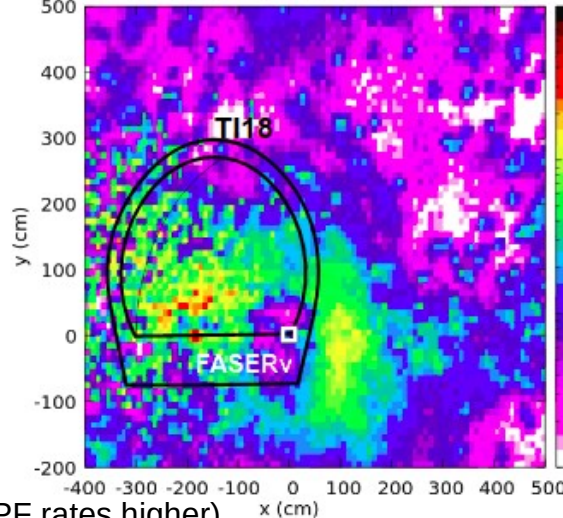
WG4:

- hope to trigger discussions, new ideas welcome (!)
(currently ongoing: muon-philic scalars; LFV? ...)
- SM physics case?

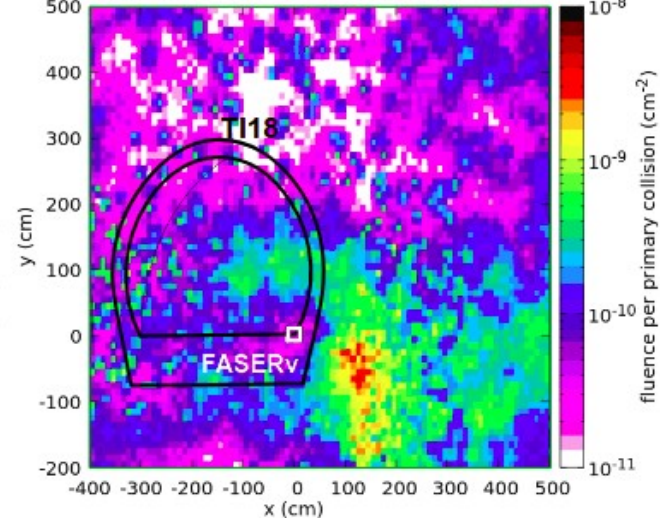
Fluence rate ($\text{GeV}^{-1} \text{cm}^{-2} \text{s}^{-1}$) for muons: 10 GeV thresh



HL-LHC: Muon- distribution at FASER



HL-LHC: Muon+ distribution at FASER



GENERAL GOALS AND ORGANIZATION

- The FPF community goal – preparations towards CDR
(mostly facility and experiments, but physics case drives the discussions)
- FPF physics working groups (+ different groups for facility and experiments)

WG1 – Neutrino Interactions (Leader: Juan Rojo)

WG2 – Forward Charm Production (Hallsie Reno)

WG3 – Light Hadron Production (Luis Anchordoqui, Dennis Soldin)

WG4 – BSM physics (Brian Batell, Sebastian Trojanowski)

- WG4 (BSM) goals:

a) **trigger further discussions about possible unique BSM physics opportunities of the FPF,**

Where do FPF experiments have unique and/or complementary sensitivity in comparison to e.g., beam-dump searches at lower energies and high- p_T searches at the LHC?

several specific goals (subgroups, next slides) + open for new ideas (!)

b) **facilitate exchange of ideas** related to FPF BSM physics (slack channel, community, possible feedback from experimental representatives)

5TH FORWARD PHYSICS FACILITY WORKSHOP

Primary focus this time: facility, experiments, next steps

<https://indico.cern.ch/event/1196506/>

The screenshot shows a web browser displaying the Indico event page. The browser's address bar shows the URL <https://indico.cern.ch/event/1196506/>. The page features a large blue header with the FPF logo, which consists of a stylized particle detector cross-section on the left and the text "FPF" in large, bold, black letters, with "orward physics facility" in a smaller, italicized font below it. A red double-headed arrow is superimposed over the logo. Below the header, the event title "5th Forward Physics Facility Meeting" is displayed. The event details section includes the dates "15–16 Nov 2022", the location "CERN", and the time zone "US/Central timezone". A search bar is present on the right side of the event details. On the left, there is a navigation menu with options: "Overview", "Registration", "Participant List", and "Videoconference". The "Overview" section is currently selected. The event description starts with "Event Description: The Forward Physics Facility (FPF) project is moving forward! At the 5th Forward Physics Facility Meeting we will focus on the facility design of the experiments, and quantitative studies of the physics potential of the proposed..."

15–16 Nov 2022
CERN
US/Central timezone

Enter your search term

Overview
Registration
Participant List
Videoconference

Starts 15 Nov 2022, 03:00
Ends 16 Nov 2022, 11:00
US/Central

CERN
6/R-012 - conference room
Room 93/R-031 also booked for parallel sessions
[Go to map](#)

Event Description:
The Forward Physics Facility (FPF) project is moving forward! At the 5th Forward Physics Facility Meeting we will focus on the facility design of the experiments, and quantitative studies of the physics potential of the proposed...

WORKSHOP

PLEASE UPDATE YOUR REGISTRATION

Needed to make sure how many people will attend the workshop in person at CERN

For on-site attendance, if you need visitor access contact:

Jamie Boyd (Jamie.Boyd@cern.ch)

1. Go to <https://indico.cern.ch/event/1196506/registrations/87321/>
2. click on registration
3. click on modify (first screen shot)
4. select attendance option

Registration

Registration



Your registration has been completed



Modify



Withdraw

ORGANIZATION OF WG4 EFFORTS

- mostly work in subgroups & individual projects / papers of WG4 members
- slack channel for communication with the entire WG4
(emails -> we will copy all the essential updates to the slack channel)
- number of general WG4 meetings will be kept low
(next update meeting ~Feb/Mar 2023)
- essential to make progress in selected topics within the next year
- all new ideas are certainly very highly welcome:
 - we are happy to provide feedback,
slack channel/google doc for keeping track of different projects
 - can ask experimental representatives if new signature etc. is proposed

Working Group Experimental Contacts:

	WG5 FASER2	WG6 FASERnu2	WG7 FLArE	WG8 AdvSND	WG9 FORMOSA
WG4	Josh McFayden	Aki Ariga, Tomoko Ariga	Steve Linden, Wenjie Wu	Cristovao Vilela	Matthew Citron

SUBGROUPS (OPEN LIST)

Some topics across different WGs or subgroups
(e.g., neutrino fluxes/spectra → BSM studies)

oscillations

ν

TOPICS

LLPs

FORESEE

...

Muon-philic LLPs

LFV?

SM?

μ

new ideas/directions
highly welcome (!)

mCPs & ionization
(probes of mCPs &
FORMOSA BSM searches)

Heavy BSM physics

Quirks

...

other BSM neutrino

...

tridents

DOCUMENTS & PLANS

DOCUMENTS

- New results produced within subgroups could certainly lead to publication(s)
- Other individual research papers prepared by WG4 members

PLANS

- In the coming days, contact people who have already expressed interest in specific subgroup topics
- Let us know if you have ideas for various subgroups and want to join...
- ...or if you want to propose a new topic
- if you work / will work on individual research projects related to BSM & FPF, we are happy to provide feedback

FPF was thought to significantly extend physics goals of the LHC
This includes BSM studies but also a broad SM physics programme
WG4: What other unique/interesting BSM physics scenarios can be studied there?

PHYSICS AT THE FPF

