

# Update on FPF Facility Progress

FPF Experiments Mtg

29/8/22

Jamie Boyd

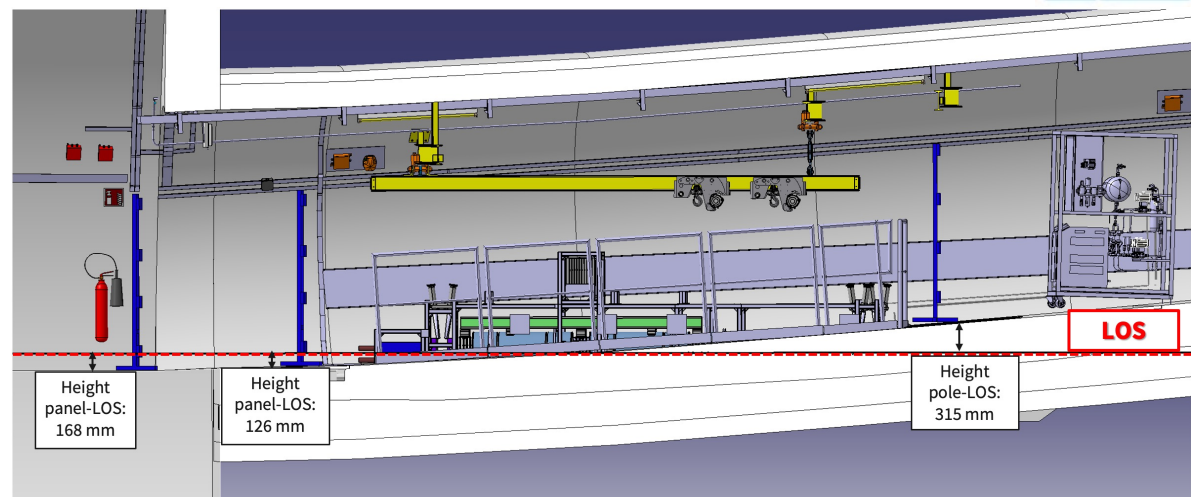
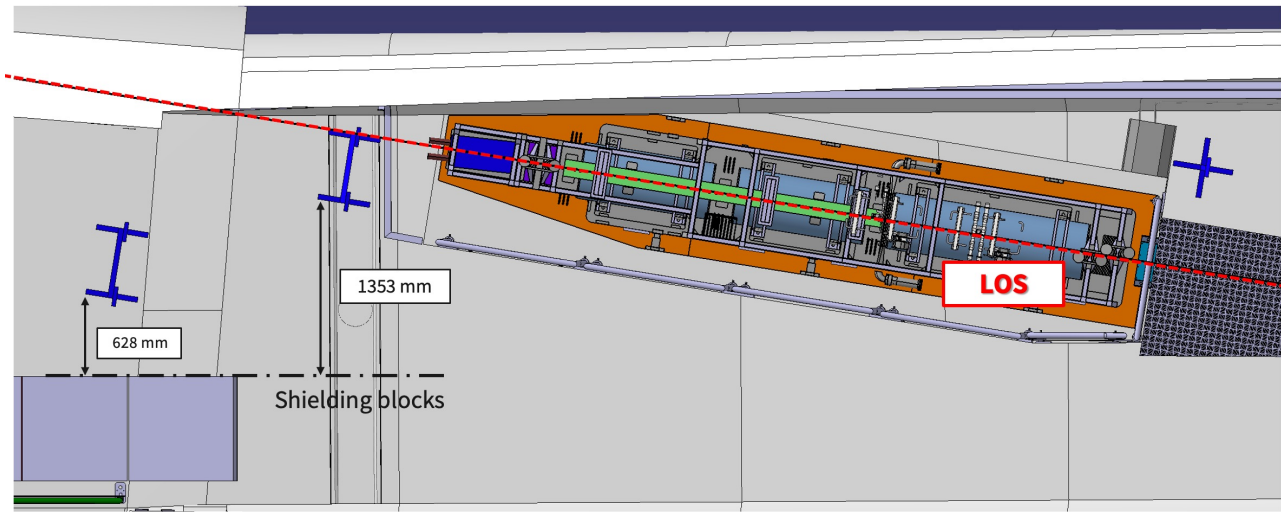
Unfortunately I cant make this meeting, but these slides give an overview of progress on the FPF since the last meeting.

Snowmass process final meeting in Seattle 16-26 July: <https://indico.fnal.gov/event/22303/>  
FPF well represented with several talks, and included in final plenary discussions.

Strong interest from US community.

FPF Snowmass White paper accepted for publication in Journal of Physics G (to appear soon).

I have updated this page: <https://pbc.web.cern.ch/fpf-resources> with links to talks, papers, tools related to FPF.



Plan to install an array of passive (emulsion) muon detectors around the LOS in FASER area to map out the muon flux for 2022 LHC running up to 2m from the LOS.

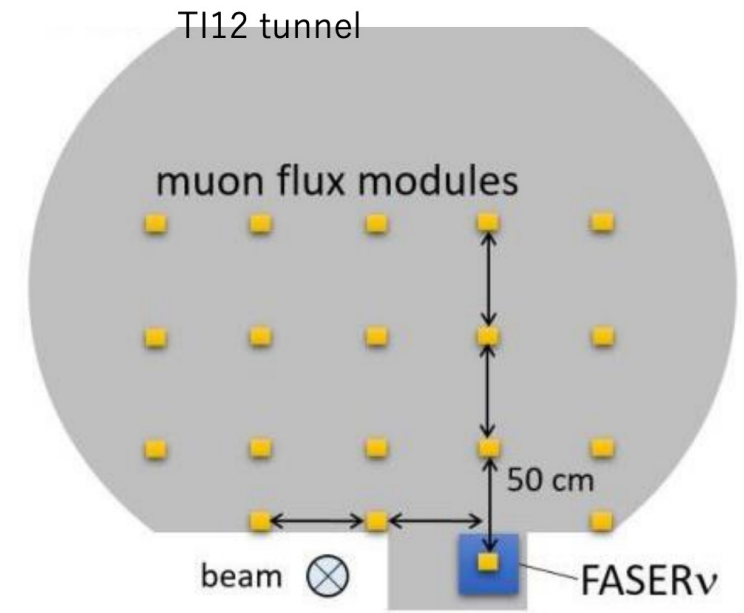
Integration study carried out by CERN team.

Engineering Change Request (ECR) needed to install things in the LHC tunnel, under approval by the LHC Machine Committee:

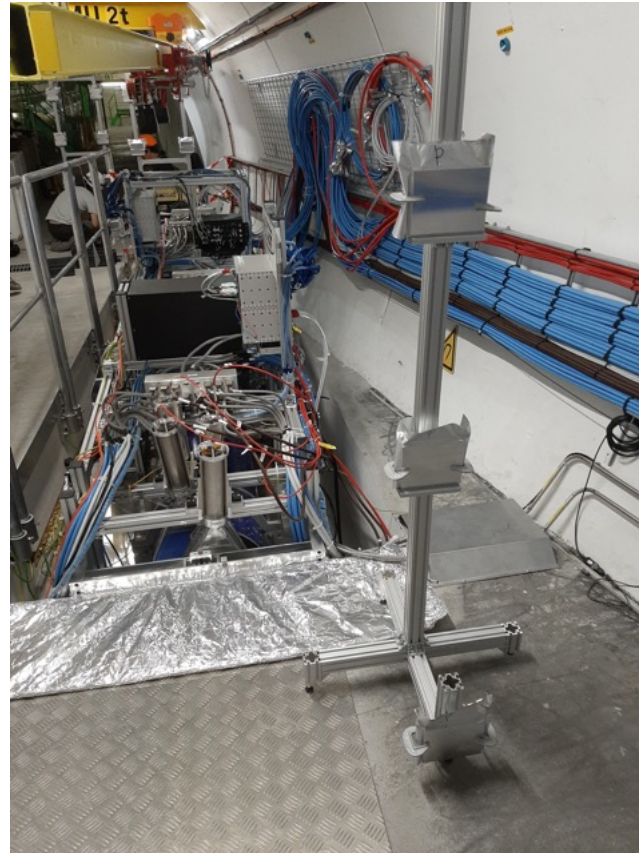
<https://edms.cern.ch/document/2752446/0.1>

Plan to install these detectors in ~1 month and remove in early September.

Should prove very useful for benchmarking the muon simulations for the FPF.

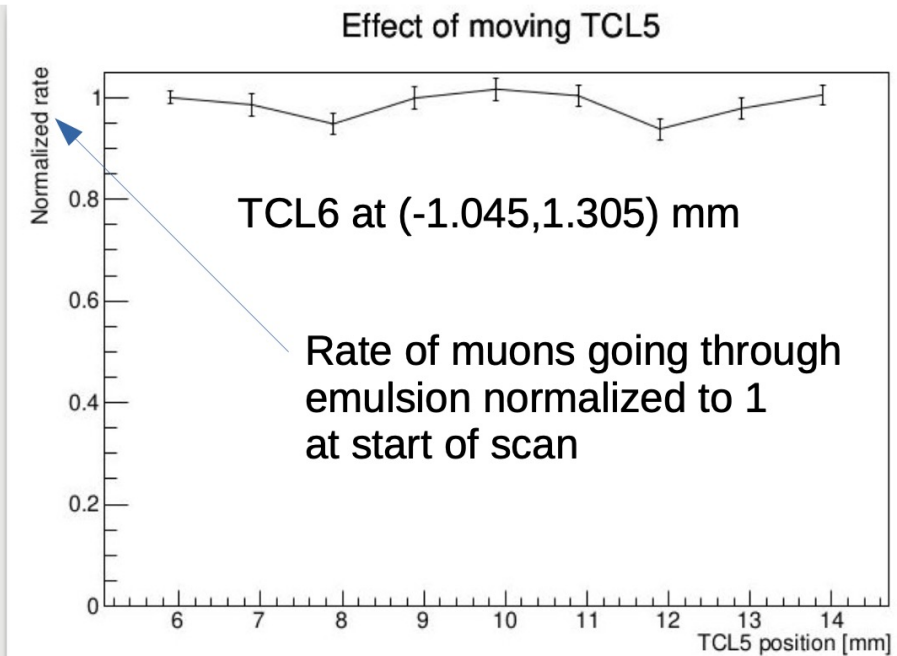
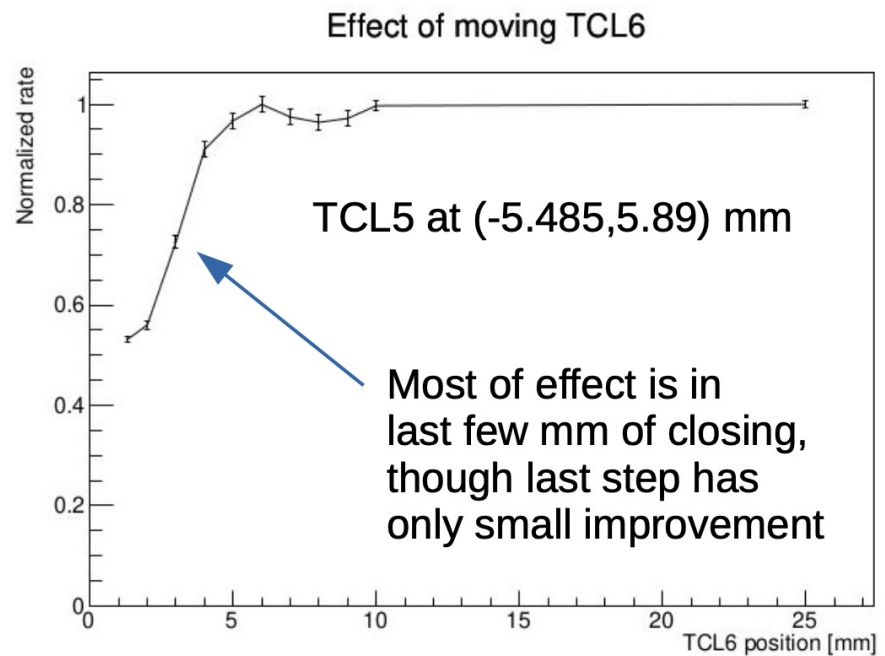


Installed into TI12 on 26/7 – and will be extracted on in TS1 (after  $\sim 10/\text{fb}$  of data delivered).  
Will be very useful for measuring the muon flux away from the LOS, and comparing to simulations.



FASER experiment has been taking physics data since July 5th. Measures the rate of muon on the LOS. In general the observed rate is broadly consistent with the expectation from FLUKA and previous in situ measurements. Observe  $\sim 0.6\text{Hz/cm}^2$  (FLUKA estimate  $\sim 0.5\text{Hz/cm}^2$ ). Also see evidence for rate increasing away from LOS as predicted by FLUKA.

However, noticed a significant dependence on the TCL collimator settings (which are changed when the AFP Roman Pot detectors are inserted a few minutes into the fill). In order to understand this we did a dedicated scan of the TCL5 and TCL6 collimator settings to see how they effect the FASER trigger rate. SND@LHC do not see dependence on collimator settings, likely only effects muon very close to the LOS.



Strong dependence on TCL6 settings. FLUKA simulations for FPF used HL-LHC baseline TCL6 settings – may be interesting to simulate possible other options to see sensitivity for FPF.

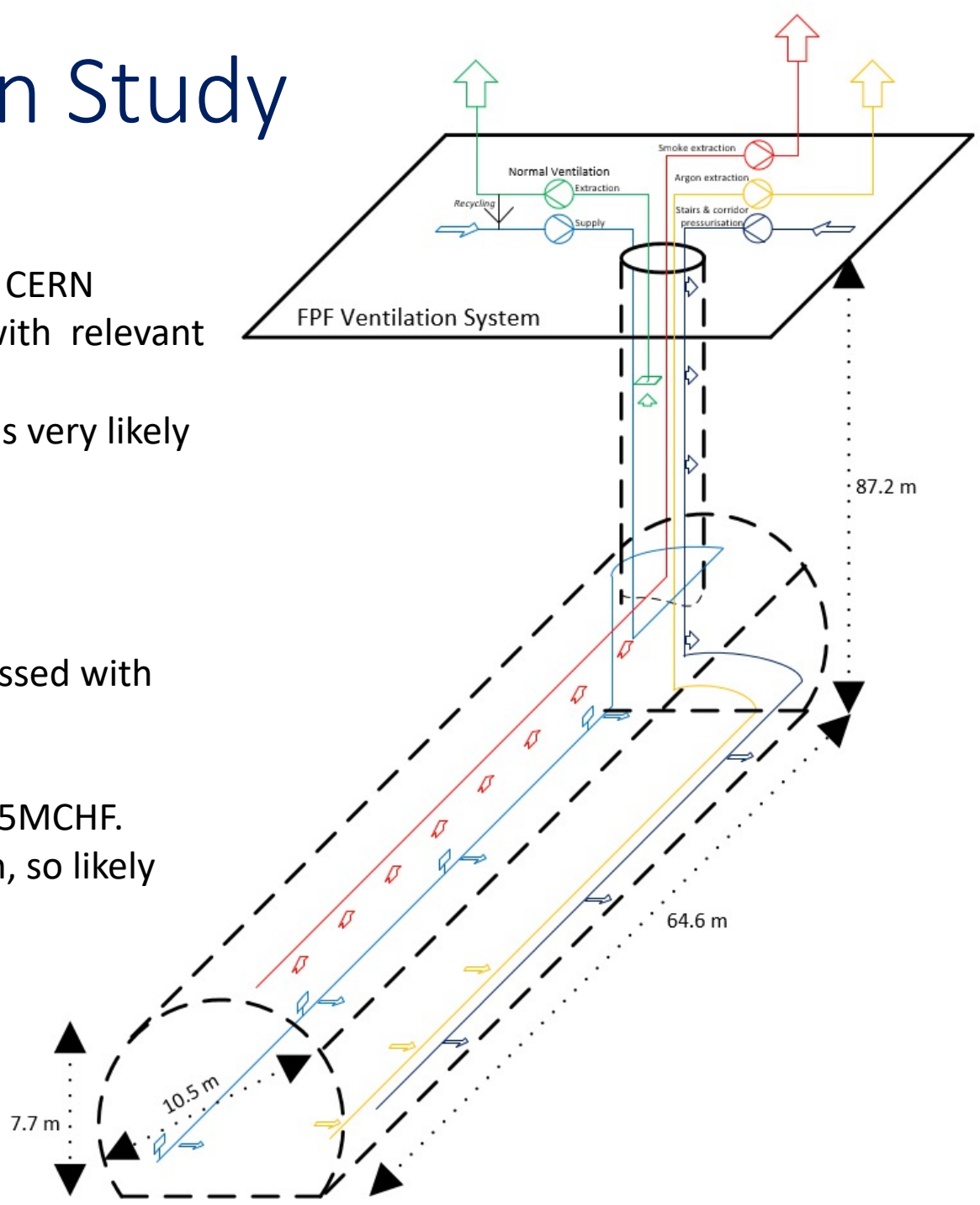
# FPF Ventillation Study

More detailed study on ventillation being carried out by CERN cooling and ventillation team (EN-CV), after discussion with relevant fire/smoke safety experts (HSE).

Current design, assumes shaft can be open (confirmed as very likely by Radioprotection (RP) team), and includes:

- Fresh air
- Pressurization
- Smoke extraction
- LAr evacuation included, but details need to be discussed with safety including FLArE specifications

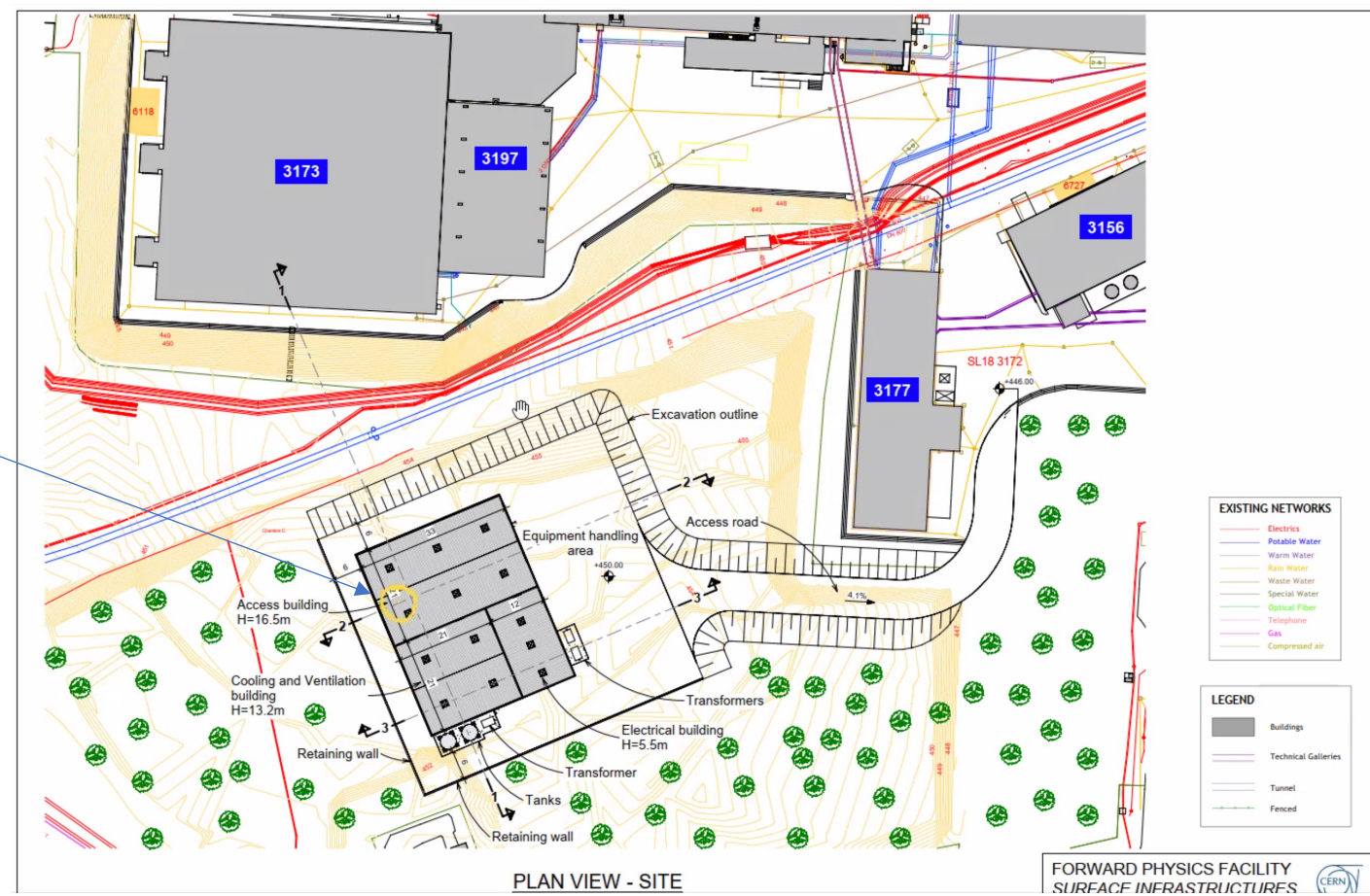
Preliminary costing of ventillation system (no cooling) 2.5MCHF.  
 (In white paper 7MCHF given for cooling and ventillation, so likely this is significantly cheaper).



# Civil Engineering: Site Investigation

Civil engineering team are starting a site investigation study. With external consultant are planning to drill a core down to proposed FPF cavern level (90m) at location of shaft. Will provide important information on on the structural strength of the rock at the cavern location, as well as understanding any contaminates in the rock, and would be fed into a revised design/costing. Hope to have drilling and analysis carried out before the end of the year.

Planned drilling location

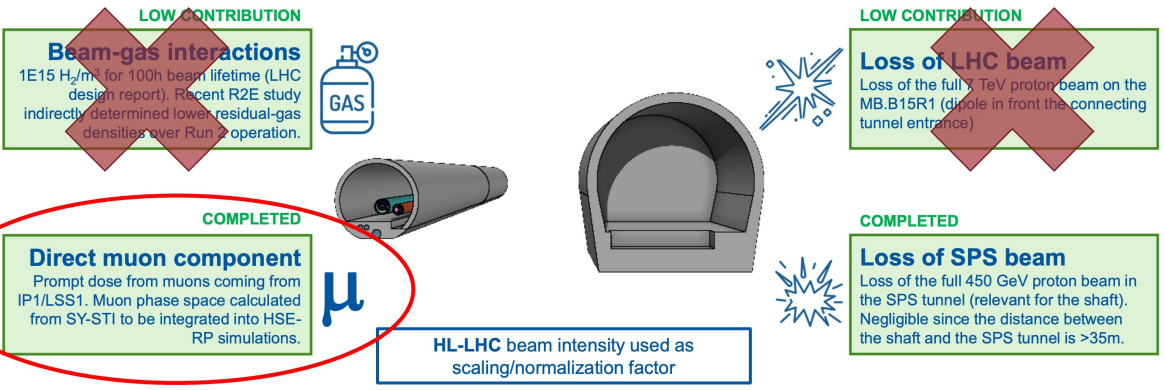


# RP Study on access to cavern during HL-LHC operations

RP team have been studying if access to FOF cavern is possible during HL-LHC operations due to radiation. Had previously considered radiation in cavern from: LHC beam-gas interactions, accidental beam loss in LHC, Beam losses in SPS – and shown these are not relevant (after removal of connection between LHC and FPF). Latest study relates to the dose from the muon flux going through the cavern.

## OPERATION

## ACCIDENT

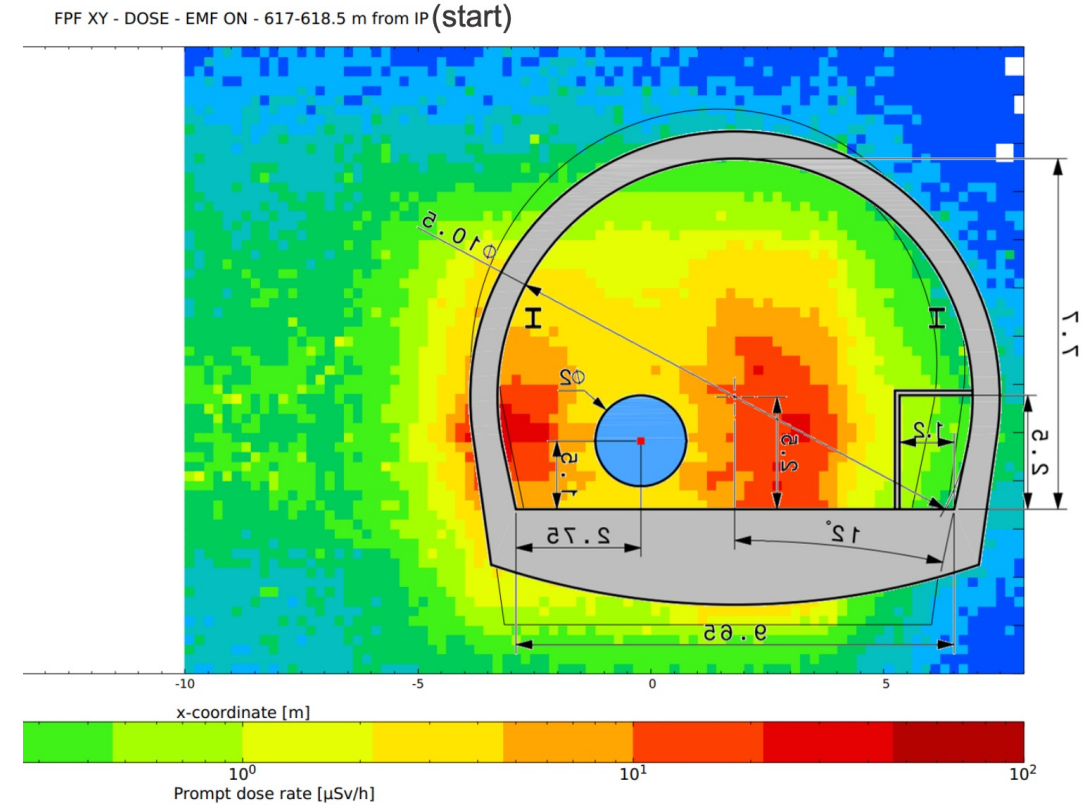
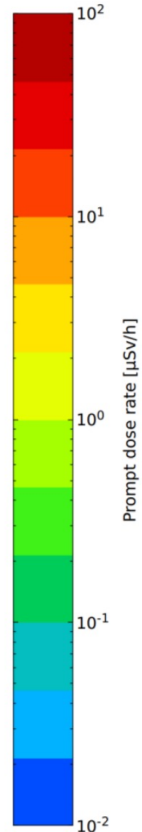
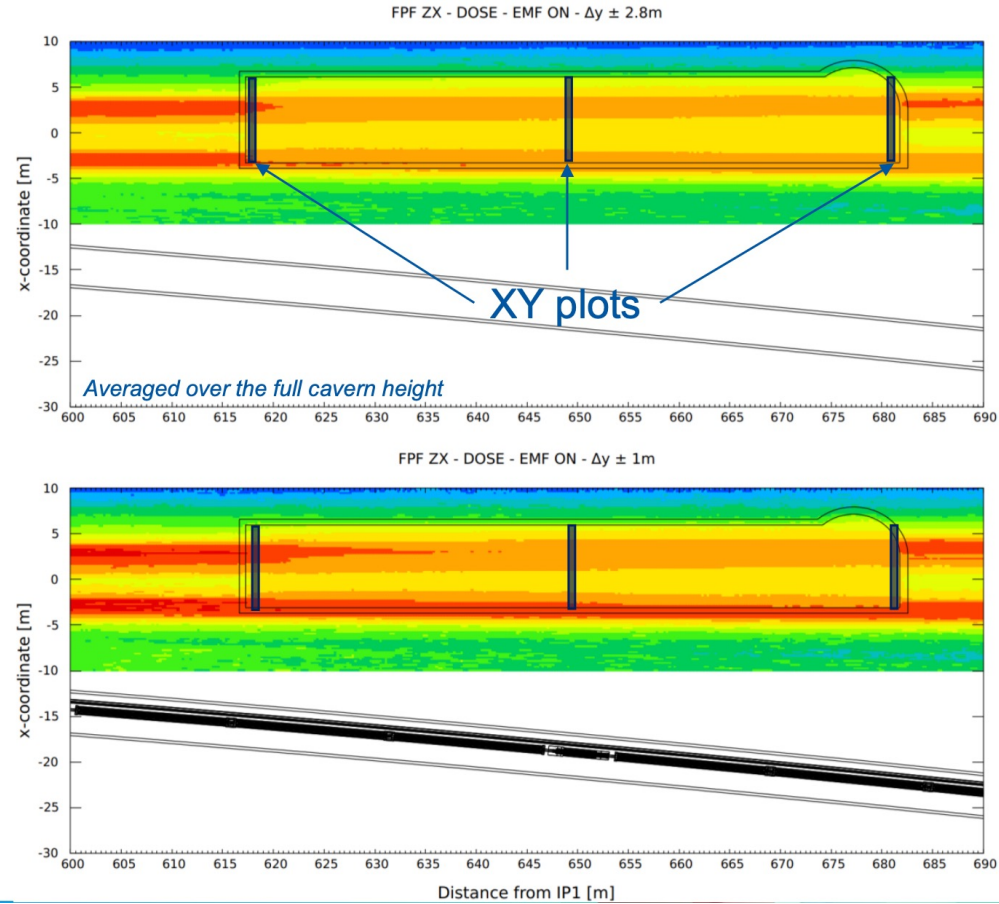


Dose from prompt muons is studied using FLUKA simulations, starting from the simulated muon flux shown by the FLUKA team. Studies done for a luminosity of  $7.5e34\text{cm}^{-2}\text{s}^{-1}$  (the ultimate HL-LHC luminosity), not expected to be reached in Run-4. Dose scales linearly with luminosity.

More details on this study in these slides:

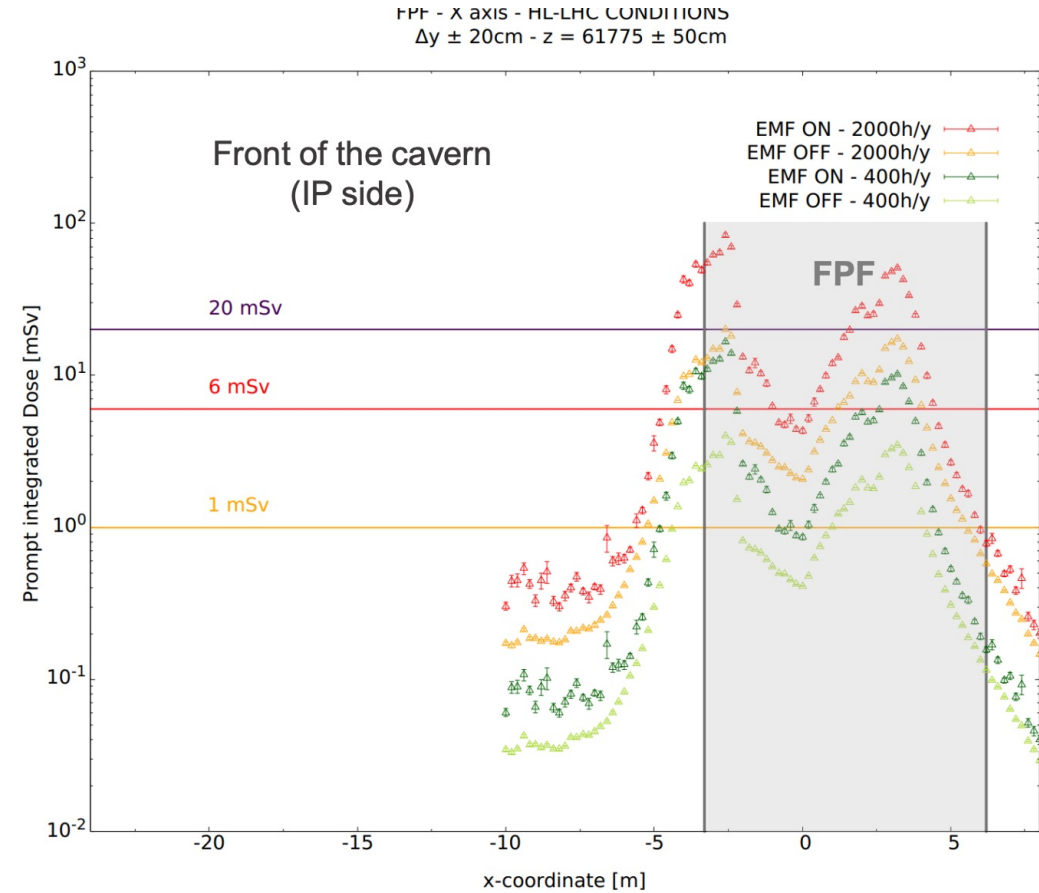
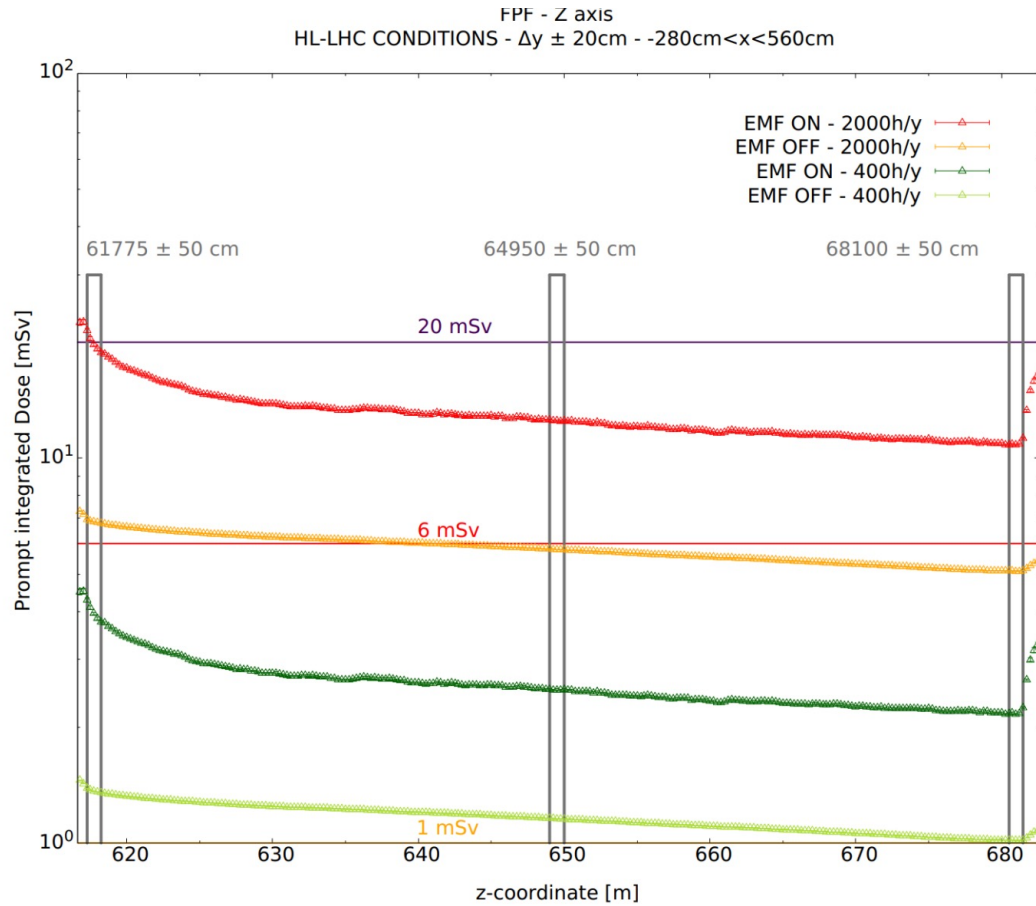
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Dose follows hot spots of high muon flux.

Dose higher at entrance to cavern due to muon interaction in rock producing local low energy hadrons.



Yearly dose (assuming  $7.5 \times 10^{34}$  lumi for full year). (EMF-ON, is better modelling in FLUKA).

Accumulated yearly dose limit is 6mSv for an area occupied <20% of the time. (Green is 20% of red curve).

Exceeded locally in limited number of locations (in muon hot spots).

Estimated dose rate (not shown)  $< 0.3\text{mSv/h}$  everywhere – not a problem.

# RP Study on access to cavern during HL-LHC operations

Conclusions from RP team:

- ✓ Direct contribution from muons coming from IP1/LSS1 can limit the accessibility to the cavern during LHC operation i.e.  $> 6$  mSv (low-occupancy) may be achieved locally.
- ✓ No permanent control rooms are foreseen underground. Nevertheless, *“During installation and commissioning, there maybe people in the cavern for an extended period, but this will be only for a short period and not routine operation”* → time to be quantified.
- ✓ Integration of FPF not fully clear at present → exact location where people could stand to be clarified.
- ✓ Classification as Supervised Radiation Area (low-occupancy, i.e.  $< 20\%$  working time) seems possible but some open points to clarify depending on the layout (integration) and operation of the facility.

Given that the study was at  $7.5e34$  luminosity and assumed HL-LHC operations for 100% time in year, it should be possible to access the cavern during operations. Especially in first year(s) of Run 3 (for finishing CE works, installation of services and experiments) when luminosity will be lower. Some specific local areas of the cavern (corresponding to the muon hot spots) could be inaccessible during HL-LHC operations.

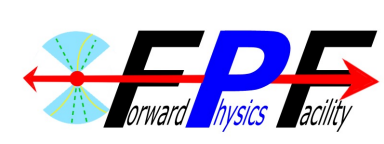
Good progress on the FPF facility. Since FPF white paper:

- FLUKA muon estimate completed (mostly positive)
- RP study concluded (positive)
- Preliminary design/costing for ventilation (positive)
- Ongoing study on effect of vibrations during excavation on HL-LHC
- Ongoing FLUKA study on effectiveness of sweeper magnet
- Input from FASER on muon rate in Run 3
  - Observe significant effect of collimators on rate on LOS
  - Muon emulsion detectors installed around LOS will provide more information
- Site investigation for civil engineering starting

Plan to write up the completed items above in a PBC public note in the next months.

Many thanks to CERN teams for all of the above work.

**Need to make progress on the experiments and required technical infrastructure.**



Backup....



# Radiation Areas classification

EDMS  
810149

Area	Annual dose limit (year)	Ambient dose equivalent rate		Sign
		permanent occupancy	low occupancy	
Non-designated	1 mSv	0.5 µSv/h	2.5 µSv/h	
Supervised	6 mSv	3 µSv/h	15 µSv/h	
Simple Controlled	20 mSv	10 µSv/h	50 µSv/h	
Limited Stay	20 mSv	-	2 mSv/h	
High Radiation	20 mSv	-	100 mSv/h	
Prohibited	20 mSv	-	> 100 mSv/h	

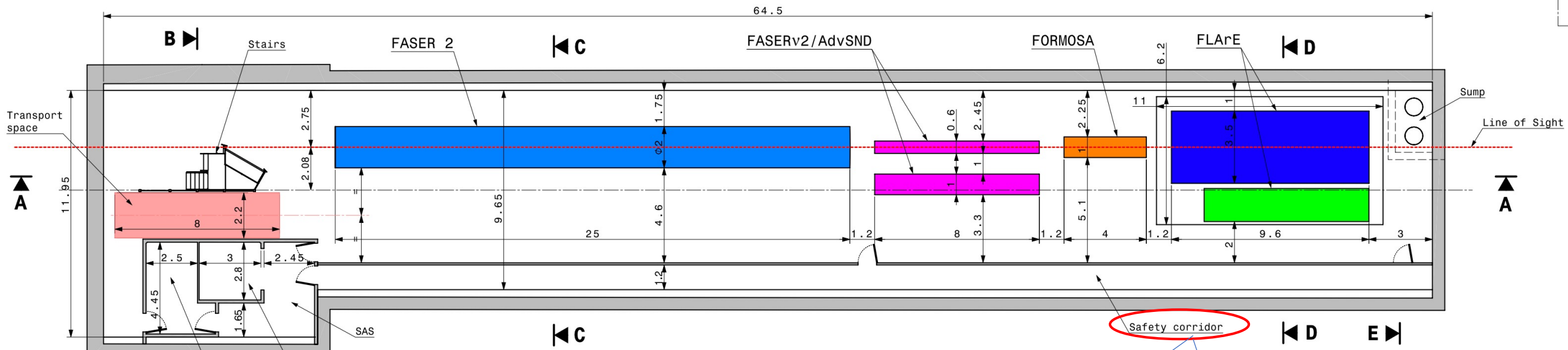
Low-occupancy:  
< 20% working time

Radiation Area

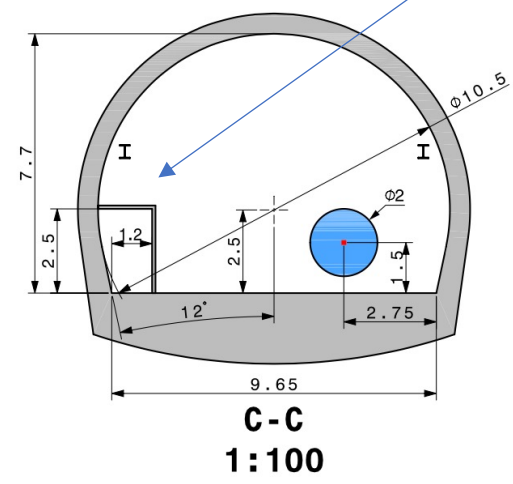
Controlled Area

- ✓ The CERN RP group has reviewed the signage used in radiation areas, by introducing a new colour code for better visualizing the radiological risk level
- ✓ The RP rules determining the area classification were not changed

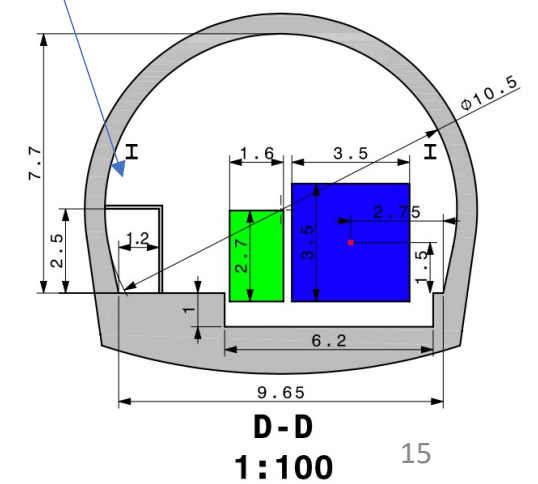
# Reminder: Cavern design...



Plan view - Cavern  
1:100



C-C  
1:100



D-D  
1:100