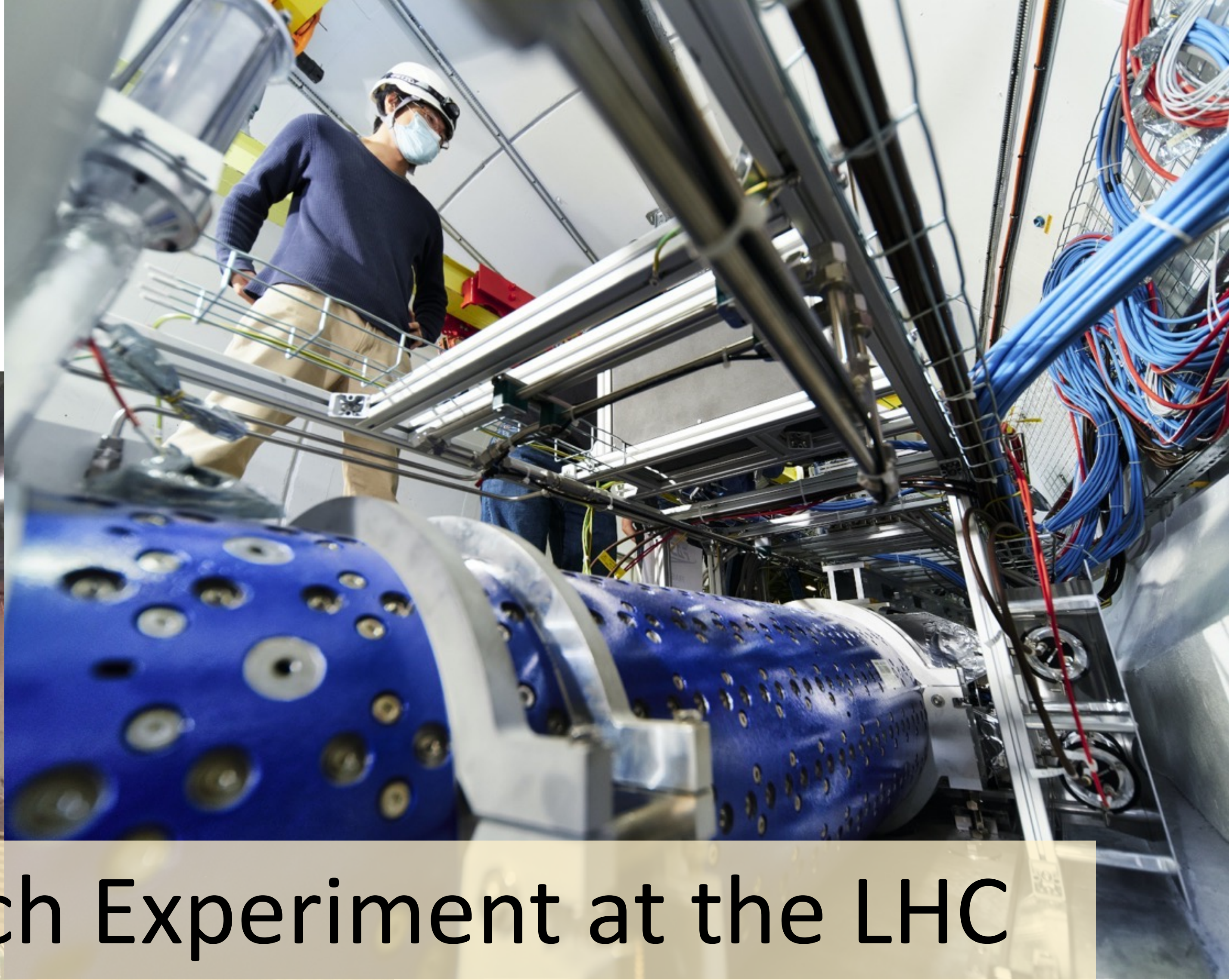
2nd International Workshop on Forward Physics
and Forward Calorimeter Upgrade in ALICE

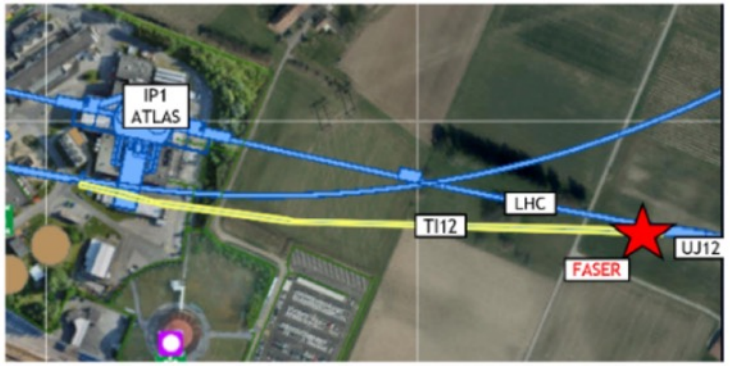
13 Mar 2023

FASER: Forward Search Experiment at the LHC

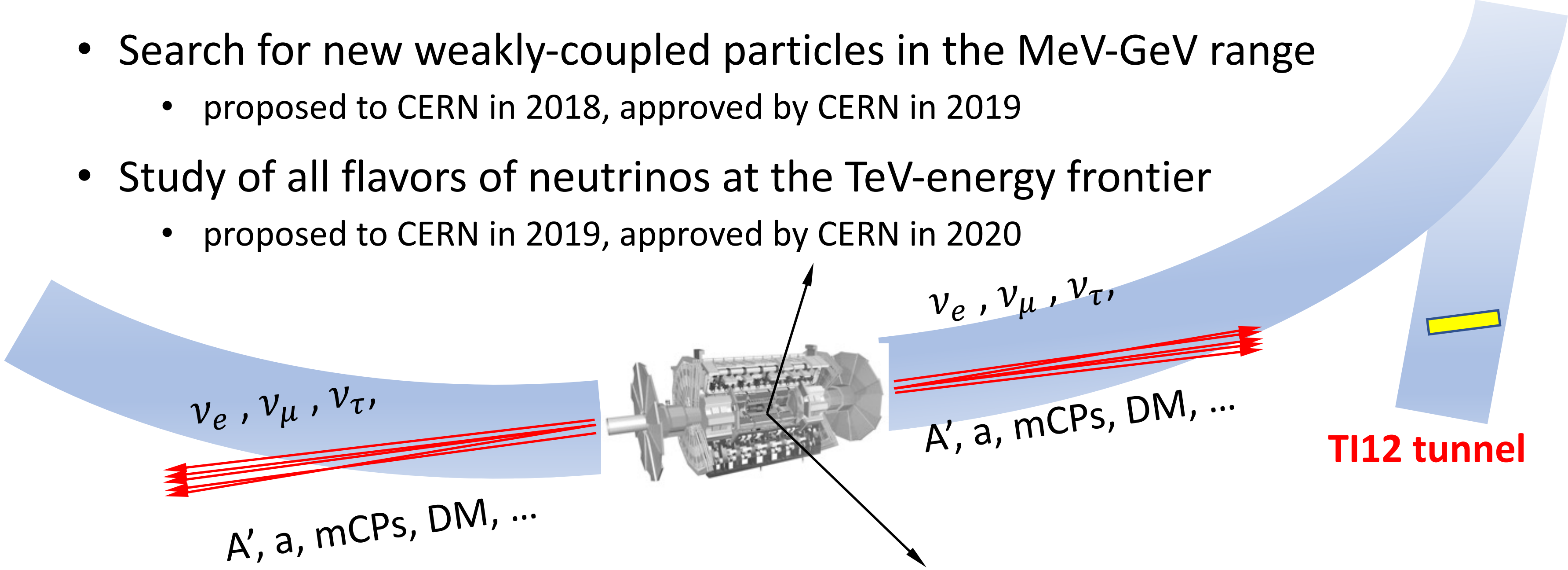
Hidetoshi OTONO (Kyushu University)

FASER experiment



FASER is a new forward experiment of LHC, located 480 m downstream from the ATLAS IP. Successfully started data taking in Run 3 from July 2022 for:

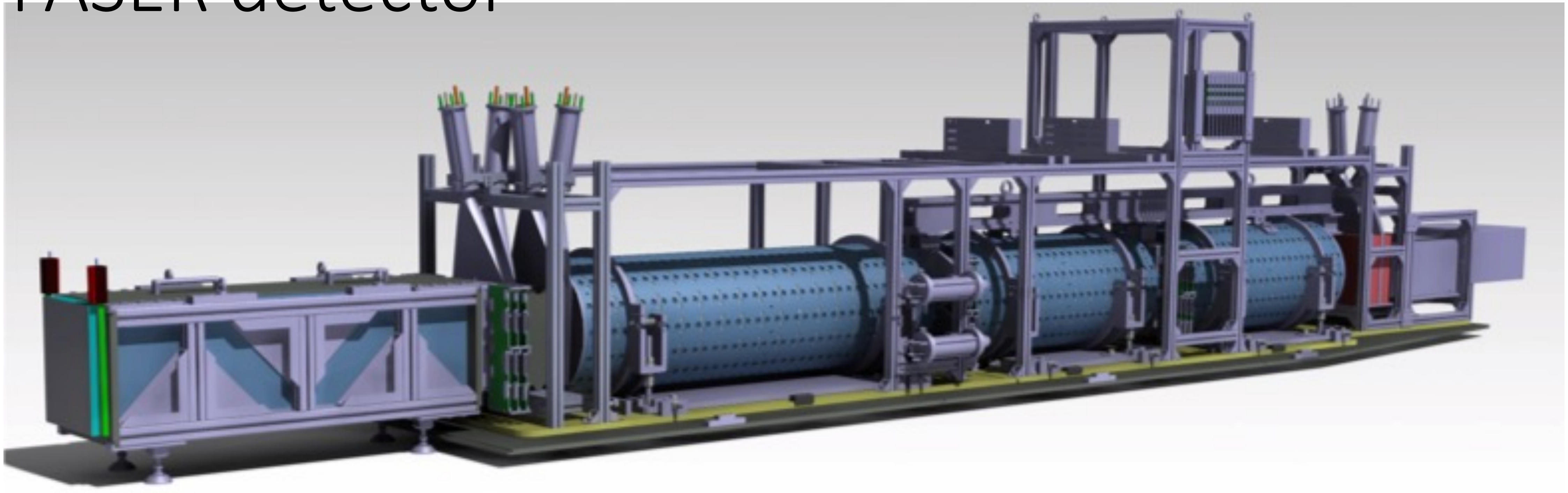
- Search for new weakly-coupled particles in the MeV-GeV range
  - proposed to CERN in 2018, approved by CERN in 2019
- Study of all flavors of neutrinos at the TeV-energy frontier
  - proposed to CERN in 2019, approved by CERN in 2020

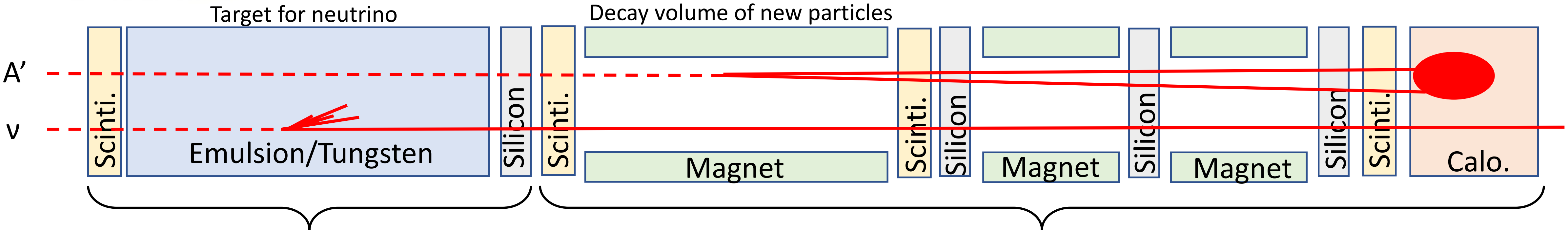


Favorable location, except that refurbishment is needed to be an experimental site.

- Background from collision point is only high-energy muon at about 1 /cm^2/sec, thanks to ~100-m rock
- Radiation level from LHC is quite low, around 4×10^{-3} Gy/year (= 4×10^{7} *1*-MeV neutron/cm^2/year)

FASER detector

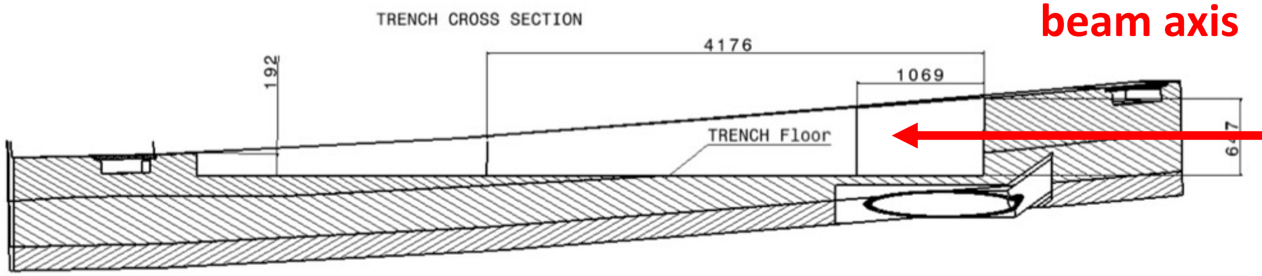




For neutrino physics:
Installation completed 2022 March

For new particle search:
Installation completed 2021 March

Civil engineering work



Aug 2018

Nov 2020

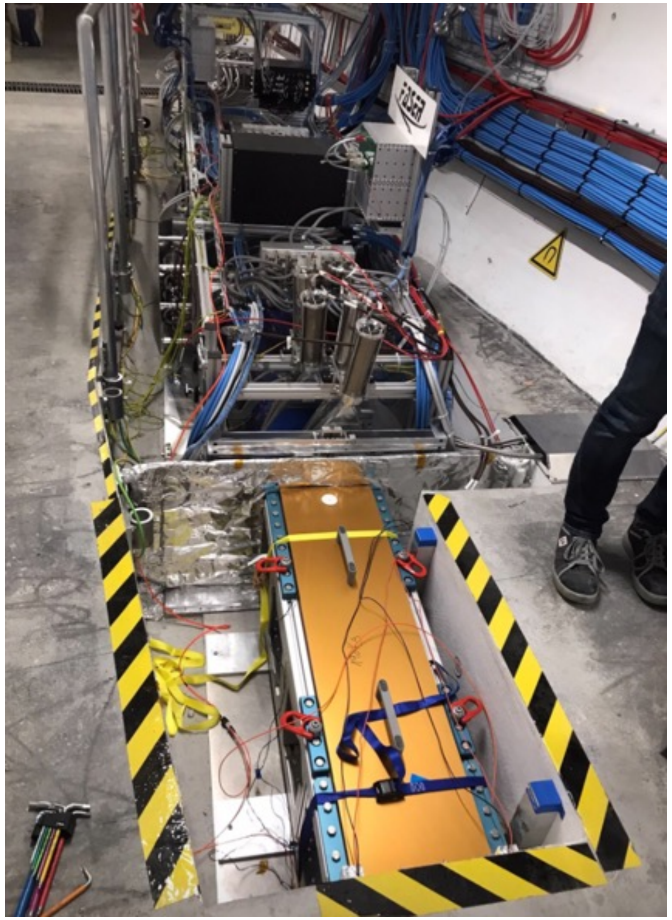
The floor in TI12 excavated by ~50 cm to have the FASER detector on beam axis

FASER detector installation

FASER spectrometer (magnets and tracker), scintillators and calorimter

April 2021

Emusion/Tungsten detector, IFT and scintillator



March 2022

Searching for new particles in MeV-GeV range

Motivated by dark matter

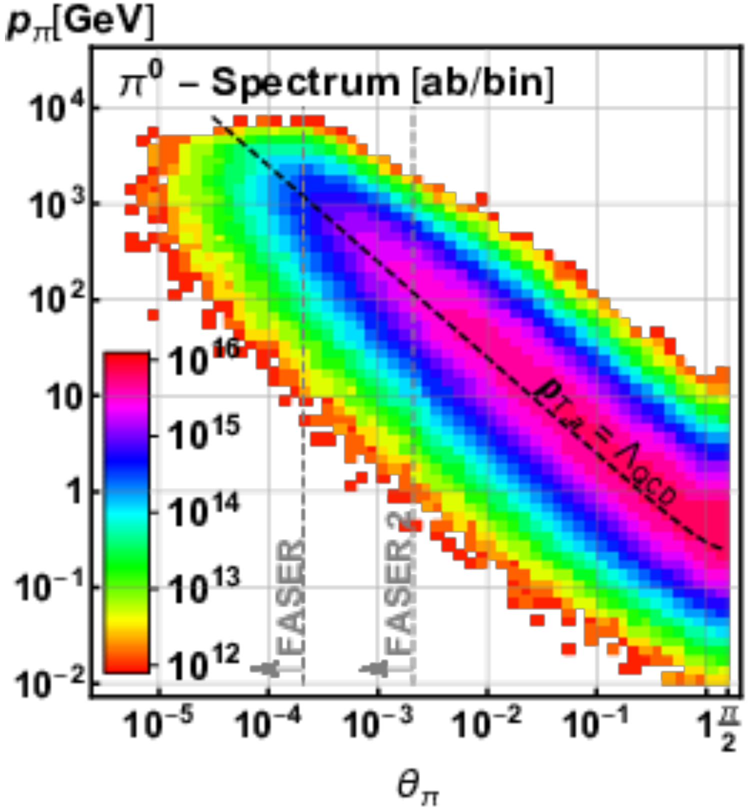
- Example is a dark photon (A’) – vector portal to dark sector
- Could be produced very rarely in decay of a π^0
- Could be long-lived due to small coupling constant

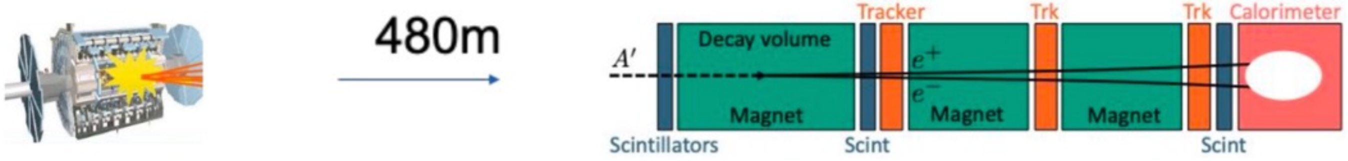
Huge flux of π^0 produced in LHC collision provides strong opptunity

- $O(10^{15})$ of π^0 in FASER acceptance (r = 10 cm) in Run 3
  - corresponding to 10^{-8} solid angle
- Very energetic - typically E > 1 TeV

Dark photon (A’) decays into a collimated pair of charged paritcle

- $m_{A'}$ = 200 MeV and E = 2 TeV, the separation is O(200) um at the first tracker
- $e^+ e^-$ for most of the $m_{A'}$ range relevant for FASER





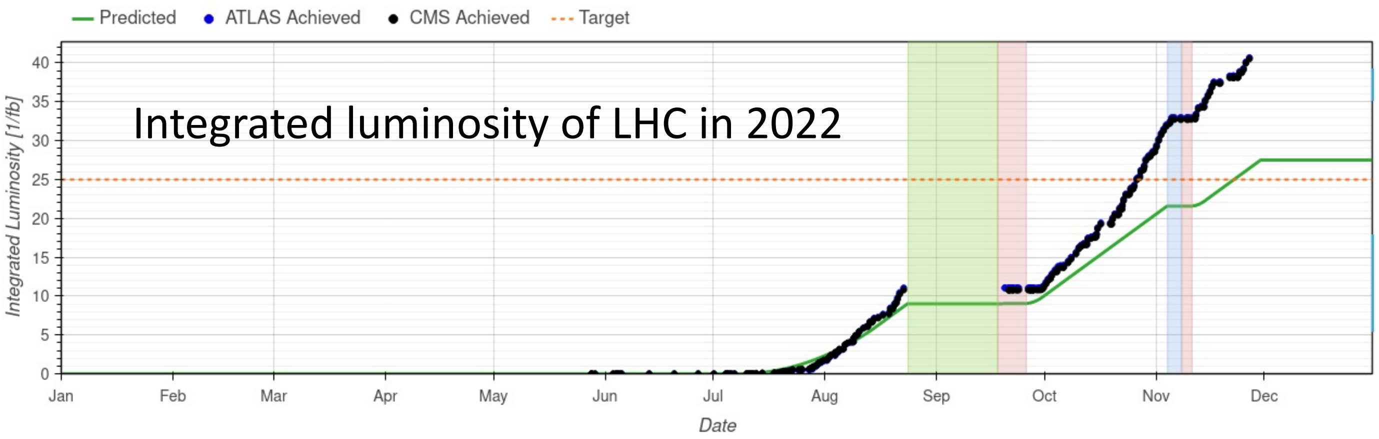
Searching for new particles in MeV-GeV range

FASER is the first far collider experiment for new particle searches

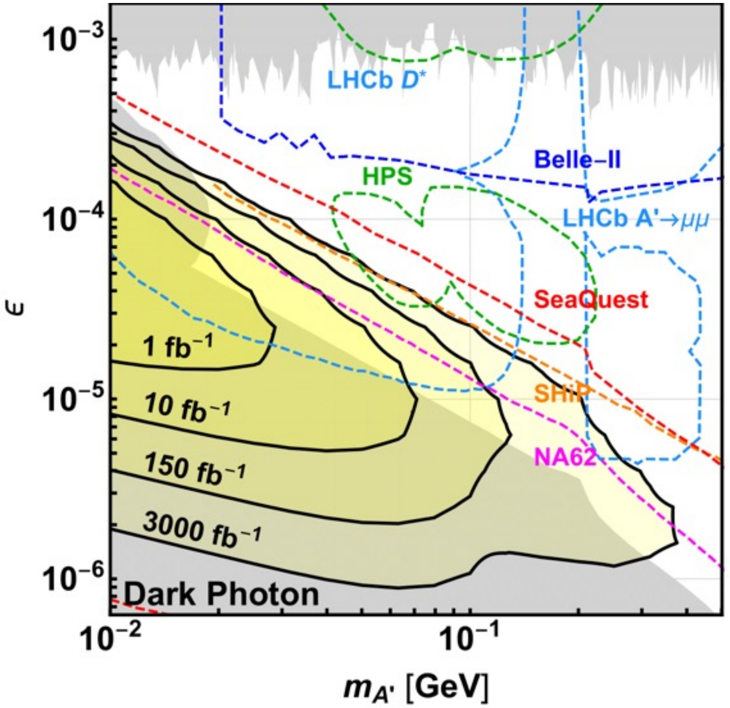
- Unique approach provides senstivity to unexplored region with the first 1 fb^{-1} of the LHC collision

LHC finished the 2022 operation end of November

- More than 40 fb^{-1} delivered at the ATLAS interaction point
- FASER successfully collected the data, the first result expected in Q1 2023



Integrated luminosity of LHC in 2022



FASER will also have sensitivity to other dark sector scenarios including ALPs, other gauge bosons, …

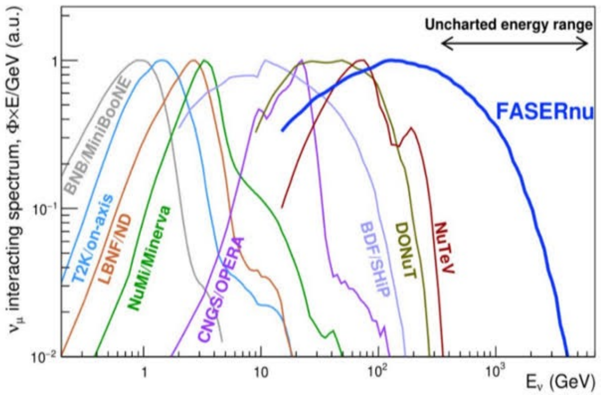
- Comprehensive summary found in [Phys. Rev. D 99, 095011 (2019)]

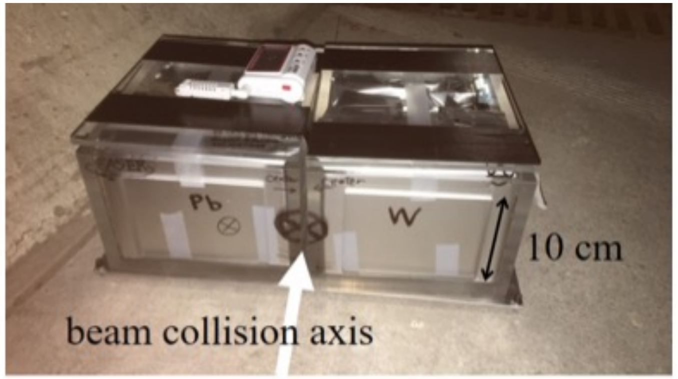
Exploring neutrinos at the TeV-energy frontier

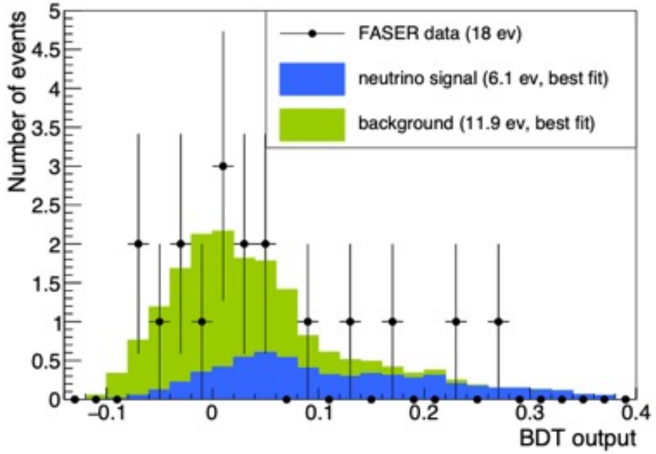
The LHC collisions also produce a copious number of neutrinos at uncharted energies

- FASER is the first experiment to probe collider neutrinos

Phys. Rev. D 104, L091101





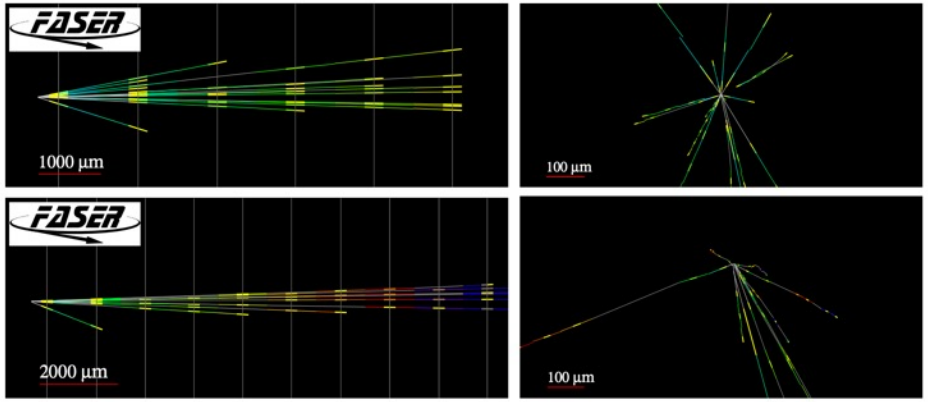


In 2018, a 29 kg emulsion detector had been installed

- the fiducial mass used for the pilot analysis was only 12 kg
- exposed to 12.2 fb^{-1} data
- best fit value of 6.1 neutrino interactions (3.3 expected) - 2.7σ

In Run3, 1.1 ton emulsion detector is installed

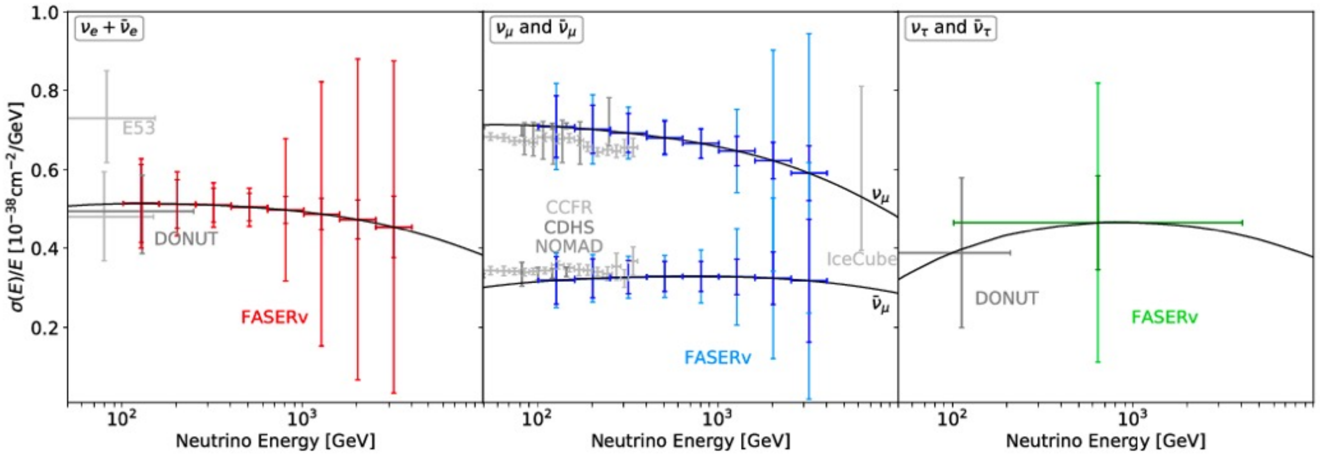
- the first result expected in Q1 2023



Exploring neutrinos at the TeV-energy frontier

Sensitive to new physics by measuring scattering cross sections and studying the final states

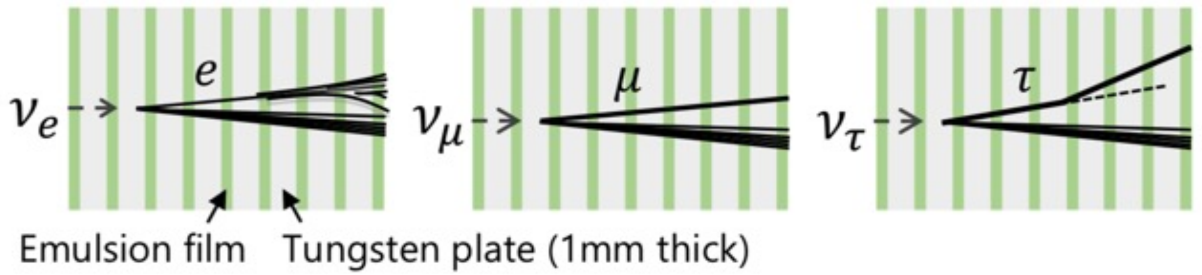
- Expected number of CC neutrino interaction with 250 fb^{-1} in Run 3

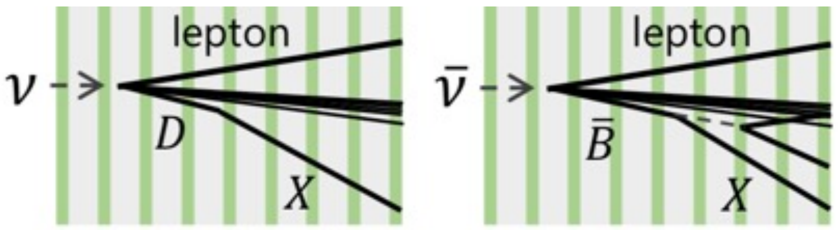


Generators		FASERν		
light hadrons	heavy hadrons	$\nu_e + \bar{\nu}_e$	$\nu_\mu + \bar{\nu}_\mu$	$\nu_\tau + \bar{\nu}_\tau$
SIBYLL	SIBYLL	1501	7971	24.5
DPMJET	DPMJET	5761	11813	161
EPOSLHC	Pythia8 (Hard)	2521	9841	57
QGSJET	Pythia8 (Soft)	1616	8918	26.8
Combination (all)		2850^{+2910}_{-1348}	9636^{+2176}_{-1663}	67.5^{+94}_{-43}
Combination (w/o DPMJET)		1880^{+641}_{-378}	8910^{+930}_{-938}	$36^{+20.8}_{-11.5}$

based on PhysRevD.104.113008

- Emulsion detector provides great ID for all leptons and heavy flavor hadrons from neutrino interaction

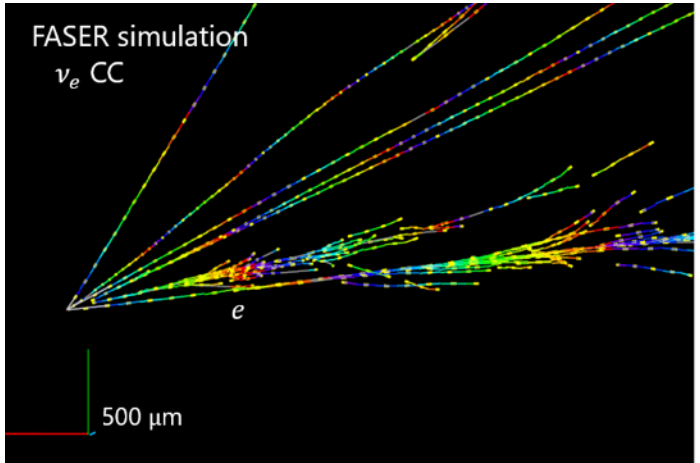


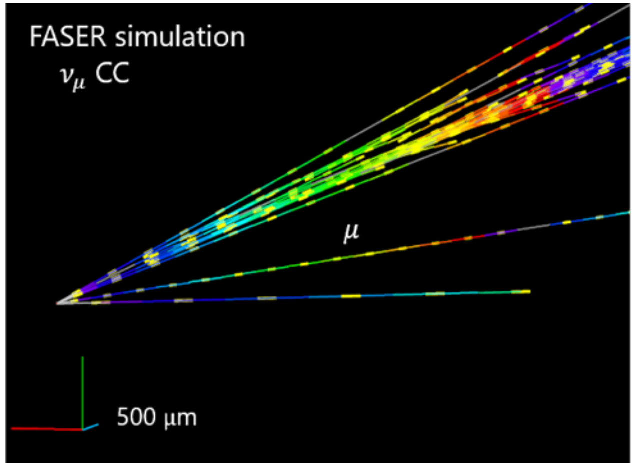


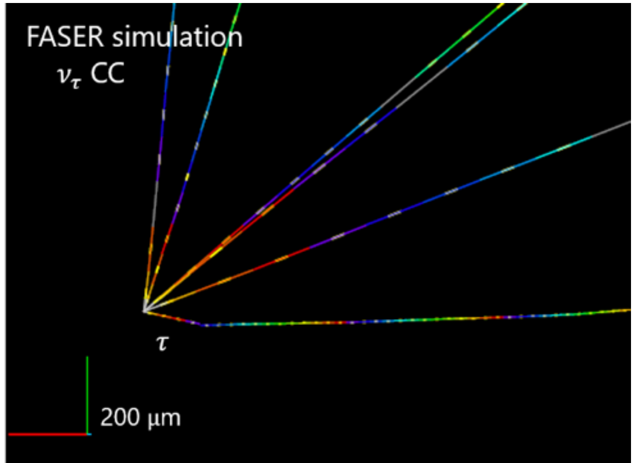
Emulsion/Tungsten detector

All flavors of neutrino interactions can be identified

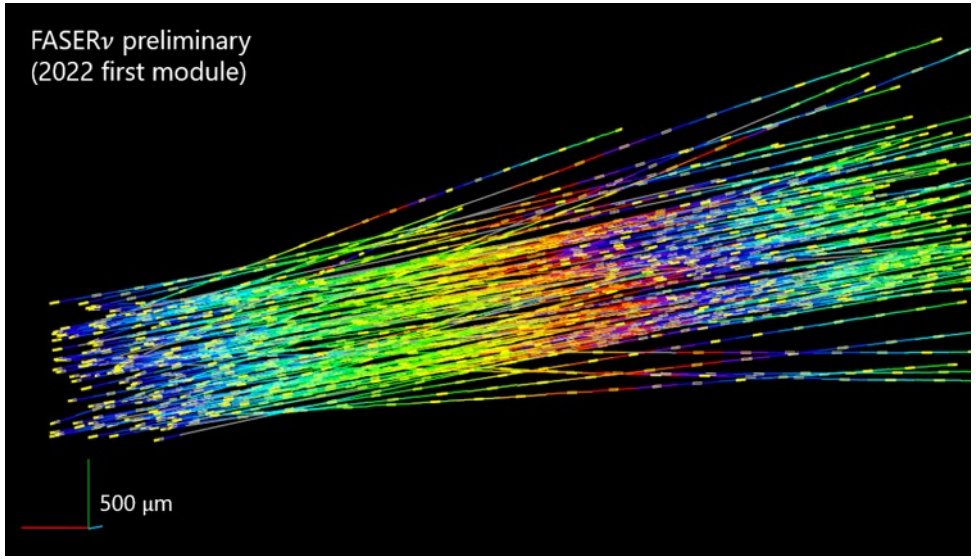
- Heavy quark production also can be distinguished
- 730 x 1.1-mm-thick tungsten plates, interleaved with emulsion films
- 25 x 30 cm^2, 1.1 m long, 1.1 ton detector (220 X_0 / 8 λ_{int})
  - ~10000 ν_μ, ~1000 ν_e and ~10 ν_τ expected in Run 3
- 3 replacements each year
  - emulsion will be produced a few months before installation







The first result from the emulsion films



Three installations done in 2022

- The last removal on 29th Nov right after the LHC operation

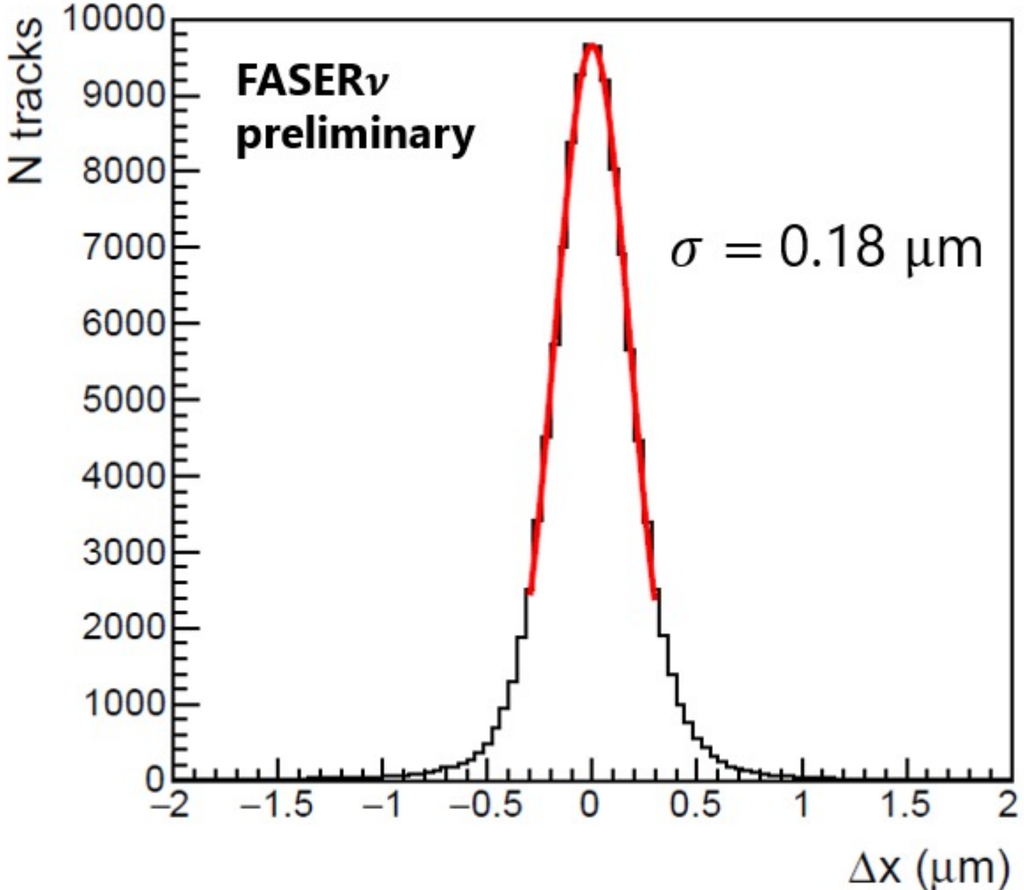
		Integrated luminosity per module (fb^{-1})	N ν int. expected
2022 1st module	Mar 15 – Jul 26	0.5	~7
2022 2nd module	Jul 26 – Sep 13	10.6	~530
2022 3rd module	Sep 13 – Nov 29	(~30)	(~1500)

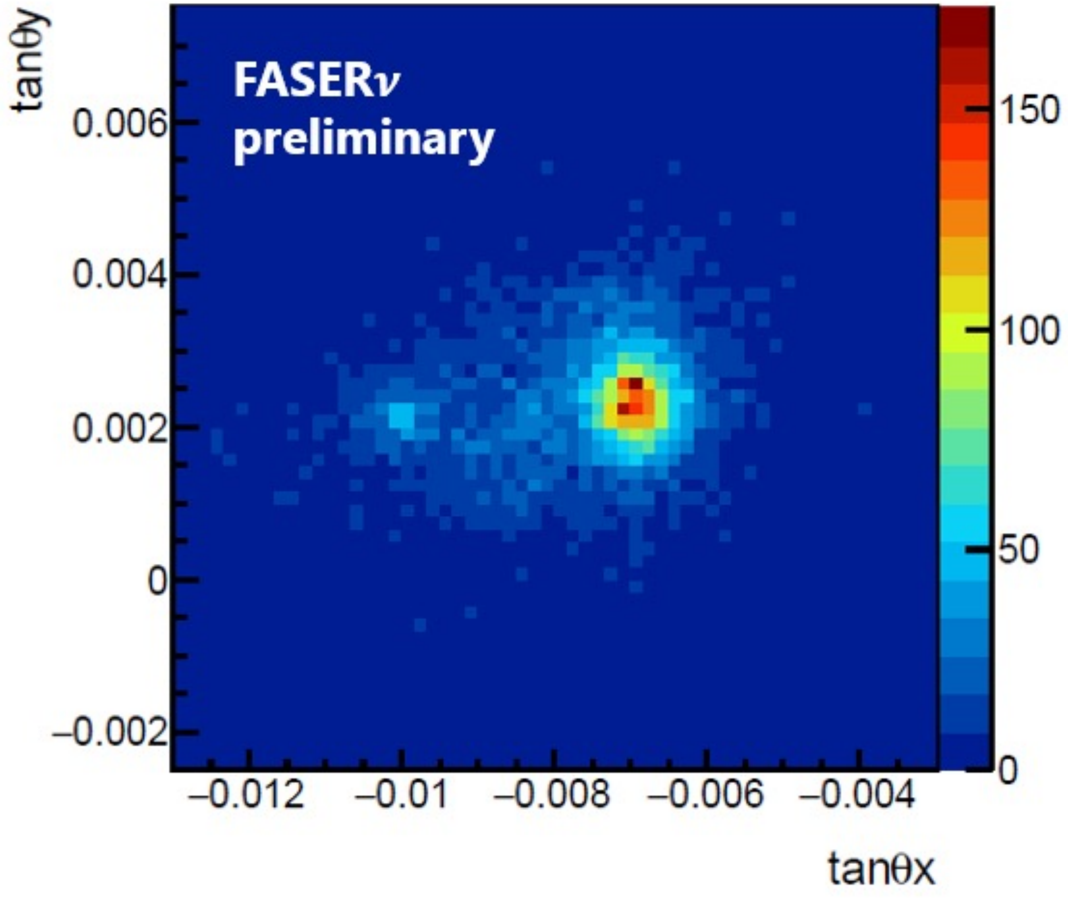
1st module is used to commission the workflow

- The track density measured in the data sample is 1.2×10^4 /cm^2 – consistent to the expectation

Very good position/angular resolution

The position deviation of 0.2μm between the track hits and the straight-line fits to reconstructed tracks





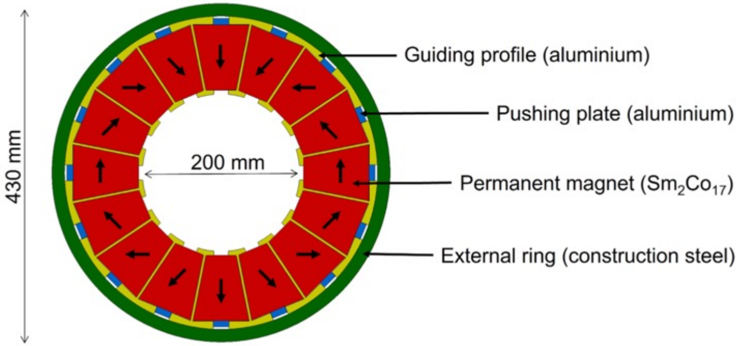
The angular spreads of the main peak are ~0.5 mrad, mainly due to the scattering through 100 m of rock.

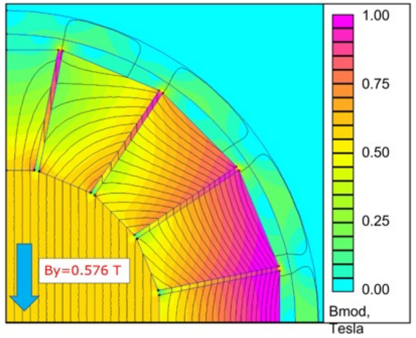
Magnet system

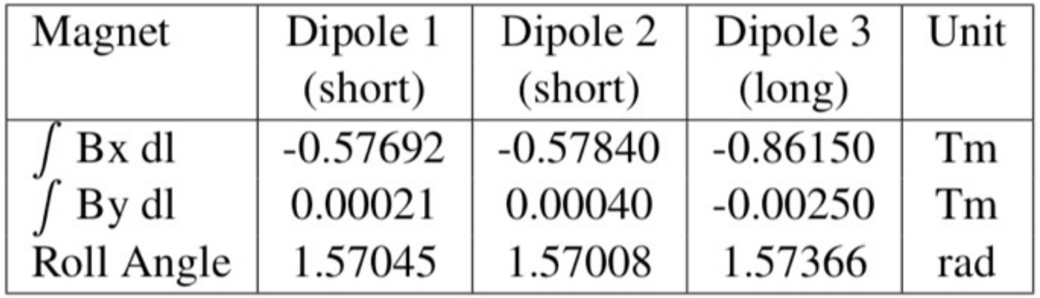
The magnets were designed, constructed and measured by the CERN magnet group

Three 0.57 T permanent dipole magnets (1.5m-long x 1 and 1m-long x 2)

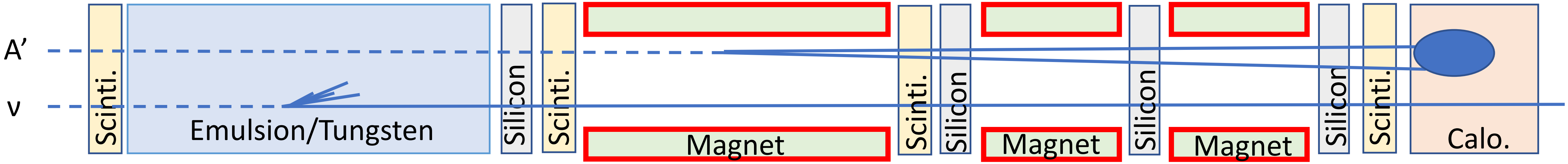
- Sufficient magnetic field to separate a pair of charged particles, assuming tracking detectors with good resolution
- Compact and robust design adapted to cope with limited space in the tunnel and limited access during Run3
- The assembled dipoles were measured with single-stretched wire (SSW) and 3D Hall probe mapper







Magnet	Dipole 1 (short)	Dipole 2 (short)	Dipole 3 (long)	Unit
$\int$ Bx dl	-0.57692	-0.57840	-0.86150	Tm
$\int$ By dl	0.00021	0.00040	-0.00250	Tm
Roll Angle	1.57045	1.57008	1.57366	rad



Target for neutrino

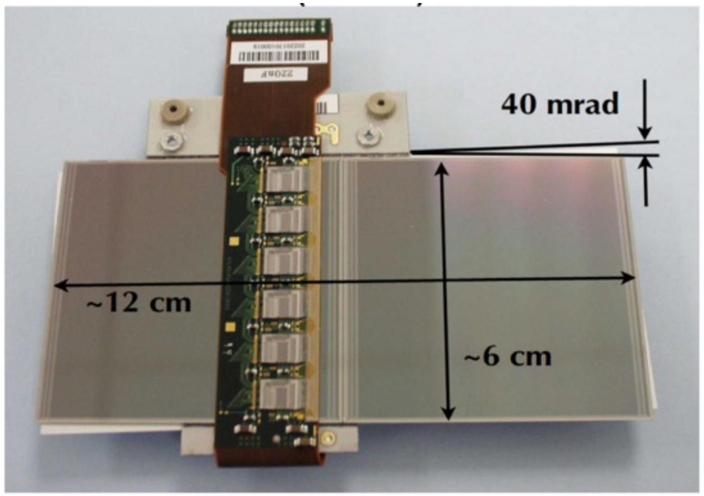
Decay volume of new particles

Tracker station

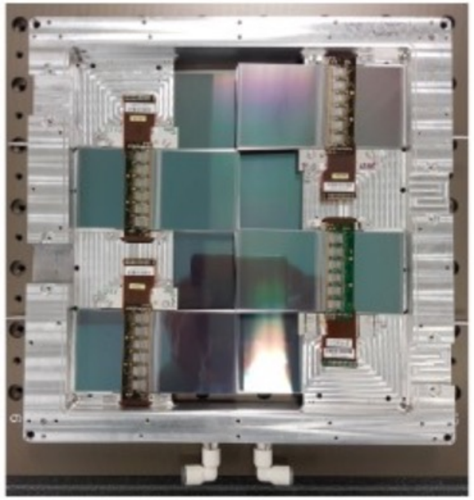
ATLAS SCT module:
- 6cm x 12cm x 2 sides (40 mrad)
- 80 um pitch/ 768 strips per side
- Resolution: 17 um x 580 um
- 6 ASICs per side

Four stations total; one station as interface tracker to emulsion detector and three stations for spectrometer

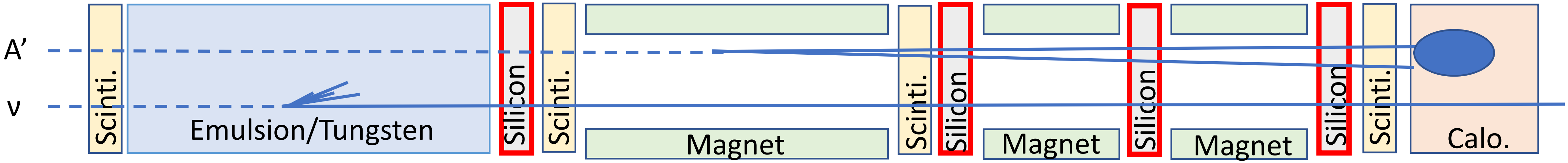
- Based on ATLAS SCT modules - 4 station x 3 layers x 8 modules = 96 modules



Tracker plane →



Tracker station →



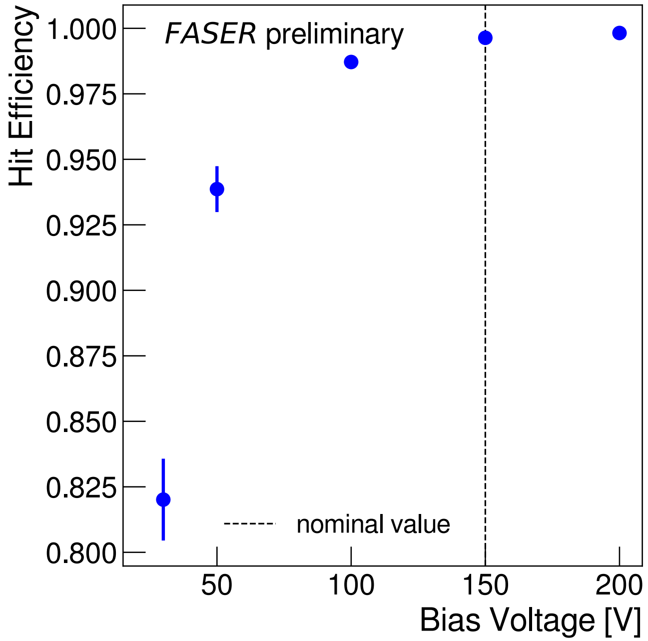
Target for neutrino

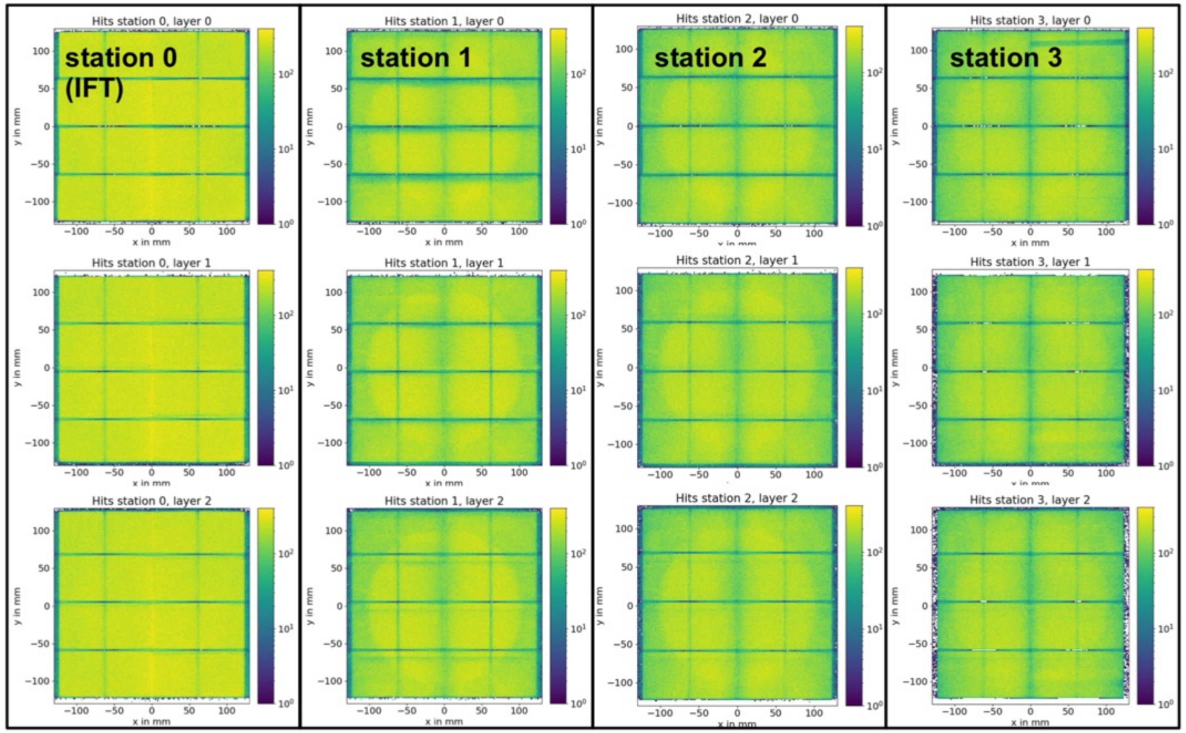
Decay volume of new particles

Tracker station performance

Hit efficiency of 99.64 ± 0.10% at 1.0 fC threshold and 150V

- 99.7% strips are active
- Uniform distiribution inside magnet aperture except for gaps between SCT modules

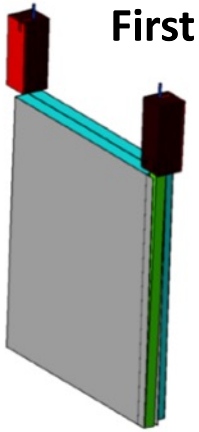




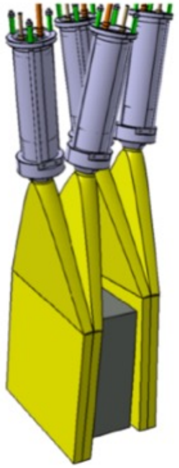
Scintillation detectors

Four scintillator stations are commissioned and installed

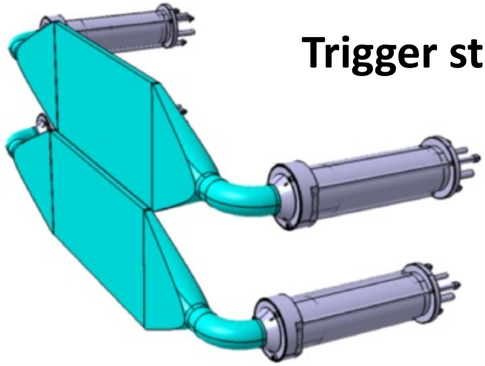
- Veto incoming charged particle, precise timing, and pre-shower for calorimeter
- Scintillators, light guides and PMT housing constructed at CERN scintillator lab (EP-DT)



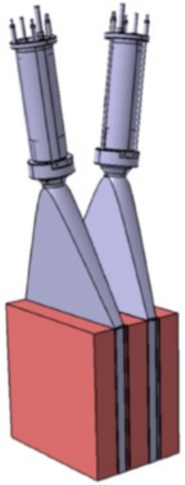
First veto station



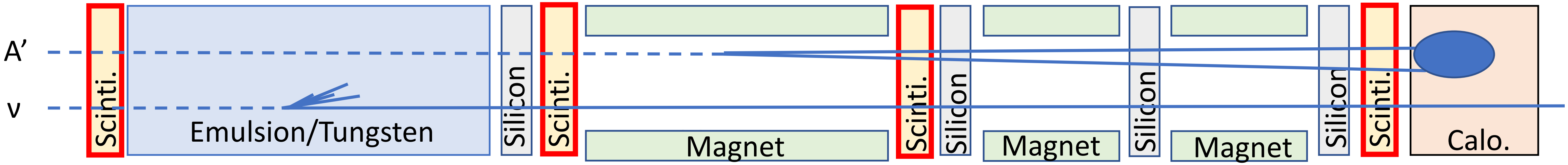
Second veto station



Trigger station



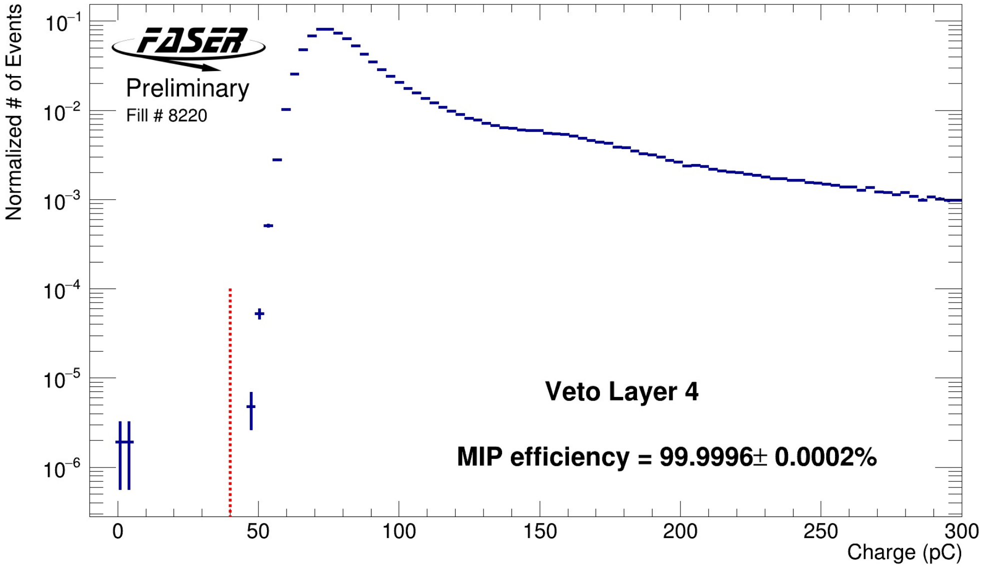
Preshower station

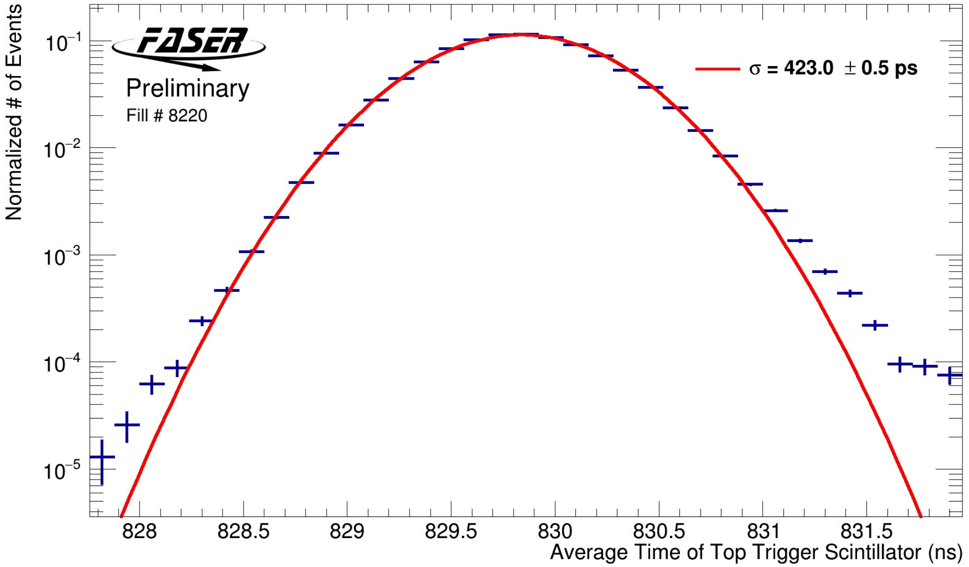


Scintillator performance

More than 99.99% efficiency achieved for each scintillator

- O(10^8) muon expected in Run3 would be rejected; sufficient for zero background in new particle search





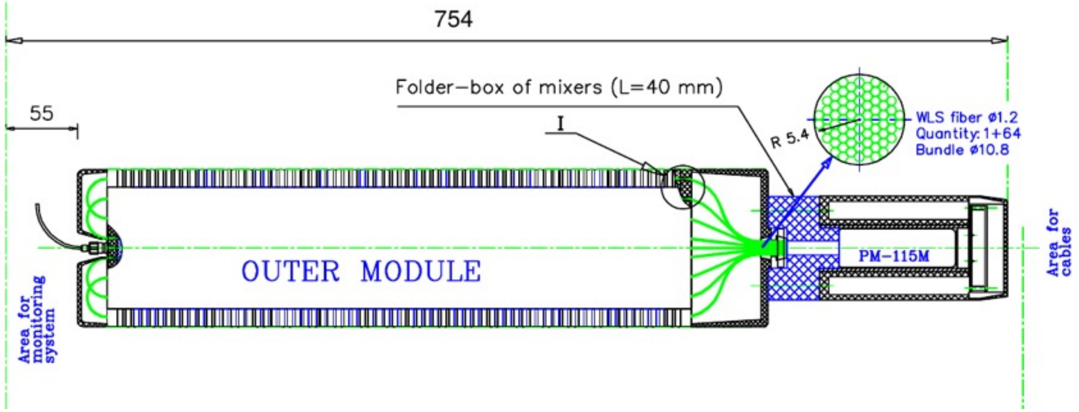
Trigger scintillator provides timing resolution of 423 ps, sufficinet to identify bunch crossing ID of LHC

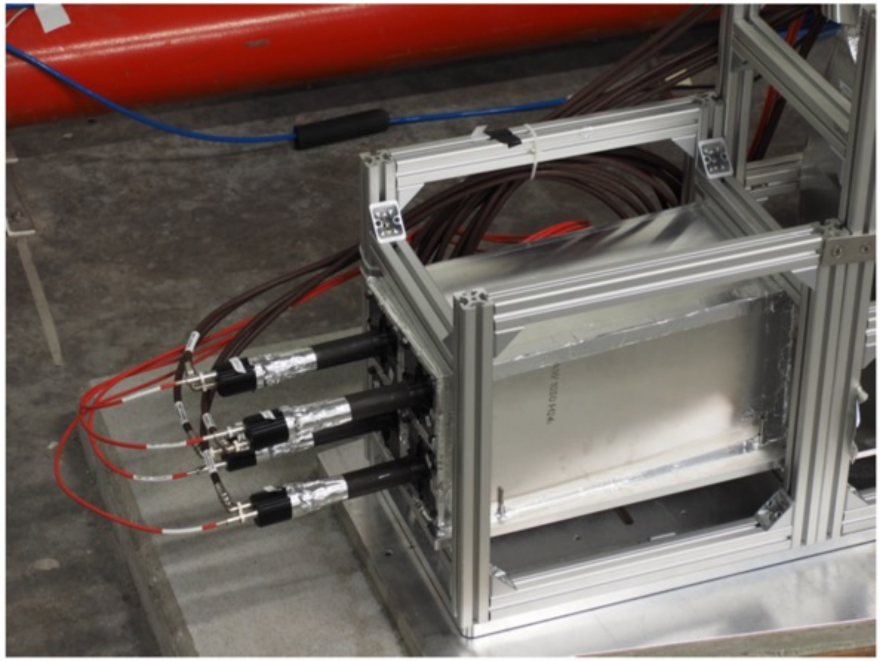
- Average time of two PMTs on both ends of the trigger scintillator to correct for timewalk

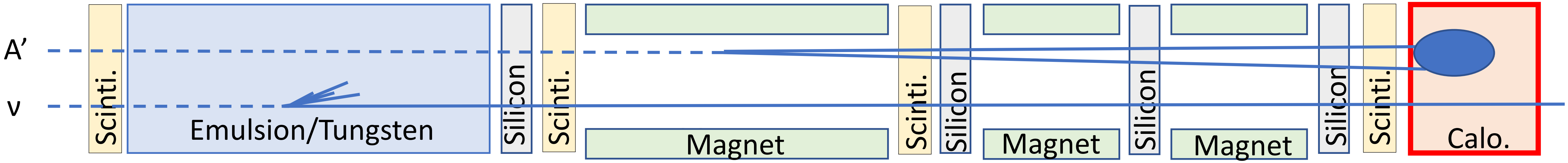
Electromagnetic calorimeter

Calorimeter utilizes spare LHCb ECAL module x 4

- one module has:
    - 12 cm x 12 cm x 75 cm (25 X_0)
    - 66 layers of (2mm lead and 4mm scintillator)







A’

ν

Scinti.

Emulsion/Tungsten

Silicon

Scinti.

Magnet

Scinti.

Silicon

Magnet

Silicon

Magnet

Silicon

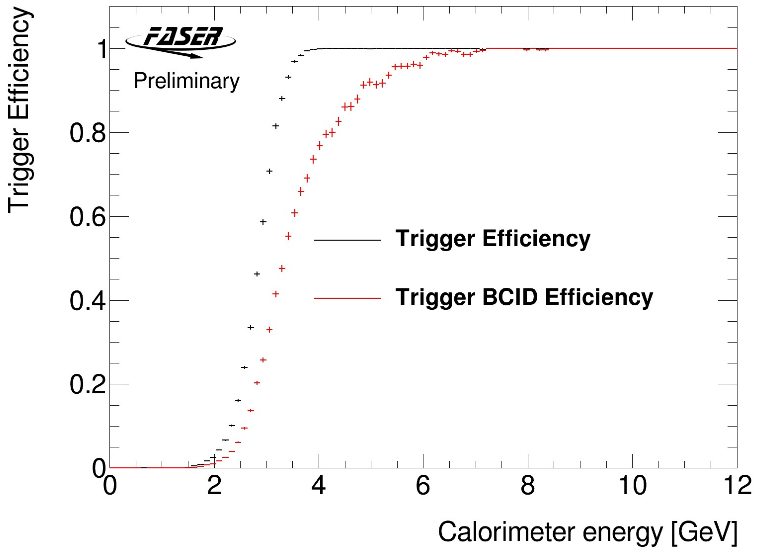
Scinti.

Calo.

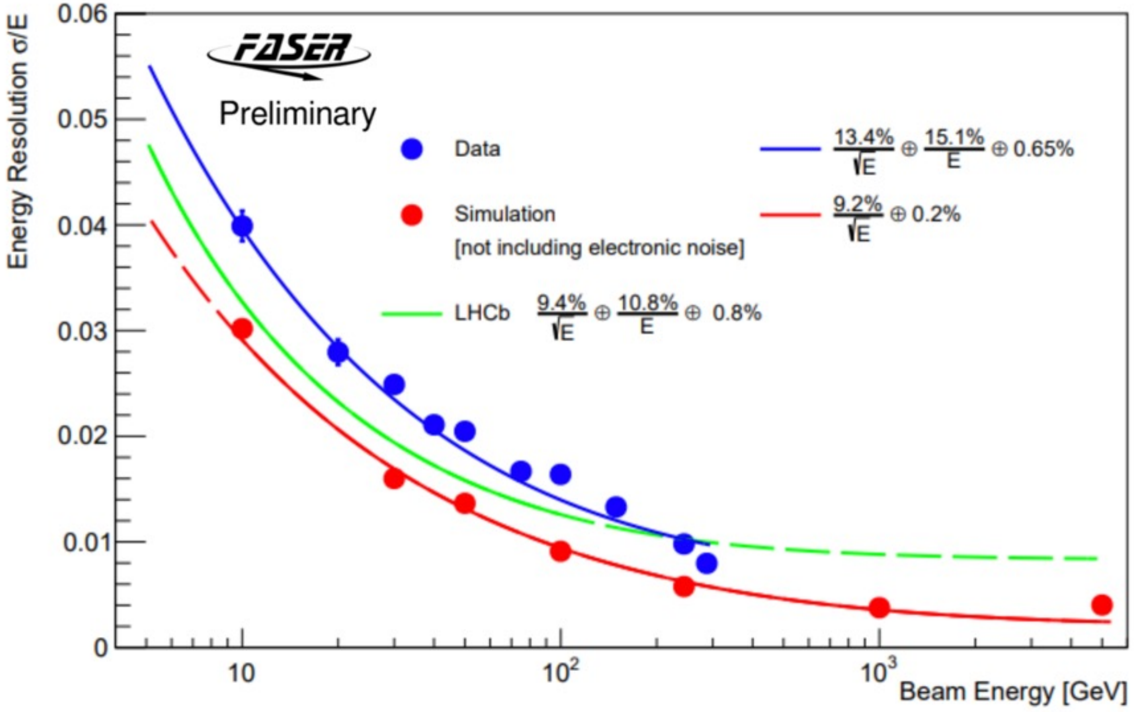
EM Calorimeter – performance

LHC collision data shows calorimeter provides timing resolution of 256 ps, requiring:

- EM energy is above 4 GeV
- only events with unsaturated PMT signals
- BCID to be consistent with a colliding bunch ID



Testbeam at SPS in 2021 summer

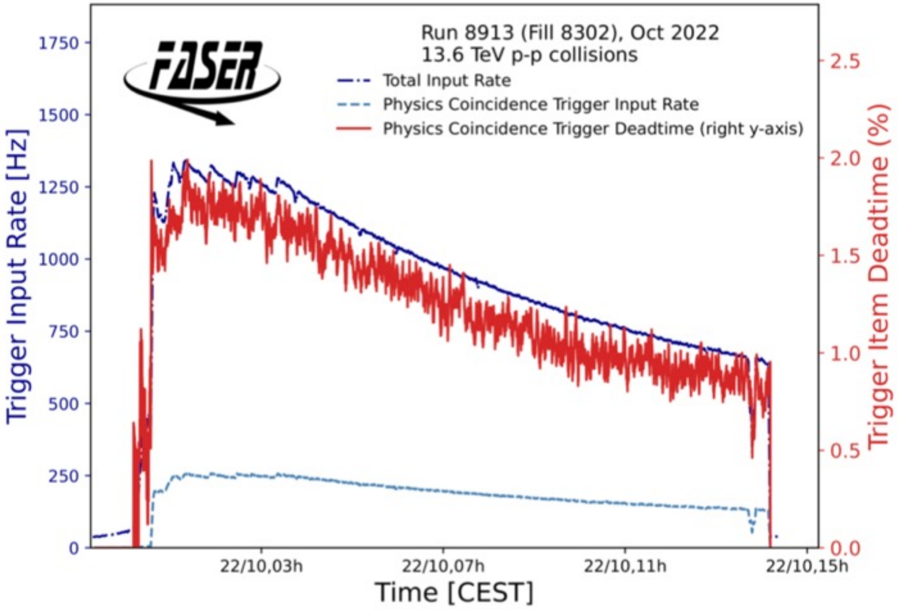


Close to the intrinsic 239 ps timing resolution of the LHC

Stable data taking thoughout 2022

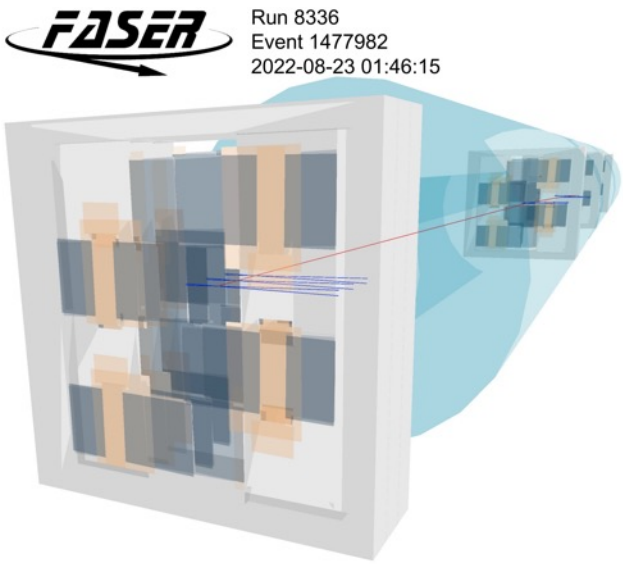
The number of bunches in LHC has reached 2400 since August 2022

- Maximum trigger rate around 1.2 kHz, giving dead time less than 2%
- Physics coincidence trigger (foremost veto and the preshower scintillator station) around 200Hz
  - our main triggered background is not muons passing through from IP1 but particles triggering individual trigger stations



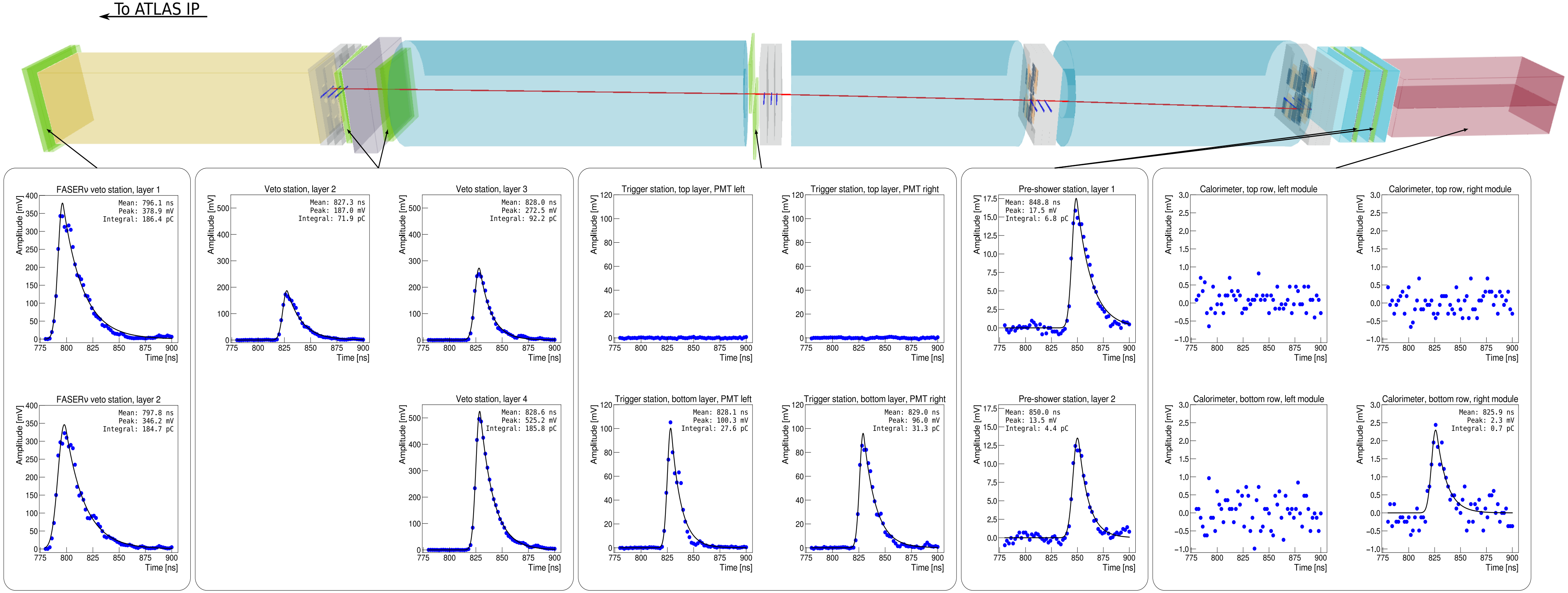
- only 850 pb^{-1} (< 2.5% of full dataset) data lost due to operational issues

Muon event from LHC collission

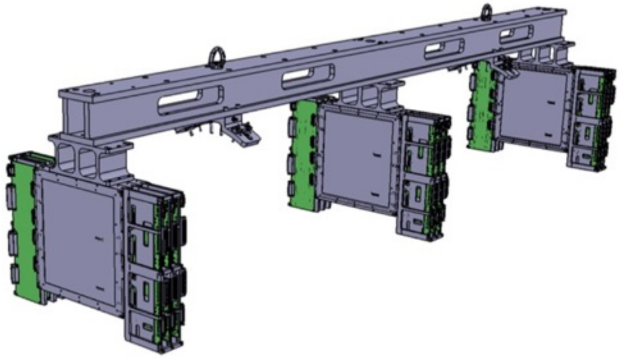


Run 8336
Event 1477982
2022-08-23 01:46:15

Reconstructed momentum 21.9 GeV

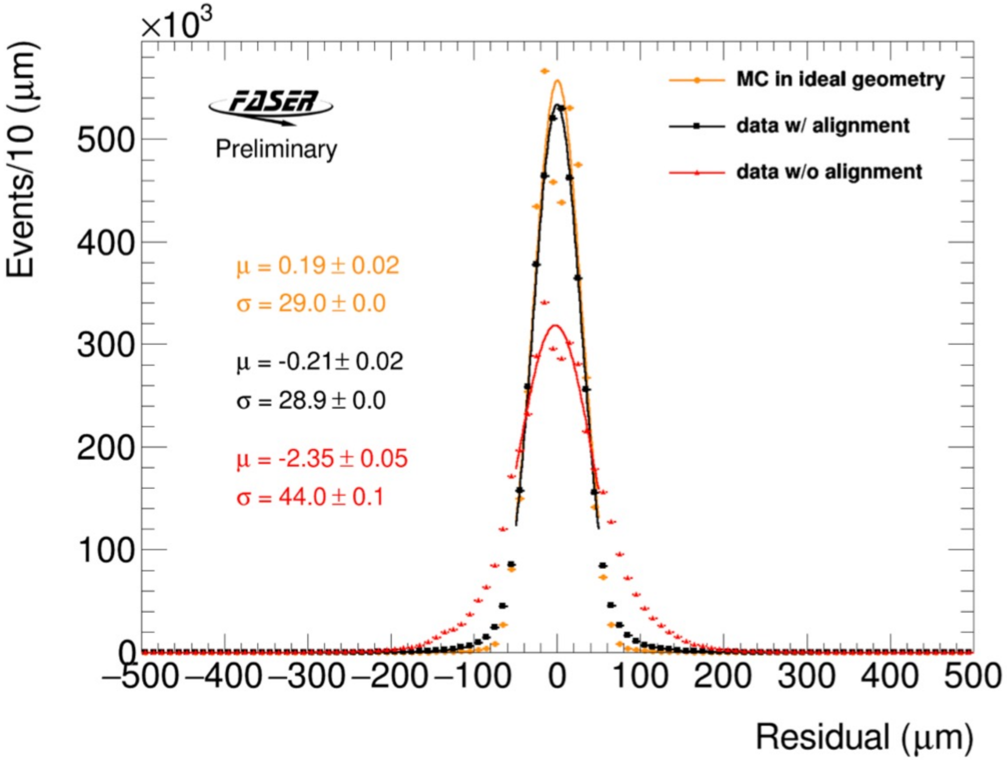


Tracker alignment in progress



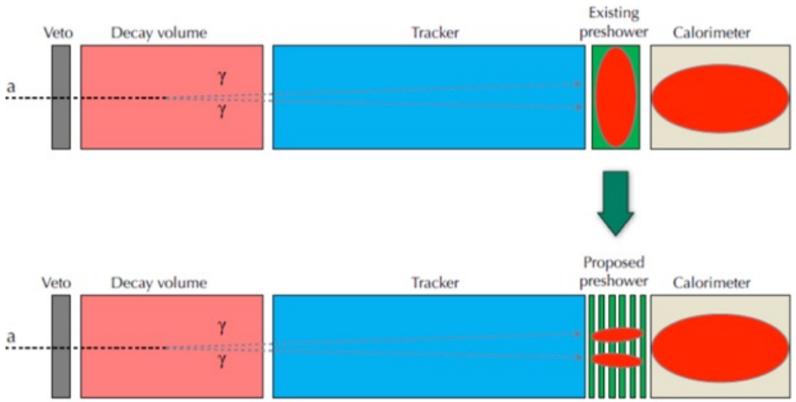
Track based alignment clearly improves residual and track chi2 for the three tracker station

- These three tracker stations are connected to the backbone, mechanically decoupled from fourth tracker station (IFT)
- Without alignment (44.0 um) -> With alignment **(28.9 um)** : comparable to MC in ideal geometry (29 um)



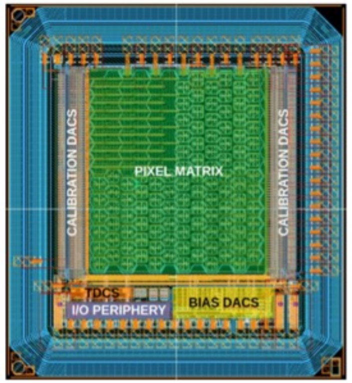
Alignment with IFT in progress

Upgrade planned for 2025

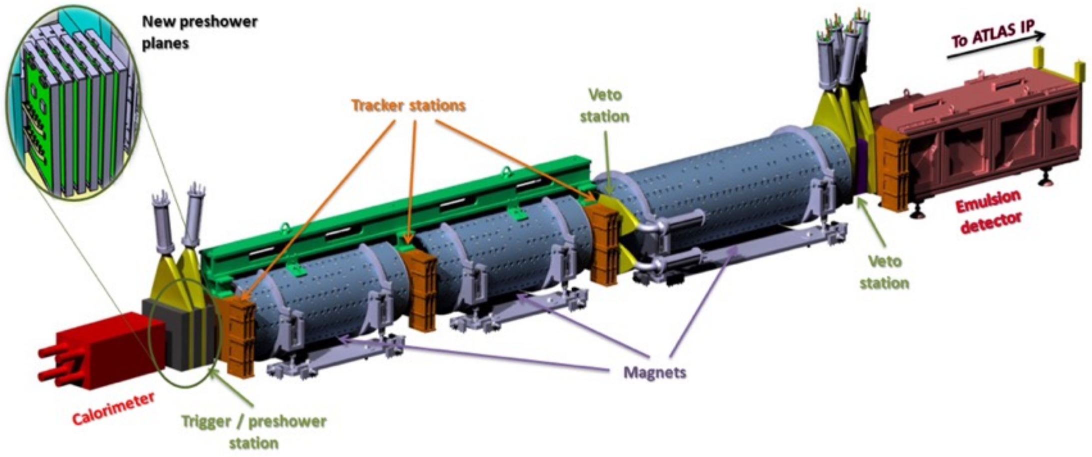


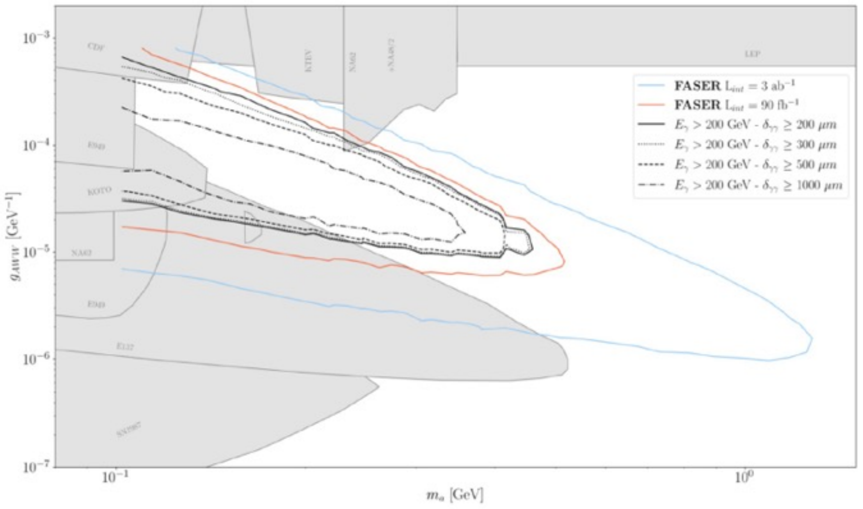
The preshower scintillator will be replaced by silicon pixel detector

- Installation is planned at the end of 2024, aiming to take data in 2025 (the last year of Run3)
- Separation of 2 close-by gammas down to 200 um enables us to get strong sensitivity for ALP -> 2 gamma
- Monolithic Active Pixel Sensors (MAPS) with SiGe BiCMOS technology developed by University of Geneve



JINST 17 P02019

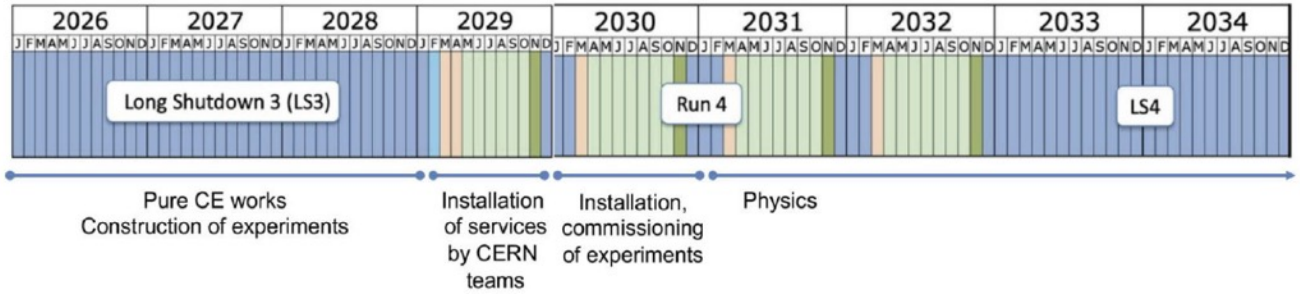




CERN research board formally approved this preshower project in April 2022

- Technical proposal is public: https://cds.cern.ch/record/2803084/

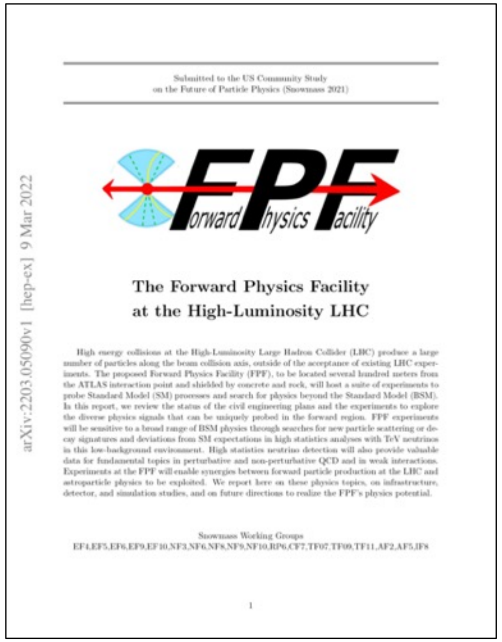
Toward HL-LHC



A new facility called the Forward Physics Facility (FPF) under intensive discussion

- FASER progressing well, however TI12 is too small to exploit full physics potential in the forward region of the LHC
- Discussion started since 2020, summarizing white paper in March 2022 for snowmass
  - 5th FPF Meeting, Nov 2022: https://indico.cern.ch/event/1196506/
- 617 m from ATLAS interaction point (opposite side of FASER) near SM18
- 65m long, 9.7m wide, 7.7m high cavern; 88m high shaft and surface building

2203.05090 (to appear in J Phys G)



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

Forward Physics Facility

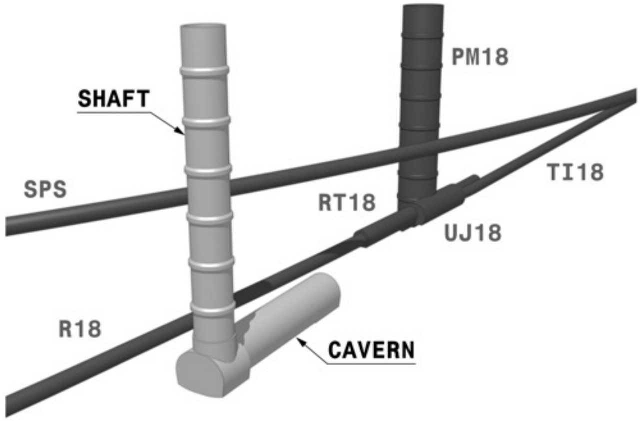
The Forward Physics Facility
at the High-Luminosity LHC

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 will be sensitive to a broad range of BSM physics through searches for new particle scattering or decay signatures and deviations from SM expectations in high statistics analyses with TeV neutrinos in this low-background environment. High statistics neutrino detection will also provide valuable data for fundamental topics in perturbative and non-perturbative QCD and in weak interactions. Experiments at the FPF will enable synergies between forward particle production at the LHC and astroparticle physics to be exploited. We report here on these physics topics, on infrastructure, detector, and simulation studies, and on future directions to realize the FPF's physics potential.

Snowmass Working Groups
EF4,EF5,EF6,EF9,EF10,NF3,NF6,NF8,NF9,NF10,RP6,CF7,TF07,TF09,TF11,AF2,AF5,IF8

1

arXiv:2203.05090v1 [hep-ex] 9 Mar 2022

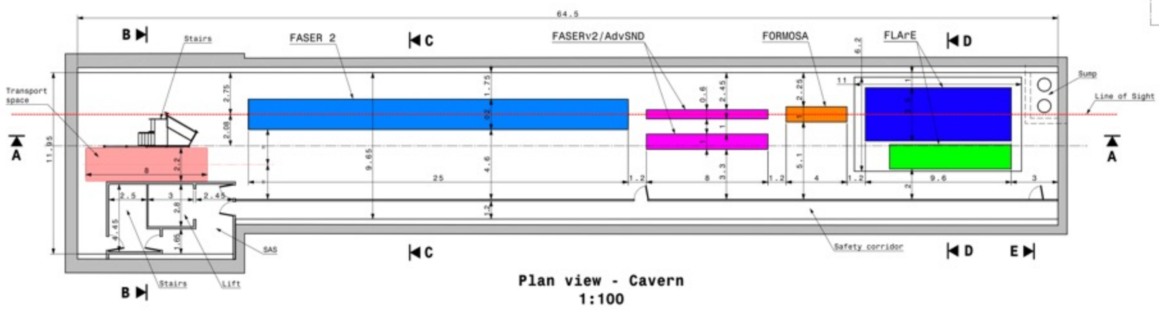


CERN civil engineering team provides a preliminary cost estimation of 40 MCHF including services

Currently proposed FPF experiments

At the moment there are 5 proposed experiments to be situated in the FPF.
With different capabilities and covering different rapiditiy regions:

- FLArE
    - $\mathcal{O}$(10tn) LAr TPC detector
    - DM scattering
    - Neutrino physics (ν_μ / ν_e , capabilitty for ν_τ under study)
        - Full view of neutrino interaction event
- FASERv2
    - $\mathcal{O}$(20tn) emulsion/tungsten detector (FASERv x20)
        - Mostly for tau neutrino physics
    - Interfaced to FASER2 spectrometer for muon charge ID ($\nu_\tau / \overline{\nu}_\tau$ separation)
- AdvSND
    - Neutrino detector slightly off-axis
        - Provides complementary sensitvity for PDFs from covering different rapidity to FASERv2
- FASER2
    - Detector for observing decays of light dark-sector particles
    - Similar to scaled up version of FASER (1m radius vs 0.1m)
        - Increases sensitivity to particles produced in heavy flavour decay
    - Larger size requires change in detector and magnet technology: Superconducting magnet
- FORMOSA
    - Milicharged particle detector
    - Scintillator based, similar to current miliQan experiment



Jamie Boyd

Conclusion

FASER is a new forward experiment at the LHC in the unused tunnel, TI12 for:

- discovery of a light weakly-coupled particle in MeV-GeV range
  - Spectrometer (Tracker and magnets), scintillators and calorimeter installed in March 2021
  - preshower scintillator will be replaced by silicon pixel detector at the end of 2024
- probe all flavors of neutrinos at the TeV-energy frontier
  - Emulsion/Tungsten detector, veto scintillator and interface tracker installed in March 2022
  - Emulsion/Tungsten detector replaced every Technical Shutdown (~3 times in one year)

Successful data taking from the beginning of LHC Run3 in 2022

- smooth operations and excellent detector performance
- first physics results from FASER expected in Q1 2023

Towards HL-LHC, Forward Physics Facility is proposed to host several experiments

- Workshop organized every half year for intensive discussion toward conceptual design
  - The last one (FPF5) was held Oct 2022 - https://indico.cern.ch/event/1196506/

FASER Acknowledgements

FASER is supported by:

HEISING-SIMONS FOUNDATION

SIMONS FOUNDATION

CERN

Swiss National Science Foundation

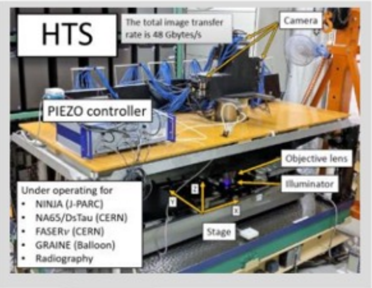
In addition, FASERν is supported by:

erc

科研費 KAKENHI

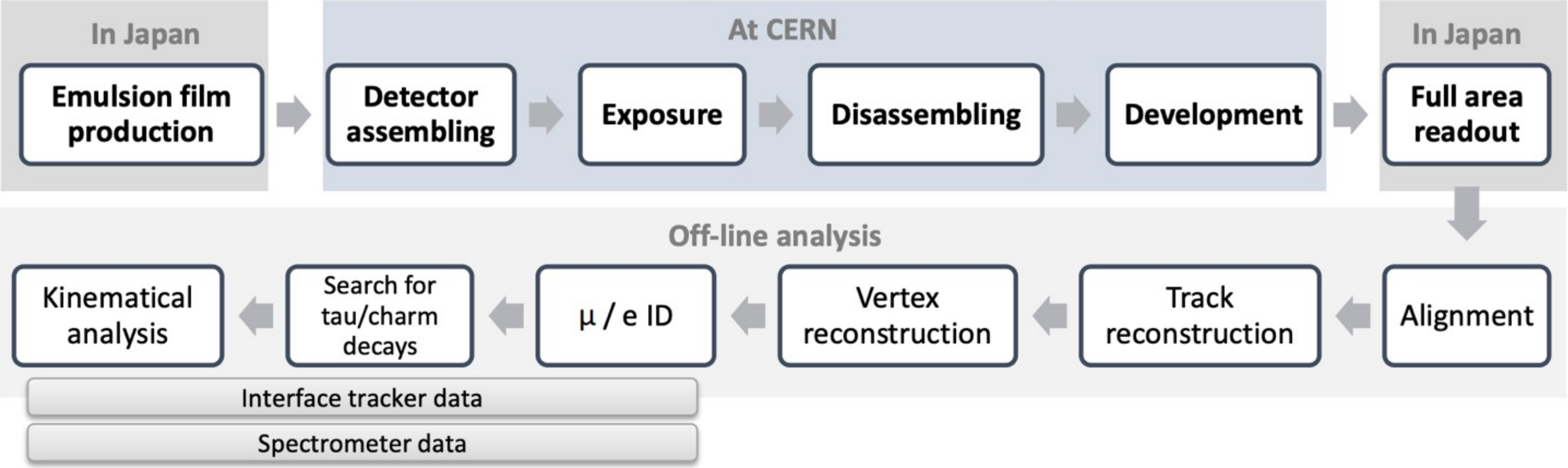
FPF studies supported by:

Physics Beyond Colliders



The total image transfer rate is 48 Gbytes/s

Under operating for
- NINJA (J-PARC)
- NA65/DsTau (CERN)
- FASERν (CERN)
- GRAINE (Balloon)
- Radiography



In Japan

Emulsion film production

At CERN

Detector assembling → **Exposure** → **Disassembling** → **Development**

In Japan

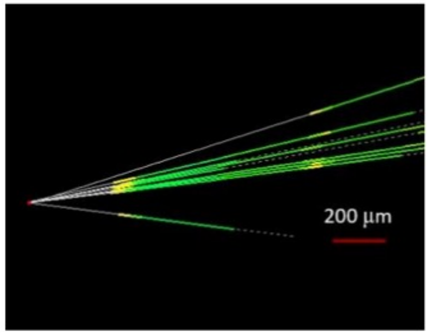
Full area readout

Off-line analysis

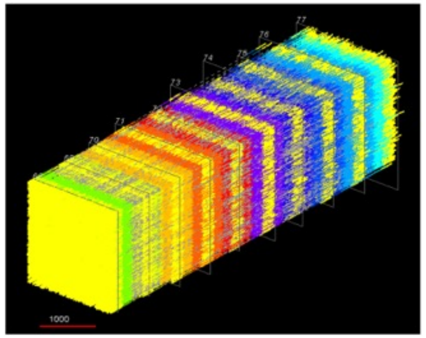
Alignment → Track reconstruction → Vertex reconstruction → μ / e ID → Search for tau/charm decays → Kinematical analysis

Interface tracker data

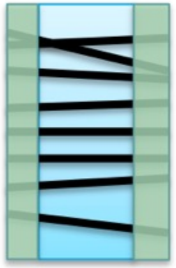
Spectrometer data

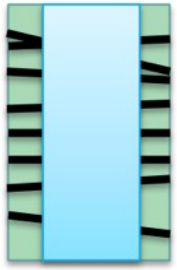


500-1000 TB/Run3



~500 TB/Run3





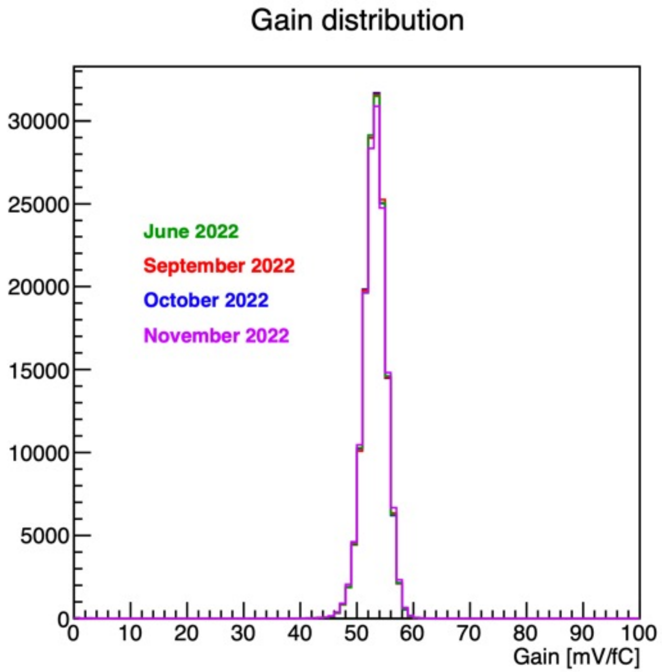
Stable performance in 2022

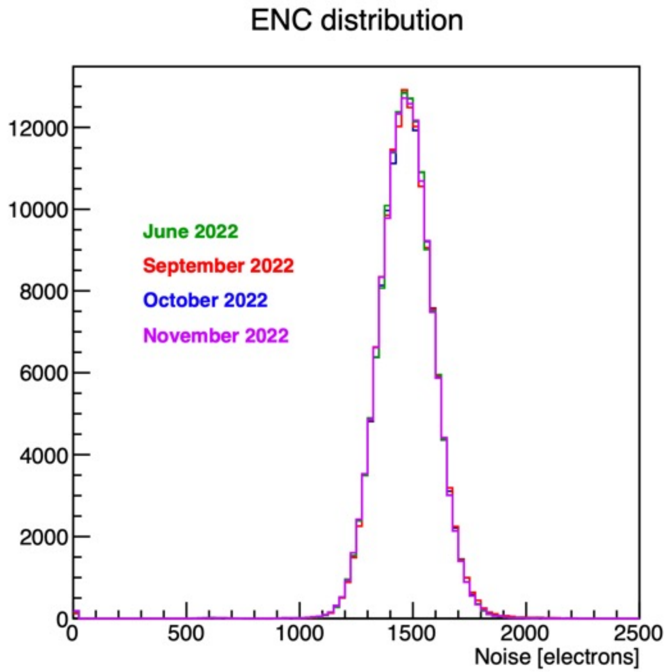
More than 99.5% strips are active:

- The number of defective strips (dead, low-gain, low ENC and noisy strips) are stable

Calibration periodically performed, showing good stability on gain and electric noise charge (ENC)

- Consistent to the measurement by ATLAS SCT group

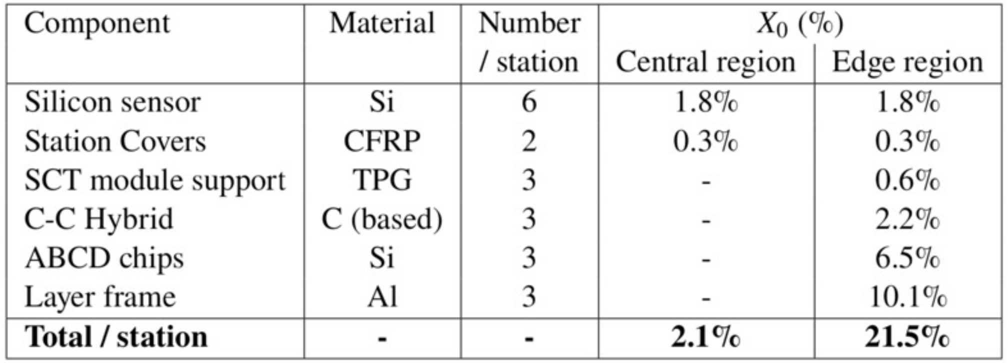




FASER detector material

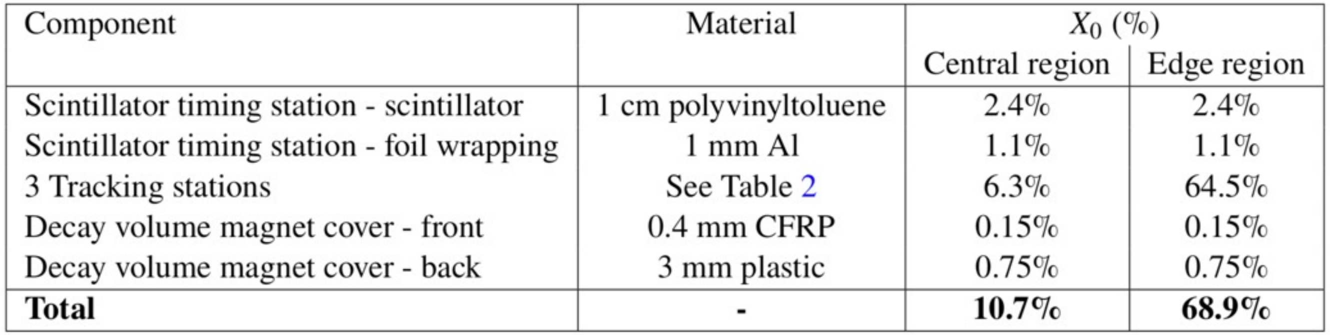
The amount of material inside the magnet aperture is minimized to reduce physics backgrounds

- The largest fraction of material is in the tracking stations
  - No Layer frame and electronics in the central region (|x| < 4 cm)

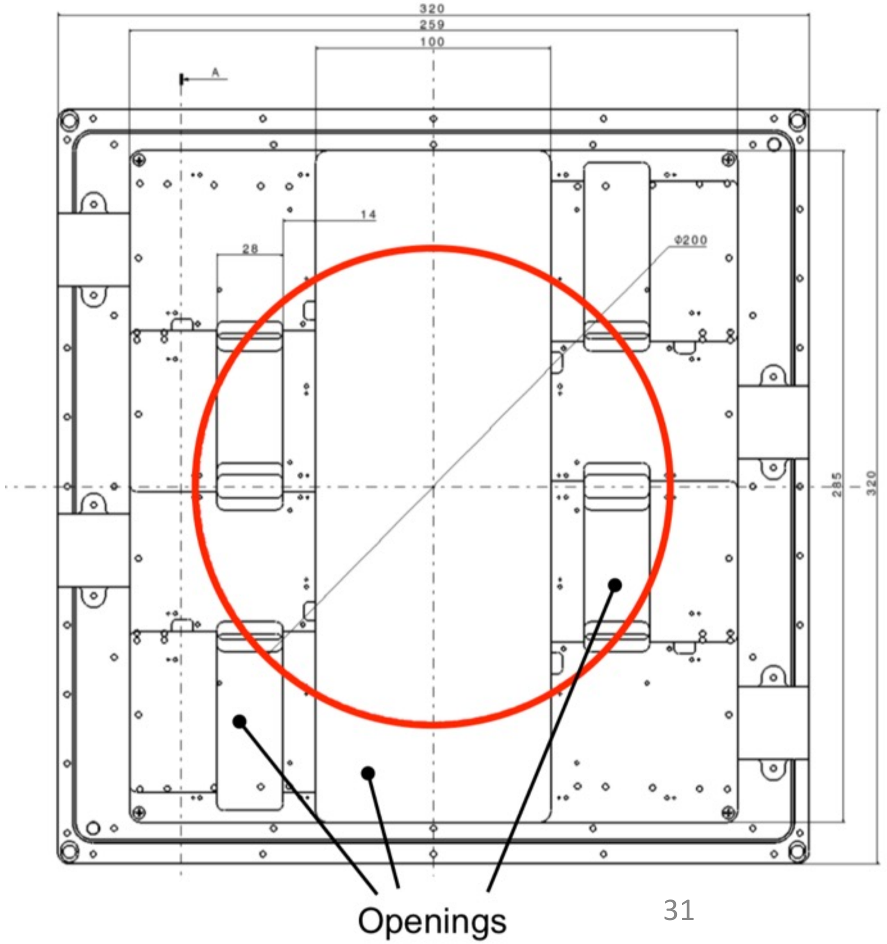


Component	Material	Number / station	X_0 (%)	
			Central region	Edge region
Silicon sensor	Si	6	1.8%	1.8%
Station Covers	CFRP	2	0.3%	0.3%
SCT module support	TPG	3	-	0.6%
C-C Hybrid	C (based)	3	-	2.2%
ABCD chips	Si	3	-	6.5%
Layer frame	Al	3	-	10.1%
Total / station	**-**	**-**	**2.1%**	**21.5%**

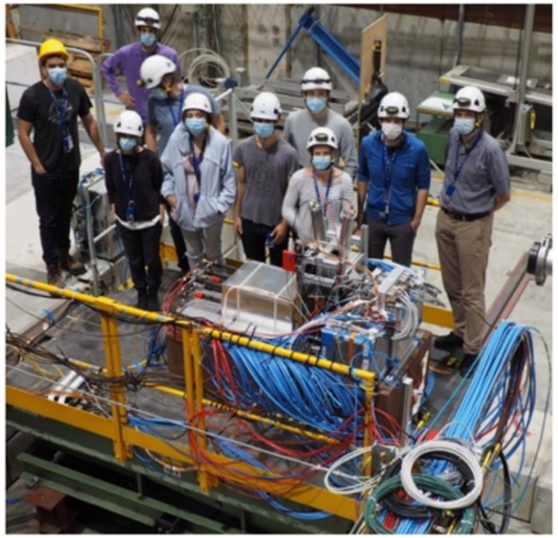
- 0.1 X_0 for the central region and 0.7 X_0 for the edge region



Component	Material	X_0 (%)	
		Central region	Edge region
Scintillator timing station - scintillator	1 cm polyvinyltoluene	2.4%	2.4%
Scintillator timing station - foil wrapping	1 mm Al	1.1%	1.1%
3 Tracking stations	See Table 2	6.3%	64.5%
Decay volume magnet cover - front	0.4 mm CFRP	0.15%	0.15%
Decay volume magnet cover - back	3 mm plastic	0.75%	0.75%
Total	**-**	**10.7%**	**68.9%**

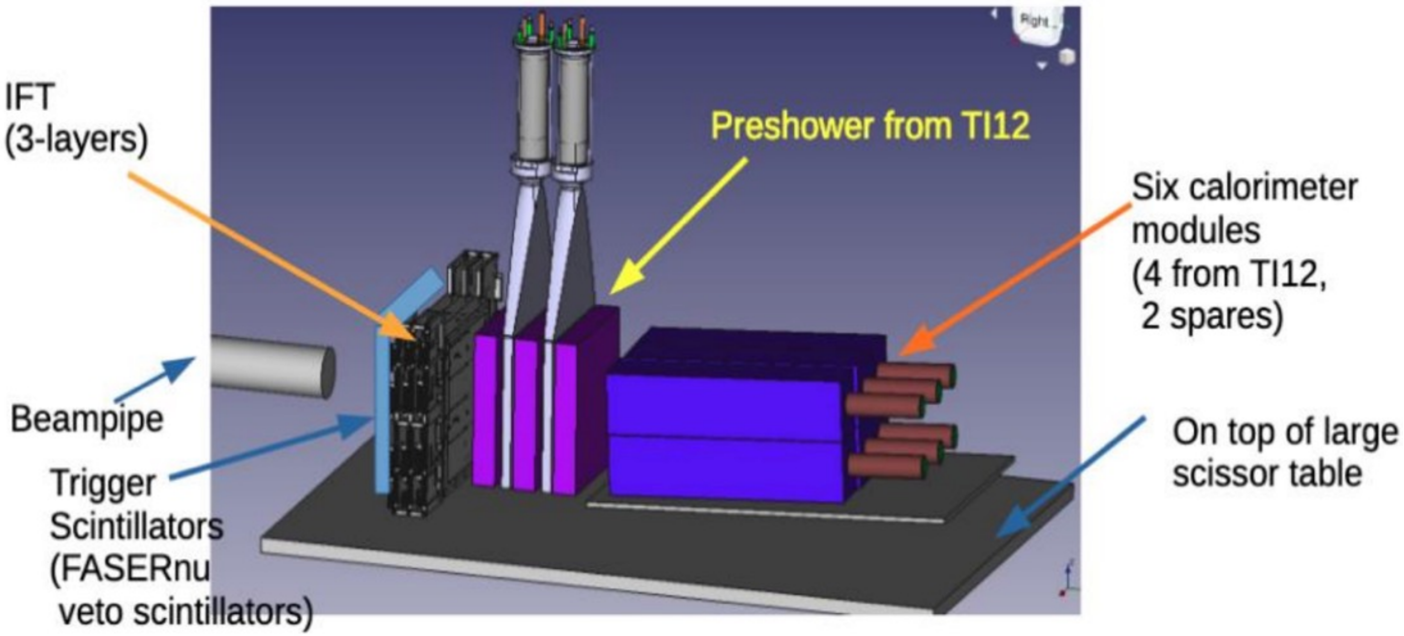


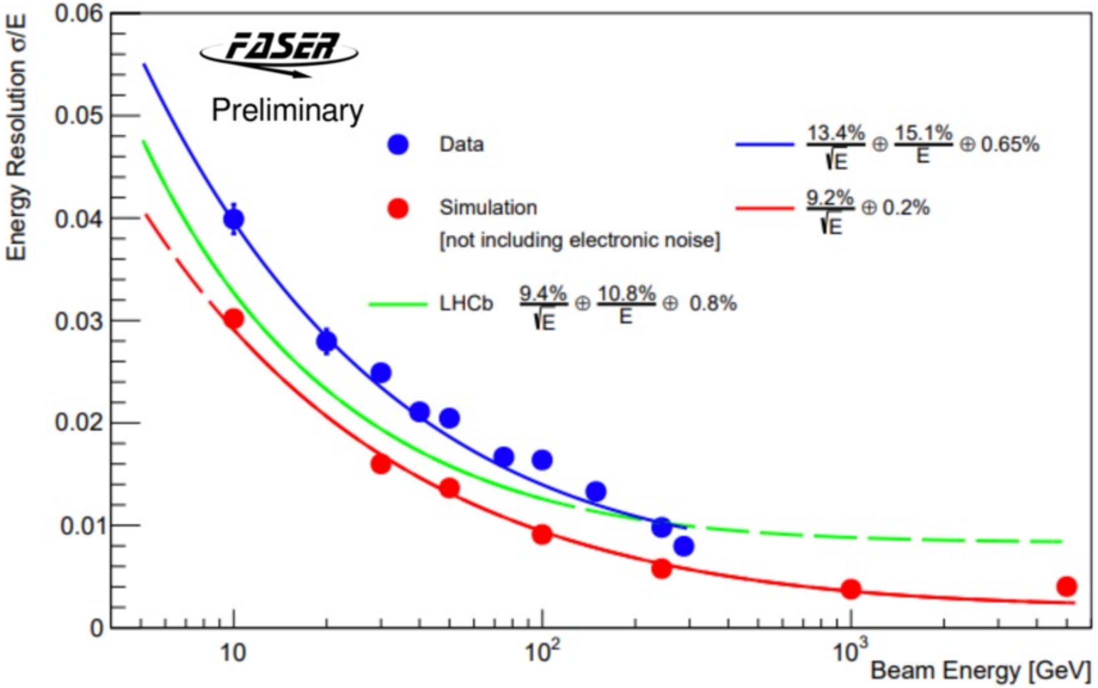
EM Calorimeter – test beam at SPS



Testbeam at SPS in 2021 summer

- Tracker + preshower scintillator + Calorimeter
- Reasonable resolution compared to the LHCb result and simulation for high energy electrons





Trigger and DAQ system

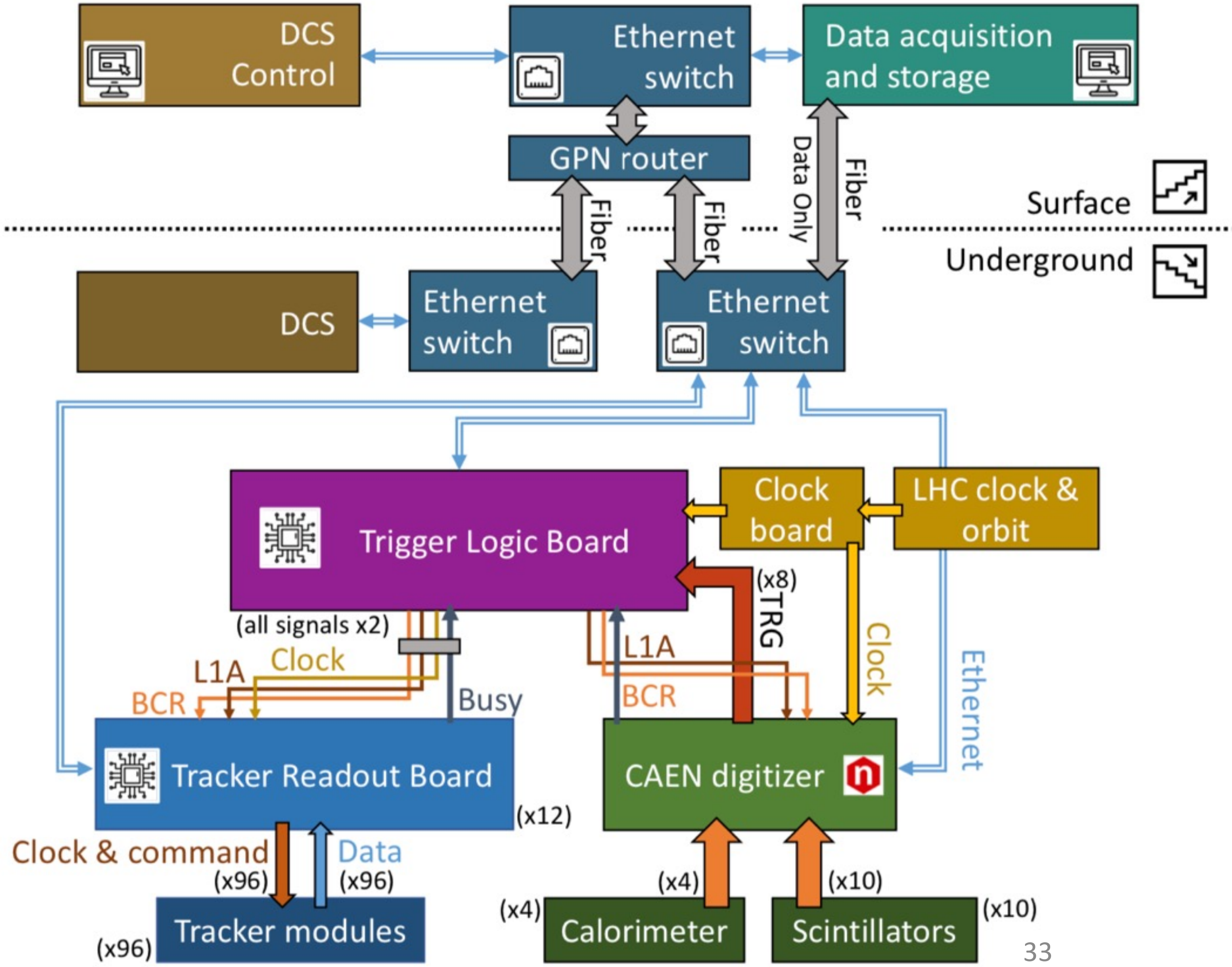
Readout electronics in TI12

- Tracker: Custom GPIO board
- Scintillator and Calorimeter: CAEN digitizer
- Trigger: Custom GPIO board
  - Clock and bunch taken from LHC
- Ethernet switch -> Servers on surface

DAQ Software implemented on DAQling

- open-source framework developed at CERN

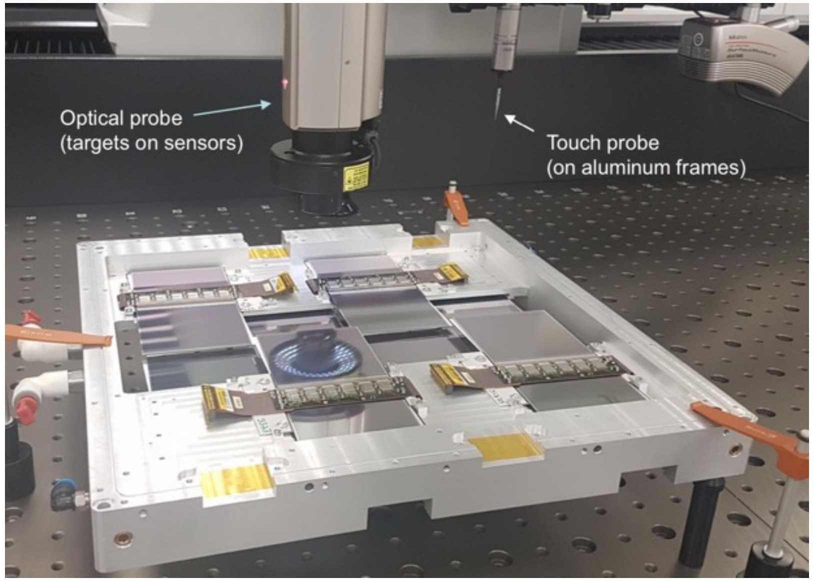
Paper is published: [2021 JINST 16 P12028]()



Tracker plane/station metrology and survey

Each plane/station is measured with a mechanical touch-probe and an optical camera

- All frames satisfied the required tolerances (±20 μm) with respect to the CAD manufacturing drawings
- The maximum deviation was 100 μm in positioning the SCT module



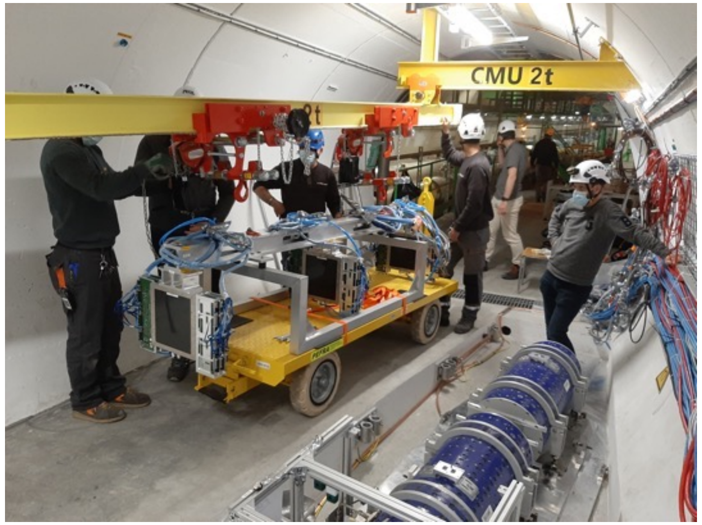
Before and after installation TI12, 3D laser scanning was performed by the CERN survey group

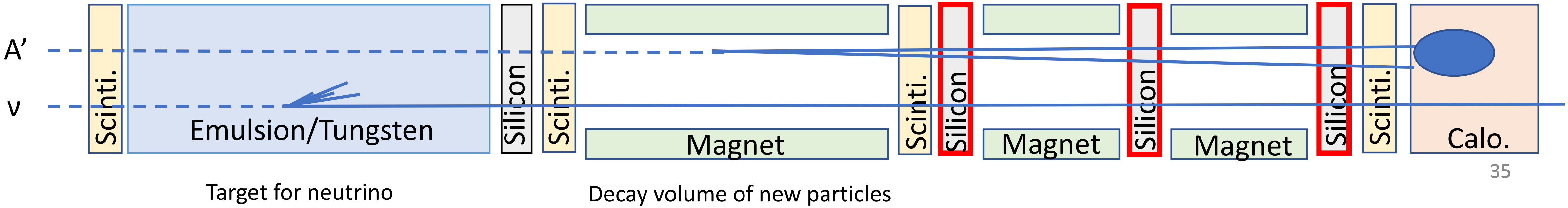
- measured the position of the survey points on the tracker station with O(16 μm) accuracy.

Paper is published: NIMA 1034 (2022) 166825

FASER spectrometer assembled in March 2021

After commissioning in EHN1, three tracker stations are integrated with the magnets

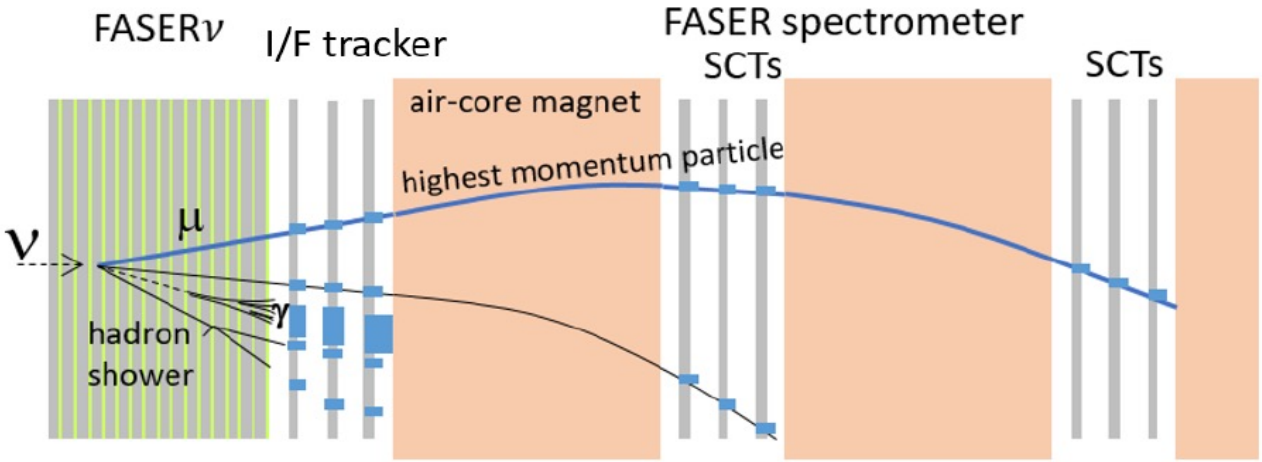


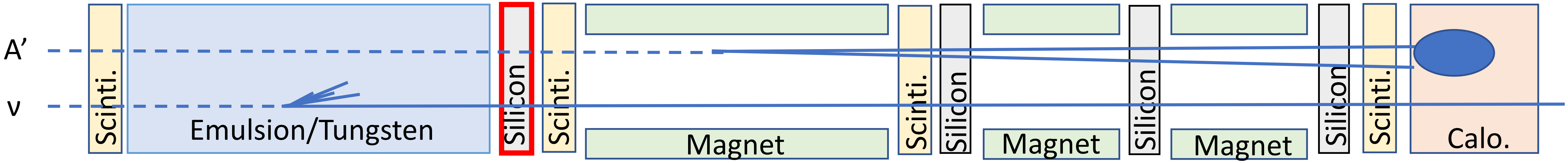



IFT installed in Nov 2022

Track matching between the emulsion and IFT enable us to reconstruct with the spectrometer, enabling

- charge identification, improved energy resolution and better background rejection





Target for neutrino

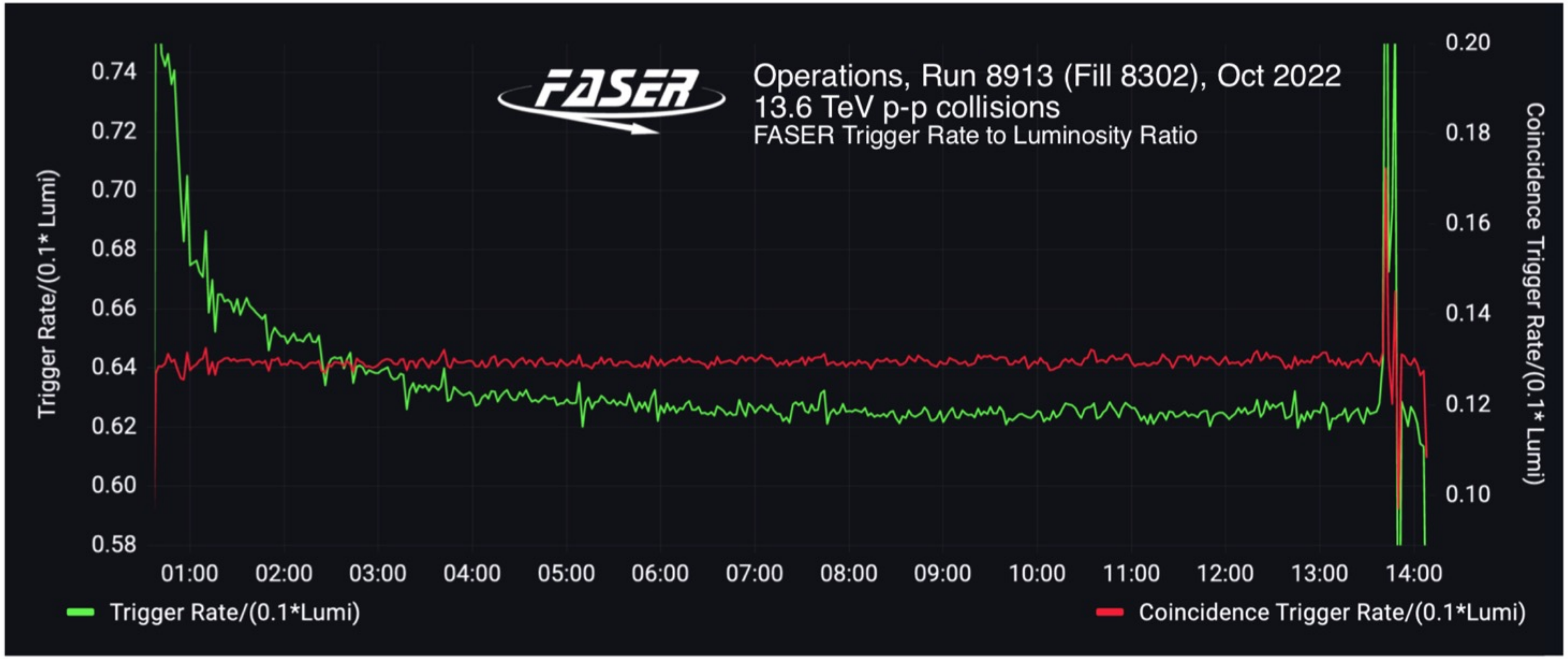
Decay volume of new particles

Trigger rate v.s. luminosity

The total trigger rate (green) falls off faster than luminosity at the start of fill

- higher beam-induced background apparent at the beginning of the fill

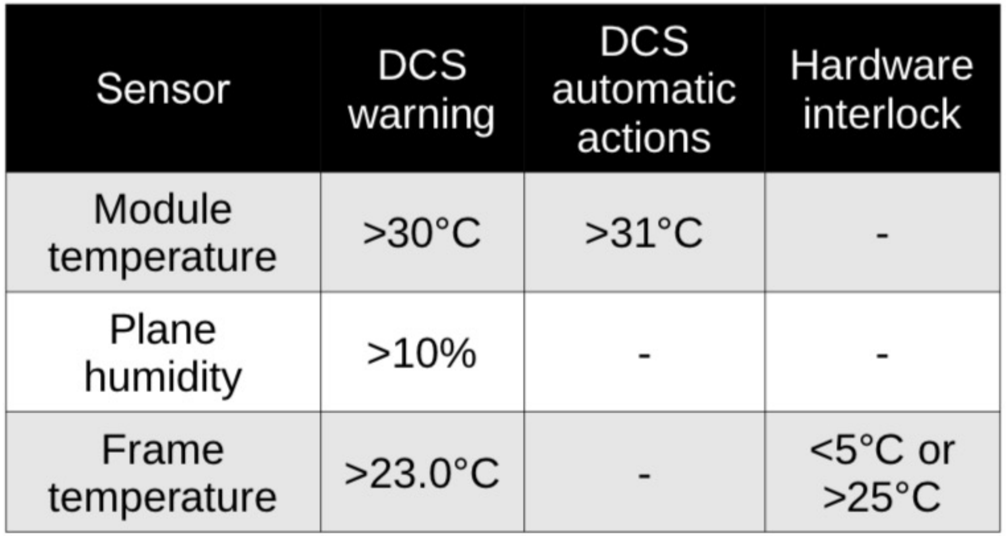
The coinsidence trigger rate (red) almost correlated with luminosity



Tracker cooling system

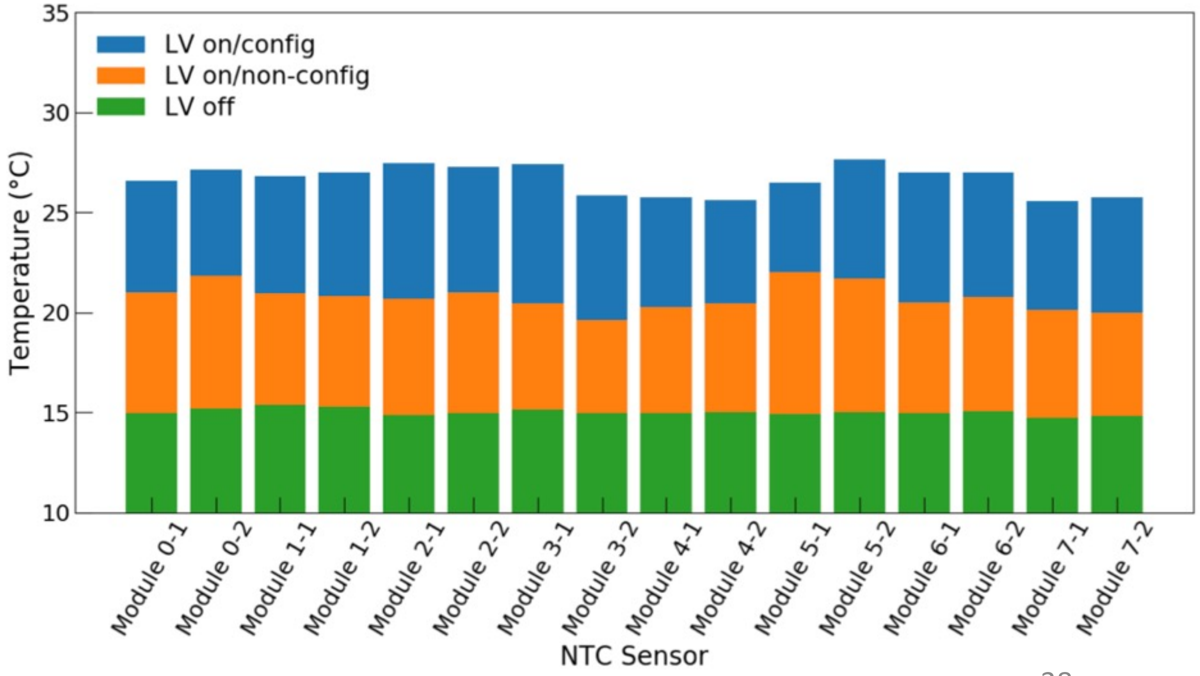
Two air-cooled water chiller used, whose coolant temperature at 15 ◦C

- one is running to cool the detector and the other acts as a hot spare
- If both chillers are not operating correctly, the power supply system is forced to be turned off by the hardware interlock system
- Module temperature is kept well below 30 ◦C

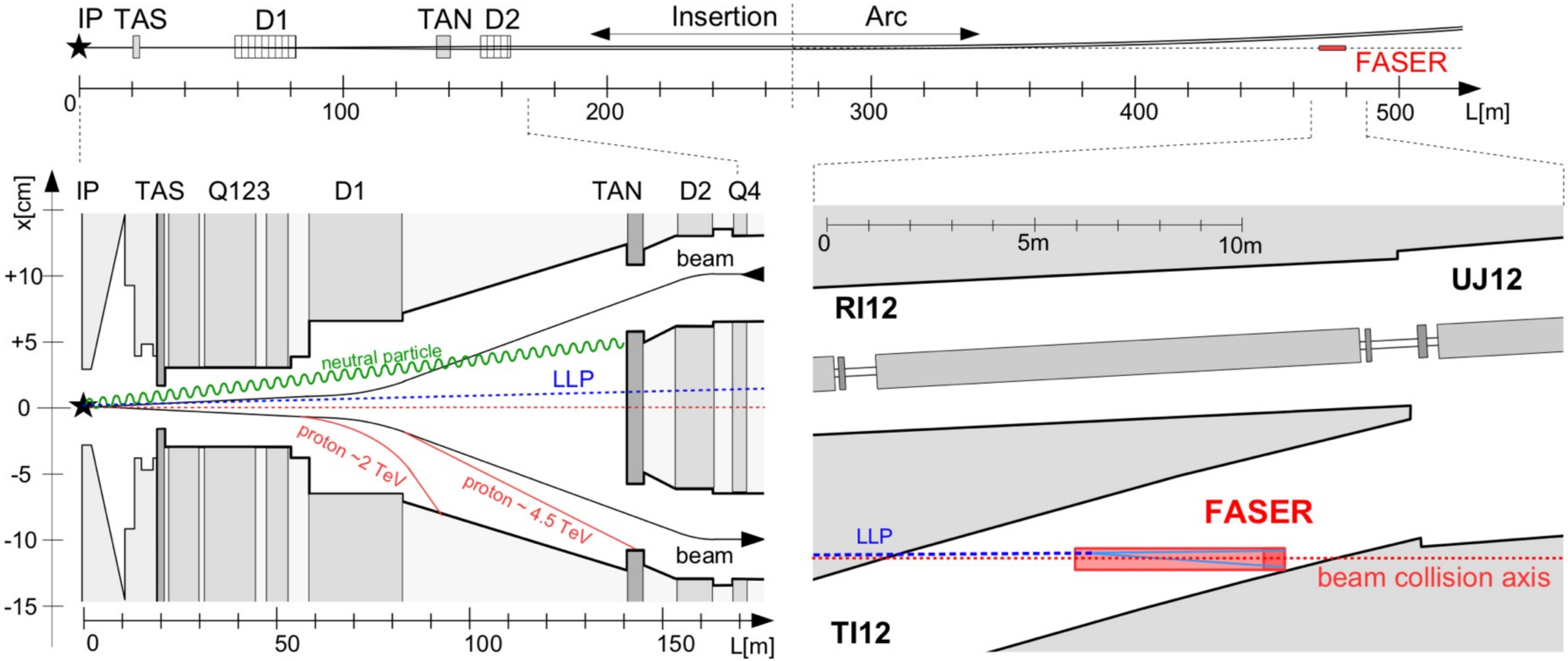


Sensor	DCS warning	DCS automatic actions	Hardware interlock
Module temperature	>30°C	>31°C	-
Plane humidity	>10%	-	-
Frame temperature	>23.0°C	-	<5°C or >25°C

glass-transition temperature of the glue: 35°C



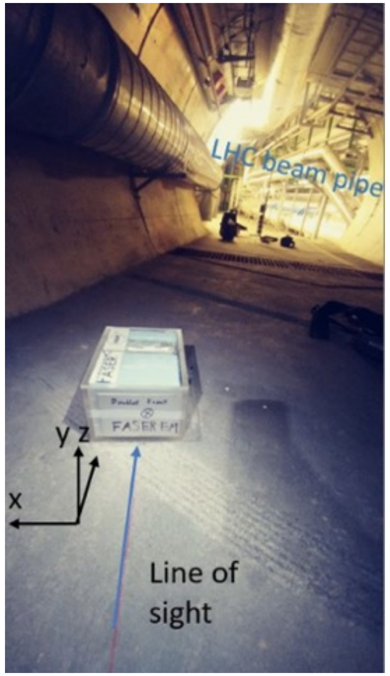
More detail about FASER location

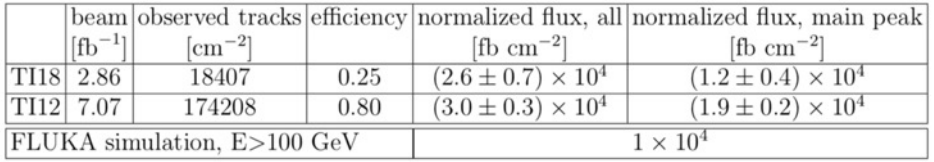


In-situ background measurement in 2018

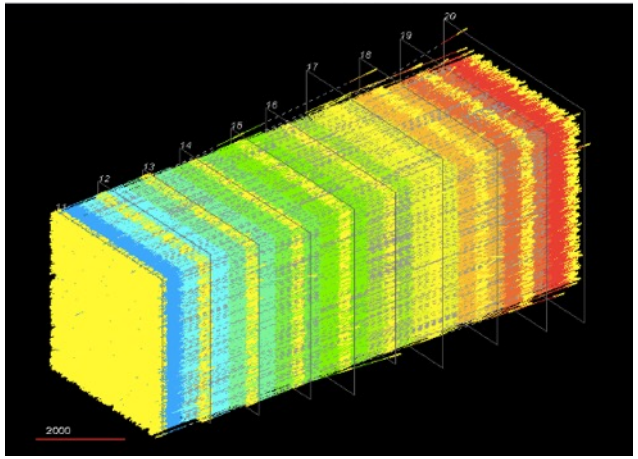
No infrastructure in 2018 (last year of Run 2) – quick/reliable measurement needed

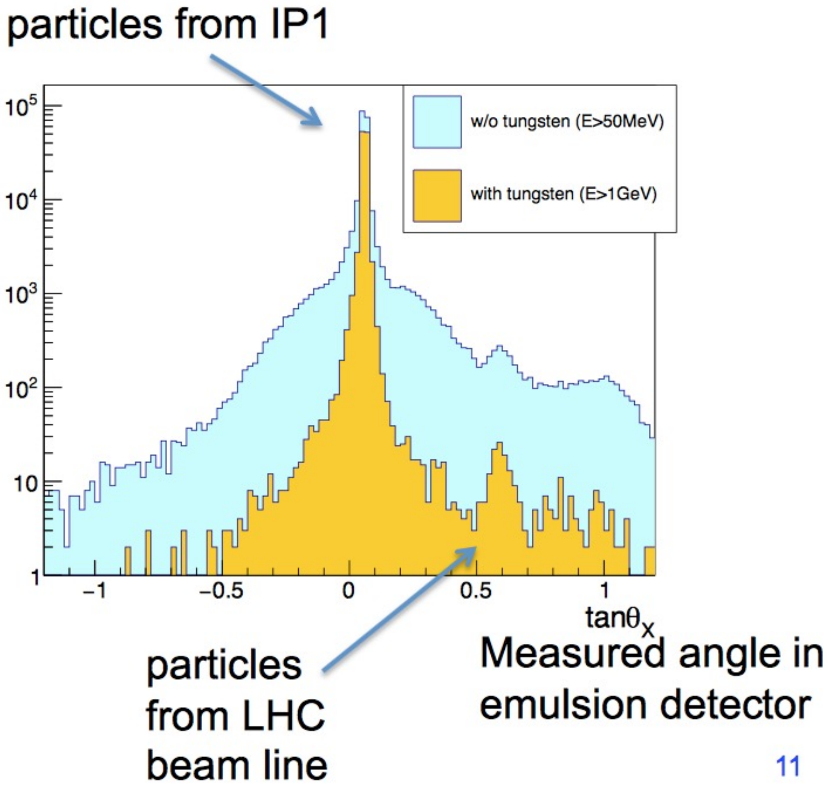
- an emulsion detector exposed to 7 fb^{-1} in TI12
  - Good agreement with FLUKA simulation, accelerating FASER detector design





	beam [fb^{-1}]	observed tracks [cm^{-2}]	efficiency	normalized flux, all [fb cm^{-2}]	normalized flux, main peak [fb cm^{-2}]
TI18	2.86	18407	0.25	$(2.6 \pm 0.7) \times 10^4$	$(1.2 \pm 0.4) \times 10^4$
TI12	7.07	174208	0.80	$(3.0 \pm 0.3) \times 10^4$	$(1.9 \pm 0.2) \times 10^4$
FLUKA simulation, E>100 GeV				1×10^4	




particles from IP1

particles from LHC beam line

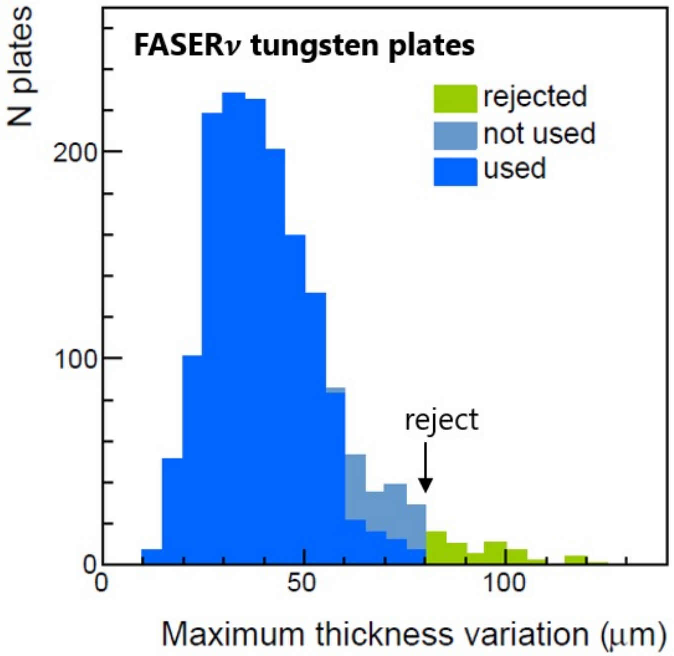
Measured angle in emulsion detector

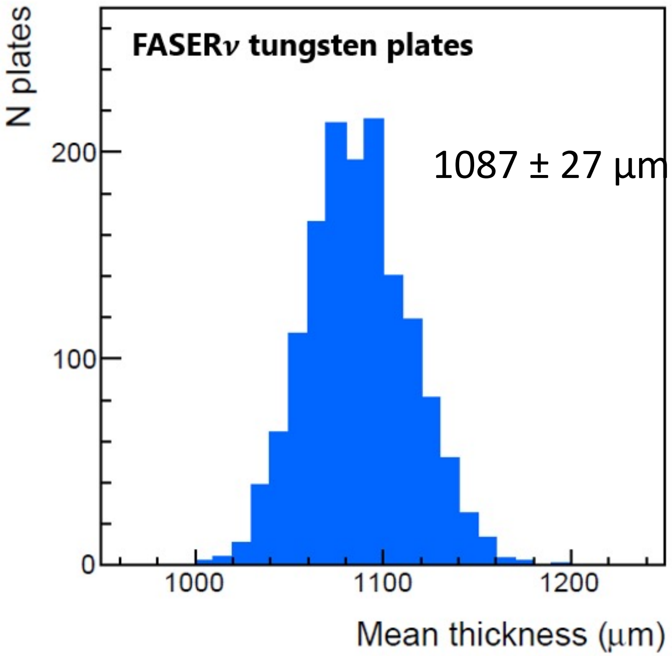
- a TimePix BLM to confirm that the muon rate was correlated with luminosity at IP1

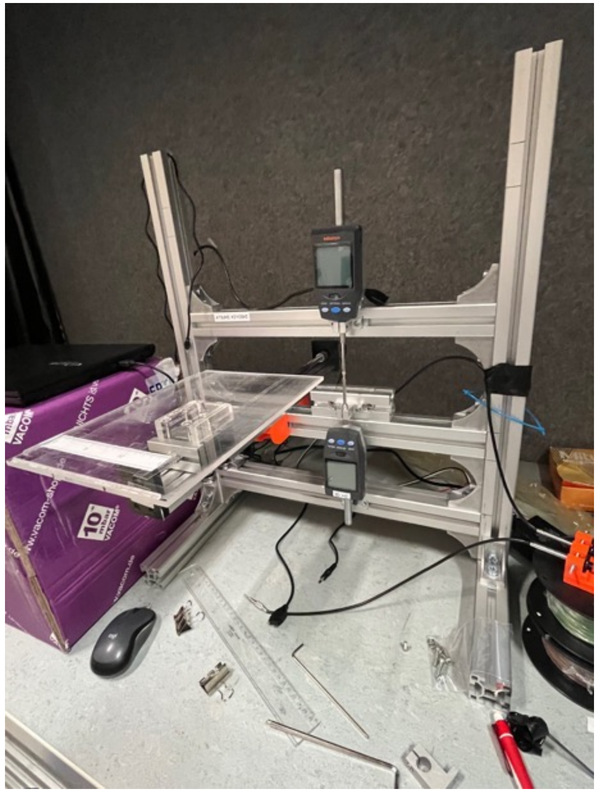
Thickness uniformity of the tungsten plates

A total of 1622 plates were semi-automatically measured using a custom made apparatus

- the maximum difference among the 24 points points on each plate was checked.
- 1562 plates with a difference smaller than 80 microns were selected as good quality
  - corresponding to 90% of the measured plates
- 1460 plates are used to construct the emulsion detector





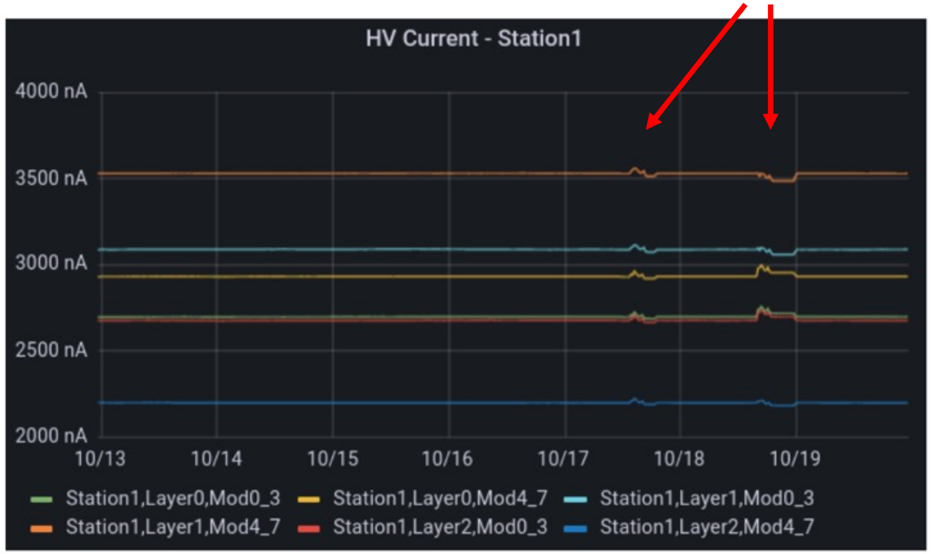


FASER detector operation

No control room for FASER operation – two people remotely have responsibility on safe operation

- Live monitoring via Grafana for DAQ, DCS, trigger and LHC status
- Alarms sent to Mattermost, shared with experts

Related to tracker calibration



Last updated
2022-09-20 14:49:32

PMT High Voltage
Min voltage -860 v
Max voltage -1845 v
Max current -458 uA

TRB max temps
Station0 30.7 °C
Station1 30.3 °C
Station2 33.1 °C
Station3 30.9 °C

PDU power outputs
MPODs 7.87 A
DAQ 1.54 A
TRBs 366 mA
TLB+Fans 280 mA
TIMs+Switches (UPS) 992 mA

	Tracker Status for Station0	Tracker Status for Station1	Tracker Status for Station2	Tracker Status for Station3
Max Bias Voltage	150 v	150 v	150 v	150 v
Min Bias Voltage	150 v	150 v	150 v	150 v
Max Bias Current	3.25 uA	3.53 uA	3.36 uA	3.34 uA
Max analog current	1.07 A	1.05 A	1.05 A	1.06 A
Max digital current	477 mA	499 mA	490 mA	482 mA
Max module temperature	28.9 °C	28.7 °C	28.9 °C	28.1 °C
Dewpoint	-101 °C	-31 °C	-37 °C	-41 °C

Trigger rate
Current Physics Event Rate 1.03 kHz

Run Info
Run Number 8333
Total events 7994065
Run Start 08/21/2022, 08:18:54 PM
Run Type Physics
Run Status Started

Event Building Status
STATUS 0
BCID mismatches 0
corrupted fragments 0
timeouts 0
duplicate source IDs 0
Missing TLB events 0
Missing Digi events 0
Missing TRB events 0

Byte rate to file
Data recording rate to physics stream 22.7 MB/s

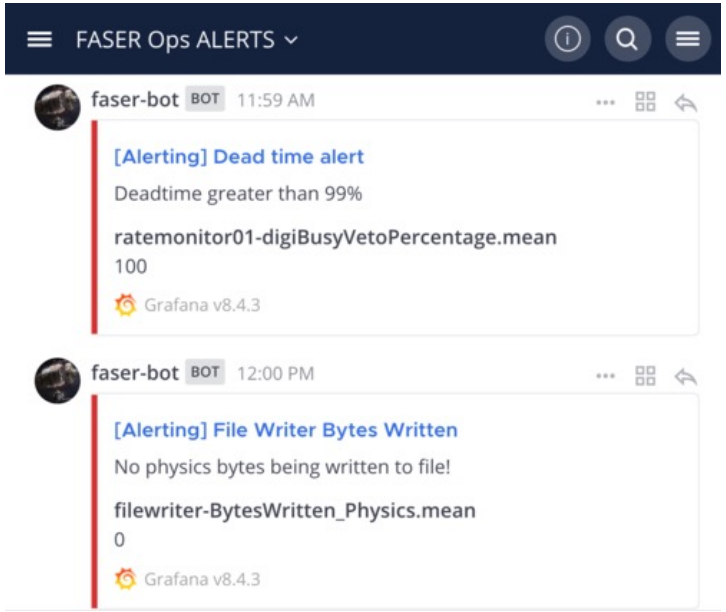
FileWriter Status
STATUS 0

Digitizer Status
STATUS 0
bad fragments 0
empty fragments 0

Trigger Board Status
average payload size [bytes] 24
STATUS 0
bad fragments 0
missing event ID 0
lost orbits 10

FASER DAQ Dashboards (scroll to see all)
Search
Calorimeter Threshold rates
DAQ File Transfers
DAQ Status Overview

	TRB 11 (IFT Station Layer 0) Status	TRB 12 (IFT Station Layer 1) Status	TRB 13 (IFT Station Layer 2) Status
TRB average payload size [bytes]	206	204	204
STATUS	0	0	0
bad fragments	0	0	0
checksum mismatches	0	0	0
PLL error (lock to external clock)	0	0	0
missing event ID	0	0	0



faser-bot BOT 11:59 AM

[Alerting] Dead time alert

Deadtime greater than 99%

ratemonitor01-digiBusyVetoPercentage.mean
100

Grafana v8.4.3

faser-bot BOT 12:00 PM

[Alerting] File Writer Bytes Written

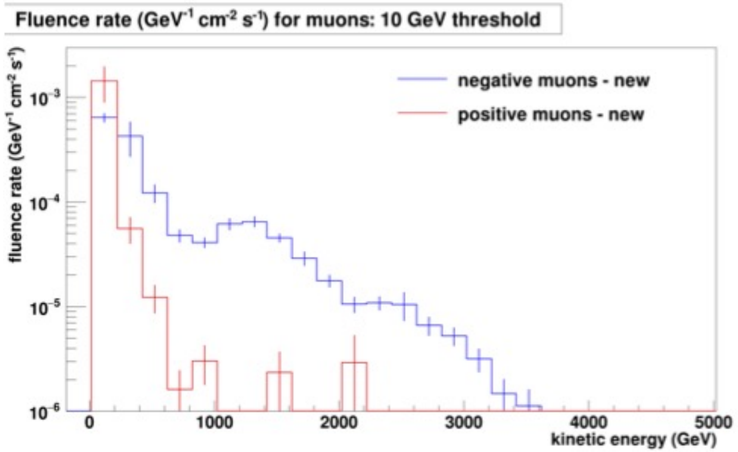
No physics bytes being written to file!

filewriter-BytesWritten_Physics.mean
0

Grafana v8.4.3

This operation model works very well in 2022

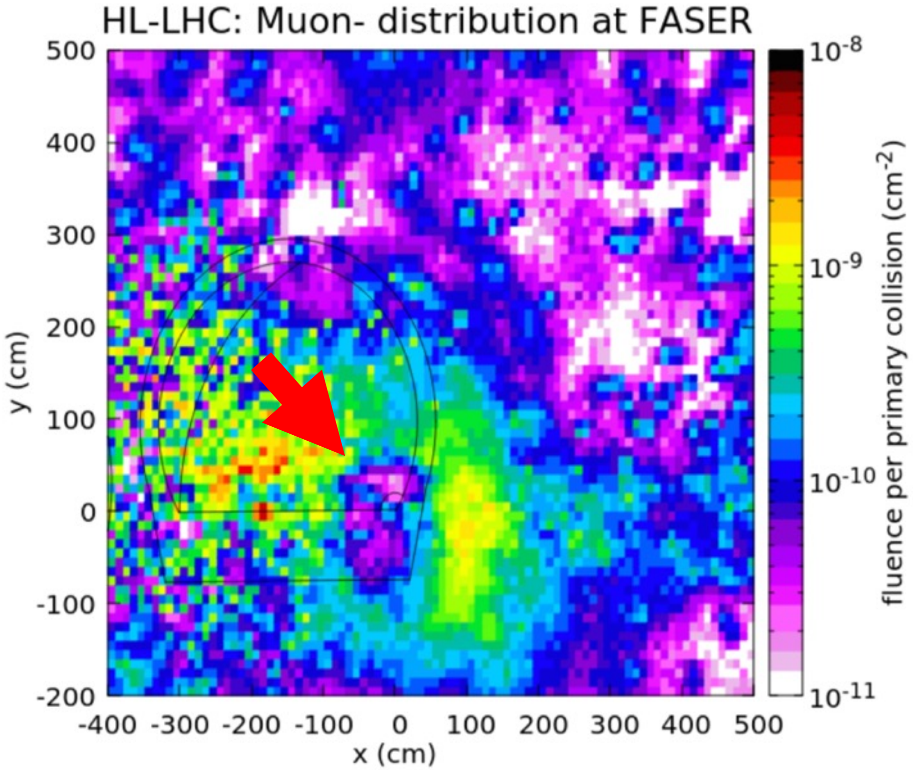
Background simulation

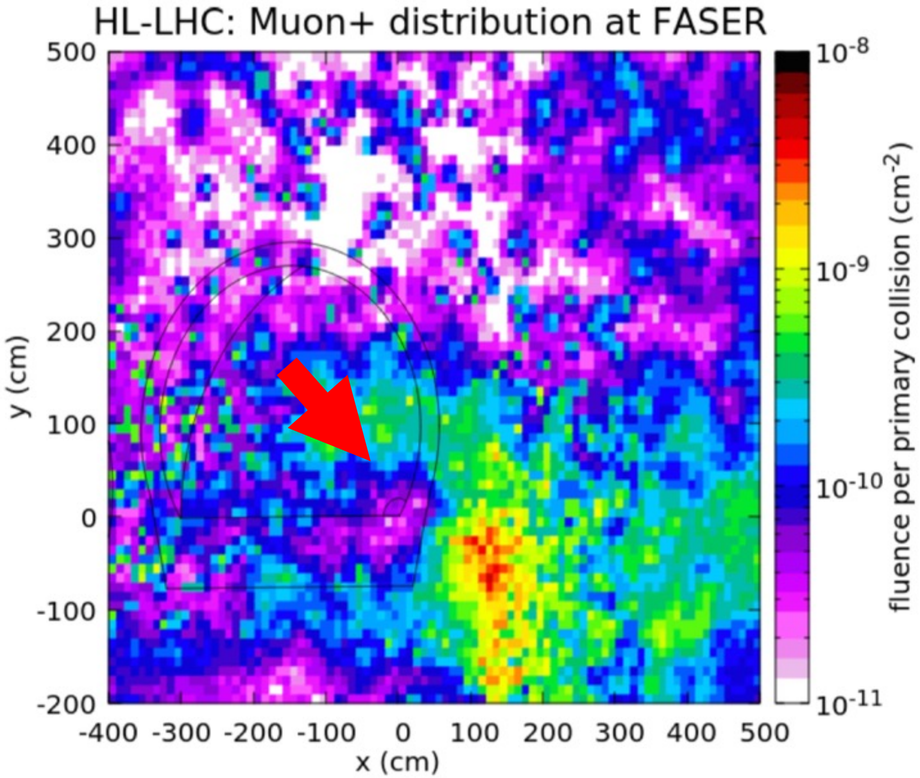


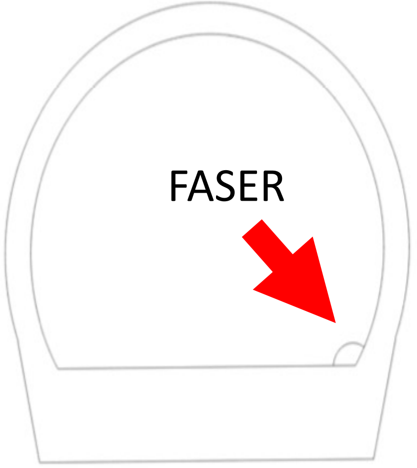
Simulation implied that FASER would be located in very lucky place

- 10^{-3} less flux compared to just 1m away since LHC magnets seems to sweep charged particles
- No neutral particle by 100m thick rock

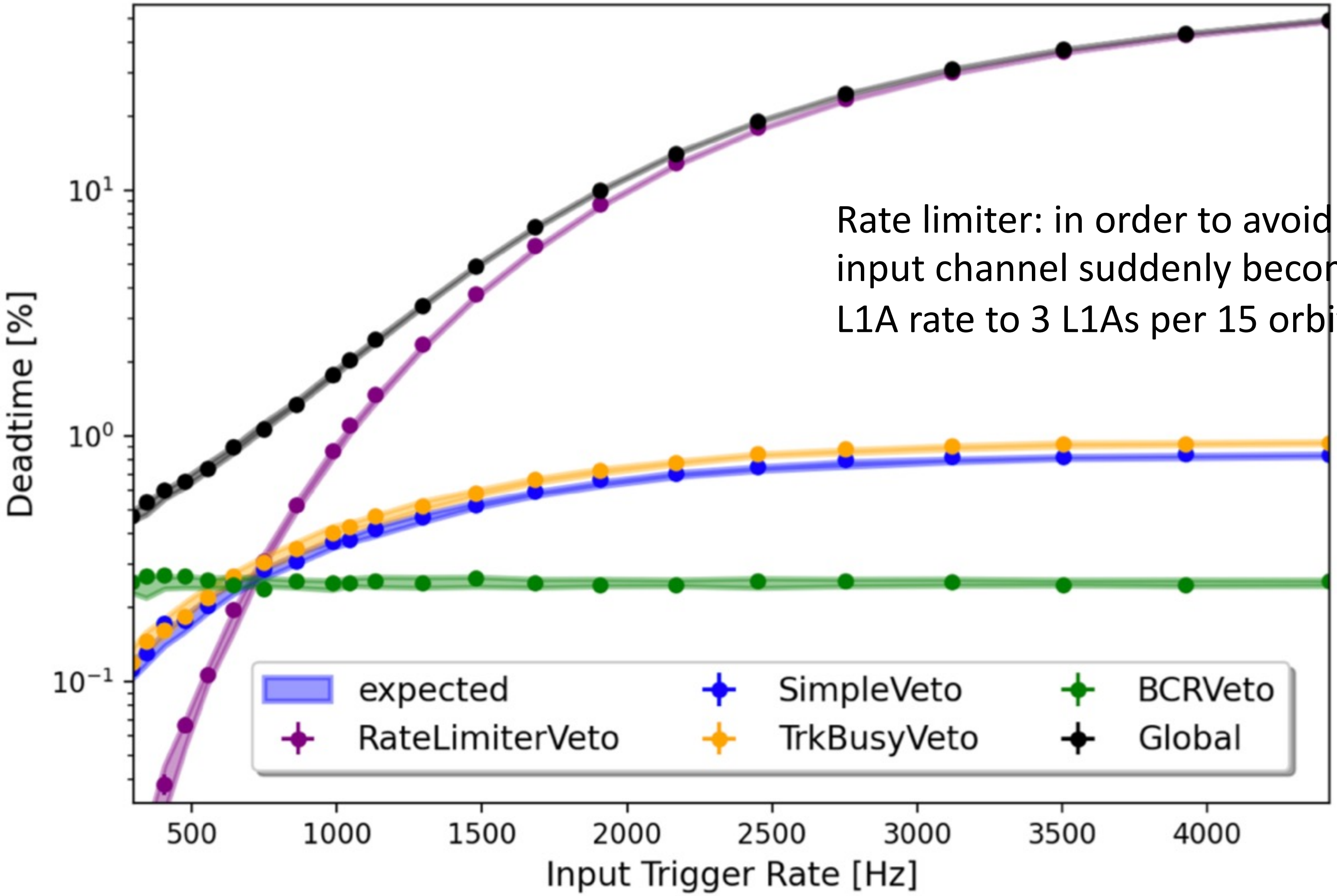
should be confirmed by measurement





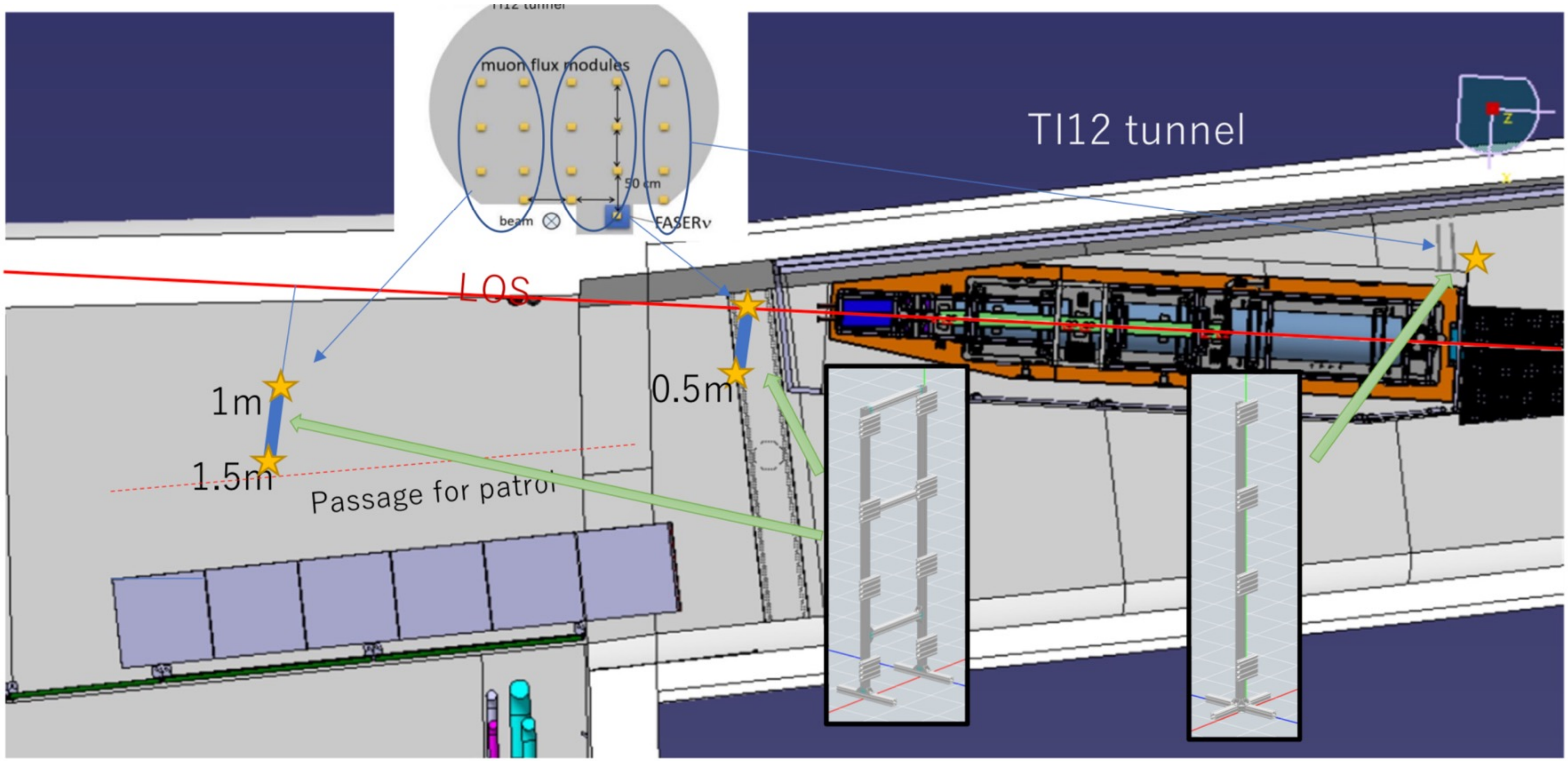


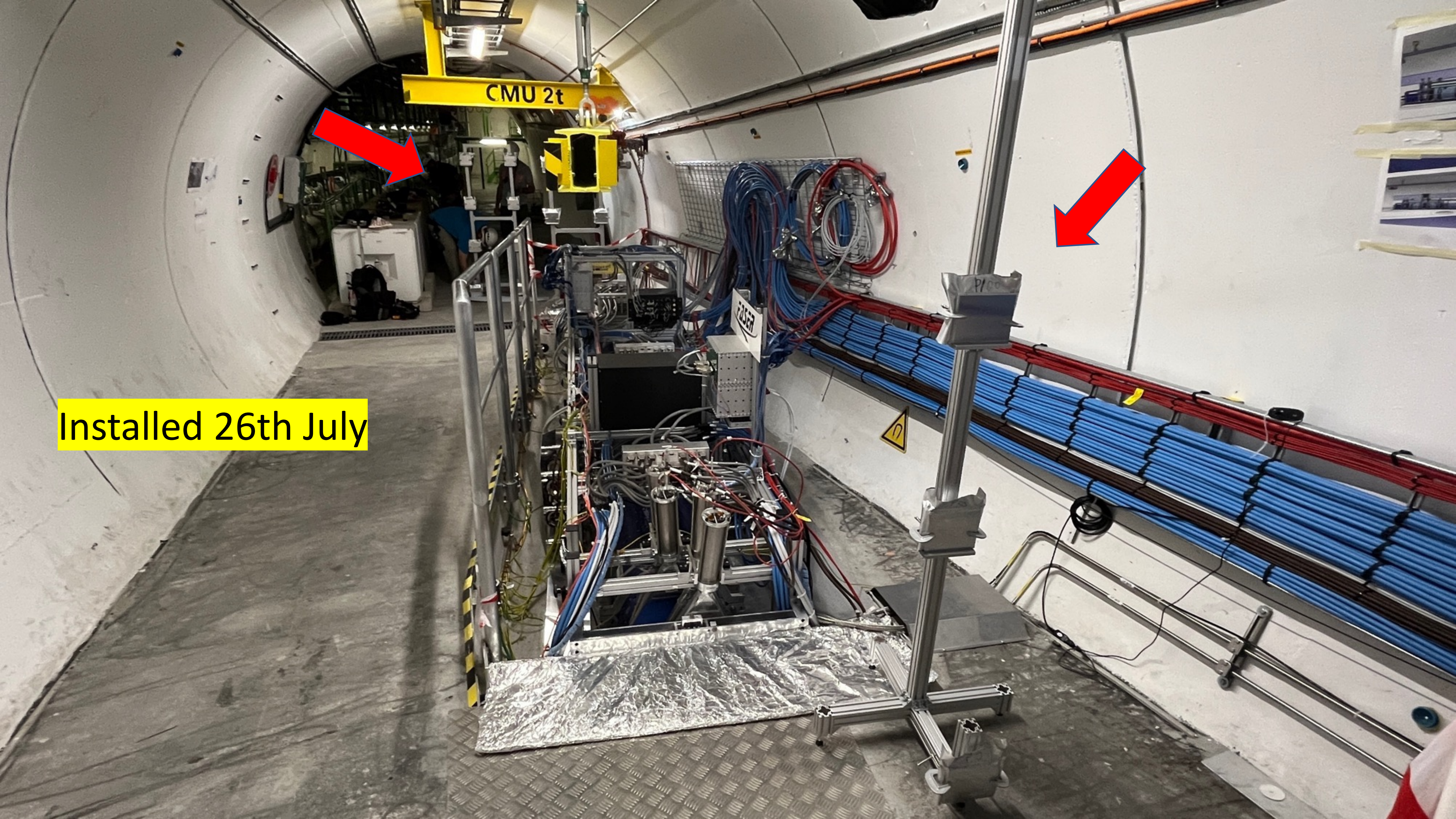
DAQ - deadtime



Rate limiter: in order to avoid uncontrolled high rates from a
input channel suddenly becoming noisy, a rate limiter limits
L1A rate to 3 L1As per 15 orbits (or 2.2 kHz).

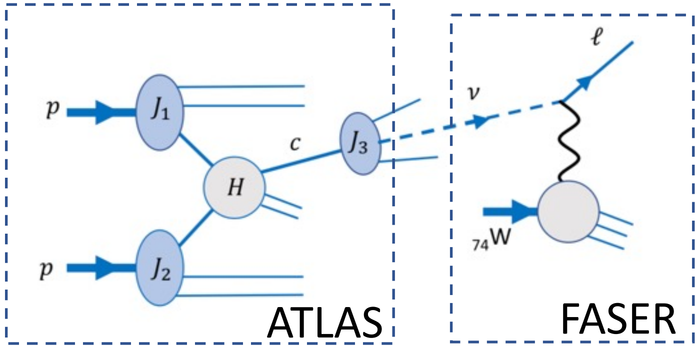
Further measurement from end of July in 2022



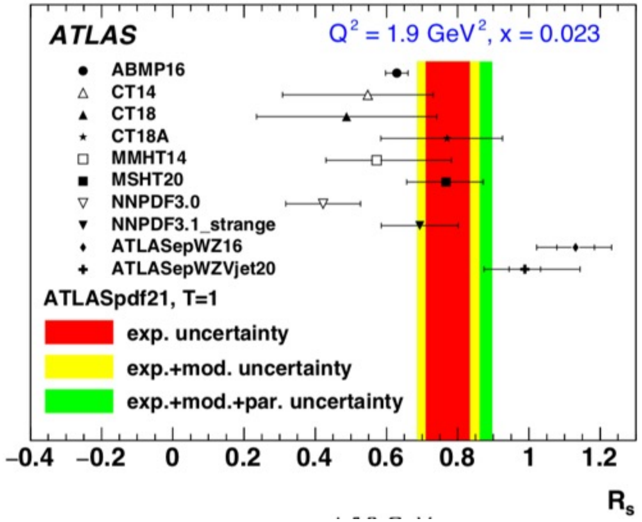


Installed 26th July

QCD



$$R_s \equiv \frac{s(x,Q^2)+\bar{s}(x,Q)}{\bar{u}(x,Q)+\bar{d}(x,Q)}$$

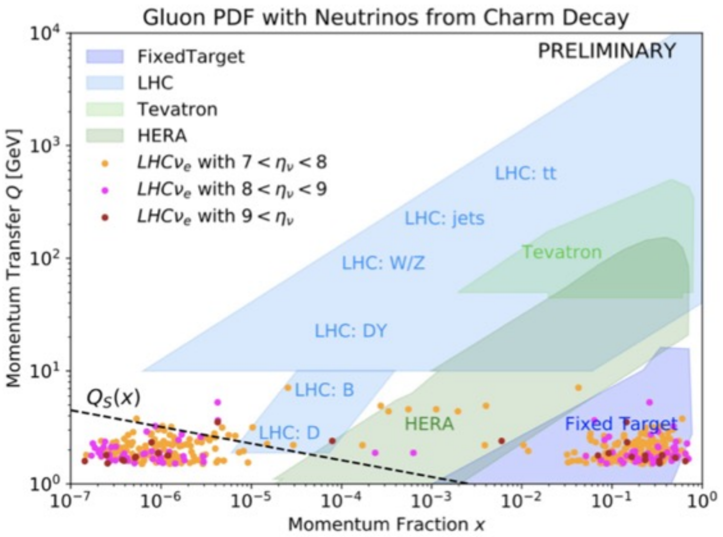


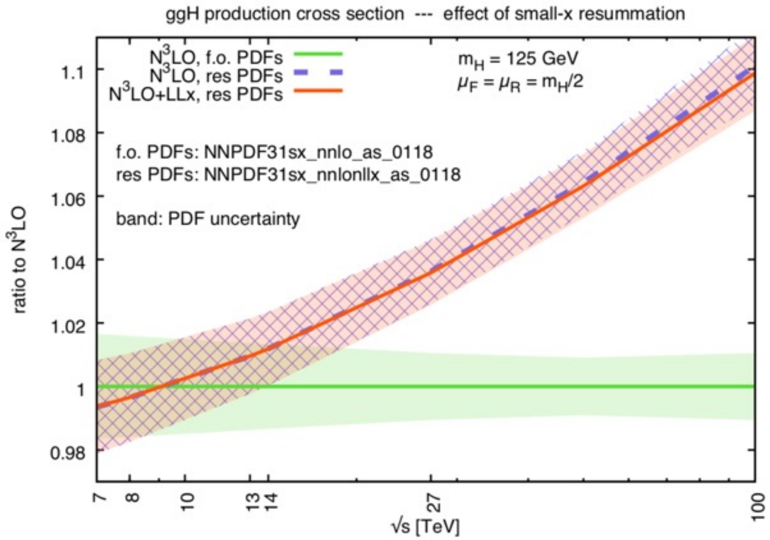
Neutrino-induced DIS could probes strangeness puzzle

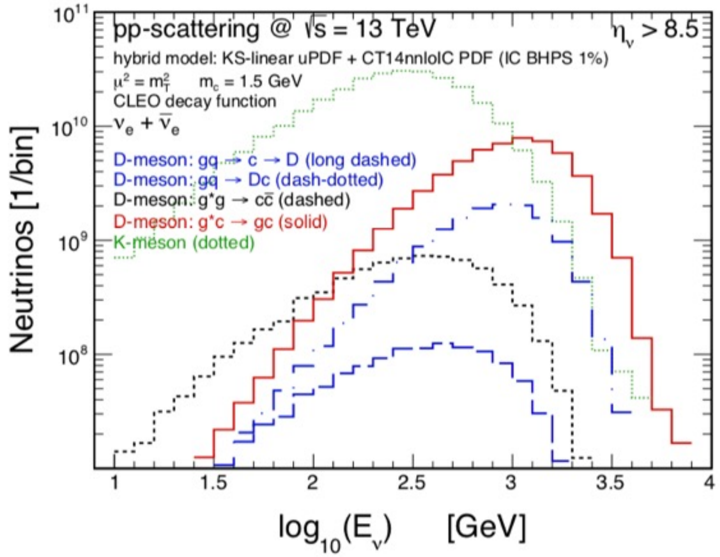
- Provide new information by measuring branch of D -> μ
- Constrain proton PDF, and nuclear PDFs

Neutrino is generated from low x & high x regions of the colliding protons

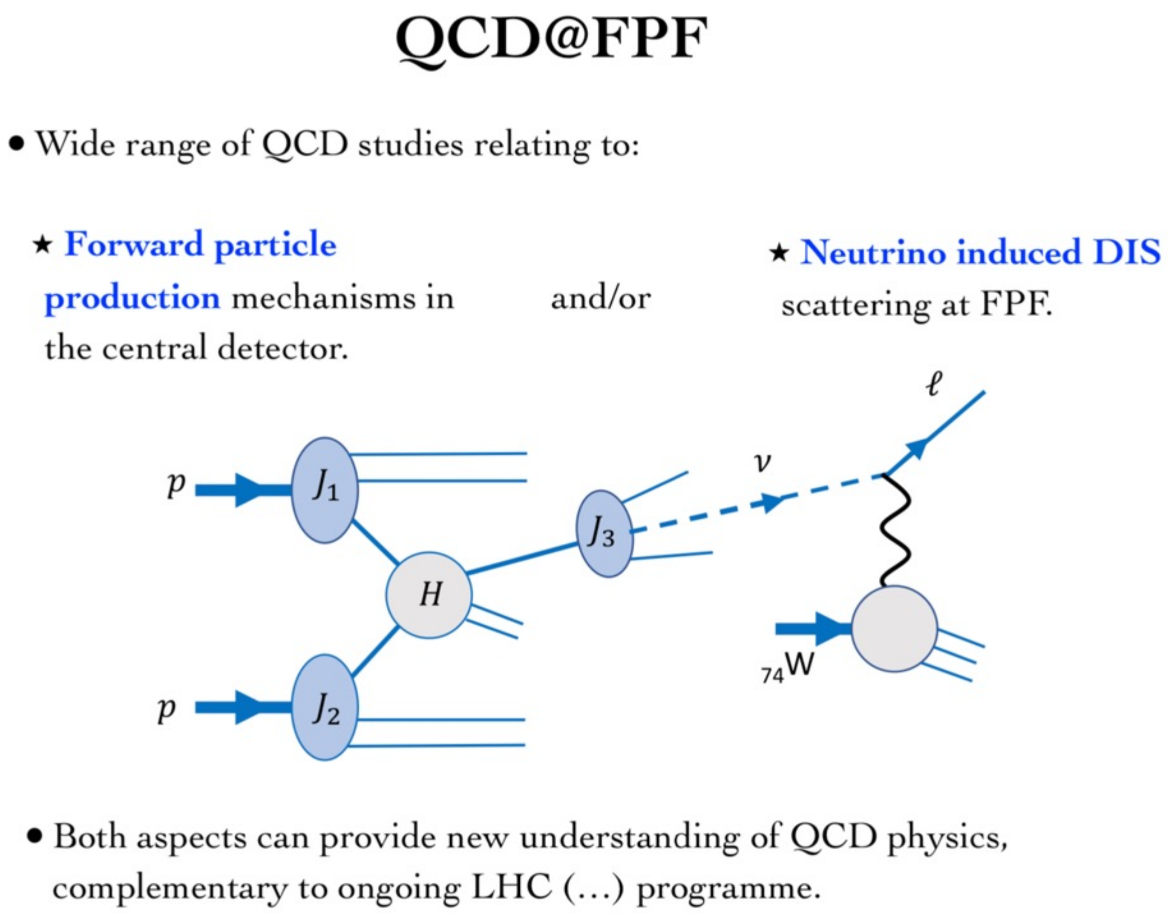
- Low-x Gluon PDF affecting Higgs production x-sec in FCC, intrinsic charm, and so on







QCD in the forward region



QCD@FPF

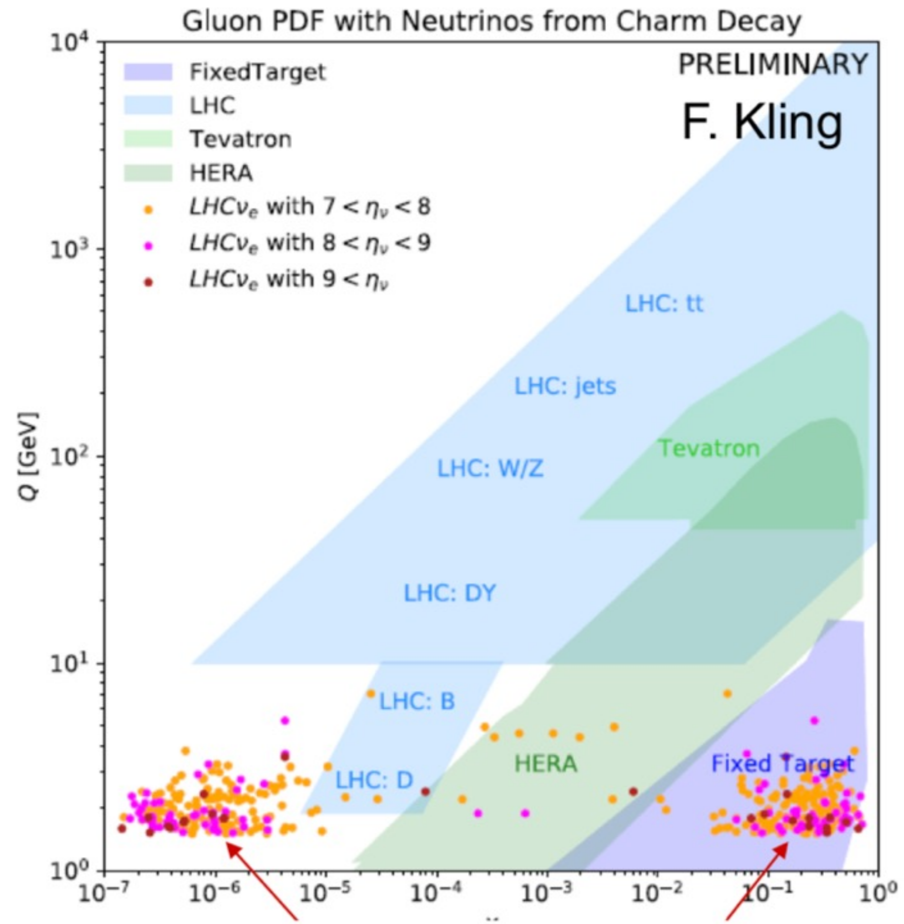
- Wide range of QCD studies relating to:

★ **Forward particle production** mechanisms in the central detector.

and/or

★ **Neutrino induced DIS** scattering at FPF.

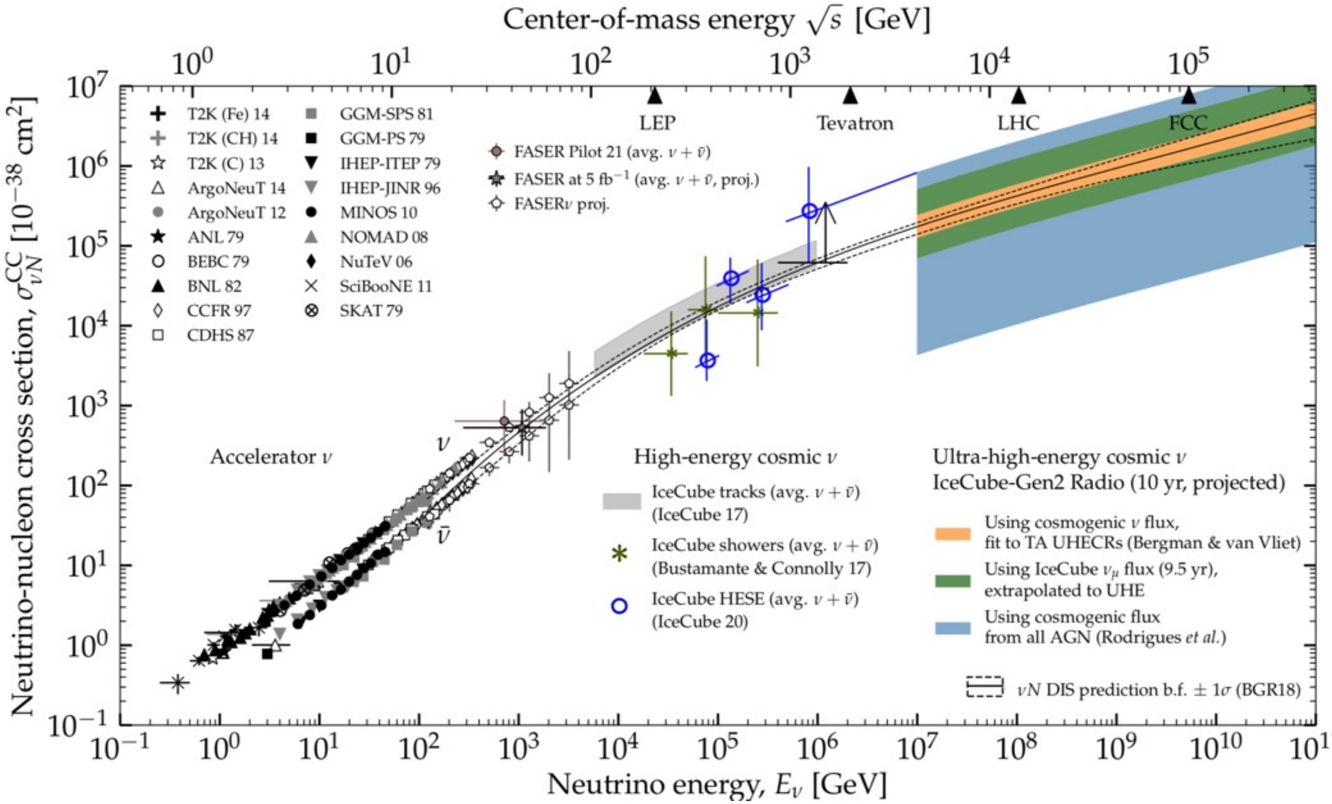
- Both aspects can provide new understanding of QCD physics, complementary to ongoing LHC (…) programme.

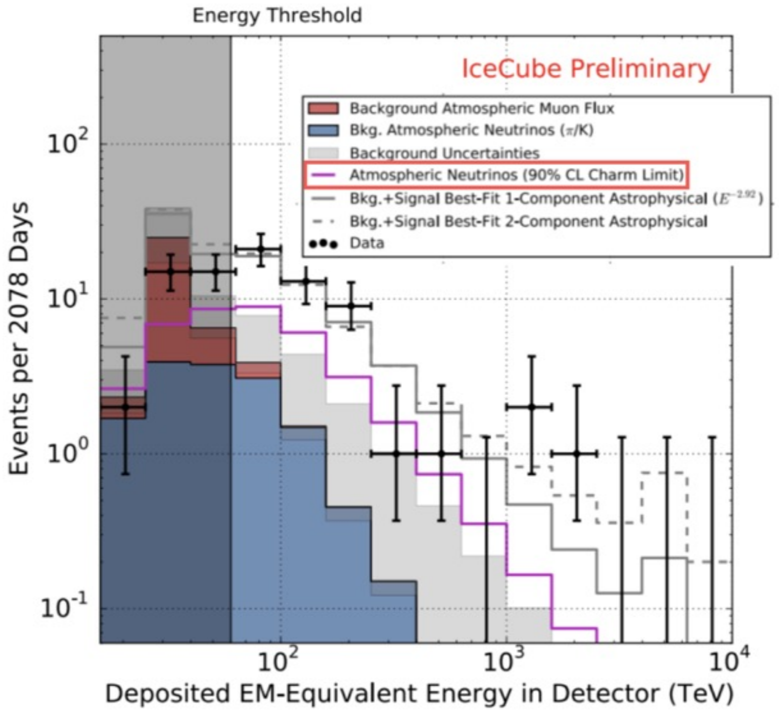


Lucian Harland-Lang, 4th FPF workshop:
https://indico.cern.ch/event/1110746/contributions/4701724/attachments/2382412/4071581/lhl_FPF_QCD.pdf

Astoroparticle physics

13 TeV center-of-mass pp collision corresponds to 100 PeV proton in lab frame



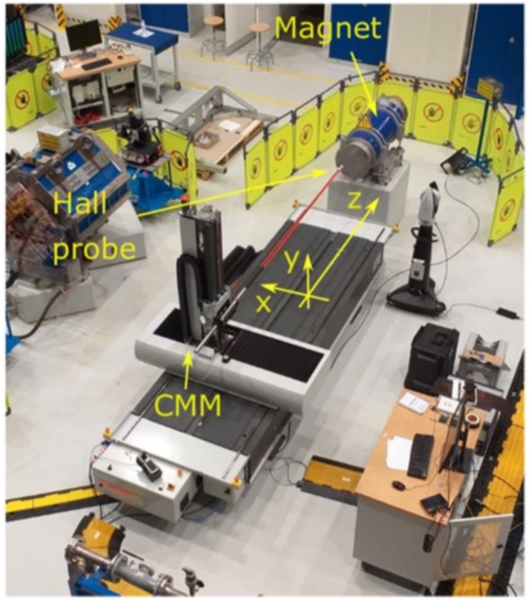


Better understanding of atomospheric neutrino could improve the IceCube experiment

Magnetic measurements

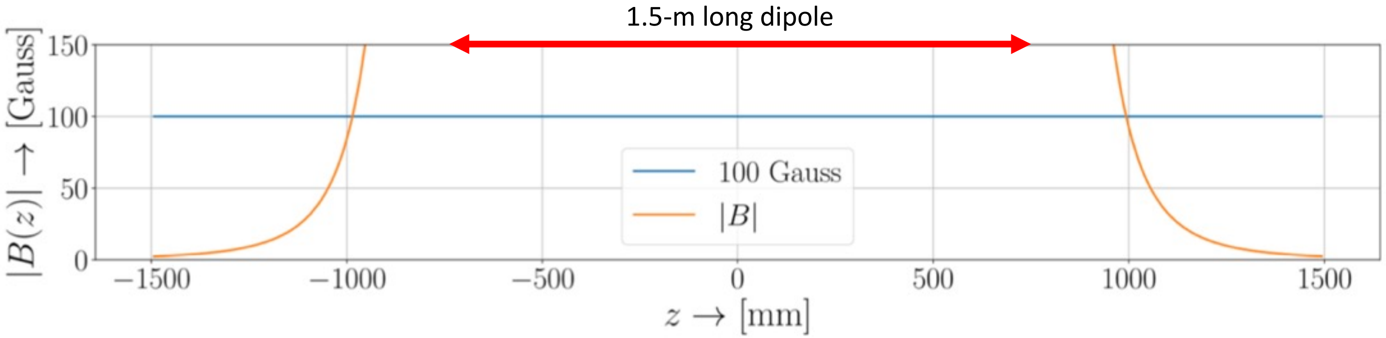
The assembled dipoles were measured with single-stretched wire (SSW) and 3D Hall probe mapper

- Measured integrated field and field orthogonality for the three dipoles within specified value



Magnet	Dipole 1 (short)	Dipole 2 (short)	Dipole 3 (long)	Unit
$\int$ Bx dl	-0.57692	-0.57840	-0.86150	Tm
$\int$ By dl	0.00021	0.00040	-0.00250	Tm
Roll Angle	1.57045	1.57008	1.57366	rad

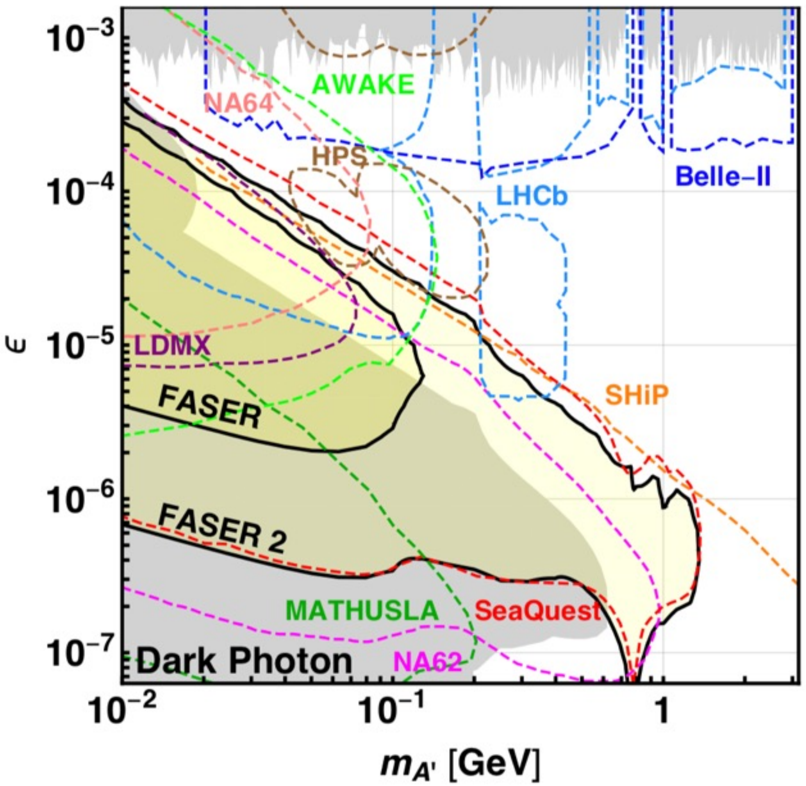
- Stray field in the central axis of the magnet
  - less than 10 mT (100 Gauss) about 250 mm from the magnet apparture



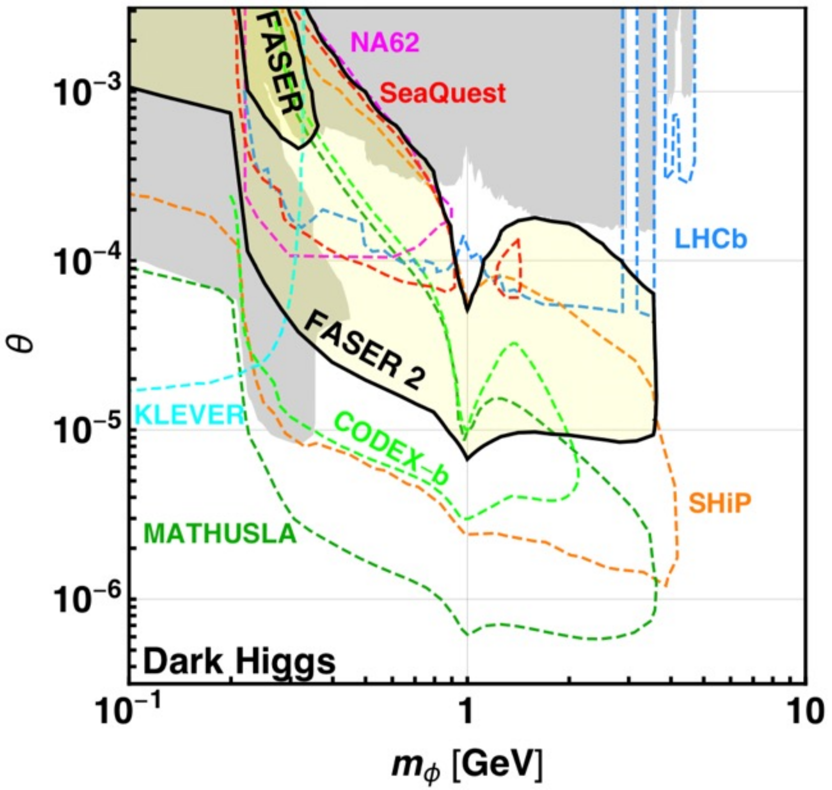
- Zero stray field outside the side of the magnet

FASER/FASER 2 physics reach for various model

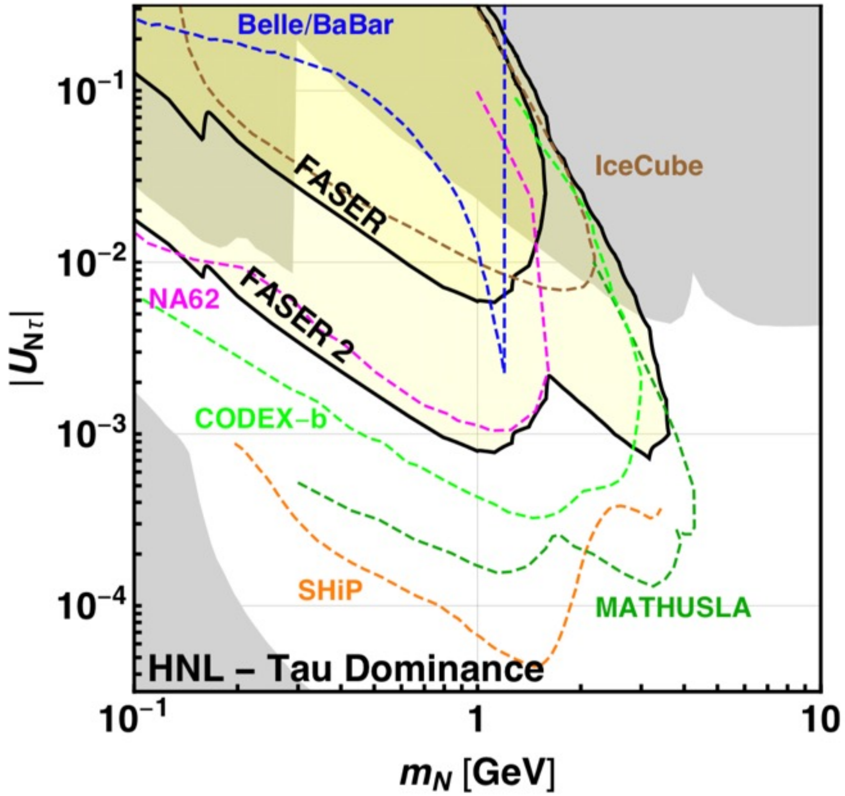
Dark photon



Dark higgs



Heavy neutral lepton



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Tracker Timing, threshold and HV scan

Early collision data in July/Aug 2022 was used to

- set proper fine timing delay (390 ps step), and
- evaluate hit efficiency as a function of threshold and HV
  - Hit efficiency of 99.64 ± 0.10% at 1.0 fC and 150V