



Laboratoire de Physique des Hautes Energies

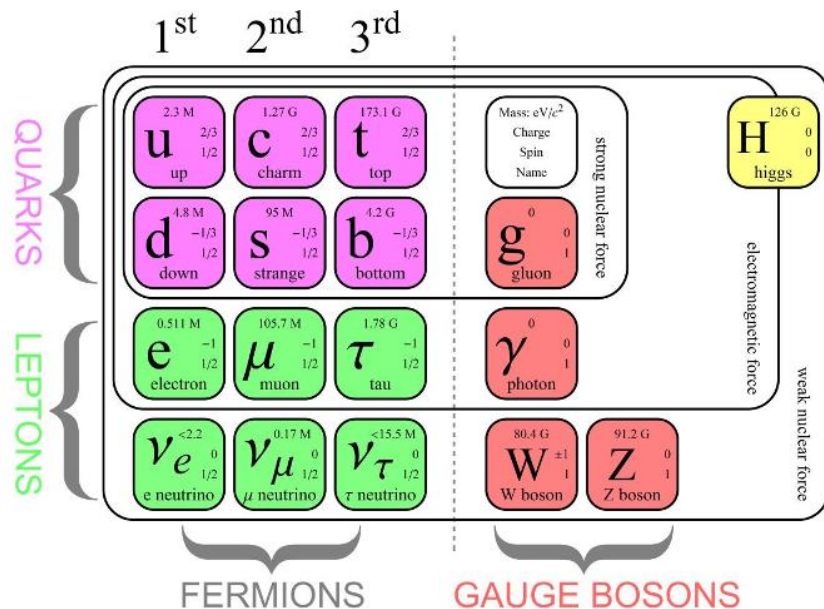


**LPHE
for future
Master
students**

Fred Blanc
Laurent Dufour
Guido Haefeli
Radoslav Marchevski
Chiara Perrina
Olivier Schneider
Lesya Shchutka

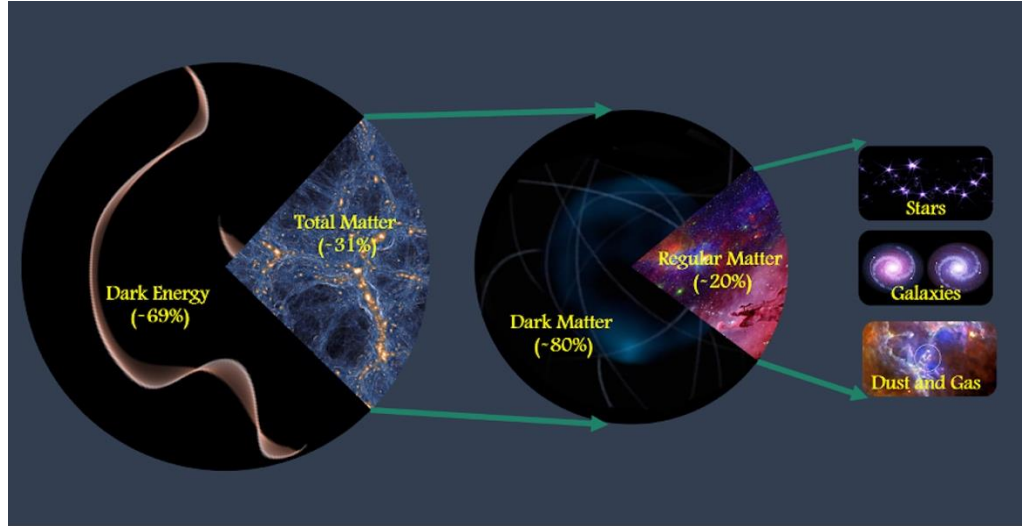
April 28, 2026

Standard model of particle physics



- seemingly complete since 2012:
 - 3 generations of matter particles, identical apart from their mass
 - carriers for 3 forces
 - Higgs mechanism for masses
- works very well for all phenomena observed *in the lab*
 - several tensions here and there exist

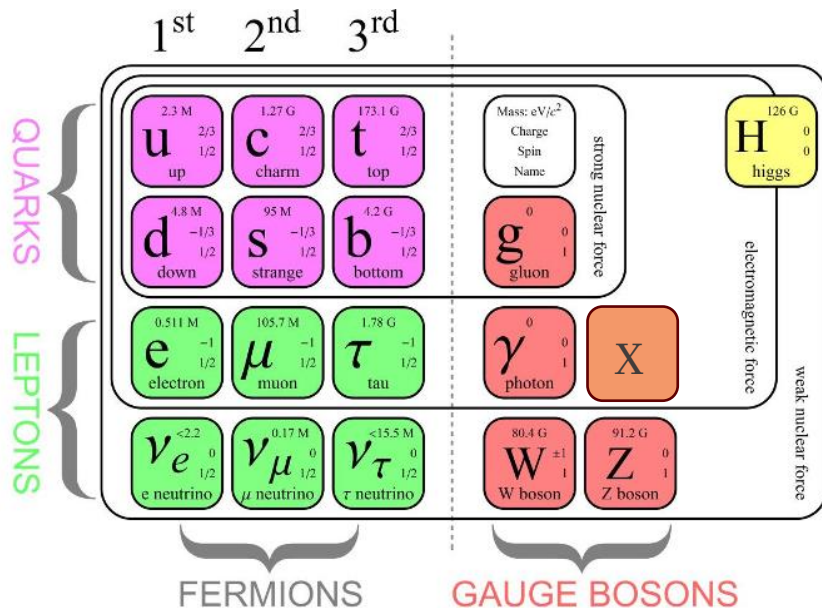
Why not stop there?



- + there are many more arguments of why standard model of particle physics is not an ultimate theory

- standard model accounts for about 5% of the content of the universe
- dark matter was “discovered” more than 90 years ago – and still no explanation for its nature

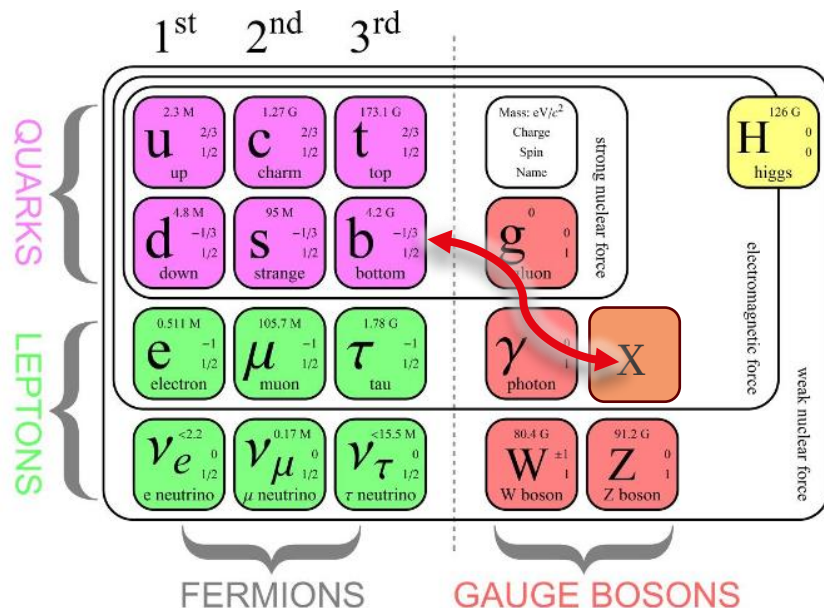
All these motivate searching for “new physics”



- Physicists confident about this picture
 - In the master programme you will learn why, and how
- Can we use the same approach to search for the physics *beyond* this model?

Directly find remnants of X in collision data

... but how?



- Physicists confident about this picture
 - In the master programme you will learn why, and how
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Indirectly find X through changes in the behaviour of other particles

Very good track record (e.g. top quark)

LHC and detectors – our main tool

First idea of the LHC in 1976

Approved for construction in 1994

Started stable operation in 2009

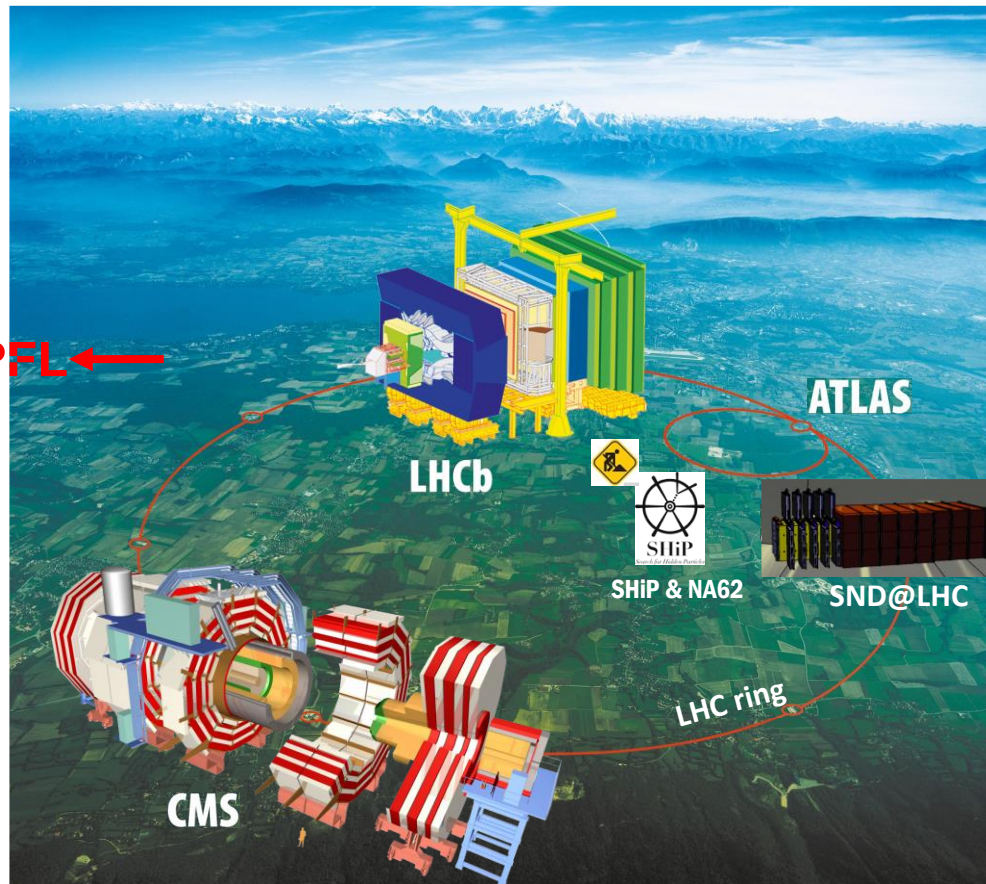
Planned to run until ~2040

Extremely useful in both ways of
probing New Physics

Some numbers:

- pp collisions at 7, 8, 13, 13.6 TeV with 25 ns bunch crossing
- LHC and experiments power consumption: 750 GWh/year
- Produces 4 TB/s of data

EPFL ←



... but not our only tool: DAMPE

DArk **M**atter **P**article **E**xplorer:
space telescope for high energy
gamma-ray, electron and
cosmic-ray detection

Launched in 2015, designed to
search and study **dark matter
particles** and study cosmic rays

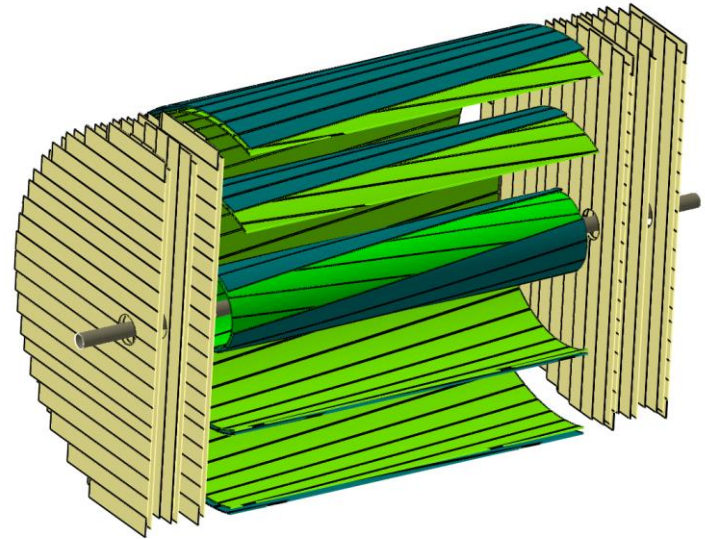
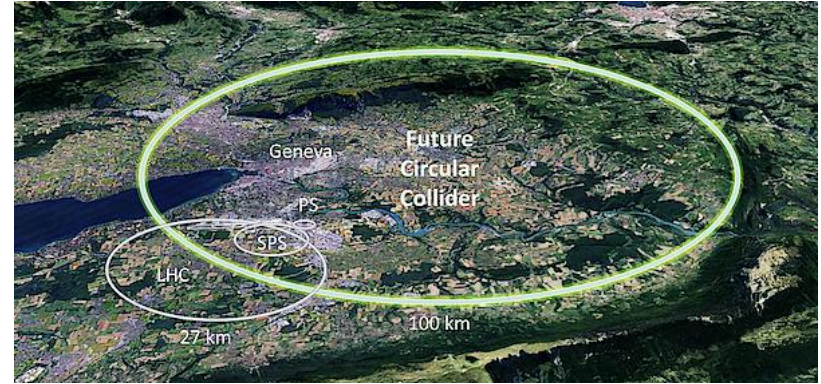
LPHE involved mostly in **data
analysis**, also R&D for potential
new space-based telescope



EPFL

SciFi for the FCC-ee: Future Circular Collider

- FCC-ee is proposed to be built for operation in 2040s
- We need to design its physics program **and experiments** now!
- We contribute physics studies & SciFi tracker R&D projects for FCC experiments

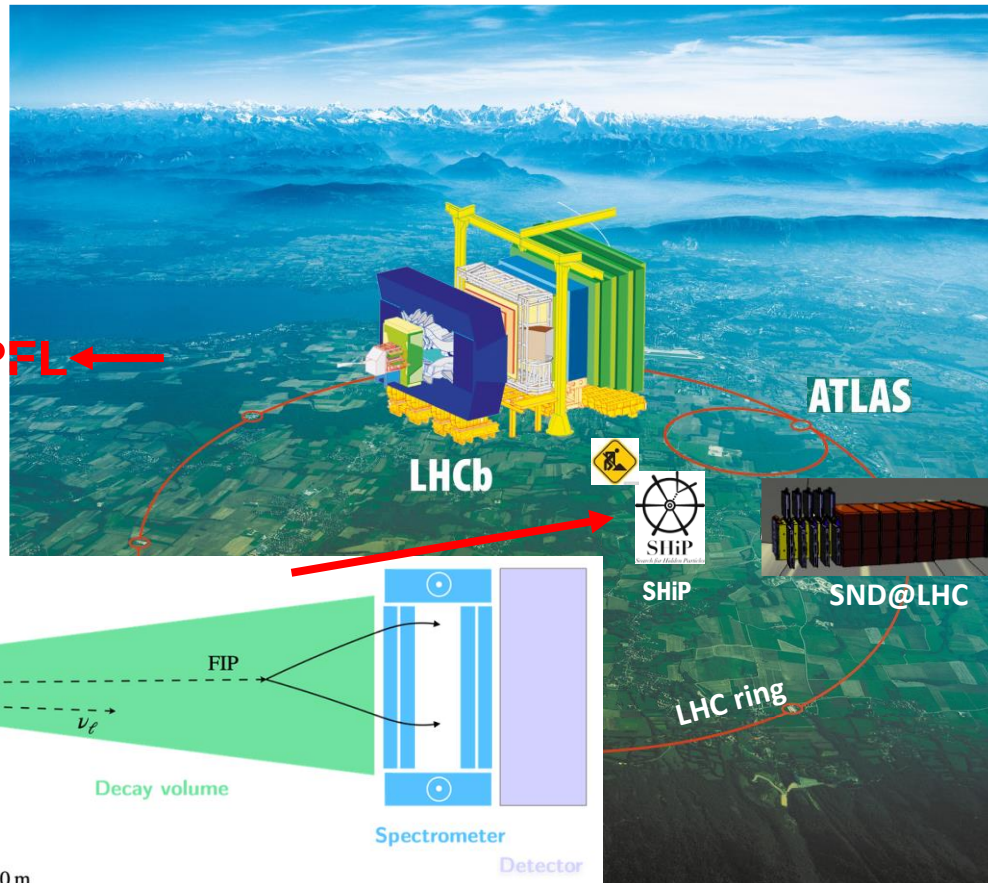
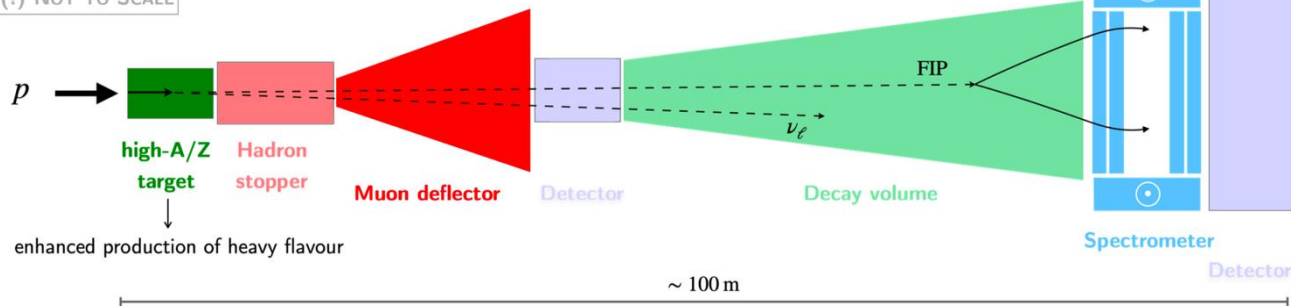


SciFi tracker layout for an FCC experiment

SHIP: Search for Hidden Particles

- The SHiP experiment has recently been approved by CERN
- Goal is to look directly for weakly interacting particles, complementary to LHC
- Construction in the next 4y

(!) NOT TO SCALE

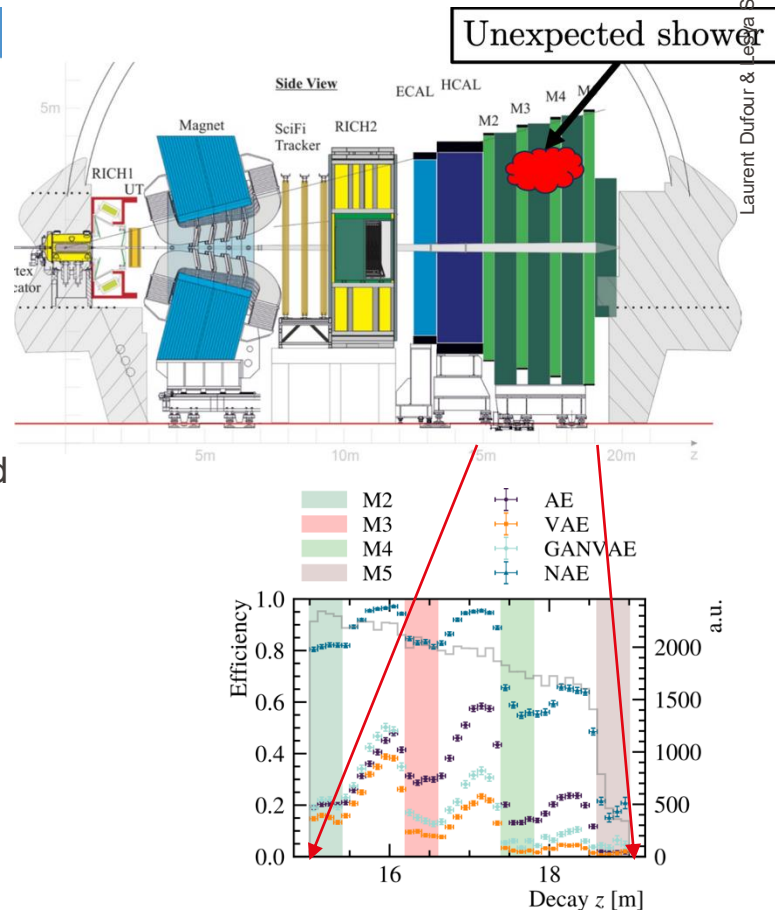


Examples of student projects at LPHE

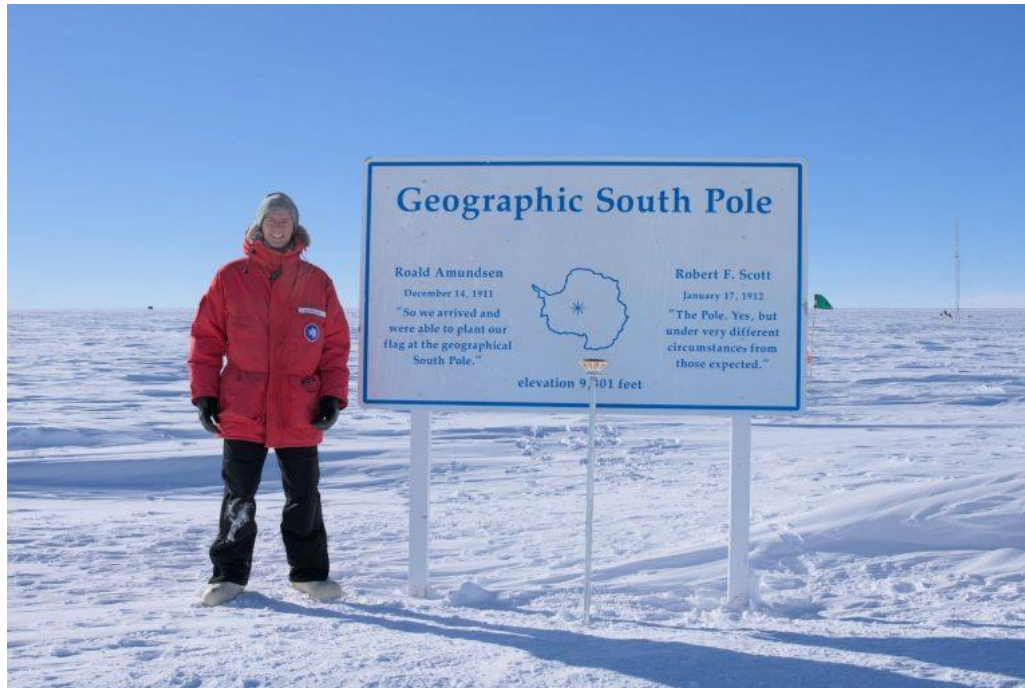
Thesis	
Report number	CERN-THESIS-2024-082
Title	An anomaly detection based trigger for long lived particles decays in the LHCb muon detector
Author(s)	Hartman, Luca (Ecole Polytechnique, Lausanne)
Publication	84.
Thesis note	Master : Ecole Polytechnique, Lausanne : 2024
Thesis supervisor(s)	Henry, Louis ; Shchutska, Lesya
Note	Presented 24 Jun 2024
Subject category	Detectors and Experimental Techniques
Accelerator/Facility, Experiment	CERN LHC ; LHCb

- proposed and developed a machine-learning-based anomaly detection algorithm:
 - normalized autoencoder (NAE) performed the best
- introduced it to LHCb data-taking in 2024
- presented the results on behalf of LHCb at a major international conference in Boston and at a machine-learning workshop in Geneva
- Now a PhD student at LPHE

<https://cds.cern.ch/record/2902447>



Master thesis: external (on IceCube)



- physics projects at LPHE
- external Master thesis
- Marc went to the South Pole doing a “winterover”: running the IceCube detector
- more reading in CERN and LPHE news:
 - <https://cerncourier.com/a/the-coolest-job-in-physics/>
 - <https://www.epfl.ch/labs/lphe/en/fulfilling-his-dream-marc-is-going-to-antarctica-for-the-icecube-experiment/>

Instrumentation projects: SciFi



Brand new SciFi* tracker for LHCb

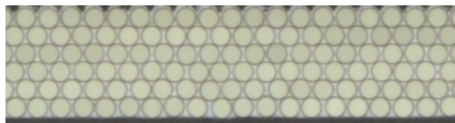
- R&D and construction at LPHE
- installed and taking data

**scintillating fibre*

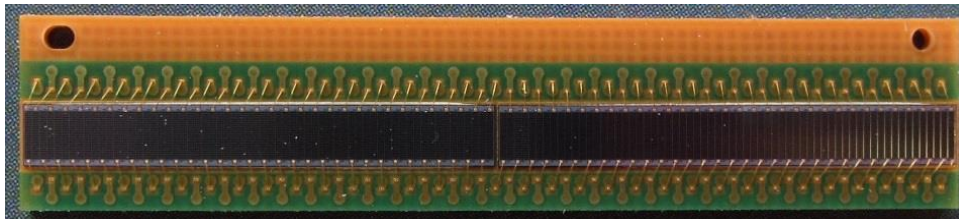
SciFi: charged particle tracking detector

- Scintillating fibres

- $\varnothing 250$ microns
- 6 layers



- Light read out by photodetectors:



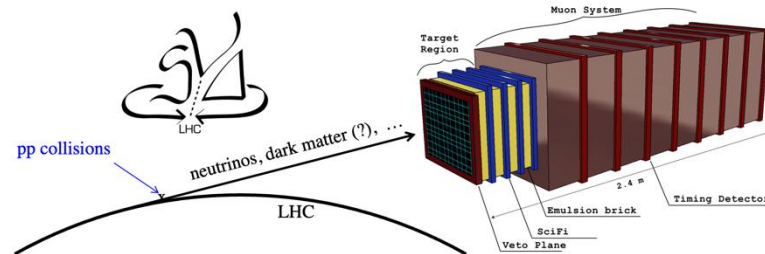
← 32.59 mm →

- Fast data acquisition: at 40 MHz (each 25 ns)



SciFi for the **SND@LHC**: Scattering and Neutrino Detector at the **LHC**

- more compact SciFi stations:
 - $39 \times 39 \text{ cm}^2$
- active R&D of new features:
 - particle time arrival measurement (300 ps precision)
 - electron shower imaging and energy measurement
- data-taking since 2022
- detector operation ongoing
- data analysis is on the way



SND in the LHC tunnel

The start of the start

Physics project I

Full experiment as a start: Physics Project I

Cosmic ray detection with a ECAL

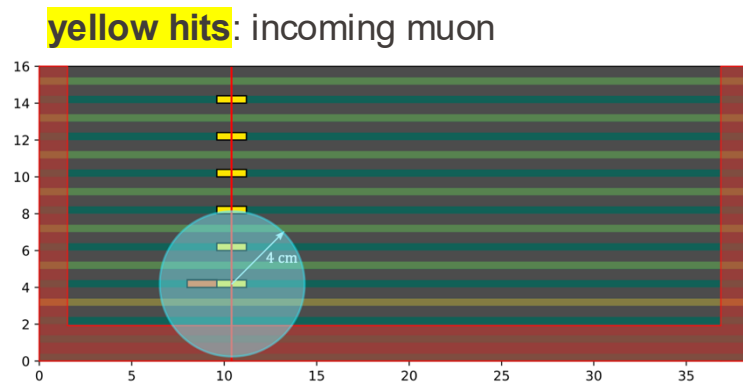
- relatively new addition
- students are developing new features each semester:
 - develop and refine simulation
 - decide how to take data
 - develop reconstruction algorithms
 - new analysis ideas
- achieved muon lifetime measurement in fall'22 for the first time!

- design, construction and operation of a small complete particle physics experiment
- work in a group of 2-3 people
- final written report by each group



Cosmic ray detection with an Electromagnetic calorimeter

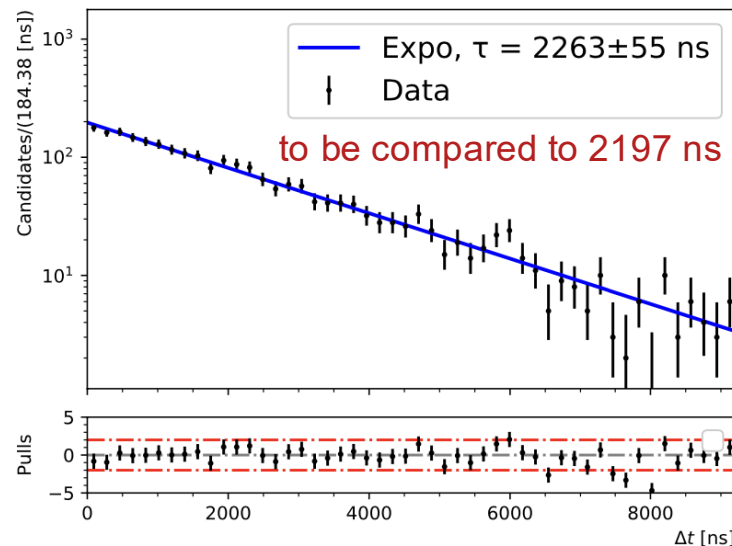
Example event of a decaying muon



orange hits: electron from $\mu \rightarrow e\nu\nu$ decay

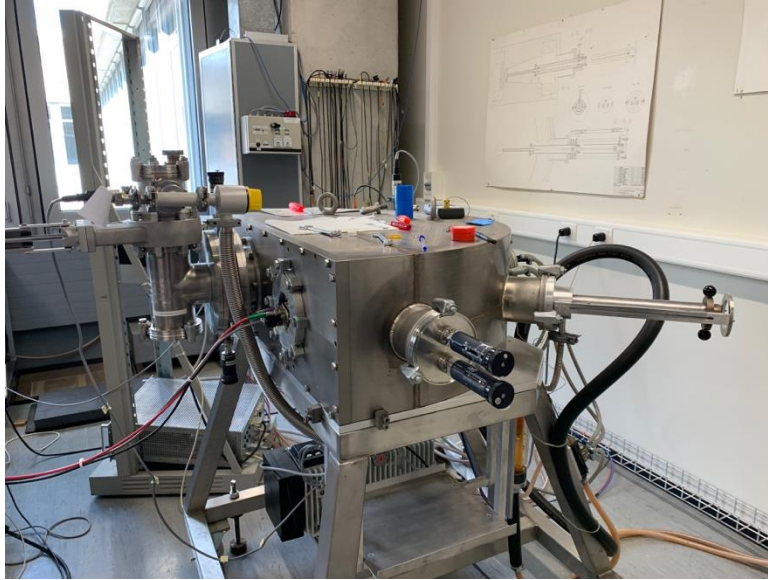
Time interval between the arrival of the muon and production of the electron is $\Delta t = 3299$ ns

Result by the students (fall'22)



Physics Project I: two other experiments

β -spectrometer: “measure” ν mass



μ lifetime & moment measurement



The next step: individual, you choose

08:57	4D track reconstruction for data quality studies	8m	
	Supervisor: Alina Kleimenova Responsible teacher: Radoslav Marchevski Speaker: Alina Kleimenova (EPFL - Ecole Polytechnique Federale Lausanne (CH))		
	Tp4b_2026_na62...		
09:05	Study of excess signal of the irradiated single cell SPAD	8m	
	Supervisor: Shuqi Sheng Responsible teacher: Guido Haefeli Speaker: Shuqi Sheng (EPFL - Ecole Polytechnique Federale Lausanne (CH))		
	TP4b_SIPM_SPA...		
09:13	Measurement of decay-time resolution with 2026 data	8m	
	Supervisor: Andrea Villa Responsible teacher: Laurent Dufour Speaker: Andrea Villa (EPFL - Ecole Polytechnique Federale Lausanne (CH))		
	villa_TP4b_kickof...		
09:21	Prospects of searching for $B_s \rightarrow \tau\tau$ in $e/\mu + 3\pi$ mode at FCC-ee	7m	
	Supervisor: Xunwu Zuo Responsible teacher: Lesya Shchutka Speaker: Xunwu Zuo (EPFL - Ecole Polytechnique Federale Lausanne (CH))		
	FCC-ee Bs tautau ...		

Physics Project II spring'26 edition



LPHE Physics Project II (=TP4b) kick-off meeting

Monday 16 Feb 2026, 08:15 → 15:25 Europe/Zurich

BSP 626 (EPFL)

Chiara Perrina (EPFL - Ecole Polytechnique Federale Lausanne (CH)),
Fred Blanc (EPFL - Ecole Polytechnique Federale Lausanne (CH)),
Guido Haefeli (EPFL - Ecole Polytechnique Federale Lausanne (CH)),
Laurent Dufour (EPFL - Ecole Polytechnique Federale Lausanne (CH)),
Lesya Shchutka (EPFL - Ecole Polytechnique Federale Lausanne (CH)),
Olivier Paul Schneider (EPFL - Ecole Polytechnique Fédérale de Lausanne (CH)),
Radoslav Marchevski (EPFL - Ecole Polytechnique Fédérale de Lausanne (CH))

08:15 → 08:25	Physics Project (TP4) kick-off: Introduction	8m	
	Convener: Olivier Paul Schneider (EPFL - Ecole Polytechnique Fédérale de Lausanne (CH))		
08:15	Welcome and general information	10m	
	Speaker: Olivier Paul Schneider (EPFL - Ecole Polytechnique Fédérale de Lausanne (CH))		
	TP4b_kick-off_Intr... TP4b_kick-off_Intr...		
08:25 → 10:15	Physics Project (TP4) kick-off: Presentation of the proposed projects by the supervisors	8m	
	Convener: Olivier Paul Schneider (EPFL - Ecole Polytechnique Fédérale de Lausanne (CH))		
08:25	Measuring the Impact of Correlated Noise on SIPM Photon Detection Efficiency	8m	
	Supervisor: Jou-An Chen Responsible teacher: Radoslav Marchevski Speaker: Jou-An Chen (EPFL - Ecole Polytechnique Federale Lausanne (CH))		
	TP4b_kickoff_16F...		
08:33	Timing-enhanced track segment matching in LHCb Upgrade II	8m	
	Supervisor: Spencer Collaviti Responsible teacher: Lesya Shchutka Speaker: Spencer Collaviti (EPFL - Ecole Polytechnique Fédérale de Lausanne (CH))		
	Timing_enhance... TP4b_Intro_Prese... TP4b_Intro_Prese...		
08:41	Spectroscopy study for the baryonic decay of $\Lambda_b^0 \rightarrow \Lambda_c^+ K_s^0 K^-$ at LHCb	8m	
	Supervisor: Yiyang Ding Responsible teacher: Lesya Shchutka Speaker: Yiyang Ding (EPFL)		
	TP4b_kickoff_Yiy... TP4b_kickoff_Yiy...		
08:49	Systematic uncertainties of $B(B_{(s)}^0 \rightarrow K_S^0 K_S^0)$ measurement at LHCb	8m	
	Supervisor: Kerim Guseinov Responsible teacher: Radoslav Marchevski Speaker: Kerim Guseinov (EPFL - Ecole Polytechnique Federale Lausanne (CH))		
	26w08-tp4b.pdf		

More information and application

- More information on Master level courses and Physics Project I:
 - <https://www.epfl.ch/labs/lphe/enseignement/>
- To apply for Physics Projects I and II, fill out the form provided by the Physics Section (<https://sb-projects.epfl.ch>) which will be available from **July 28 to August 17, 2026**.
- If you wish to express interest or have any question (also ahead of time), feel free to reach out to any of us (simultaneously)

Prof. Olivier Schneider



Prof. Lesya Shchutska



Prof. Fred Blanc



Prof. Radoslav Marchevski



Prof. Chiara Perrina



Prof. L. Dufour



Dr. Guido Haefeli





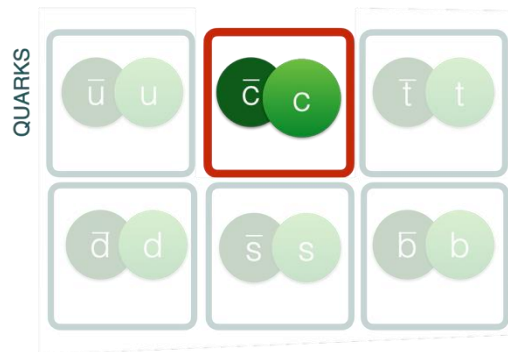
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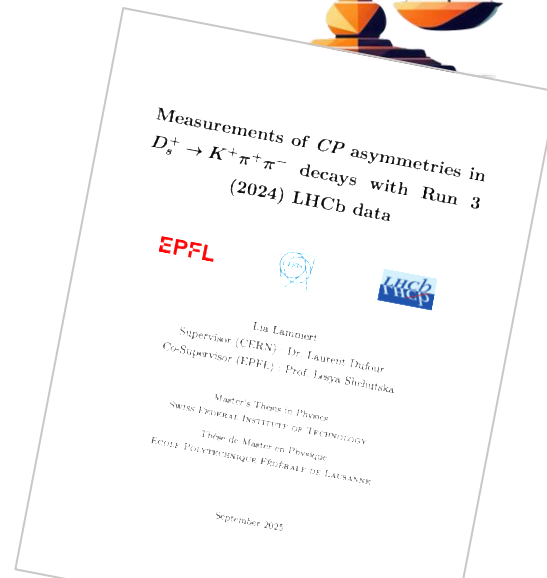
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- Differences between matter & antimatter: key to the structure of the universe
- **What happens in the second generation?**
- Looked closely at the first data of the new Run 3 LHCb detector, while data were coming in.
Linked detector conditions directly to features in data
- Now starting a PhD student in observational cosmology in Paris



Work continued by a PhD student
good chance of publication