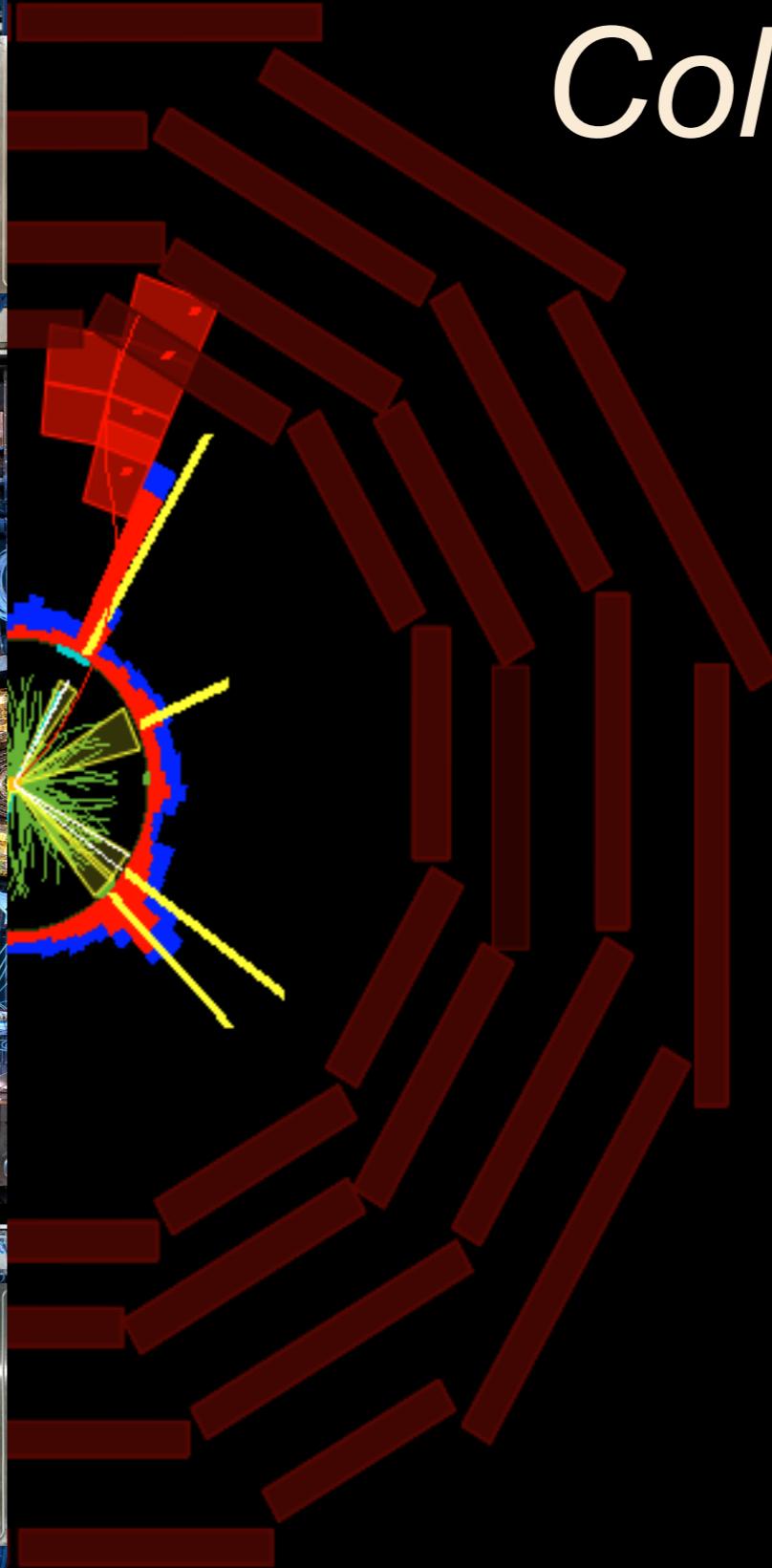


Particle Physics Collaboration

*MIT Physics
NUPAX Division
Welcome!*

*Christoph Paus
09/10/2021*



Particle Physics Collaboration (PPC)

Faculty

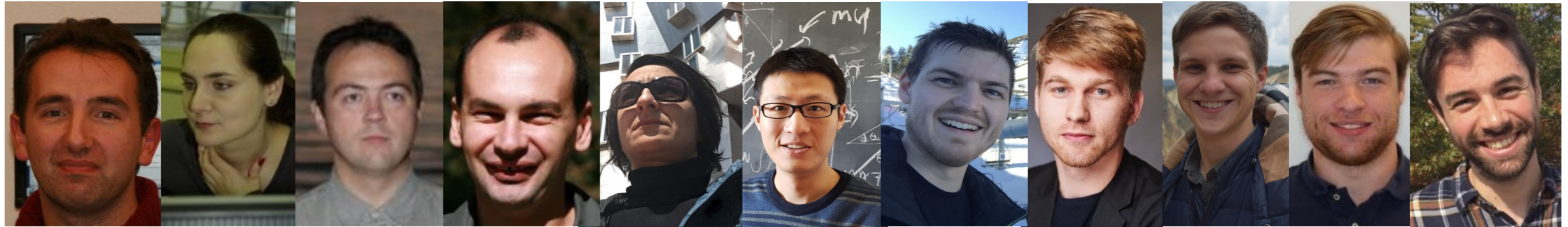


Christoph Paus

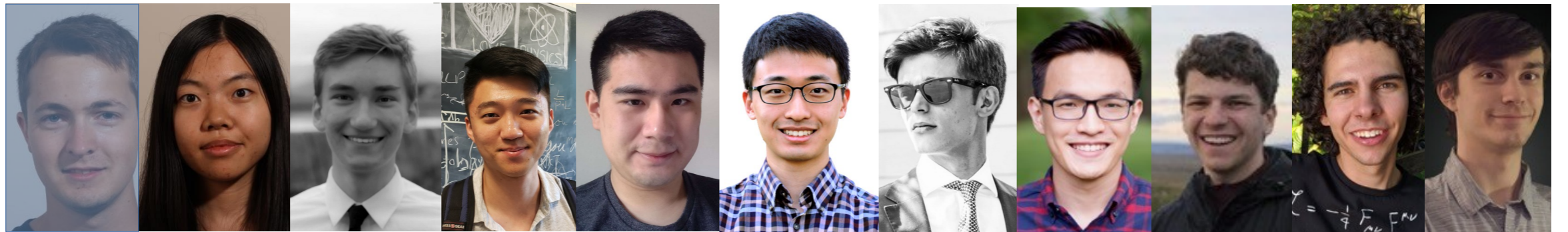


Philip Harris

Research Scientists, Postdocs



Graduate Students



Undergrads

many many many

Join in 2022
Run 3 just started.



Typical Theses Topics in PPC

Michael Mulhearn (CDF, 2004)

- [A Direct Search for Dirac Magnetic Monopoles](#)

Alberto Belloni (CDF, 2007)

- [Observation of \$B_s^0\$ - \$B_s^0\$ Oscillations and the Development and Application of the Same-Side-Kaon Flavor Tagging](#)

Khaldoun Makhoul (CDF, 2009)

- [CP Violation in Flavor Tagged \$B_s \rightarrow J/\psi \phi\$ Decays](#)

Kevin Sung (CMS, 2012)

- [Search for Higgs to \$ZZ\$ to \$ll\nu\nu\$ channel with the CMS](#)

Joshua Bendavid (CMS, 2012)

- [Evidence for a narrow Higgs-like diphoton resonance with a mass of 125 GeV in \$pp\$ collisions at \$\sqrt{s}=7-8\$ TeV](#)

Aram Apyan (CMS, 2016)

- [Electroweak physics and evidence for a Higgs Boson decaying to a pair of tau leptons with the CMS Detector](#)

Siddarth Narayanan (CMS, 2019)

- [Search for Dark Matter using Jets and Jet Substructure at the Large Hadron Collider](#)

Life After PPC

Mike Mulhearn
PhD 2004
Professor at UC Davis



Boris Iyutin
PhD 2007
Director at
Bank of America



**CEM High-Frequency
Trading Systems**

Duncan Ralph
PhD 2014
Fred Hutchinson Cancer
Research Center



**Using ML to find
cures for cancer
and HIV**

Careers of some of
our graduate students

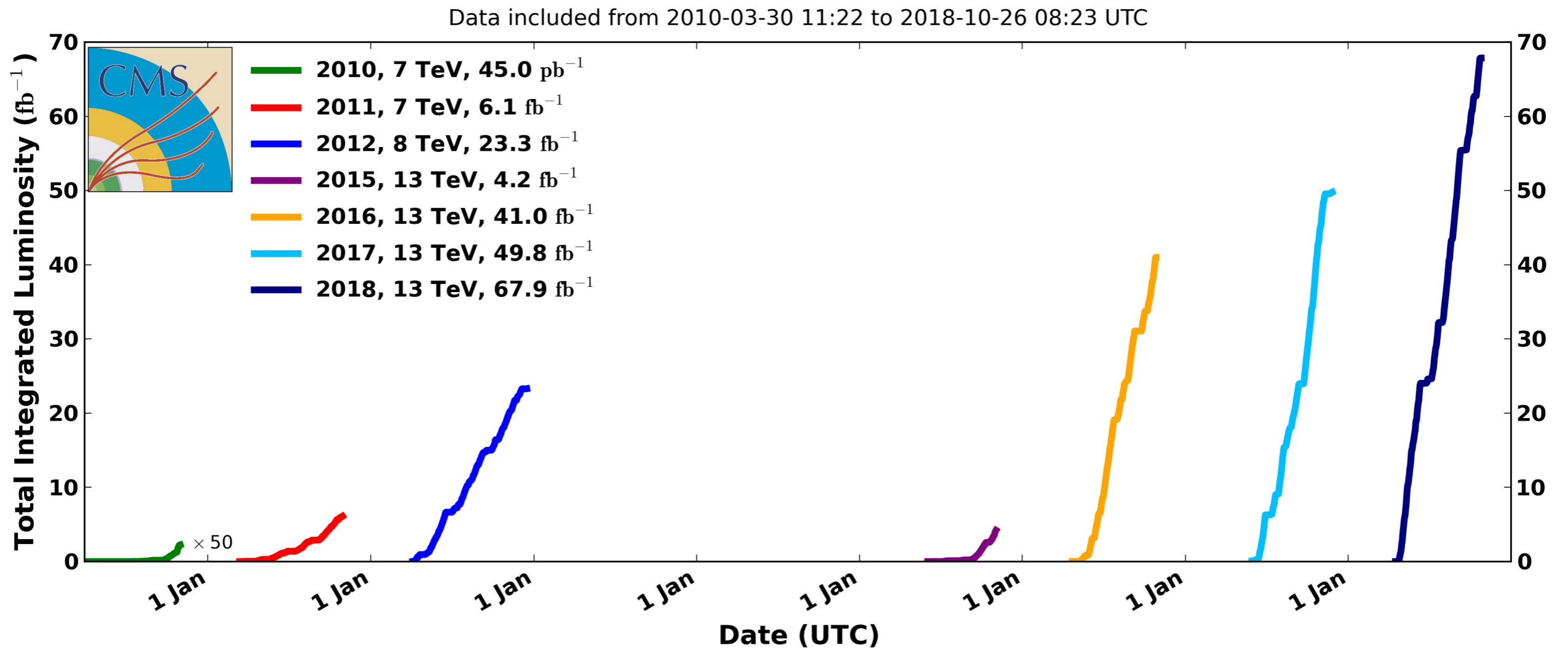
Valentina Dutta
PhD 2014
Assist. Prof. At CMU



Large Hadron Collider (LHC)



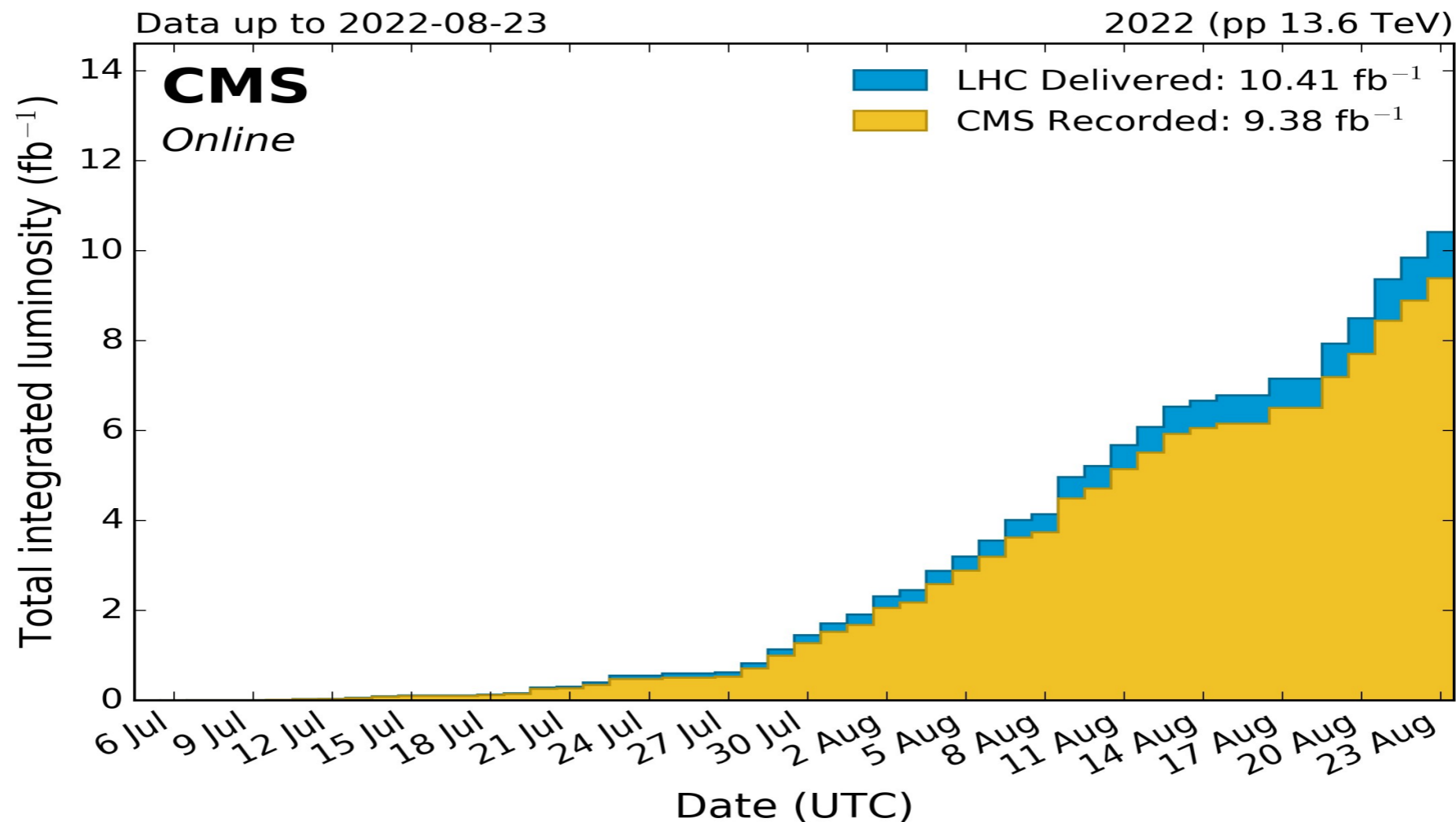
Great Run 2 Data in Hand



Rich Run 2 (and Run 1) data

- Some very interesting measurements have not yet been done (ex. triboson vertex measurements with photons)
- Ideal for prototyping analysis ideas right now and see what comes out (ex. Soft Unclustered Energy Pattern / dark showers)

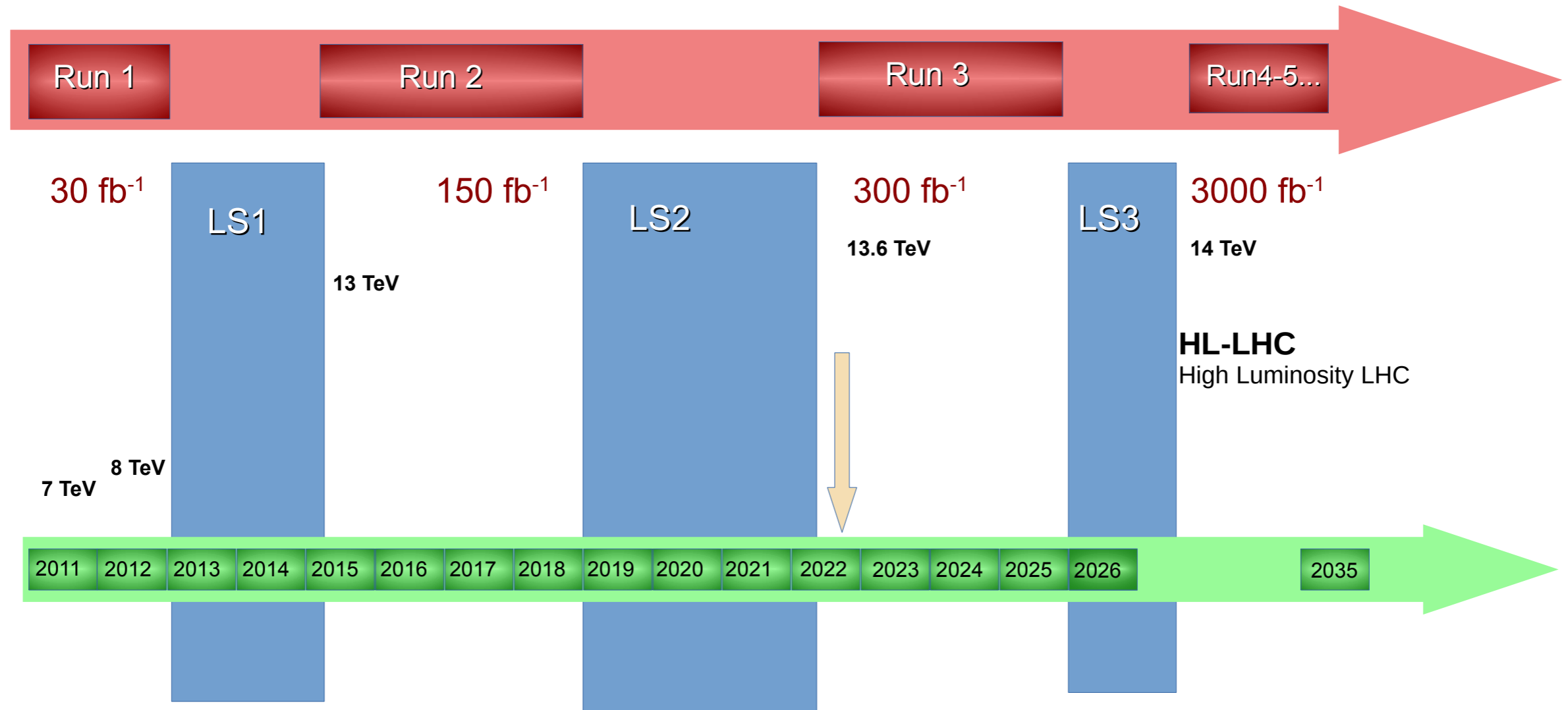
Run 3 has started (July 5)



Brand new Run 3 data rolling in

- Expect another 200-300/fb
- Significantly improved triggers in most our analyses will provide substantial improvements for measurements in Run 3, beyond just lumi scaling
- Small hick-up (1 month) after magnet quench with leaking cooling fluid

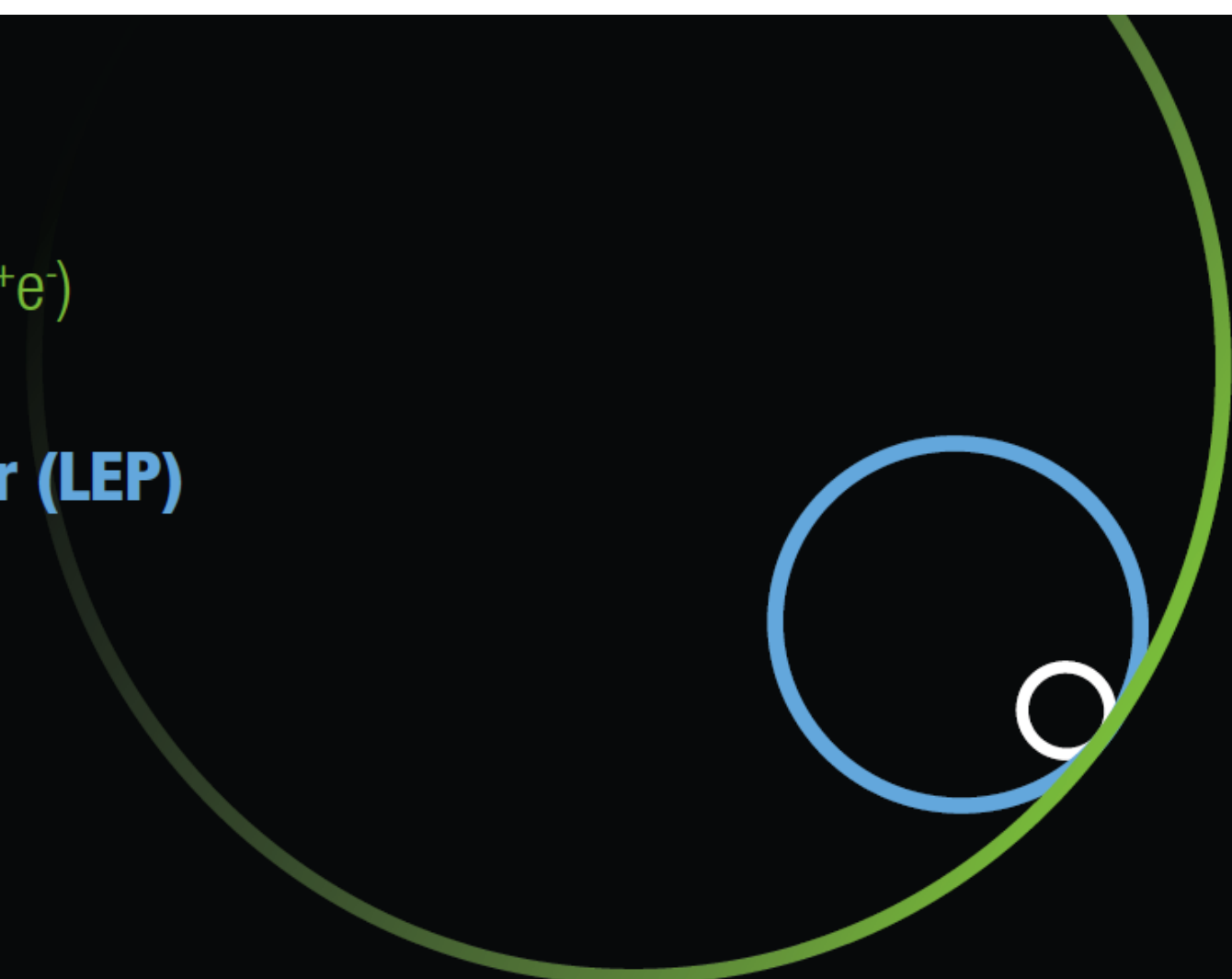
LHC Schedule



Fabulous plan for the short/medium and long term

- Run 3 with new highest CM energy and highest integrated luminosity is coming up
- Right on time for students to make an impact and do a great analysis

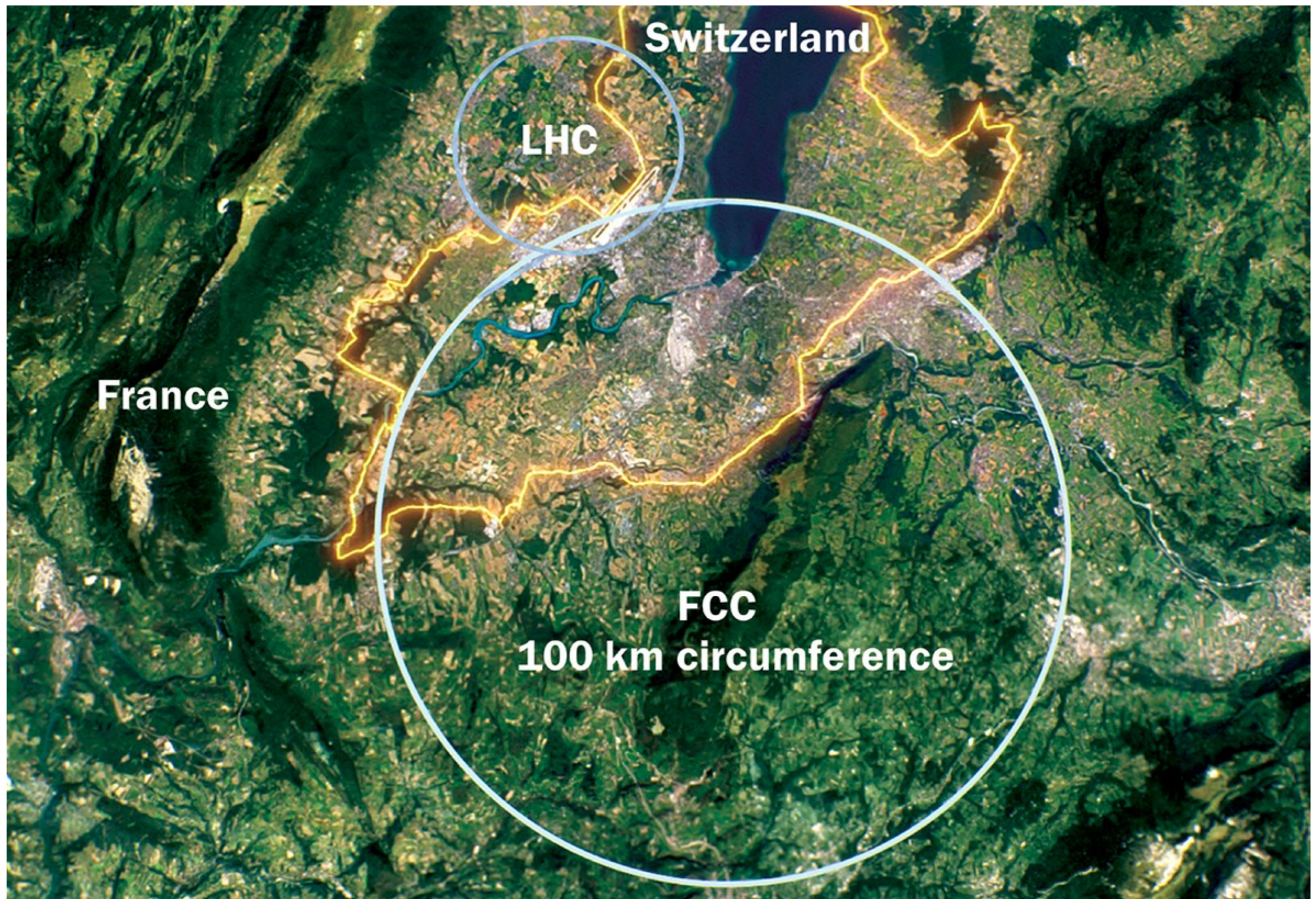
Very Long Term

- **Future Circular Collider (FCC)**
Circumference: 90 -100 km
Energy: 100 TeV (pp) 90-350 GeV (e^+e^-)
 - **Large Hadron Collider (LHC)**
Large Electron-Positron Collider (LEP)
Circumference: 27 km
Energy: 14 TeV (pp) 209 GeV (e^+e^-)
 - **Tevatron**
Circumference: 6.2 km
Energy: 2 TeV ($p\bar{p}$)
- 

Planning for 2040 and beyond

- we are leading intense discussion about what is after
(MIT has Higgs boson and electroweak precision physics co-conveners)
- extraordinary opportunities: expensive and massive

Very Long Term: FCC



Opportunities

Get hands on large data set now

- Existing Run 2 data offer rich opportunities to hone your skills right now

Get your hands on the detector

- Detector for Run 3 is running and needs to be operated – you can take an important role
- The new detector for Run 4/5 (HL-LHC) is being actively developed
- Right on time for students to make an impact and do a great analysis

Find a great topic for your thesis – Run 3 data

- ***Run 3 will complete in December 2025 – the time could not be more perfect***

Conclusion

Broad physics and detector programs

- Higgs, dark matter, and other new physics, precision tests
- Software, computing, trigger, DAQ, and HCAL/HGCal projects

PPC strong leader in CMS detector and physics

Run-3 in full swing and HL-LHC will come soon

Very active in future collider projects (FCC)

We still have one slot for a student joining!



4%

LHC Status Run 3 in progress (small pause for repair)