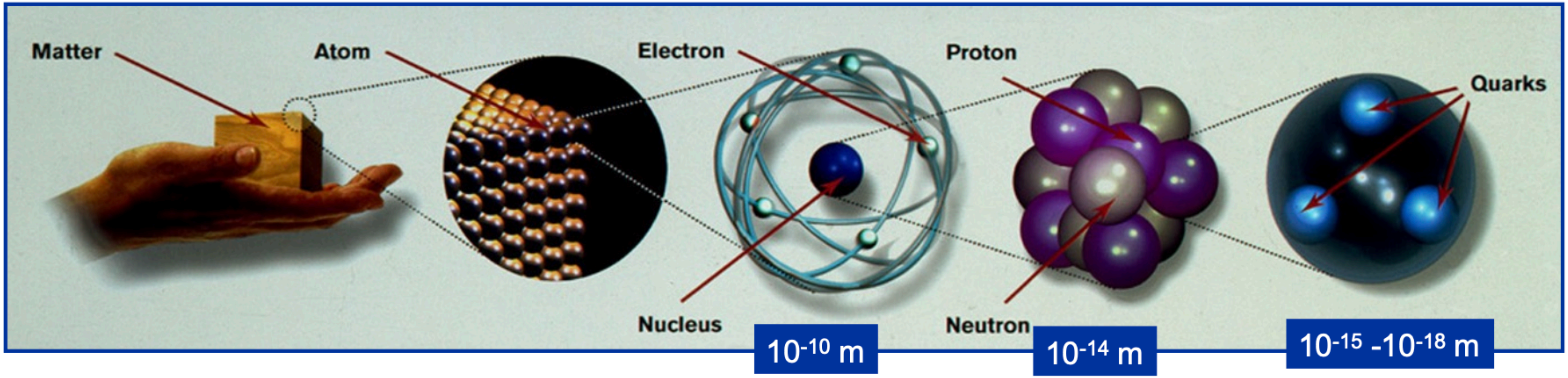
The FCC project

A glimpse into the Future of High Energy Particle Physics

Photo from one of the future interaction points of FCC

Patrizia Azzi - 19/2/2026 - Catania

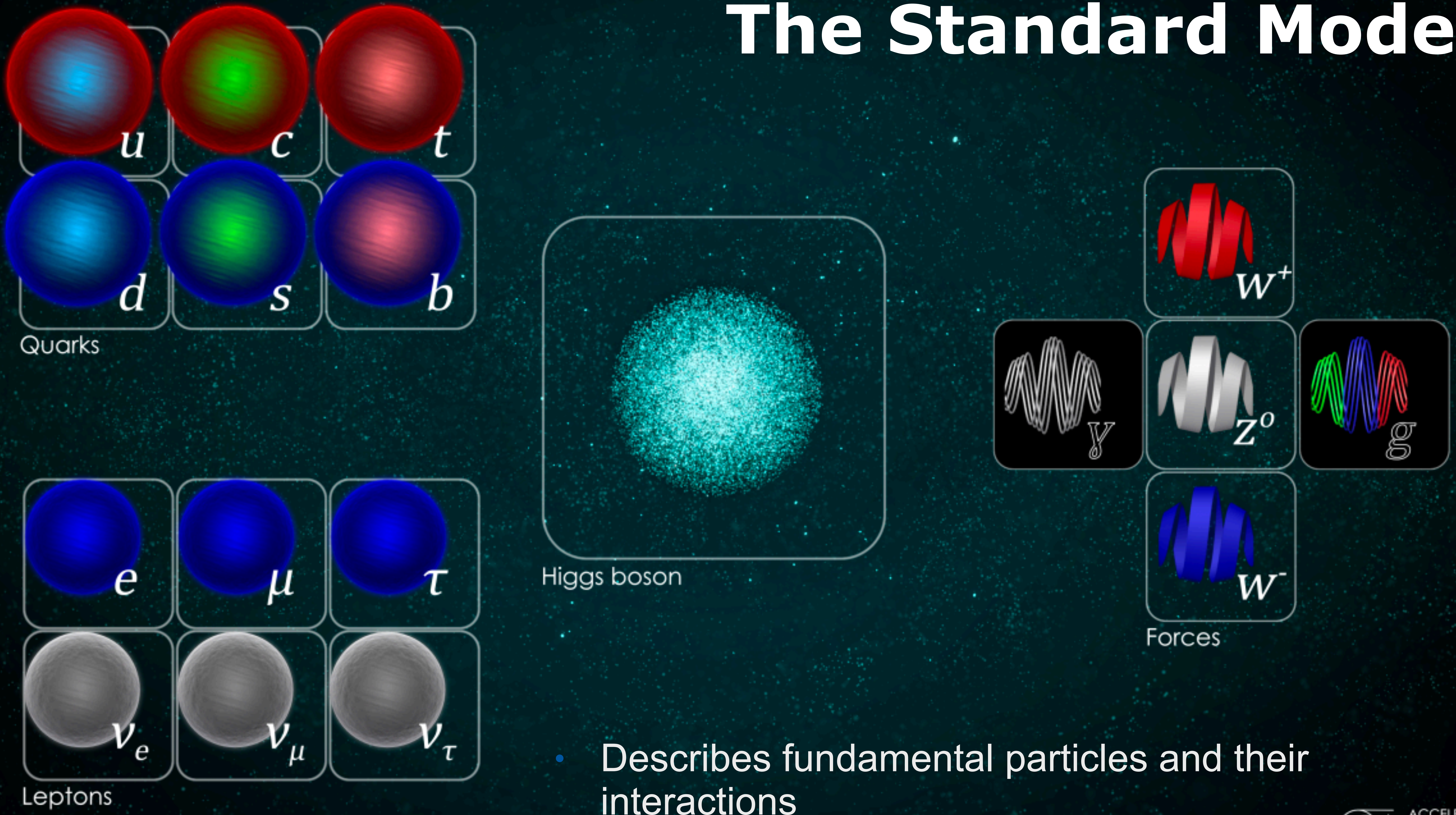
At CERN we study elementary particles - the smallest constituents of matter and the Universe - and the fundamental laws of Physics



Machines like the LHC allow us to study matter at scales smaller than 10^{-18}m

- we try to understand the structure and evolution of the Universe
- we use the infinitely small to understand the infinitely big

The Standard Model

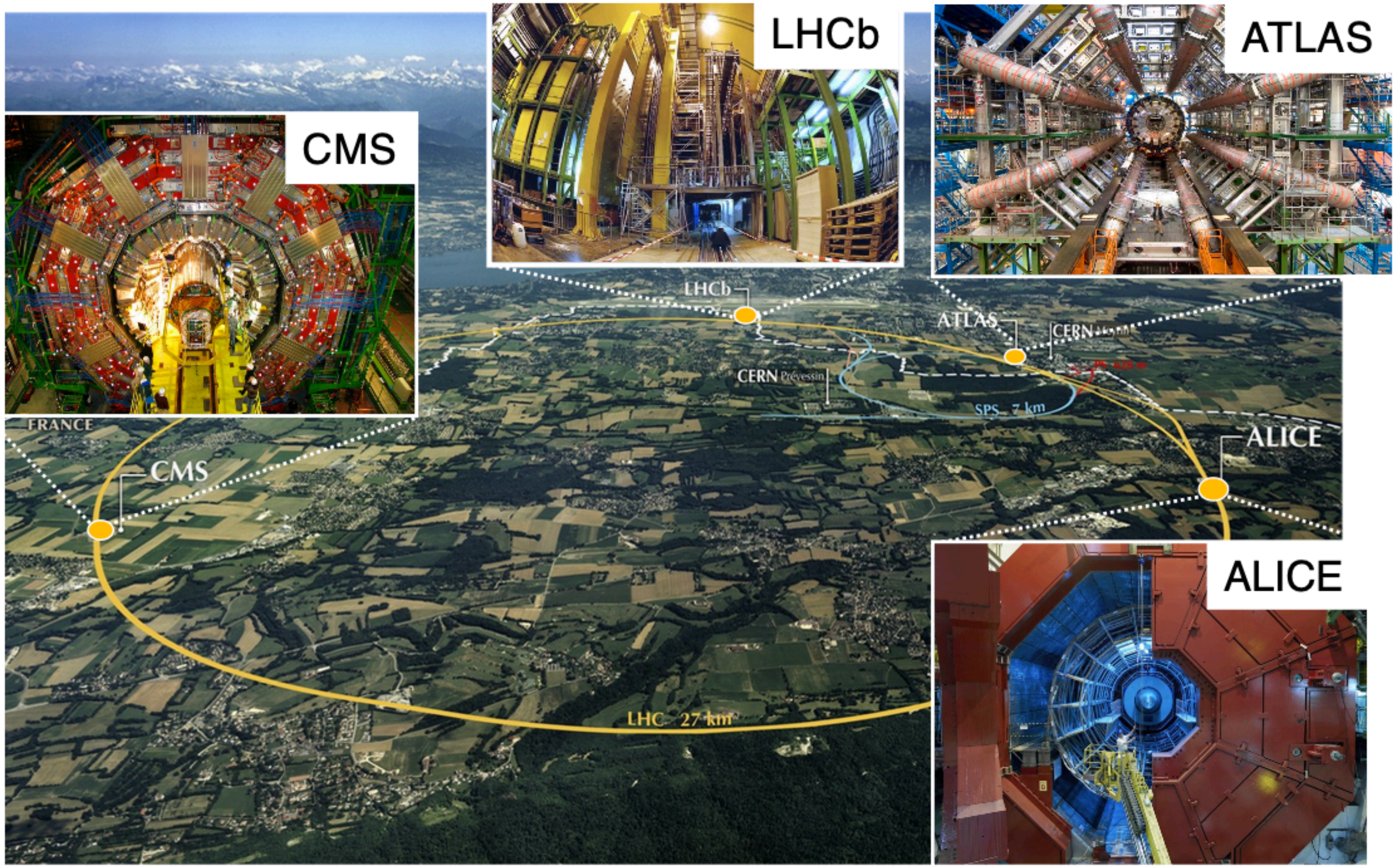


- Describes fundamental particles and their interactions
- Observable matter is only 5% of the Universe

CERN ACCELERATING SCIENCE

Our research is based on THREE fundamental tools and the most advanced technologies

The Large Hadron Collider (LHC) the most powerful accelerator in the world

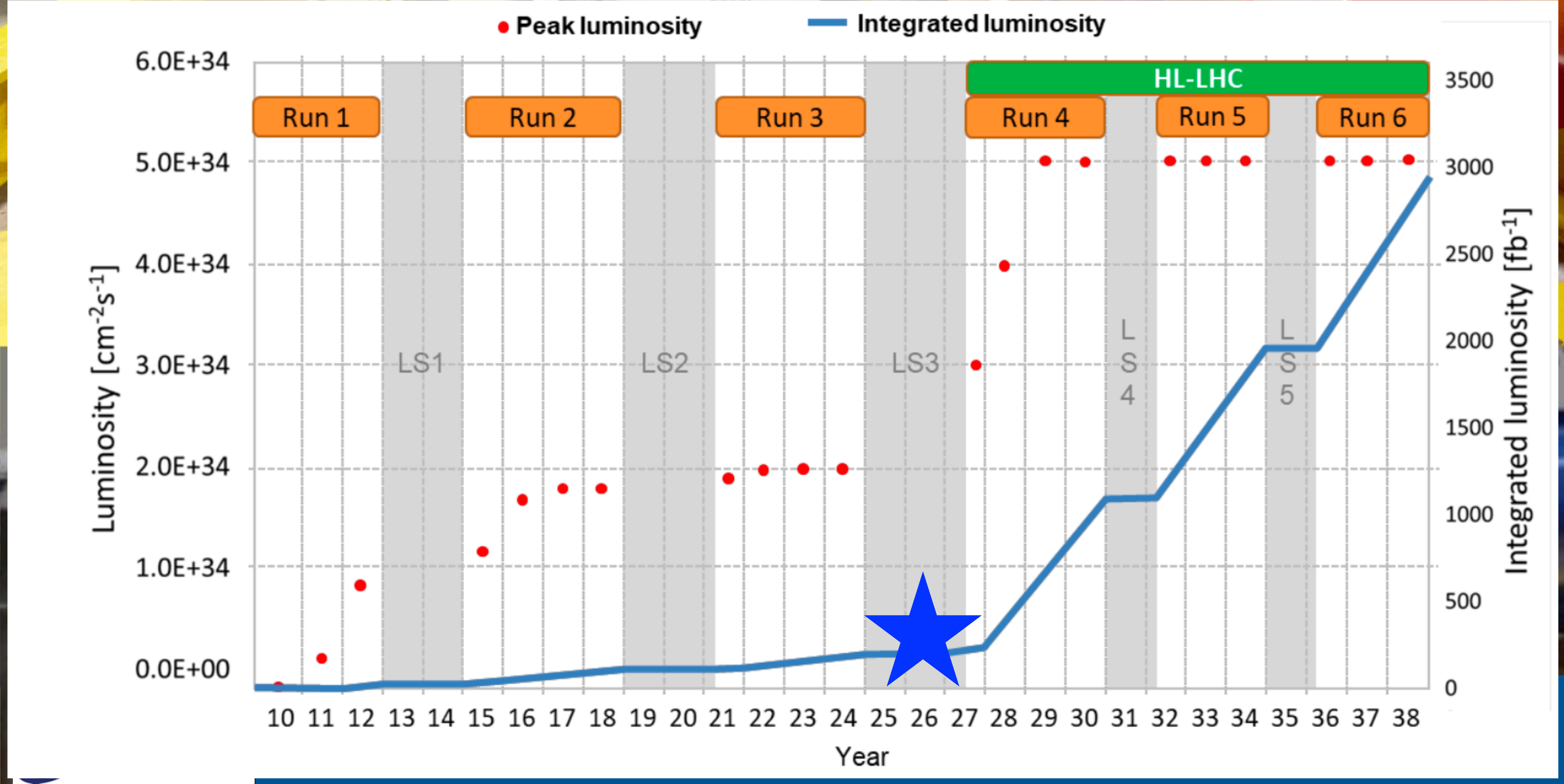


A 27km ring, 100m underground, spanning Switzerland and France

Started operations in 2010 with proton-proton collisions at unprecedented energies (now 13.6 TeV)

NB. The tunnel was built in the 1980s for the Large Electron Positron (LEP) collider (1989-2000)

High-Luminosity LHC upgrade

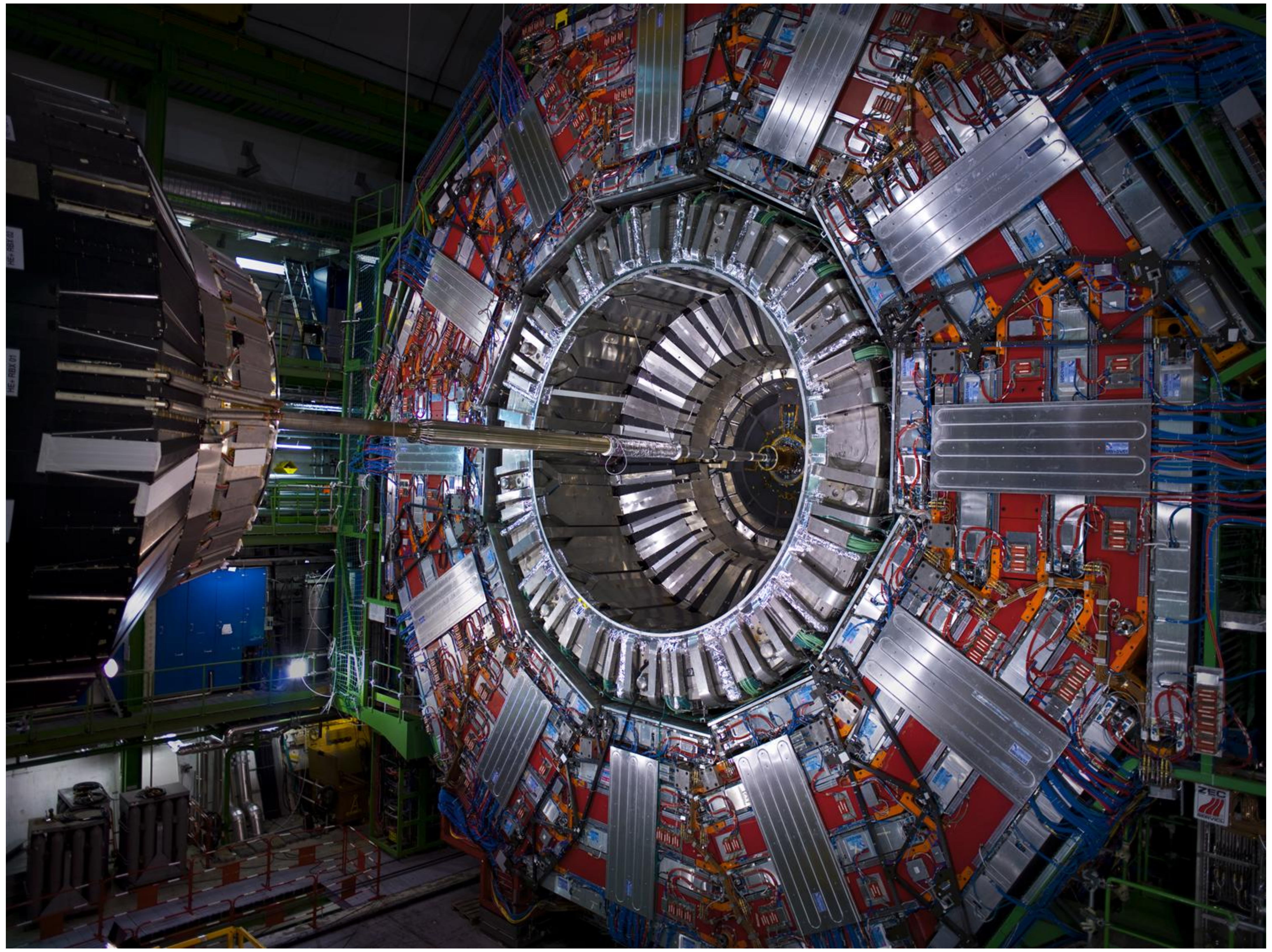


- ✓10x more collisions than LHC (14 TeV)
- ✓Study rare processes, improve precision, and discover new phenomena
- ✓Operational from ~2030 until 2041

The LHC Legacy

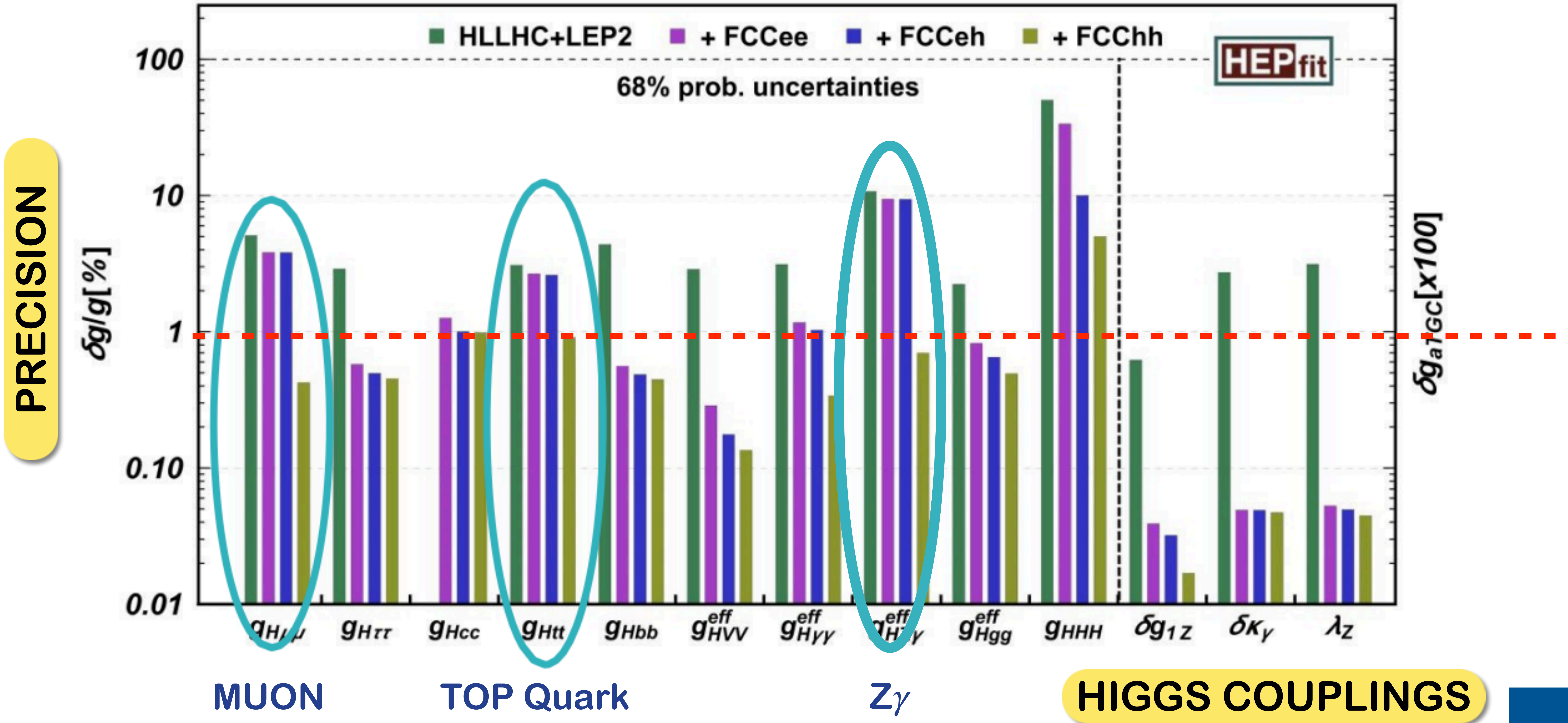
So far…

- SM confirmed to high accuracy up to the TeV
- Higgs boson discovered at the SM predicted** mass
  - **by precision EWK measurements from LEP
- No hints of new physics:
  - Traditional models under siege
  - New approaches & strategies appearing



Understanding better the Higgs…and more

- HL-LHC will remain unmatched for measuring some Higgs coupling until a much higher energy machine will be available



*Phys. Rev. Lett. 132 (2024) 221802

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Why new colliders?

- Many open questions after HL-LHC: dark matter, matter–antimatter asymmetry, neutrino masses.
- Higgs couplings are deeply linked to the structure of our Universe.

FCC, an instrument to explore the unknown

New Physics beyond the Standard Model may be hidden anywhere

We need a very large and very fined grained experimental "net"

✓large enough to search everywhere
✓with a mesh fine enough not to let even the smallest anomalies escape

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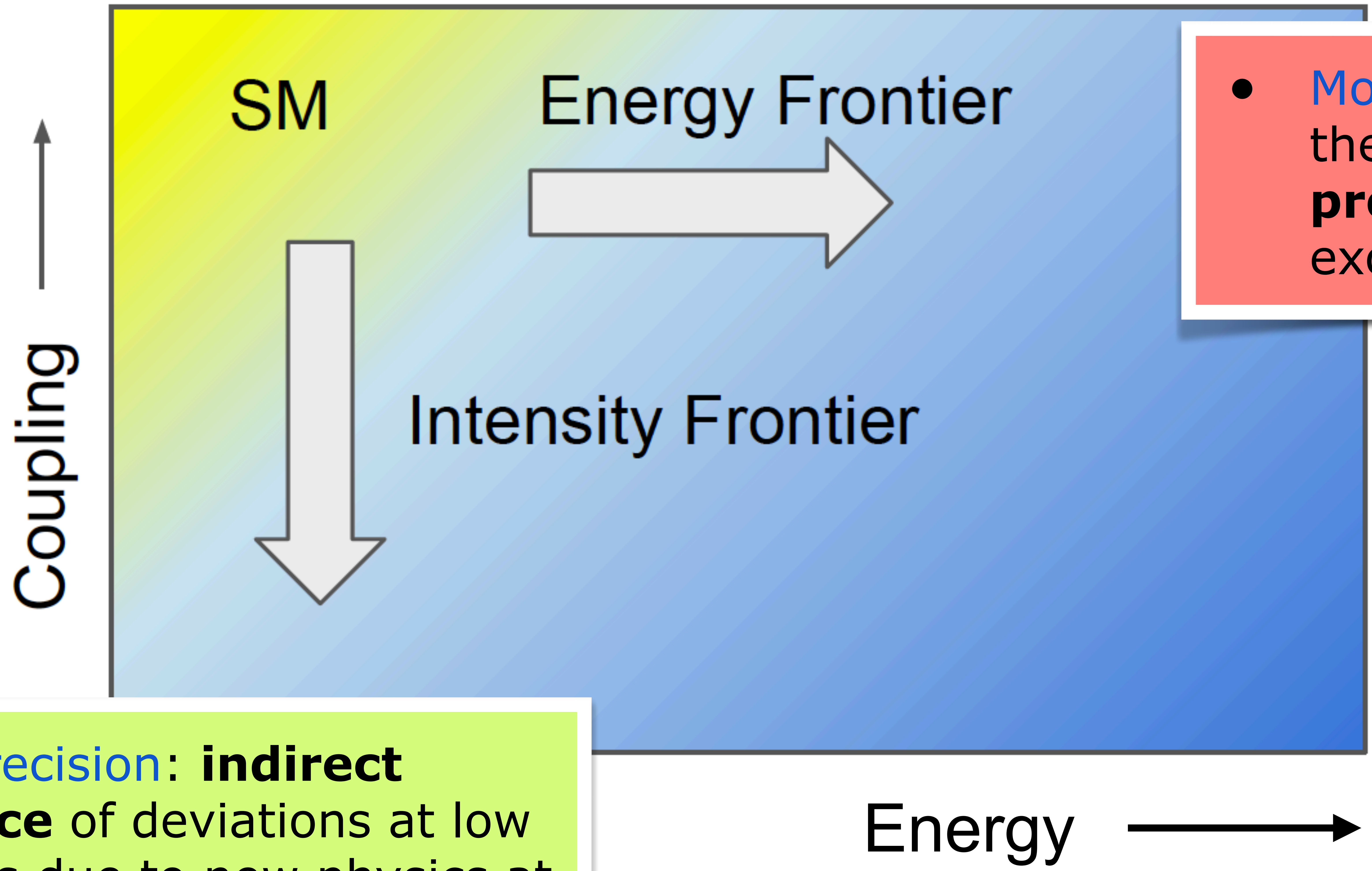
Pushing the frontiers of knowledge

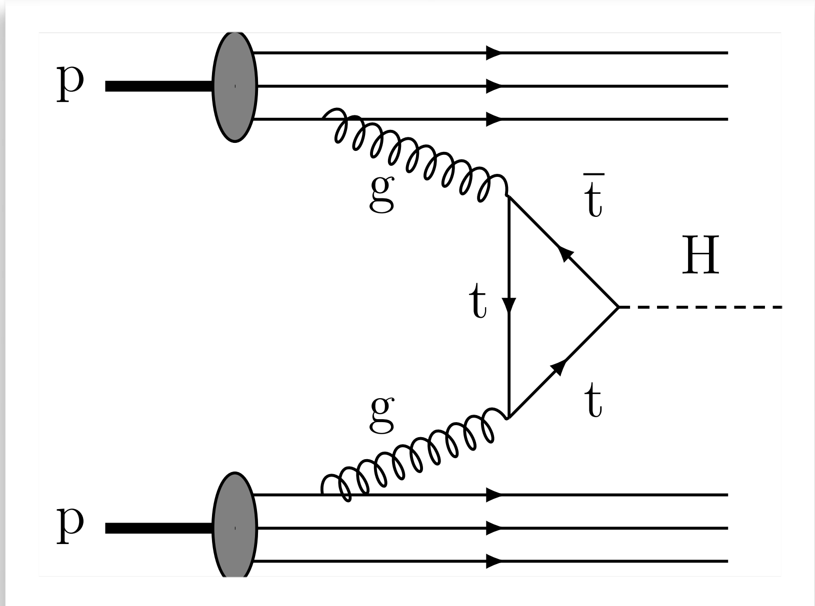
Intensity Frontier:
extreme resolution

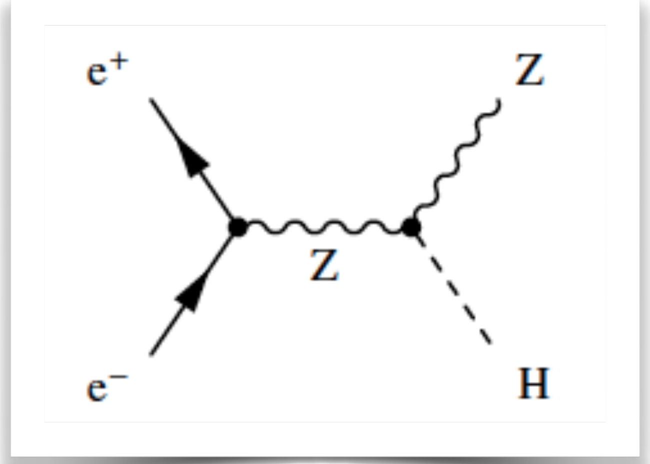
Energy Frontier:
exploring deeper scales

A combined solution



- More energy: to have the possibility to **produce** new heavy exotic particles



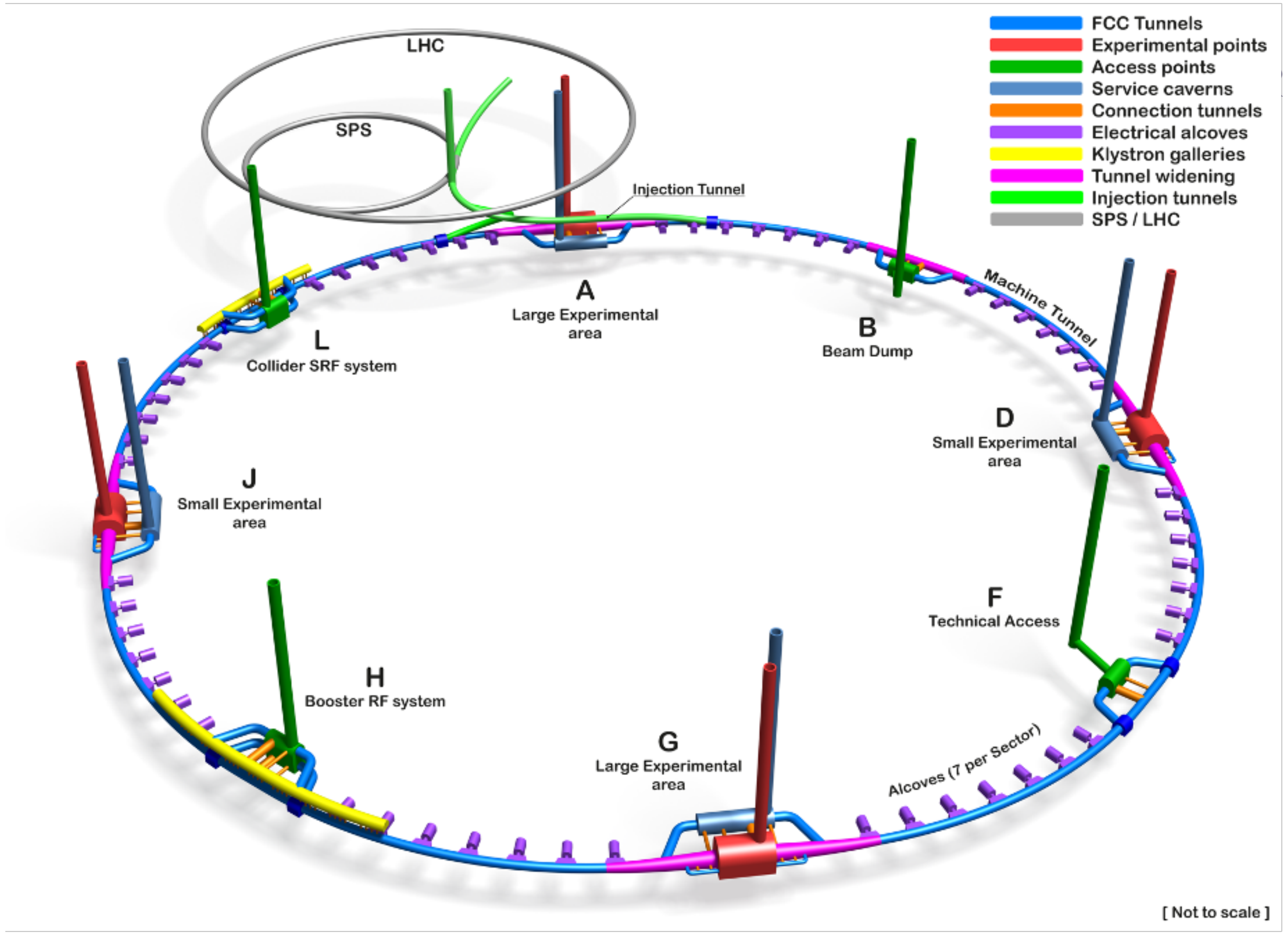


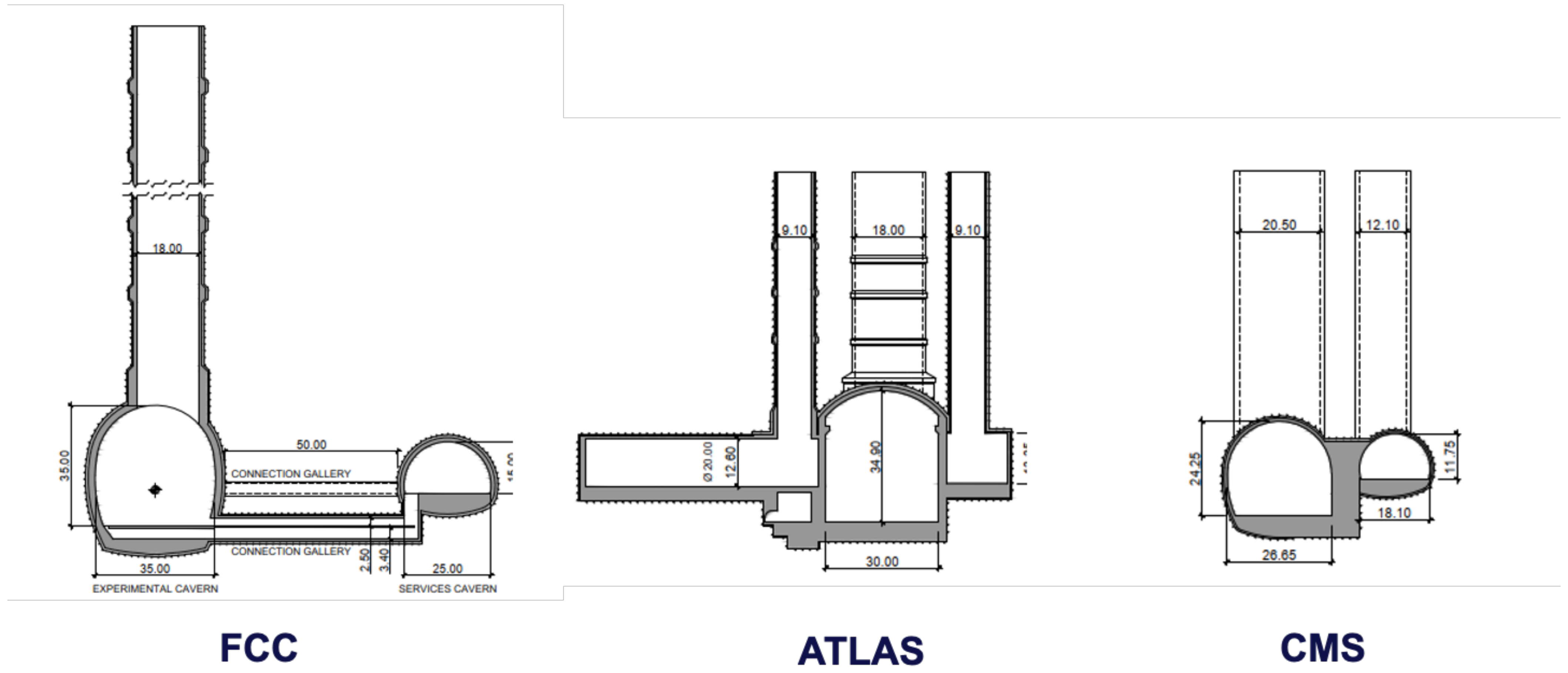
- More precision: **indirect evidence** of deviations at low energies due to new physics at much higher scales

Strength

In shared infrastructure

- **Phase 1: FCC-ee (Z, W, H, $t\bar{t}$): Higgs, electroweak & top factory with very large luminosity**
- **Phase 2: FCC-hh (~100 TeV) natural continuation toward the energy frontier with collisions of protons and heavy ions**
- Making use of the current acceleration chain
- Using one tunnel (and one set of caverns) for both stages
  - Following LEP-LHC model
  - 90.7 km ring, 8 surface points



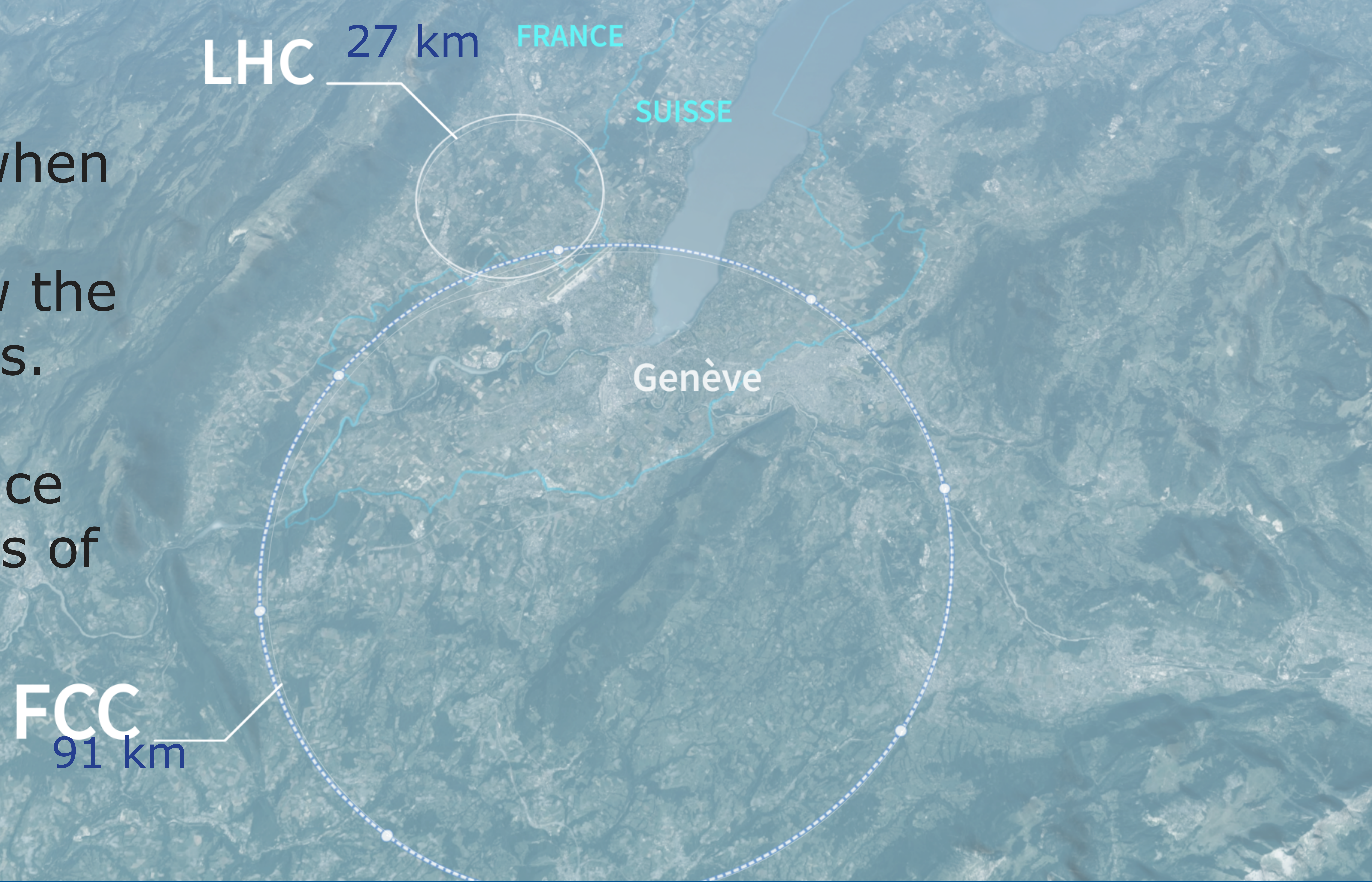


- **4 Experimental areas** 2 large (> ATLAS) & 2 small (~CMS)
- Deepest shaft: 400m
- Average shaft depth: 243m

Why FCC must be so large?

Electrons lose energy when turning. A larger ring reduces losses, to allow the reach of higher energies.

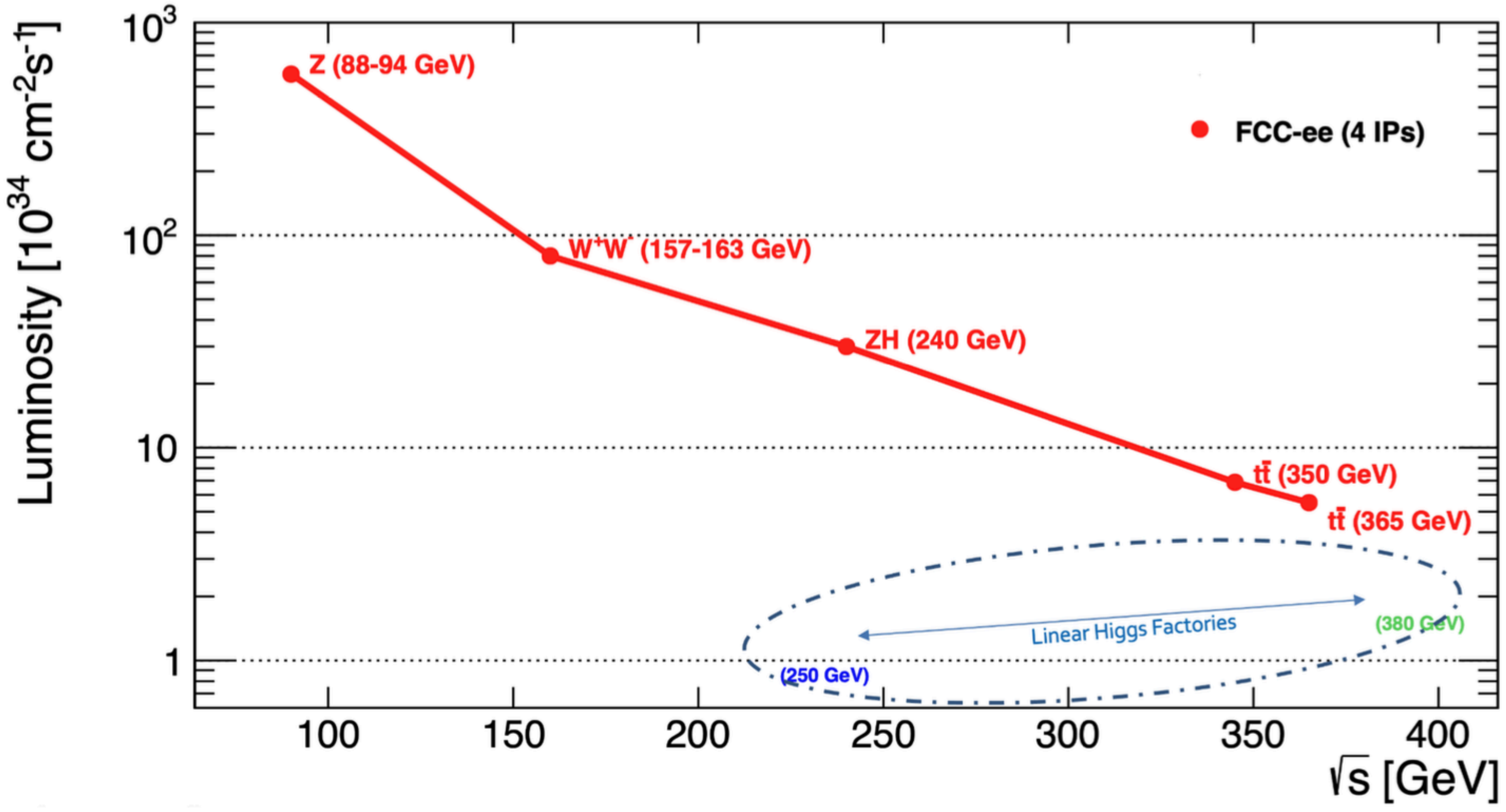
FCC-ee is able to produce all the heaviest particles of the Standard Model
W, Z, Higgs, and Top



FCC: the 90.7 km tunnel design

FCC-ee – Exploring the invisibile

FCC-ee like a high-precision microscope to study the Higgs and the Standard Model



Able to produce all the heaviest particle of the Standard Model (W,Z,H t)

2045 — FCC-ee (Phase 1) — 2060 — FCC-hh (Phase 2) — 2100

FCC-ee basic design choices and performance

Combining concepts from past and present lepton colliders

- **Double ring e^+e^- collider**
- **Synchrotron radiation power 50 MW/beam at all beam energies.** $\Delta E/\text{turn} \sim \gamma^4/\rho = (E/m_0)^4/\rho$
- **Asymmetric IR layout and optics to limit synchrotron radiation** towards the detector and to provide large **horizontal crossing angle 30 mrad** for crab-waist collision optics, demonstrated at DAFNE (Italy) and SuperKEKB (Japan)
- **Top-up injection scheme as at modern light sources** and as at recent e+e- colliders, PEP-II (USA), KEKB & SuperKEKB (Japan), BEPCII (China), requires booster synchrotron in collider tunnel

Giant step in efficiency:
→10^4–10^5x luminosity/el.energy of LEP
→ more sustainable physics

Stage 1: e+e- collider FCC-ee

FUTURE CIRCULAR COLLIDER

Consolidated main parameters

Never produced before at a lepton collider!

parameter	Z	WW	H (ZH)	Top
beam energy [GeV]	45.6	80	120	182.5
synchrotron radiation/beam [MW]	50	50	50	50
beam current [mA]	1294	135	26.8	5.1
number bunches / beam	11200	1852	300	64
total RF voltage 400/800 MHz [GV]	0.08 / 0	1.0 / 0	2.09 / 0	2.1 / 9.2
luminosity / IP [10^{34} $cm^{-2}s^{-1}$]	145	20	7.5	1.4
total integrated luminosity / IP / year [ab^{-1} / yr]	17	2.4	0.9	0.17
beam lifetime [min]	21	13	9	10
	4 years 6×10^{12} Z LEP x 10^5	**2 years** > 10^8 WW LEP x 10^4	**3 years** > 2×10^6 H	**5 years** 2×10^6 tt pairs

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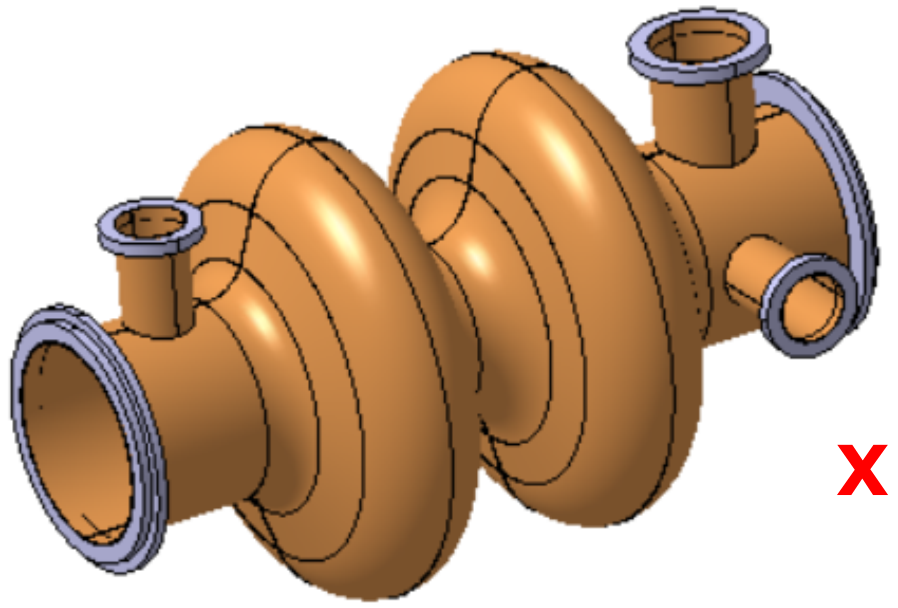
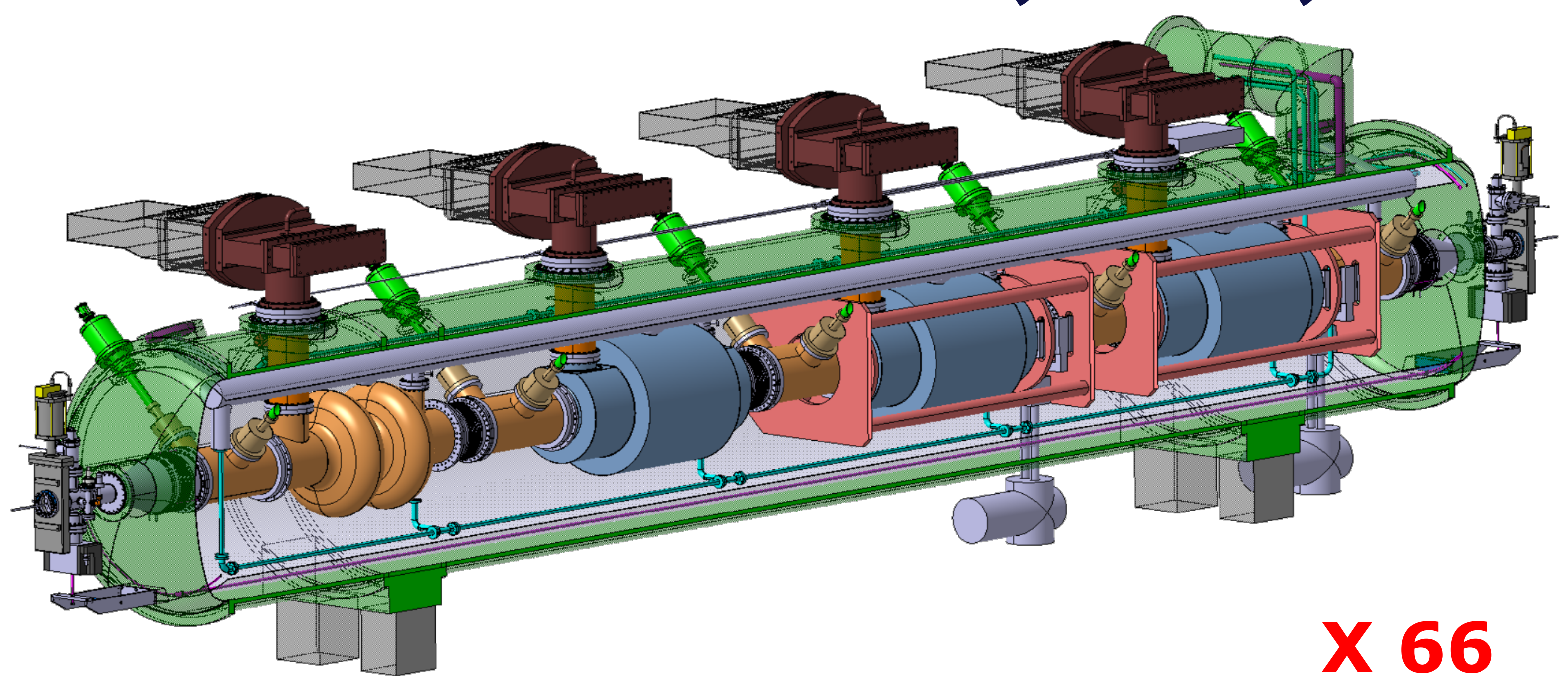
I. Syratchev

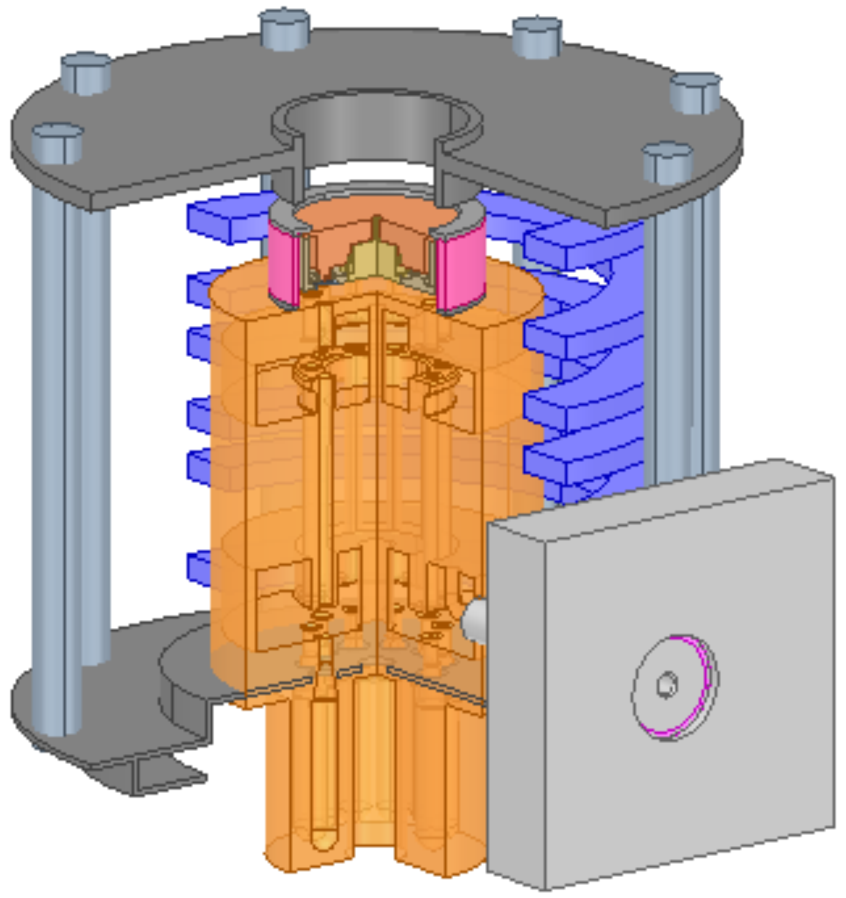
400 MHz RF system – collider Z, W, ZH



X 264



X 66



X 264

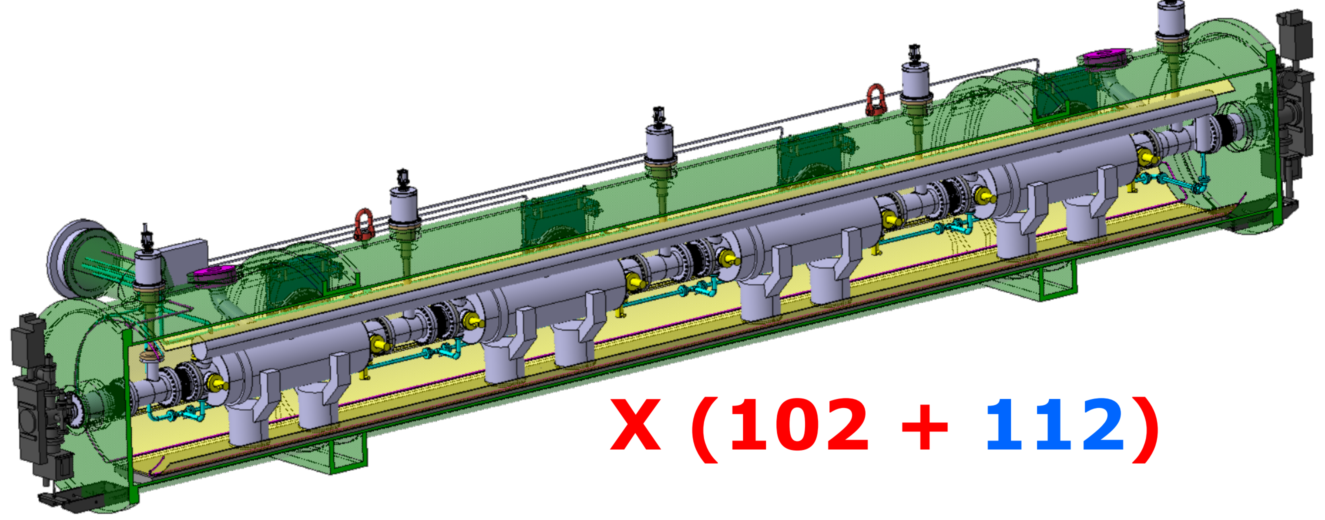
SC elliptical cavity
- 400 MHz, 2-cell,1.5 m. long
- Electropolished & seamless RF surface
- Niobium thin film with HiPIMS

Cryomodule
- Segmented design, 4 cavities
- Vertical FPC, HOM damping & extr.
- Frequency tuning system
- Thermal and magnetic shielding

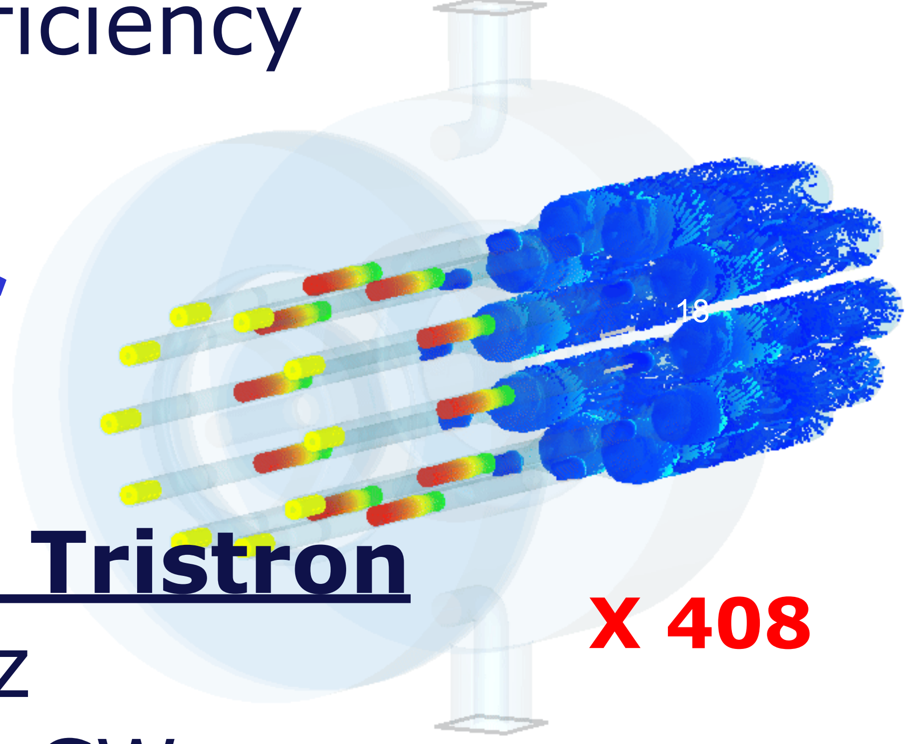
Multibeam Tristron
- **400 MHz**
- 46 kV, 500 kW, CW
- ~ 90% efficiency

800 MHz RF system – for $t\bar{t}$ collider and booster

X (408 + 448)



X (102 + 112)



X 408

X 448

SC elliptical cavity
- 800 MHz, 6-cell
- Nb_3Sn if R&D is successful

Cryomodule
- Segmented design, 4 cavities, 2 K
- Operation at 4.5 K if R&D successful

Multibeam Tristron
- 800 MHz
- 250 kW, CW

Solid State Amplifier (SSA)
- 800 MHz
- 10-15 kW pulsed

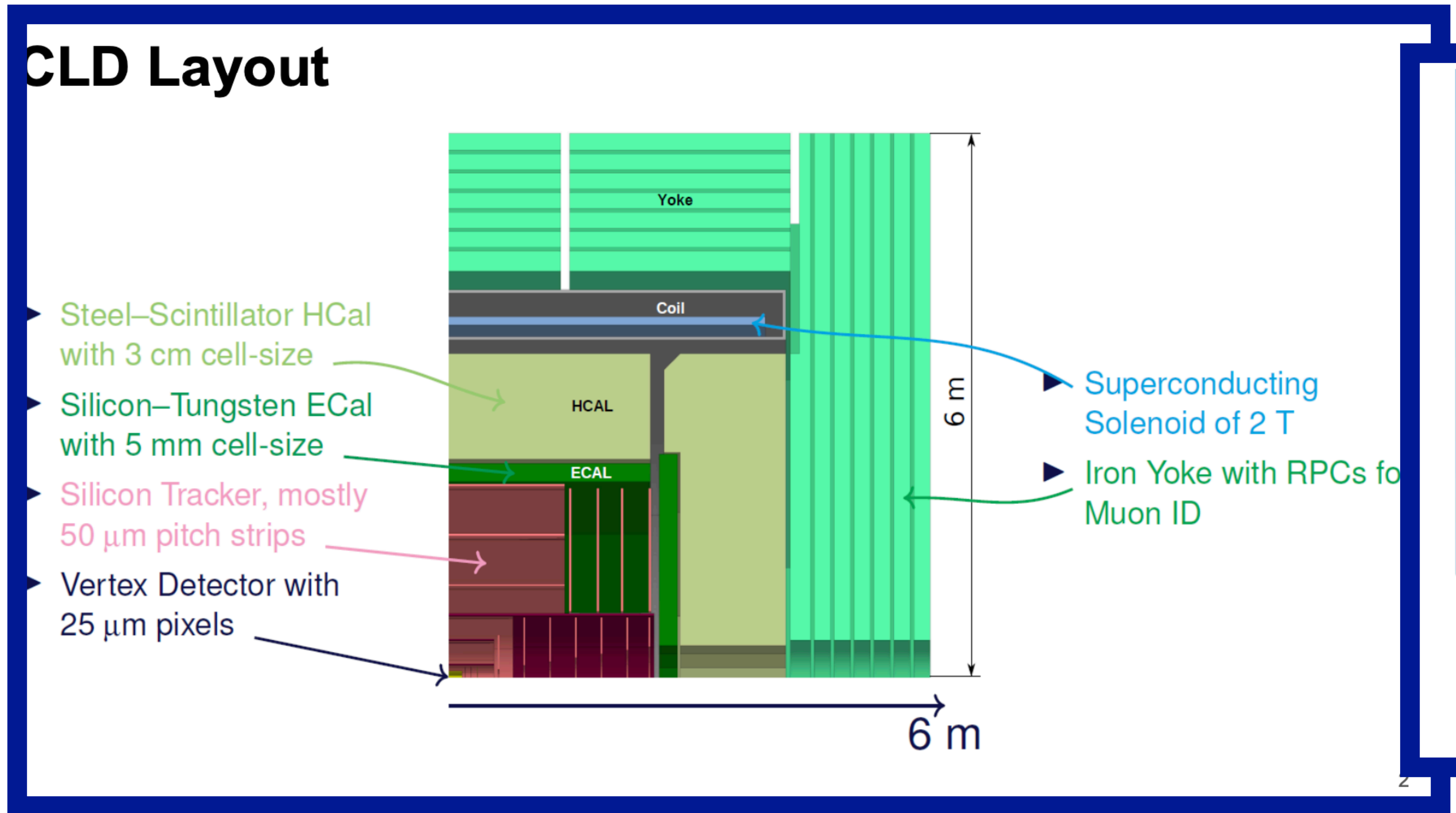
A. Butterworth

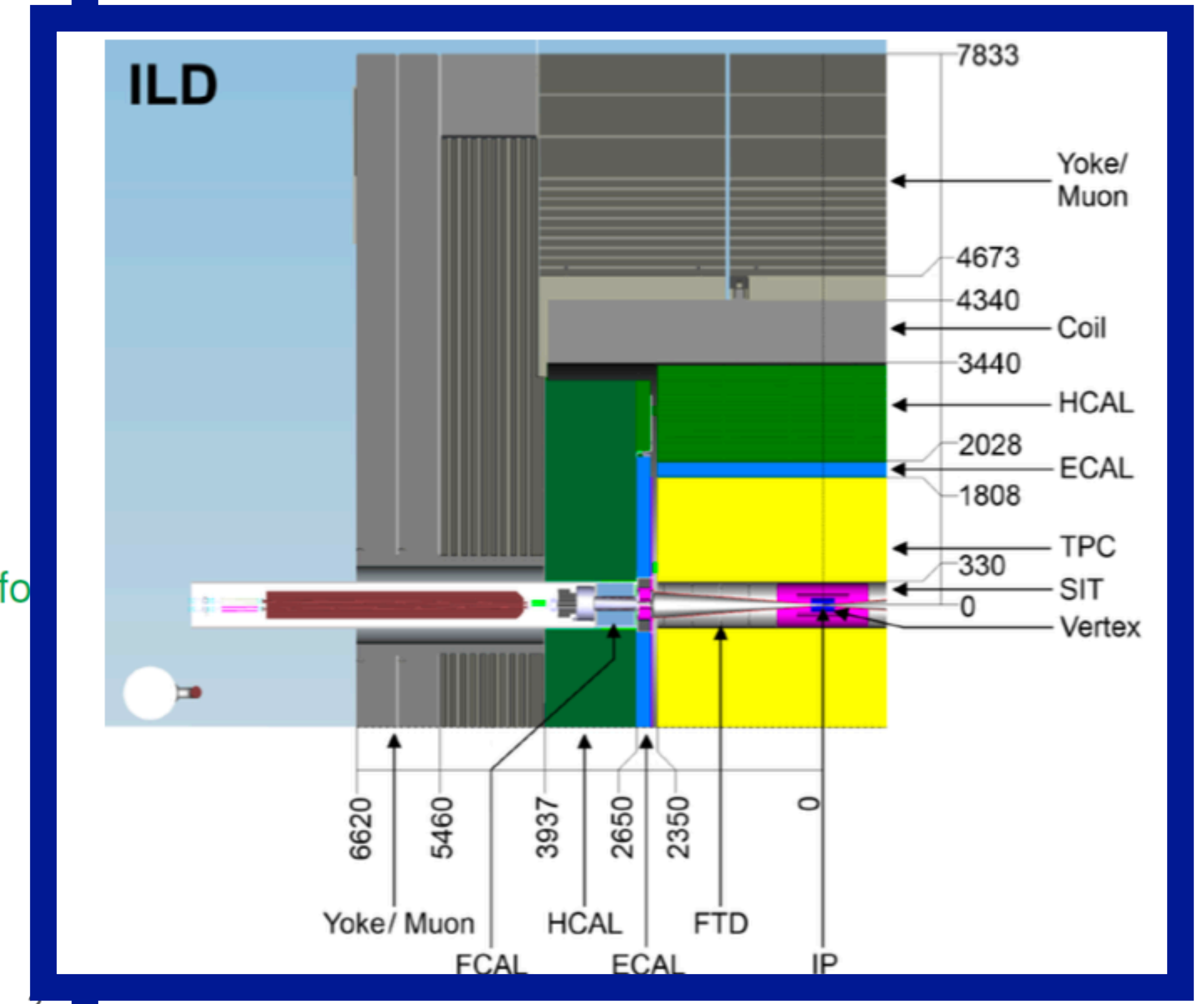
Flexible collider program

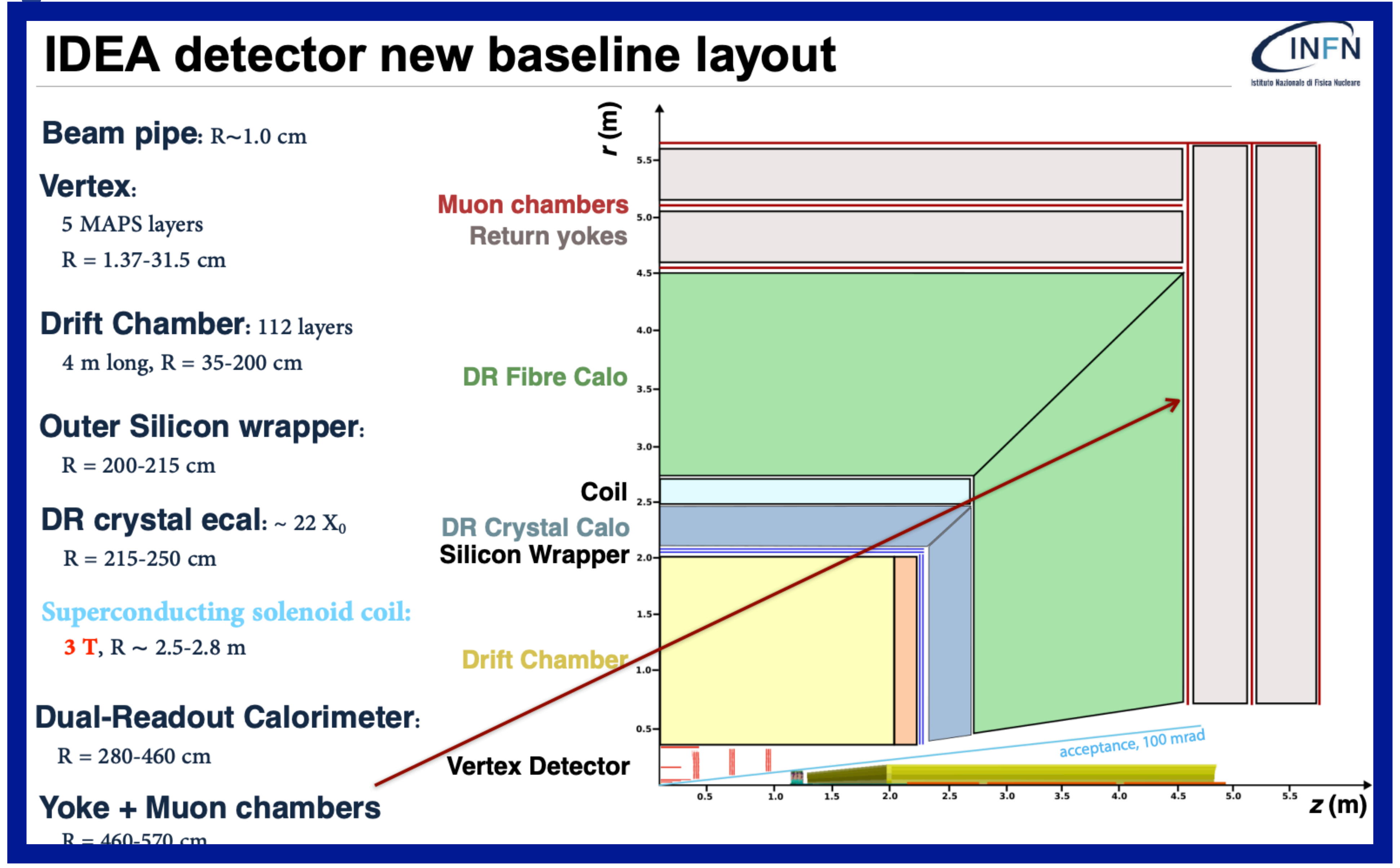
- **Opportunities** beyond the baseline plan (√s below Z, 125GeV, 217GeV; larger integrated lumi…)
- **Opportunities** to exploit FCC facility differently (to be studied more carefully):
  - using the electrons from the injectors for beam-dump experiments,
  - extracting electron beams from the booster,
  - reusing the synchrotron radiation photons.

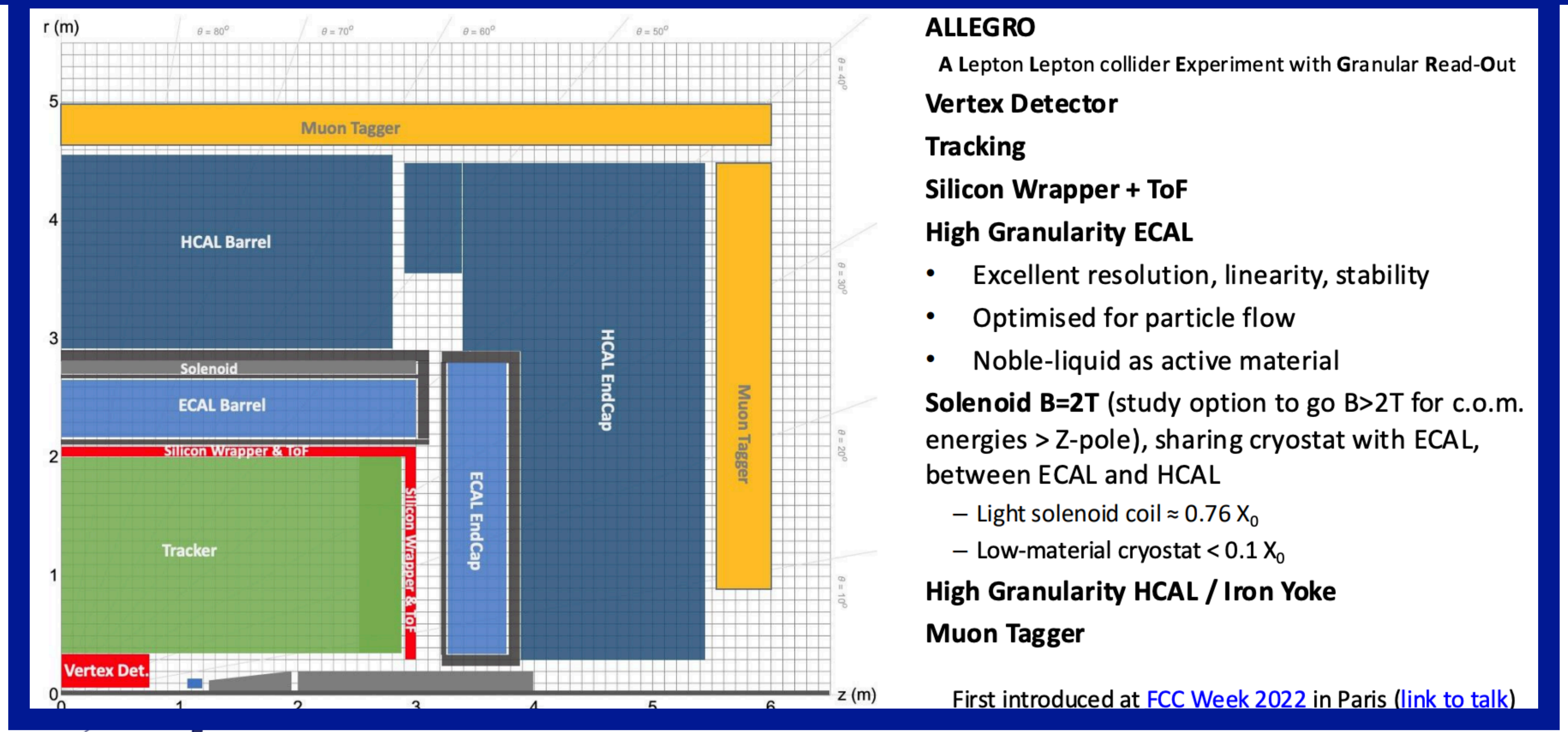
Preliminary detector concepts

4IPs to fill! more ideas being explored









- Detector requirements from Higgs physics are not the most stringent (vertex, calo res for PF)
- Much stronger, non trivial, requirements from physics at the Z pole (EWK prec., Flavor, BSM)

FCC-ee: lots of data for a very rich program

search for new particles with very weak interactions

Axion-like particles, dark photons,
Heavy Neutral Leptons
Long lifetimes - LLPs

FCC-ee

Higgs Physics

Top Physics

flavour factory
(10^{12} bb/cc; 1.7x10^{11} $\tau\tau$)

τ physics

B physics

Not only precision, but new discoveries possible!

Exhaustive Characterization of the Higgs

not yet observed

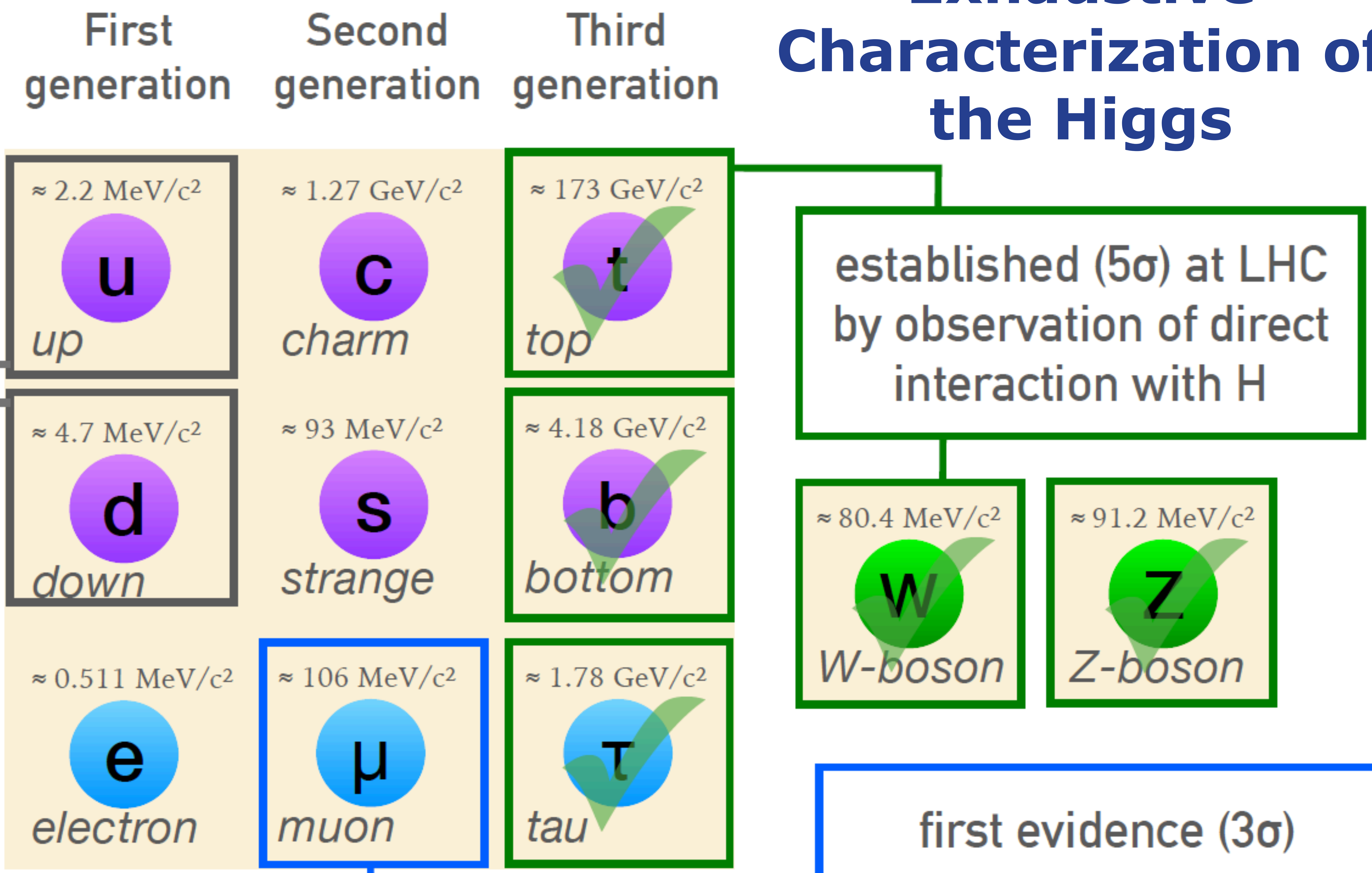
garanteed at FCC-ee

very difficult!

need new ideas!

considered impossible

maybe accessible at FCC-ee



first evidence (3σ)

to be conclusively established at the LHC within 3 – 10 years

Exhaustive Characterization of the Higgs
not yet observed
garanteed at FCC-ee
very difficult!
need new ideas!
considered impossible
maybe accessible at FCC-ee
First generation
Second generation
Third generation
≈ 2.2 MeV/c²
u
up
≈ 1.27 GeV/c²
c
charm
≈ 173 GeV/c²
t
top
≈ 4.7 MeV/c²
d
down
≈ 93 MeV/c²
s
strange
≈ 4.18 GeV/c²
b
bottom
≈ 0.511 MeV/c²
e
electron
≈ 106 MeV/c²
μ
muon
≈ 1.78 GeV/c²
τ
tau
established (5σ) at LHC by observation of direct interaction with H
≈ 80.4 MeV/c²
W
W-boson
≈ 91.2 MeV/c²
Z
Z-boson
first evidence (3σ)
to be conclusively established at the LHC within 3 – 10 years

Exhaustive Characterization of the Higgs

First generation | Second generation | Third generation

not yet observed

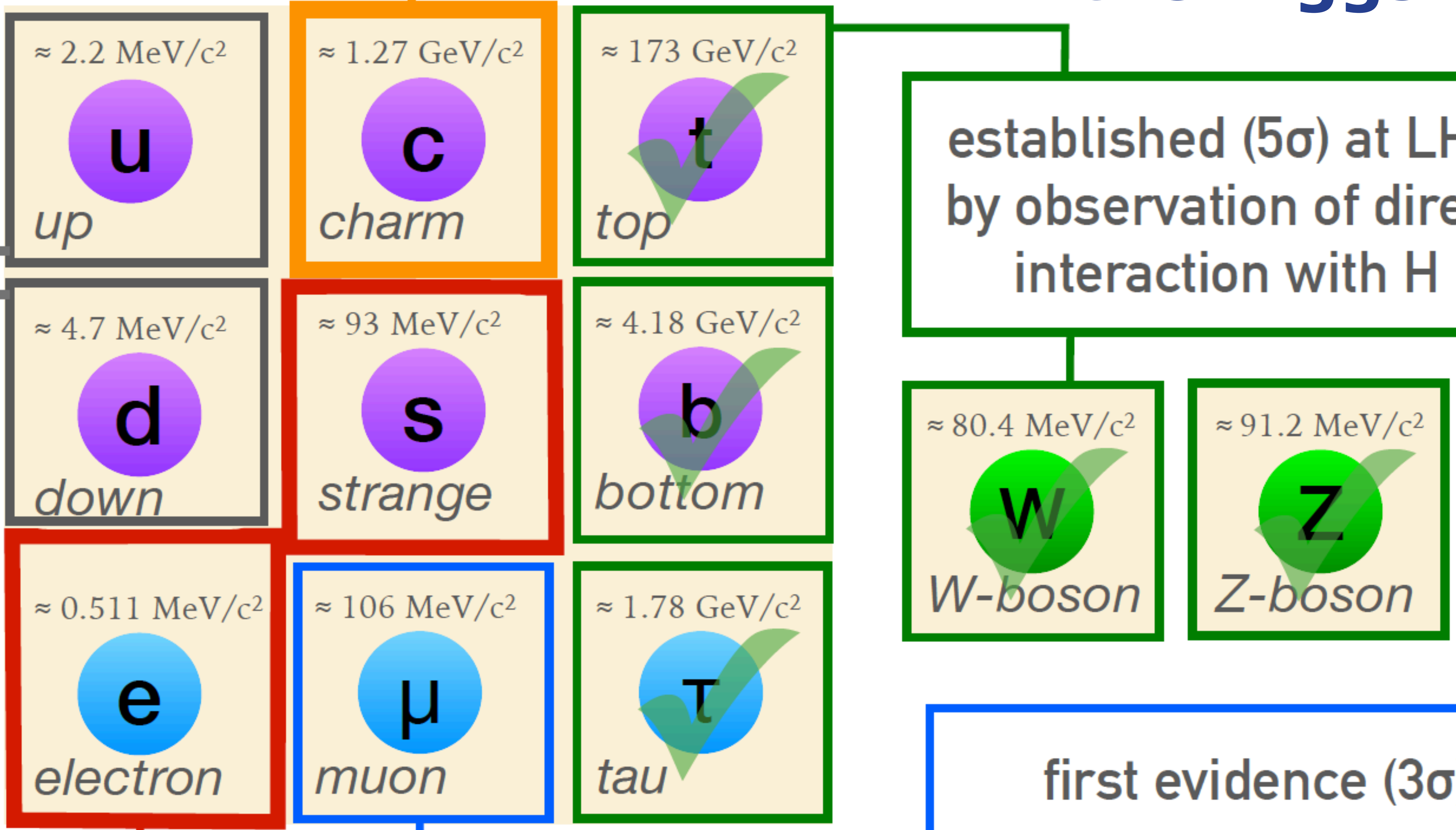
garanteed at FCC-ee

very difficult!

need new ideas!

considered impossible

maybe accessible at FCC-ee



established (5σ) at LHC by observation of direct interaction with H

first evidence (3σ)

to be conclusively established at the LHC within 3 – 10 years

Precise studies of Z, W, and Top

FUTURE CIRCULAR COLLIDER

arXiv:2106.13885

- Exquisite √s precision (100keV@Z, 300keV@WW)
- ~50 times better precision than LEP/SLD on EW precision observables
- Target: reduce systematic uncertainties to the level of statistical

Need TH results to fully exploit Tera-Z

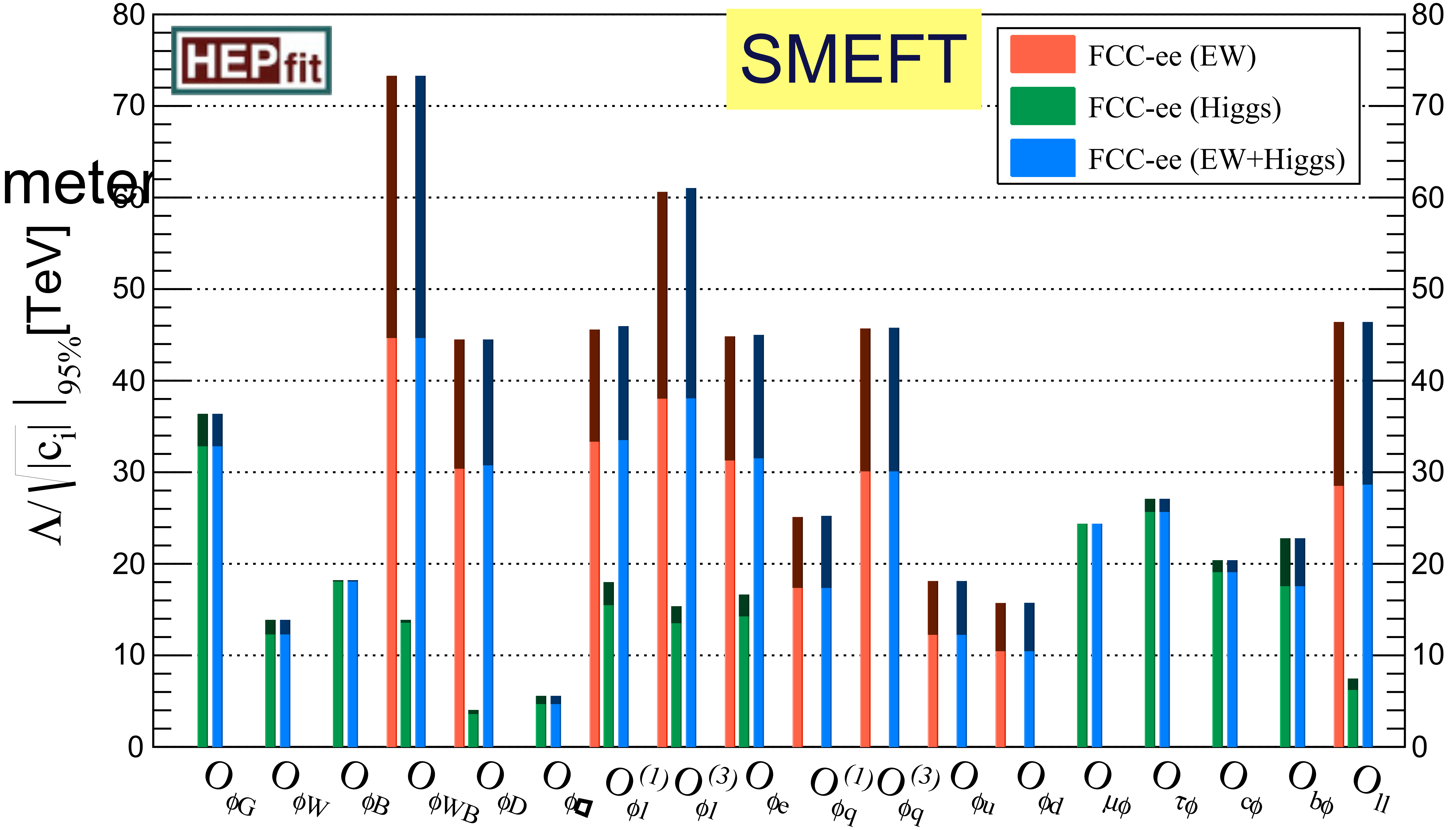
Quantity	Current precision	FCC-ee stat. (syst.) precision	Required theory input	Available calc. in 2019	Needed theory improvement†
m_Z Γ_Z $\sin^2\theta^\ell_{\rm eff}$	2.1 MeV 2.3 MeV 1.6×10^{-4}	0.004 (0.1) MeV 0.004 (0.025) MeV $2(2.4)\times10^{-6}$	non-resonant $e^+e^-\to f\bar{f}$, initial-state radiation (ISR)	NLO, ISR logarithms up to 6th order	NNLO for $e^+e^-\to f\bar{f}$
m_W	12 MeV	0.25 (0.3) MeV	lineshape of $e^+e^-\to WW$ near threshold	NLO ($ee\to 4f$ or EFT frame-work)	NNLO for $ee\to WW$, $W\to f\bar{f}$ in EFT setup
HZZ coupling	—	0.2%	cross-sect. for $e^+e^-\to ZH$	NLO + NNLO QCD	NNLO electroweak
$m_{\rm top}$	100 MeV	17 MeV	threshold scan $e^+e^-\to t\bar{t}$	N^{3}LO QCD, NNLO EW, resummations up to NNLL	Matching fixed orders with resummations, merging with MC, α_s (input)

†The listed needed theory calculations constitute a minimum baseline; additional partial higher-order contributions may also be required.

Precision: indirect effects of New Physics

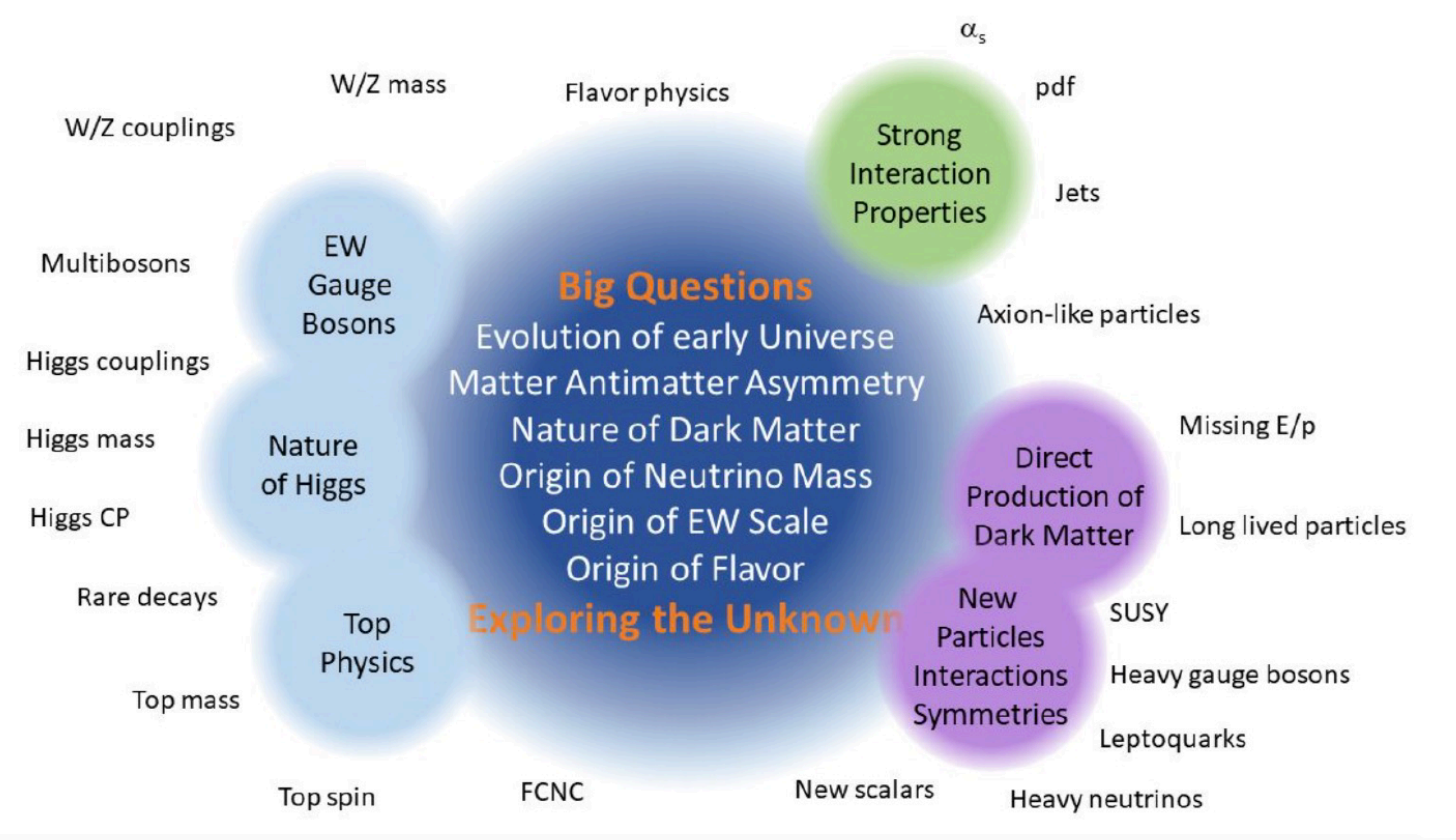
Indirect sensitivity to 70 TeV scale sector from precision EWK/Higgs

• parameter



FCC-ee is a compass that points toward the physics to be explored with FCC-hh

FCC-hh – Esploring the unknown at high energies



FCC-hh a telescope to look far and answer the remaining open questions

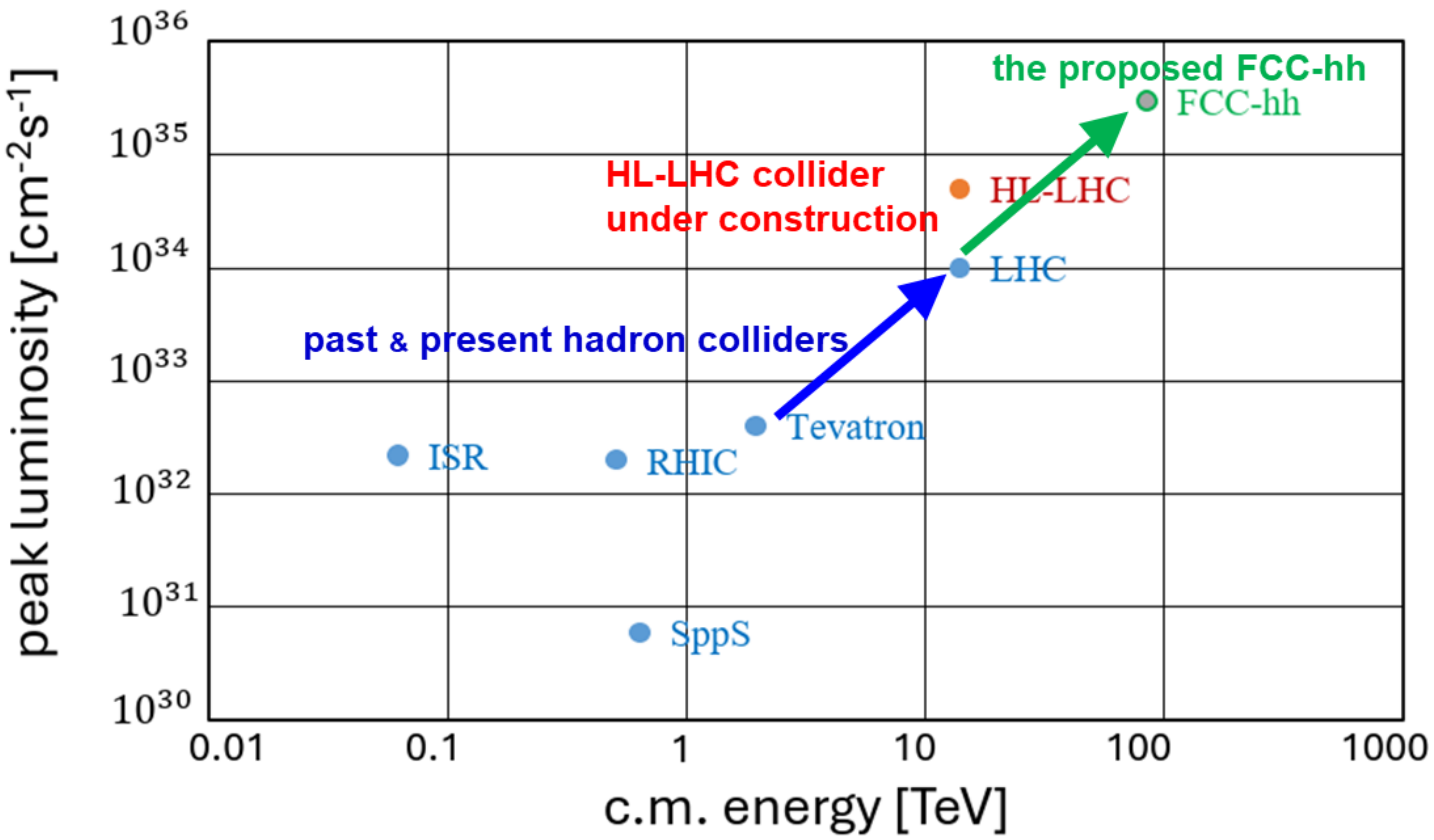
Hadron collisions at a center of mass of ~10TeV

2045	FCC-ee (Phase 1)	2060	FCC-hh (Phase 2)	2100

FCC-hh: highest collision energies

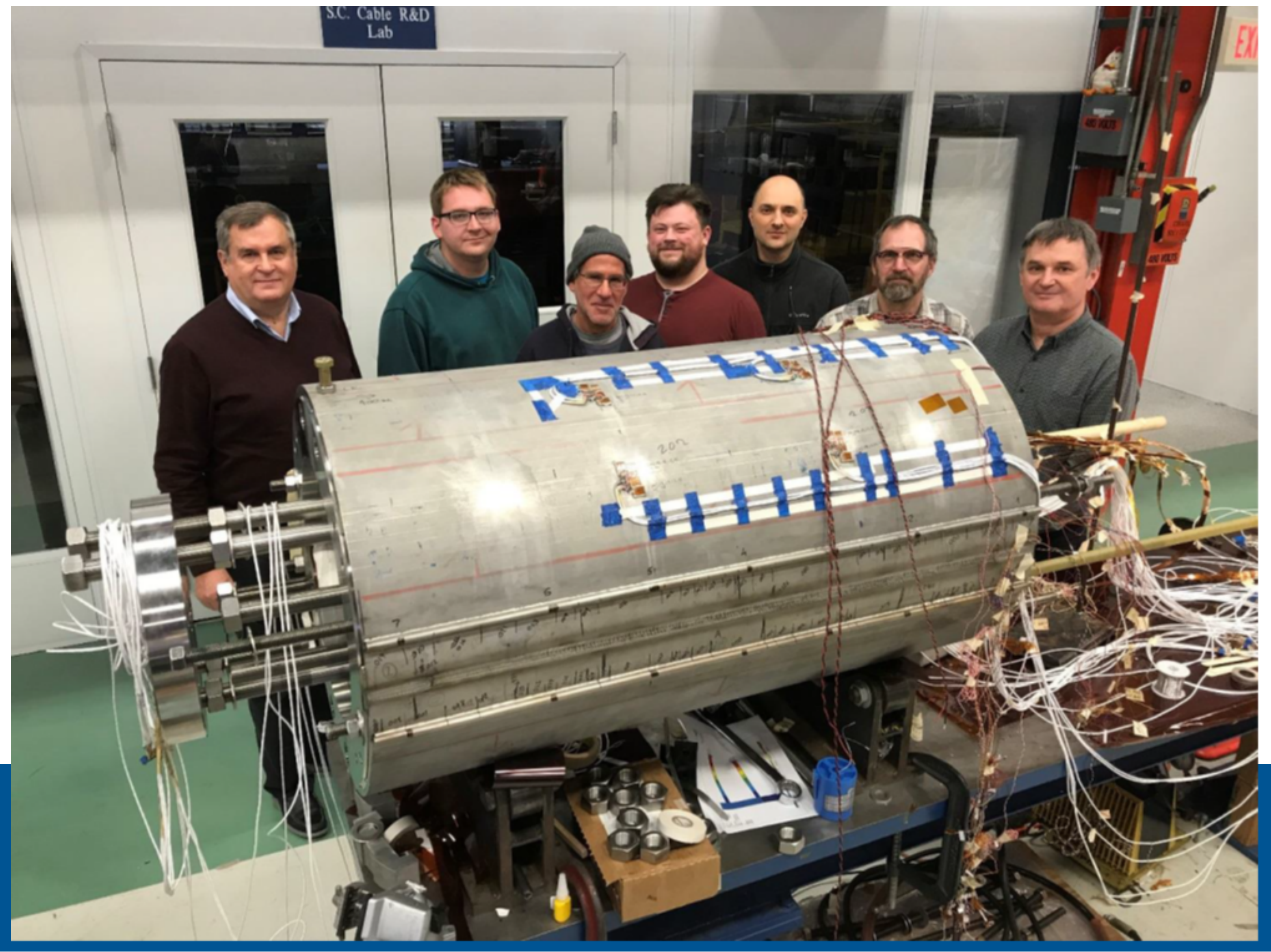
FUTURE CIRCULAR COLLIDER

- **order of magnitude performance increase** in both **energy & luminosity**
- **20 ab-1 per experiment collected over 25 years** of operation (vs 3 ab^{-1} for LHC)
- similar performance increase as from Tevatron to LHC
- **key technology: high-field magnets**



from
LHC technology
8.3 T NbTi dipole

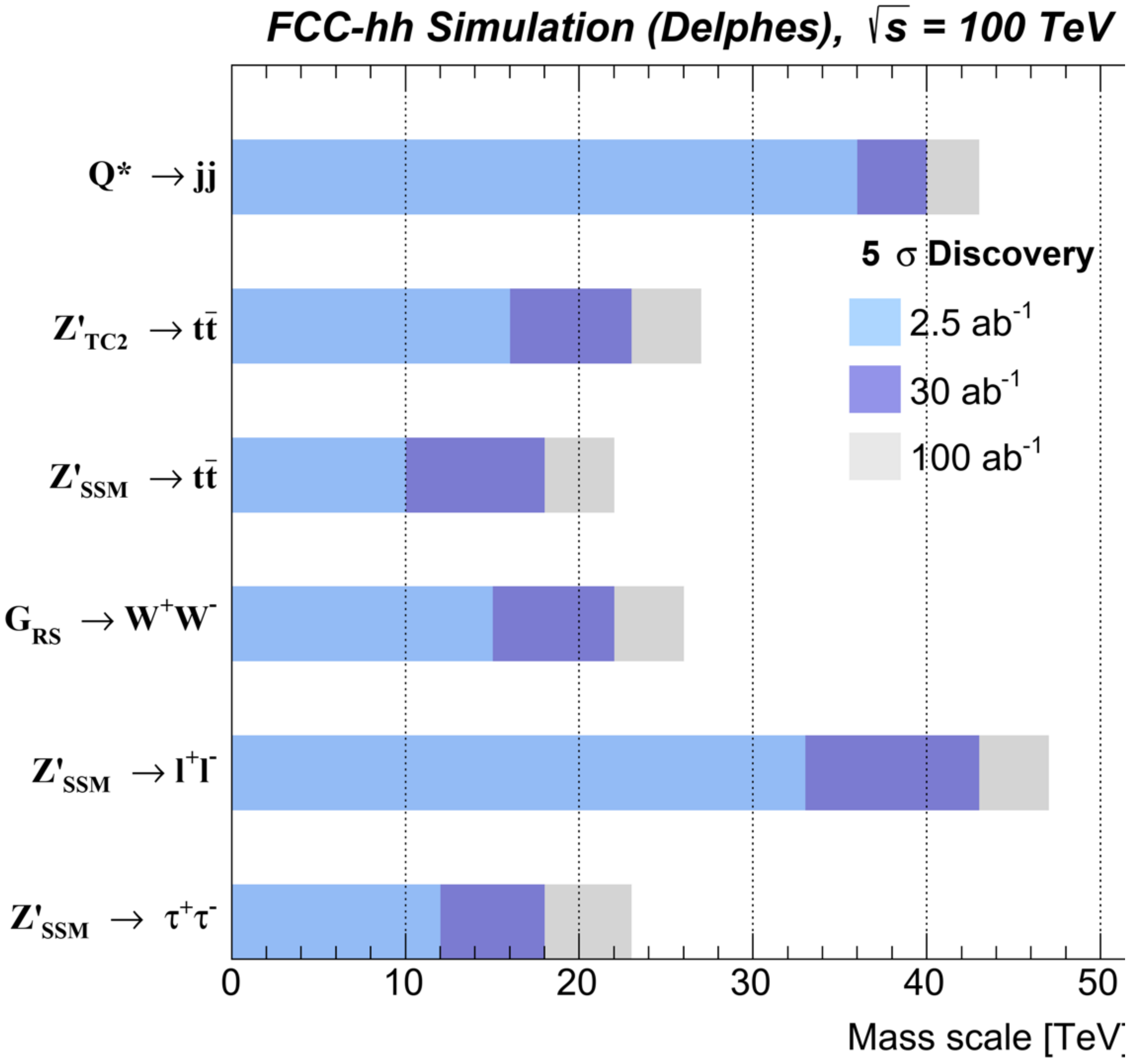
via
HL-LHC technology
12 T Nb_3Sn quadrupole



FNAL dipole demonstrator 4-layer cosϑ 14.5 T Nb_3Sn in 2019

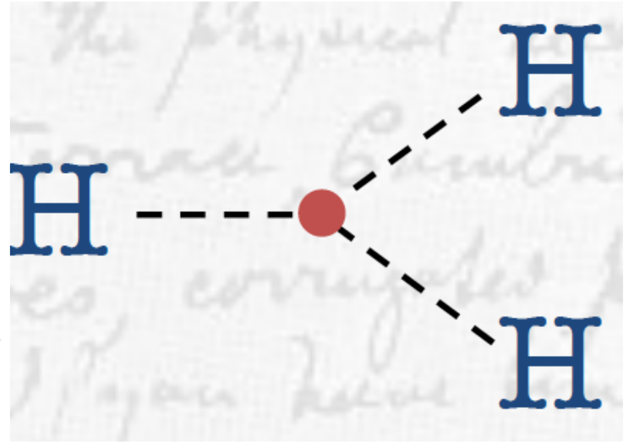
FCC-hh Direct discovery potential

- Higher parton centre-of-mass energy ➡ high mass reach:
  - Strongly coupled new particles, new gauge bosons (Z’, W’), excited quarks: up to 40 TeV!
  - Extra Higgs bosons: up to 5-20 TeV
  - High sensitivity to high energy phenomena, e.g., WW scattering, DY up to 15 TeV

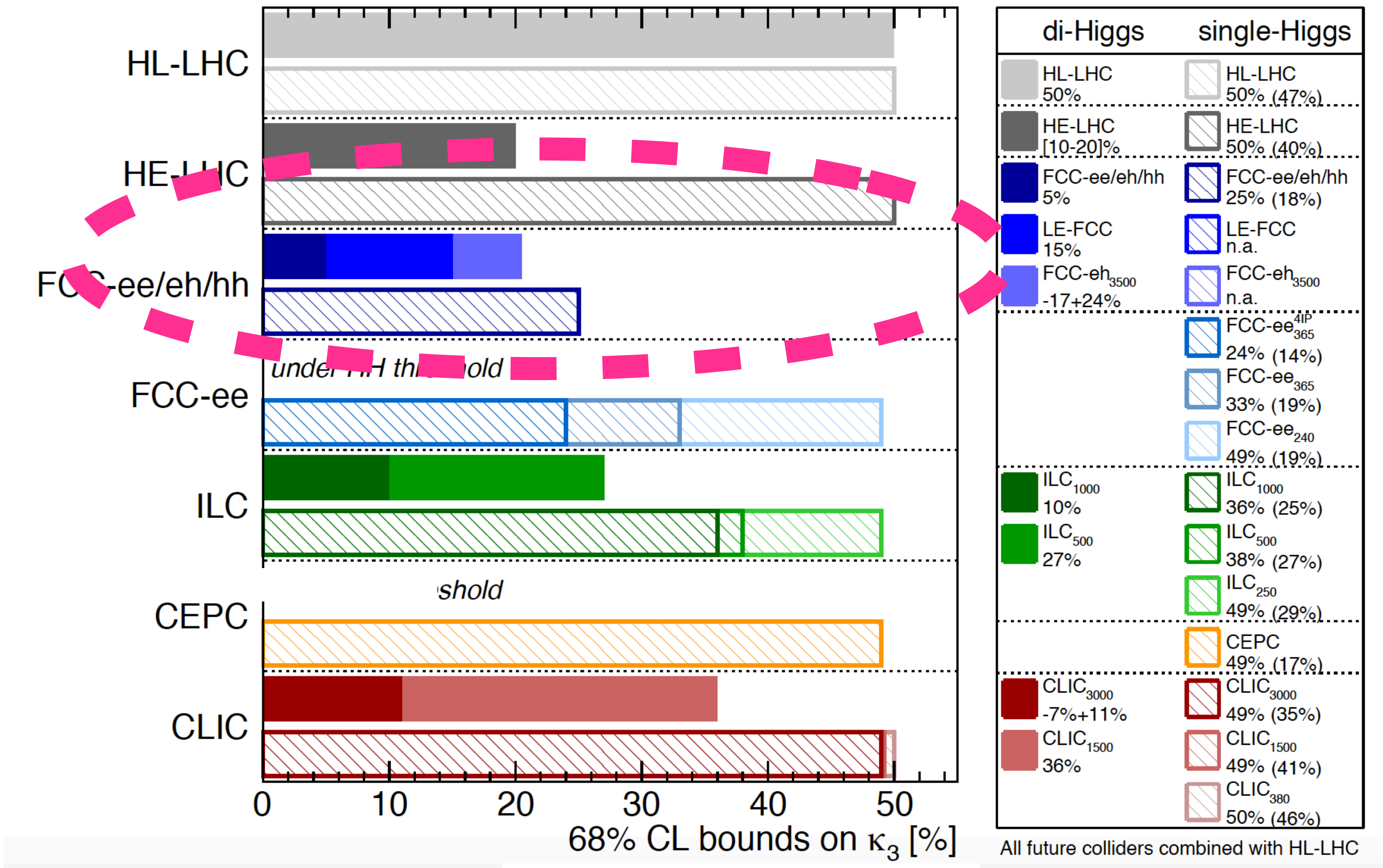


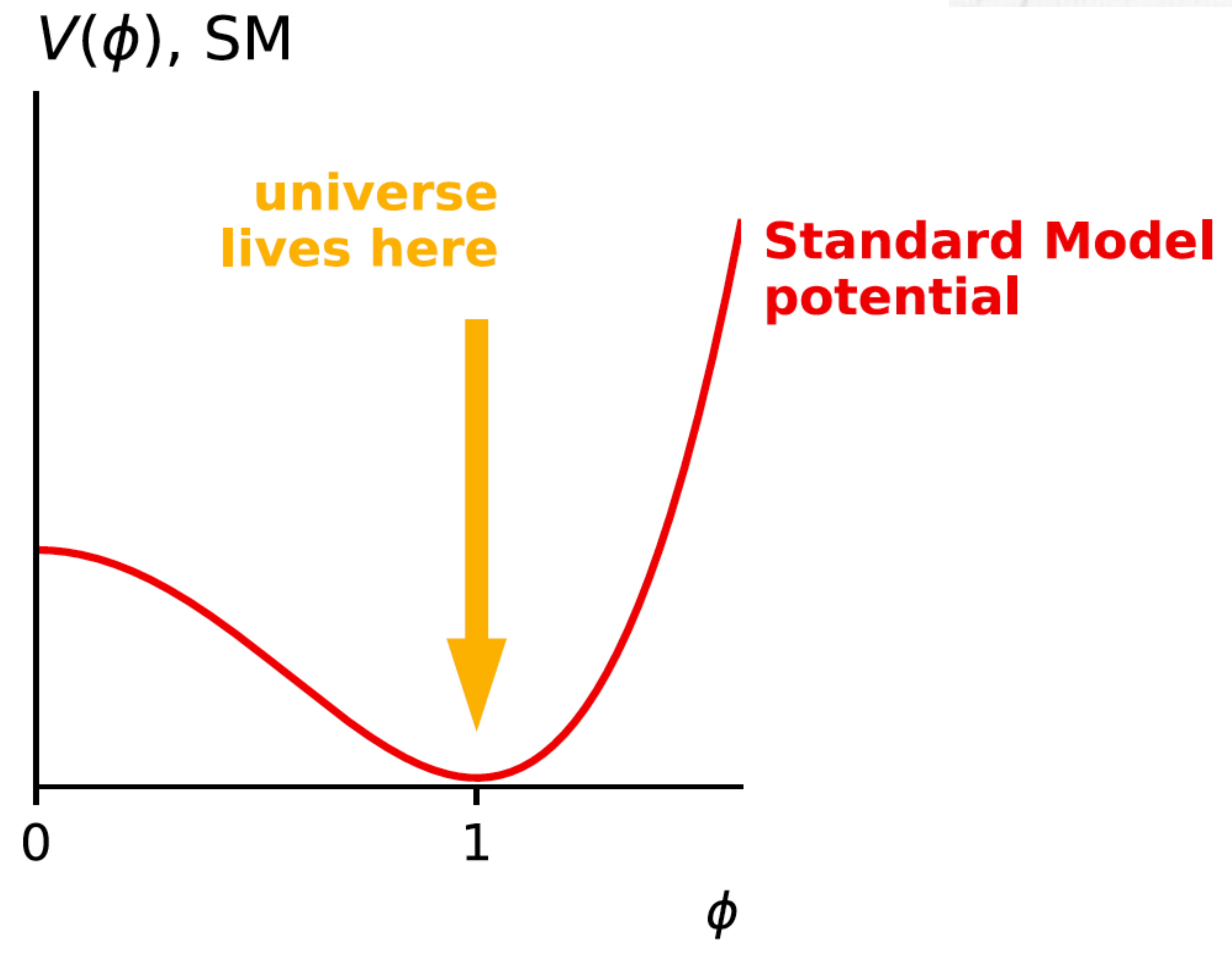
about x6 LHC mass reach at high mass, well matched to reveal the origin of deviations indirectly detected at the FCC-ee

Study the nature of the Higgs potential



FCC integrated program will measure λ_3 at 5%





G. Salam

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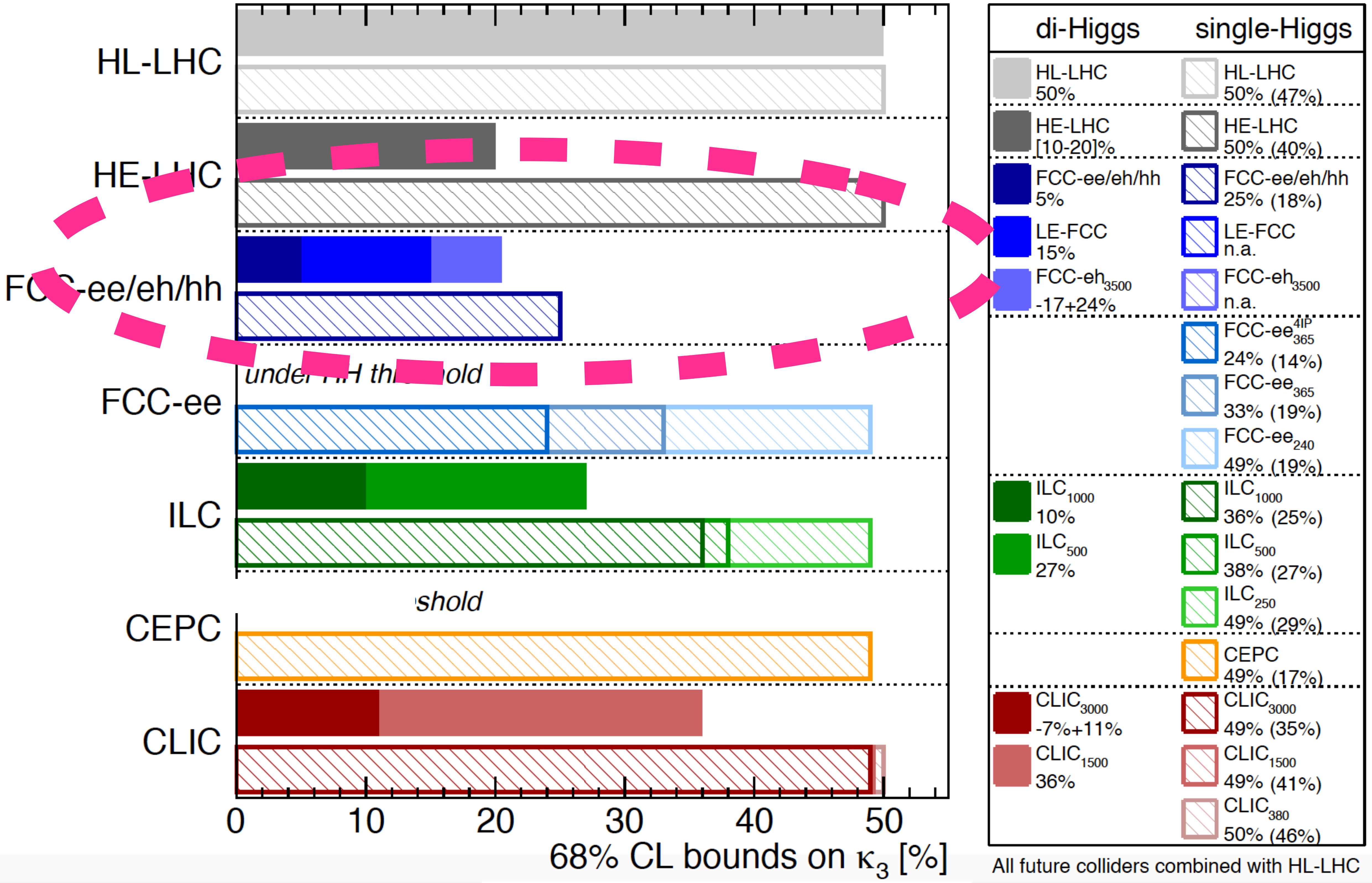

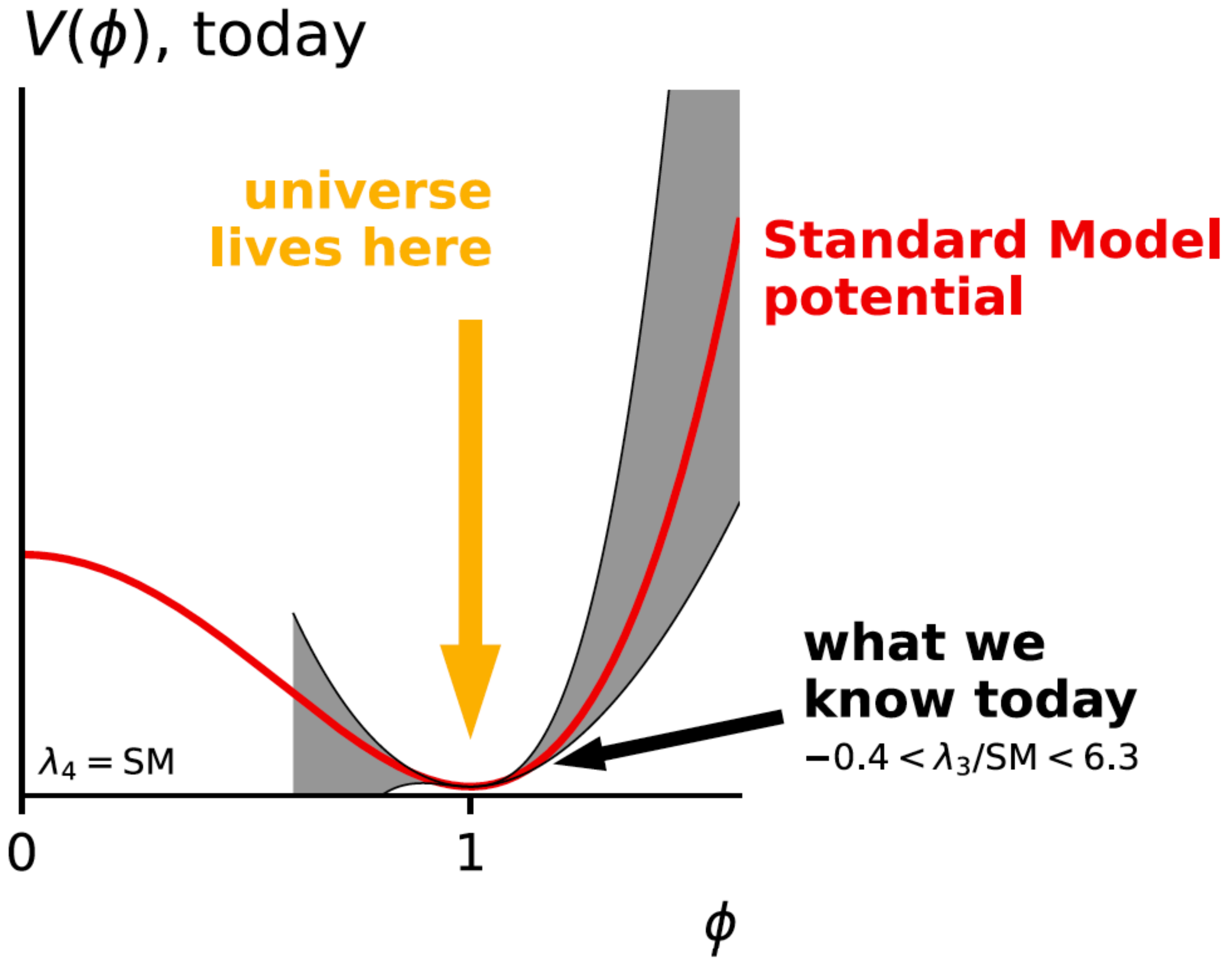

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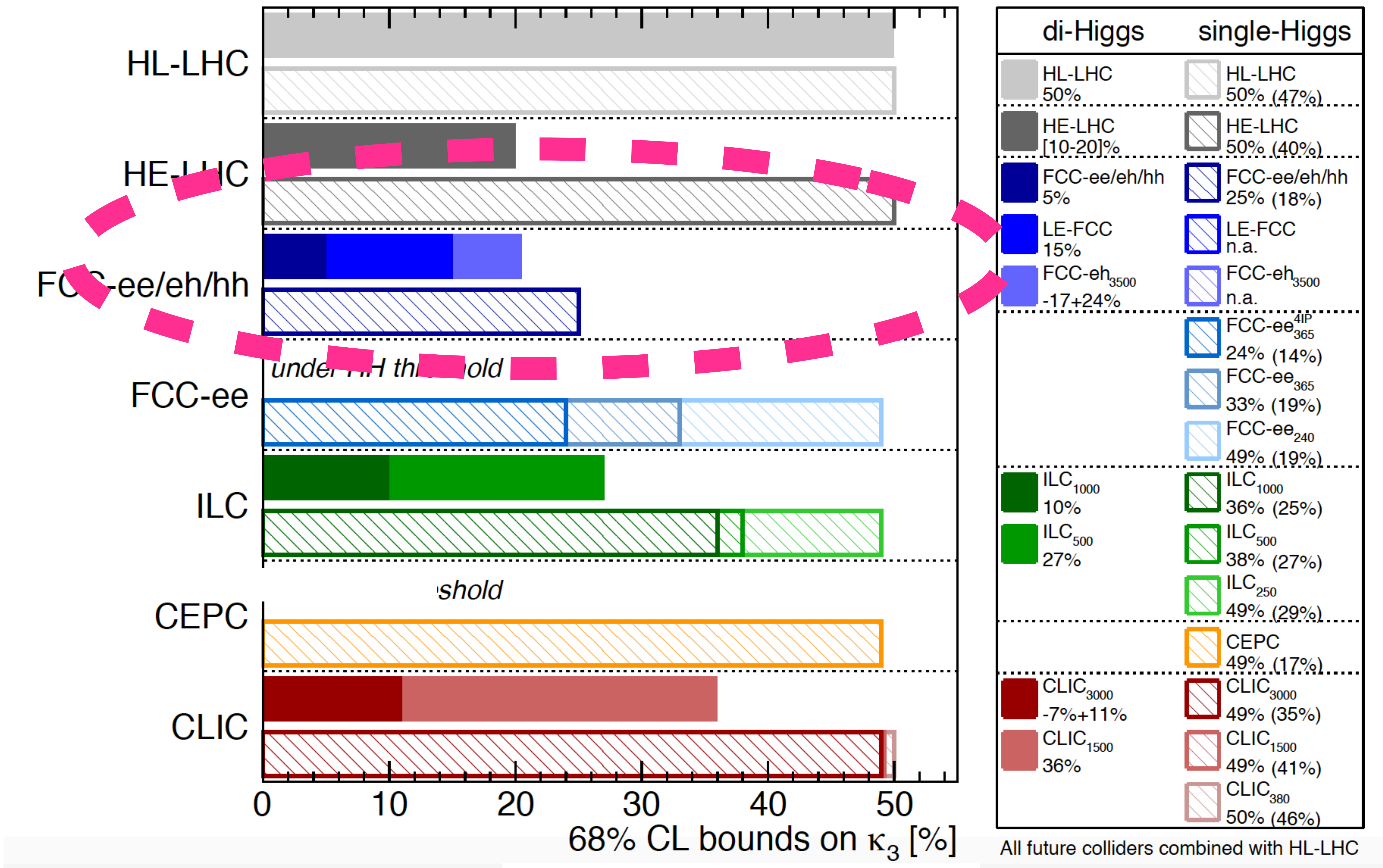

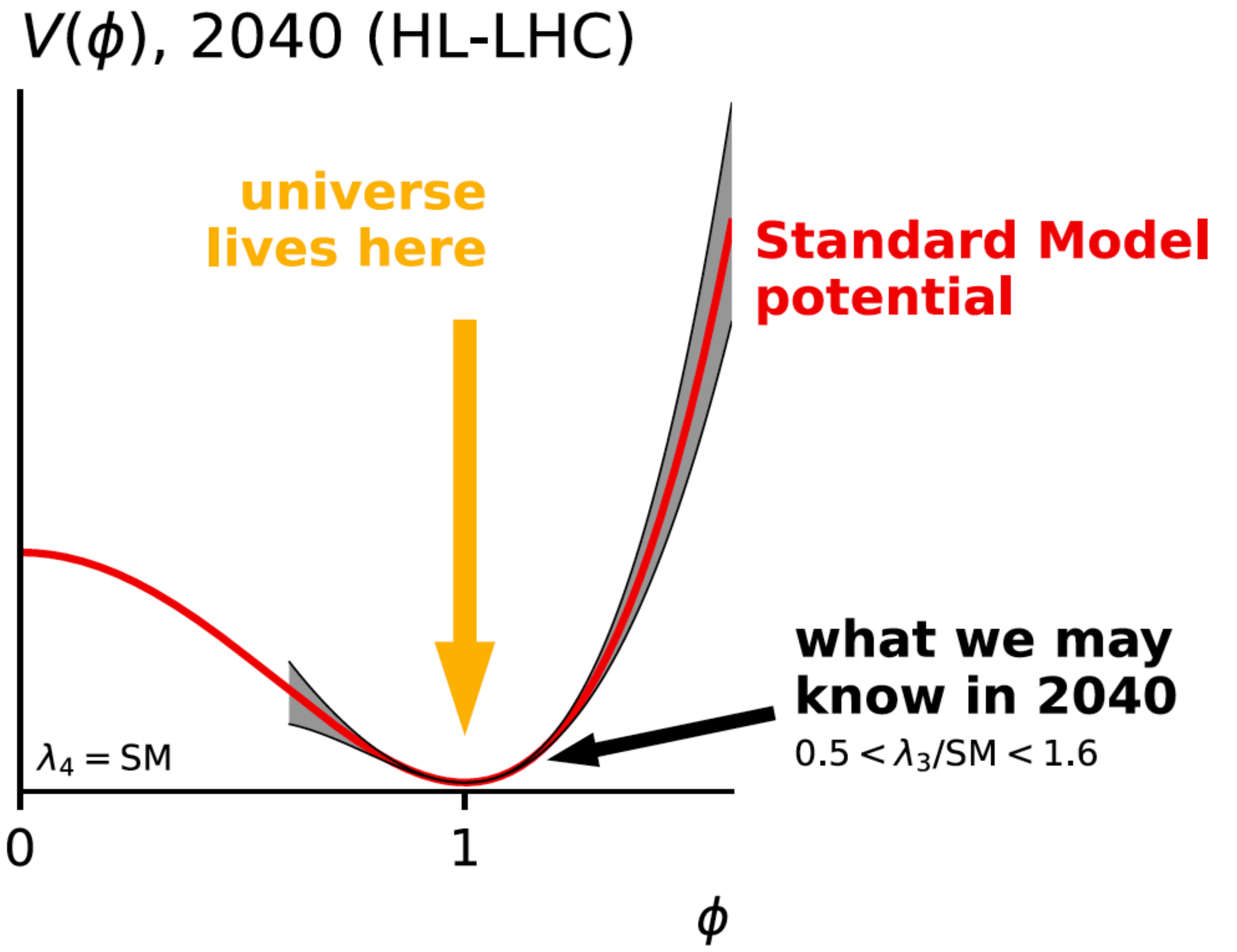

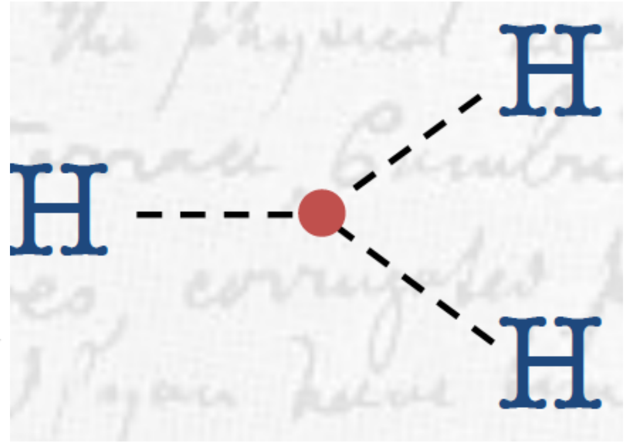

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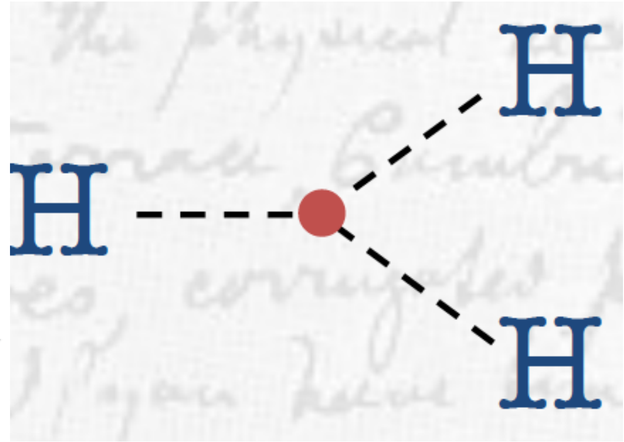
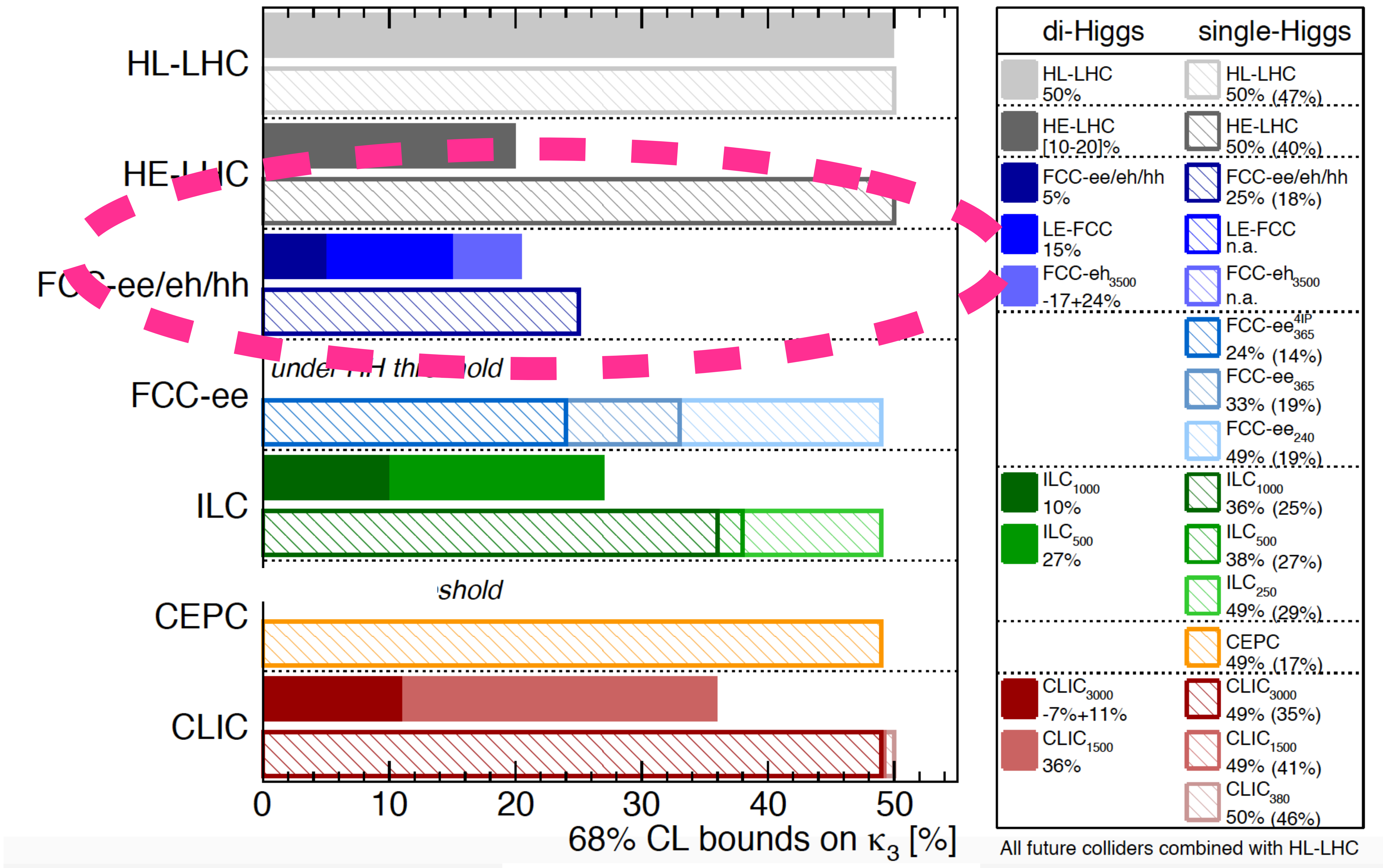
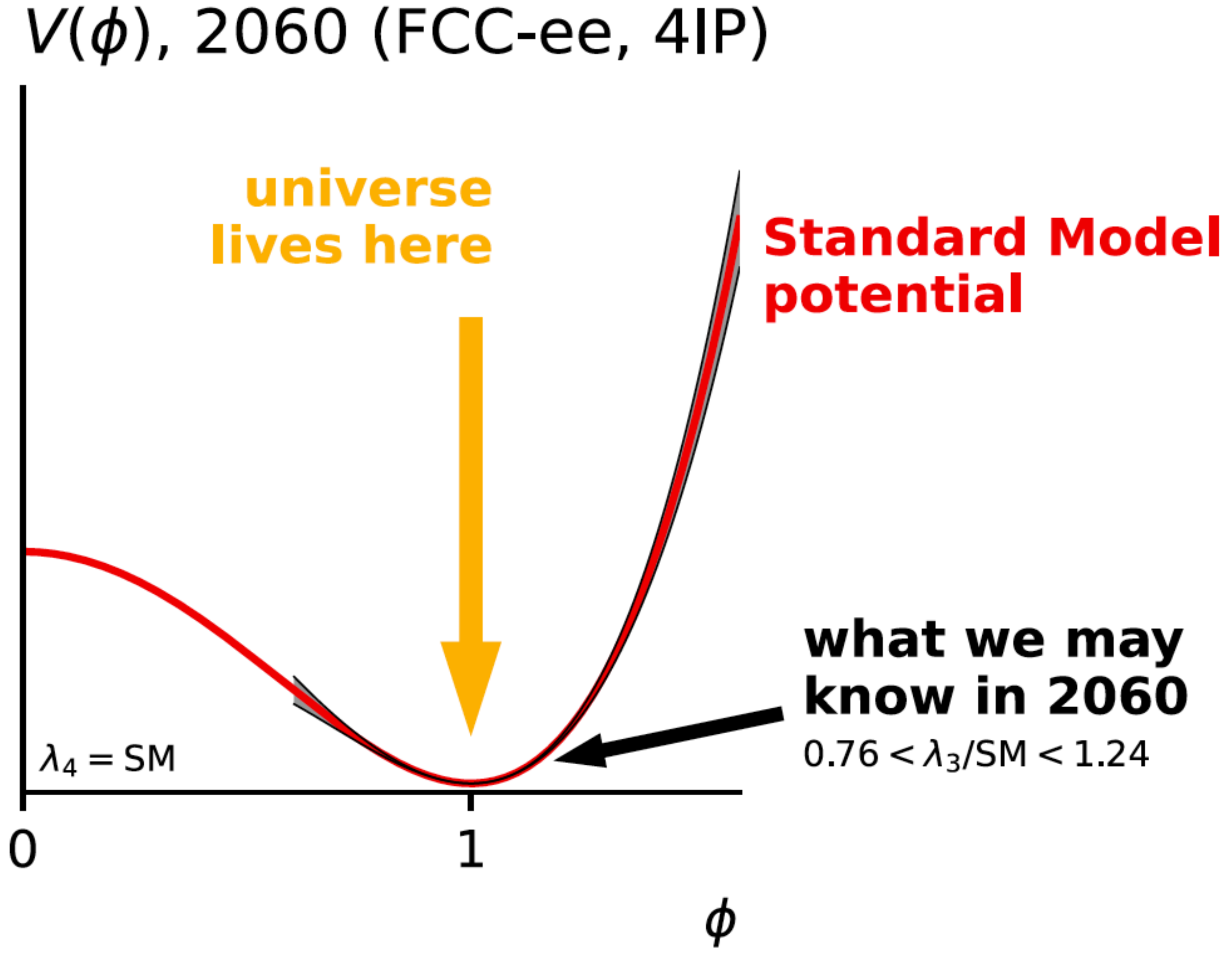


FCC integrated program will measure λ_3 at 5%





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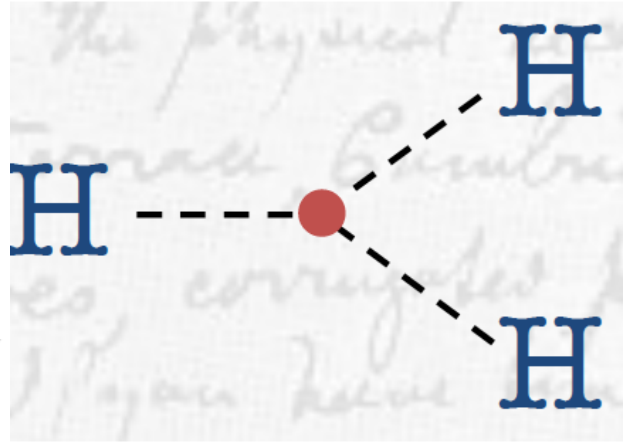
Study the nature of the Higgs potential



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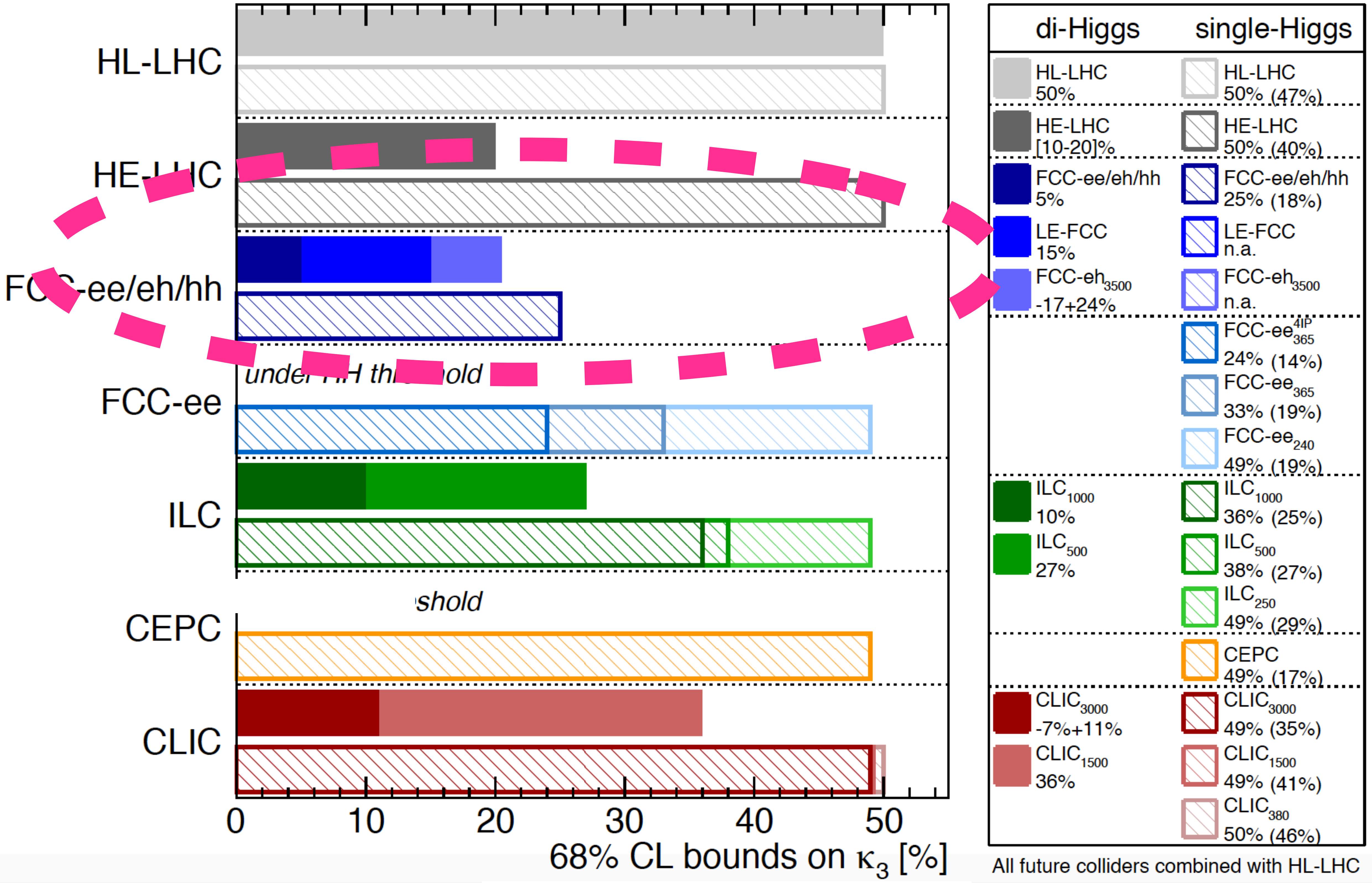

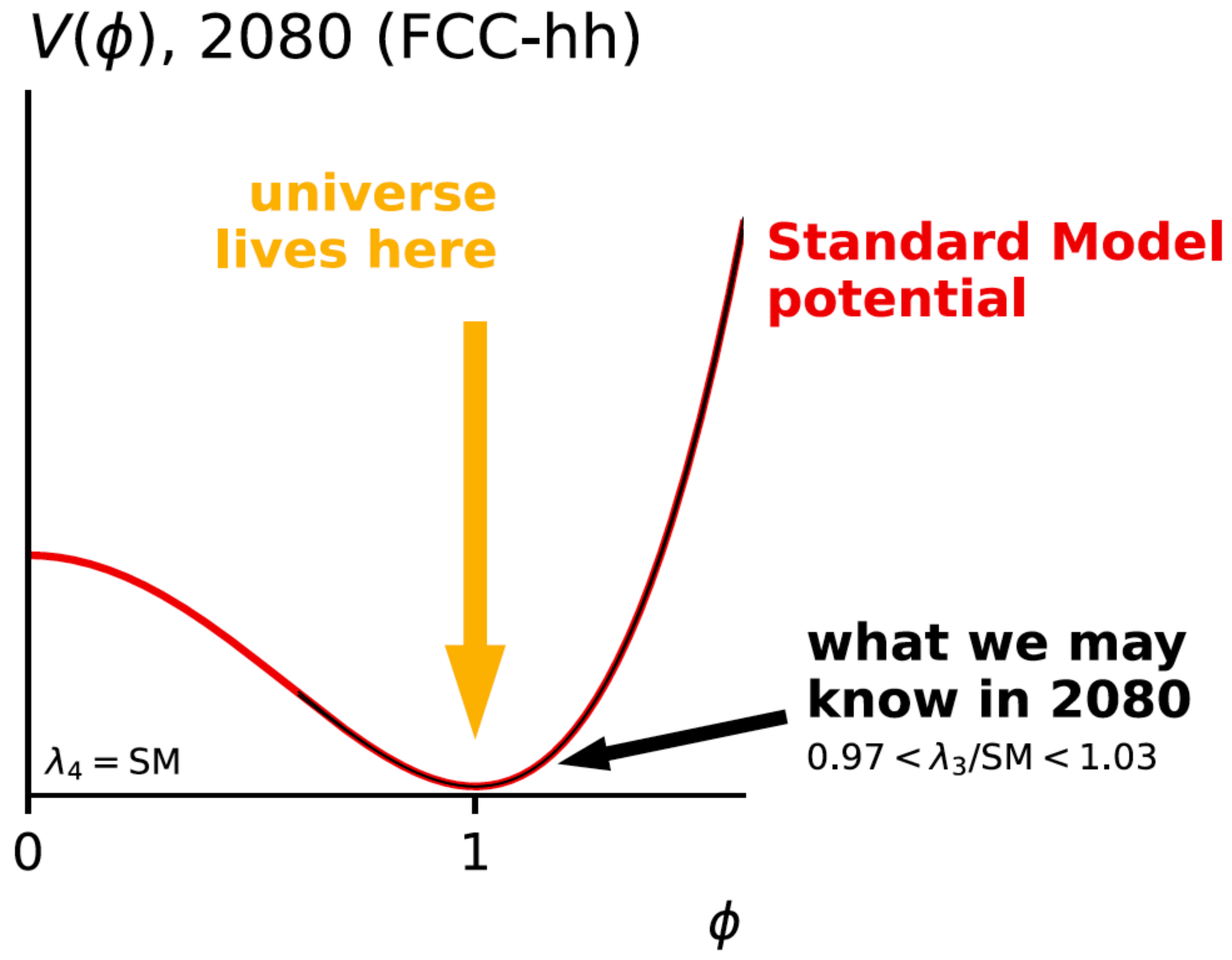

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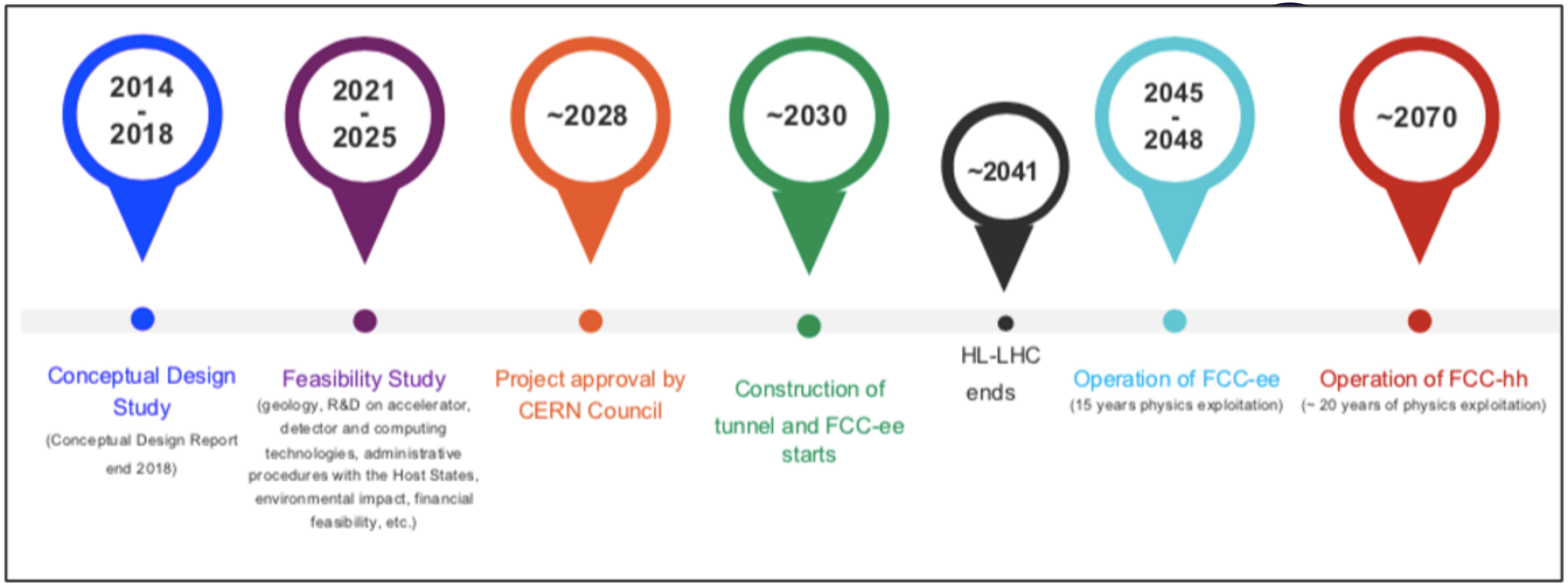
G. Salam

Strength

In size and timescale



- FCC-ee technology is mature → construction in parallel to HL-LHC operation
- Physics a few years after the HL-LHC (2045-2048)
  - Continuity of HEP guaranteed & only facility commensurate to size of community
- Two-stage approach:
  - Allows to spread the cost of the (more expensive) FCC-hh over more years
  - 20 years of R&D work towards affordable magnets
  - Optimization of overall investment by reusing civil engineering and large part of the technical infrastructure

“I believe FCC is the best project for CERN’s future, we need to work together to make it happen“

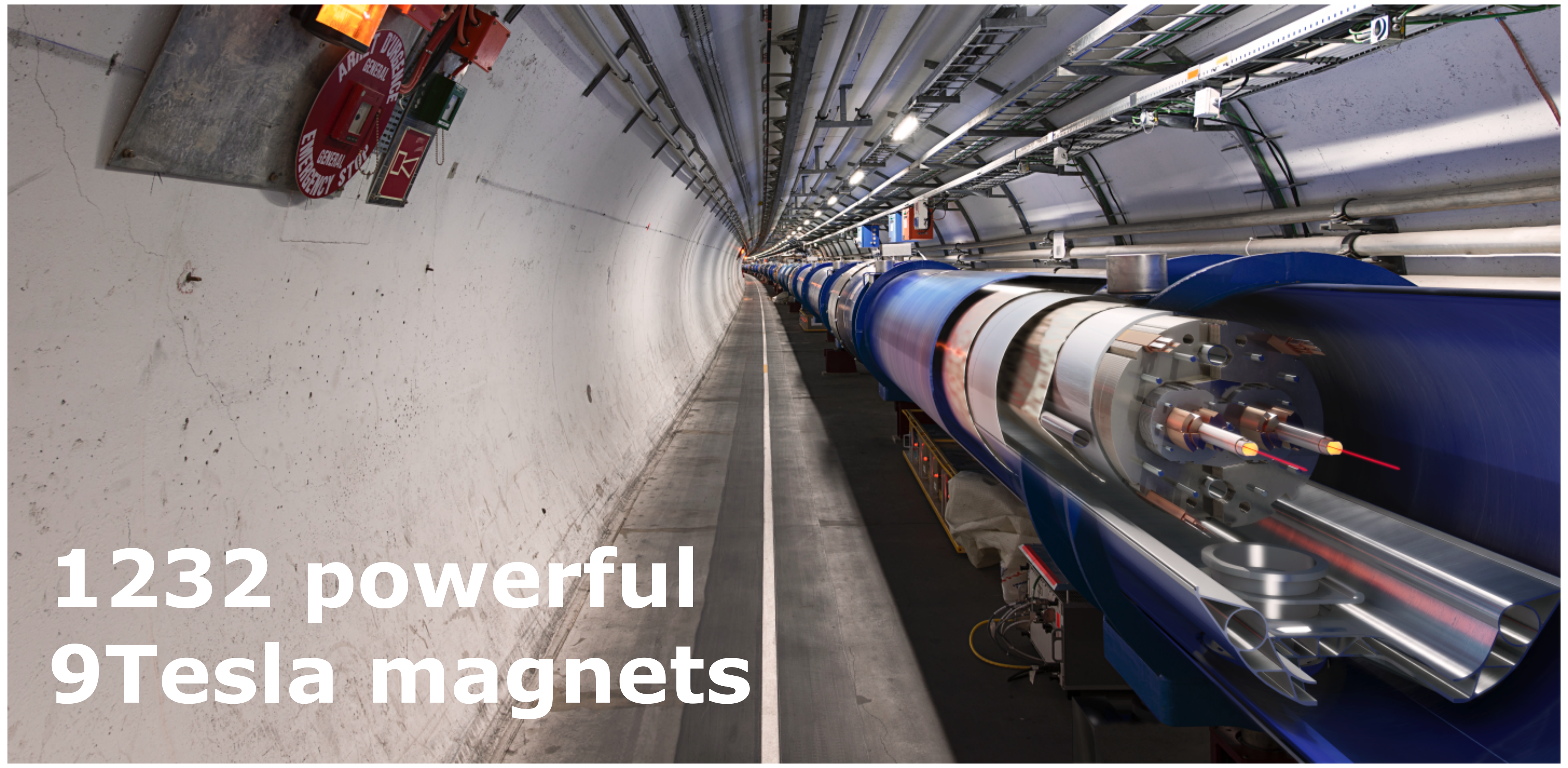
- Fabiola Gianotti, FCC Week London, 5th June 2023

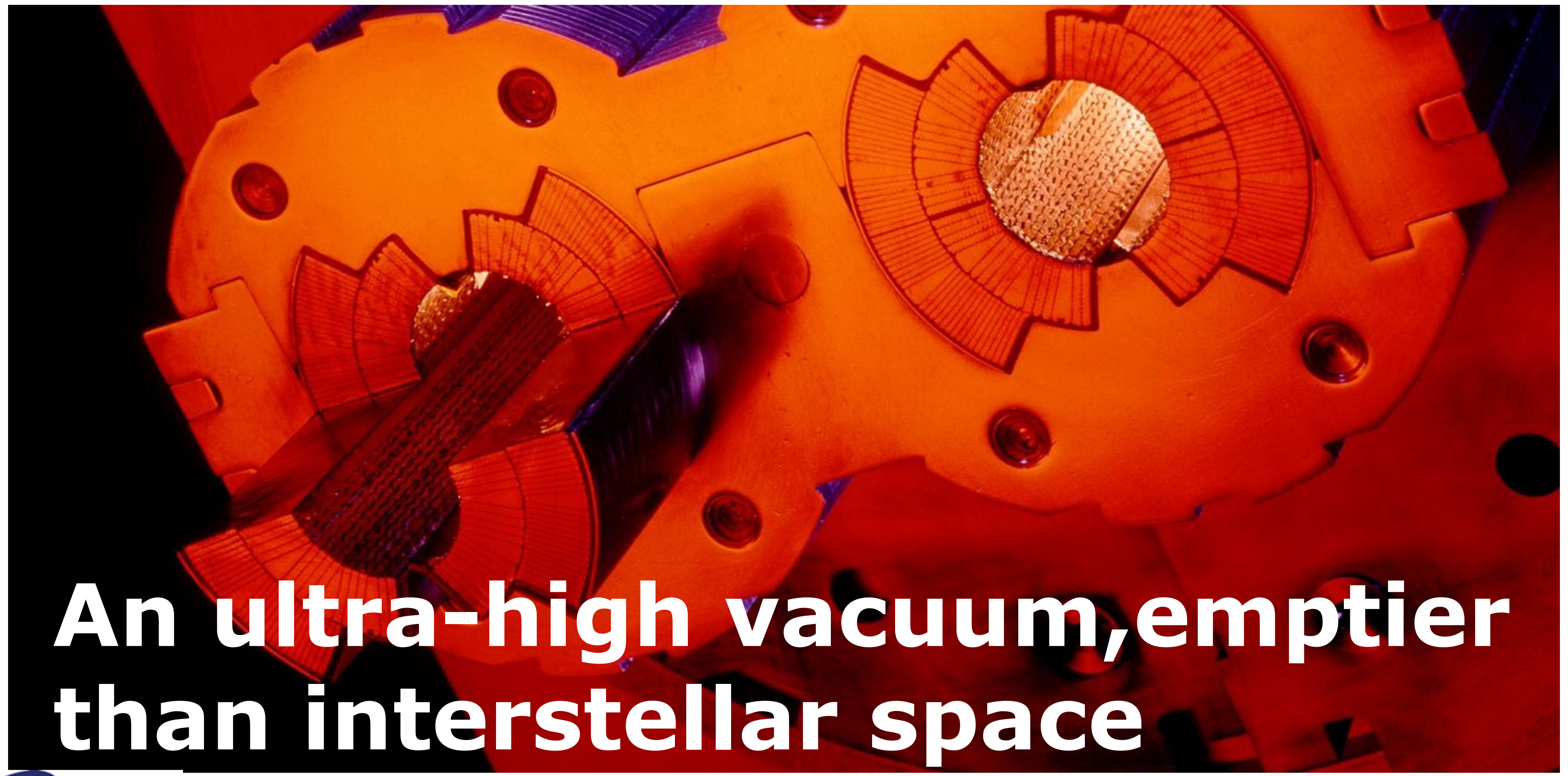
CERN with the Future Circolar Collider project will push scientific research to the end of the XXIst century

Only in this way can we secure the future of fundamental physics and uncover the deepest secrets of the Nature of the Universe we live in.

BACKUP

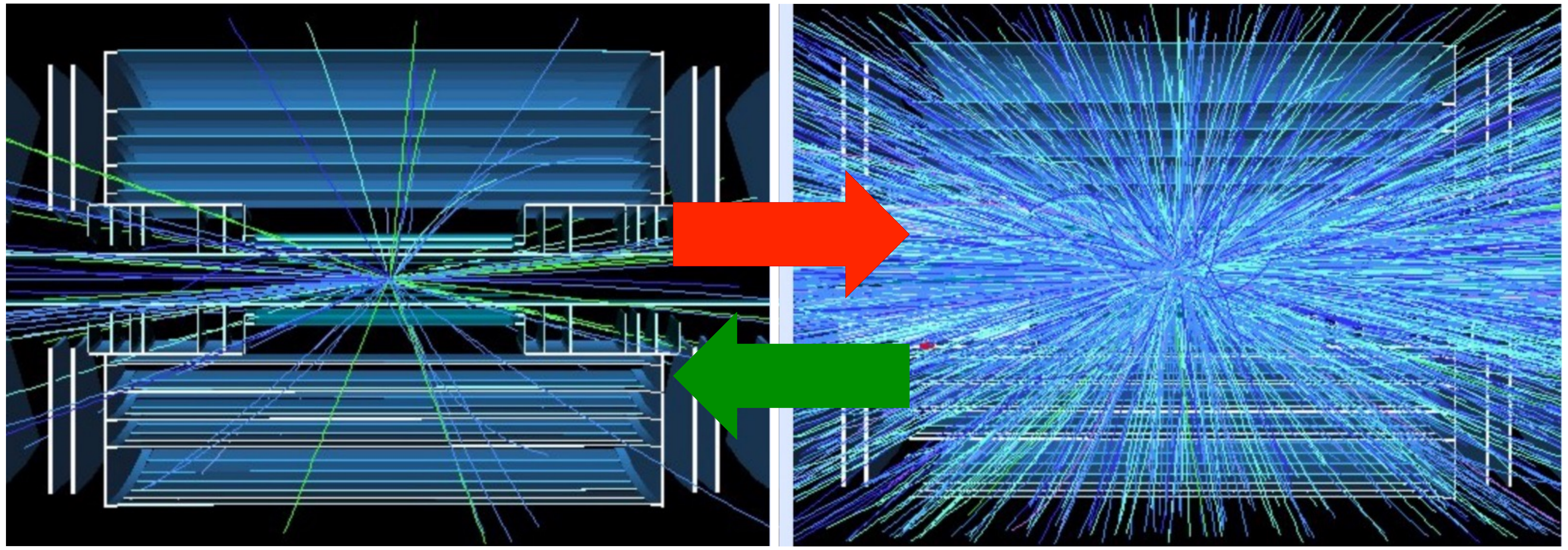
Incredible technologial challenges



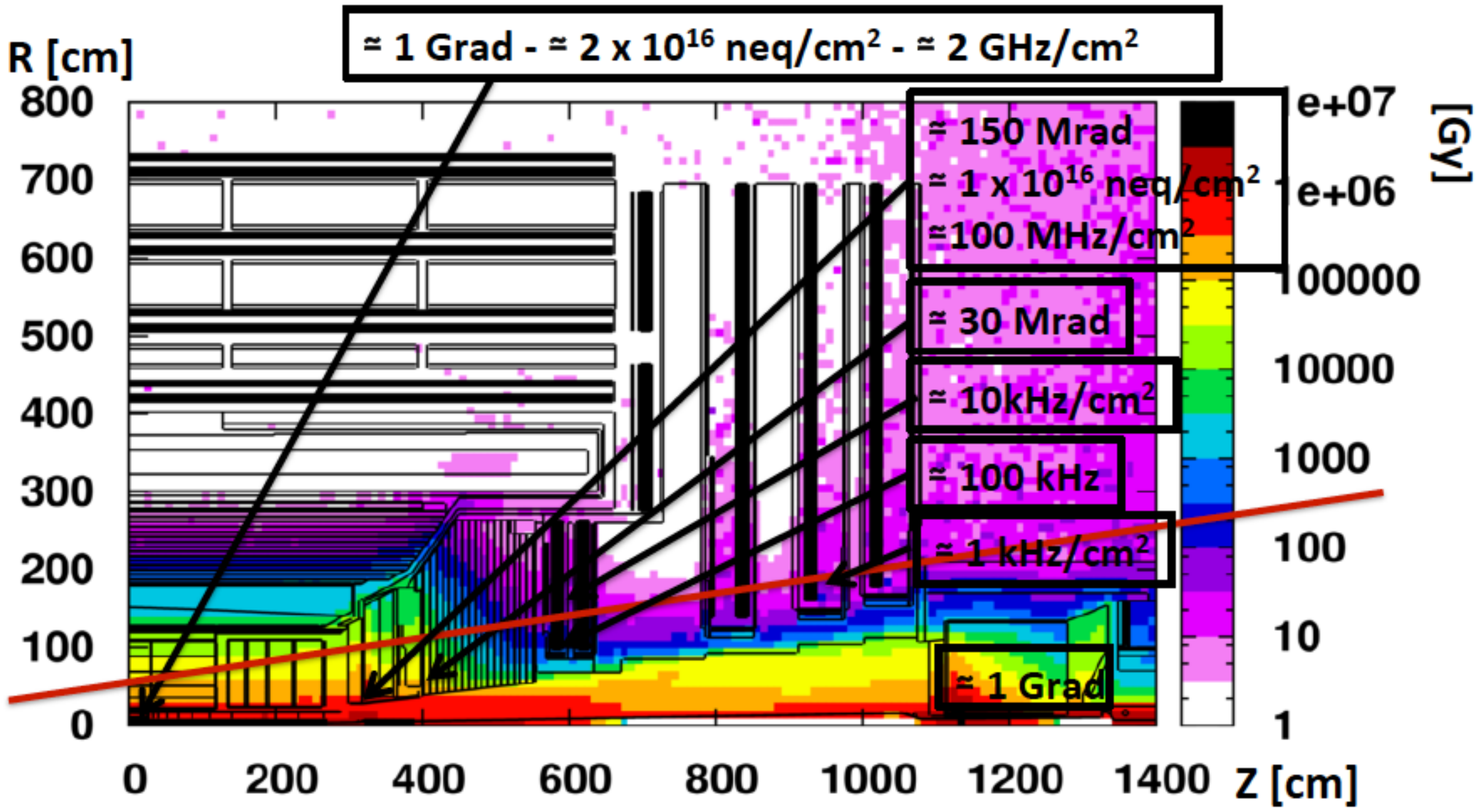


HL-LHC experimental challenges

25 pileup 200 pileup



Overlapping Collisions (Pileup)



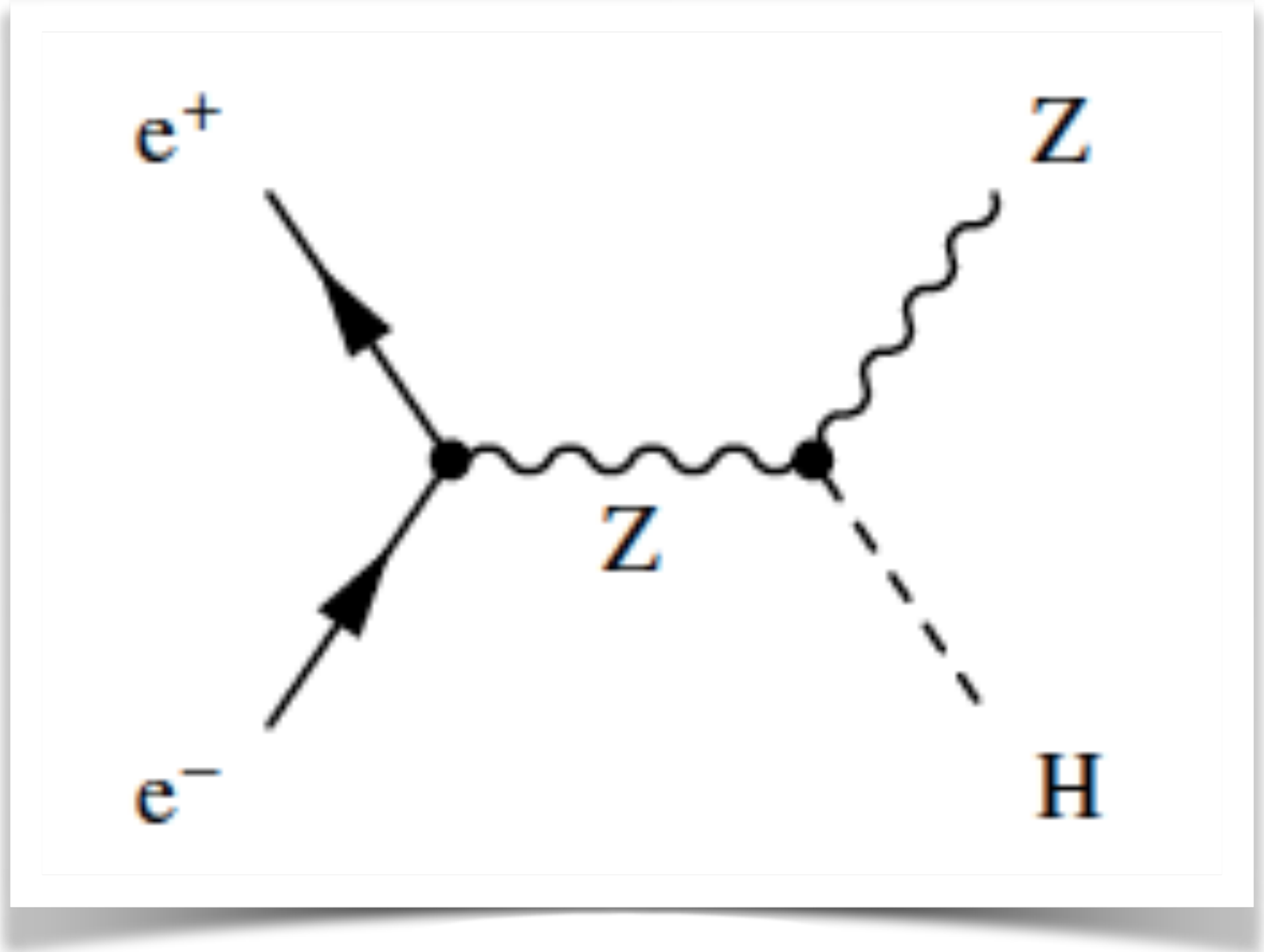
Roughly reaching limits of current techniques in several systems

Radiation Damage

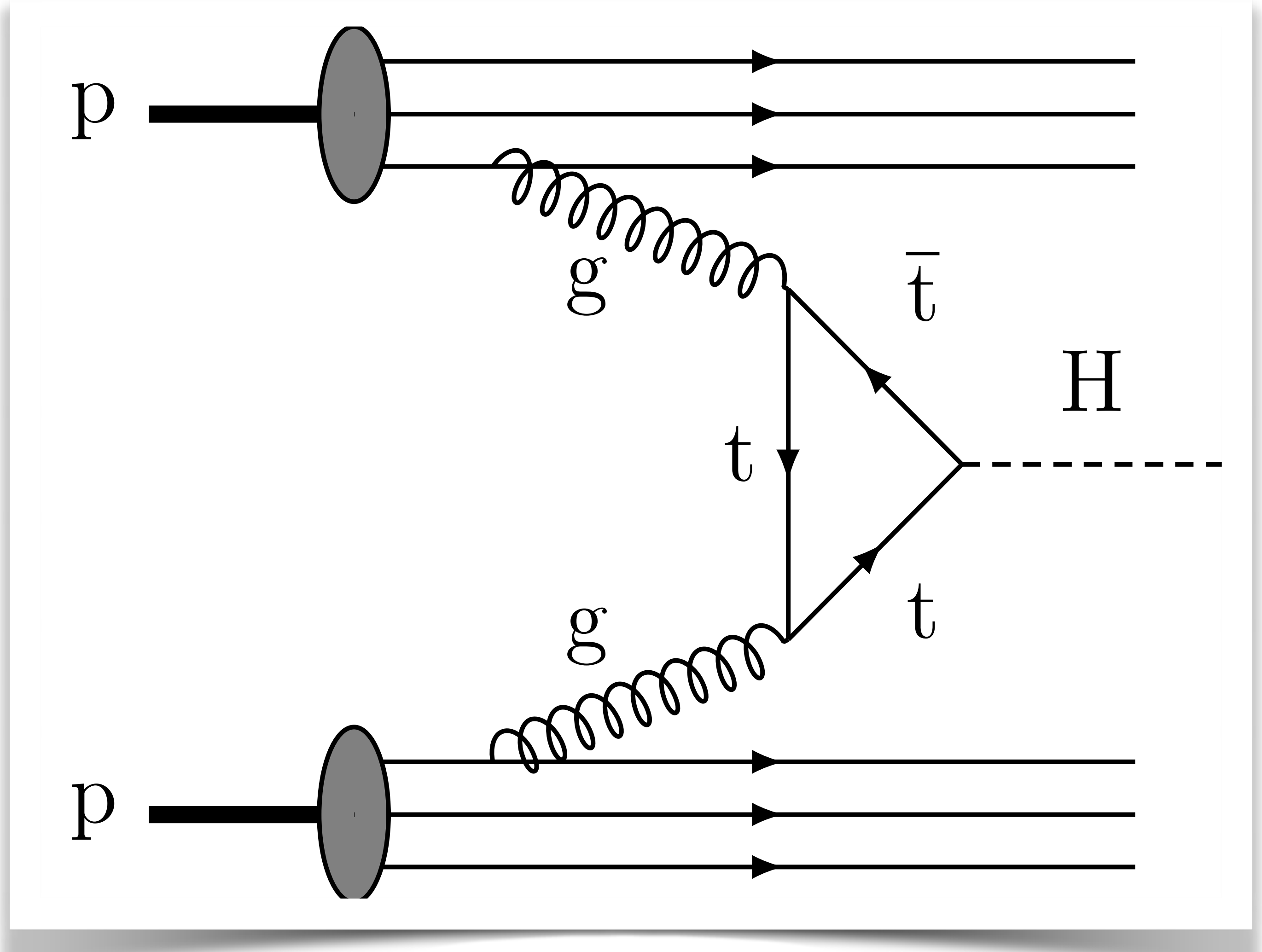
Which way to go?

Accessing two physics frontiers

- **INTENSITY FRONTIER Precision (electron-positron)**
  - Electrons point-like
  - Clean experimental conditions
  - High precision possible

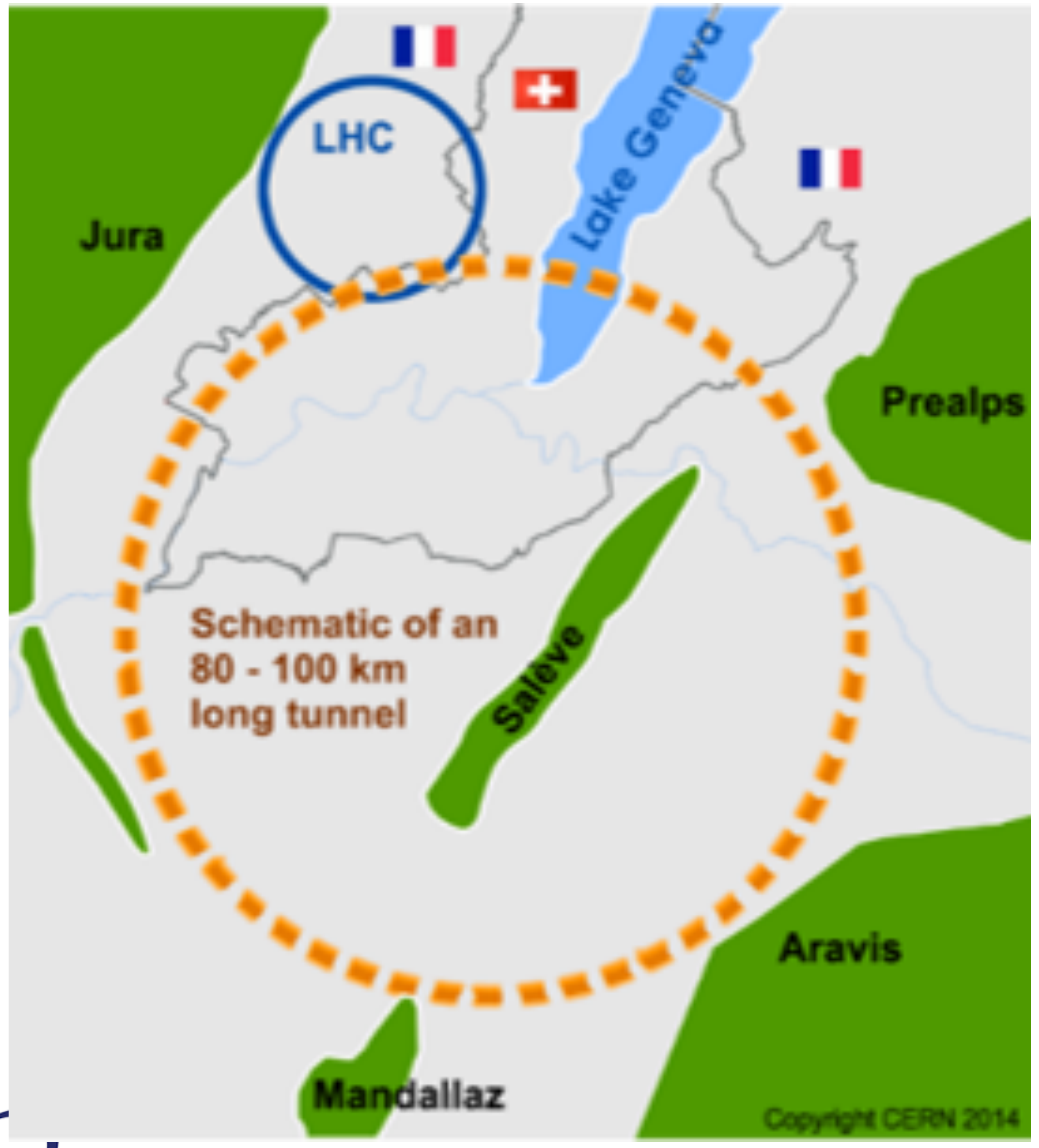


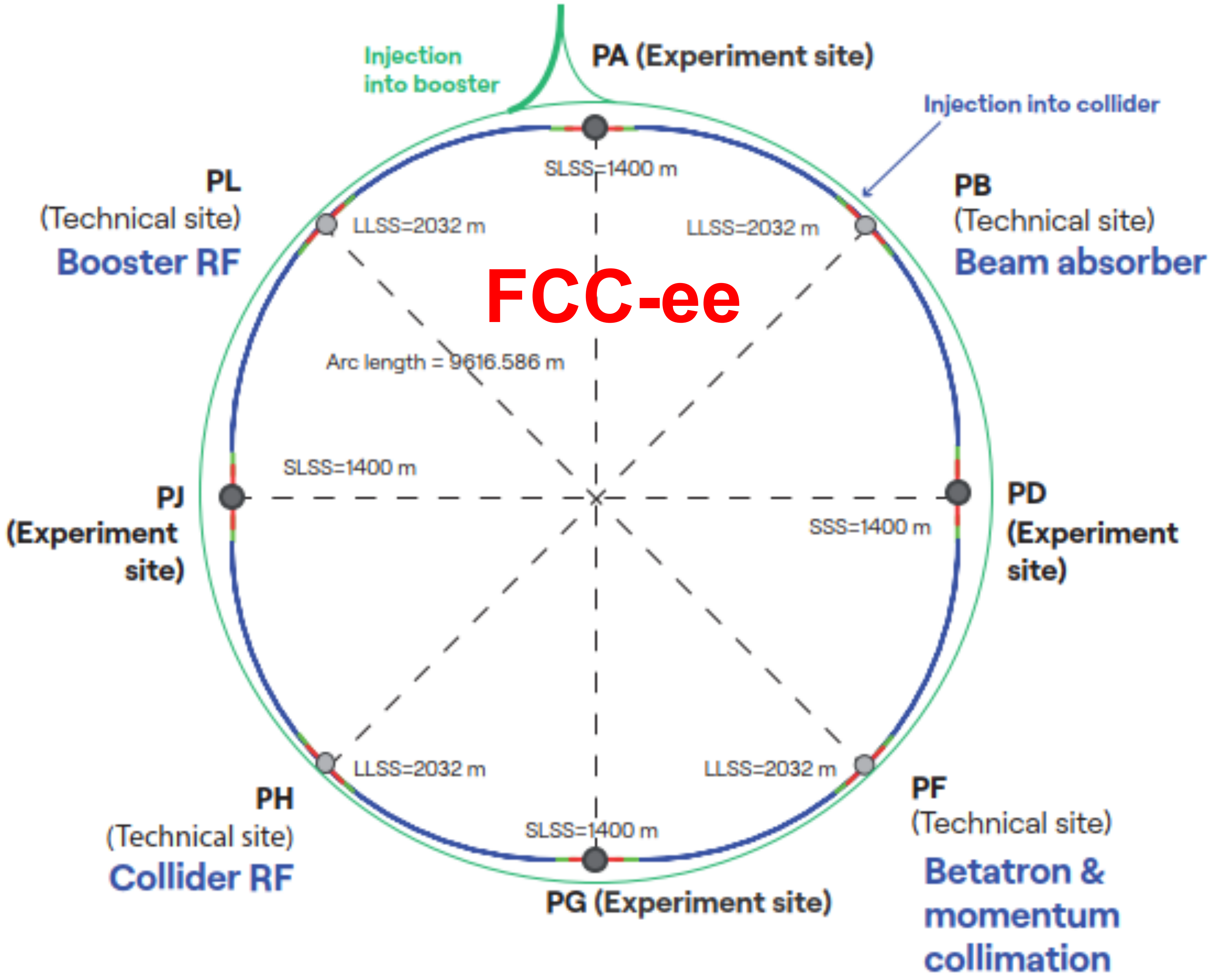
- **ENERGY FRONTIER Discovery (hadron-hadron)**
  - Protons compound objects
  - High cross section for coloured objects, large QCD background
  - Heavy: can be accelerated to high energies

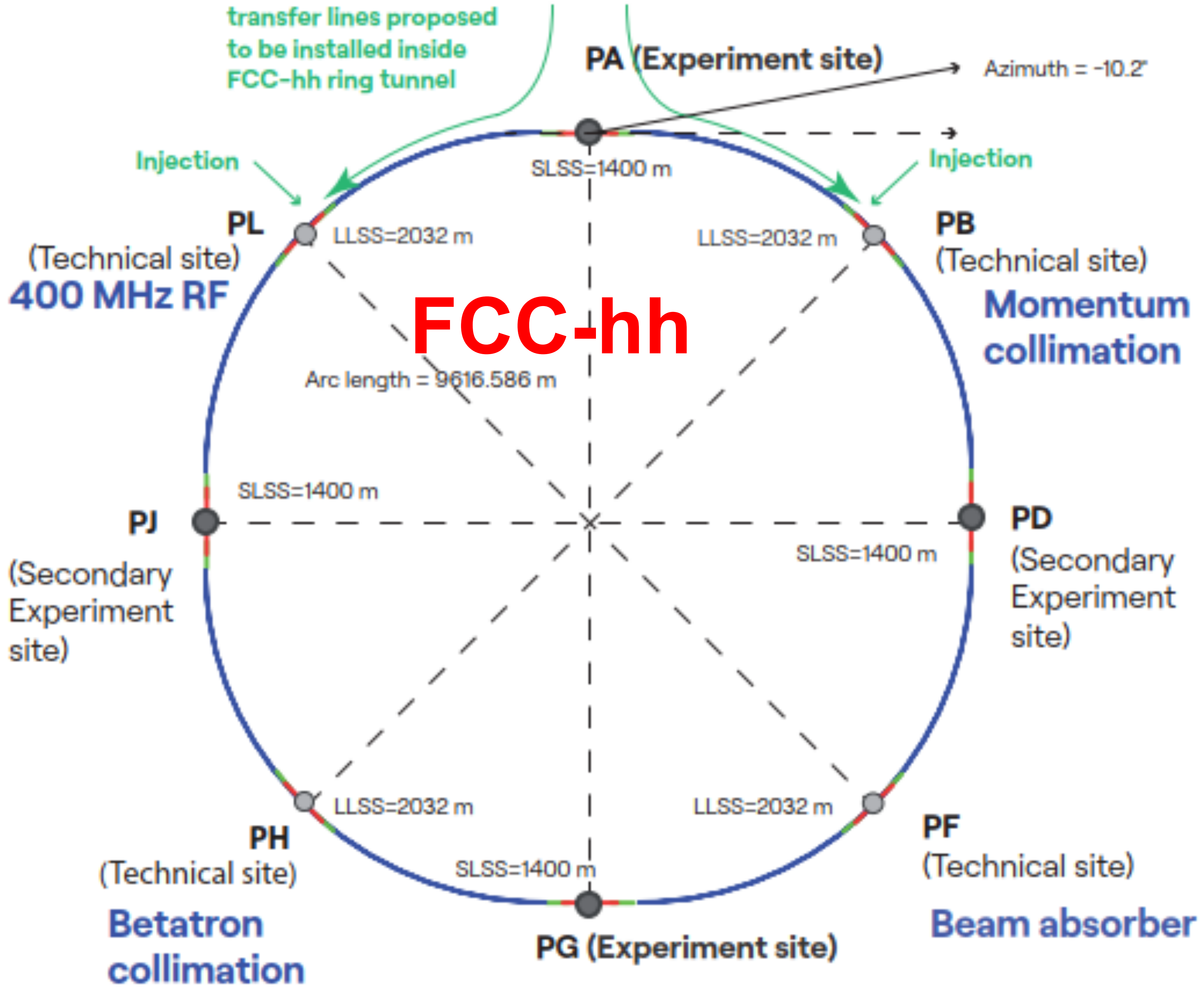


FCC integrated program – Vision

- **Phase 1: FCC-ee (Z, W, H, $t\bar{t}$): Higgs, electroweak & top factory with very large luminosity**
- **Phase 2: FCC-hh (~100 TeV) natural continuation toward the energy frontier with collisions of protons and heavy ions**
- **Construction and technical expertise based on the reutilization the existing CERN infrastructue**
- **This project allows to continue High energy physics exploration after the end of HL-LHC**







2020 - 2045

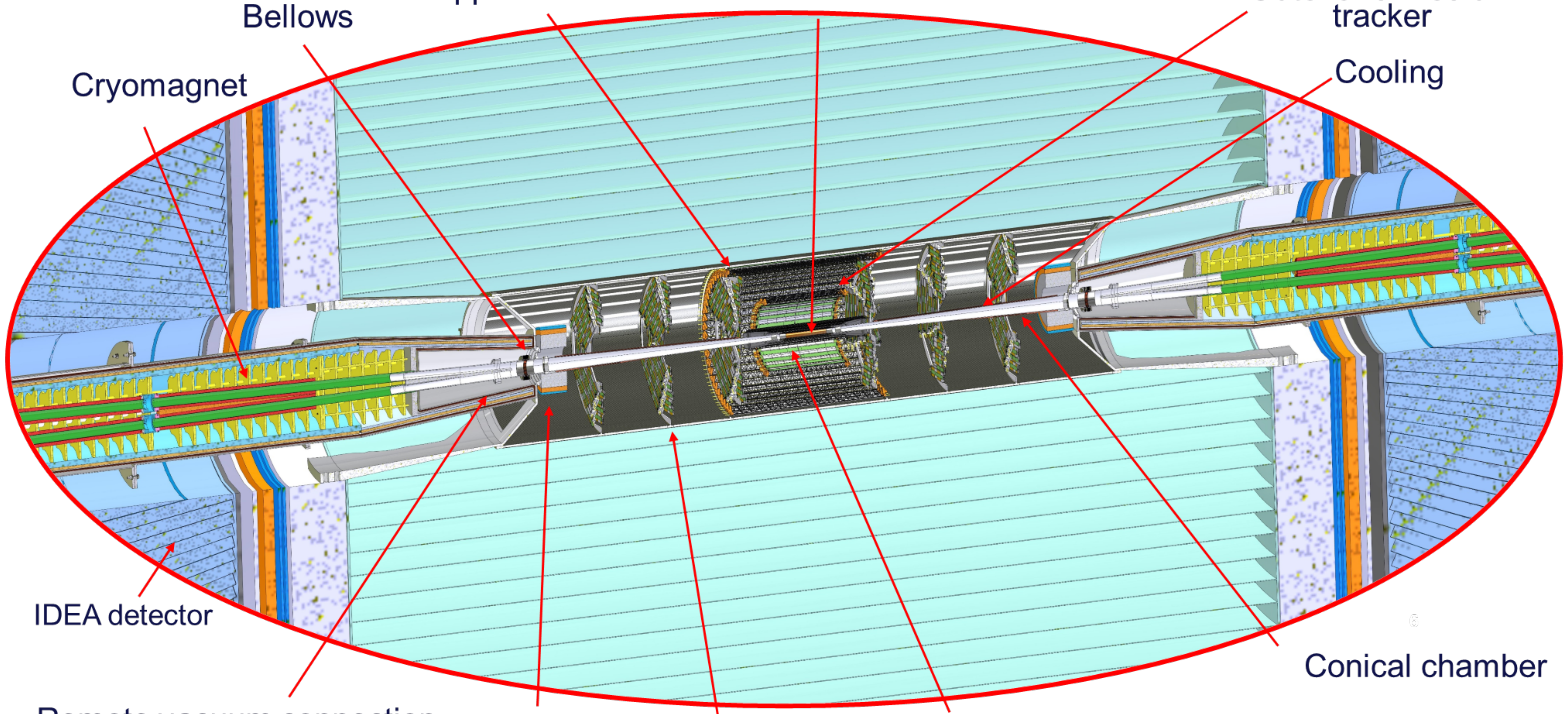
2048 - 2062

2079 - 2104

Machine-Detector Interface

Machine		FCCee	CEPC	ILC	SuperKEKB
Crossing-angle	mrad	30	33	14	83
L*	m	2.2	1.9	3.5	0.935
Vertical β_y* at IP	mm	0.7-1.6	0.9-2.7	0.4	0.3
Detector soln field	T	2/3	3	3.5/5	1.5
Detector stay clear	mrad	100	118/141	90	350/436
Two beam ΔX at L*	mm	66	62.7	49	77.6
He temperature	K	1.9	4.2	4.5	4.5

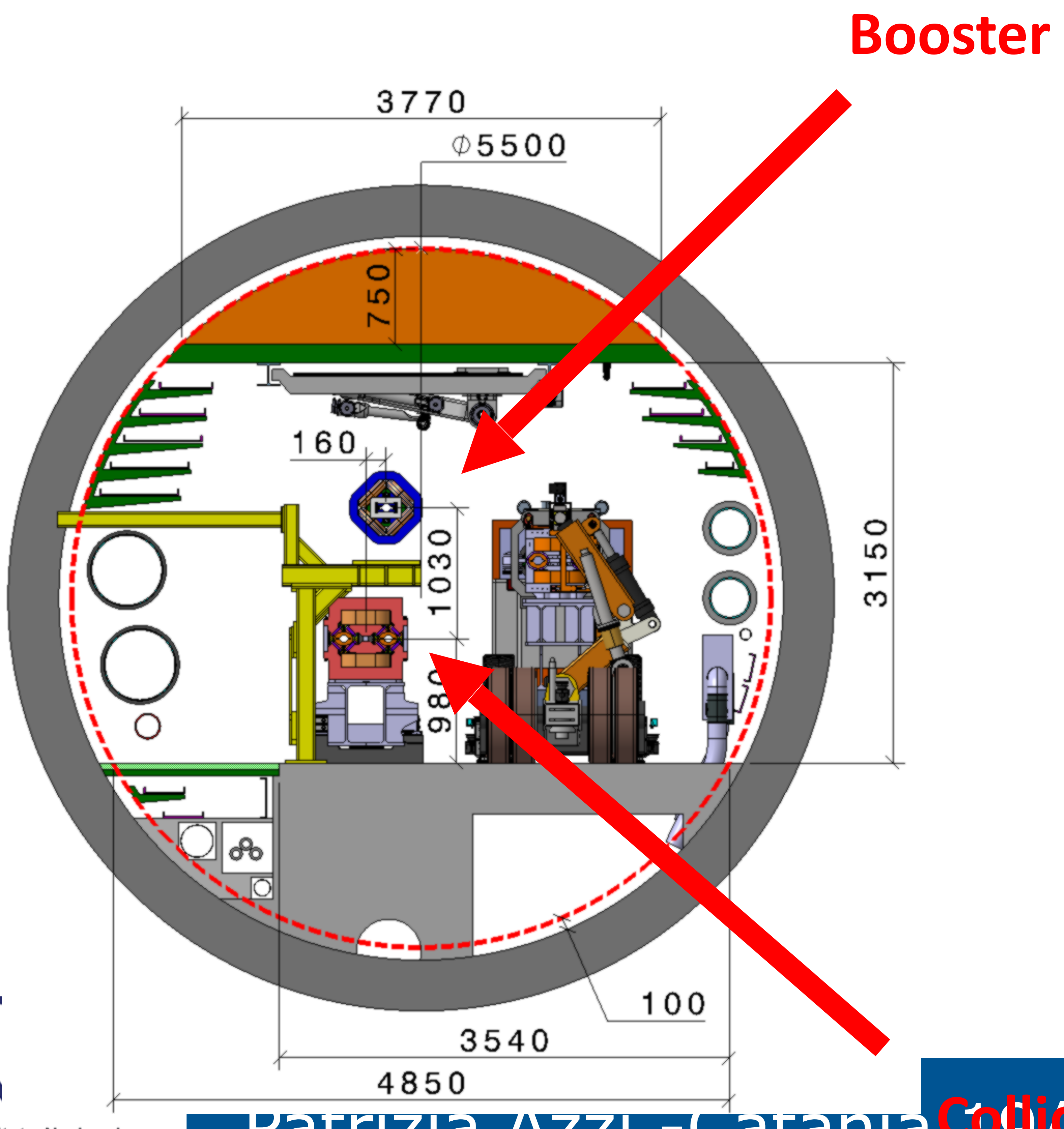
- **Key topics:**
  - SC IR magnet system & cryostat design
  - 3D integration
  - IR mock-up at INFN-LNF

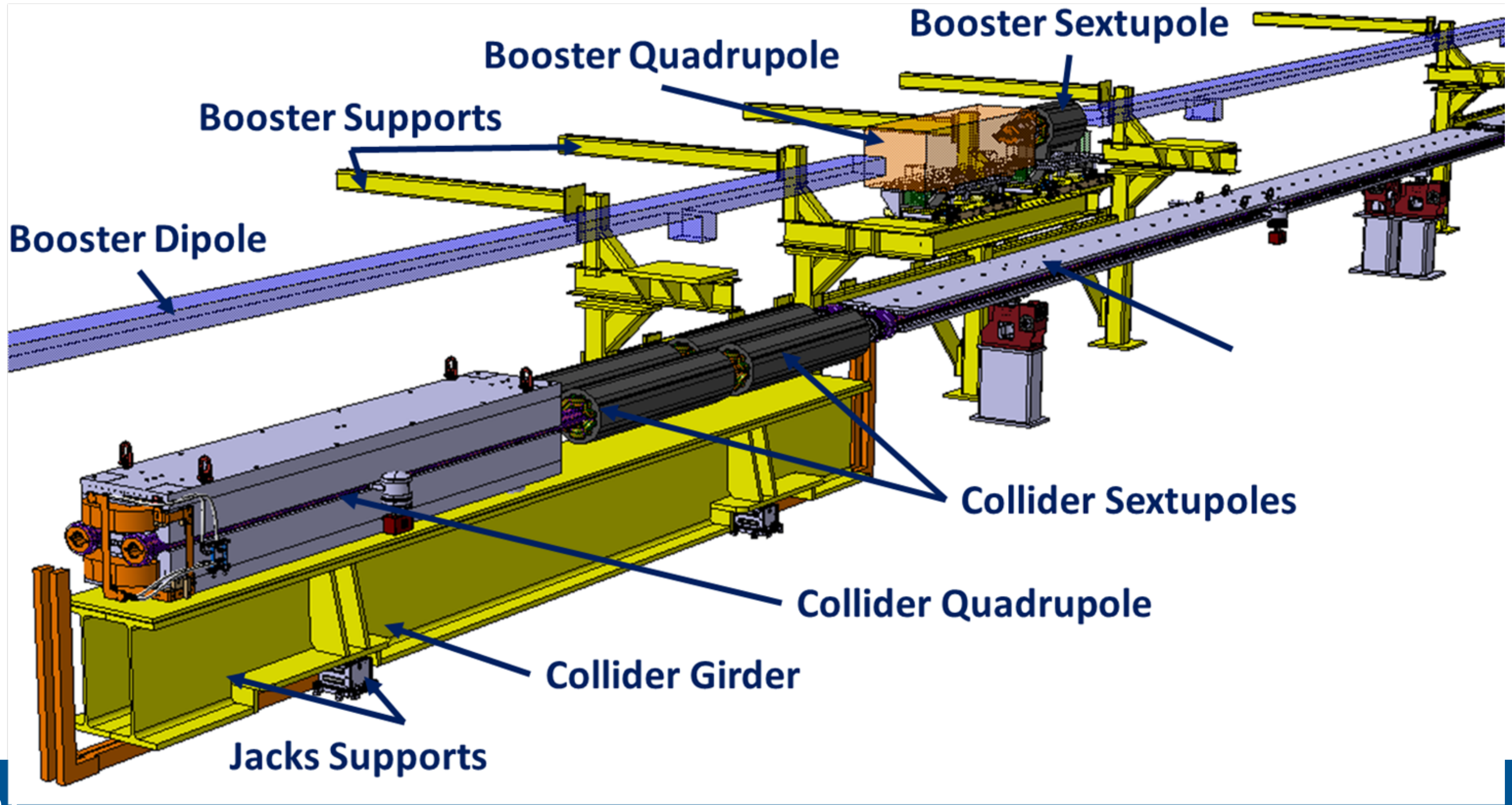


M. Boscolo, F. Palla, INFN

FCC-ee booster

- full energy booster, ramping from 20 GeV to 46 GeV – 182.5 GeV;
- injection ~several times per minute to keep collider beam currents constant;
- booster intensity ~1% of collider; full RF voltage as in collider





FCC-ee Energy range & luminosity

FUTURE CIRCULAR COLLIDER

Working point	Z, years 1-2	Z, later	WW, years 1-2	WW, later	ZH	$t\bar{t}$	
$\sqrt{s}$ (GeV)	88, 91, 94		157, 163		240	340–350	365
Lumi/IP ($10^{34}\,\text{cm}^{-2}\text{s}^{-1}$)	70	140	10	20	5.0	0.75	1.20
Lumi/year (ab^{-1})	34	68	4.8	9.6	2.4	0.36	0.58
Run time (year)	2	2	2	0	3	1	4
Number of events	6×10^{12} Z		2.4×10^{8} WW		1.45×10^{6} ZH + 45k WW $\rightarrow$ H	1.9×10^{6} $t\bar{t}$ +330k ZH +80k WW $\rightarrow$ H	

"Tera-Z"

Preliminary numbers (with new optics).
Up to 10.8/ab at √s=240GeV (3y)
and up to √s=3/ab at 365 GeV(5y)

INFN Istituto Nazionale di Fisica Nucleare

FCC-ee Energy range & luminosity

LEP Data statistics accumulated every 2 minutes!

Working point	Z, years 1-2	Z, later	WW, years 1-2	WW, later	ZH	$t\bar{t}$	
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FCC-ee Energy range & luminosity

LEP Data statistics accumulated every 2 minutes!

In each detector:
10^5 Z/sec, 10^4 W/hour,
1500 Higgs/day, 1500 top/day

Working point	Z, years 1-2	Z, later	WW, years 1-2	WW, later	ZH	$t\bar{t}$	
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FCC-ee Energy range & luminosity

FUTURE CIRCULAR COLLIDER

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"Tera-Z"

Preliminary numbers (with new optics).
Up to 10.8/ab at √s=240GeV (3y)
and up to √s=3/ab at 365 GeV(5y)

Never produced before at a lepton collider!

Detector Requirements summary from FSR

FUTURE CIRCULAR COLLIDER

	Aggressive	Conservative	Comments
Beam-pipe	$\frac{X}{X_0} < 0.5\%$	$\frac{X}{X_0} < 1\%$	$B \to K^*\tau\tau$
Vertex	$\sigma(d_0) = 3 \oplus 15\,/\,(p\sin^{3/2}\theta)\ \mu\text{m}$ $\frac{X}{X_0} < 1\%$	–	$B \to K^*\tau\tau$ R_c
	$\delta L = 5\,\text{ppm}$	–	$\delta\tau_\tau < 10\,\text{ppm}$
Tracking	$\frac{\sigma_p}{p} < 0.1\%$ for $\mathcal{O}(50)$ GeV tracks	$\frac{\sigma_p}{p} < 0.2\%$ for $\mathcal{O}(50)$ GeV tracks	$\delta M_H = 4\,\text{MeV}$ $\delta\Gamma_Z = 15\,\text{keV}$ $Z \to \tau\mu$
	t.b.d.	$\sigma_\theta < 0.1$ mrad	$\delta\Gamma_Z(\text{BES}) < 10\,\text{keV}$
ECAL	$\frac{\sigma_E}{E} = \frac{3\%}{\sqrt{E}}$	$\frac{\sigma_E}{E} = \frac{10\%}{\sqrt{E}}$	$Z \to \nu_e\bar{\nu}_e$ coupling, B physics, ALPs
	$\Delta x \times \Delta y = 2 \times 2\ \text{mm}^2$	$\Delta x \times \Delta y = 5 \times 5\ \text{mm}^2$	τ polarization boosted π^0 decays bremsstrahlung recovery
	$\delta z = 100\ \mu\text{m}$, $\delta R_{\text{min}} = 10\ \mu\text{m}$ $(\theta = 20°)$	–	alignment tolerance for $\delta\mathcal{L} = 10^{-4}$ with $\gamma\gamma$ events
HCAL	$\frac{\sigma_E}{E} = \frac{30\%}{\sqrt{E}}$	$\frac{\sigma_E}{E} = \frac{50\%}{\sqrt{E}}$	$H \to s\bar{s},\ c\bar{c}$, gg, invisible HNLs
	$\Delta x \times \Delta y = 2 \times 2\ \text{mm}^2$	$\Delta x \times \Delta y = 20 \times 20\ \text{mm}^2$	$H \to s\bar{s},\ c\bar{c}$, gg
Muons	low momentum ($p < 1$ GeV) ID	–	$B_s \to \nu\bar{\nu}$
Particle ID	3σ K/π $p < 40$ GeV	3σ K/π $p < 30$ GeV	$H \to s\bar{s}$ $b \to s\nu\bar{\nu}, \ldots$
LumiCal	tolerance $\delta z = 100\ \mu\text{m}$, $\delta R_{\text{min}} = 1\ \mu\text{m}$ acceptance 50-100 mrad	–	$\delta\mathcal{L} = 10^{-4}$ target (Bhabha)
Acceptance	100 mrad	–	$e^+e^- \to \gamma\gamma$ $e^+e^- \to e^+e^-\tau^+\tau^-(c\bar{c})$

- Beyond a Higgs factory
  - Good vertex, excellent PID for flavor tagging
    - In particular for strange
  - jet energy resolution (calorimetry/ Particle-Flow)
- Strong non trivial requirements at the Z pole:
  - Z width (mom. resolution)
  - Tau lifetime (abs. Vertex length scale)
  - Tau pol. (calorimeters)
  - Luminosity: acceptance
  - B physics: beampipe, vertex resolution
  - LLPs: continuous tracking and calorimetry, timing

Non-exhaustive list! .. still much to be understood, in particular at the Z pole!

FCC-ee Tera-Z run: discovery machine

ALPS

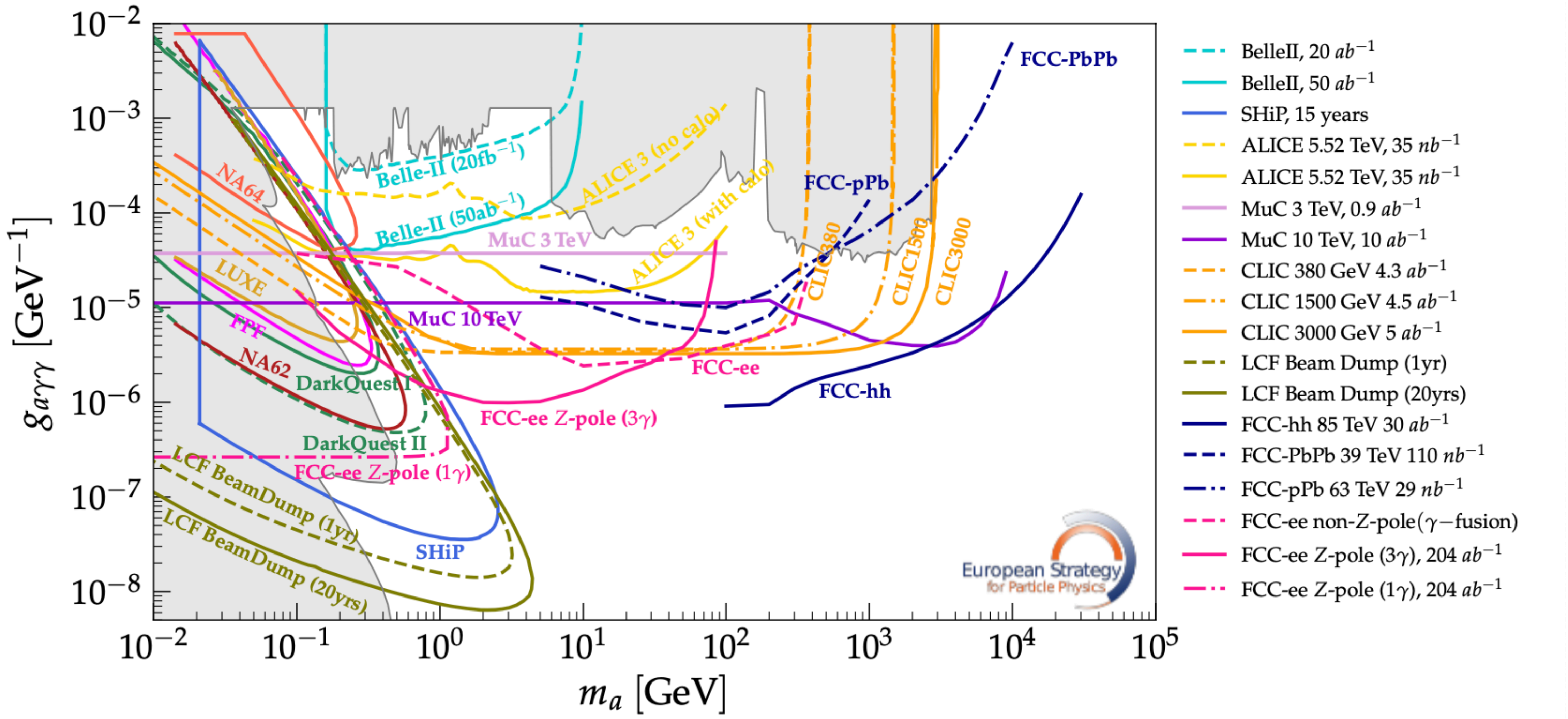


Fig. 8.16: Sensitivity projections for ALPs coupling to photons as a function of the ALP mass. All curves correspond to 90% CL exclusion limits, except for FCC-ee, FCC-hh, and LCF (95% CL exclusion limits).

Heavy Neutral Leptons

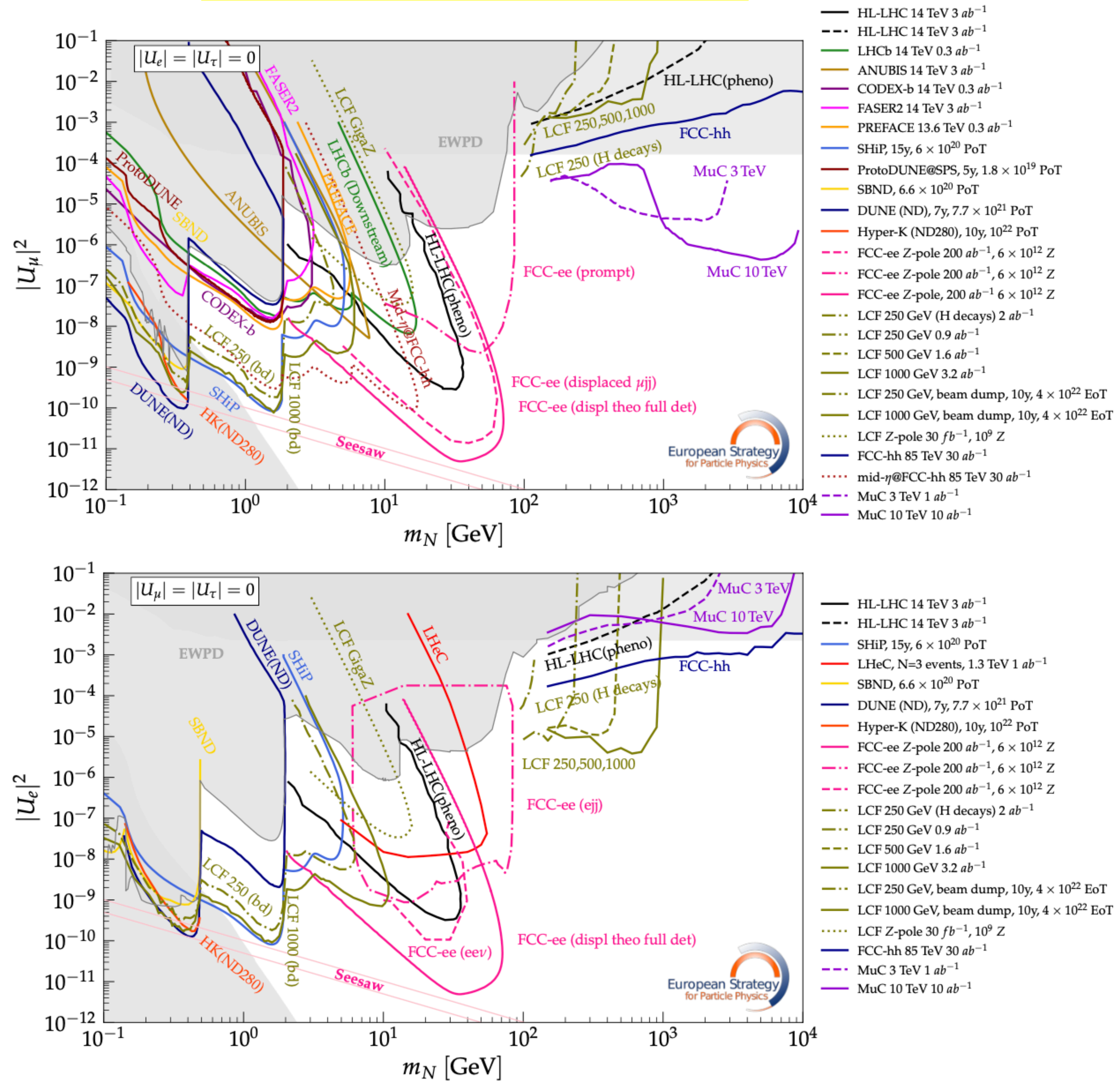


Fig. 8.19: Exclusion limits for HNLs mixing with muon (Top) and electron (Bottom) neutrinos.

- Enormous number of produced Z-bosons at FCC-ee gives the opportunity to discover new particles that interact in a very weak (feeble) manner. They could be good candidates for Dark Matter

Stage 2: hadron collider FCC-hh

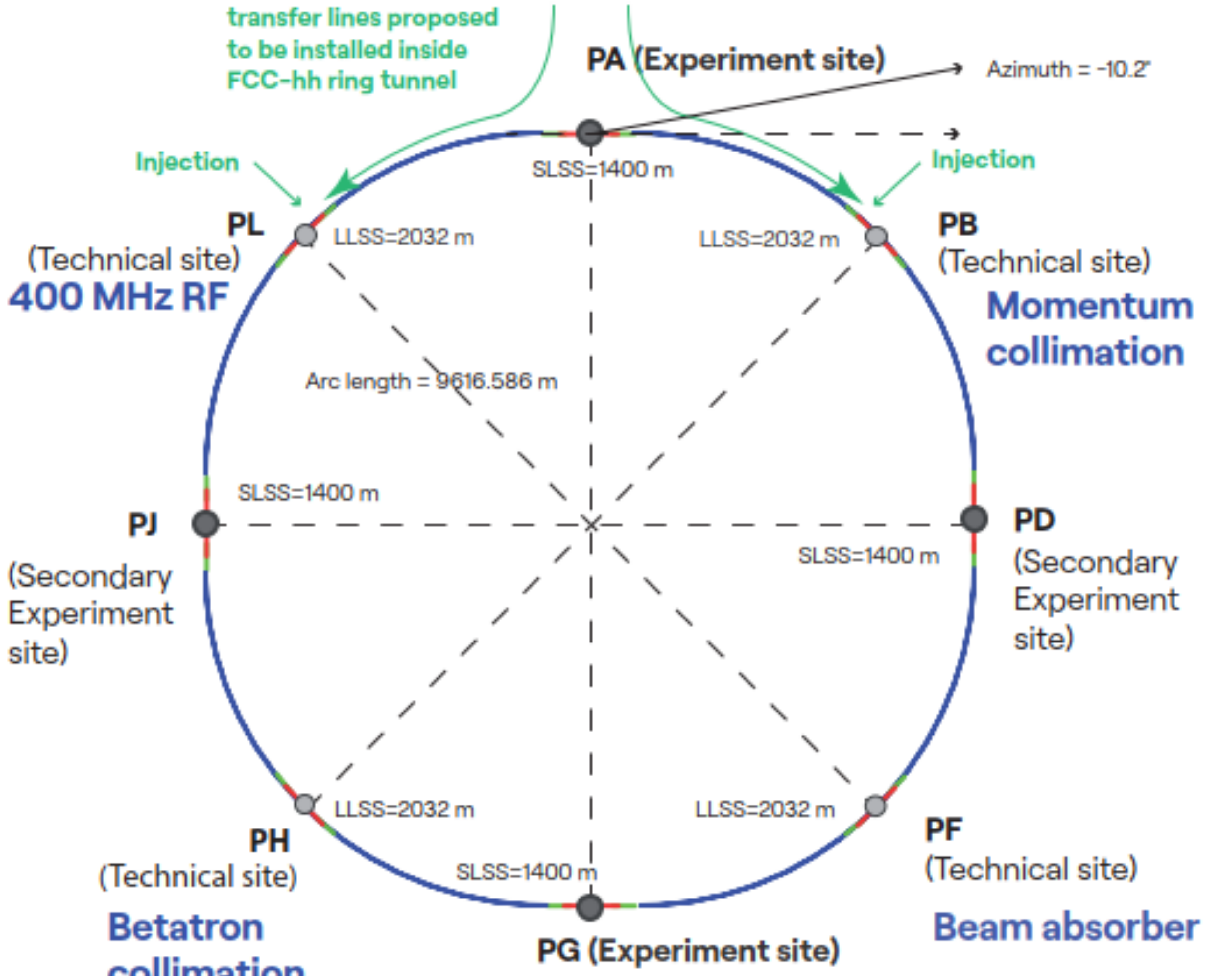
FUTURE CIRCULAR COLLIDER

Parameter optimization to lower electricity consumption (~max. consumption of FCC-ee)
Magnetic field considered realistic with today's technologies (Nb3Sn, ~14T, 1.9 K)

Main parameters FSR 2025

parameter	FCC-hh	FCC-hh CDR	HL-LHC
collision energy cms [TeV]	85	100	14
dipole field [T]	14	16	8.33
circumference [km]	90.7	97.8	26.7
beam current [A]	0.5	0.5	1.1
synchr. rad. per ring [kW]	1200	2400	7.3
peak luminos. [10^{34} $cm^{-2}s^{-1}$]	30	30	5 (lev.)
integr. luminosity / IP [fb^{-1}]	20000	20000	3000

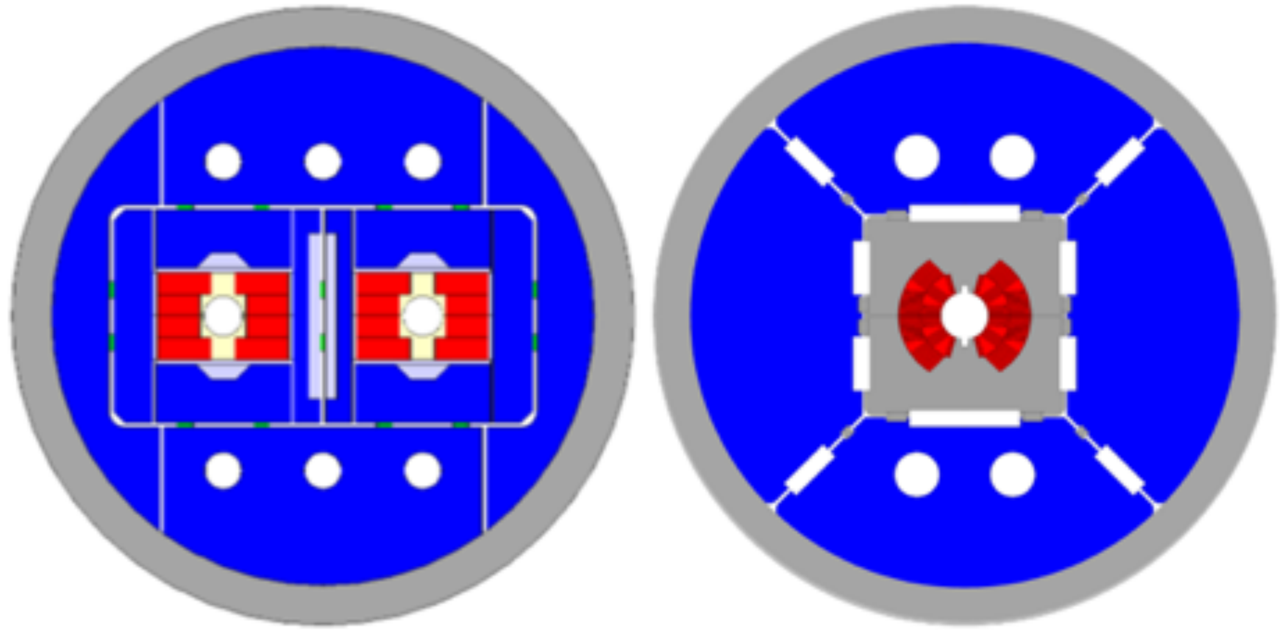
FCC-hh functional layout



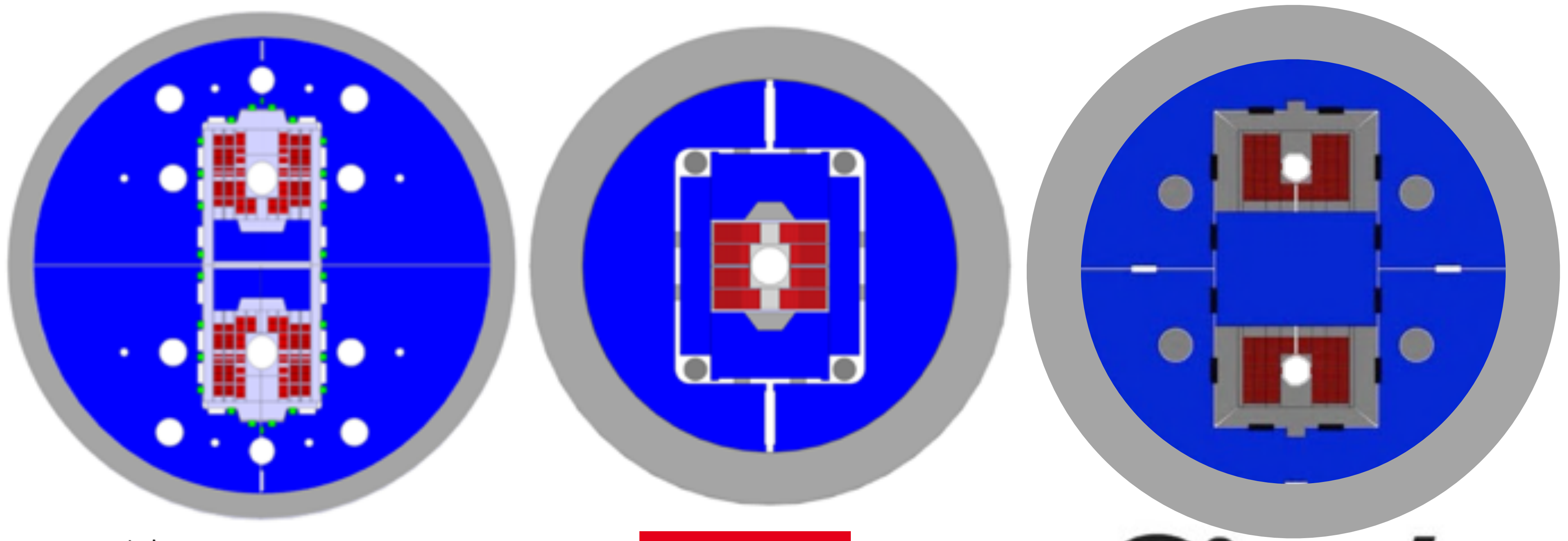
- For Nb_3Sn @ 1.9 K: 355 MW el, consumption and 2.3 TWh/y
- For Nb_3Sn @ 4.5 K potential to reduce to ~1.8 TWh/y as for FCC-ee.

FCC-hh High-Field Magnet Nb_3Sn and HTS R&D

Nb_3Sn:
- 12- and 14-T short demonstrators
- Different coil geometries
- tests scheduled for 2026



CERN
CERN INFN Istituto Nazionale di Fisica Nucleare



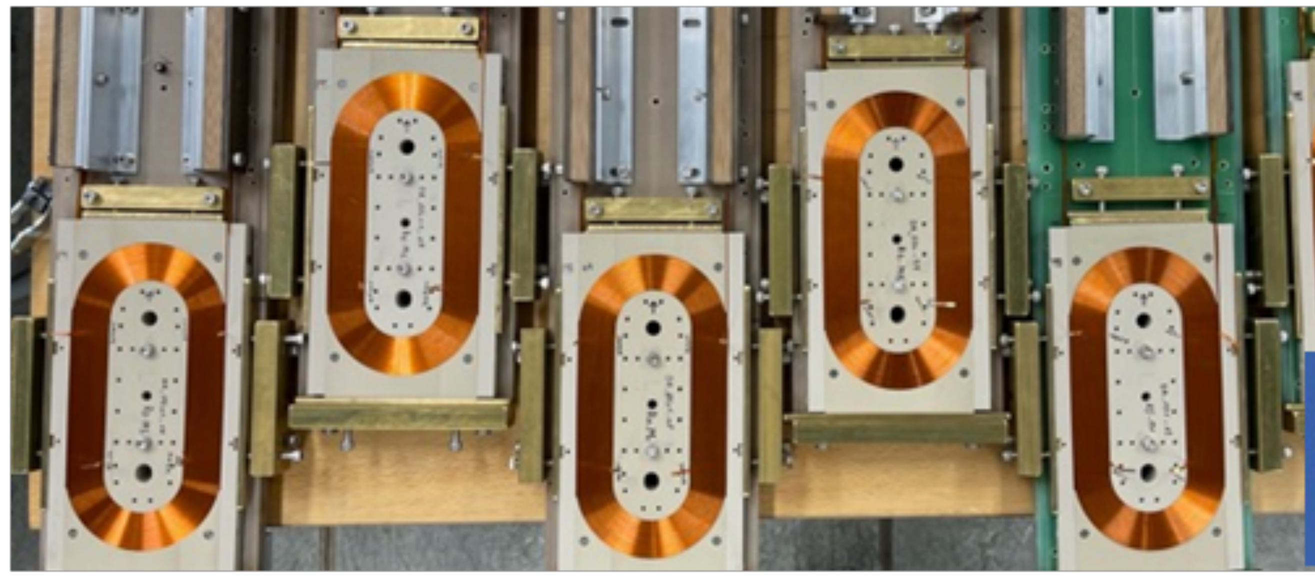
PSI
cea
Ciemat Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

B. Auchmann, E. Todesco

HTS R&D in various domains:
- REBCO and IBS Conductor R&D
- Racetrack coil developments

KIT Karlsruhe Institute of Technology
KC4 KIT-CERN Collaboration on CC

REBCO coated-conductor R&D line at KIT.

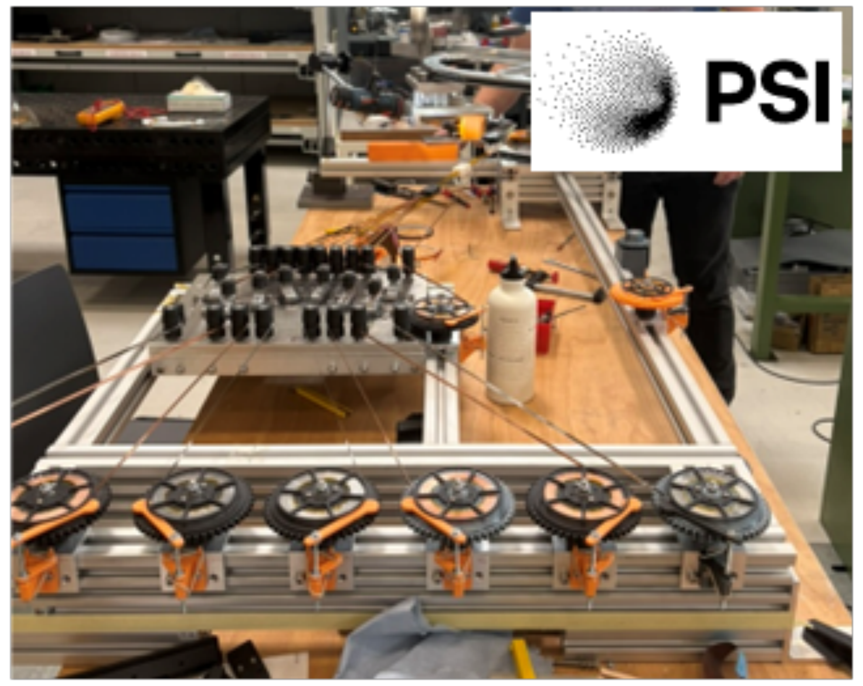


CERN

Insulated tape-stack coils for assembly in common-coil config at CERN.

SPIN

Iron-based SC powder synthesis and R&D tape fabrication at CNR SPIN



PSI

Fabrication of racetrack from solder-impregnated tape-stack cable at PSI.

cea

CEA process development for metal-insulated racetrack coils.

Down selection of technology by 2035-2040

FCC-ee cost estimate (FSR 2025)

Capital cost (2024 CHF) for construction of the FCC-ee is summarised below. This cost includes construction of the entire new infrastructure and all equipment for operation at the Z, WW and ZH working points.

Domain	Cost [MCHF]
Civil engineering	6,160
Technical infrastructures	2,840
Injectors and transfer lines	590
Booster and collider	4,140
CERN contribution to four experiments	290
FCC-ee total	**14,020**
+ four experiments (non-CERN part)	1,300
FCC-ee total incl. four experiments	**15,320**

Note: Upgrade of SRF (800 MHz) & cryogenics for $t\bar{t}$ operation corresponds to additional cost of 1,260 MCHF.

A global endeavour

From the FCC Feasibility Study …to the endorsement of the European Strategy

"An **electron-positron** Higgs factory is the highest-priority next collider. For the longer term, the European particle physics community has the ambition to operate a **proton-proton** collider at the highest achievable energy."

— CERN council approved the Strategy and CERN management implemented it —

FCC Feasibility Study (FS) started in 2021 and will be completed in 2025.

Mid-term review in 2023.

Mark Thomson

FCC and the European Strategy – digging deeper

- The **FCC-ee** would deliver the world's **broadest high-precision particle physics programme**
  - Outstanding discovery potential through the Higgs, electroweak, flavour and top sectors, as well as advances in QCD
  - Its technical feasibility is demonstrated via the FCC feasibility study
  - Scope and costs are well defined, plausible funding models exist
- The FCC-ee would maintain **European leadership in high-energy particle physics,** also advancing technology and providing societal benefits
- **FCC-ee** would also **pave the way towards a hadron collider** reusing the tunnel and much of the infrastructure, providing a direct **discovery reach well beyond the 10 TeV parton energy scale**

→ Flagship project at CERN, which will allow Europe to play a leading role in the field