ESPP Update – a velencei Open Symposium tanulságai

Varga Dezső, ESG delegált

- A “következő nagy gyorsító”-t keresi a CERN, ami 25-30 év múlva indulhat
- Tudományos cél: nem látszik hogy biztosan megválaszol-e egy “nagy kérdést”
- Nagyon sok szempont szóbajön, nem csak a fizika (pénz, emberi erőforrás, környezeti hatás...)

A kérdésfeltevés a (nemzeti, tudományos) közösségek felé

- 1. What is your preferred large-scale post-LHC accelerator for CERN?
- 2. What is your preferred alternative, if the preferred option would not be feasible?
- 3. What is your preferred alternative, if the preferred option would not be competitive?

- Megjelent a Physics Briefing Book és a Prelim. Project Assessment!

Visszatekintés: a 2020-as Update és ahogy megvalósult

- Cél volt a HL-LHC elindítása 2030-ig (2030-ban várható)
- Koordinált kutatási irányok: CERN Neutrino Platform; DRD kollaborációk
- Nem-”nagy-gyorsítós fizika” – széleskörű program
- Elektron-pozitron Higgs-gyár a “nagy gyorsító” prioritás – FCC Feasibility study
- Környezetvédelmi megfontolások (kibocsátás, hulladék)

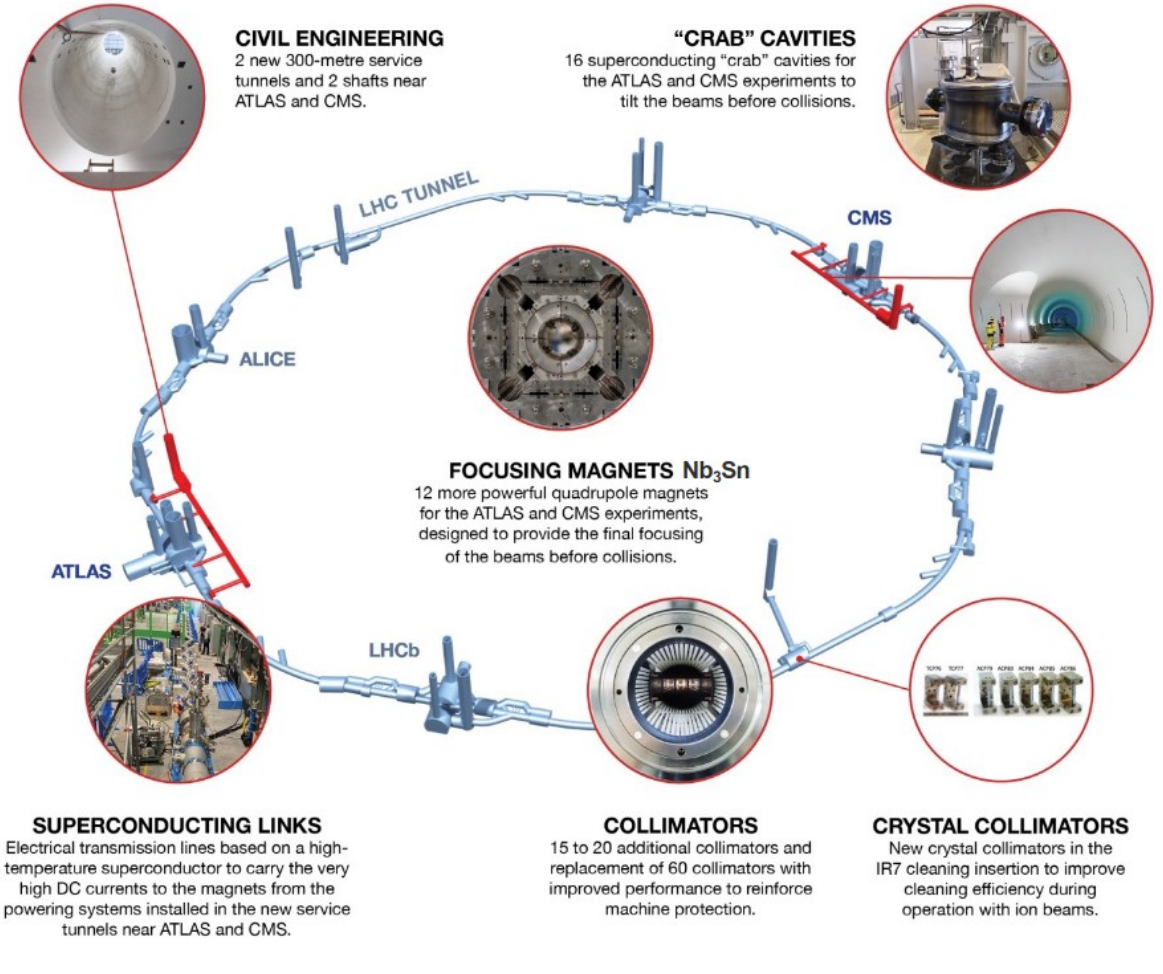
Fabiola Gianotti talk

HL-LHC : accelerator upgrade

- ~ 1.2 km of accelerator replaced
- variety of new technologies
- > 80% of budget committed

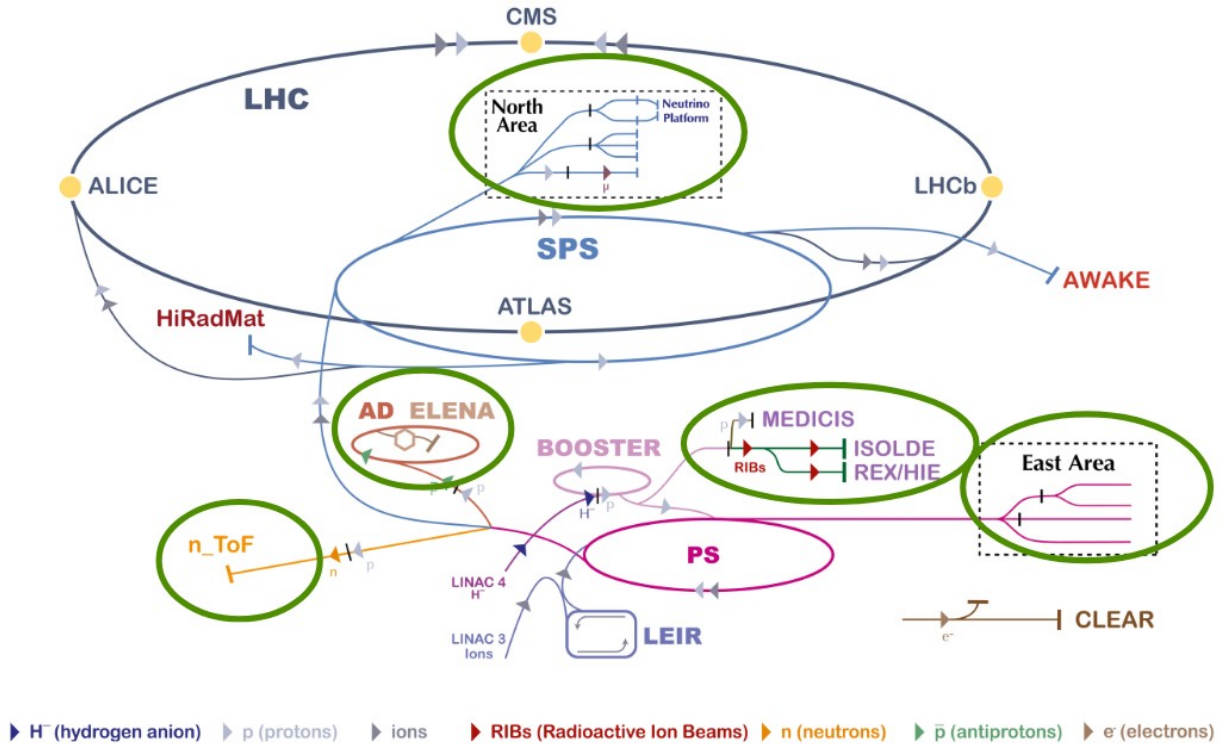
HL-LHC expected to start 2030

Detector upgrades:
CMS Phase 2
ALICE3



Physics Beyond Colliders Study Group (CERN)

Pursuing a compelling scientific programme complementary to high-energy colliders



ISOLDE: radioactive nuclei facility

n-TOF: n-induced cross-sections

CLOUD: impact of cosmic rays on aeorosols and clouds

AD / ELENA: Antiproton Decelerator for antimatter studies

COMPASS → AMBER: hadron structure and spectroscopy

NA61/SHINE: ions and neutrino targets

NA62: rare kaon decays

NA64: search for dark photons

NA65: study of tau neutrino production

Neutrino Platform: ν detector R&D for experiments in the US and Japan

SHiP: future beam dump experiment with high-intensity beams

Etc. etc.

Exploiting the unique capabilities of CERN accelerator complex
~ 20 projects, ~ 3 500 scientists

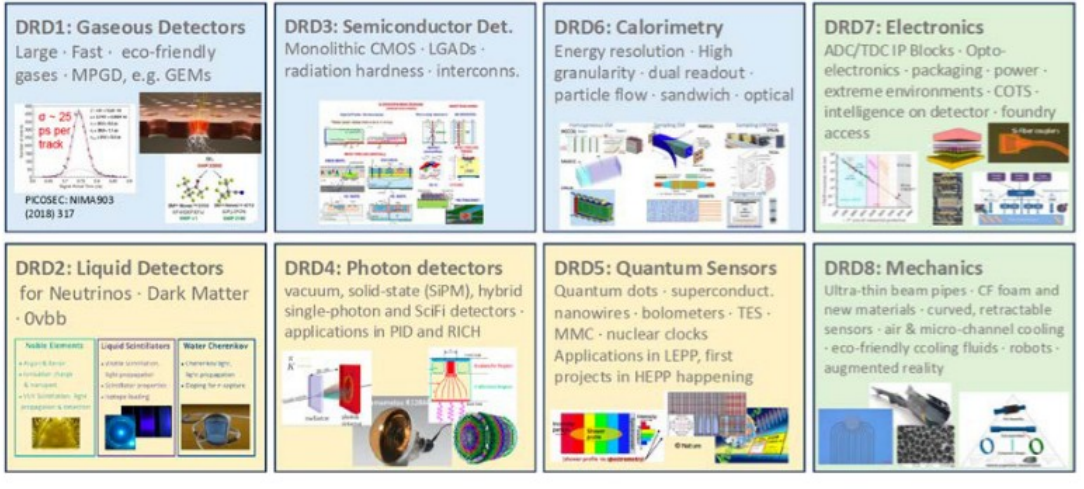
R&D on Detector Technologies

2020 Strategy Update:

*The **success of particle physics experiments relies on innovative instrumentation and state-of-the-art infrastructures.** To prepare and realise future experimental research programmes, the community must **maintain a strong focus on instrumentation**. **Detector R&D programmes and associated infrastructures should be supported at CERN, national institutes, laboratories and universities**. Synergies between the needs of different scientific fields and industry should be identified and exploited to boost efficiency in the development process and increase opportunities for more technology transfer benefiting society at large.*

“More solid funding support needs to be secured”

- Eight **Detector R&D Collaborations** (DRDs) have been set up, following the ECFA Detector R&D Roadmap, **focussing on strategic R&D**
- Still in infancy, but expected to grow, once HL-LHC is built
- **General Strategic recommendations** have not yet all been implemented



2026 Update: hogyan tovább?

- Következő “flagship project” minimum 30 év
- Európa (CERN) vezető szerepe megtartható-e?
- Biztos hogy rendkívül költséges, ki finanszírozza (pl US, ahogy a HL-LHC-t is)?
- Egyéb tudományterületek: hogyan kapcsolódik, melyekkel versenyzik (pénzügyi és emberi forrásokért)
- A CERN jövőjéről a CERN vezetősége dönt! Az ESPPU egy széles körű fórum a döntés megalapozására

Towards the recommendations on the next CERN flagship project

(1) Physics Potential

Physics Briefing Book (→ 30 Sept. 2025)

→ Assessment of overall Physics Potential **(ESG Working Group)**

(2) Project assessment

(Technical feasibility, required R&D, risks, timeline, costs and human resources (including estimates for the associated detectors), environmental impact

(ESG working group)

(3) Final input by the National HEP communities

(→ 14 Nov. 2025)

Részecskefizika nyitott kérdései

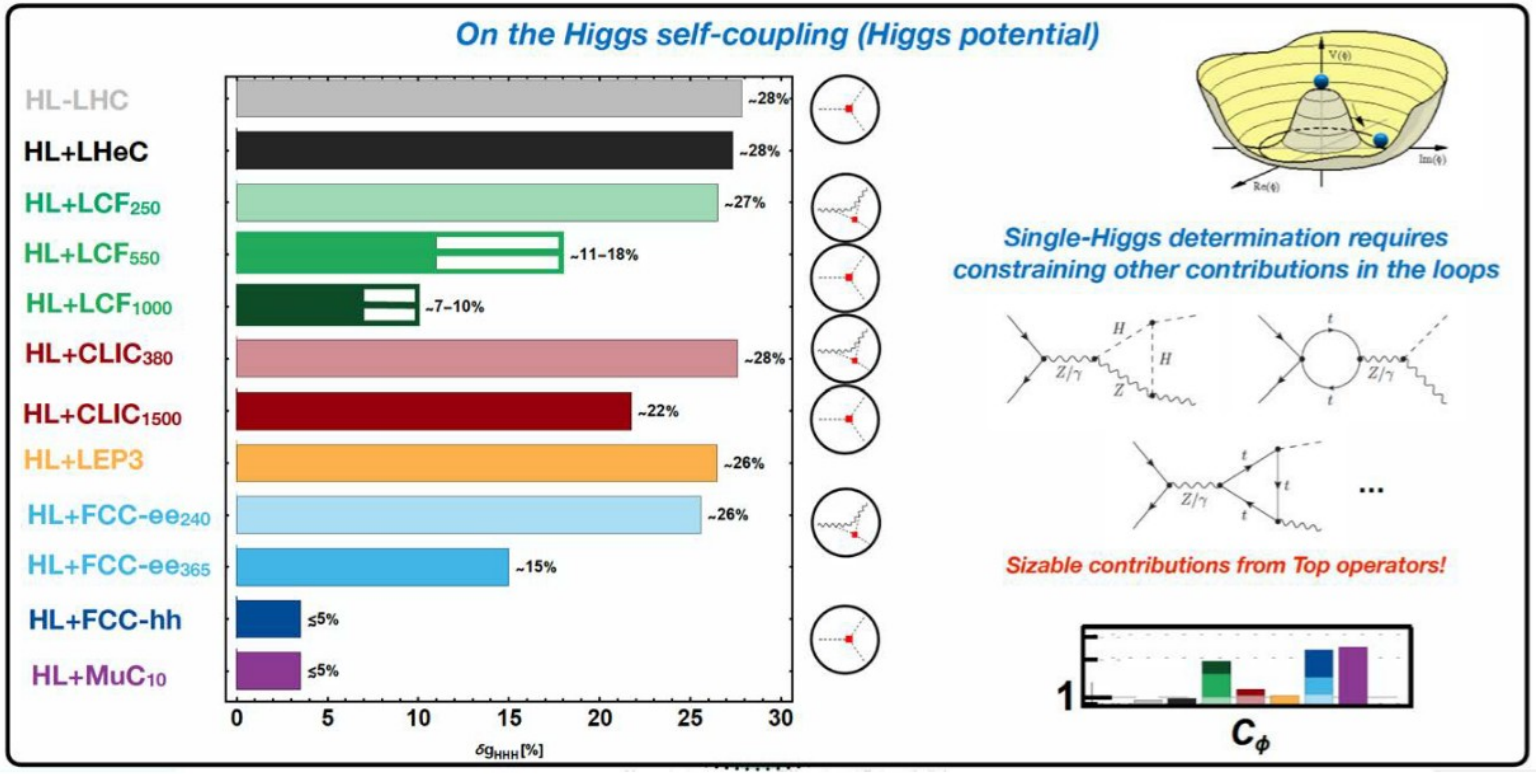
- Higgs öncsatolás (benchmark), HL-LHC biztosan “észleli”, FCC-ee valamelyest méri, FCC-hh precíziós mérés
- Íz-fizika (ritka bomlások, CKM mátrix precíziósan)
- Elektrogyenge csatolás precíziósan

- Sötét anyag, BSM, …. (és ezek kapcsolata más tudományágakkal, pl kozmológia)

Higgs-öncsatolás: p+p-ben mérhető jól, e+e- -ban nem

HL-LHC várható

FCC-hh
MuColl



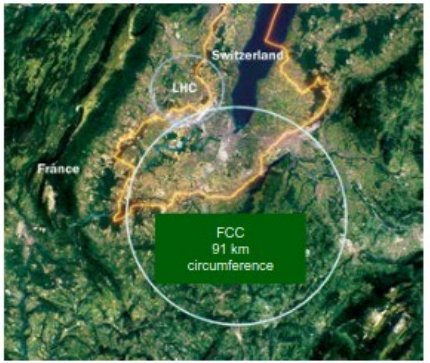
Gyorsító opciók (realisztikussági sorrendben)

- FCC-ee + FCC-hh
- Csak FCC-hh (ha megépül a CEPC?)
- LEP3
- Lineáris gyorsító
- Müon ütköztető

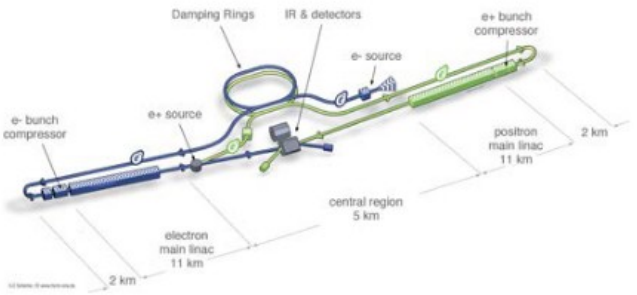
Proposed large-scale projects at CERN, ~ 2045

e^+e^- colliders
("Higgs factories")

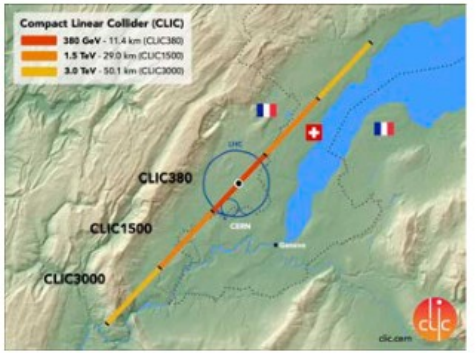
FCC-ee (e^+e^-, circular, 91 – 365 GeV)



LCF (e^+e^-, linear, 91 – 240, 550 GeV)



CLIC (e^+e^-, linear, 380 GeV, 1.5 TeV)



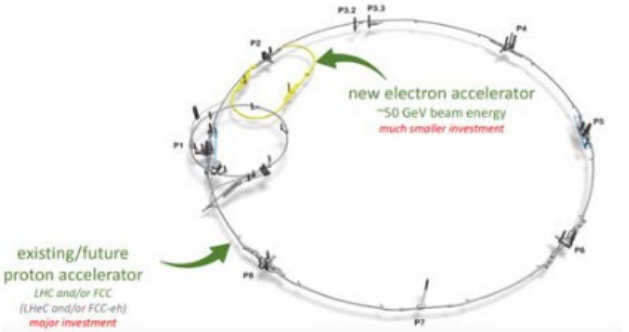
FCC: Feasibility Study elkészült

Intermediate projects

(Leave room (time, budget, resources) for further development of THE machine that can probe directly the energy frontier at the 10 TeV parton scale)

LEP3 (e^+e^-, circular, 91 – 230 GeV)

LHeC (ep, circular, electron ERL, 50 GeV e^-, > 1 TeV ep collisions)

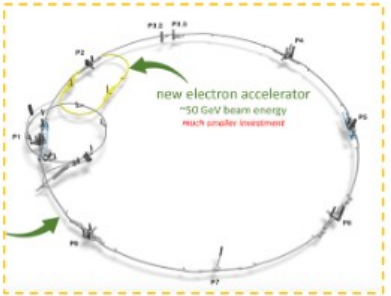


Potential for development: future 10 TeV parton-scale collider options

FCC-ee

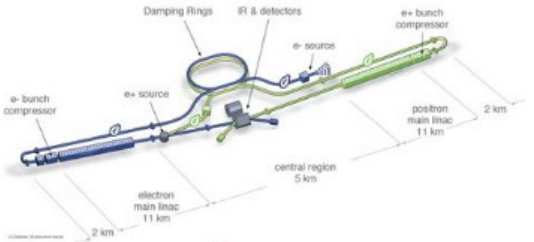
LEP3

LHeC



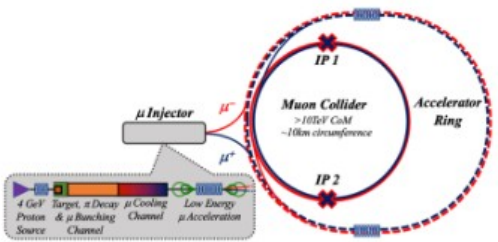
PERLE

LCF, CLIC



R&D

FCC-hh,
baseline 85 TeV (→ 120 TeV)



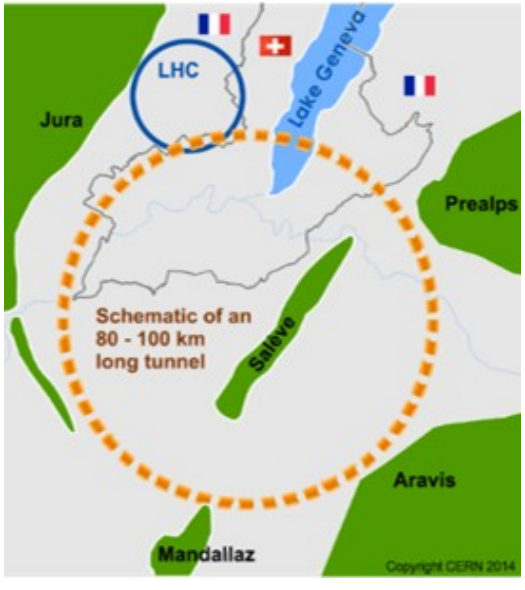
Muon Collider (3, 10 TeV)

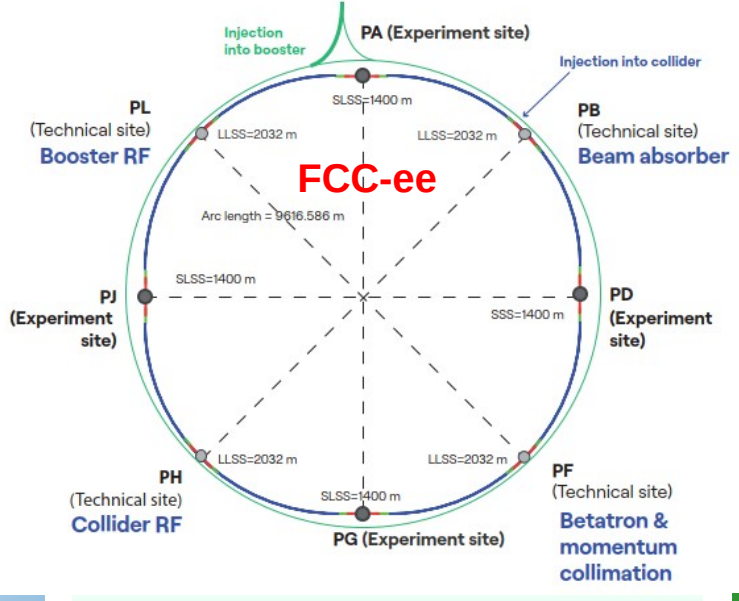
e^+e^- with improved acceleration technologies
LCF, C^3 (→ 1 TeV), CLIC (1.5 TeV), HALHF, …

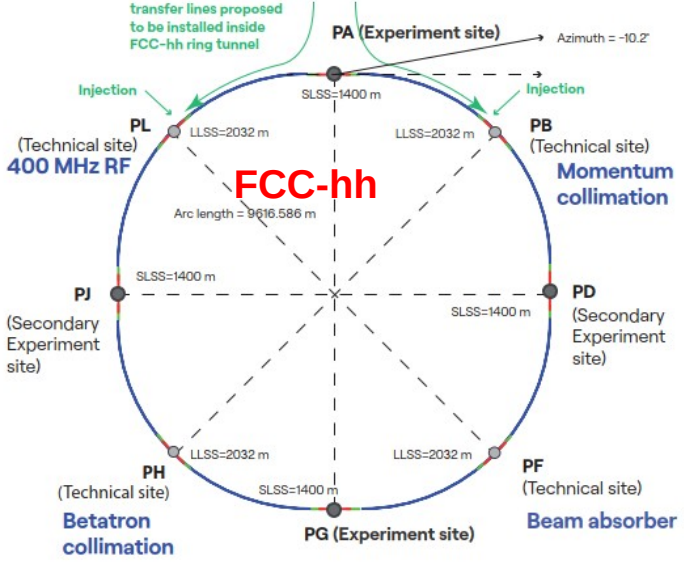
FCC integrated program – scope

M. Benedikt

- stage 1: FCC-ee (Z, W, H,) as Higgs factory, electroweak & top factory at highest luminosities
- stage 2: FCC-hh (~100 TeV) as natural continuation at energy frontier, pp & AA collisions; e-h option
- common civil engineering and technical infrastructures, building on and reusing CERN's existing infrastructure
- FCC integrated project allows the start of a new, major facility at CERN within few years of the end of HL-LHC exploitation



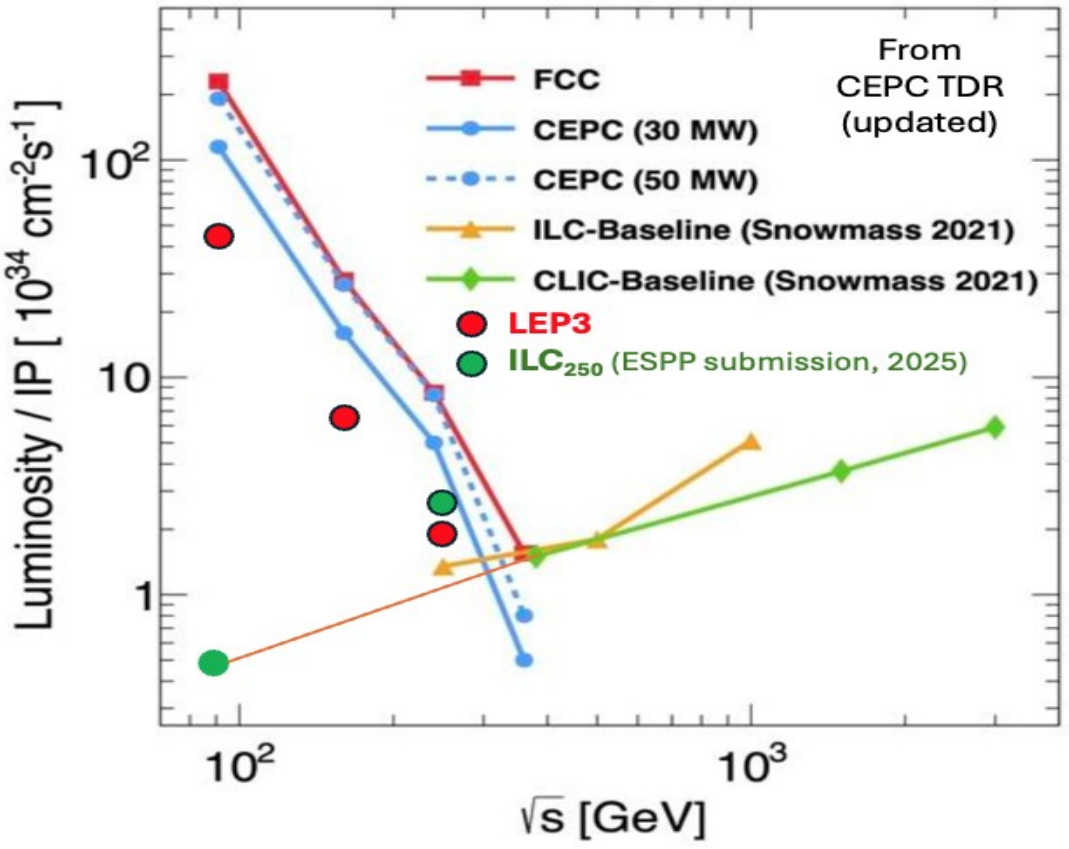




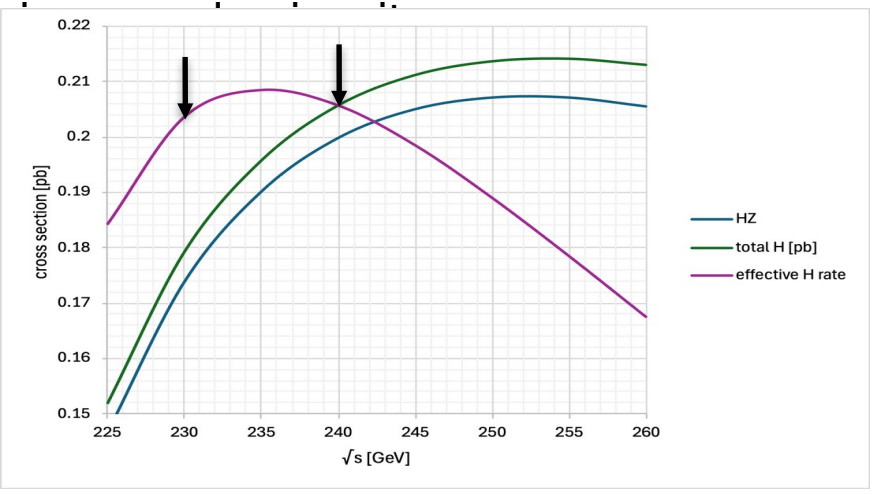
2020 - 2045 | 2046 - 2065 | 2070 - 2100

Imperial College London

e^+e^- Colliders: Instantaneous Luminosity & $\sqrt{s}$



In circular e+e- colliders, for the same synchrotron power loss, at a lower energy, more current can be put to



LEP3: Run at $\sqrt{s}$ =230 GeV

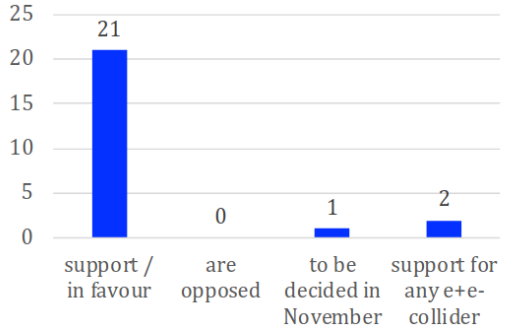
- Only 10% higher energy than LEP.
- 18% lower synchrotron power loss at $\sqrt{s}$=230 GeV compared with 240 GeV.

Nemzeti vélemények

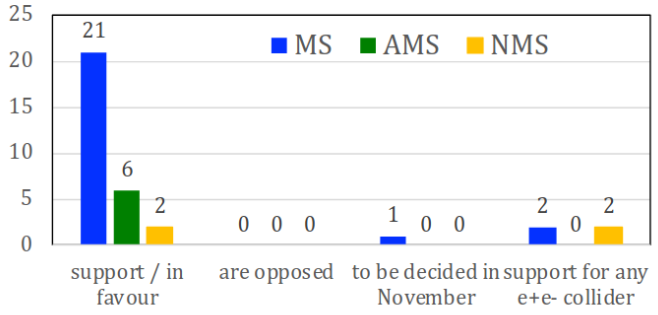
- FCC integrált program tűnik preferáltnak – nem látszik más, reméljük hogy “feasible”
- Magyar oldalról kiegészítés: LEP3 releváns-e? Nem-gyorsítós részecskefizika (kozmikus részfiz, GW)? Nem-nagygyorsítós fizika? (SPS, PS, ADC?) Folytonosság a karrierben, fiatal kutatók életpálya kilátások?

What is the preferred large-scale accelerator for CERN

CERN Member States (MS)



… incl. Associate- and Non-Member States (MS)



- Overwhelming support (21/24 CERN MS HEP communities) in favour of the integrated FCC-ee/hh programme
- Support as well from Associate Member states (AMS) and Non-member states (NMS)