FCC-contacts / July 21st 2023

Reunion FCC/DRD-contacts

vendredi 21 juil. 2023, 13:30 → 15:00 Europe/Paris

Description

13:30 → 13:50 **News, ILD, ECFA, DRD, IN2P3** 20m

Orateur: Gregorio Bernardi (APC Paris CNRS/IN2P3)

13:50 → 14:30 **FCC/DRD-France en 2023 @ IPHC 22-24 November 2023** 40m

Orateurs: Ziad El Bitar (IPHC), jeremy andrea (IPHC)

14:30 → 15:00 **Tour de table des activités dans les labos / Demandes Dialog / NSIP/mailing list** 30m

Orateurs: Dr Fairouz MALEK (LPSC-Grenoble, CNRS-IN2P3, UGA), Farès Djama (CPPM), Giovanni Marchiori (APC Paris), Jan Stark (L2I Toulouse, CNRS/IN2P3, UT3), Jean-Baptiste de Vivie (LAL Orsay), Luc Poggioli (LPNHE Paris), Marco Delmastro (LAPP), Nicolas Morange (IJCLab), Roberto Salerno (LLR), Stephane Monteil (Laboratoire de Physique de Clermont - UCA/IN2P3), Suzanne GASCON-SHOTKIN (IPN Lyon), Vincent BOUDRY (LLR - CNRS, École polytechnique/IPP Paris), Ziad El Bitar (IPHC), auguste besson (Institut Pluridisciplinaire Hubert Curien), jeremy andrea (IPHC)

Directorate meeting with CERN's personnel

- **Reiteration of the strong words already heard at P5/BNL and FCC week/London**
  - @ BNL: "The 2020 update of the European Strategy identified a Higgs factory as the highest-priority next collider and **FCC as the preferred option for a future collider at CERN**. FCC has immense physics potential but is also a very challenging and ambitious project. Feasibility Study will be completed at the end of 2025. Substantial resources allocated; plenty of opportunities for very interesting work. "
  - @ London: "I believe **FCC is the best project for CERN's future** ! we need to work together to make it happen" & "It's the only facility commensurate to the size of the CERN community (**at least 4 experiments**)"
    - → PJ: "Best FCC week ever, with high momentum building up towards approval"
- **Now expressed to a wider audience (and future builders/users)**

Scientific vision and programme

Based on the 2020 updated of the European Strategy for Particle Physics (ESPP)

Full exploitation of the LHC:

- successful Run 3: $\sqrt{s}$ =13.6 TeV; integrated luminosity targets: 250 fb^{-1} (ATLAS and CMS), 25-30 fb^{-1} (LHCb), 7 nb^{-1} (ALICE, Pb-Pb)
- High-Luminosity LHC upgrade (construction underway, further upgrades to ALICE and LHCb being planned): operation 2029-2041

"Scientific diversity" programme complementary to LHC experiments:

- current experiments and facilities at Booster, PS, SPS
- participation in accelerator-based neutrino projects outside Europe (currently mainly LBNF/DUNE) through Neutrino Platform
- new opportunities (e.g. North Area upgrade to higher intensity beams) initially nurtured in "Physics Beyond Colliders" study group

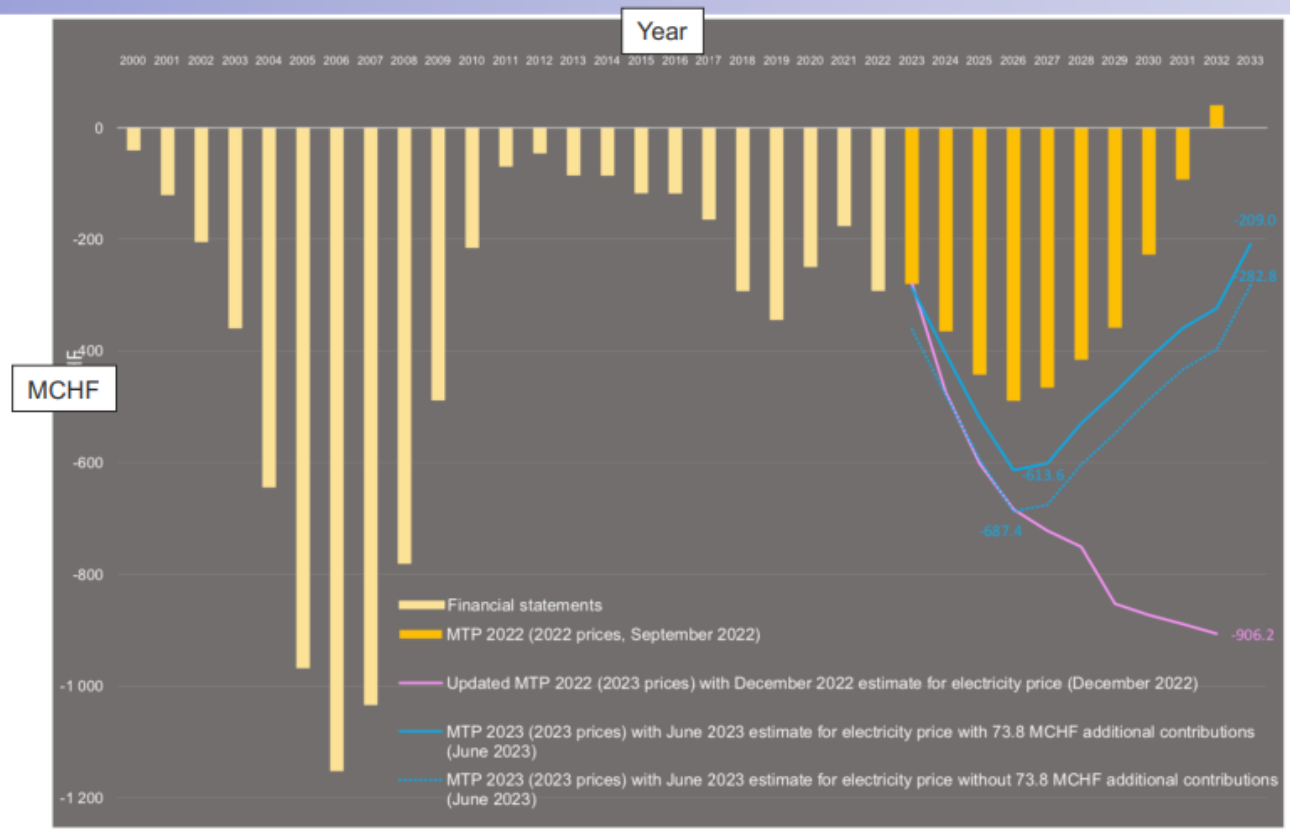
Preparation of CERN's future:

- intense accelerator, detector and computing R&D programmes
- Future Circular Collider (FCC) Feasibility Study → report end 2025
- R&D and design studies for alternative options: CLIC, muon colliders → reports end 2025

Next update of ESPP expected in 2026-2027 → input to be submitted by end 2025

Can CERN afford FCC?

Cumulative budget deficit in 2023 MTP



CBD in 2023 MTP is back to “healthy shape”, thanks to the additional, exceptional contribution from Member and Associate Member States (73.8 M), significant savings from CERN’s Budget (280 M, including 8.7 M crisis levy on staff basic salaries) and reduction of electricity costs (125 M over 2024-2028), which, all together, more than offset the additional expenses

Why FCC ?

1) Physics : best overall physics potential of all proposed future colliders

- ❑ FCC-ee : ultra-precise measurements of the Higgs boson, indirect exploration of next energy scale (~ x10 LHC)
- ❑ FCC-hh : only machine able to explore next energy frontier directly (~ x10 LHC)
- ❑ Also provides heavy-ion collisions and, possibly, ep/e-ion collisions
- ❑ 4 collision points → robustness; specialized experiments for maximum physics output

2) Timeline

- ❑ FCC-ee technology is mature → construction can proceed in parallel to HL-LHC operation and physics can start few years after end of HL-LHC operation (2045-2048) → This would keep the community, in particular the young people, engaged and motivated.
- ❑ FCC-ee before FCC-hh would also allow:
  - cost of the (more expensive) FCC-hh machine to be spread over more years
  - 20 years of R&D work towards affordable magnets providing the highest achievable field (high-T superconductors!)
  - optimization of overall investment : FCC-hh will reuse same civil engineering and large part of FCC-ee technical infrastructure

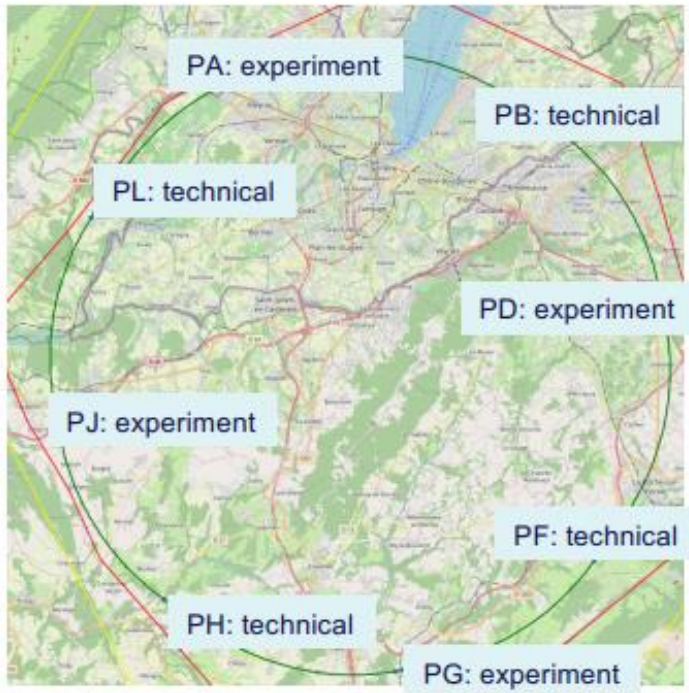
3) It's the only facility commensurate to the size of the CERN community (4 major experiments)

Is it feasible? Isn't it too ambitious?

-- Ongoing Feasibility Study showing spectacular progress → see next slide
-- FCC is big, audacious project, but so were LEP and LHC when first conceived → they were successfully built and performed far beyond expectation → demonstration of capability of our community to deliver on very ambitious projects
-- FCC is best project for future of CERN (for above reasons) → we have to work to make it happen

Recent progress of the FCC Feasibility Study (only few examples here …)

- Implementation scenario fixed : ~ 91 km ring, 8 surface sites
- Work to adapt design parameters of colliders, injectors and infrastructure to implementation scenario well advanced.
- First round of direct exchanges with all municipalities affected by surface sites completed. Very fruitful interactions with Host States (FR and CH) at national and local levels (e.g. concerning land reservation, powering and other infrastructure, coherent communication with the populations, etc.). Environmental studies ongoing.
- 3D underground civil engineering model established for scheduling and costing purpose.
- Completing preparation work for detailed site investigations (9 areas with uncertain geological conditions) that will start in 2024
- Significant progress on design and parameter optimisation of FCC-ee, FCC-hh and injectors
- R&D work ongoing for main technologies, including construction of mock-up and small components and proof of principle demonstrations for several items (MDI, positron source, high-field magnets, etc.)
- Funding scenarios developed → being discussed with Council.
- Fruitful ongoing discussions with US, European Commission and other potential partners about their possible contributions.



Five years ago …

- **CDR run plan and projected integrated luminosities** (1 year = 1.08×10^7 seconds)

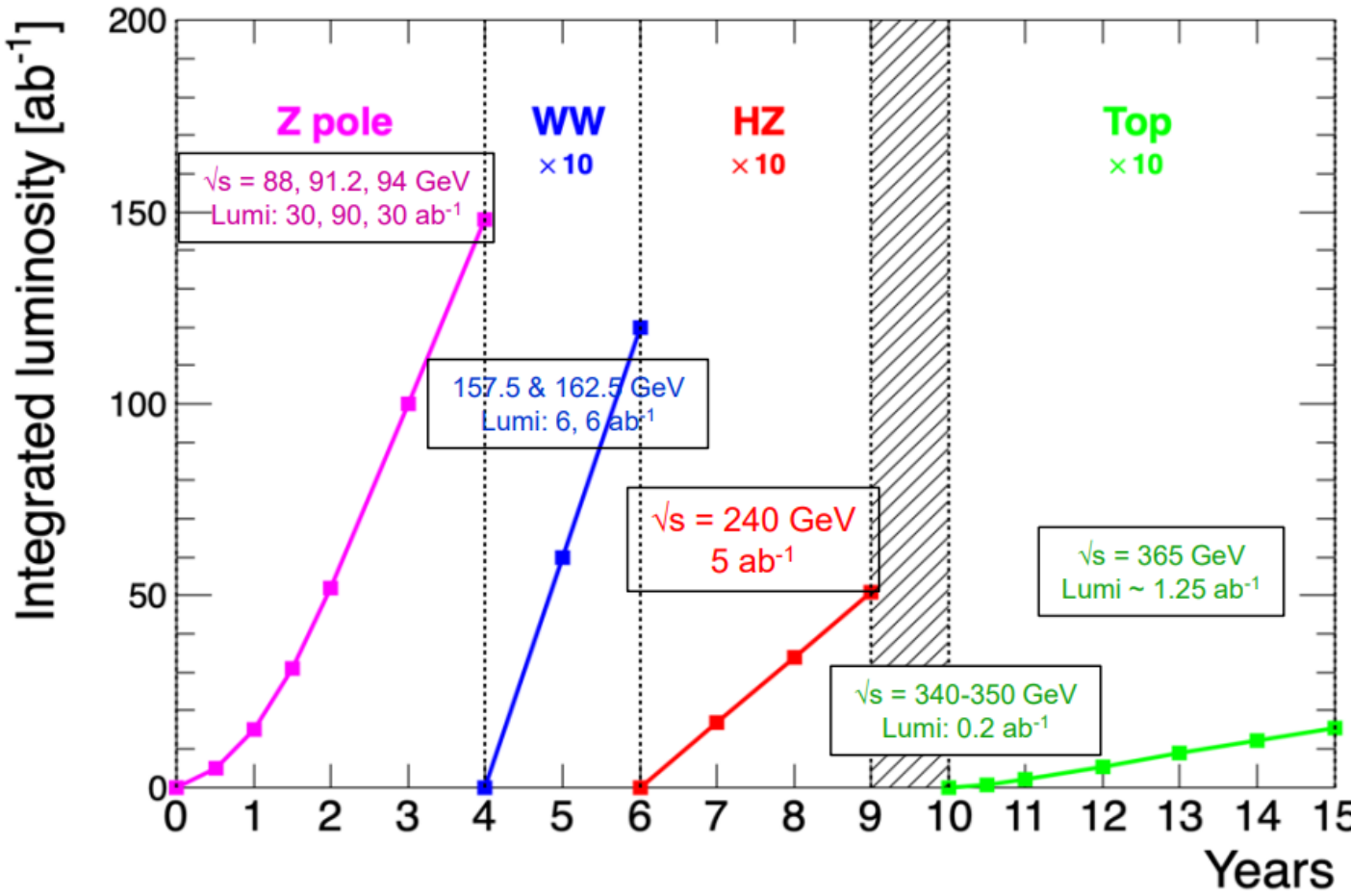
Working point	Z, years 1-2	Z, later	WW	HZ	$t\bar{t}$	
$\sqrt{s}$ (GeV)	88, 91, 94		157, 163	240	340-350	365
Lumi/IP ($10^{34}\,cm^{-2}s^{-1}$)	115	230	28	8.5	0.95	1.55
Lumi/year (ab^{-1}, 2 IP)	24	48	6	1.7	0.2	0.34
Physics Goal (ab^{-1})	150		10	5	0.2	1.5
Run time (year)	2	2	2	3	1	4
Number of events	5×10^{12} Z		$2\,10^8$ WW	10^6 HZ + 25k WW → H	$10^6 t\bar{t}$ +200k HZ +50k WW → H	

- **Table taken from "FCC-ee: Your Questions Answered"** https://arxiv.org/abs/1906.02693
  - A sensible way to distribute luminosity within the original constraints of the study
    - ➔ Two interaction points, fifteen years of running
  - Deemed just sufficient for a minimal (yet remarkable) physics outcome
    - ➔ With the smallest possible set of centre-of-mass energies
    - ➔ Enabling the study of all particles of the Standard Model with a real chance of discovery

See PED summary talk from Guy Wilkinson at the FCC week 2023

Five years ago …

- **Proposed sequence of events**
  - **Was not defined by scientific considerations, but was set by practical arguments**
    - Most natural technically
    - Most effective RF-staging plan
    - Most economic funding profile
  - **Total duration: 15 years**



  - **Altogether, it offered the quickest and most affordable execution of the project**

FCC Week 2023: Updated parameters

For the mid-term report: Luminosity / IP has decreased at all energies since the CDR

- The ring shrank from 100 km to 90.7 km
  - ~10% luminosity reduction
    - ➔ e.g, from 230 to ~210.10^{34} cm^{-2} s^{-1} at the Z pole
- With the updated ring layout, the baseline number of IPs moved from 2 to 4
  - New baseline advertised by Fabiola at the BNL P5 meeting
    - ➔ "Commensurate with CERN's scientific ambition and size of community"
  - With a gu-estimated reduction factor of 0.85 at each IP (with respect to 2 IP)
    - ➔ e.g, from 210 to 180.10^{34} cm^{-2} s^{-1} at the Z pole: almost 10^{13} Z and 2 10^{6} ZH with 4 IP
- Instabilities were discovered (too short lifetime), and lattice was fixed for the FCC week
  - With 2 IP and 4 IP (more severe with 4 IP)
    - ➔ Reduction from 180 to 140.10^{34} cm^{-2} s^{-1} at the Z pole (4 IP)
    - ➔ Reduction from 210 to 180.10^{34} cm^{-2} s^{-1} at the Z pole (2 IP)

See Frank's presentation

We look forward to a substantial luminosity increase at all energies for the final report

Keeping the CDR physics menu and sequence (4 IPs)

- **Instantaneous/integrated luminosities, updated parameters** (1 year = 1.2 × 10^7 seconds)

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} cm^{-2}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 HZ + 45k WW → H	1.9 10^6 $t\bar{t}$ +330k HZ +80k WW → H	

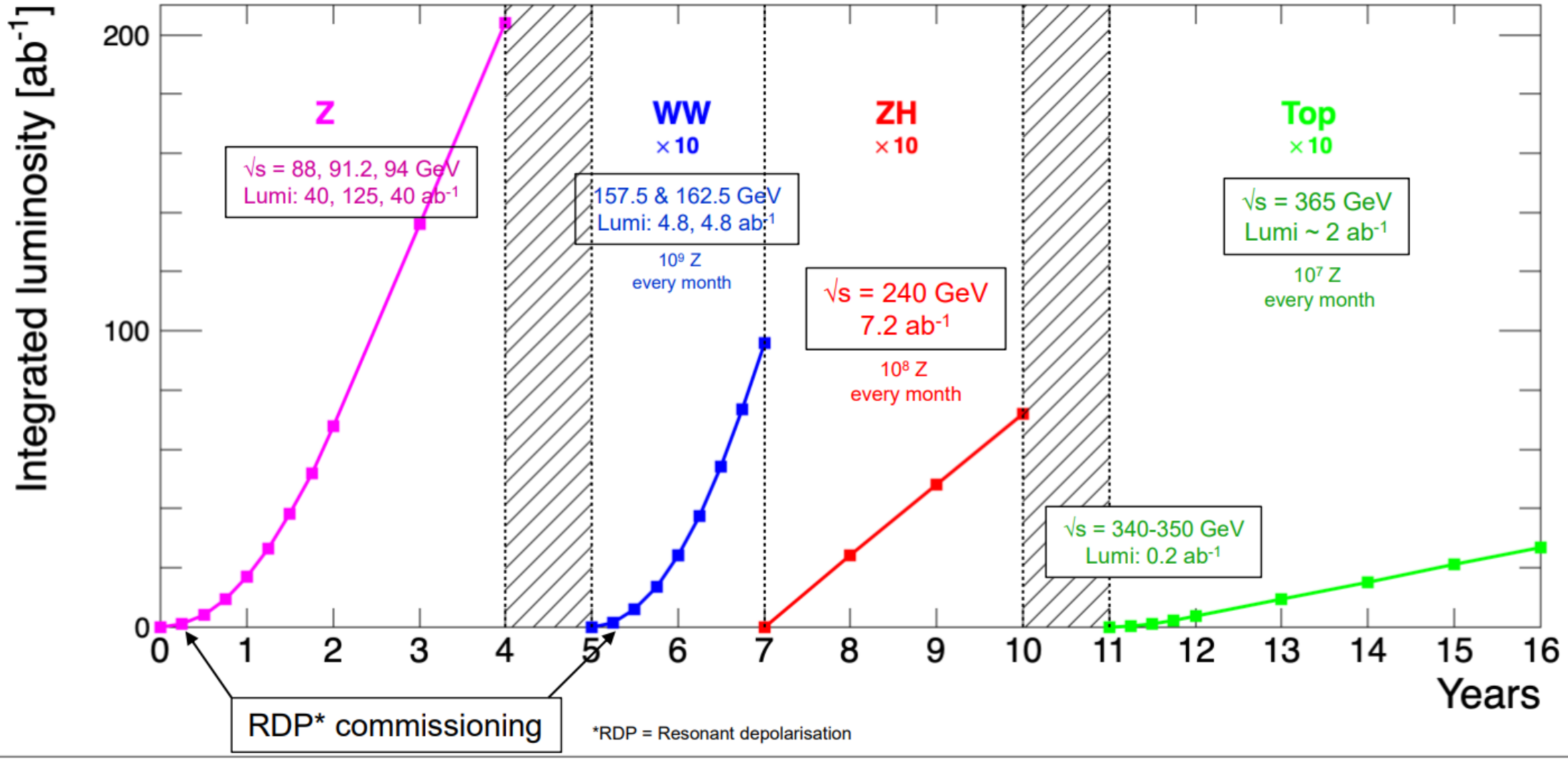
CDR (2 IPs): 5.10^{12} Z 2.10^8 WW 10^6 ZH 10^6 tt

- These numbers will be the baseline for the PED chapter of the mid-term report
- A few new items with respect to the CDR
  - One year shutdown to install the ZH + WW RF system
  - Two years at half-luminosity for the ZH + WW run
    - ➔ The ZH + WW run may start either with ZH or with WW

Total duration: 16 years

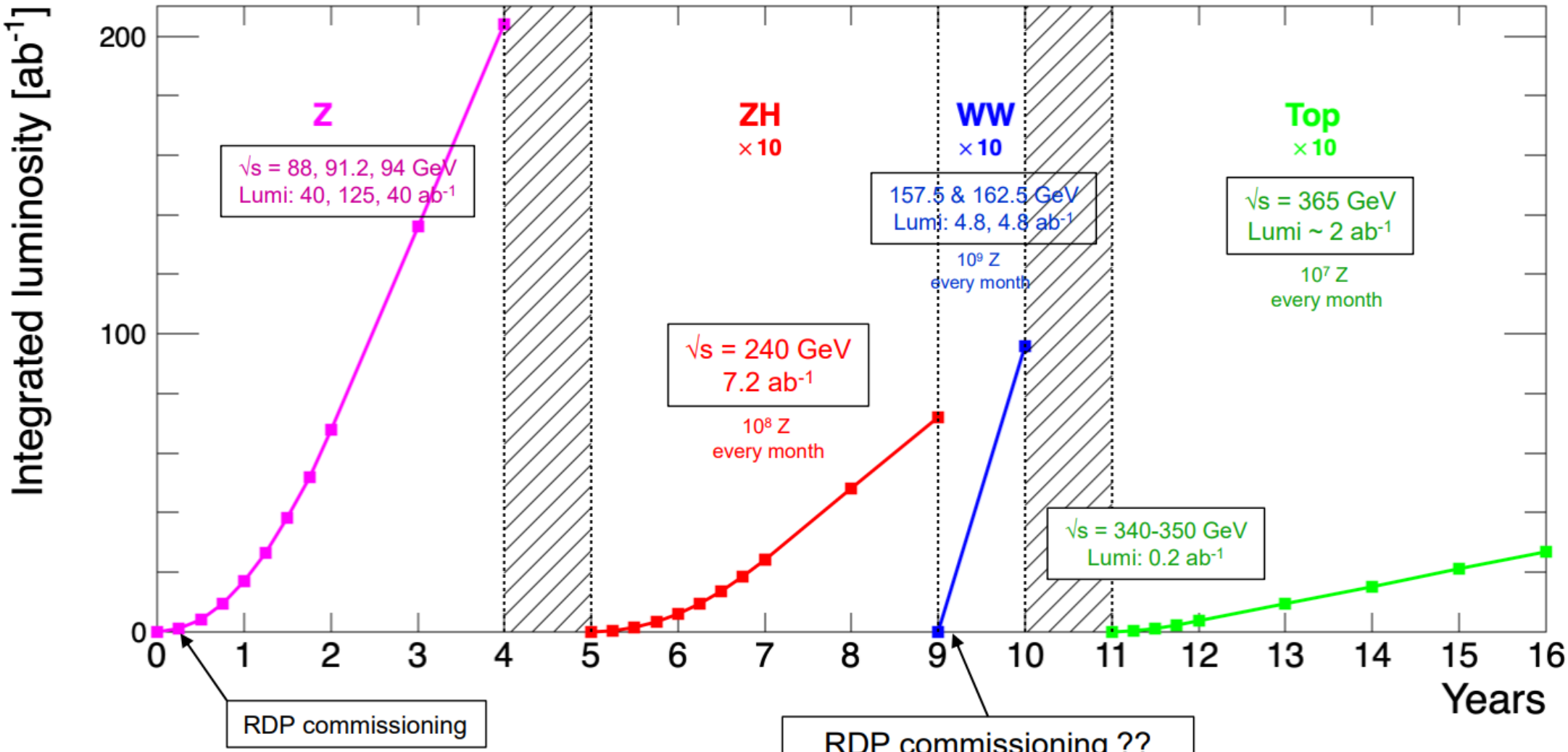
Baseline sequence with 4IPs

- **Baseline for the mid-term review**



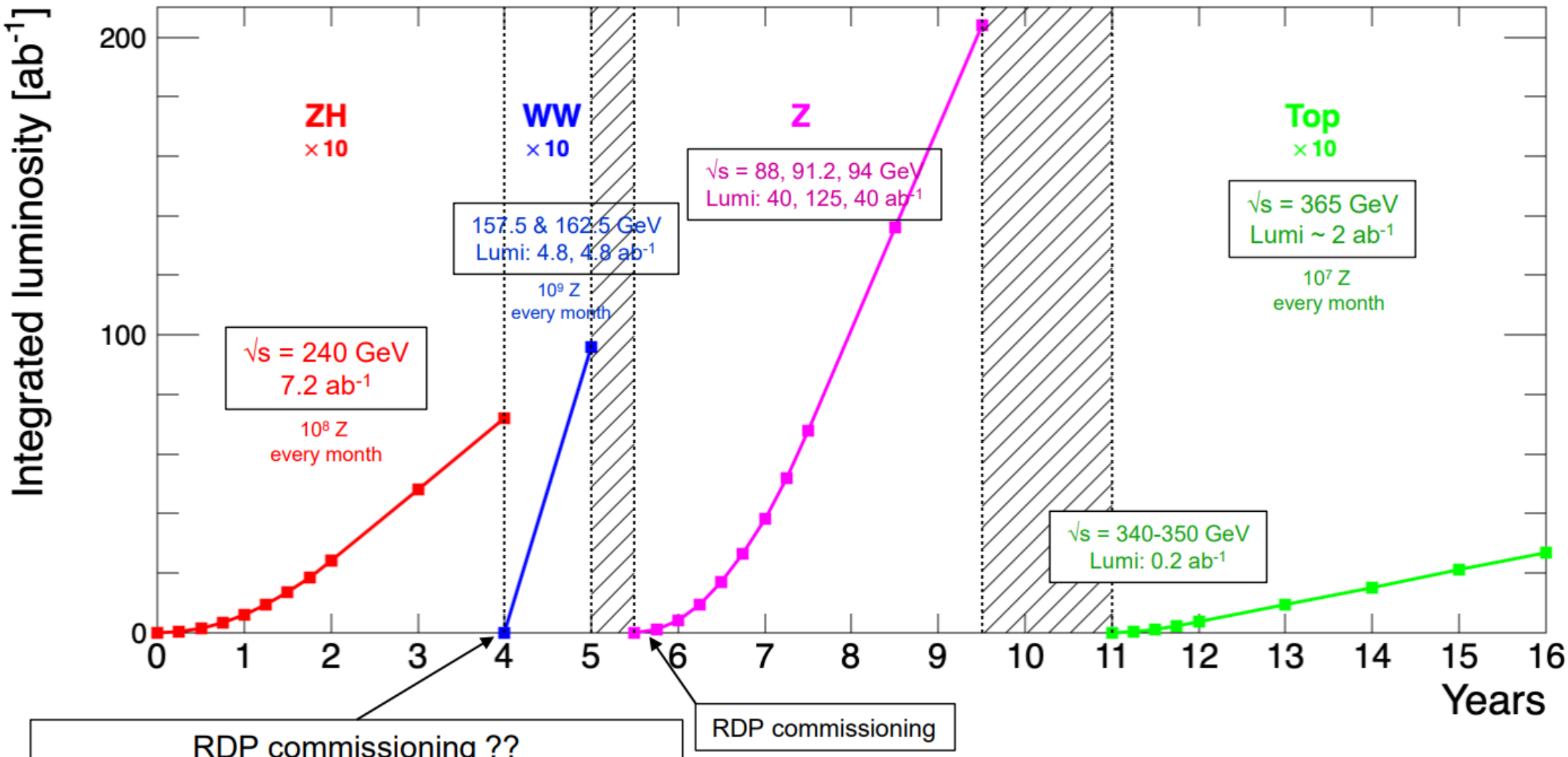
Alternative sequence with 4IPs (1)

- **First alternative: ZH runs starts after 5 years (instead of 7 years)**



Alternative sequence with 4IPs (2)

- **Second alternative: Start with the ZH run**



Towards a new run plan for the final report ?

- **Three important axioms resulted from our reflexions**
  - **All energy settings are needed to extract the (minimal) baseline FCC-ee physics outcome**
    - With the maximal integrated luminosity at each energy
    - Irrespective of their chronological sequence

See PED summary talk from Guy Wilkinson at the FCC week 2023

  - **The FCC-ee scientific outcome can be greatly extended**
    - With more energy settings
    - With larger integrated luminosities
      - ➔ Larger specific luminosity; More luminosity / IP; More IPs; More running time …
    - With adequate flexibility of operation and readiness for surprises / exotic user requests
  - **The TeraZ run is the most ambitious part of the FCC-ee, scientifically and technically**
    - Flexibility and readiness for surprises will be the key here
    - It is recommended not to confine it to a single block in the first four years of operation
    - It is important to establish the feasibility of scheduling a Z pole run after the ZH/WW run
      - ➔ Ideally with a first Z pole run during the initial period of operation

Workshops / news from ECFA

3. ECFA-EPS meeting at EPS Conference in August 2023

- The EPS-HEP Conference will take place in Hamburg from 21 – 25 August
(change of format, Monday – Friday, **ECFA-EPS session on Thursday 24 Aug, 16:30 – 18:45**)

16:00	**Coffee break** *Audimax, Universität Hamburg*	16:00 - 16:30
	Introduction by the ECFA chair — *Karl Jakobs* *Audimax, Universiatet Hamburg*	16:30 - 16:35
	The FCC feasibility study — *Michael Benedikt* *Audimax, Universiatet Hamburg*	16:35 - 17:05
17:00	**Status of e+e- Higgs factory projects** — *Jenny List* *Audimax, Universiatet Hamburg*	17:05 - 17:35
	ECFA study on e+e- Higgs factories — *Giovanni Marchiori* *Audimax, Universiatet Hamburg*	17:35 - 18:00
18:00	**The ECFA early career researcher panel** — *Armin Ilg* *Audimax, Universiatet Hamburg*	18:00 - 18:15
	ECFA detector R&D roadmap — *Didier Contardo* *Audimax, Universiatet Hamburg*	18:15 - 18:45

In addition there are two **Plenary Talks**:

- Overview on Detector R&D highlights / recent achievements (Erika Garutti, Hamburg)
- Overview on Accelerator R&D highlights / recent achievements (Steinar Stapnes, CERN)

News from ECFA

- Karl's mandate as head of ECFA is finishing this year
- Election of new chair: Sept. 16, Lisbon
  - 12 nominations
  - 6 nominees accepted to run for election
    - Daniela Bortoletto UK
    - Paris Sphicas Greece
    - Gregorio Bernardi France
    - Juan Fuster Spain
    - Matthew Wing UK
    - Aleandro Nisati Italy

Preferential vote, one ranked list per European country, ECFA member or associate (29 countries voting)

News from ECFA I

- **Second Higgs/EW/Top Factory ECFA Workshop,**
  - 11 (wed)-13(fri) October 2023, Capaccio-Paestum
  - Webpage: https://agenda.infn.it/event/34841/
  - Registration open till Oct. 4 (Sept. 13 if you want to have a seat on the bus from/to Naples airport)
  - Fees: 460 EUR will full board at the conference hotel

- **Upcoming meetings**
  - June 21-22, Brussels: 2nd Topical Meeting on Generators – link
  - Wed. June29, 2pm: ECFA WG1 FLAV 1st meeting (zoom) – link

ECFA workshop timetable

Tue 10th Oct	Wed 11th Oct	Thu 12th Oct	Fri 13th Oct
	Plenary – Theory landscape Focus topics	Plenary – WG2 & WG3	Plenary – WG1, 2 & 3
		Coffee	Coffee
Software tutorial (optional)	Coffee	Plenary – special topics Detector issues How to present the Higgs factory case	Plenary – WG2 & WG3 Physics vision
	Parallel – Focus topics		
	Lunch	Lunch	
Software tutorial (optional)	Parallel	Parallel	
	Tea		
	Parallel	Tea	
		Plenary – Status of Higgs factory projects Towards a Higgs factory and beyond	
		ECR panel discussion	
	Poster session		
Dinner	Dinner	Workshop dinner	

Strong focus is put on on high-priority topics;

+ lot of room for discussions

Focus Topics

1. H->ss
2. ZH angular distributions / CP studies
3. Higgs self-coupling
4. W mass at threshold and continuum
5. Full studies of WW and evW processes, aTGCs
6. Top threshold detector-level sim study & scan optimisation
7. Luminosity measurement
8. New exotic scalars
9. Long-lived particles
10. Exotic top decays
11. CKM matrix elements with on-shell & boosted W decays
12. B → $K^{0*}\tau^+\tau^-$
13. EWK precision: 2-fermion final states
14. Measurement of b- and c-fragmentation functions / hadronisation
15. Measurement of gluon splitting to bb / cc & interplay with separating h → gluons from h →bb/cc

	relevant $\sqrt{s}$			
	91 GeV	161 GeV	240/250 GeV	350-380 GeV
1			X	X
2			X	X
3			X	X
4		X	X	X
5			X	X
6				X
7	X	x	x	x
8	x	x	x	x
9	x	x	x	x
10				x
11		x	X	x
12	X			
13	X	X	X	X
14	X	x	X	X
15	X	x	X	X

All containing many aspects, e.g. theory calculations / MC generators / reconstruction techniques / EFT interpretation / detector-level studies / interface to detector requirements / …

7th FCC PED/Physics Workshop

- **Host: LAPP, Annecy.**
  - **see the presentation by G. Lamana at the last PED coordination meeting**
- **Dates: Jan. 29-Feb. 2, 2024**
  - Rooms booked for us:
    - Auditorium (211);
    - Amphitheatre (54);
    - One room (16);
    - One room (34);
- **Local Organization**
  - Local organizers: G. Lamana + TBA

- (IAS Hong Kong HEP programme: Jan. 8-26)
- Chamonix week?

FCC/Higgs Factory/DRD France-Italie workshop en 2024

Proposition de dates: du Lundi 4 Novembre matin au Mercredi 14h (arrivée Dimanche donc)

Palazzo Franchetti.

C’est le week-end du 1er Novembre (qui est un vendredi) donc il faudra réserver tot.

FCC/Higgs Factory/DRD France workshop @ IPHC 22-24 Novembre

IPHC organisera le FCC France/Higgs Factory/DRD workshop du mercredi 22 midi au vendredi 24 Novembre 14h

Laurent Vacavant a confirmé sa presence jeudi et vendredi (arrivée mercredi soir)

Organisation scientifique

Thèmes/ organisation des sessions:

- DRD / FCC oriented Auguste, Didier, Giovanni, Nicolas, Suzanne, Vincent, Maxim, Paul
- Software: Ziad, Gerald
- Physics Cases studies Fairouz, Fares, Luc, Marco, Roberto, Stéphane
  + Pheno G. Cacciapaglia
- General/Proto-collaborations/EoI Détecteurs Didier, Greg, Laurent S., Roy, All

Wednesday 22/11			
Welcome and lunch at noon			
Plenary session-1 14h-15H30			
13:50-14:00	Welcome		
14:00-14:30	FCC general status		
14:30-14:50	Accelerator overview		
14:50-15:00	Goals of the workshop		
	Talk about LHC end / Upgrade		
coffee break			
Plenary session-2 16H00-18H30		**Physics**	
18H30-19H30 Round table ?			
Thursday 23/11			
09h-10h45 Tracking-1			
coffee break			
11h15-13h00 Calo-1			
LUNCH break			
14h15-15h45 Software/Analysis			
coffee break			
16h15-18h00 Discussion / Which Options			
Friday 24/11			
09h-10h00		**Tracking-2**	**EoI's**
10h-11h00		**Calo-2**	**EoI's**
coffee break			
11h30-12h45		**Physics/Software**	
		Conclusions	

A discuter lors de notre dernière réunion avant le break:

Vendredi 21/7 à 13H30 (ou jeudi ?)

Tour de table

APC
CPPM
IJC Lab
IPHC
IP2I
LAPP
LLR
LPC
LPNHE
LPSC
L2IT

COUT VOYAGE	Annecy FCC Phys wkshop 1000	US FCC-week 2500	FCC-France italie/venise 1300	FCC-meet CERN 400	ECFA FC wkshop 1300	stages & FCC-FR & info.	TOTAL (kE) TOT	TOT with col. H	notifié 2023	(* = en tenar
APC+FCC-FR	3000	5000	3900	1600	3900	6000	17,4	23	15	GB(0,8*), GM(0,4*),
CPPM	0	0	0	0	0		0	0	3	FD(0,35*)
IJC Lab	0	0	0	0	0		0	0	5	NM(0,4*), JL(0,35*)
IPHC	0	0	0	0	0		0	0	9	ZE(0,6), pd(0,5), GD
IP2I	0	0	0	0	0		0	0	8	GB(0.15), DC (0.2),
LAPP	0	0	0	0	0		0	0	4	MD(0,3*), m2(0,3)
LLR	0	0	0	0	0		0	0	8	RS (0,35*), VB(0,35
LPC	0	0	0	0	0		0	0	6	RM(0,2), SM(0,15),
LPNHE	2000	2500	1300	400	1300		7,5	5	4	LP(0,8), AB(0,8), BM
LPNHE	0	0	0	0	0		0	0	4	LP(0,8), AB(0,8), BM
LPSC	0	0	0	0	0		0	0	4	m2(0,3)
L2IT	0	0	0	0	0		0	0,0	0	
TOTAL-2024							24,9	28,4	70	