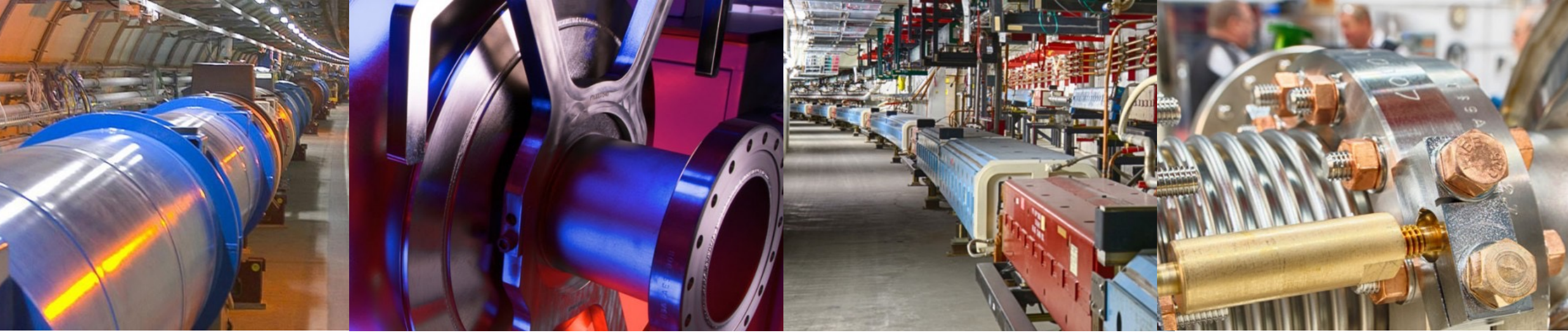


A Global Strategy for Particle Physics

Pierluigi Campana (INFN Frascati, ICFA chair)

LCWS 2024, Tokyo, July 11, 2024

ICFA

The opinions reported represent the Chair’s point of view, and not necessarily that of the full ICFA Committee

ICFA: mandate & membership

ICFA is an international organization, set up in 1976 under IUPAP-C11 sponsorship, in which discussions can take place on international aspects of particle physics, in particular the large future accelerators

More formally its aims, as redefined in 1985, are as follows:
• To promote international collaboration in all phases of the construction and exploitation of very high energy accelerators
• To organize regularly world-inclusive meetings for the exchange of information on future plans for regional facilities and for the formulation of advice on joint studies and uses
• To organize workshops for the study of problems related to super high-energy accelerator complexes and their international exploitation and to foster research and development of necessary technology

16 Members: Europe (CERN & member states, 3), USA (3), Japan (2), Russia (2), Canada (1), China (1), Other Countries (3), IUPAP C11 chair (ex-officio), Scientific Secretary

All major HEP Lab directors are represented (CERN, FNAL, KEK, IHEP, DESY, …)

ICFA Panels

ICFA activity is organized in panels on specific topics concerning accelerator and particle physics, set up to facilitate international discussion and coordination: They organize schools and workshops on their specific topics and often put out bulletins, newsletters and other records of their activities.

- Instrument Innovation and Development (chair Ian Shipsey, Oxford)
- Beam Dynamics (chair Yuan He, Lanzhou)
- Advanced and Novel Accelerators (chair Patric Muggli, CERN & MPI)
- Sustainable Accelerators and Colliders (chair Thomas Roser, BNL)
- Data Lifecycle (chair Kati Lassila-Perini, Helsinki)

- ILC International Development Team (chair Tatsuya Nakada, EPFL), *formed in 2002 to facilitate the realization of the International Linear Collider (ILC), and since 2020 with the mandate to make preparations for the ILC Pre-Lab in Japan, which is the next step in the ILC project*

Contributing to keep experts in contact through meetings, etc… is beneficial to advancement in accelerator science of future large (and smaller) infrastructures

For an historical review of ICFA activities, see R. Rubinstein, Int. J. Mod. Phys. A 31 (2016) 1630063

ICFA: role & vision

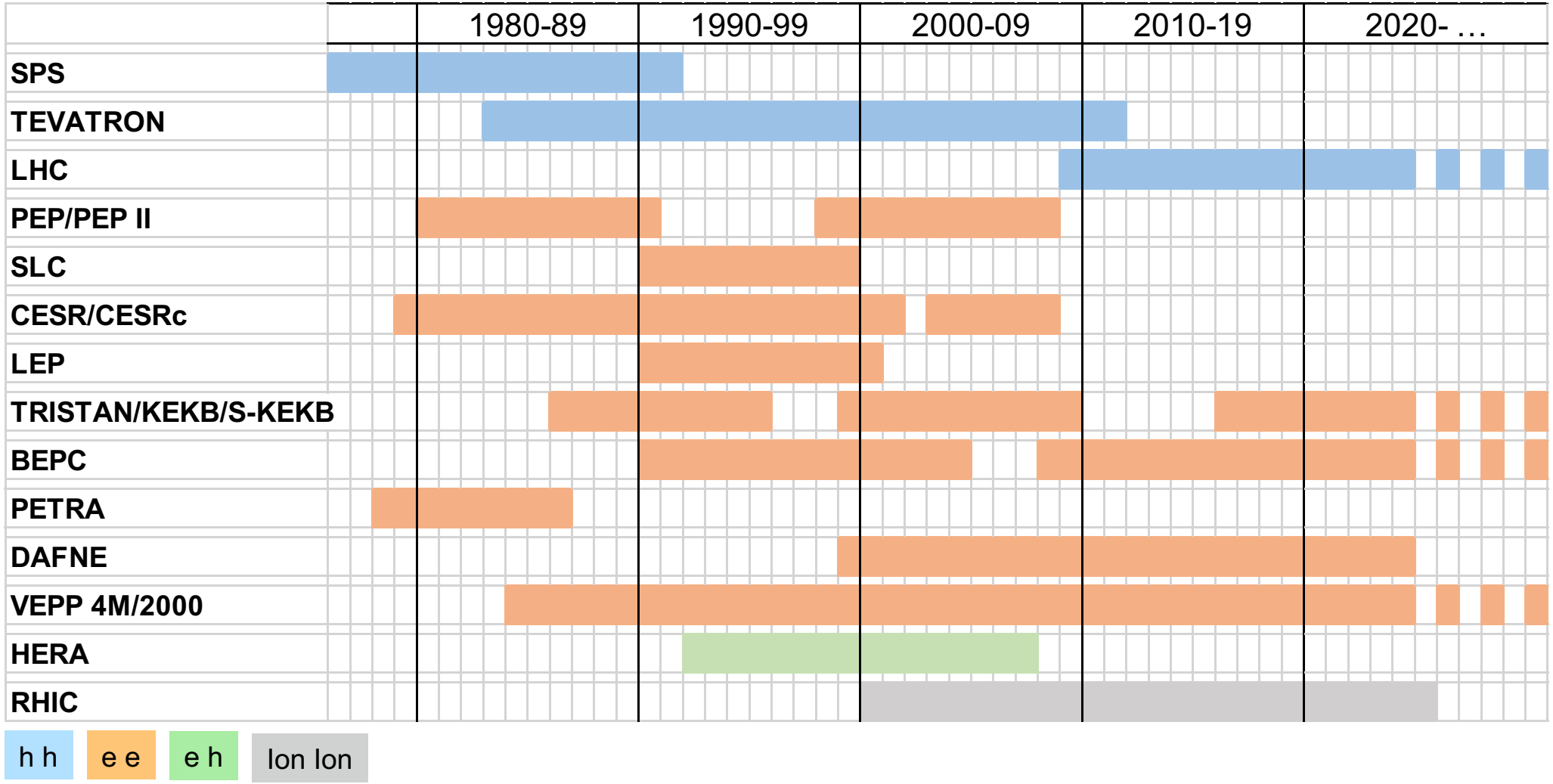
- ICFA needs to enlarge its current perspective to other new projects appearing at the horizon with increasing level of maturity: e+ e- circular colliders CEPC/FCC, etc …

- ICFA is not expected to "*decide on which will be the next global collider*", but to follow and endorse projects having reached a high level of scientific and technical definition, consensus, and help in getting political support

- ICFA, at a level of lesser resources and political complexity, should consider and promote, and possibly optimize, the set-up of smaller programs at the differents HEP labs, both in collider-based and in physics beyond collider, to preserve diversity and also education in the field, targeting especially the young generation

- ICFA meets three times per year, and a triennial ICFA Seminar is organised, an international exchange of information on plans for future facilities in particle physics. The seminar is attended by the directors of most of the world's major laboratories in our field, senior particle and accelerator physicists, and government science officials from several countries

The Golden Age of Colliders



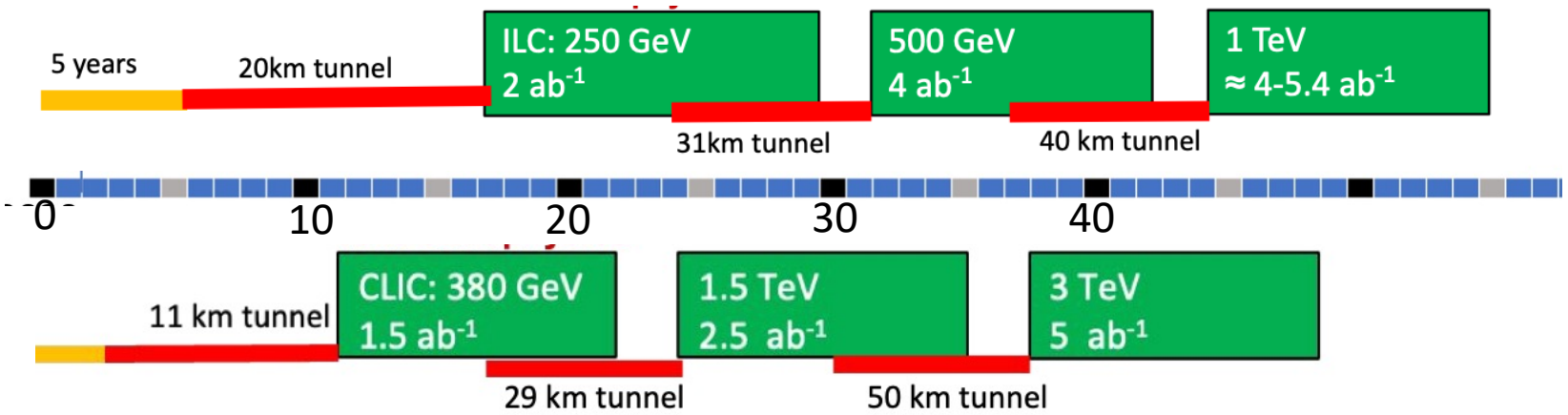
A Global Strategy (?)

A general consensus among the HEP community, also in consideration of the available technologies, **is that the study of the Higgs boson** is of utmost importance, beyond the precision achievable at the end of HL-LHC

To achieve this goal, some projects have reached a high level of maturity, others are approaching it

Dates of possible approval still to be defined

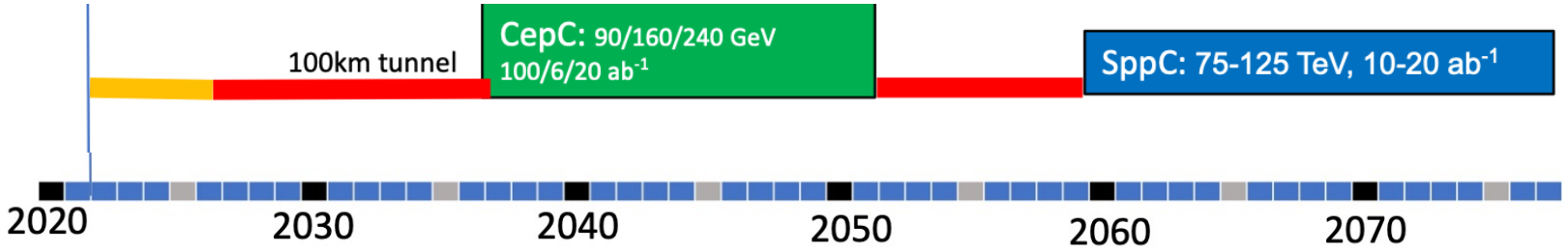
TDR in 2013 – Japan site

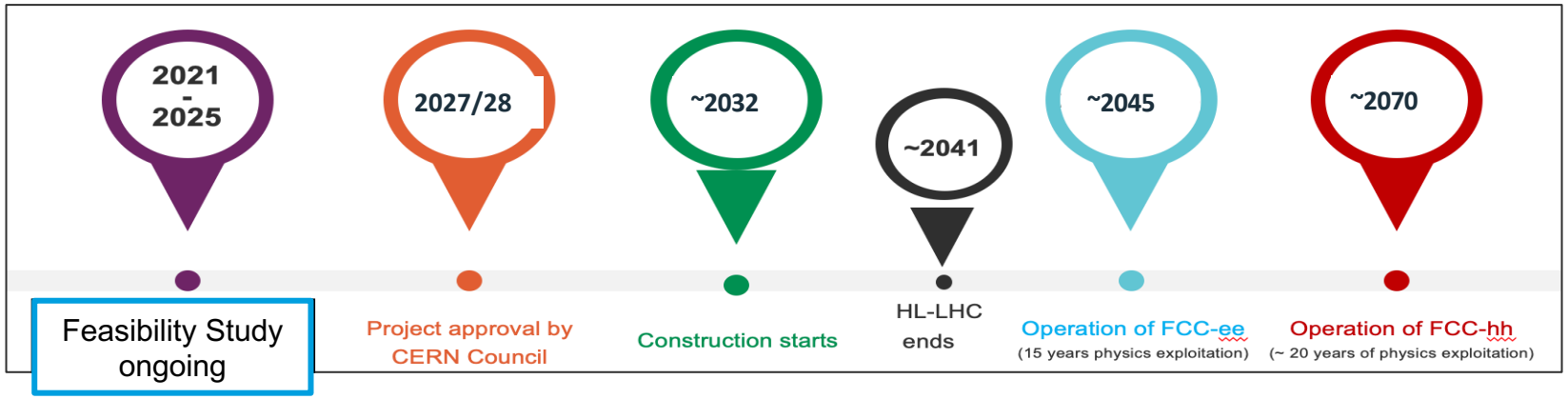


PIP in 2018 – CERN site

Re-elaborated from Snowmass EF 2021

TDR in 2023





+ other future projects

HALHF

Tentatively, we could have 1-2 machines operating in the time window **around 2035-2045**

Looking "global" to projects (quick and dirty calculation)

					COST/GDP
HERA	cost	0.7 G$	Fed. Rep. G. 1984 (const. starts)	0.7 B$	10 x 10^{-4}
~20% non-german contributions					
LEP	cost	1.4 G$	EU+CH GDP 1984 (const. starts)	2.7 B$	5 x 10^{-4}
LHC	cost	5 G$	EU+CH GDP 1998 (approval year)	8 B$	6 x 10^{-4}
benefitting of LEP tunnel + 15% NMS contributions					
FCCee	cost	12 G$	EU+CH+UK GDP 2023	22 B$	5 x 10^{-4}
CEPC	cost	5 G$	China GDP 2023	18 B$	3 x 10^{-4}
ILC	cost	7 G$	Japan GDP 2023	4.2 B$	17 x 10^{-4}

"Globalisation" and exploitation time of the Research Infrastructures are further assets in project conception

Areas of global discussion

- Governance

- Impact of project size
    - science motivation (when facing other emerging research areas)
    - organisation, cost and availability of funding
    - extra cost/difficulties when collider is built in a green site
    - operation and maintenance
    - life cycle assessment (global CO_2 footprint)

- Time span (often 10-15 y after construction approval)
    - evaluation of cost increase during construction
    - HEP sociological aspects (few experiments, many scientists: e.g. CERN has 12k users)
    - lack of youngs' interest in far-off in time projects

- HEP "environment" must also guarantee
    - diversity in science (smaller, shorter time scale Part. Phys. research programs)
    - access to HEP technologies in countries with developing particle physics communities
    - positive actions against gender and nationality disparities

Governance: A variety of approaches

Independent Regional Road Maps: CERN ESPP, DOE-NSF P5, CAS 5 Year Plan, MEXT …

Different international involvements:
- GLOBAL: machine and detectors funding are fully shared among participants (→ ITER, although with in-kind model, not particularly satisfactory), IGO-like governance

- INTERNATIONAL: machine (only partially) and detectors funding are shared among participants, i. e. host lab maintains governance of the project

- REGIONAL: machine is funded by host country, and detectors funding are shared among participants

Past colliders were largely regional infrastructures (at still affordable costs), with few international exceptions (e. g. HERA, LHC)
and quite substantial international commitments in experimental apparatus

Next large machines will need new requirements in term of governance !

Concluding remarks

Our science is, and it will remain, curiosity driven

Bottom-up community approach represents a key element in deciding which will be the next (very large) machines: policy makers must count on a strong support from a large consensus

However, scientific goals must be "filtered" with feasibility (technical, economical), political support, world-wide situation, pressure from other sciences, and social endorsement

ICFA (together with HEP community) must be ready to facilitate and to support programs which keep alive our science, and to leave open a platform where different regional aspirations can be confronted and discussed

Despite difficult times in which we live, we all still believe scientific collaboration remains a GLOBAL tool for Universe laws deciphering

> Nothing truly valuable can be achieved except by the unselfish cooperation of many individuals, A. Einstein