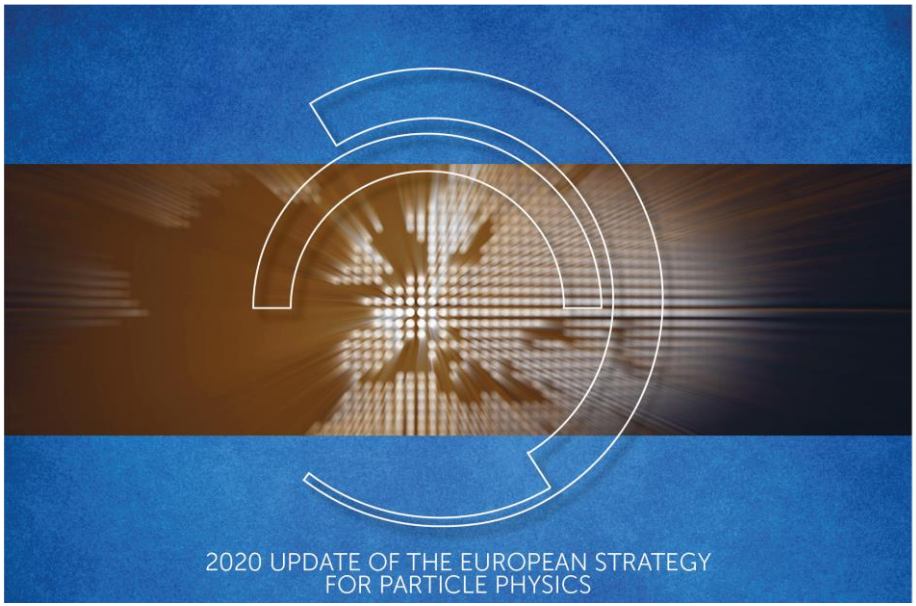
国际势态

高能量前沿粒子物理



方亚泉，高杰，李煜辉，梁志均，刘建北，**娄辛丑**，阮曼奇，史欣，杨海军，张华桥，张照茹，朱宏博

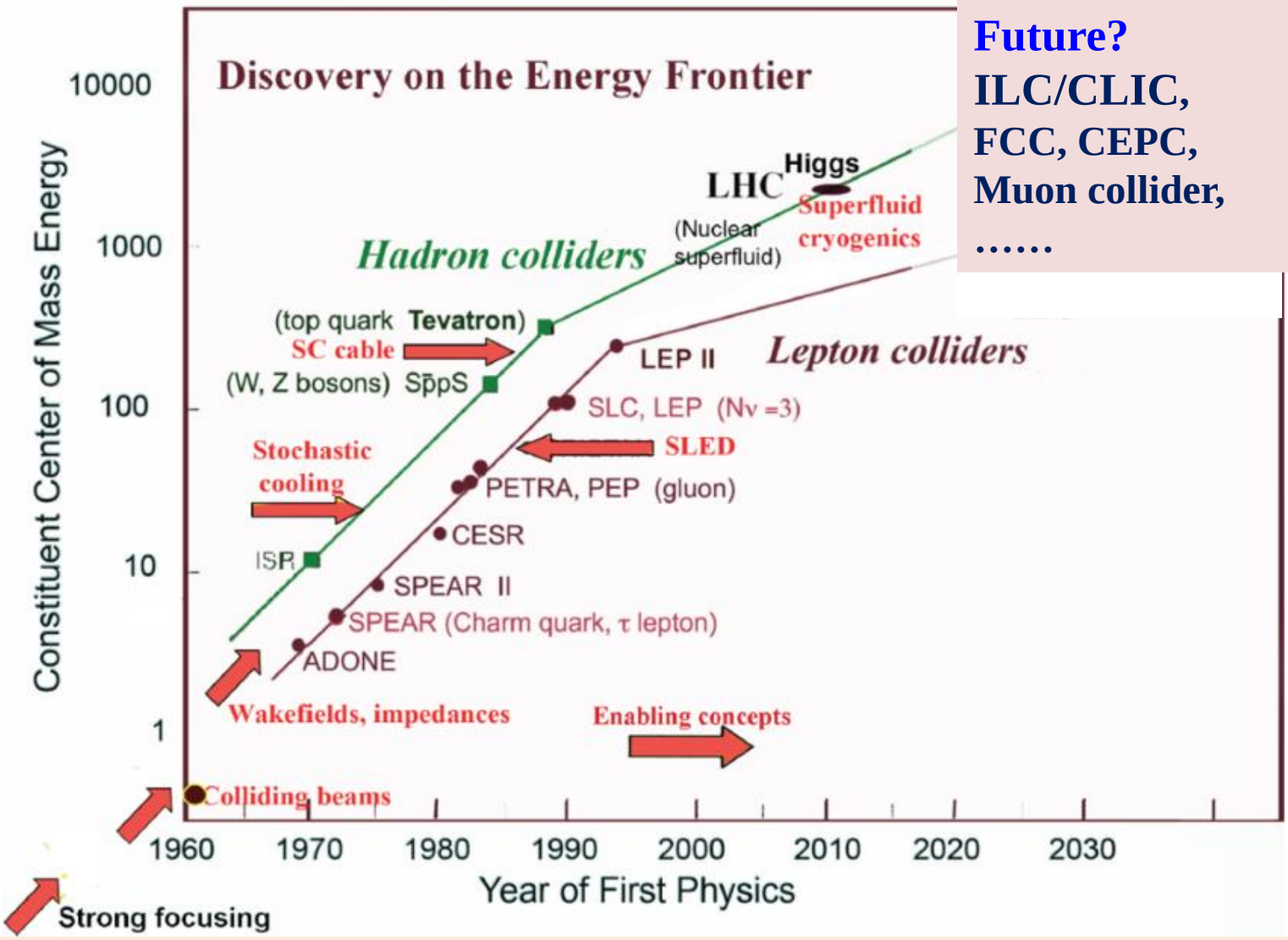
中国科学院高能物理研究所

Status and Progress - abroad

Particle Physics at the Energy Frontier

- A bit of history and the keys to success
- Landscapes and national roadmaps
- Collaboration and geopolitical realities
- Comments and summary

A bit of history



Future?
ILC/CLIC,
FCC, CEPC,
Muon collider,
……

Innovations, higher energies, (more advanced instrument, larger community)
⇒ discoveries, deep understanding of nature

keys to success

- Innovations in technology and in design
- Organization + leadership
- Planning and execution of the plan
- Intensive theoretical development
- Creative mind, dedicated professionals, and many very bright young scientists in the pipeline
- Strong government support and continuous funding
- ……

Landscapes and National Roadmaps

particle physics at the energy frontier

Europe
Landscapes and national roadmaps

The LHC physics program the most active energy frontier experiments

Upgrades to the detectors at the (HL-)LHC

The LHC accelerator upgrade towards to the HL-LHC

China is deeply involved in both physics and technologies

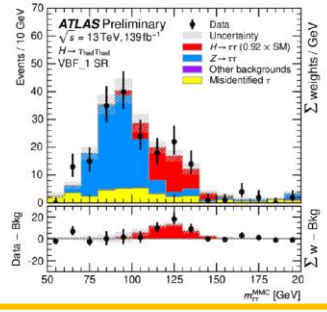
Europe - Landscapes and national roadmaps

The LHC Physics Program

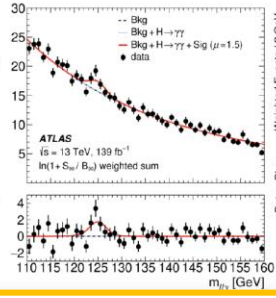
ATLAS Higgs results Highlight

- Evidence of Higgs rare decay channel H → γ γ* → ll γ
- Search for 2nd generation fermions (H →μμ, H→cc)
- Significance for VBF H→ττ, H → WW* ,H→γ γ above 5 σ

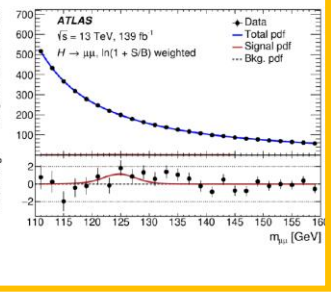
VBF H→ττ
5.3 σ (6.2 σ) obs (exp)



Evidence of H → γ γ*
3.2 σ (2.1σ) obs (exp)

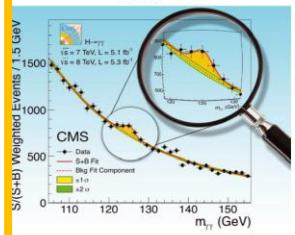


Search for H →μ μ
2σ (1.7σ) obs (exp)



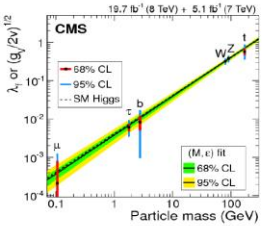
CMS results Highlight

2012



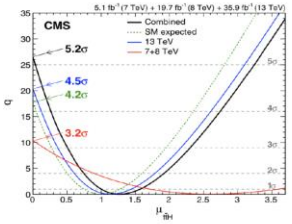
Observation of Higgs

2015



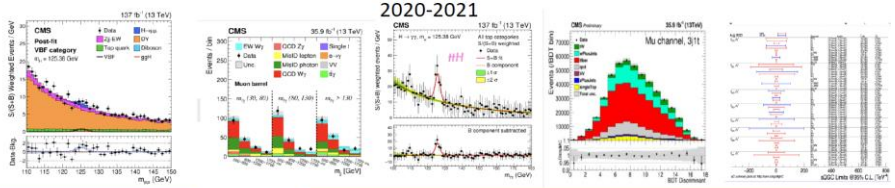
Higgs couples to bosons

2018



Higgs couples to 3rd fermion

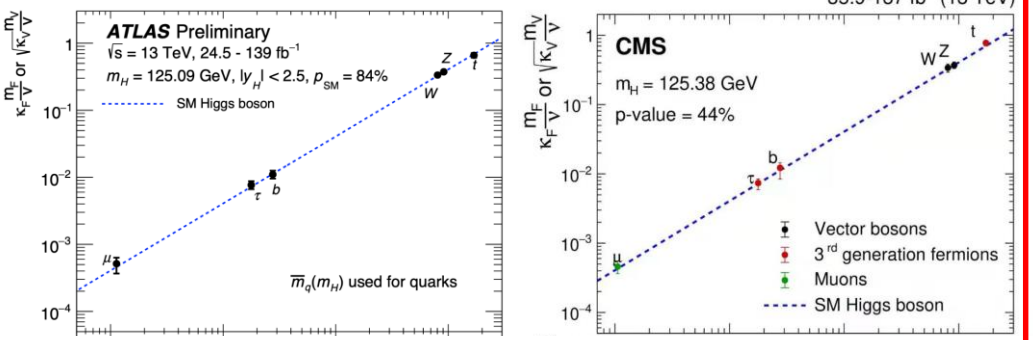
2020-2021



Evidence of H->μμ

Observations （VBS,ttH,tW） in solo channels...

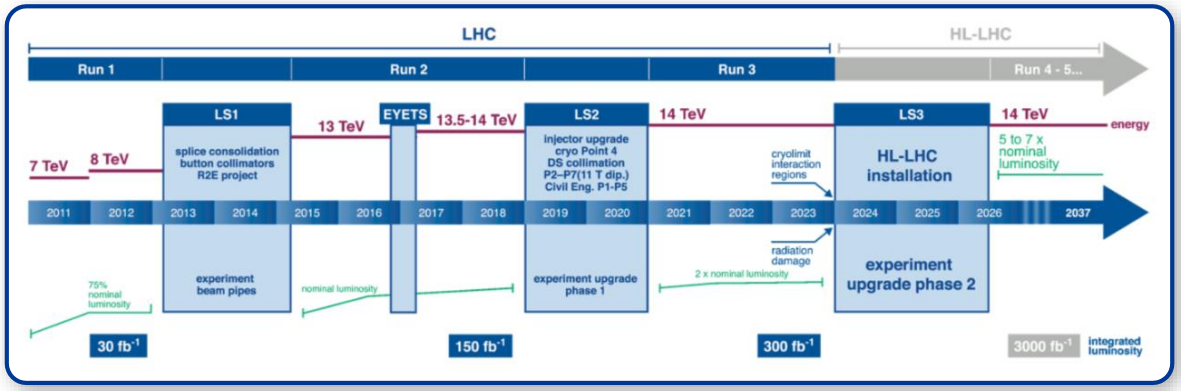
Higgs coupling vs. mass of final state quarks & leptons

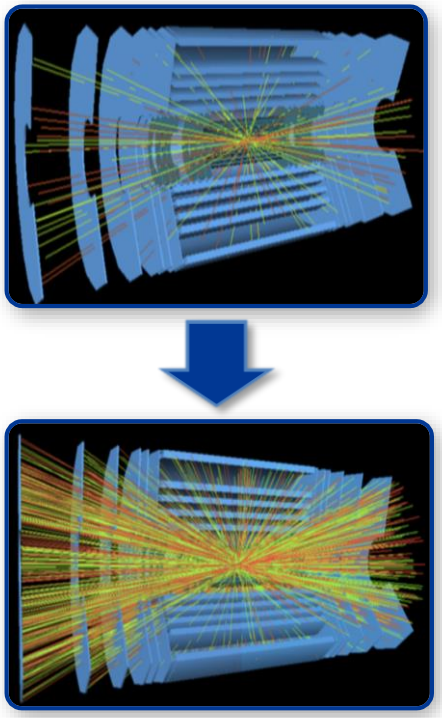


remarkable test of the Standard Model

Europe - Landscapes and national roadmaps

The LHC and HL-LHC Experimental Program



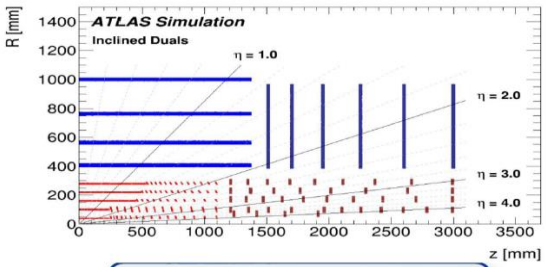


- HL-LHC will start in ~ 2027
- Instantaneous luminosity 7.5×10^{34} $cm^{-2}s^{-1}$, 5~7.5x increase
- Average number of interactions per bunch crossing (pile-up events) reach 200

progressive, well-planned upgrades of the accelerator, detectors, computing-infrastructures

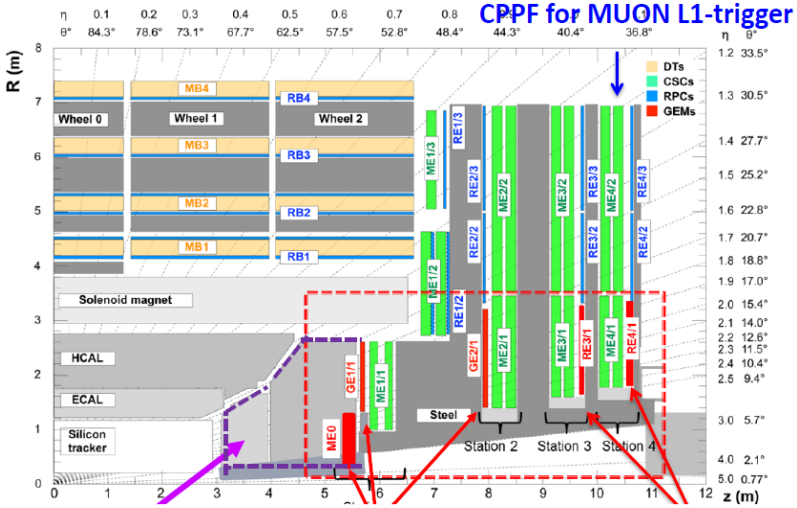
Challenging detector upgrades by ATLAS & CMS - examples

ATLAS Inner Tracker

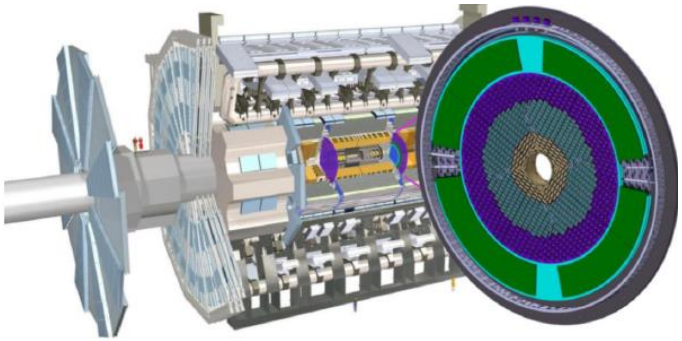


CMS muon/trigger …

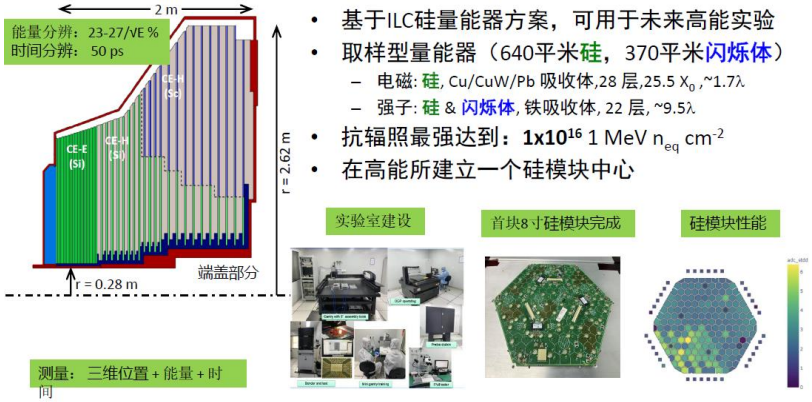
1/3 of CSC for ME4/2
CPPF for MUON L1-trigger



ATLAS HGTD Timing Detector



CMS HG Calorimeters



- 基于ILC硅量能器方案，可用于未来高能实验
- 取样型量能器（640平米硅，370平米闪烁体）
  - 电磁: 硅, Cu/CuW/Pb 吸收体,28 层,25.5 X_0 ,~1.7λ
  - 强子: 硅 & 闪烁体, 铁吸收体, 22 层, ~9.5λ
- 抗辐照最强达到：**1x10^{16}** 1 MeV n_{eq} cm^{-2}
- 在高能所建立一个硅模块中心

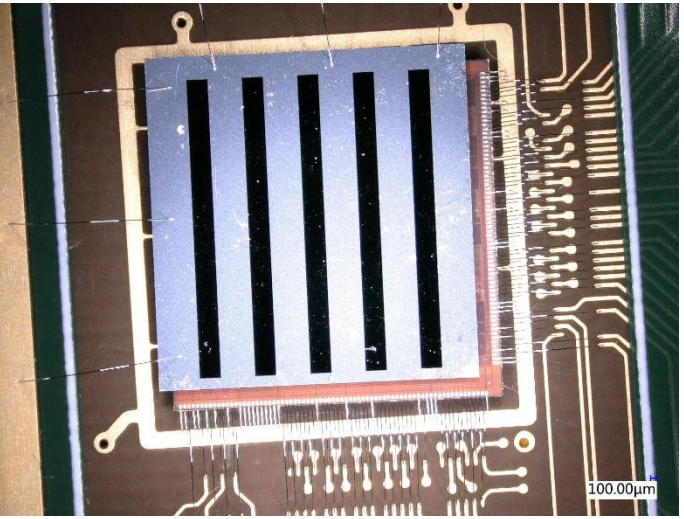
substantial contributions from Chinese institutes

ATLAS High granularity timing detector (HGTD)

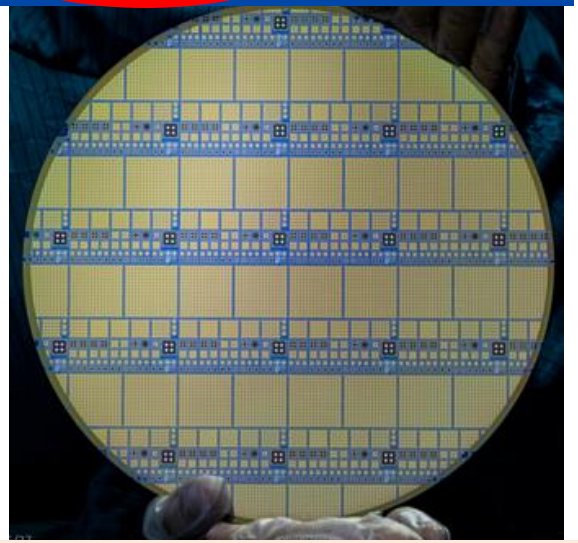
ATLAS China made major contribution in HGTD project approval

- **Leading 3 m^2 detector production（~1/2 of HGTD）**
- **Developed domestic radiation-hard LGAD ultra-fast sensors**
  - Reach 50ps up to fluence **$2.5x10^{15}$ N_{eq} /cm^2**
  - Aim to be the first domestic silicon sensor in LHC experiment
- **Leading HGTD peripheral electronics**

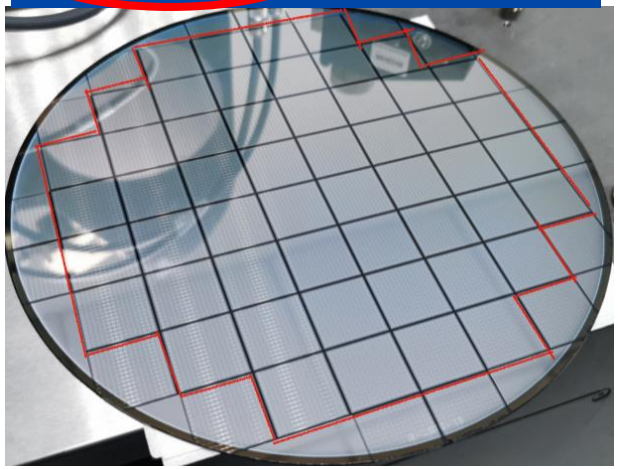
Mini-modules by IHEP



IHEP-IME sensor wafer



USTC-IME sensor wafer



strong leadership by & contribution from Chinese institutes

Europe
Landscapes and national roadmaps

Future Accelerators

FCC(ee,hh), CLIC and muon collider
the physics program
the design, the technology and much more

European Particle Physics Strategy Update, June 2020

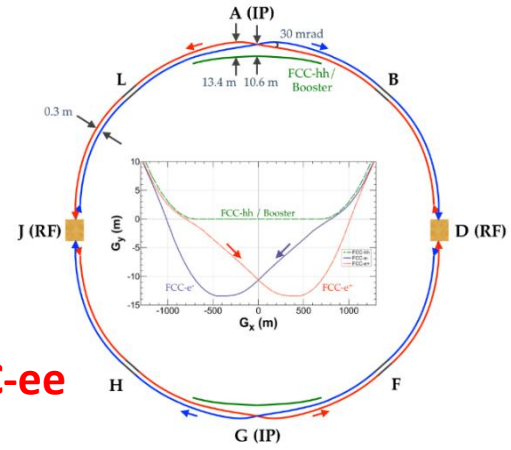
Roadmaps and R&D rollout – with strong funding

development in parallel with CEPC

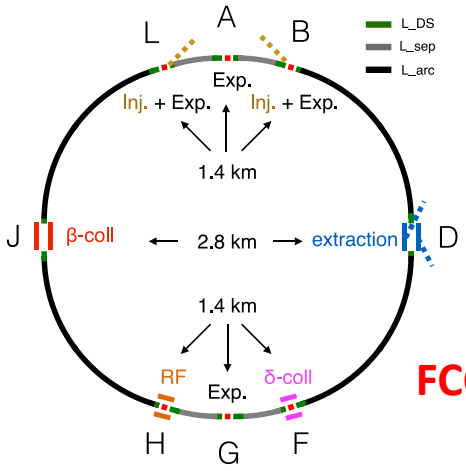
The FCC integrated program at CERN

Comprehensive cost-effective program maximizing physics opportunities

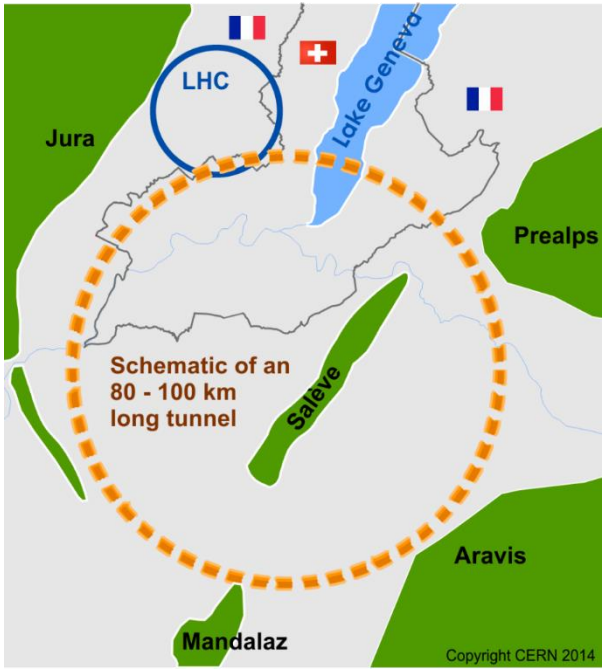
- **Stage 1: FCC-ee (Z, W, H, tt) as first generation Higgs factory, EW and top factory at highest luminosities.**
- **Stage 2: FCC-hh (~100 TeV) as natural continuation at energy frontier, with ion and eh options.**
- Complementary physics
- Integrating an ambitious high-field magnet R&D program
- Common civil engineering and technical infrastructures
- Building on and reusing CERN's existing infrastructure.
- FCC integrated project plan is fully integrated with HL-LHC exploitation and provides for seamless continuation of HEP.



FCC-ee

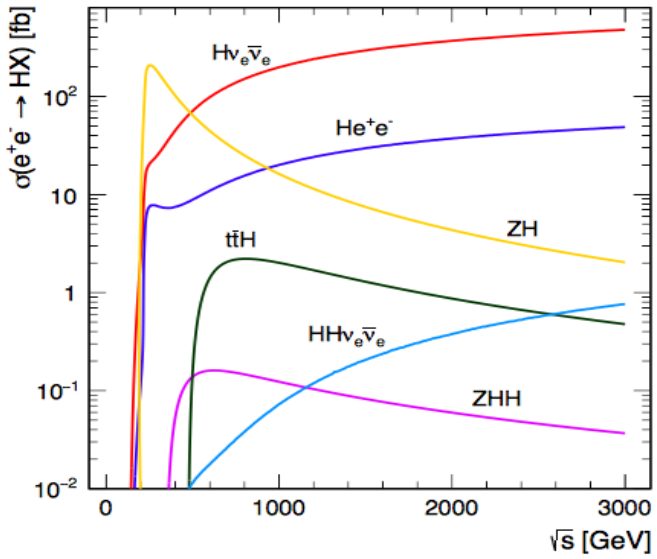


FCC-hh

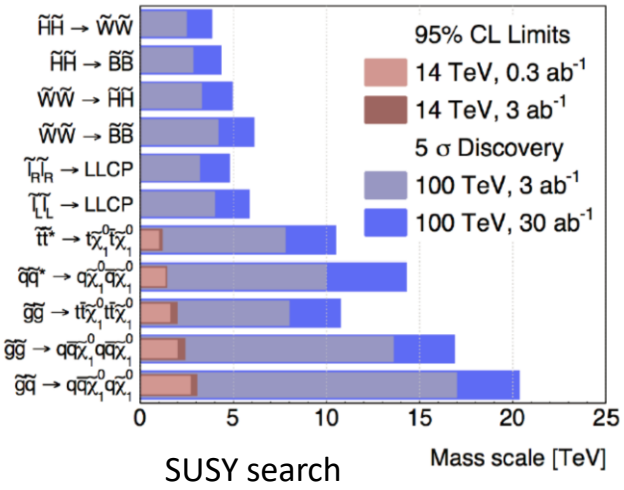


Physics program at the Future Circular Collider (FCC)

Two operations : 240/365 GeV (The latter for top measurements), 100TeV



$\sqrt{s}$ (GeV)	240		365	
Luminosity (ab^{-1})	5		1.5	
$\delta(\sigma BR)/\sigma BR$ (%)	HZ	$\nu\bar{\nu}$ H	HZ	$\nu\bar{\nu}$ H
$H \to$ any	±0.5		±0.9	
$H \to b\bar{b}$	±0.3	±3.1	±0.5	±0.9
$H \to c\bar{c}$	±2.2		±6.5	±10
$H \to gg$	±1.9		±3.5	±4.5
$H \to W^+W^-$	±1.2		±2.6	±3.0
$H \to ZZ$	±4.4		±12	±10
$H \to \tau\tau$	±0.9		±1.8	±8
$H \to \gamma\gamma$	±9.0		±18	±22
$H \to \mu^+\mu^-$	±19		±40	
$H \to$ invisible	< 0.3		< 0.6	



SUSY search

⇑

FCC(pp)

EXPLORE 10-100 TeV energy scale (and beyond) with Precision Measurements
-- ~20-100 fold improved precision on many EW quantities (equiv. to factor 5-10 in mass)
m_Z, m_W, m_{top}, $\sin^2\theta_w^{eff}$, R_b, α_{QED} (m_z) α_s (m_z m_W m_τ), Higgs and top quark couplings
model independent «fixed candle» for Higgs measurements, ee-H coupling.

DISCOVER a violation of flavour conservation or universality and unitarity of PMNS @10^{-5}
-- ex FCNC (Z --> μτ , eτ) in 5 10^{12} Z decays and τ BR in 2 10^{11} Z→ ττ
+ flavour physics (10^{12} bb events) (B→s ττ etc..)

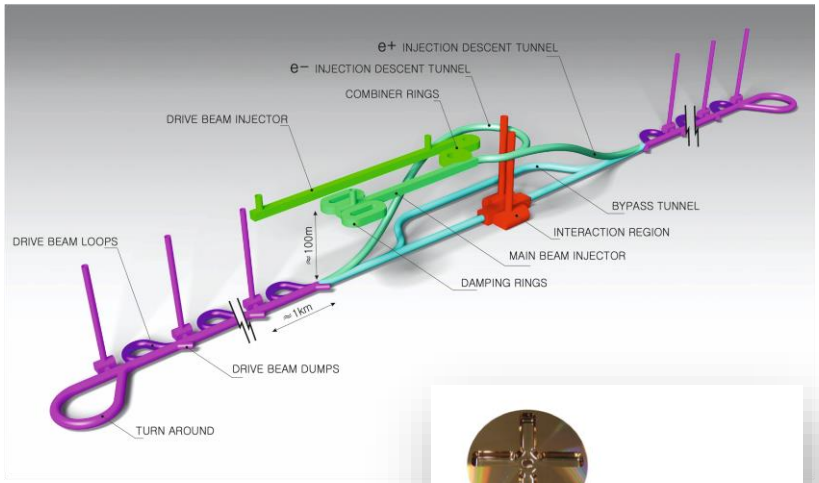
DISCOVER dark matter as «invisible decay» of H or Z (or in LHC loopholes)

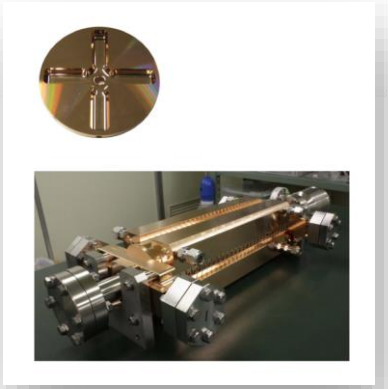
DISCOVER very weakly coupled particle in 5-100 GeV energy scale
such as: Right-Handed neutrinos, Dark Photons, ALPS, etc..

⇐ **FCC(ee)**

enormously rich physics and discovery potentials

CLIC - Compact Linear e^+e^- Collider





Accelerating structure prototype for CLIC: 12 GHz (L~25 cm)

The Compact Linear Collider (CLIC)

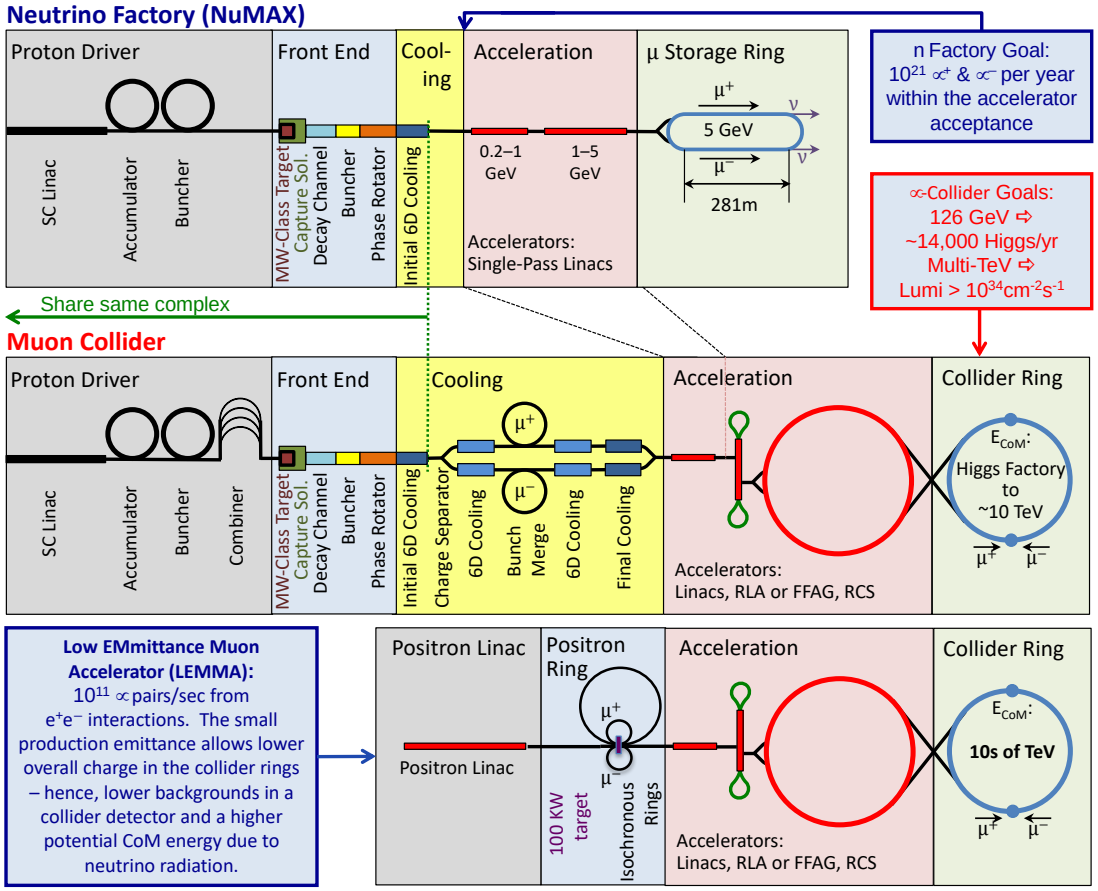
- **Timeline:** at CERN (~2035 Technical Schedule)
- **Compact:** Novel and unique two-beam accelerating technique with high-gradient room temperature RF cavities (~20'500 cavities at 380 GeV), ~11km in its initial phase
- **Expandable:** Staged programme with collision energies from 380 GeV (Higgs/top) up to 3 TeV (Energy Frontier)

- CDR in 2012. Updated project overview documents in 2018 (Project Implementation Plan). See resource slide.

- **Cost:** 5.9 BCHF for 380 GeV (stable wrt 2012)
- **Power:** 168 MW at 380 GeV (reduced wrt 2012), some further reductions possible

- Comprehensive **Detector and Physics** studies

A Muon Collider at CERN



Muon Collider Option for a Higgs Factory Based on a Proton Driver Source

Broad Applications:

- Neutrino Factories
- Colliders from ~100 GeV to 10s of TeV scale
- Secondary Beams

Potential Sources:

- Proton-driver with ionization cooling
- Positron-driver with low emittance

Muon Accelerator Design Status

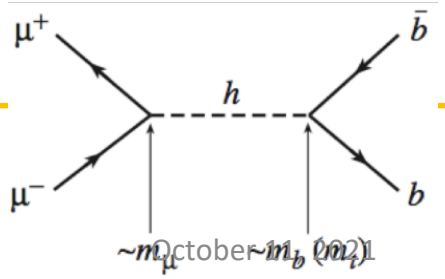
- Full conceptual designs for NFs
- Key feasibility tests from MAP/MICE completed successfully!
- Now ready for a more detailed collider conceptual design study

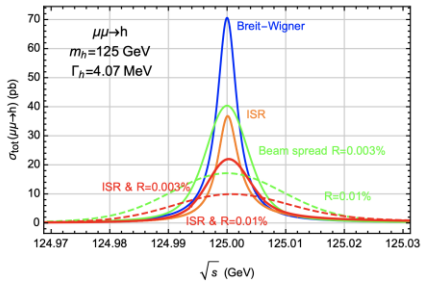
Physics at Compact Linear Collider (CLIC)

- **Three stage: 380 GeV (updated from 350 GeV for ttbar coupling measurement), 1.5 TeV, 3.0 TeV.**
- **Physics**
  - **380 GeV run : Higgs measurement, top mass scan, top coupling measurement.**
    - **The precisions of Higgs parameters are 1-5% and can reach 1% or better combining 1.5/3 TeV runs**
    - **Top mass measurement can reach tens of MeV**
  - **1.5,3 TeV runs : Higgs self coupling, top-Yukawa coupling, search for BSM new physics.**
    - **Di-Higgs (Heavy Higgs), ttH**
    - **SUSY, Z', etc.**

Physics at Muon Collider (MuC)

- Larger mass of the muon allows a smaller foot print and higher energies compared to e^+e^- counterparts, although suffering from major challenges of finite lifetime and cooling.
- Physics:
  - **Higgs factory at ~125 GeV** : line-shape scan of the Higgs boson, simultaneous measurement of the Higgs boson mass, width and muon Yakawa at unprecedented precision.
  - **High Energy runs up to 100 TeV to probe** :
    - **Top Yukawa coupling, Multi-Higgs, possible new physics contributed to Muon g-2**
    - **Moun has a structure**
    - **Vector boson machine**
    - **WIMP dark matter**





Design and R&D of critical systems

- Collider Ring （180GeV for tt mode）
- Booster Ring
- Linac & Damping ring
- MDI changes
- High efficiency klystron: 3 prototypes are under the development.
  - The 1st is for the test; 2nd is the high efficiency klystron in the true sense; 3rd is the new design with Multi Beam Klystron (MBK) technique.
- Linac: S-band prototype for high power RF load, 80MW
- Superconducting RF system
- CEPC Magnets
- MDI SC magnet
- Progress of Electro-static Magnetic Deflector

Plus detector systems, ….. **supported by strong funding from EU**

欧洲粒子物理战略规划更新
European Particle Physics Strategy (EPPS)

The **2020 European Particle Physics Strategy Update** (**EPPSU**) effort was launched in 2018, and was completed in June 2020.

LHC, HL-LHC

"The successful completion of the high-luminosity upgrade of the machine and detectors should remain the focal point of European particle physics, together with continued innovation in experimental techniques…."

"The full physics potential of the LHC and the HL-LHC, including the study of flavour physics and the quark-gluon plasma, should be exploited."

New Strategy 2020 新规划

High-priority future initiatives

a) **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.** Accomplishing these compelling goals will require innovation and cutting-edge technology:

b) **Innovative accelerator technology** underpins the physics reach of high-energy and high-intensity colliders. …. must **intensify accelerator R&D and sustain it** with adequate resources…… A **roadmap** should prioritise the technology, should be defined in a timely fashion and coordinated among CERN and national laboratories and institutes.

Europe's funding for future energy frontier collider projects (2021-2025):

FCC 20 MCHF/year

CLIC 5.5 MCHF/year

muon collider 2 MCHF/year

SC magnet 190 MCHF/10 years; **detector** 90 MCHF/11 years

FCC at CERN

FCC-Feasibility Study

To deliver a Feasibility Study Report (FSR) by the end of 2025, with a primary focus on the tunnel and the surface infrastructures.

The Feasibility Study has a budget of 100 MCHF from 2021 to 2025.

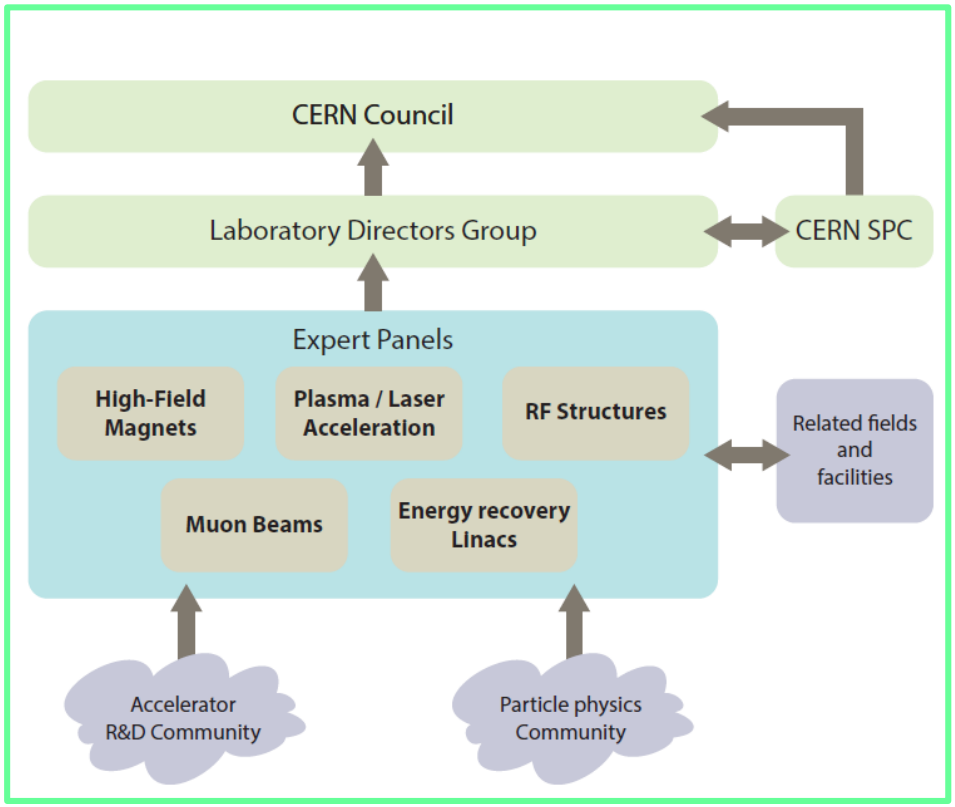
Main deliverables of the Feasibility and heir timelines

main deliverables and timelines of the FCC Feasibility Study	2021				2022				2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
technical design work and R&D in all relevant areas																				
progress review on key technology R&D programs																				
development and documentation of implementation scenario																				
design update for preferred implementation variant																				
communications plan development and implementation																				
development of funding models and concepts																	update			
development of project organisation and operation models																	update			
CDR cost update with external review																				
general coherence review (mid-term)																				
detailed design for Feasibility Study Report																				
environmental evaluation process and impact study with host states					preparation															
high-risk areas site investigations					preparation															
project cost update with external review																				
Feasibility Study Report																				

Europe

Landscapes and national roadmaps

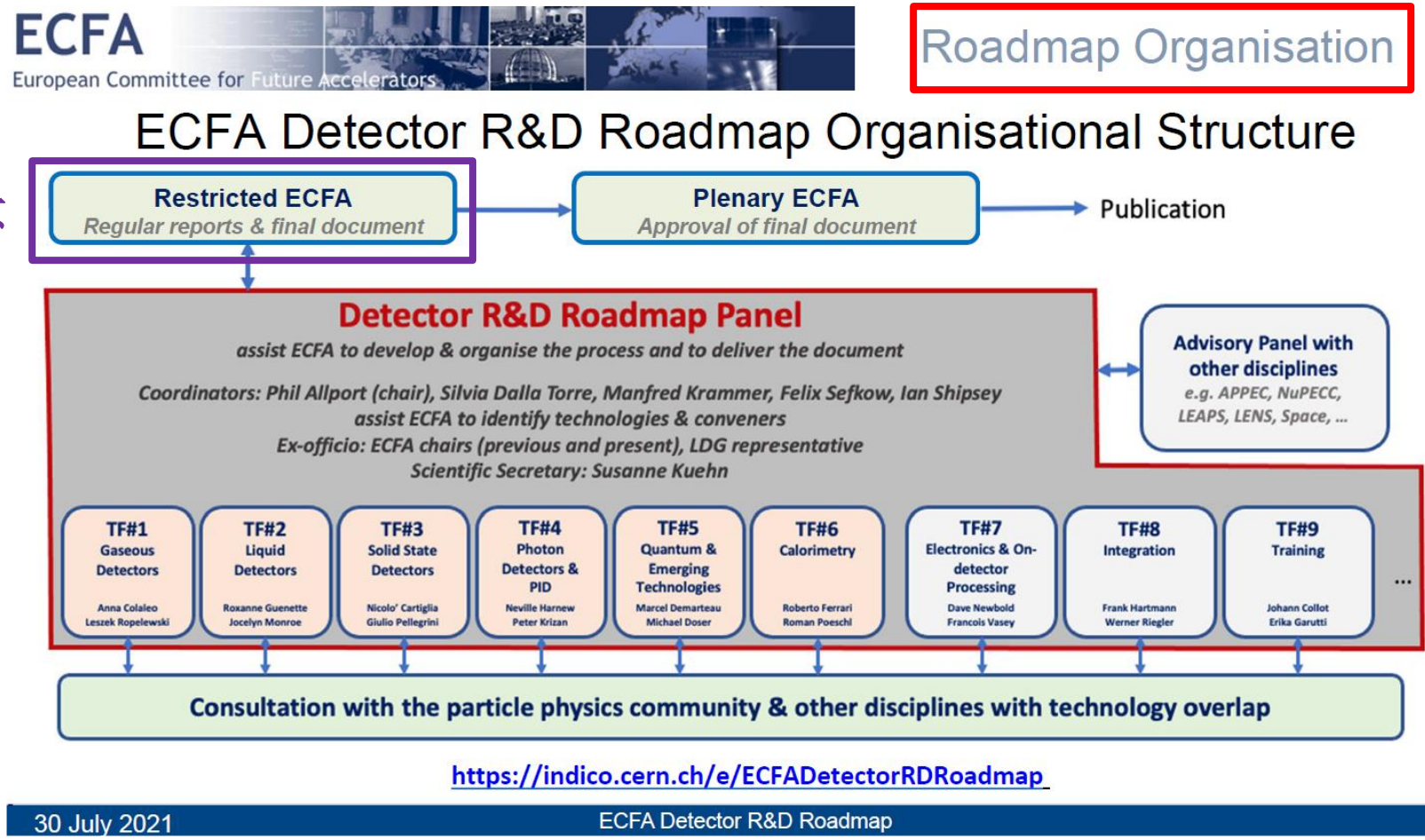
in the making 流程



Dave Newbold @ EPS2021

Europe

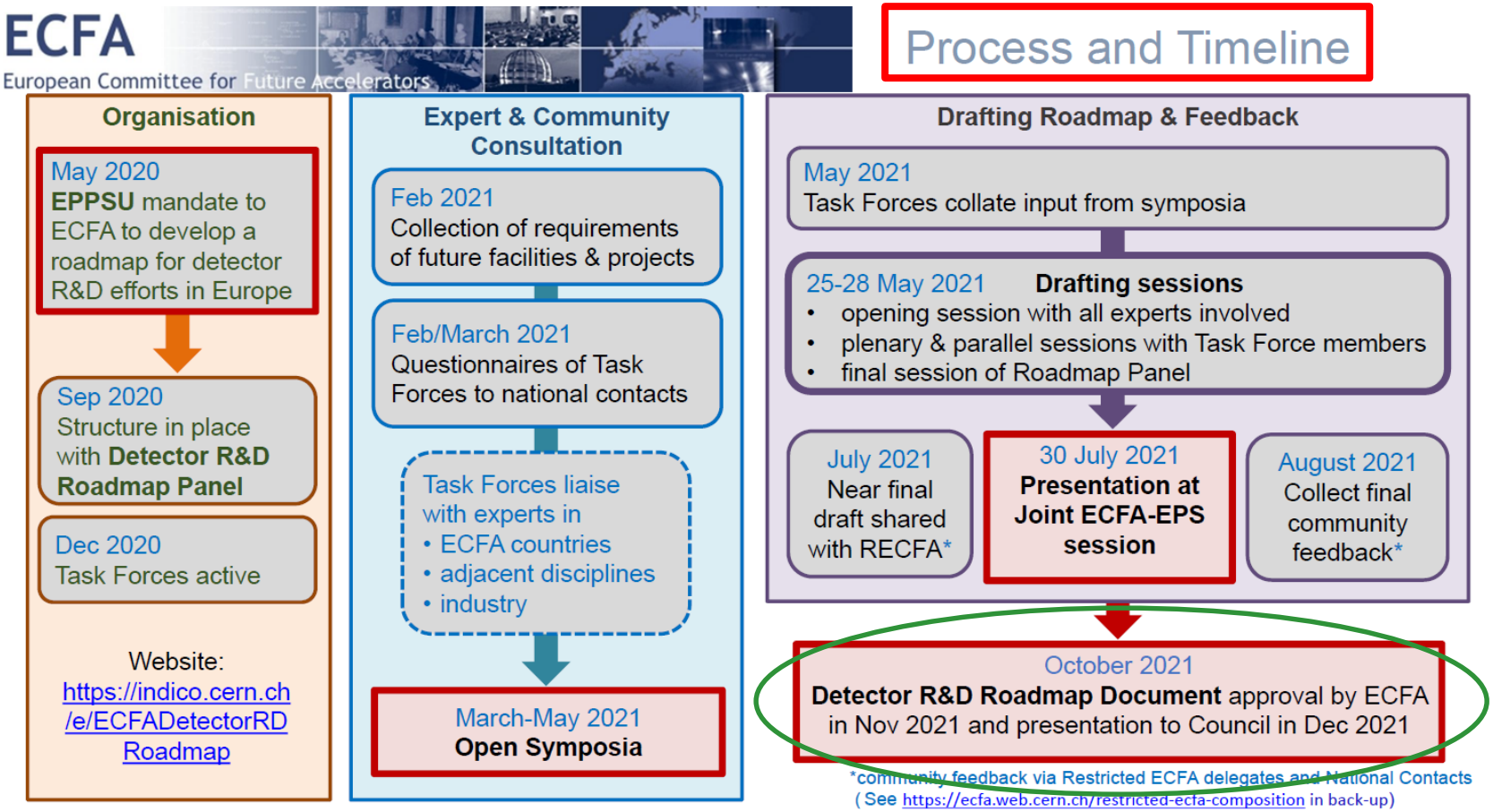
Landscapes and national roadmaps



Phill Allport at EPS 2021

Europe

Landscapes and national roadmaps



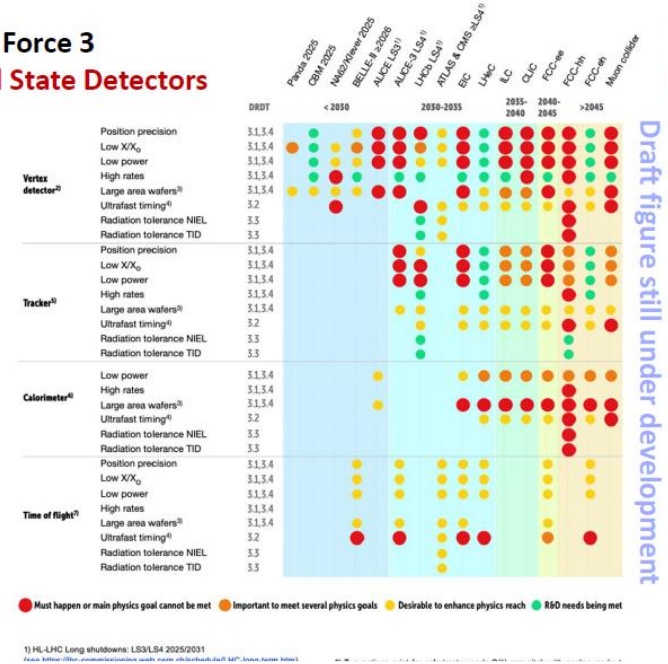
Phill Allport at EPS 2021

Europe
Landscapes and national roadmaps

ECFA
European Committee for Future Accelerators

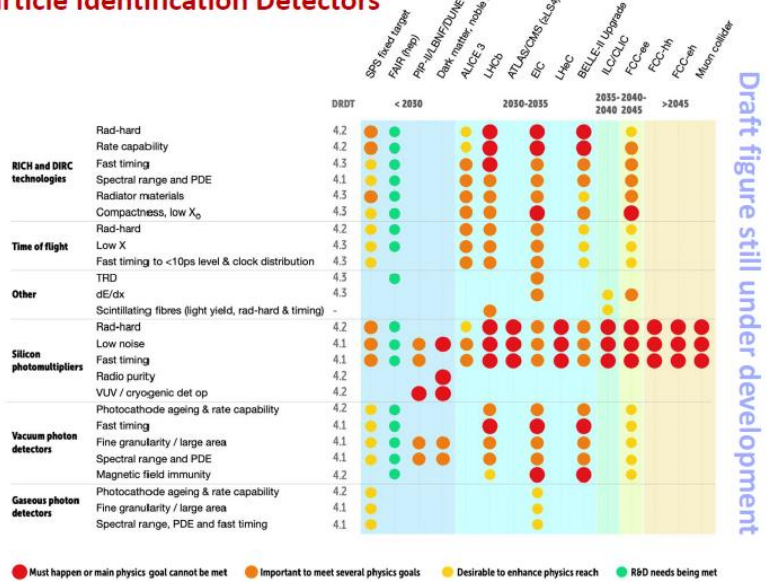
Detailed ECFA Timeline

Task Force 3
Solid State Detectors



Draft figure still under development

Task Force 4 Photon Detectors and Particle Identification Detectors



Draft figure still under development

Phill Allport at EPS 2021

United States
Landscapes and national roadmaps

Building for Discovery

Strategic Plan for U.S. Particle Physics in the Global Context

Since 2014

5 Science Drivers

- Use the Higgs boson as a new tool for discovery
- Pursue the physics associated with neutrino mass
- Identify the new physics of dark matter
- Understand cosmic acceleration: dark energy and inflation
- Explore the unknown: new particles, interactions, and physical principles.

Recommendations

Program-wide Recommendations
Project-specific Recommendations
Funding Scenarios
Enabling R&D

Report of the Particle Physics Project Prioritization Panel (P5)

United States
Landscapes and national roadmaps

- The enormous physics potential of the LHC, which will be entering a new era with its planned high-luminosity upgrades, will be fully exploited.

(HL-)LHC physics, upgrades

- The interest expressed in Japan in hosting the International Linear Collider (ILC) is an exciting development. Participation by the U.S. in project construction depends on a number of important factors, some of which are beyond the scope of P5 and some of which depend on budget Scenarios. As the physics case is extremely strong, all Scenarios include ILC support at some level through a decision point within the next 5 years.

ILC was not approved in the time frame, continued participation without major funding investment

- Specific investments will be made in essential accelerator R&D and instrumentation R&D. The field relies on its accelerators and instrumentation and on R&D and test facilities for these technologies.

Continuing investment in critical and new technologies (RF cavity with N_2 doping, plasma acceleration, nm beam, quantum computing, ML,AI,…)

Report of the Particle Physics Project Prioritization Panel (P5)

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Unconstrained budget scenario – two additional high priority activities

- Develop a greatly expanded accelerator R&D program that would emphasize the ability to build very high-energy accelerators beyond the High-Luminosity LHC (HL-LHC) and ILC at dramatically lower cost.

- Play a world-leading role in the ILC experimental program and provide critical expertise and components to the accelerator, should this exciting scientific opportunity be realized in Japan.

Report of the Particle Physics Project Prioritization Panel (P5)

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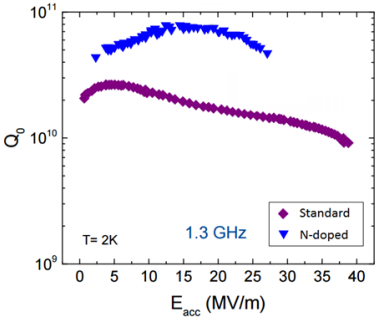
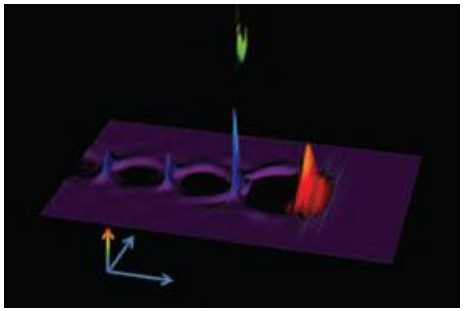
Innovations

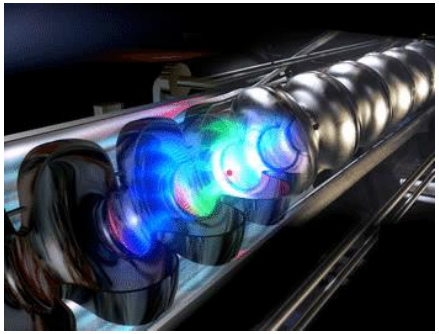
N_2 doping
High Q RF



Fermilab

laser-plasma accelerators





BELLA group
Berkeley Lab

Quantum Computing - quantum support vector machine (QSVM), detects Higgs bosons at the LHC. The algorithm run both on quantum simulators and on physical quantum hardware (on Google Tensorflow Quantum, IBM Quantum and Amazon Braket, ~20 qubits and a 5K-event dataset,)

quantum algorithm for the parton shower by LBNL theorist PhysRevLett.126.062001

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① **Define the most important questions for HEP & related fields**
② **Identify the most promising opportunities to address these questions in a global context**

U.S. Strategic Planning Process for Particle Physics

~year-long process
Snowmass Community-Wide "Science" Study
Organized by Division of Particles and Fields (DPF) of APS

Input to P5

The Snowmass community planning exercise, that had been delayed since January 2021 due to the COVID-19 pandemic, resumed the full activity in September 2021

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The **Snowmass community planning exercise -** the full activity from September.

1. Snowmass Day: To get on a new starting point, …., host of a half-day zoom meeting: the “Snowmass Day”, on **September 24, 2021**.
We envision a virtual meeting **recording available**

Plenary: 2 hours, 12:00pm - 2:00pm EDT. Short presentations from all on plans for the upcoming activities.

Breakout sessions: 2:30pm EDT. This is the opportunity to discuss frontier's status and future plans in details, to conduct cross-talk and interconnections between frontiers.

2. CSS: The dates for the Snowmass Community Summer Study (CSS) to be held the University of Washington-Seattle have been fixed at **July 17-27, 2022.**

https://snowmass21.org/start

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White Paper submission to arXiv: by March 15, 2022.

Late submissions and updates are likely not to be incorporated in the working group reports, but will be included in the Snowmass on-line archive documents.

- **Preliminary reports** by the Topical Groups due: no later than May 31, 2022.
- **Preliminary reports** by the Frontiers due: no later than June 30, 2022.
- **Snowmass Community Summer Study** (CSS): **July, 2022 at UW-Seattle**.
- All final reports by TGs and Frontiers due: no later than September 30, 2022.
- **Snowmass Book** and the on-line archive documents due: **October 31, 2022**.

Update of P5 will follow, to be coordinated by DOE, DPF and labs

https://snowmass21.org/start

United States
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Possible energy frontier focal points:

Continued participation in the (HL-)LHC program

Emphasize on innovations and tech. breakthroughs (QC,AI, green lab, new…)

Muon collider design + R&D

Strong hand in the ILC (especially if Japanese government moves forward)

Cooperation with the FCC (ee,hh) group in key technologies

Push the field to find ways to probe the Universe and strive for discovery

plus lots of "frontiers" and "considerations" to watch out for

Japan
Landscapes and national roadmaps

Japan's Strategy for Energy Frontier

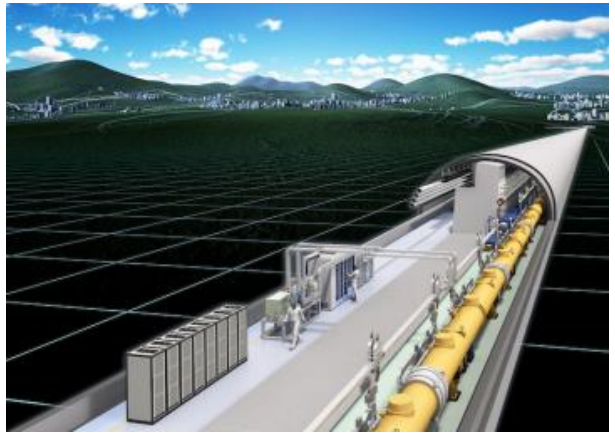
- **Current HE research concentrates on (HL-)LHC**

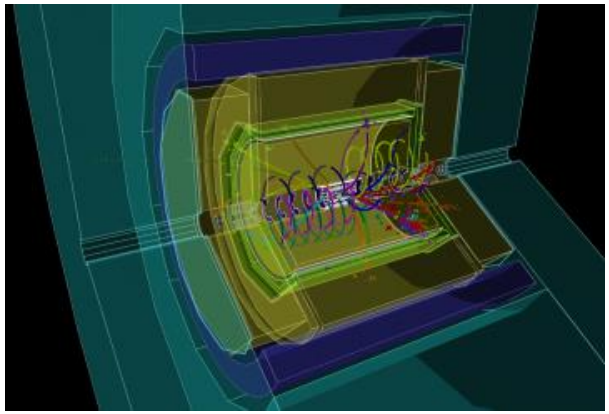
"… continuing studies of new physics should be pursued using the LHC and its upgrades."

- **Future HE project in Japan is the ILC**

"… construction of the International Linear Collider with a collision energy of 250 GeV should start in Japan immediately without delay so as to guide the …. through the research of the Higgs particle …."

Final Report by the Committee on Future Projects in High Energy Physics, September 2017
http://www.jahep.org/files/20170906-en.pdf

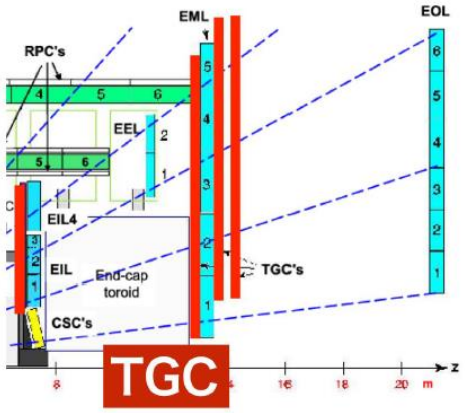




Japan
Landscapes and national roadmaps

Japan in ATLAS & LHC/HL-LHC

- ATLAS Japan collaboration started in 1994.
  - Tokyo, KEK, Tsukuba, Waseda, Ochanomizu, Tokyo Tech, Tokyo Metropolitan, Shinshu, Nagoya, Kyoto, Kyoto U of Education, Osaka, Kobe, and Kyushu
- Japan's contribution to LHC started as early as 1995, the first as a non-member state of CERN.
  - Recent contributions toward Run3 include: Calorimeter trigger upgrade, Muon trigger upgrade with New Small Wheel, repairs of Silicon Strip and Pixel Detectors
- HL-LHC listed as a priority project in MEXT's Roadmap in 2017.
  - D1 Magnet for beam separation
  - Silicon Pixel & Strip, Muon Trigger



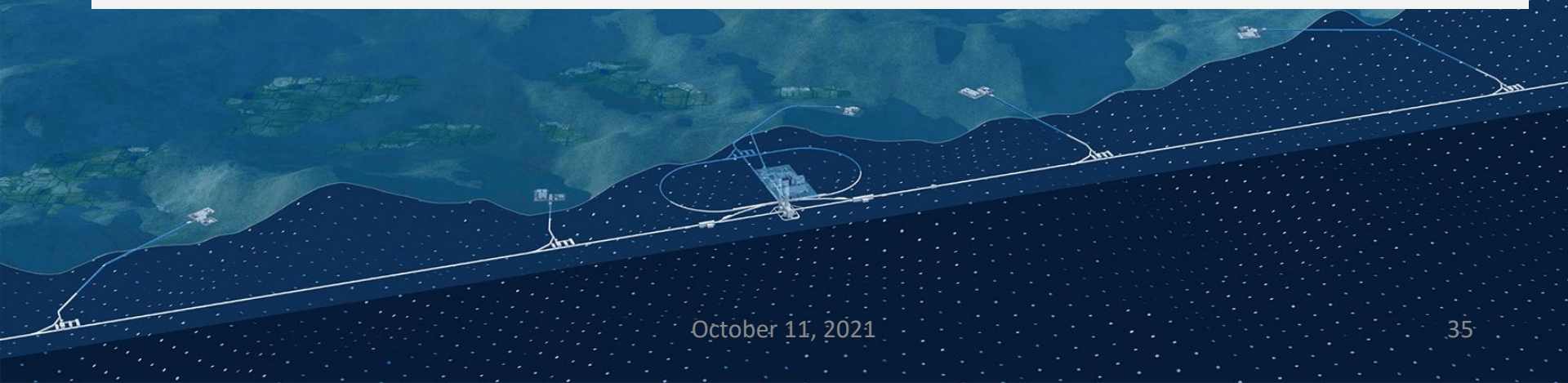
2020.08.02 **ICFA announces a new phase towards preparation for the International Linear Collider. ICFA approved the formation of the ILC International Development Team as the first step towards the preparatory phase of the ILC project, with a mandate to make preparations for the ILC Pre-Lab in Japan.**

2020.08.31 Snowmass2021 LOI "Update of the Japanese Strategy for Particle Physics“

2020.10.28 The **ILC Steering Panel** was established by the Japan High Energy Physics Committee (HEPC) of the Japan Association of High Energy Physicists (JAHEP). **“Leading the high energy physics community in Japan toward a timely realization of the ILC”**

2021.01.16 The JAHEP **ILC Steering Panel** released a report "**Recent Progress Towards the Realization of the ILC in Japan: Cooperative Efforts by Academia, Industry, and Local Region**".

2021.06.02 The ILC International Development Team has released "**ILC Preparatory Laboratory proposal**". http://www.jahep.org/files/input_JapanHEPC_20191213.pdf



ILC International Development Team

Created by the ICFA for preparing the ILC Pre-lab proposal
Unlike LCB/LCC, this is focused on the ILC

established in August 2020

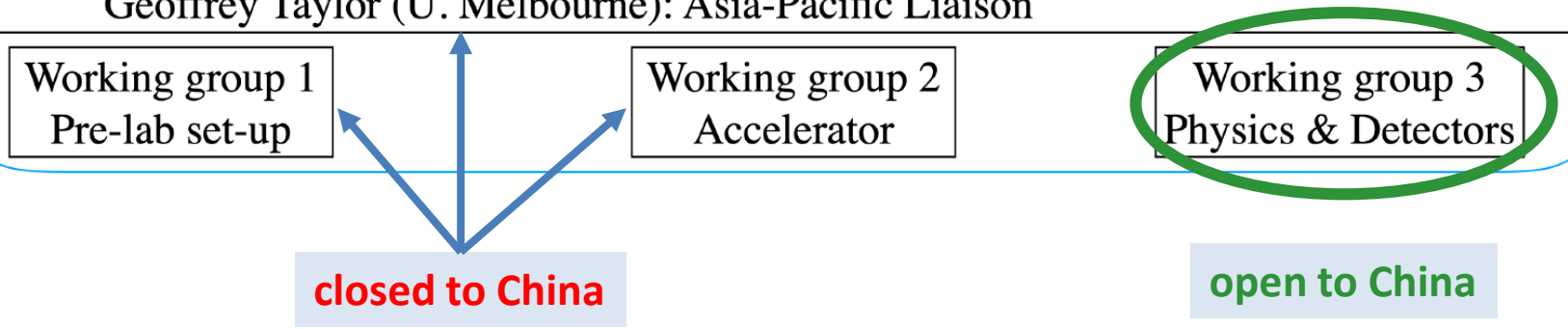
ICFA

Published the ILC Pre-Lab Proposal in June 2021

ILC-IDT

Executive Board

Andrew Lankford (UC Irvine): Americas Liaison
Shinichiro Michizono (KEK): Working group 2 Chair
Hitoshi Murayama (UC Berkeley/U. Tokyo): Working group 3 Chair
Tatsuya Nakada (EPFL): Executive Board Chair and Working group 1 Chair
Yasuhiro Okada (KEK): KEK Liaison
Steinar Stapnes (CERN): Europe Liaison
Geoffrey Taylor (U. Melbourne): Asia-Pacific Liaison



The ILC

ILC Project Timeline

Struggling to start the ILC Pre-Laboratory

Toshinori Mori

What's happening in Japan

IDT published its proposal for ILC Pre-Lab in June

Japanese HEP community submitted a report on remaining challenges of ILC to MEXT in June

- MEXT is starting now:
  - an experts committee to examine the progress on the remaining challenges based on the community's report and the IDT proposal
  - to exchange views and have discussion on the project with the US and European counterparts, starting this autumn

We are hopeful that these will eventually lead to the start-up of ILC Pre-Lab!

MEXT is cautious

Toshinori Mori

Collaboration and geopolitical realities

Collaboration:

Continued collaboration and coordination among Europe, US and Japan

Shared R&D on critical technologies (nano beam, design and components,…)

Close organization association and consultation, with funding agency invovelment

Europe and US have strong roles in the ILC

Cooperation with the FCC (ee,hh) group in key technologies

Push the field to find ways to probe the Universe and strive for discovery

Geopolitical realities:

National interest and politics can get in the way, sometimes
Some HEP technologies may be restricted
Scientific exchange would be more challenging

implication for the necessity of R&D and innovation in China

Comments & Summary

- The present energy frontier, centered around LHC, is very active & productive
- Europe, Japan and US all have their own HE frontier strategies, and have updated them or will come up with updates in the near future
- Europe, Japan have plans for future energy frontier accelerators; US may come up with a muon collider program; they all aim high and have a dream
- Energy frontier remains global and requires sustained R&D and innovations
- Expected from the energy frontier, there are many important scientific questions to answer, technological challenges to solve, and issues-barriers to overcome

- Going for the future, will there be a HE accelerator beyond the HL-LHC in the world?
  our colleagues in Europe, Japan, US are working hard to ensure a positive outcome

Special Acknowledgement:

Val Gibson	**Chair, CERN Collab. Board**
Karl Jacobs	**Chair, ECFA**
Tao Han	**Chair, US DPF**
Toshinori Mori	**Chair, Japan HEPC**

Additional Slides

Europe

Landscapes and national roadmaps in the making

- The end product
  - Council (200pp; panel reports plus synthesis) – will subsequently be public
  - Summary report in 'glossy' format for funding agencies etc (10pp)
  - Long reports from panels, possibly published
- From January 2022, the 'implementation phase' should begin
  - Follow-up process is still to be determined for both roadmaps
- Questions for the community (with reference to talks by panel chairs)
  - Are there accelerator R&D requirements not yet captured?
    - Both within the five topical areas, and outside them
  - What are the appropriate target timescales for R&D outputs?
    - Based upon ambitions for future machines, but also potential improvements of current machines
  - What is the optimal balance between 'generic' long term R&D, medium-term topical R&D, and near term concrete studies for new machines?
  - Are there instances where machine and detector R&D must be linked strongly?
  - What opportunities exist for scientific exploitation of the R&D demonstrators?
- Timely feedback is welcome in this last phase of the 'public' discussion
  - Please let us know your views via your ECFA representative, or directly to LDG

Dave Newbold @ EPS2021

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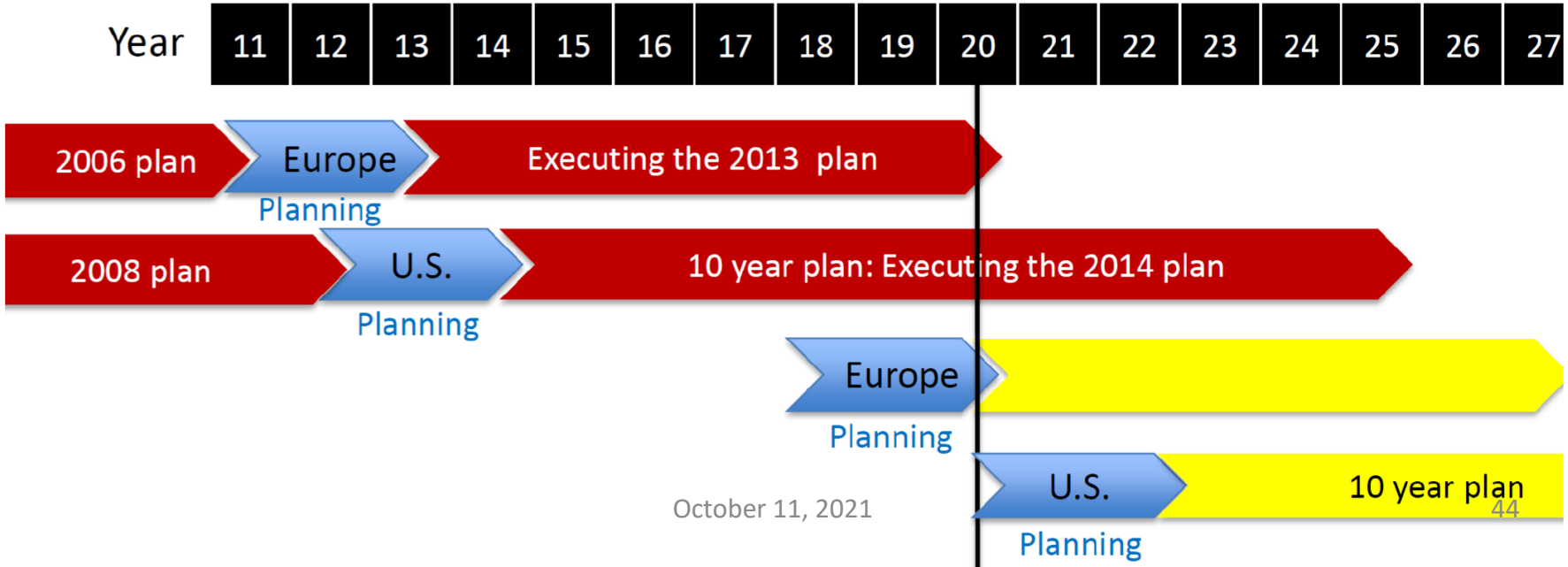
Particle Physics is Global

Europe and U.S.

- Frequency: 7 years (Europe), ~8 years (U.S.)
- Process: ~2 years in total (~1 year on science by the community + ~1 year priorities)

Snowmass (U.S.) P5 (U.S.)

Japan, Canada, China, Latin America, …



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Input to Snowmass 2021: Letters of Interest & Contributed Papers

Letters of Interest (submission period: April 1, 2020 – August 31, 2020)

Letters of interest allow Snowmass conveners to see what proposals to expect and to encourage the community to begin studying them. They will help conveners to prepare the Snowmass Planning Meeting that will take place on November 4 - 6, 2020 at Fermilab. Letters should give brief descriptions of the proposal and cite the relevant papers to study. Instructions for submitting letters are available athttps://snowmass21.org/loi

Contributed Papers (April 1, 2020 – July 31, 2021)

Contributed papers will be part of the Snowmass proceedings. They may include white papers on specific scientific areas, technical articles presenting new results on relevant physics topics, and reasoned expressions of physics priorities, including those related to community involvement. These papers and discussions throughout the Snowmass process will help shape the long-term strategy of particle physics in the U.S.

Contributed papers will remain part of the permanent record of Snowmass 2021. Instructions for submitting contributed papers are available at https://snowmass21.org/submissions/

Index to LOI, Submitted Papers, by Frontier

Energy Frontier (EF) (0)
Neutrino Physics Frontier (NF) (2)
Rare Processes and Precision Measurements (RF) (0)
Cosmic Frontier (CF) (1)
Theory Frontier (TF) (0)
Accelerator Science and Technology Frontier (AF) (1)
Instrumentation Frontier (IF) (1)
Computational Frontier (CompF) (0)
Underground Facilities and Infrastructure (UF) (0)
Community Involvement (CommF) (0)

Participation by scientists from (I am aware of)

LOI + CP: CEPC accelerator, detector, BESIII physics, young theorists active

Other: Energy Frontier Physics Questions, CEPC updates, advising and convener roles

United States
Landscapes and national roadmaps

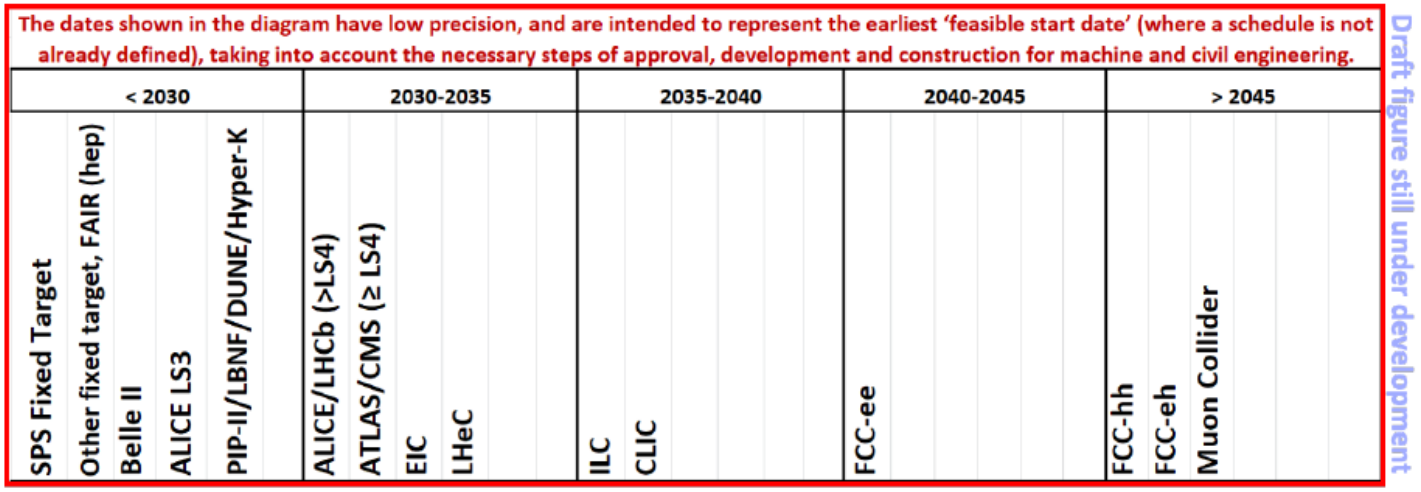
Summary of Scenarios

Project/Activity	Scenarios			Science Drivers					Technique (Frontier)
	Scenario A	Scenario B	Scenario C	Higgs	Neutrinos	Dark Matter	Cosm. Accel.	The Unknown	
Large Projects									
Muon program: Mu2e, Muon g-2	Y, Mu2e small reprofile needed	Y	Y					✓	I
HL-LHC	Y	Y	Y	✓		✓		✓	E
LBNF + PIP-II	Y, LBNF components delayed relative to Scenario B.	Y	Y, enhanced		✓			✓	I,C
ILC	R&D only	R&D, possibly small hardware contri-butions. See text.	Y	✓		✓		✓	E

Report of the Particle Physics Project Prioritization Panel (P5)

Europe
Landscapes and national roadmaps

Facilities and Experiments Timeline



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DPF Community Planning Process - Community-wide meetings and workshops include

- Snowmass Kick-off Town-Hall meeting (virtual): April 18, 2020 (during the

The Snowmass community planning exercise, that has been delayed since January 2021 due to the COVID-19 pandemic, will resume the full activity from September 2021

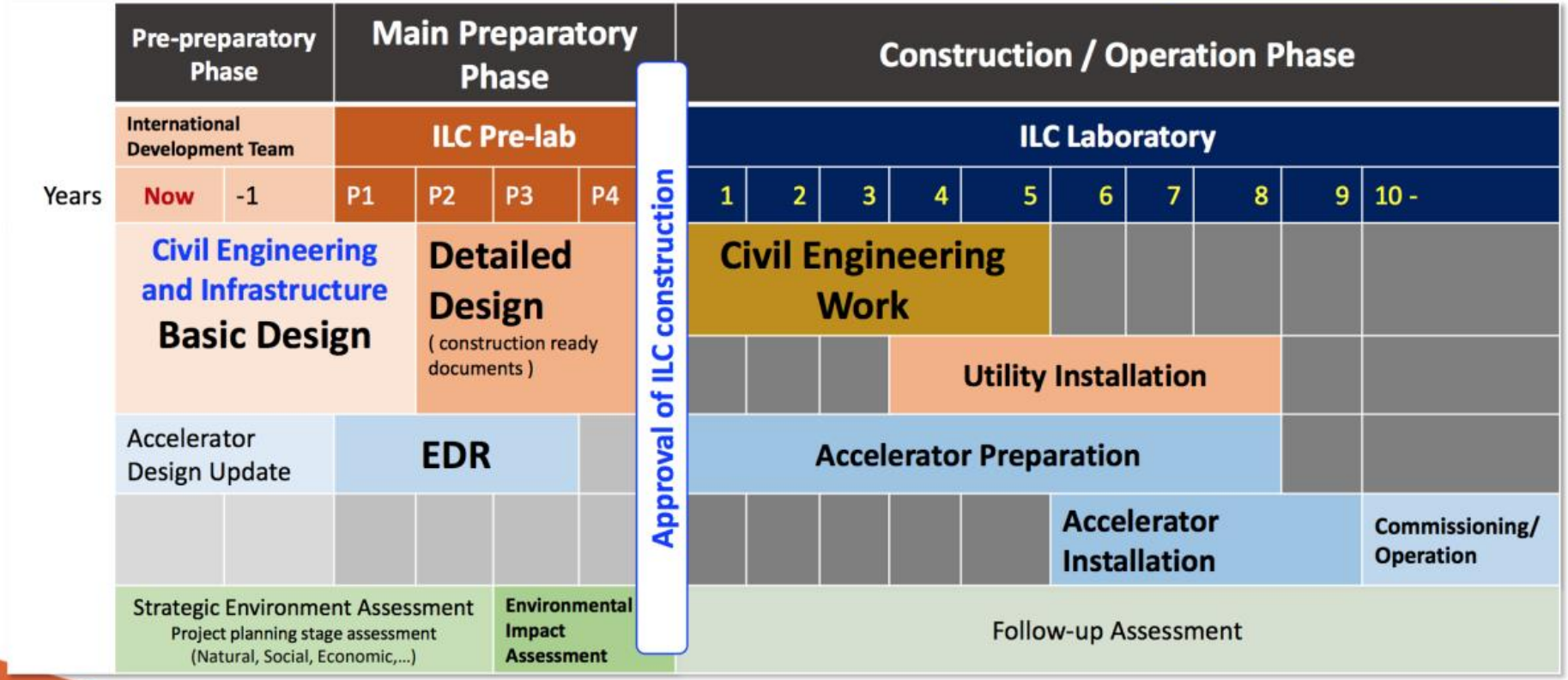
economic consideration.

For all the meetings and workshops, we will make sure that we are inclusive to those who participate remotely and we will have a special session to discuss APS efforts for openness and the importance of open international collaboration.

Japan
Landscapes and national roadmaps

The ILC

N.Terunuma, AWLC2020

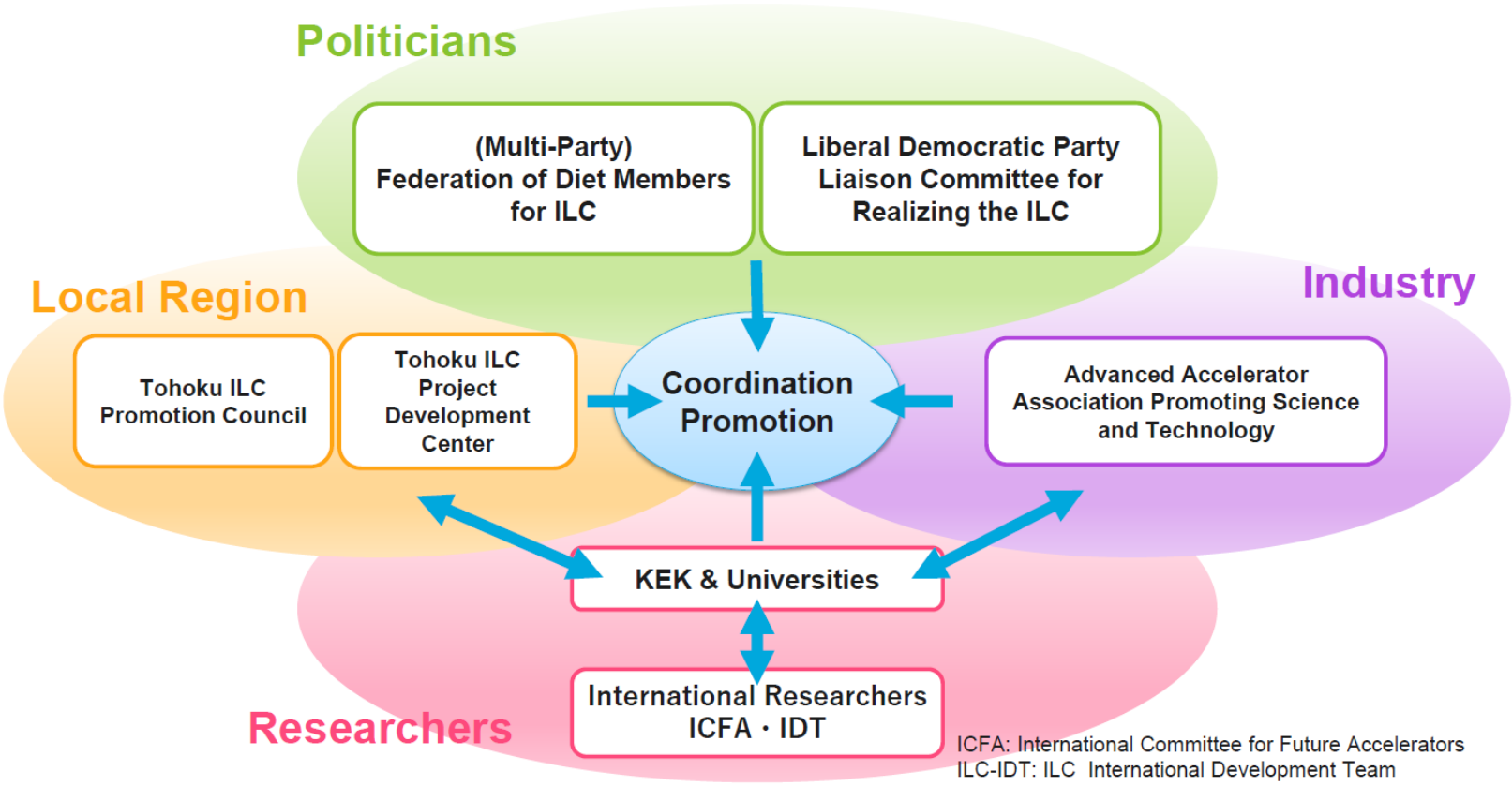


References; (1) TDR, (2) Recommendations on ILC Project Implementation, 2019.

https://indico.ihep.ac.cn/event/11444/session/6/contribution/10/material/slides/0.pdf

The ILC

Organizations Promoting the ILC Project in Japan



The four sectors are actively working for coordinated promotion of the ILC.