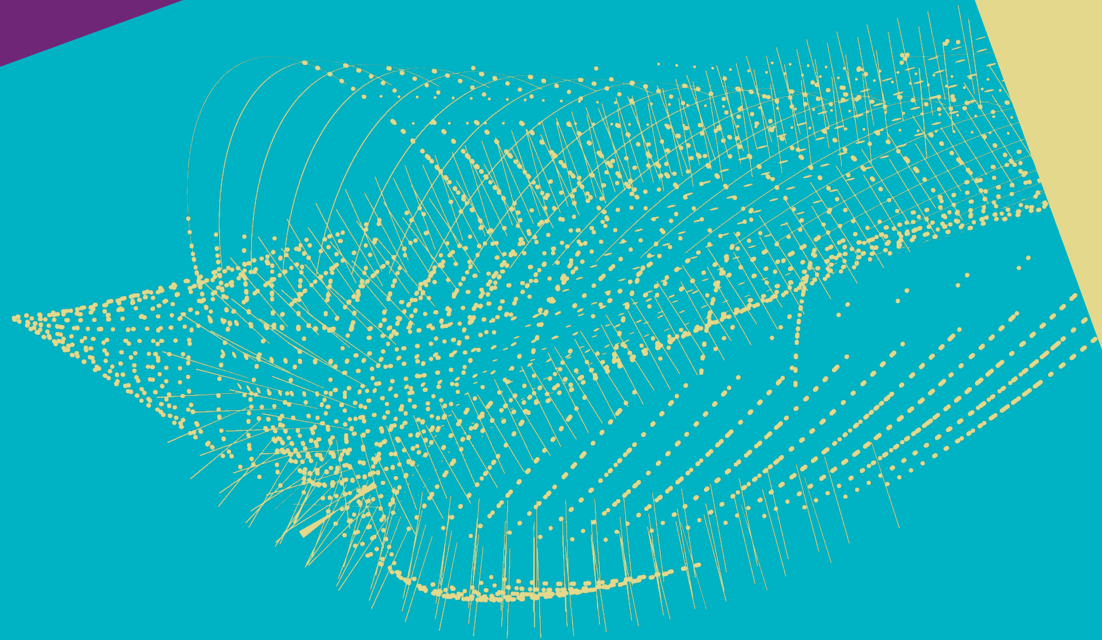
Nikhef

SUBTITEL



ESPPU UPDATE

Tekst

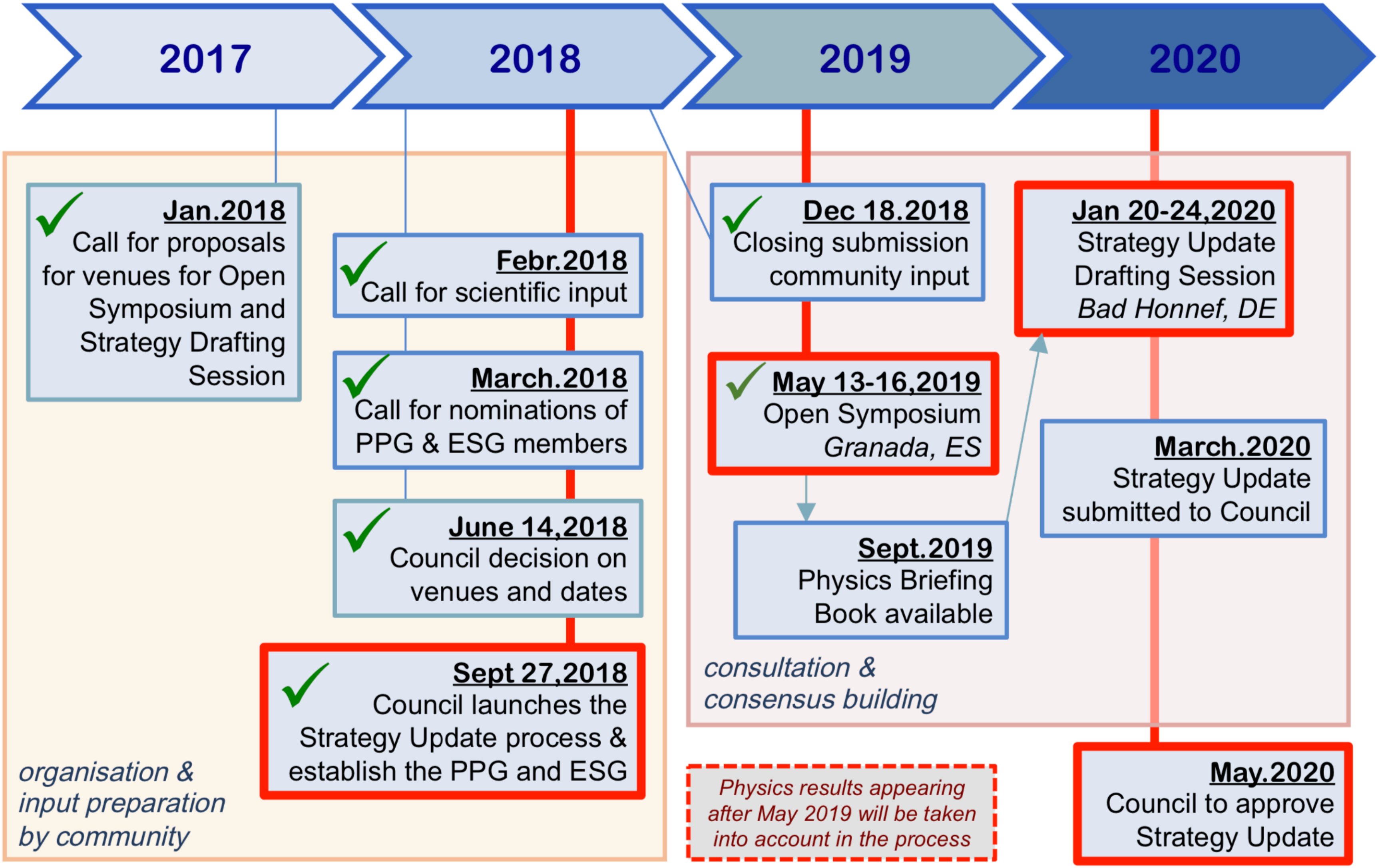
ESPPU

Collect input from our community

- Tuesday October 22nd,
  - 15:00-17:00 hrs, H331
  - Collect pro's & cons for the 5 scenario's for large infra
- Wednesday November 27th
  - 13:00 - 15:00 hrs, H331
  - Second round - emphasis on remaining items

Vista update: Nikhef strategy discussion ~June 2020

- Mid-term update of Nikhef strategy
  - Consequences after the ESPPU has been finalised, in May 2020
  - Role for WAR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Improvements for the CERN Organization and Laboratory

We formulate a number of recommendations that Nikhef views relevant for the CERN laboratory

1. The link with industry can be further intensified, notably also for the Dutch industry. A better balance of the industrial returns between the member States can be achieved by making the procurement rules more flexible. In this respect we would also encourage further steps to facilitate the recruitment of Dutch technical students, fellows and staff members.

2. CERN is encouraged to investigate and implement a better balance between the CERN membership contribution and M&O contributions of the collaborations for member- and non-member countries.

3. Open science can be brought to the next level at CERN by stimulating open data as put forward by the European Open Science Cloud and by encouraging open membership of collaborations, such that authors can access data of multiple collaborations. Cross-experiment and cross-collaboration projects should be stimulated.

4. Physics Collaborations in Europe should give more opportunities for individuals to present their views in conferences and publications, for example in the form of shortened author-list notes or publications that should be publicly accessible.

5. The computing and data analysis challenges ahead of us are enormous. CERN should develop a strategy to further support data science as a separate research item, both at the CERN lab and in co-ordinating the European community effort. This will require to make data science jobs attractive in the strong competition with industry.

OUR INPUT TO ESPPU

CERN LAB

6. CERN should continue to strengthen its role as a centre for theoretical particle phenomenology, to perform state-of-the-art calculations relevant to high energy and high precision collider physics as well as Astroparticle physics topics. The Netherlands support the proposal as is put forward by CERN and APPEC to establish a network of

European institutions active in theoretical Astroparticle physics, with a central position taken by CERN.

OUR INPUT TO ESPPU

CERN LAB

Future Particle Physics Developments

The program of CERN should maximize the exploitation of its physics potential. Keywords here are 'high precision', 'high energy' and 'diversification'. The Netherlands support both a flagship program with high physics potential, as well as a diversification program to maximize the potential to find BSM physics.

7. The successful realization of the High Luminosity LHC is the highest priority, including the upgraded general-purpose experiments Atlas and CMS, as well as flavour physics with LHCb and heavy-ion physics with Alice.

8. The Netherlands strongly support the construction of an electron-positron collider, complementary to the LHC, that can study the properties of the Higgs boson and other particles with unprecedented precision, and whose energy can be upgraded.

9. We look forward to the imminent statement from Japan on hosting the ILC, including guidance about the resources foreseen. In the scenario that the ILC (phase-1) project in Japan is approved, CERN should take a visible and vivid role in its design, construction and exploitation and utilize the full potential of CERN's capabilities. CERN's CLIC technology is seen as an ideal opportunity for an energy upgrade in the ILC infrastructure in Japan.

10. For the Netherlands, taking part in large new international infrastructural projects such as the ILC can only be done via the CERN Membership. The Dutch particle physics community expects CERN to be the leading and co-ordinating European partner in such projects.

11. If Japan does not propose to host the ILC, CERN should optimize the costs to construct a high luminosity e^+e^- machine of 250 GeV to become online in the mid-2030-ies.

12. The FCC-ee and FCC-pp programs are strongly linked and highly ambitious: the construction of the FCC-ee facility is an excellent opportunity with the vision to construct the FCC-pp in the future as well. CERN should therefore strengthen the combined physics case and scrutinize these two projects together.

13. In the meantime, CERN should prepare vigorously for a future accelerator on-site by pushing the R&D efforts for high-gradient acceleration, e.g. wakefield- and high field magnet technology. In addition, the feasibility of building a muon collider should be pursued.

OUR INPUT TO ESPPU

COLLIDER PHYSICS

CERN involvement to Astroparticle Physics

Given that the fields and communities of Astroparticle Physics and Gravitational Wave physics are internationally growing, CERN should widen its physics palette and welcome the hosting and support of the Astroparticle program part that is relevant for fundamental Particle Physics.

14. CERN should take measures to optimize diversity within its physics program. We support the "Physics Beyond Colliders" initiative at CERN to optimally use its existing accelerator infrastructure. The neutrino platform with, e.g. ProtoDUNE, is an excellent new initiative and we encourage CERN to continue this fruitful collaboration with other particle physics laboratories, such as Fermilab.

15. CERN should initiate a 'Dark Matter' platform to advance technological and experimental challenges in this field of research, similar to the neutrino platform.

16. CERN's mission and governance is well suited and profitable to be involved and play an active role in the construction of the Einstein Telescope third generation Gravitational Wave interferometer. CERN should take a visible and vivid role in the design, construction and exploitation of the Einstein Telescope.

OUR INPUT TO ESPPU

APP

Open Symposium
Towards updating the European Strategy for Particle Physics
May 13-16, 2019, Granada, Spain
https://cafpe.ugr.es/eppsu2019/
~600 participants
Information captured in 8 thematic summary talks

Physics Briefing Book
Physics Preparatory Group

- Overviewing the submitted input and the discussions in Granada
- Excluding references etc. about 200 pages
- The work of many!
- Today: towards a public release of the PBB

Physics Briefing Book

European Strategy Update

Input for the European Strategy for Particle Physics Update 2020

Electroweak Physics: Richard Keith Ellis[1], Beate Heinemann[2,3] *(Conveners)*
Jorge de Blas[4,5], Maria Cepeda[6], Christophe Grojean[2,7], Fabio Maltoni[8,9], Aleandro Nisati[10],
Elisabeth Petit[11], Riccardo Rattazzi[12], Wouter Verkerke[13] *(Contributors)*

Strong Interactions: Jorgen D'Hondt[14], Krzysztof Redlich[15] *(Conveners)*
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Nestor Armesto[18], Daniël Boer[19], David d'Enterria[20], Tetyana Galatyuk[21], Thomas Gehrmann [22],
Klaus Kirch[23], Uta Klein[24], Jean-Philippe Lansberg[25], Gavin P. Salam[26], Gunar Schnell[27],
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Gudrun Hiller[39], Gino Isidori[22], Yoshikata Kuno[40], Alberto Lusiani[41], Yosef Nir[36],
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Neutrino Physics & Cosmic Messengers: Stan Bentvelsen[45], Marco Zito[46,47] *(Conveners)*
Albert De Roeck [20], Thomas Schwetz[29] *(Scientific Secretaries)*
Bonnie Fleming[48], Francis Halzen[49], Andreas Haungs[29], Marek Kowalski[2], Susanne Mertens[44],
Mauro Mezzetto[5], Silvia Pascoli[50], Bangalore Sathyaprakash[51], Nicola Serra[22] *(Contributors)*

Beyond the Standard Model: Gian F. Giudice[20], Paris Sphicas[20,52] *(Conveners)*
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Matthew McCullough[20], Gilad Perez[36], Philipp Roloff[20], Veronica Sanz[55], Andreas Weiler[44],
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Dark Matter and Dark Sector: Shoji Asai[56], Marcela Carena[57] *(Conveners)*
Babette Döbrich[20], Caterina Doglioni[53], Joerg Jaeckel[28], Gordan Krnjaic[57], Jocelyn Monroe[58],
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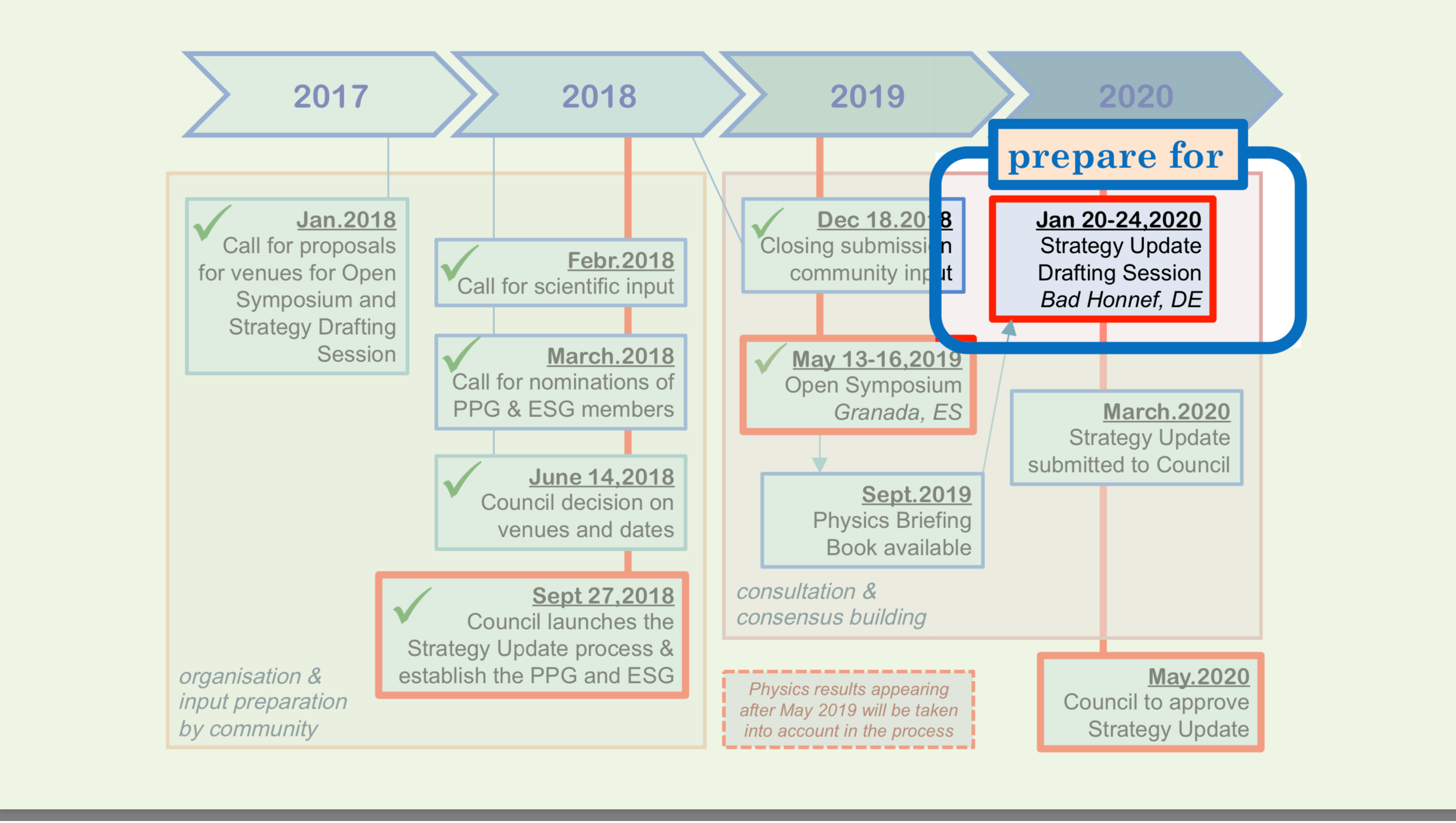
Philip Burrows[26], Frank Zimmermann[20] *(Scientific Secretaries)*
Michael Benedikt[20], Edda Gschwendtner[20], Erk Jensen[20], Mike Lamont[20], Wim Leemans[2],
Lucio Rossi[20], Daniel Schulte[20], Mike Seidel[62], Vladimir Shiltsev[63], Steinar Stapnes[20],
Akira Yamamoto[20,64] *(Contributors)*

Instrumentation and Computing: Xinchou Lou[65], Brigitte Vachon[66] *(Conveners)*
Roger Jones[67], Emilia Leogrande[20] *(Scientific Secretaries)*
Ian Bird[20], Amber Boehnlein[68], Simone Campana[20], Ariella Cattai[20], Didier Contardo[69],
Cinzia Da Via[70], Francesco Forti[71], Maria Girone[20], Matthias Kasemann[2], Weidon Li[65],
Lucie Linssen[20], Felix Sefkow[2], Graeme Stewart[20]*(Contributors)*

Editors: Halina Abramowicz[72], Roger Forty[20], and the Conveners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Presentation with a view to update the Strategy

1) The Physics Briefing Book is our key document
2) A meta-level sketch of the landscape beyond Granada
3) Scenarios with colliders in Europe to update the Strategy
   (related draft document communicated to ESG on 23 Sept 2019)

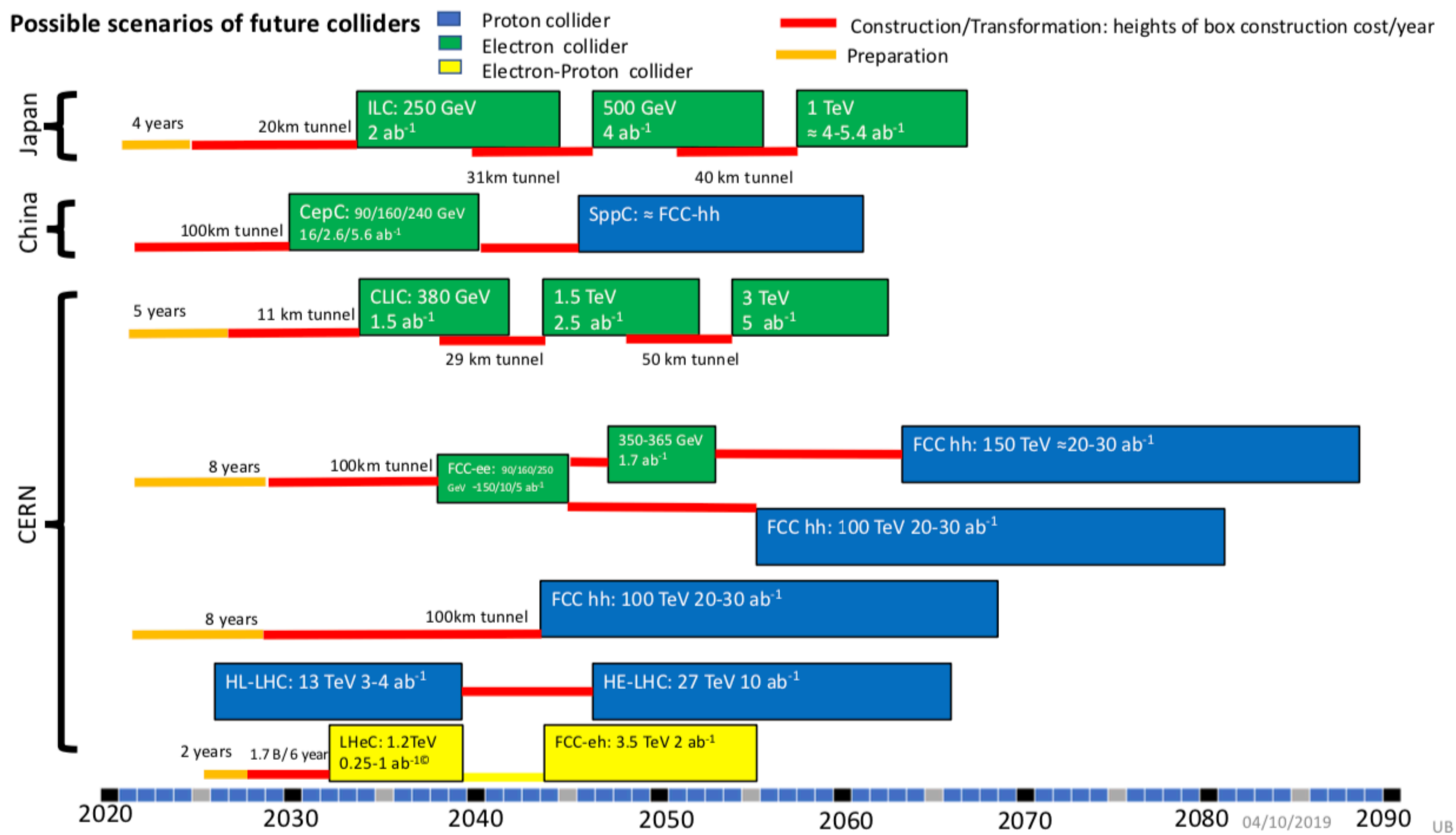
Remarks:

Not the solutions, but identifying options & challenges
Not the final view, but an initial strawman view

Some key questions listed

5 SCENARIO'S TO CONSIDER

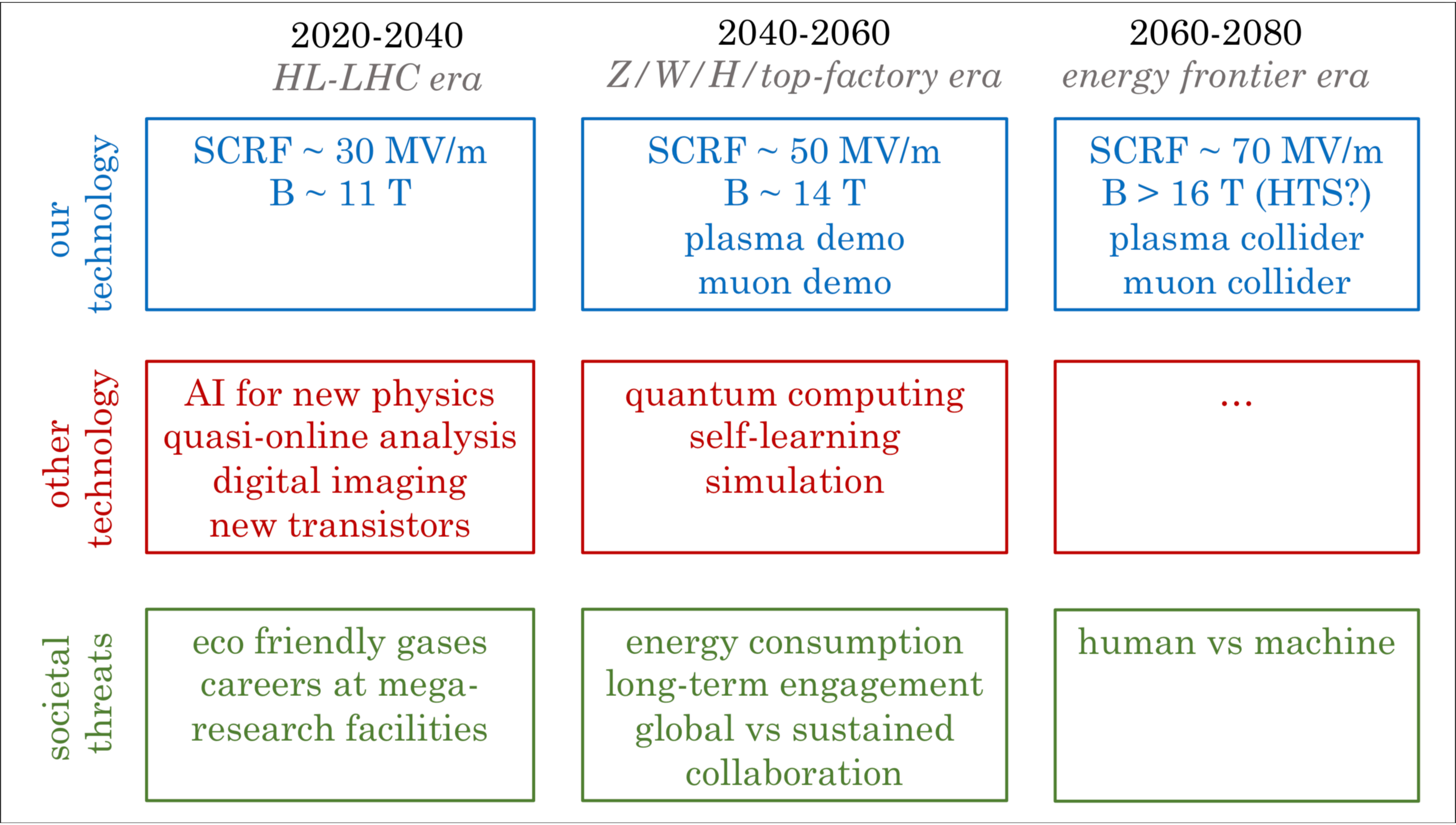
	2020-2040		2040-2060	2060-2080
			1st gen technology	**2nd gen technology**
CLIC-all	HL-LHC		**CLIC380-1500**	CLIC3000 / other tech
CLIC-FCC	HL-LHC		**CLIC380**	FCC-h/e/A (Adv HF magnets) / other tech
FCC-all	HL-LHC		**FCC-ee (90-365)**	FCC-h/e/A (Adv HF magnets) / other tech
LE-to-HE-FCC-h/e/A	HL-LHC		**LE-FCC-h/e/A (low-field magnets)**	FCC-h/e/A (Adv HF magnets) / other tech
LHeC-FCC-h/e/A	HL-LHC	**+ LHeC**	**LHeC**	FCC-h/e/A (Adv HF magnets) / other tech


Possible scenarios of future colliders
Proton collider
Electron collider
Electron-Proton collider
Construction/Transformation: heights of box construction cost/year
Preparation
Japan
4 years
20km tunnel
ILC: 250 GeV 2 ab-1
500 GeV 4 ab-1
1 TeV ≈ 4-5.4 ab-1
31km tunnel
40 km tunnel
China
100km tunnel
CepC: 90/160/240 GeV 16/2.6/5.6 ab-1
SppC: ≈ FCC-hh
CERN
5 years
11 km tunnel
CLIC: 380 GeV 1.5 ab-1
1.5 TeV 2.5 ab-1
3 TeV 5 ab-1
29 km tunnel
50 km tunnel
8 years
100km tunnel
FCC-ee: 90/160/250 GeV -150/10/5 ab-1
350-365 GeV 1.7 ab-1
FCC hh: 150 TeV ≈20-30 ab-1
FCC hh: 100 TeV 20-30 ab-1
8 years
100km tunnel
FCC hh: 100 TeV 20-30 ab-1
HL-LHC: 13 TeV 3-4 ab-1
HE-LHC: 27 TeV 10 ab-1
2 years
1.7 B/6 year
LHeC: 1.2TeV 0.25-1 ab-1
FCC-eh: 3.5 TeV 2 ab-1
2020
2030
2040
2050
2060
2070
2080
04/10/2019
2090
UB

Accelerator technology at Granada

Not written in stone, but on the collider front we might identify three eras

- the *immediate future* (2020-2040)
  e.g. the HL-LHC era
- the *mid-term future* (2040-2060)
  e.g. the Z/W/H/top-factory era
- the *long-term future* (2060-2080)
  e.g. the energy frontier era


2020-2040
HL-LHC era
2040-2060
Z/W/H/top-factory era
2060-2080
energy frontier era
our technology
SCRF ~ 30 MV/m
B ~ 11 T
SCRF ~ 50 MV/m
B ~ 14 T
plasma demo
muon demo
SCRF ~ 70 MV/m
B > 16 T (HTS?)
plasma collider
muon collider
other technology
AI for new physics
quasi-online analysis
digital imaging
new transistors
quantum computing
self-learning
simulation
...
societal threats
eco friendly gases
careers at mega-research facilities
energy consumption
long-term engagement
global vs sustained collaboration
human vs machine

	2020-2040 *HL-LHC era*	2040-2060 *Z/W/H/top-factory era*	2060-2080 *energy frontier era*
precision frontier	H couplings to few % ν mass/mixing/nature QGP phase-transition b/c-physics	H couplings to % EW & QCD & top QGP vs Lattice QCD b/c/τ-physics	H couplings to ‰ H self-coupling to % proton structure di-boson processes
breaking the SM	next-gen K-beams proton precision e & n EDM lepton flavor ($\mu \to e$)	p EDM storage rings	rare top decays small-x physics
direct searches	Beam Dump Facility eSPS (light DM) Long-Lived Signals / ALPs DM vs neutrino floor	heavy neutral lepton	new high-mass part. next-gen hidden exp. low-mass DM

Large-Scale Projects > 1 Billion (EUR, $, CHF)

European Strategy Update

	ID	Name	Timeline	Cost	Comment	Level
CERN	146	CLIC (acc+det)	7 years construction	5890 MCHF 397 MCHF	(±20%); 380 GeV machine, drive-beam-based (klystron machine 7290); detector 397 MCHF	1
	132	FCC-ee (Z, W, H)	18 years until physics (10 years construction)	10500 MCHF +1100 MCHF	(±30%); Capital cost for three working points (Z,W,H); operation costs 85 MEUR/year (electricity, today's prices) For ttbar stage	1
	133	FCC-hh (after FCC-ee)	Physics 25 years after start of ee physics	17000 MCHF	(±30%); Capital cost with preceding ee; operations costs 180 MEUR/year (electricity, today's prices).	1
	133	FCC-hh stand-alone	23 years until physics (15 years construction)	24000 MCHF	(±30%); Stand-alone capital cost (no ee before); operations costs 180 MEUR/year (electricity, today's prices).	1
	136	HE-LHC	23 years until physics (8 years construction)	7200 MCHF	(±30%); Capital cost; operation costs 55 MEUR/year (electricity, today's prices)	1
		FCC / HE-LHC detectors	---	---	No input to ESU	
Japan	66 / 77	International Linear Collider (ILC250)	10 years construction	4800-5300 MILCU 7980 MILCU	(±25%); For ILC250, plus 10 kFTE years; European contribution to non-CFS? ILC500, plus 13.5 kFTE years	1
	107	International Large Detector	O(9-10 years)	400 MEUR	Large European participation	1
		SiD	O(9-10 years)	---	Smaller European participation	3
China	51	CEPC accelerator	Decision ≥2022	---	European contribution unclear; pre-selection large scale projects 2020	3
	29	CEPC detector	---	---	European contribution unclear	3

QUESTIONS TO REFLECT - NEXT WEEK

1) In the absence of clear indications for new physics, is a broad exploration an adequate approach for our global field? Do we want to move forward in the largest variety of directions?

2) Would it be appropriate/sufficient to move the scientific diversity program at CERN or at the National Institutes to among the highest priorities for Europe? Should the strategy engage in ranking proposals according to priority? Which are the key proposals?

3) Do we remain open towards strong participation in future collider programs outside Europe? Should such a statement remain among the highest priorities? Should we extend the scope to include a variety of options like ILC@Japan, EIC@US, CEPC@China, … ?

QUESTIONS TO DISCUSS

4) Anno 2013: "*Detector R&D programmes should be supported strongly at CERN, national institutes, laboratories and universities. Infrastructure and engineering capabilities for the R&D programme and construction of large detectors, as well as infrastructures for data analysis, data preservation and distributed data-intensive computing should be maintained and further developed.*" Should we strengthen this statement? Should we provide guidance how to achieve this? For example, related to new R&D cluster programs at CERN and in Europe, and related to the balance between blue sky R&D versus focused R&D.

5) Should we make concrete the technology collaboration with the gravitational wave community?

6) Given the important recent particle physics discoveries in astroparticle physics experiments and observatories and their promising future potential for more key discoveries in particle physics, should we come to concrete co-operation with astroparticle physics for the mutual benefit of particle physics and astroparticle physics?

summary of national priorities and interests for large future HEP projects :

country	item #	**e+e- e-w,H,.. (ILC, ...)**	e+e- incl. ttbar (FCC-ee)	e+e- incl. HH (ILC+,CLIC)	**hh beyond LHC**	hh he-LHC	hh FCC	eh	**accel. R&D**	R&D magnets FCC,he-LHC	R&D novel PWA,μ+μ-	**non-accelerator (DM,ndbd)**	**neutrino physics**	**intensity frontier**	**nuclear (FAIR,EIC...)**	**astro-particle**
A	108	**1**			**3**				**2**			√			√	√
B	122	**1**														
CH	142	**1**	1		**3**		3		**2**	2	3		√	√	√	√
CZ	88	**3**		3	**2**	2	2		**1**	1	1		√		4	
D	33	**1**		1	**3**	3	3		**2**	2	2	4	√	√	√	√
DK	61	**3**	3		**3**		3		**2**	2	2	1	√	√	√	√
E	31	**1**	3	1	**3**	3	3		**2**	2	4		√		√	√
F	15,116,155	**1**	√	√	**3**		3	√	**2**	2	√	√	√	√	√	√
FIN	55	**1**		1									√		√	√
I	26,138	**1**	1		**3**		3		**2**	2	2	√	√	√		√
IL	34	**√**			**√**							√	√	√		
N	43	**1**		1					**3**		3	√			√	√
NL	166	**1**	3	2	**3**		3		**2**	2	3	√	√	√		√
PL	125	**1**	√	√					**2**							
RO	73												√	√		
S	127	**1**		1					**2**	2	√	√	√	3		√
SLO	78															
UK	134,144	**1**		1	**2**		2	2	**3**	3	√	√	√		√	
total score:		**13,67**	3	6,83	**3,67**	1,17	3,33	0,5	**6,67**	5,33	3,75					

1…4: priority 1 to priority 4;
√: mentioned without (clear) assignment of priority
total score: =Σ(1/priority) where given; √ not counted

Notes:
– table reflects status of inputs submitted by Dec. 2018
– intended for overview of physics or projects prioritie
– see disclaimers on previous and following pages!

summary of NMS inputs:

country	item #	e+e- e-w,H,.. (ILC, ...)	e+e- incl. ttbar (FCC-ee)	e+e- incl. HH (ILC+,CLIC)	hh beyond LHC	hh he-LHC	hh FCC	eh	accel. R&D	R&D magnets FCC,he-LHC	R&D novel PWA,μ+μ-	non-accelerator (DM,ndbd)	neutrino physics	intensity frontier	nuclear (FAIR,EIC,...)	astro-particle
CDN	157	**√**	√	√	**√**	√	√					√	√			
J	63	**1**							**4**			3	2			
RUS	40								**√**			√	√	√	√	√
USA	149;150	**√**	√	√	**√**	√	√		**√**	√	√	√	√	√		√
total score:																

- 18 MS and 4 NMS submitted national inputs on HEP
- 3 MS and 3 NMS provided no explicit priorisation
- –> "total scoring" based on 15 MS
- total score defined as Σ(1/priority)

further future projects

- neutrino physics (long baseline; ndbd; cosmic)
- physics beyond colliders
- dark matter searches
- intensity frontier
- nuclear physics
- gravitational waves
- astro-particle projects