Report on the European Strategy Update the Symposium in Granada

Aleandro Nisati

June 18th, 2019

Retreat (Assisi)

The European Strategy Update

- Last Update: May 2013
- Current Update planned for May 2020
- Important bodies
  - Physics Preparatory group (PPG): 17 people
    - Organizes Symposium(May2019) and prepares *Briefing Book* (Sept.2019)
  - European Strategy Group (ESG):
    - Drafts the strategy update (Jan.2020)
  - Strategy secretariat:
    - H.Abramowicz (chair), J.D'Hondt, K.Ellis, L.Rivkin
    - Coordinates the process
  - CERN Council:
    - Approves the strategy
- CERN management is responsible for implementing strategy
- The Strategy also serves as important guideline for national Funding Agencies

European Strategy Update

EPPSU 2020

Timeline

2017 | **2018** | **2019** | **2020**

organisation & input preparation by community

- ✓ **Jan.2018** Call for proposals for venues for Open Symposium and Strategy Drafting Session
- ✓ **Febr.2018** Call for scientific input
- ✓ **March.2018** Call for nominations of PPG & ESG members
- ✓ **June 14,2018** Council decision on venues and dates
- ✓ **Sept 27,2018** Council launches the Strategy Update process & establish the PPG and ESG

consultation & consensus building

- ✓ **Dec 18.2018** Closing submission community input
- **May 13-16,2019** Open Symposium *Granada, ES*
- **Sept.2019** Physics Briefing Book available
- **Jan 20-24,2020** Strategy Update Drafting Session *Bad Honnef, DE*
- **March.2020** Strategy Update submitted to Council
- **May.2020** Council to approve Strategy Update

Physics results appearing after May 2019 will be taken into account in the process

Symposium @ Granada

- Symposium from 13 to 17 May, 2019
- Organised in Plenary and Parallel Sessions:
  - Monday 13th – morning: **Plenary** afternoon: Parallel
  - Tuesday 14th – full day Parallel
  - Wednesday 15th – morning: Parellel afternoon: **Plenary**
  - Thursday 16 – full day **Plenary**
  - (Friday 17th – Closed Session)

EPPSU 2020

Scientific Input to the Strategy Update

- Call for inputs issued February 28, 2018 with deadline for submission December 18, 2018
- 160 submissions received

Track ID	Granada sessions	Description	Conveners		
1		Large experiments and projects	PPG/ESG		40
2		National road maps	ESG		42
7	B1	Electroweak Physics (physics of the W, Z, H bosons, of the top quark, and QED)	Keith Ellis	Beate Heinemann	21
8	B2	Flavour Physics and CP violation (quarks, charged leptons and rare processes)	Belen Gavela	Antonio Zoccoli	27
5	B3	Dark matter and Dark Sector (accelerator and non-accelerator dark matter, dark photons, hidden sector, axions)	Marcela Carena	Shoji Asai	27
3	B4	Accelerator Science and Technology	Caterina Biscari	Lenny Rivkin	51
4	B5	Beyond the Standard Model at colliders (present and future)	Gian Giudice	Paris Sphicas	20
10	B6	Strong Interactions (perturbative and non-perturbative QCD, DIS, heavy ions)	Krzysztof Redlich	Jorgen D'Hondt	31
9	B7	Neutrino Physics (accelerator and non-accelerator)	Stan Bentvelsen	Marco Zito	23
6	B8	Instrumentation and Computing	Xinchou Lou	Brigitte Vachon	35
11		Other (communication, outreach, strategy process, technology transfer, individual contributions,...)	ESG		

- The Open Symposium aims to reach a consensus on the *scientific goals* of the community, based on the provided input, and assess the proposed projects and technologies to achieve those goals
- This is to ensure that the ESG is provided with all the necessary input to propose a realistic update of the Strategy; decisions on strategic choices are not expected to be taken this week

Halina Abramowicz

8 parallel sessions in Granada: B1-B8

Reminder of the ESPP 2013 "recommendations"

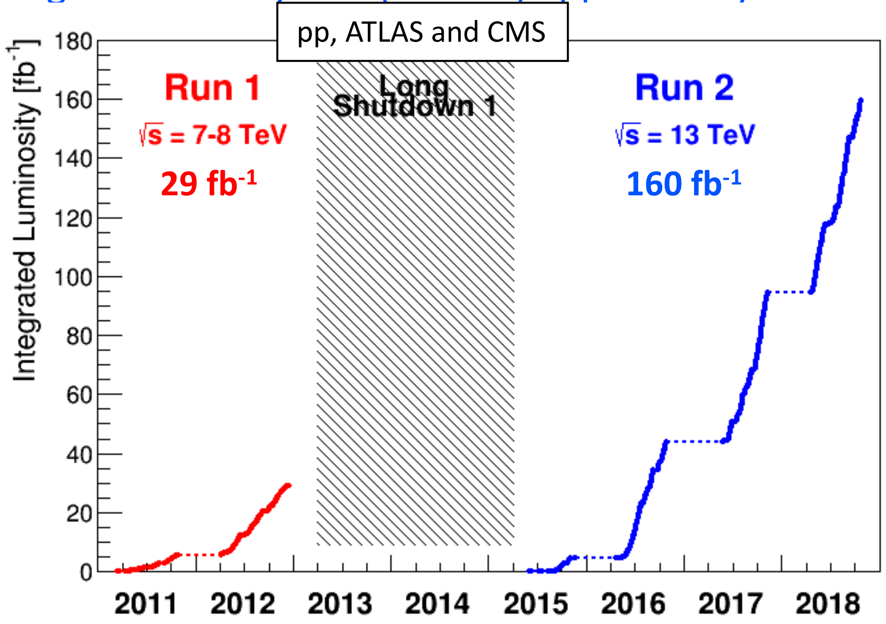
Fabiola Gianotti
Introduction talk, Granada

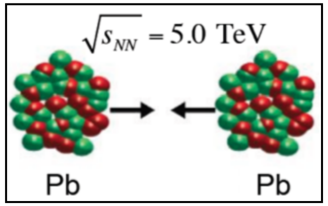
High-priority large-scale scientific projects (1)

c) Europe's top priority should be the exploitation of the full potential of the LHC, including the high-luminosity upgrade of the machine and detectors with a view to collecting ten times more data than in the initial design, by around 2030. This upgrade programme will also provide further exciting opportunities for the study of flavour physics and the quark-gluon plasma.

Run 2 completed successfully, with accelerators, experiments and computing performance exceeding expectation

High-Luminosity LHC (HL-LHC) approved by CERN's Council June 2016





Total integrated luminosity Run 2 **$\sqrt{s_{NN}}$ ~ 5 TeV**:
ALICE: ~ 1.3 nb^{-1}
ATLAS, CMS: ~ 2.4 nb^{-1}
Goal for Run 2 was ~1 nb^{-1}

Run 1 + Run 2: ATLAS, CMS: ~**189** fb^{-1} (goal was 150); LHCb: ~**10** fb^{-1}

High-Luminosity LHC

- The HL-LHC Yellow Report released end of 2018 / beginning of 2019 served as foundation of the discussions made both in the inputs and during the Symposium
- ➔ the starting point for all new proposed projects is the outcome expected from the completion of the HL-LHC physics programme
  - This was exactly the mission of the HL/HE-LHC Yellow Report
- … and the question is: what future projects would add to it

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Example: Higgs boson coupling prospects

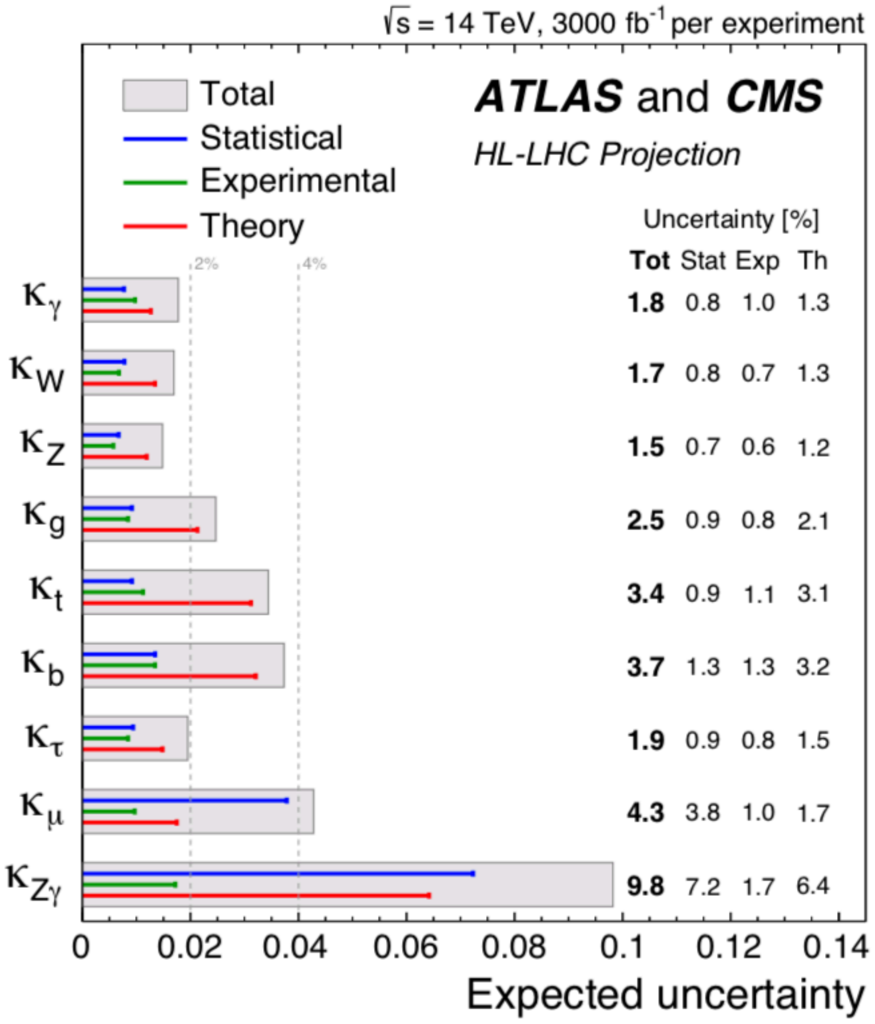


Figure 1. Projected uncertainties on κ_i, combining ATLAS and CMS: total (grey box), statistical (blue), experimental (green) and theory (red). From Ref. [2].

Accelerators related inputs

About 60 different inputs + national inputs which include accelerators

- e+e- colliders
- hh colliders
- ep colliders
- FCC
- Gamma factories
- Plasma acceleration
- Muon colliders
- Beyond colliders
- Technological developments

Input to speakers:

- Contributions of the community
- Coherent parameters (Integrated luminosity, duty cycle, readiness definition, …)
- What about costs and time schedule?

Output from speakers

- comprehensive summary of 2-3 slides, including open questions, challenges, opportunities and objectives.

Big Questions

In particular for the Accelerator Science and Technology

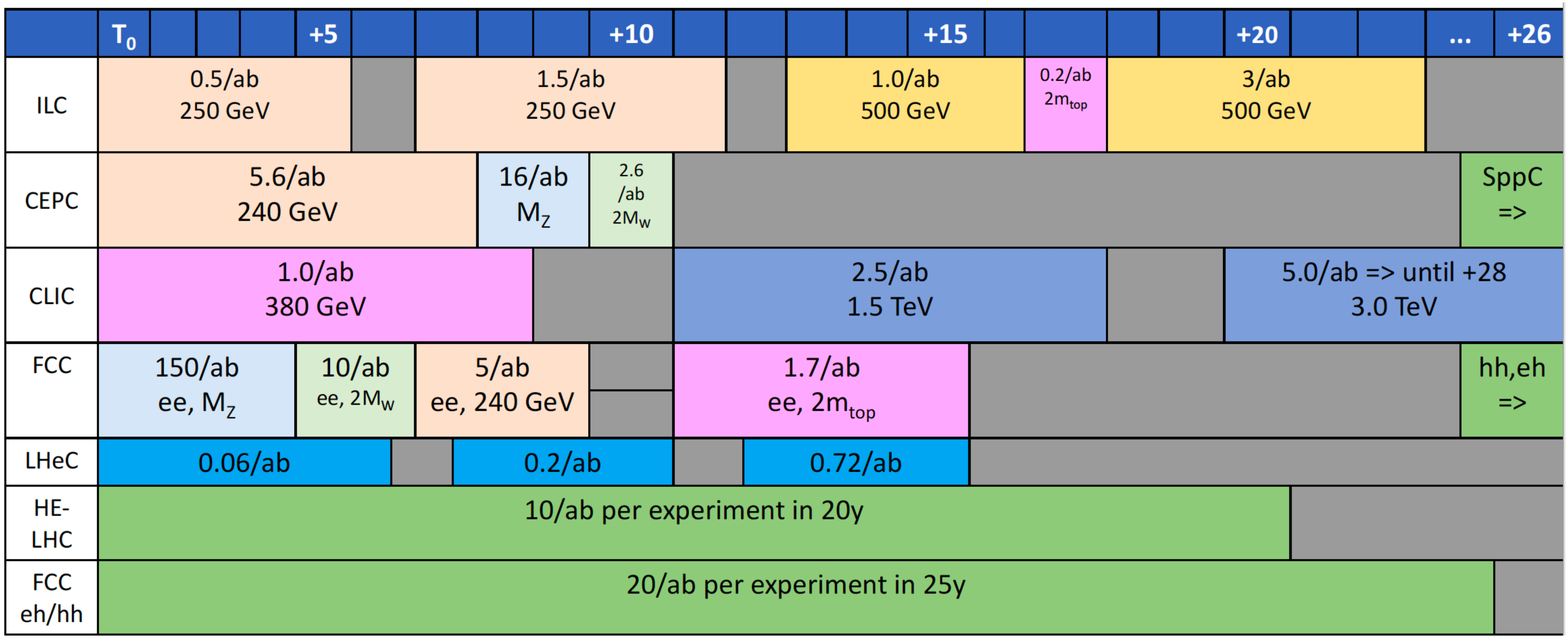
- **What is the best implementation for a Higgs factory? Choice and challenges for accelerator technology: linear vs. circular?**
- **Path towards the highest energies: how to achieve the ultimate performance (including new acceleration techniques)?**
- **How to achieve proper complementarity for the high intensity frontier vs. the high-energy frontier?**
- **Energy management in the age of high-power accelerators?**

Comparisons

Project	Type	Energy [TeV]	Int. Lumi. [a^{-1}]	Oper. Time [y]	Power [MW]	Cost
ILC	ee	0.25	2	11	129 (upgr. 150-200)	4.8-5.3 GILCU + upgrade
		0.5	4	10	163 (204)	7.98 GILCU
		1.0			300	?
CLIC	ee	0.38	1	8	168	5.9 GCHF
		1.5	2.5	7	(370)	+5.1 GCHF
		3	5	8	(590)	+7.3 GCHF
CEPC	ee	0.091+0.16	16+2.6		149	5 G$
		0.24	5.6	7	266	
FCC-ee	ee	0.091+0.16	150+10	4+1	259	10.5 GCHF
		0.24	5	3	282	
		0.365 (+0.35)	1.5 (+0.2)	4 (+1)	340	+1.1 GCHF
LHeC	ep	60 / 7000	1	12	(+100)	1.75 GCHF
FCC-hh	pp	100	30	25	580 (550)	17 GCHF (+7 GCHF)
HE-LHC	pp	27	20	20		7.2 GCHF

For comparison:
LHC: ~ 150 MW

Proposed Schedules and Evolution



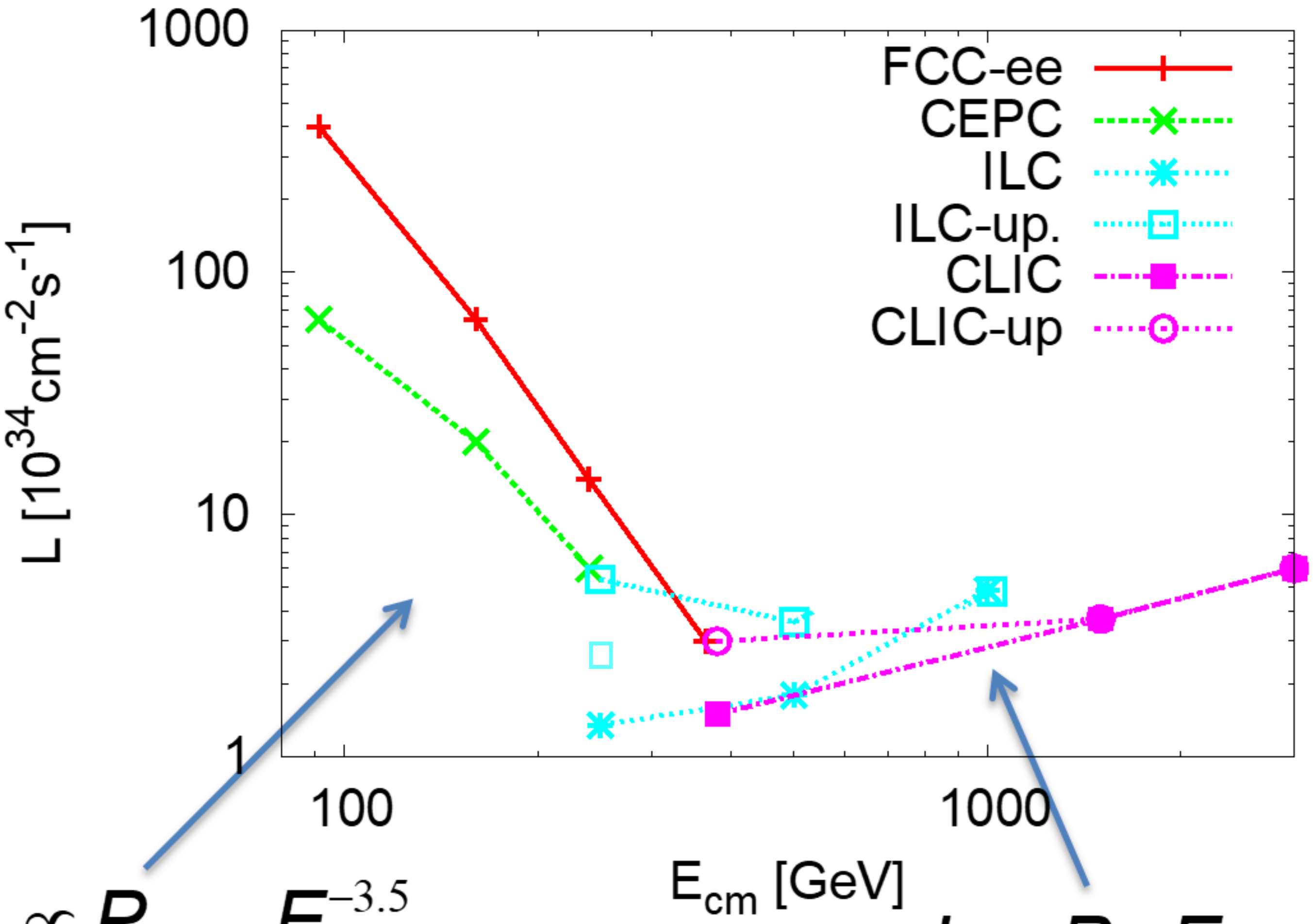
Project	Start construction	Start Physics (higgs)
CEPC	2022	2030
ILC	2024	2033
CLIC	2026	2035
FCC-ee	2029	2039 (2044)
LHeC	2023	2031

Proposed dates from projects

Would expect that technically required time to start construction is O(5-10 years) for prototyping etc.

Ours is a very dynamic field!
(Luminosity upgrades for ILC, CLIC)

Luminosity per facility



$L \propto P_{synrad} E_{cm}^{-3.5}$

$L \propto P_{RF} E_{cm}$

Maturity

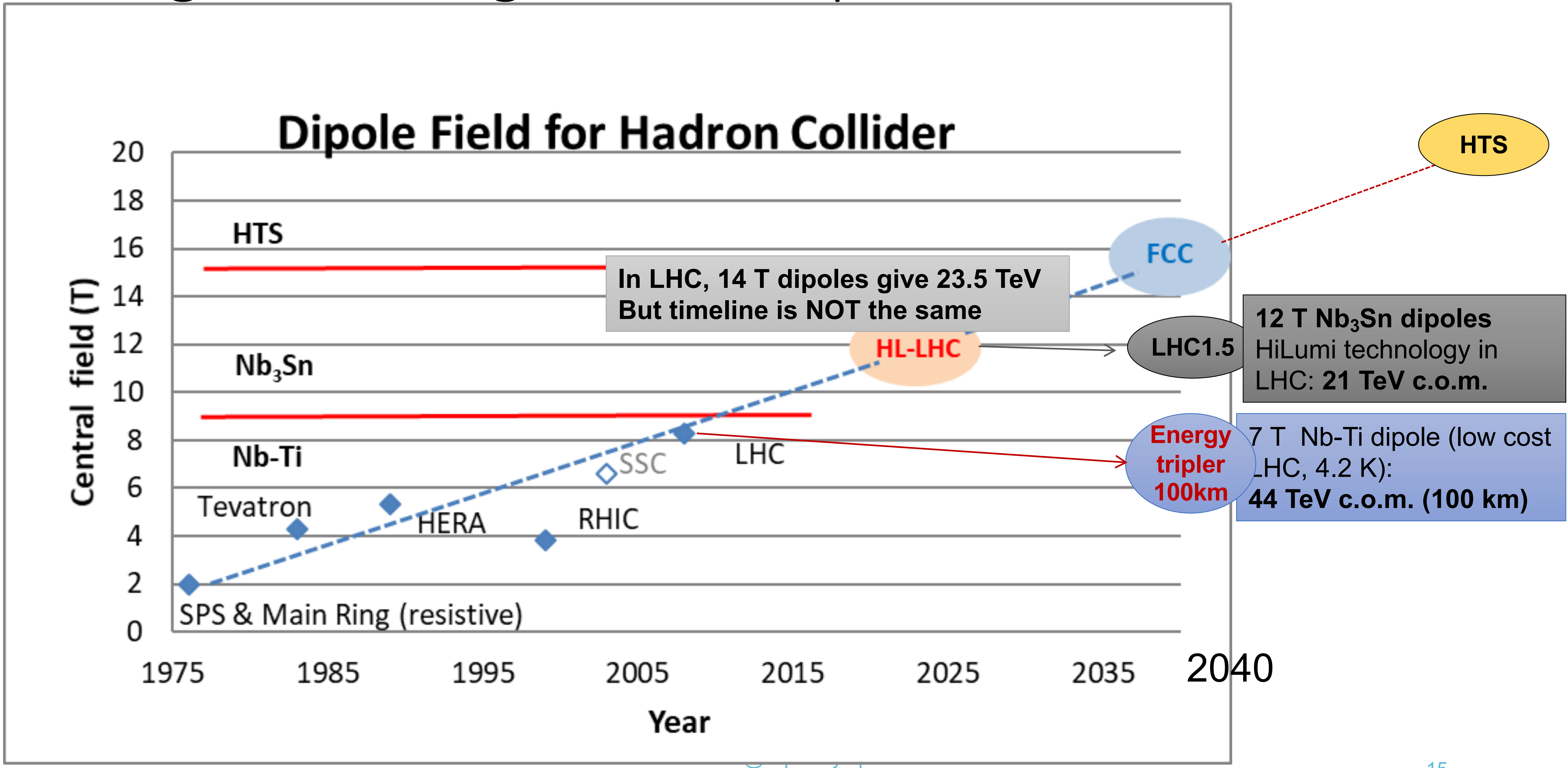
- CEPC and FCC-ee, LHeC
  - Do not see a feasibility issue with technologies or overall design
  - But more hardware development and studies essential to ensure that the performance goal can be fully met
    - E.g. high power klystrons, strong-strong beam-beam studies with lattice with field errors, …

- ILC and CLIC
  - Do not see a feasibility issue with technology or overall design
  - Cutting edge technologies developed for linear colliders
    - ILC technology already used at large scale
    - CLIC technology in the process of industrialisation
  - More hardware development and studies required to ensure that the performance goal can be full met
    - e.g. undulator-based positron source, BDS tuning, …

- Do not anticipate obstacle to commit to either CEPC, FCC-ee, ILC or CLIC
  - But a review is required of the chosen candidate(s)
  - More effort required before any of the projects can start construction

- Guidance on project choice is necessary
  - Physics potential
  - Strategic considerations

High field magnet development



Personal (A. Yamamoto) View on Relative Timelines

Timeline	~ 5	~ 10	~ 15	~ 20	~ 25	~ 30	~ 35
Lepton Colliders							
SRF-LC/CC	Proto/pre-series	Construction		Operation		Upgrade	
NRF—LC	Proto/pre-series	Construction		Operation		Upgrade	
Hadron Collider (CC)							
8~(11)T NbTi /(Nb3Sn)	Proto/pre-series	Construction		Operation			Upgrade
12~14T Nb_3Sn	Short-model R&D	Proto/Pre-series		Construction		Operation	
14~16T Nb_3Sn	Short-model R&D		Prototype/Pre-series			Construction	

Note: **LHC experience: NbTi (10 T)** R&D started in 1980's --> **(8.3 T)** Production started in late 1990's, in **~ 15 years**

Technical Challenges in Energy-Frontier Colliders proposed

		Ref.	E (CM) [TeV]	Lumino sity [1E34]	AC-Power [MW]	Cost-estimate Value* [Billion]	B [T]	E: [MV/m] (GHz)	Major Challenges in Technology
CC hh	FCC-hh	CDR	~ 100	< 30	580	24 or +17 (aft. ee) [BCHF]	~ 16		High-field SC magnet (SCM) - Nb3Sn: Jc and Mechanical stress Energy management
	SPPC	(to be filled)	75 – 120	TBD	TBD	TBD	12 - 24		High-field SCM - IBS: Jcc and mech. stress Energy management
CC ee	FCC-ee	CDR	0.18 - 0.37	460 – 31	260 – 350	10.5 +1.1 [BCHF]		10 – 20 (0.4 - 0.8)	High-Q SRF cavity at < GHz, Nb Thin-film Coating Synchrotron Radiation constraint Energy efficiency (RF efficiency)
	CEPC	CDR	0.046 - 0.24 (0.37)	32~ 5	150 – 270	5 [B$]		20 – (40) (0.65)	High-Q SRF cavity at < GHz, LG Nb-bulk/Thin-film Synchrotron Radiation constraint High-precision Low-field magnet
LC ee	ILC	TDR update	0.25 (-1)	1.35 (– 4.9)	129 (– 300)	4.8- 5.3 (for 0.25 TeV) [BILCU]		31.5 – (45) (1.3)	High-G and high-Q SRF cavity at GHz, Nb-bulk Higher-G for future upgrade Nano-beam stability, e+ source, beam dump
	CLIC	CDR	0.38 (- 3)	1.5 (- 6)	160 (- 580)	5.9 (for 0.38 TeV) [BCHF]		72 – 100 (12)	Large-scale production of Acc. Structure Two-beam acceleration in a prototype scale Precise alignment and stabilization. timing

A. Yamamoto, 190513b

*Cost estimates are commonly for "**Value**" (material) only.

Electroweak Session

Higgs precision measurements

- The work on this topic has been fully developed in the framework of the *Higgs@FutureCollider* (Higgs@FC) working group set up by the ESU PPG with ECFA
- A preliminary report has been submitted just before the Granada Symposium
  - Higgs couplings
    - Kappa framework
    - EFT framework
  - Rare decays and CP properties
  - Mass and width
  - Theory considerations

Higgs@Future Colliders Report

Higgs Boson studies at future particle colliders

- Preliminary Version -

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ABSTRACT

This document aims to provide an assessment of the potential of future colliding beam facilities to perform Higgs boson studies. The analysis builds on the submissions made by the proponents of future colliders to the European Strategy Update process, and takes as its point of departure the results expected at the completion of the HL-LHC program. This report presents quantitative results on many aspects of Higgs physics for future collider projects using uniform methodologies for all proposed machine projects of sufficient maturity. This report is still preliminary and is distributed for the purposes of discussion at the Open Symposium in Granada (13-16/05/2019).

arXiv:1905.03764

Kappa studies

$$\Gamma_H = \frac{\Gamma_H^{SM} \cdot \kappa_H^2}{1 - (BR_{inv} + BR_{unt})}$$

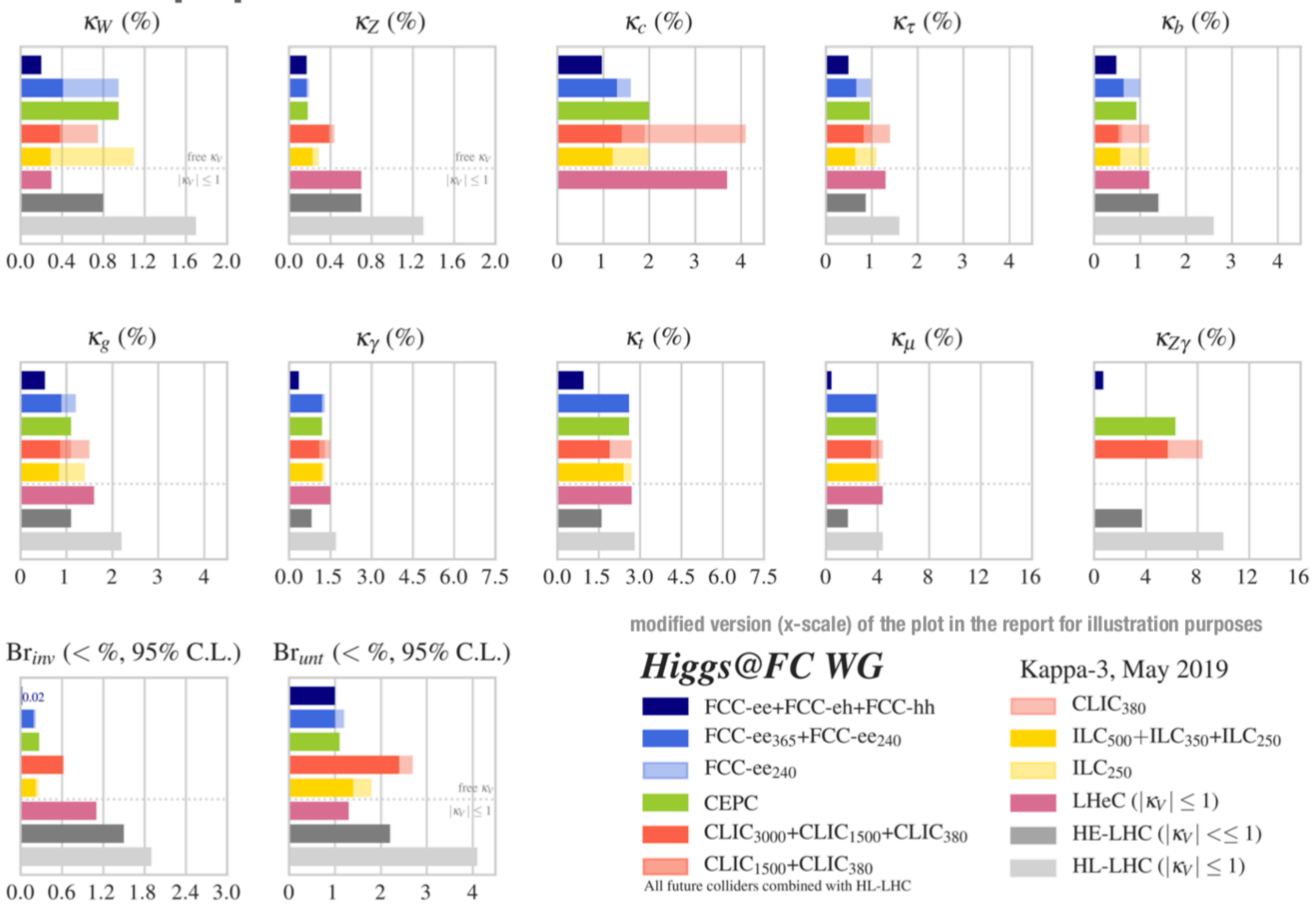
For hadron colliders
|Kv|≤1 has been impos

Scenario	BR_{inv}	BR_{unt}	include HL-LHC
kappa-0	fixed at 0	fixed at 0	no
kappa-1	measured	fixed at 0	no
kappa-2	measured	measured	no
kappa-3	measured	measured	yes

The impact of theoretical uncertainties for lepton colliders (intrinsic and parametric) is studied independently: the **baseline fits do not include intrinsic theoretical uncertainties for future lepton colliders** (they do include parametric uncertainties)

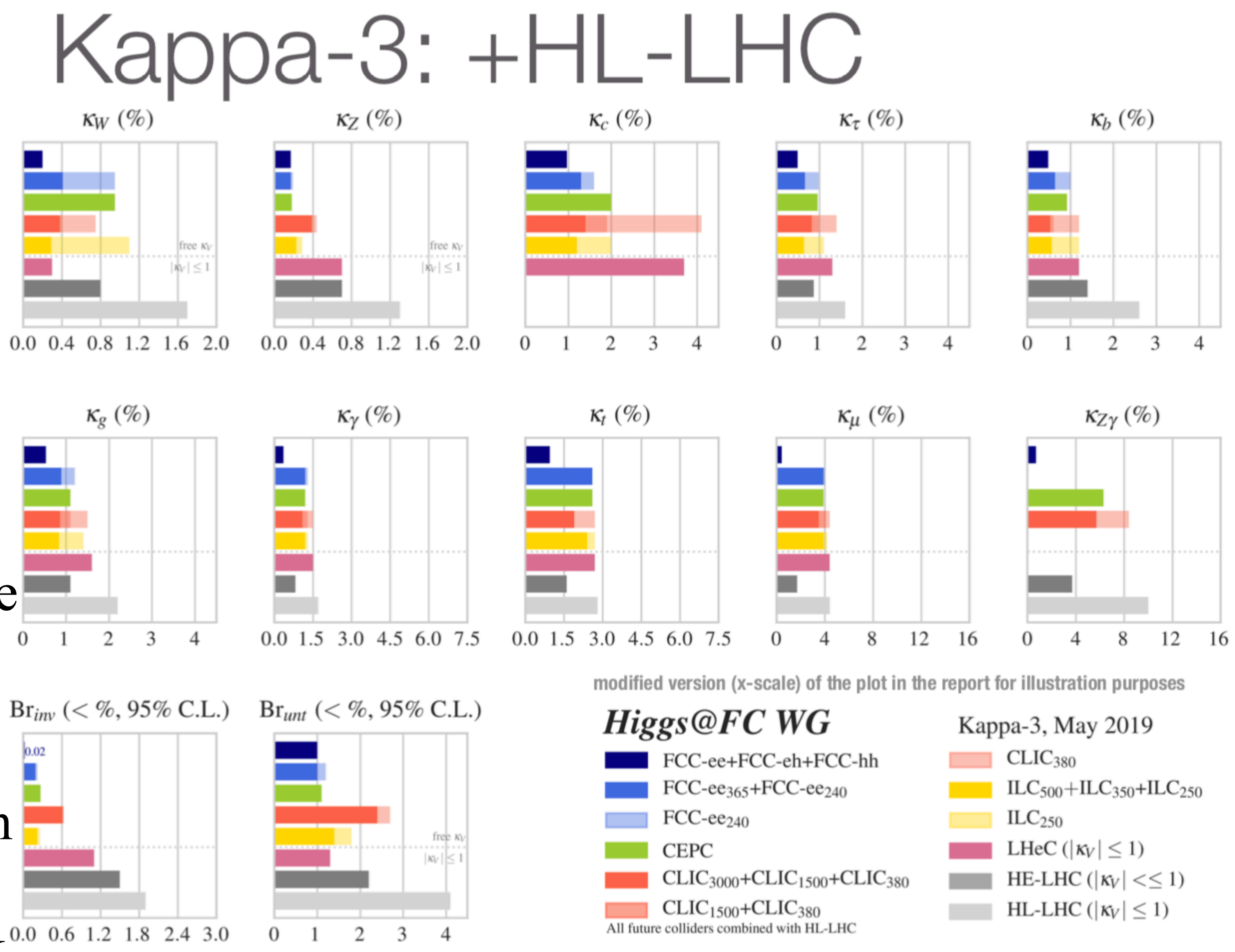
- HL/HE use S2 uncertainties (theory 1/2 wrt today), including in combinations of HL with other colliders
- FCC-hh, for production x luminosity a 1% is assumed in the original documentation
- LHeC: 0.5% production uncertainty

Kappa-3: +HL-LHC



Kappa studies

- HL-LHC (absolute) couplings achieve precisions of O(1-3%)
  - But model dependent
- HL-LHC coupling ratios are model independent
- Future ee colliders can "measure" Γ_H from data
- Future colliders (ee,ep) improve by a factor ~2 to 10 assuming the full scientific programme
- Initial stages ee colliders have comparable sensitivities (within a factor of 2)
- ee and ep colliders can access k_c

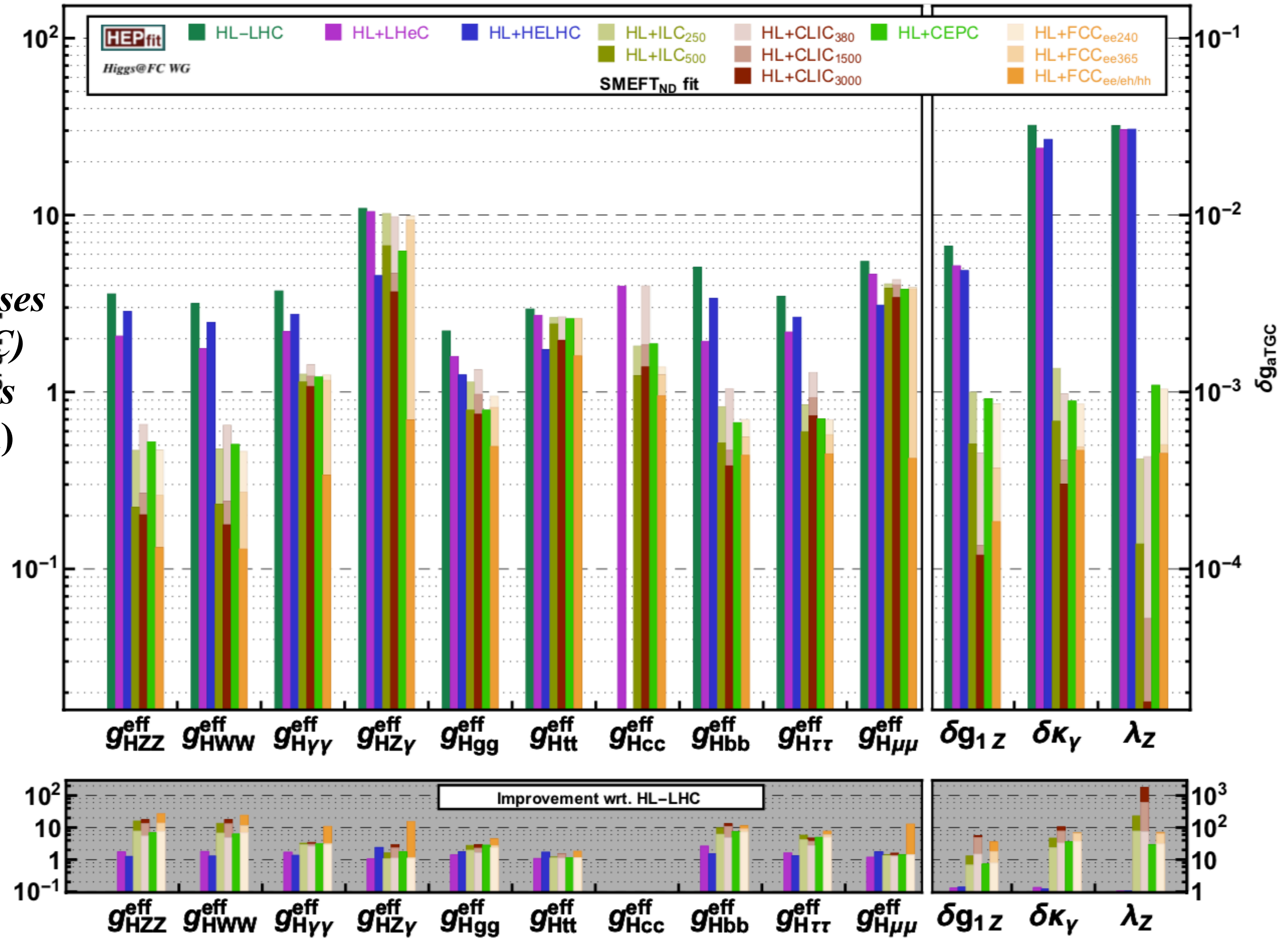


Global fit results

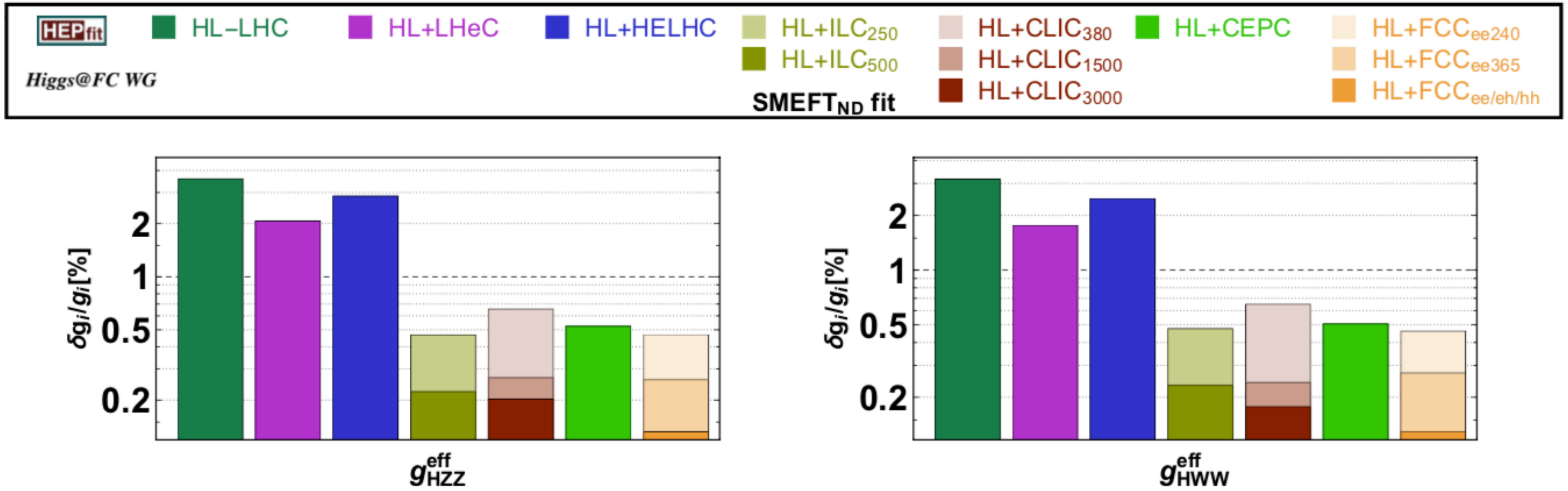
EFT Fits

Input to the fit:

Single Higgs boson processes
Diboson production (aTGC)
EWPO: Z and W properties
Top production **(if allowed)**



Sensitivity to deviations in HVV couplings



-**WARNING:** HE improvement relies on improvement of theory uncertainties

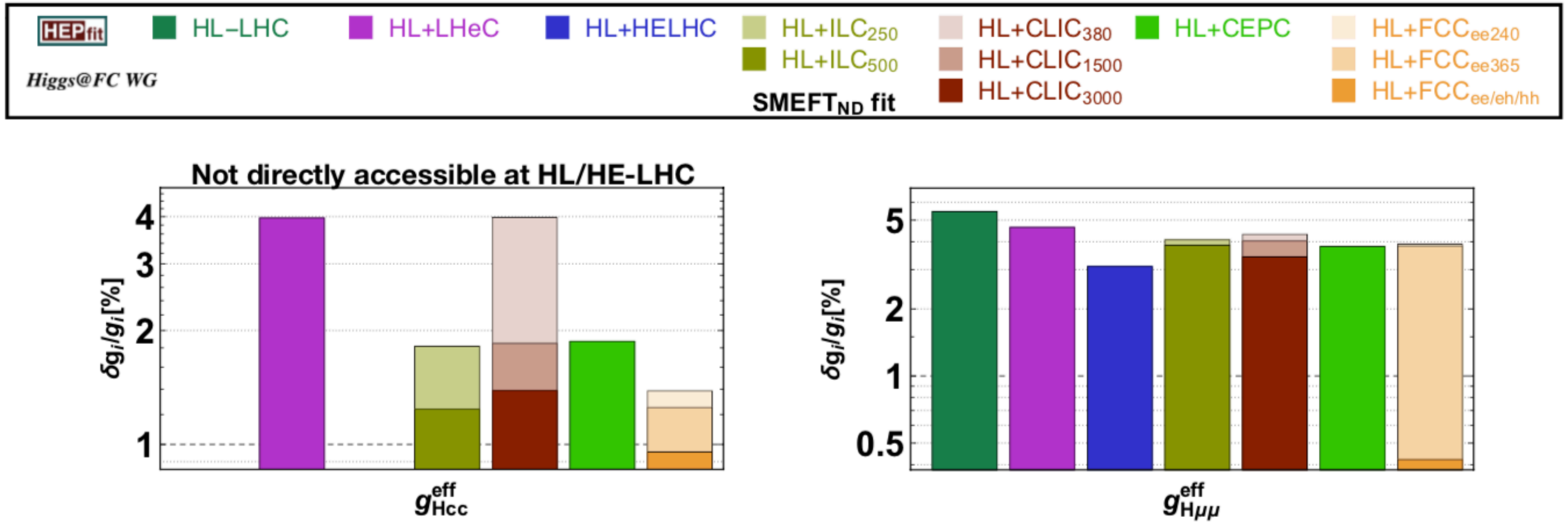
-**WARNING:** LHeC achieves <1% precision for some H rates. However, in EFT framework precision on HVV requires extra info (e.g. aTGC, angular). Results in current fit limited by LEP2 precision of aTGC (e.g. 10x LEP2 precision would bring LHeC HVV down to 0.7%)

-Lepton colliders can achieve ~per-mille accuracy. Difference is how long it may take to get there:

$\mathrm{CLIC}_{380} < \mathrm{ILC}_{250} \sim \mathrm{CEPC} \sim \mathrm{FCCee}_{240} < \mathrm{ILC}_{500} \sim \mathrm{CLIC} \sim \mathrm{FCCee}_{365}$

Global fit results

Sensitivity to deviations in *Hff* (2nd fam) couplings



-Charm coupling not directly accessible with good precision at HL-LHC/HE-LHC. Available at percent level from ep (LHeC) and Lepton colliders.

- Muon coupling: Rare decay → Statistically limited at ep/Lepton Colliders: Sub-percent precision at FCC-ee/eh/hh via hh ratios of BR (Relies on knowledge of H →ZZ* from FCC-ee)

Beate Heineman talk

of "largely" improved H couplings (EFT)

		Factor ≥2	Factor ≥5	Factor ≥10	Years from T_0
Initial run	CLIC380	9	6	4	7
	FCC-ee240	10	8	3	9
	CEPC	10	8	3	10
	ILC250	10	7	3	11
2nd/3rd Run ee	FCC-ee365	10	8	6	15
	CLIC1500	10	7	7	17
hh	HE-LHC	1	0	0	20
2nd/3rd Run ee	ILC500	10	8	6	22
	CLIC3000	11	7	7	28
ee,eh & hh	FCC-ee/eh/hh	12	11	10	>50

13 quantities in total

NB: number of seconds/year differs: ILC $1.6x10^7$, FCC-ee & CLIC: $1.2x10^7$, CEPC: $1.3x10^7$

How to measure deviations of λ_3

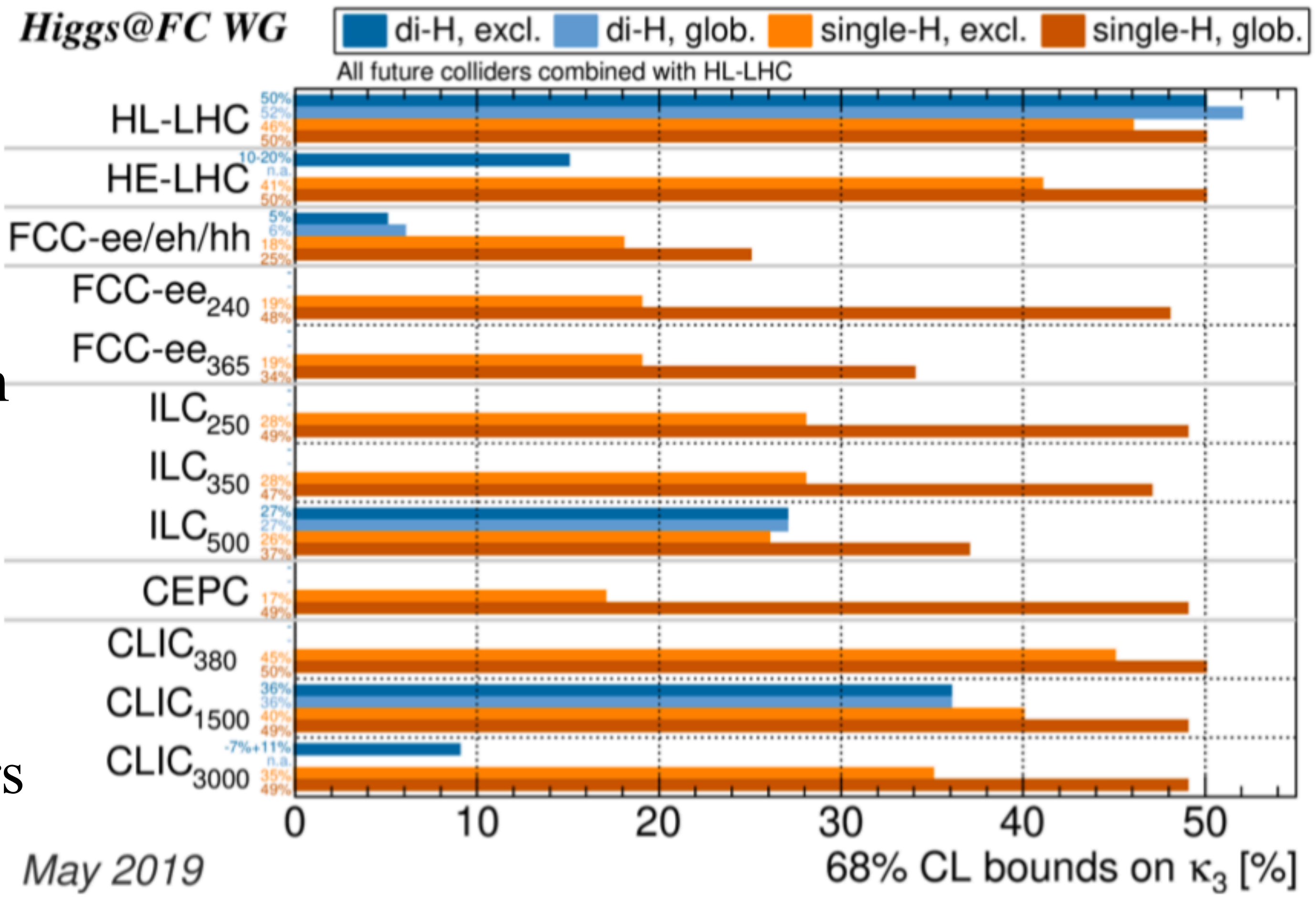
- The Higgs self-coupling can be assessed using di-Higgs production and single-Higgs production
- The sensitivity of the various future colliders can be obtained using four different methods:

	di-Higgs	single-H
exclusive	*method 1* **1. di-H, excl.** • Use of σ(HH) • only deformation of κλ	*method 3* **3. single-H, excl.** • single Higgs processes at higher order • only deformation of κλ
global	*method 2* **2. di-H, glob.** • Use of σ(HH) • deformation of κλ + of the single-H couplings (a) do not consider the effects at higher order of κλ to single H production and decays (b) these higher order effects are included	*method 4* **4. single-H, glob.** • single Higgs processes at higher order • deformation of κλ + of the single Higgs couplings

Results: global view

♦ 68% CL uncertainties on κ_λ with the four methods:

- DiHiggs: k_λ
  - HL-LHC: ~50% or better
  - HE-LHC: ~15%
  - ILC500 ~27%, CLIC1500 ~36%
  - CLIC3000 ~9% and FCC-hh ~5%
- Single Higgs: k_λ
  - FCC-ee365 and ILC500 ~35%
  - FCC-ee 21% with 4 detectors



Beyond the Standard Model (at colliders)

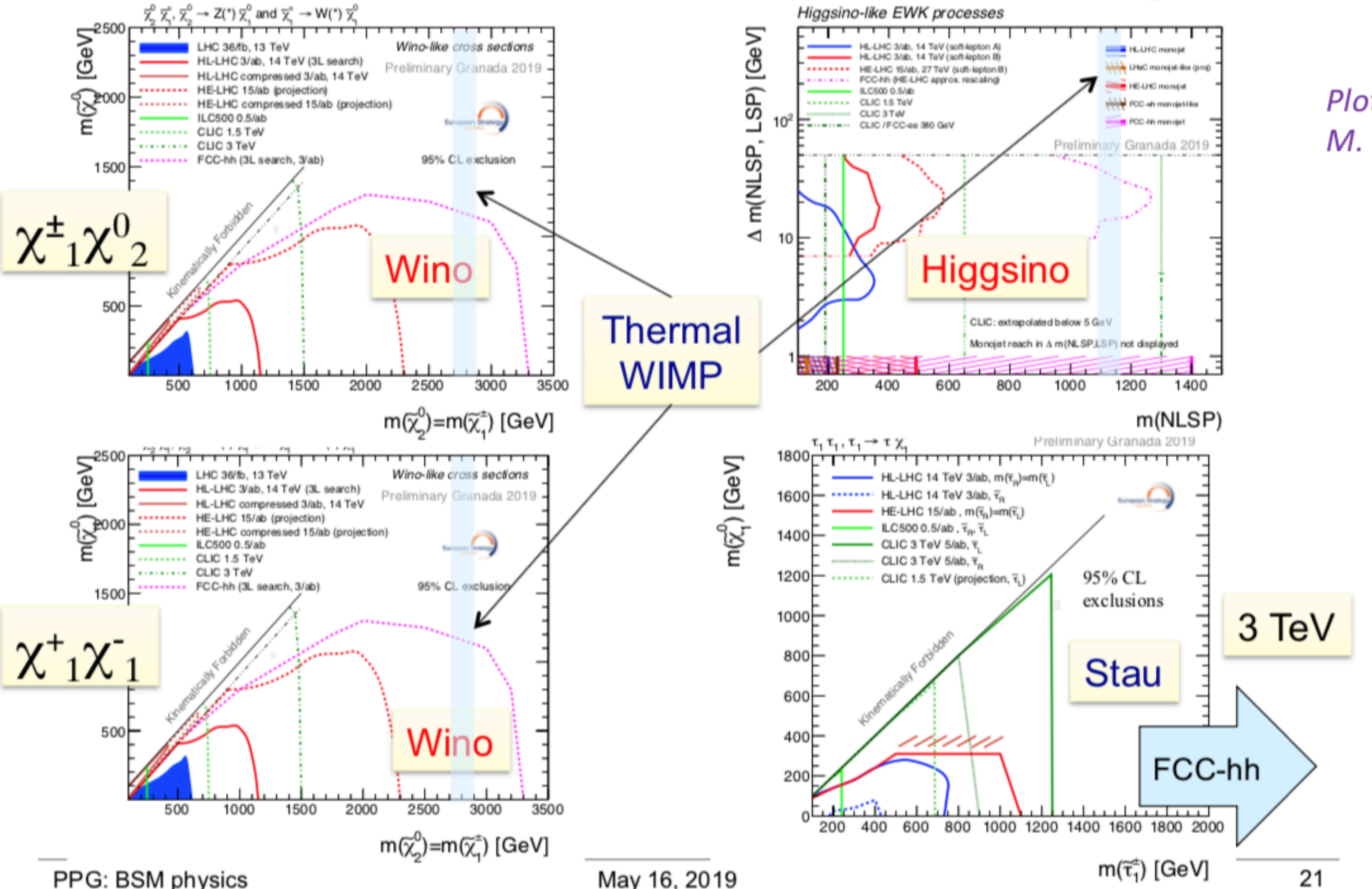
Open Symposium on the Update of European Strategy for Particle Physics

Gian Giudice and Paris Sphicas
For the BSM group
J. Alcaraz, C. Doglioni, G. Lanfranchi, M. D'Onofrio, M. McCullough, G. Perez, P. Roloff, V. Sanz, A. Weiler, A. Wulzer

- **The four big questions for BSM (@colliders):**
  - **To what extent can we tell whether the Higgs is fundamental or composite?**
    - **EWSB/NewReson, SUSY**
  - **Are there new interactions or new particles around or above the electroweak scale?**
    - **EWSB/NewReson, SUSY, Ext-H/FlavorDyn, DM, FIPs**
  - **What cases of thermal relic WIMPs are still unprobed and can be fully covered by future collider searches?**
    - **DM, FIPs, SUSY**
  - **To what extent can current or future accelerators probe feebly interacting sectors?**
    - **FIPs, SUSY**

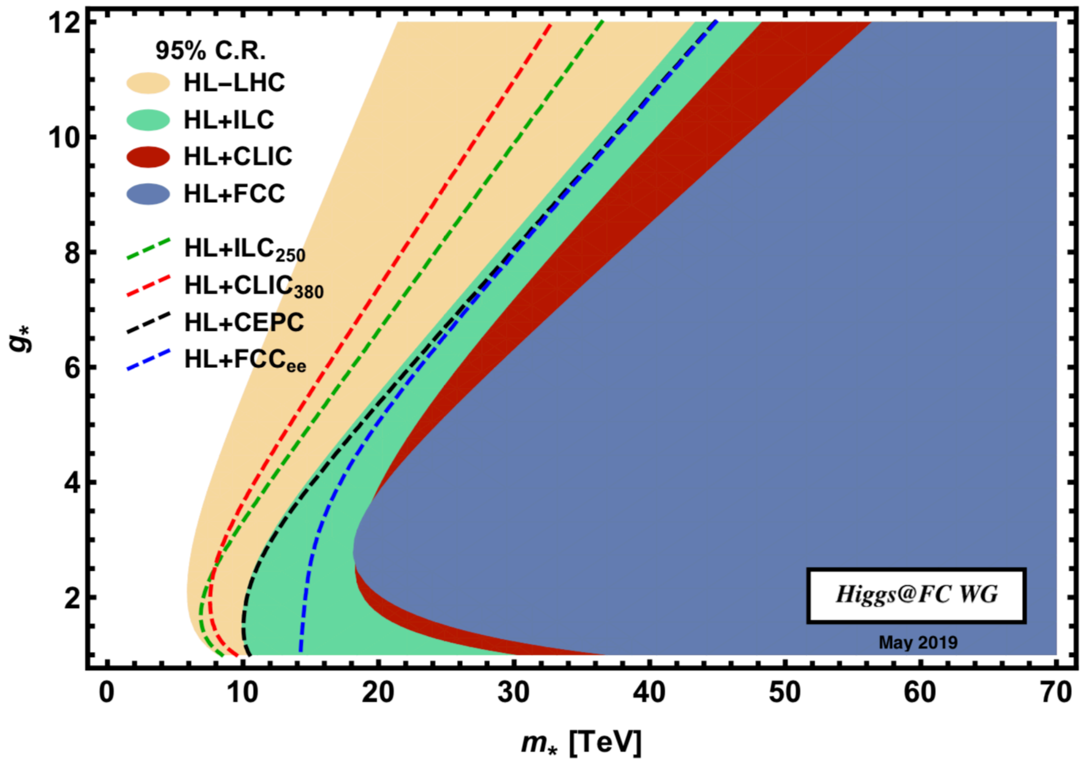
SUSY: EWK sector

Plots by M. D'Onofrio



Indirect constraints in Composite Higgs models

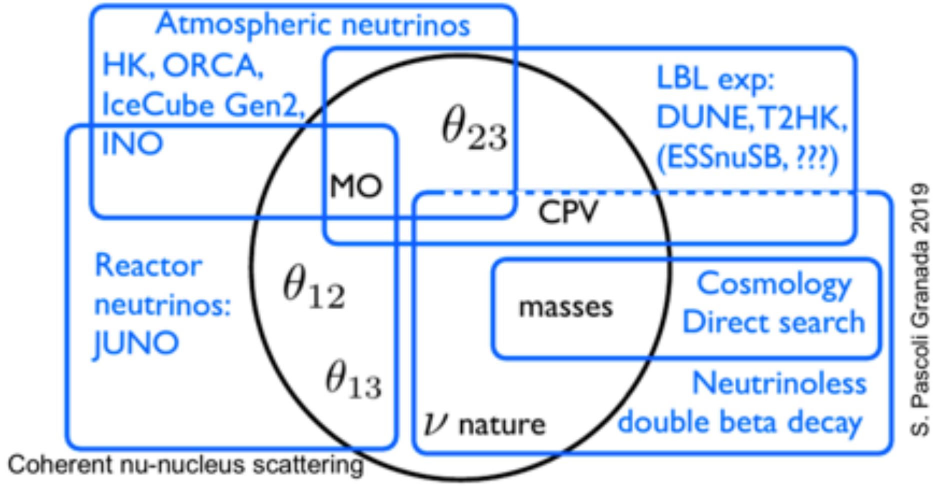
- interpretation of EFT results in terms of a broad class of composite Higgs models
  - dependence of the Wilson coefficients on new physics coupling, $g\star$, and mass, $m\star$



Allowed regions in the (g★,m★) plane from the fit presented in Figure 6,using the SILH power-counting (solid regions). Dashed lines indicate the regions constrained by the corresponding low-energy runs (or FCC-ee only for the case of the FCC project).

Neutrino Physics

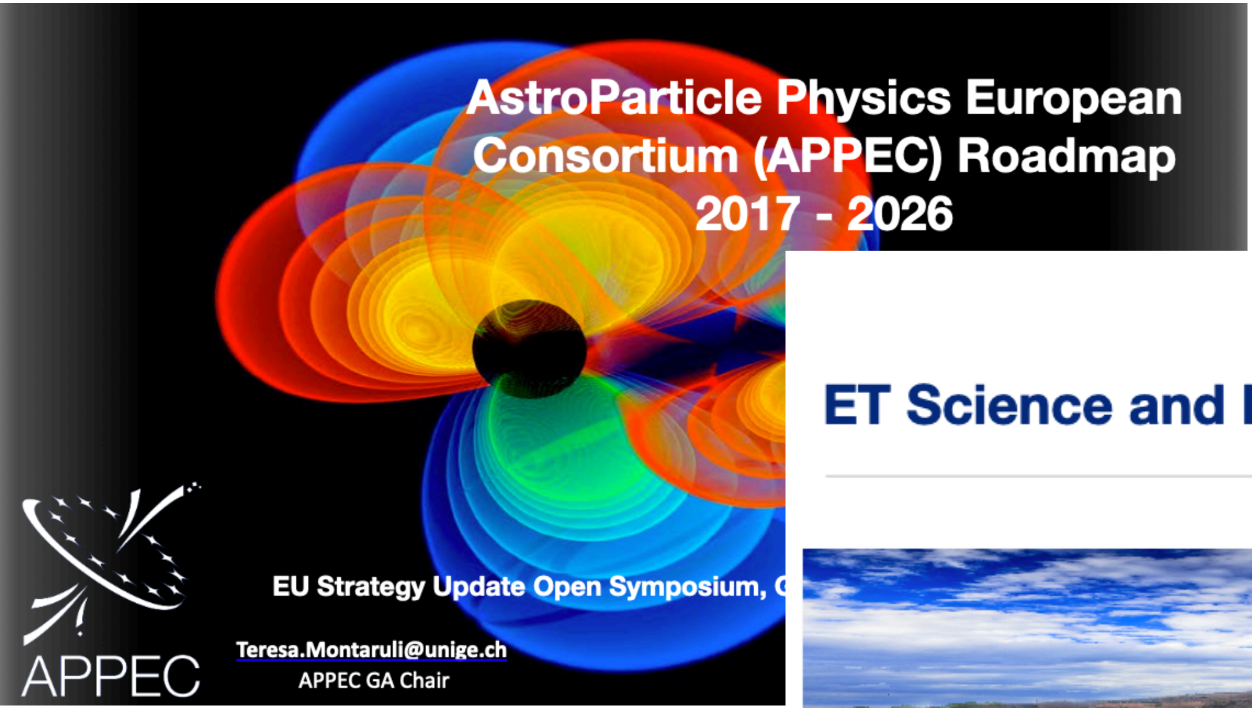
A very diverse experimental approach



Motivation : necessary to get a complete picture, make the most out of every neutrino source, test at different L/E, possible existence of new neutrino states, of Non-Standard-Interactions

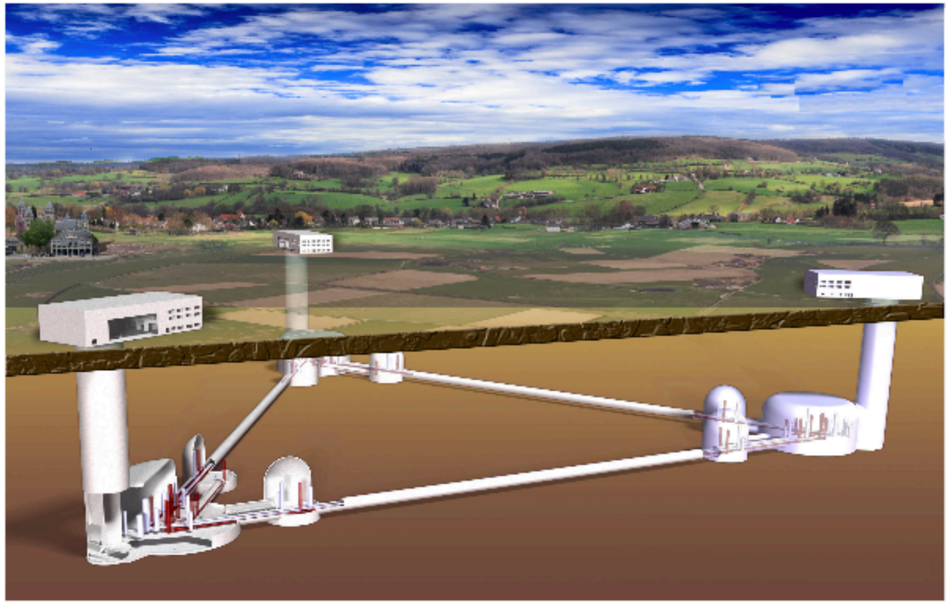
Astroparticle physics

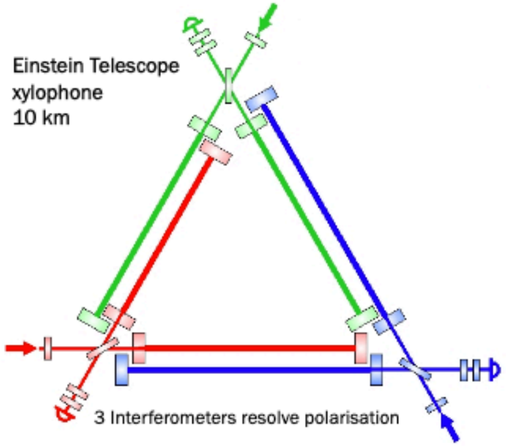
- Gravitational waves and multimessenger physics open up a new window on the Universe. Very strong physics case.
- There is a very high impact on the field of particle physics (and fundamental interactions) (eg dark matter, neutrinos, general relativity, ...)
- There is clearly an opportunity for the particle physics community and laboratories to expand their involvement in this program



ET Science and Roadmap

- 2022-23: site selection & TDR = > ET approval
-2025: infrastructure realization start
-2030-31 end of civil infrastructure construction
- 2032+: commissioning and operation





Input #64

An accelerator beam pipe without a beam (quote from C. Stegmann)

Towards 3G GW detectors

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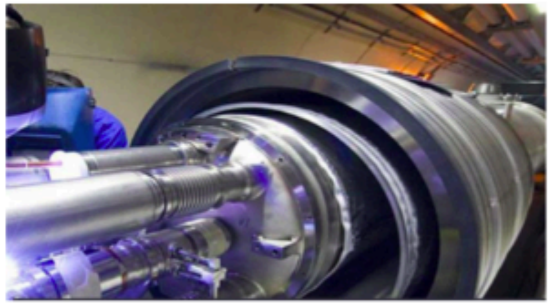
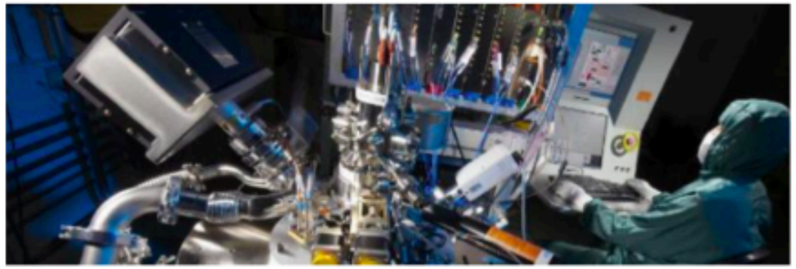



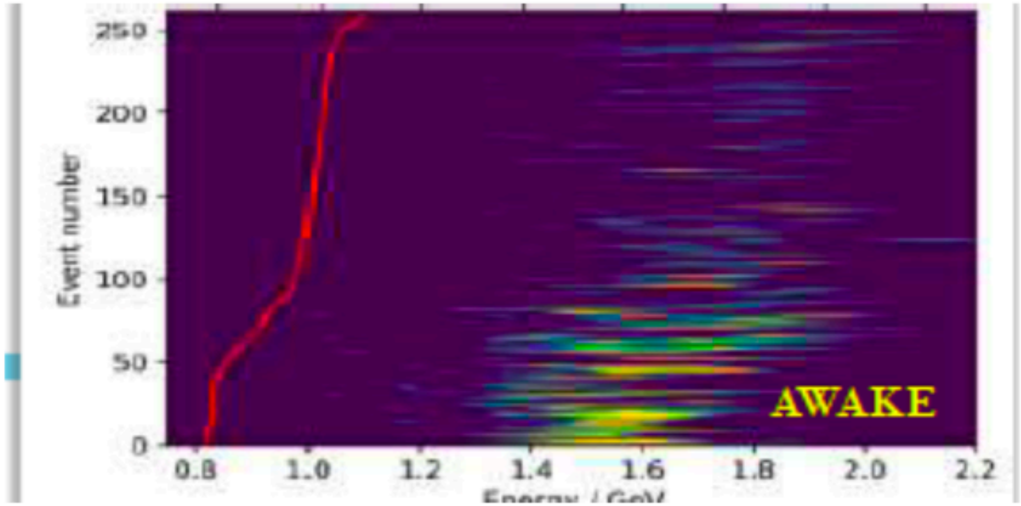

APPEC

C. Biscari, L. Rivkin

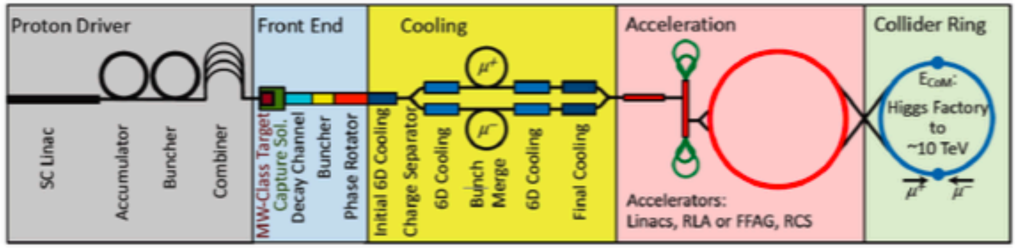
Further (Far?) Future

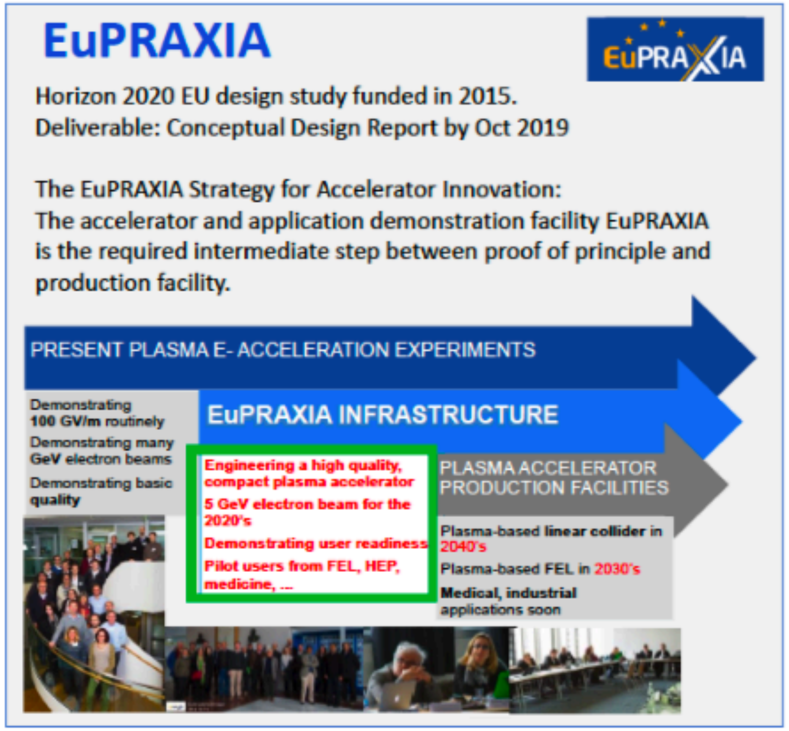
Very interesting R&D projects

- Muon collider:
  - from proton beam (rcooling success: MICE)
  - from e+e- production (LEMMA)
- Plasma wakefield acceleration:
  - High gradients possible: ~100 GV/m
  - R&D progressing well but many challenges



Muon-based technology represents a unique opportunity for the future of high energy physics research: the multi-TeV energy domain exploration.





The Muon Collider challenges

towards the highest possible energy

NEWS

Strategy update: Dream machine

17 May 2019

See Alessandro Variola talk at this retreat (May 16th)

Muon colliders are both precision and discovery machines, but significant R&D is required before they can be considered candidates for a next collider.

https://cerncourier.com/strategy-update-dream-machine/

Conclusion and …

- Impressive amount of information presented and discussed at the Symposium
  - Input from the HL-LHC Yellow Report was fundamental
- Many open points discussed and to be addresses by the ESG
  - Do we need a e+e- collider?
  - Do we want a hadron collider at CERN?
    - Install NbTi dipoles in a 100 km tunnel and continue at the same time R&D for HTS dipoles?
  - More involvement of CERN in astroparticle physics?
  - Theory support for (more) precise calculations is key
  - Tighten collaboration with industry for detector development
- ESG is working as planned, in parallel with the PPG
  - contact your National Representative to propose suggestions
    - INFN: Fabio Zwirner* (+ LNF: Pierluigi Campana; LNGS: Stefano Ragazzi)
  - Briefing Book expected sometime in September, ESG recommendation to CERN Council on January 2020.
    - CERN Council: Italy representative: Fernando Ferroni (+ H.E. Mr Gian Lorenzo Cornado)

… some (personal) comments

- It is mandatory to secure a frontier project for CERN to give future to CERN
- We have large collection of ideas & scenarios: we (we = hep community) should use this as richness
- Higgs Sector Physics: the *delta* between different options is visible, but often it is not large/decisive. This *delta* is "smaller" or comparable to the *delta* from other aspects, that include project costs, upgrade, logistic, "sociology", etc etc
- High-Energy frontier: needs multi-TeV colliders; e.g. hadron colliders
- Support to R&D for innovative new solutions is crucial:
  - Muon Collider
  - *plasma wakefield* accelerator

backup

Physics Preparatory Group (PPG)

The remit of the Physics Preparatory Group (PPG) is to prepare the scientific contribution to the work of the ESG (the "Briefing Book"), based on the input it gathers from the community. The PPG has the following composition:

Members:

- the Strategy Secretary (acting as Chair),
- four members appointed by the Council on the recommendation of the SPC,
- four members appointed by the Council on the recommendation of ECFA,
- the SPC Chair,
- the ECFA Chair,
- the Chair of the European Laboratory Directors' meeting,
- one representative appointed by CERN,
- two representatives from Asia appointed by the respective regional representatives in ICFA,
- two representatives from the Americas appointed by the respective regional representatives in ICFA.

The PPG

STRATEGY SECRETARIAT

Scientific Secretary (Chair)	Prof. Halina Abramowicz (IL)
SPC Chair	Prof. Keith Ellis (UK)
ECFA Chair	Prof. Jorgen D'Hondt (BE)
Chair EU Lab. Directors' Mtg	Prof. Lenny Rivkin (CH)

SPC	ECFA
Prof. Caterina Biscari (ES)	Prof. Stan Bentvelsen (NL)
Prof. Belen Gavela (ES)	Prof. Paris Sphicas (GR)
Prof. Beate Heinemann (DE)	Dr Marco Zito (FR)
Prof. Krzysztof Redlich (PL)	Prof. Antonio Zoccoli (IT)

CERN
Dr Gian Giudice

ASIA/AMERICAS
Prof. Shoji Asai (Japan)
Prof. Marcela Carena (USA)
Prof. Xinchou Lou (China)
Prof. Brigitte Vachon (Canada)

European Strategy Group (ESG)

Members:

- the Strategy Secretary (acting as Chair),
- one representative appointed by each CERN Member State,
- one representative appointed by each of the Laboratories participating in the major European Laboratory Directors' meetings, including its Chair (CERN, CIEMAT (Madrid-Spain), DESY (Hamburg-Germany), Irfu (Saclay-France), LAL (Orsay-France), Nikhef (Amsterdam-Netherlands), LNF (Frascati-Italy), LNGS (Gran Sasso-Italy), PSI (Villigen-Switzerland), STFC-RAL (Didcot-UK)),
- the CERN Director-General,
- the SPC Chair,
- the ECFA Chair.

Invitees:

- the President of the CERN Council,
- one representative from each of the Associate Member States,
- one representative from each Observer State,
- one representative from the European Commission,
- the Chairs of ApPEC and NuPECC,
- the Chairs of FALC and ESFRI,
- the members of the Physics Preparatory Group.
- Invitees are entitled to attend all open meetings of the ESG and to take the floor.

CERN Council

President	Dr Ursula Bassler
Secretary	Dr Fabiola Gianotti (Director-General)

Delegates

Member States

CERN is run by **23 Member States**, each of which has two official delegates to the CERN Council. One represents his or her government's administration; the other represents national scientific interests. **Each Member State has a single vote and most decisions require a simple majority,** although in practice the Council aims for a consensus as close as possible to unanimity.

Associate Member States in the pre-stage to Membership

Associate Member States

Ex-Officio Members

Chair of the FC

Chair of the SPC

Standing invitation

Chair of ECFA

Observers upon invitation

Higgs (and EW) physics at Future Colliders

- Inputs included in the fits (from ESU documents and Refs. therein):

	Higgs	aTGC	EWPO	Top EW
FCC-ee	Yes (μ, σ_{ZH}) (Complete with HL-LHC)	Yes (aTGC dom.) Warning	Yes	Yes (365 GeV, Ztt)
ILC	Yes (μ, σ_{ZH}) (Complete with HL-LHC)	Yes (HE limit) Warning	LEP/SLD (Z-pole) + HL-LHC + W (ILC)	Yes (500 GeV, Ztt)
CEPC	Yes (μ, σ_{ZH}) (Complete with HL-LHC)	Yes (aTGC dom) Warning	Yes	No
CLIC	Yes (μ, σ_{ZH})	Yes (Full EFT parameterization)	LEP/SLD (Z-pole) + HL-LHC + W (CLIC)	Yes
HE-LHC	Extrapolated from HL-LHC	N/A → LEP2	LEP/SLD + HL-LHC (M_W, $\sin^2\theta_w$)	-
FCC-hh	Yes (μ, BR_i/BR_j) Used in combination with FCCee/eh	From FCC-ee	From FCC-ee	-
LHeC	Yes (μ)	N/A → LEP2	LEP/SLD + HL-LHC (M_W, $\sin^2\theta_w$)	-
FCC-eh	Yes (μ) Used in combination with FCCee/hh	From FCC-ee	From FCC-ee + Zuu, Zdd	-

“compressed” SUSY mass spectra: how-to

- SUSY models characterized by compressed mass spectra are among the work-horses of e+e- colliders: e.g. ΔM(stop, LSP)~ GeV, higgsino-like models
- HL-LHC might be sensitive to those with two approaches
  - **monojet**, targeting ΔM ~ 1 GeV (possibly up to 10 GeV)

For **stop**:

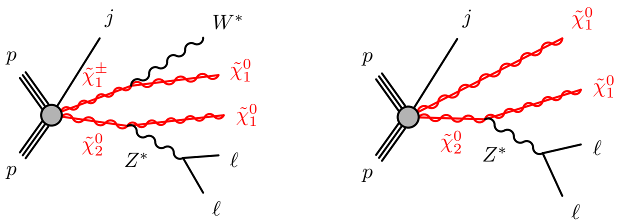
Projections with ColliderReachTool:
HL-LHC → 0.95 TeV;
[confirmed by theorists’ studies]
HE-LHC → 2 TeV;

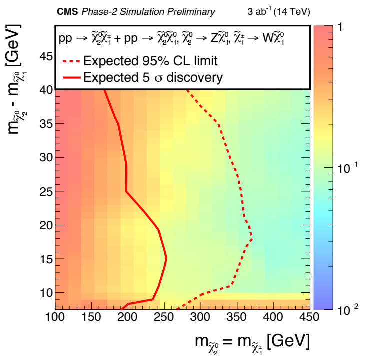
For **wino or higgsino models**:

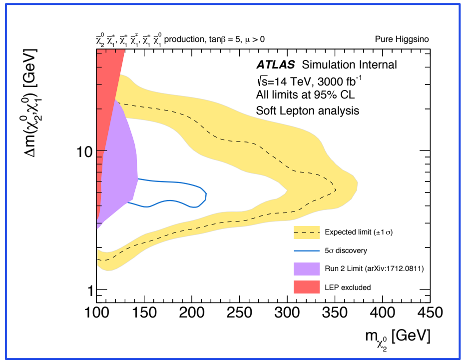
95% C.L.	Wino	Higgsino
14 TeV	280 GeV	200 GeV
27 TeV	700 GeV	490 GeV

(from HL/HE YR, section 3.1.3)

  - **ISR jet + soft leptons**, targeting ΔM ~ 2-40 GeV

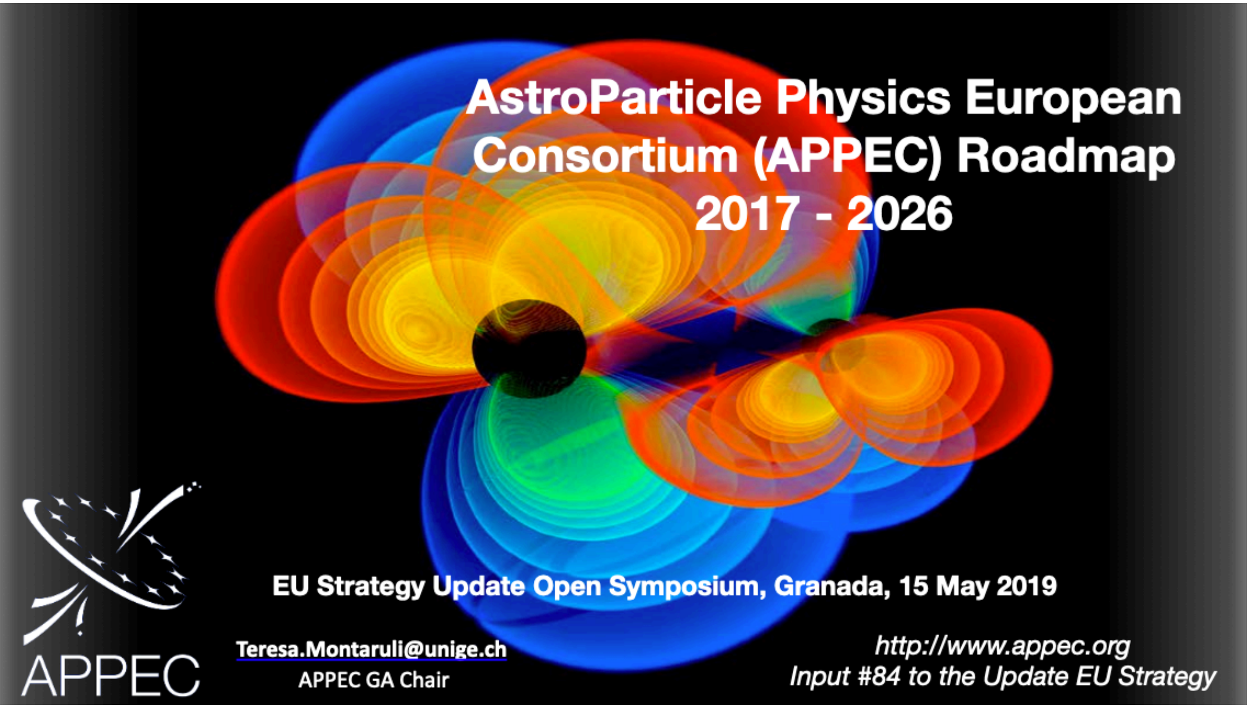






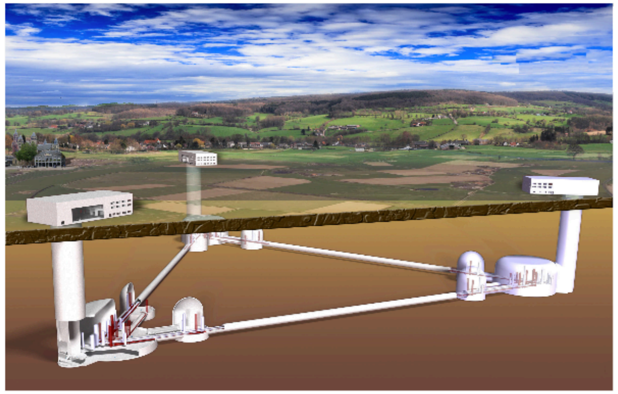
(from HL/HE YR, section 2.2.5 and 2.2.6)

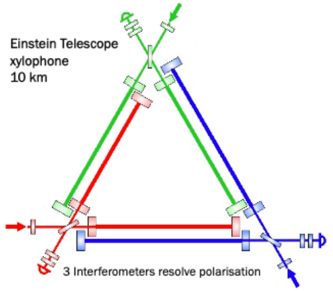
- For ΔM < 1 GeV, decays of EWK partners into LSP might be non-prompt:
  - **Disappearing tracks analyses**



ET Science and Roadmap

- 2022-23: site selection & TDR = > ET approval
-2025: infrastructure realization start
-2030-31 end of civil infrastructure construction
- 2032+: commissioning and operation





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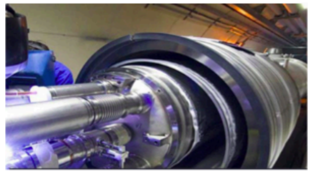

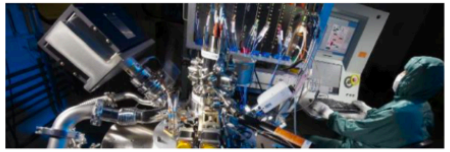

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