Swedish contribution to the European Particle Physics Strategy Update

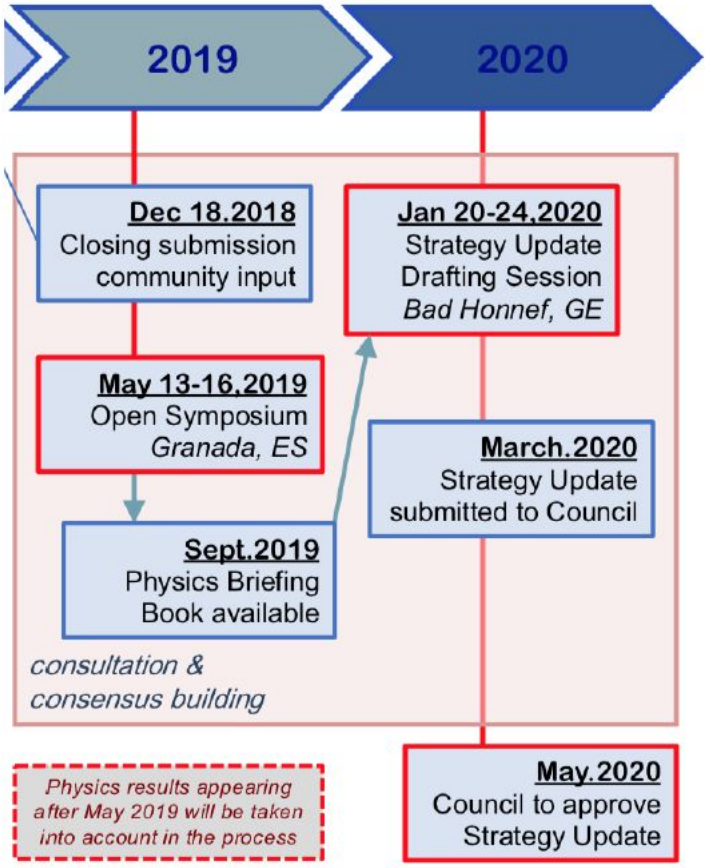
Update to European Particle Physics Strategy

http://europeanstrategyupdate.web.cern.ch.

From Council September agenda

Formal launch of the Update of the European Strategy for Particle Physics:

- Establishment of the Physics Preparatory Group (PPG) and the European Strategy Group (Swedish rep. KJA)
- Time line presented
- Proposed format of the Open Symposium (plenary and parallel sessions)



Our submission

- Not a prioritisation exercise.
- Protect and promote ongoing and planned Swedish research
- Also an opportunity to show how good we are.
- Overview of what we're doing and where we are going for short (0-10yrs) medium (10-20yrs) and long (>20yrs)
- Highlight issues wrt the strategy
  - Eg IceCube falls between strategies.
- View on future colliders and the wider field
  - Definitive statement impossible but it would be nice to say something.
- Aim for large signatory list.
  - Try to achieve consensus.

February 2018

European Strategy Update

Contact:
EPPSU-Strategy-Secretariat@cern.ch

Guidelines for submitting input for the 2020 update of the European Strategy for Particle Physics

Cover page (1 page)
Each document submitted should carry a single cover page containing no more than the title, the contact person(s) and an abstract.

Comprehensive overview (maximum 10 pages)
This core part of the document must be no more than 10 pages long (excluding the cover page) and must provide a comprehensive and self-contained overview of the proposed input. It should address:

- scientific context,
- objectives,
- methodology,
- readiness and expected challenges.

Addendum
A separate addendum is to be provided addressing the following topics (where relevant):

- interested community,
- timeline,
- construction and operational costs (if applicable),
- computing requirements.

Format and deadline for submission
The cover page and the comprehensive overview are to be submitted as a single file, the "main document", in portable document format (pdf) by 18 December 2018. The addendum is to be submitted as a separate file by the same deadline. A dedicated submission portal will be available on the EPPSU website as of October 2018, once the Strategy update has been formally launched by the Council at its September 2018 Session. The link to the EPPSU website will appear on the CERN Council's web pages - https://council.web.cern.ch/en - and be widely communicated through the appropriate channels.

Distribution
Both documents submitted (main and addendum) will be passed on to the Physics Preparatory Group (PPG) and the European Strategy Group (ESG). Unless explicitly requested otherwise, they will also be made public. The option not to make either document public will be available upon submission via the dedicated portal.

Expect 100's of submissions.

Shorter submissions (several pages) encouraged.

Aim several pages:
400 words per group

Addendums for experiments.
Expected to make separate submissions.

Deadline 18th December.

Format more suitable for indivdual experiments submissions than national submissions.

Instructions to wg's

For the Swedish PP community discussion on 18th October, can one of you give a a short (2-3 slides) presentation of your discussions and conclusions. You should also prepare text for the Swedish PP community's contribution to the strategy. Our contribution will likely be a couple of a pages so try to keep your text to around 400 words at most, following where appropriate, the attached guidelines. Please also include mention of the facilities to be used. The guidelines specify text as part of a comprehensive overview. We don't plan on writing an addendum as that is more suitable for submissions from individual experiments.

Document proposal

Introduction/overview of the Swedish community.

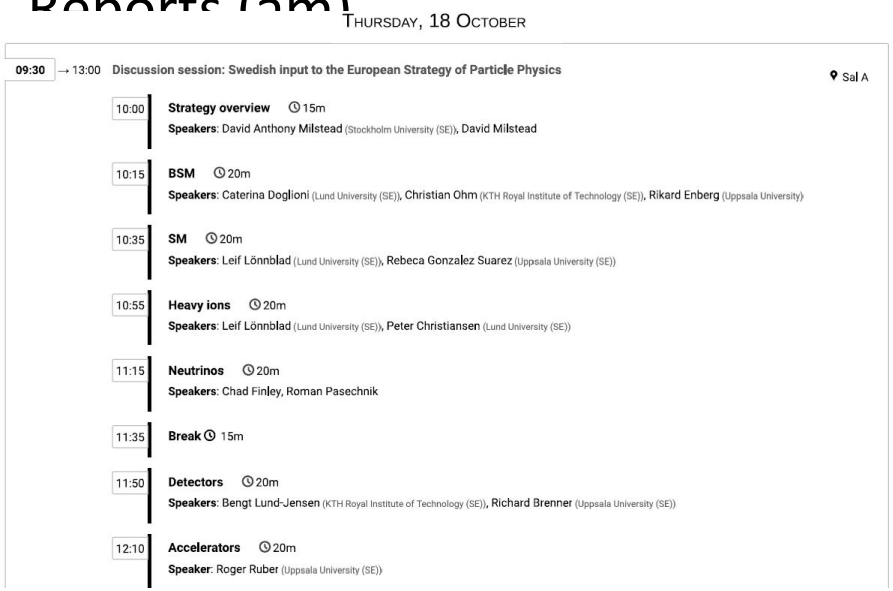
We can split/merge topics to match format :

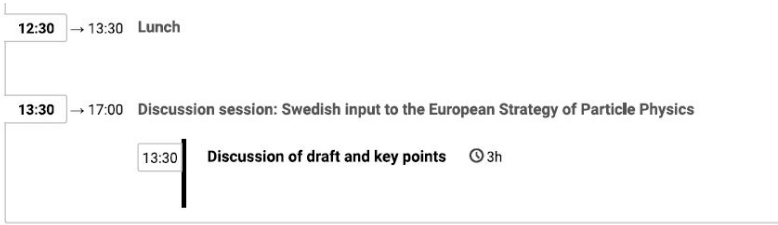
Scientific content:
New physics beyond the Standard Model at the LHC
Objectives
Look for supersymmetry, ED, generic searches, precision measurements ….
Methodology
ATLAS - upgrade and going to HL-LHC
Readiness / challenges
High lumi, successful upgrade of detector and accelerator.

Summary of key points
Eg The Swedish community believes that supporting the LHC, HL-LHC is of critical importance.
Eg An e+e- collider is vital to explore the Higgs, it needs to have an energy range to blah.
Eg some activities fall between strategies, eg IceCube.Some ”American” experiments have a wide European participation. …. Important to address this in the strategy.

This meeting

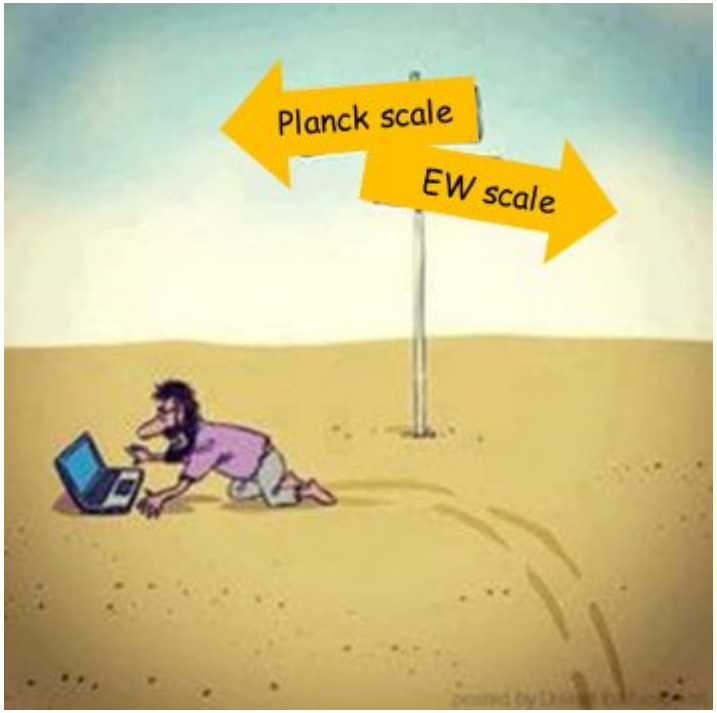
- Working groups canvassed Swedish community
- BSM (Caterina, Christian), SM (Rebeca, Leif), Heavy ions (David, Leif, Peter), Neutrinos (Chad, Roman), Detectors&software (Richard, Bengt), Accelerators (Roger, Tord)
- Early documentation : https://docs.google.com/document/d/1qSyfRQprMIg0_2-lTsOAXmhj3ehsQqg3BDP_ztzdTr0/edit?usp=sharing
- Reports (am)





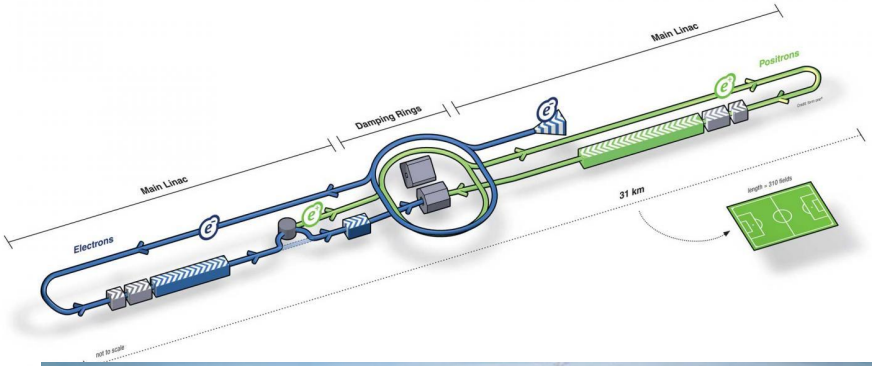
- Further discussion (pm)

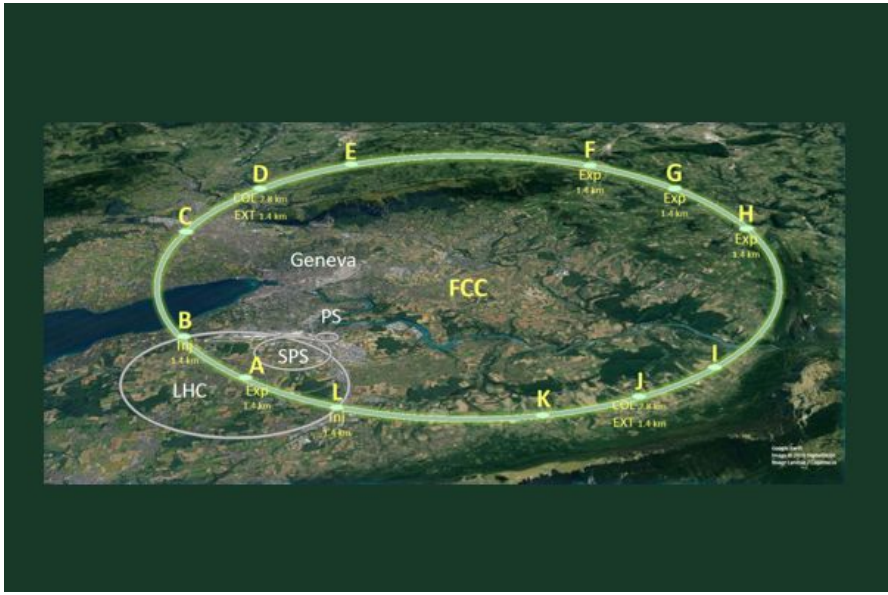
The broader issue - new colliders



- No strong reason we won't walk a few more km's into the desert
- No "no lose" theorem.
- Non-collider limits (eg eEDM -> new physics >3,30 TeV)
- Hints from g-2 , B physics
- No SUSY

The strategic issues





e^+e^- collider at

$\sqrt{s}$ ~200 - 3000 GeV

for precision Higgs/EWSB.

Precision frontier - new physics from deviations wrt SM.

hadron-hadron collider at $\sqrt{s}$ ~ 100 TeV

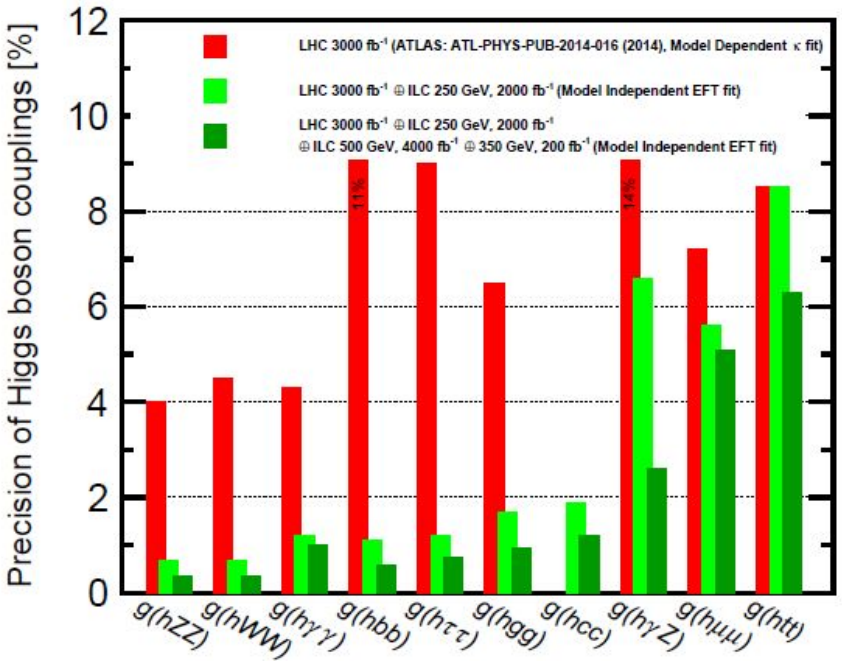
Precision Higgs/EWSB + new physics searches at energy frontier.

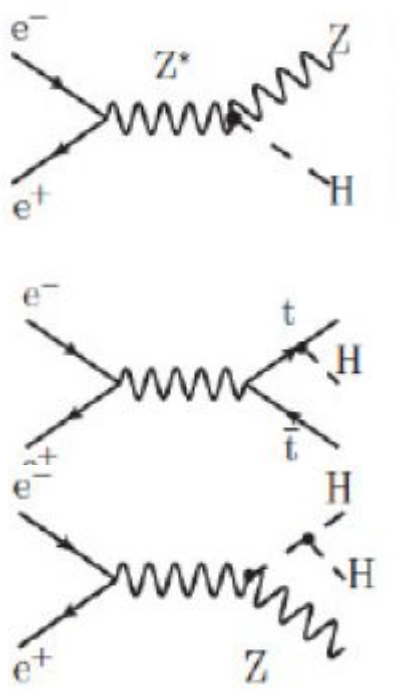
The collider market place

Collider			Location	Type	Date	Mature
ILC	0.25 0.5,1.0 ?	2	Japan	Linear e+e-	>2030	Shovel-ready TDR (2013)
CLIC	0.38 1.5,3	0.5 1.5,2	CERN	Linear e+e-	>2035	CDR (2012)
FCC-ee	0.25/0.36	10/2.6	CERN	Circular e+e-	>2035	No
LEP3	0.25	1	CERN	Circular e+e-	>2035	No
CEPC	0.25	5	China	Circular e+e-	>2035	CDR (2017)
HE-LHC	28	10	CERN	Circular hh	>2040	No
FCC-hh	100	10	CERN	Circular hh	>2045	No

$e^+ + e^- \Leftrightarrow$ high precision Higgs factory

$$\frac{\sigma(pp \to H + X)}{\sigma(pp \to X)} \sim 10^{-9} \qquad \frac{\sigma(e^+e^- \to H + X)}{\sigma(e^+e^- \to X)} \sim 0.01$$





$\sqrt{s} = 250$ GeV

g_Z, BR's ,

(LHC)-invisible

+

$\sqrt{s} = 500$ GeV

g_t, g_{HHH}

+

$\sqrt{s} = 1000$ GeV

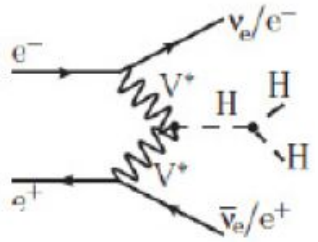
g_{HHH}

ILC~CLIC~LEP3 sensitivity, FCCee (x 2-5 better)

Tree-level sensitivity to new physics:

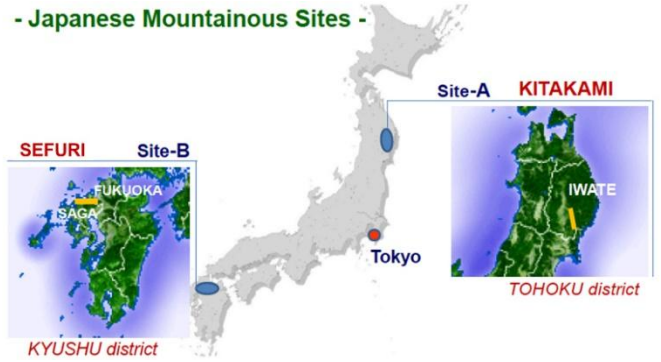
Δg <1% for $\Lambda \bullet 1$ TeV

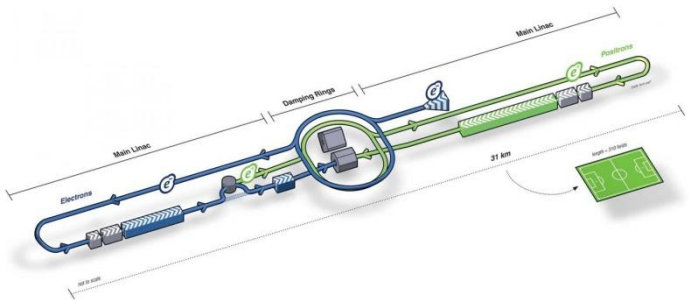
Sensitivity to new physics in loops



International Linear collider

ILC Physics Goals	500 GeV	350 GeV	250 GeV
• precision Higgs couplings	✔	✔	✔
• gHWW and overall normalization of Higgs couplings	✔	✔	
• search for invisible and exotic Higgs decay modes	✔	✔	✔
• Higgs couplings to top	✔		
• Higgs self-coupling	✔		
• search for extended Higgs states	✔		
• precision electroweak couplings of the top quark	✔		
• precision W couplings	✔	✔	
• precision search for Z′	✔		
• search for supersymmetry	✔		
• search for Dark Matter	✔		
• top quark mass from threshold scan		✔	
• precision Higgs mass			✔





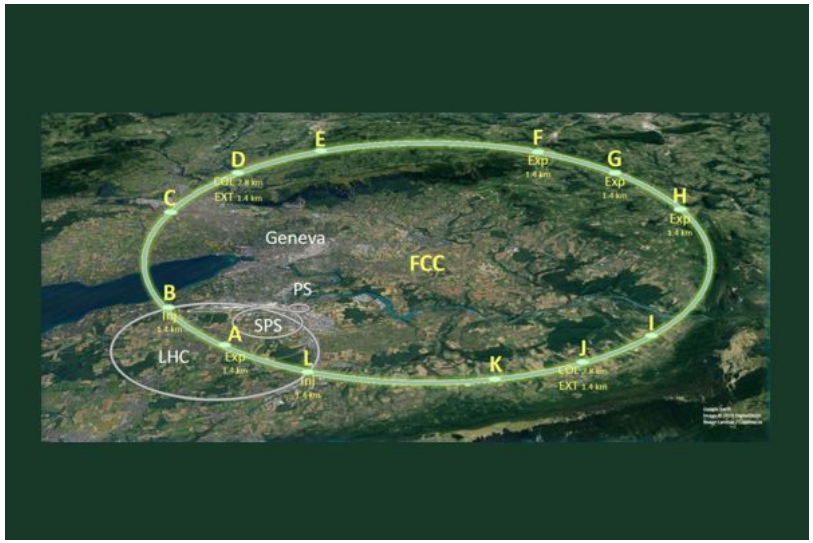
Original plan $\sqrt{s}$=500 GeV $\rightarrow$ 1 TeV .

Now $\sqrt{s}$=250 GeV , maybe 380 GeV, 500 GeV

Most (not all) core measurements are kept but a lot is lost.

Project started in the 1990's. Decision expected in 2018/2019 in time for the strategy update.

Hadron-hadron colliders



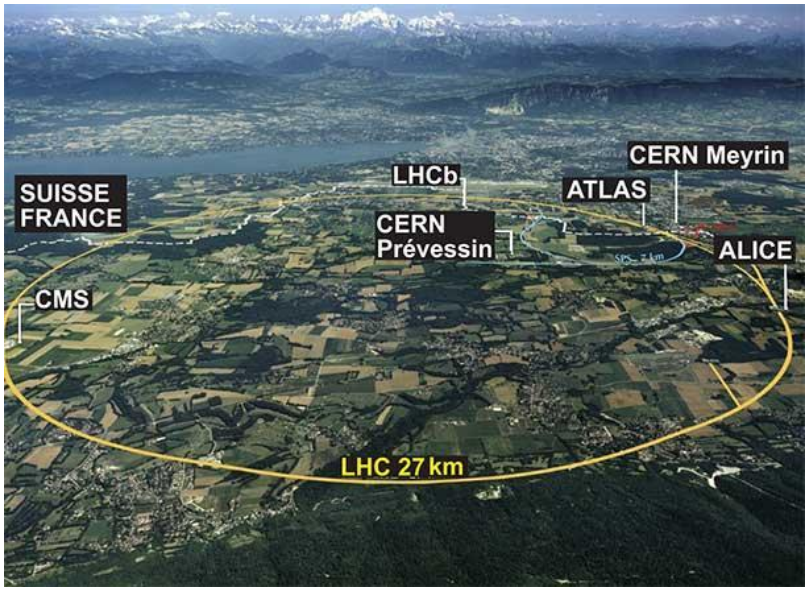
Future circular collider

pp collider at $\sqrt{s} = 100$ TeV

New tunnel (80-100 km).

16 T magnets

FCC-ee first ($\sqrt{s} = 380$ GeV) ?



High Energy LHC

pp collider at $\sqrt{s} = 28 \sim 14 \times \frac{16}{8}$ TeV

Existing tunnel

16 T magnets

LEP3 first ($\sqrt{s} \sim 240$ GeV) ?

hh physics at 100 TeV

- An order of magnitude lower in probed distance scale
- Factors ~5-10 in mass scale for new physics
- Complete exploration of the Higgs sector (quartic coupling)
  - Test electroweak baryogenesis
- High precision Higgs + SM measurements + DM searches

- No ”no lose” theorem unlike Tevatron and LHC.
- No consensus (yet??) in community.
- For the first time in ~50 years its not clear that a new insight will come from pushing the high energy frontier.
- Would dominate the field for decades without (possibly) a fundamental breakthrough