

# *Higgs Topical Lecture - projects*

W. Verkerke (Nikhef)

## Format

**Goal: you work in groups of 5-6 PhD students to investigate one topic in (future) Higgs physics**

Context: many future Higgs physics measurements have been explained concisely in the context of the European Particle Physics Strategy discussion


- All Future Accelerator collaborations submitted a concise (10p!) document outlining their physics potential
- All FA collaboration prepared a 45 minute presentation on the potential of Higgs Physics at their future collider for a EPPSG study group on Higgs performance
- Many opportunities for future measurements that will shine new light on Higgs mechanism and possible new physics

# (The European Particle Physics Strategy process)

- Last year – large plenary meeting in Granada
  - All aforementioned documents were prepared specifically for this meeting
  - On the public agenda of this meeting you can find much more information

<https://indico.cern.ch/event/808335/timetable/#20190513.detailed>

- Next step – June 19th (this Friday)
  - Public presentation of CERN Council on agreed European PP strategy
  - Recommendation of scientific priorities

 Open Symposium - Update of the European Strategy for Particle Physics

12-17 May 2019  
Granada Conference Center  
Europe/Madrid timezone  
There is a [live webcast](#) for this event.

## Timetable

< Sun 12/05 Mon 13/05 Tue 14/05 Wed 15/05 Thu 16/05 Fri 17/05 All days >

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Session legend

B1 - Electroweak Physics B2 - Flavour Physics an... B3 - Dark Matter and Da... B4 - Accelerator Scienc... see more...

08:00	<b>Registration</b>	
	Granada Conference Center	08:00 - 09:00
09:00	<b>Welcome address by the Rector of the University of Granada, the Director General of Universities (Junta de Andalucía)</b>	
	García Lorca Room, Granada Conference Center	09:00 - 09:10
	<b>Inauguration of the Symposium; Angeles Heras (Secretary of State; Ministry of Science, Innovation and Universities)</b>	
	Angeles Heras (Secretary of State; Ministry of Science, Innovation and Universities)	
	<b>Goals of the Symposium</b>	Halina Abramowicz
	García Lorca Room, Granada Conference Center	09:20 - 09:30
	<b>Implementation of the 2013 European Strategy Update</b>	Fabiola Gianotti
	García Lorca Room, Granada Conference Center	09:30 - 10:05
10:00	<b>Outstanding Questions in Particle Physics</b>	Pilar Hernandez
	García Lorca Room, Granada Conference Center	10:05 - 10:40
	Coffee break	

← Our main Higgs theory speaker for these topical lectures  
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# Format

- Many opportunities for future measurements that will shine new light on Higgs mechanism and possible new physics
  - Some of these measurement uniquely rely on information only available at future (lepton) colliders
  - Other take advantage of cleaner environment, or strongly increased data samples
- Your assignment: Study one (future) Higgs measurement
  - In the context of a particular future collider that happens to be good at that type of measurement
- Your output: a 10 minute presentation on Friday that outlines
  - The future accelerator setup (general properties, strong points) – 2/3 minutes
  - A conceptual explanation of your Higgs physics measurement, why is it important and how does it work, and the expected performance for your future accelerator. 7/8 minutes
- Focus on the concept of the measurement in your presentation, not the details
  - Focus on the ‘how’ and ‘why’ and the physics
  - Go light on the technical details (no detailed cut flows etc.)



# Project A – Invisible Higgs decays at the HL-LHC

14 TeV pp circular collider

- Physics topic: **Invisible Higgs decays @ HL-LHC**

- What can you learn from invisible Higgs decays?
- How and how well can you measure these at the HL-LHC?

- Links to documentation

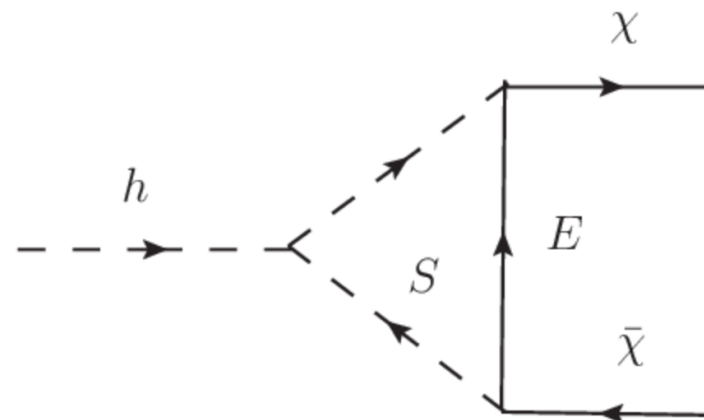
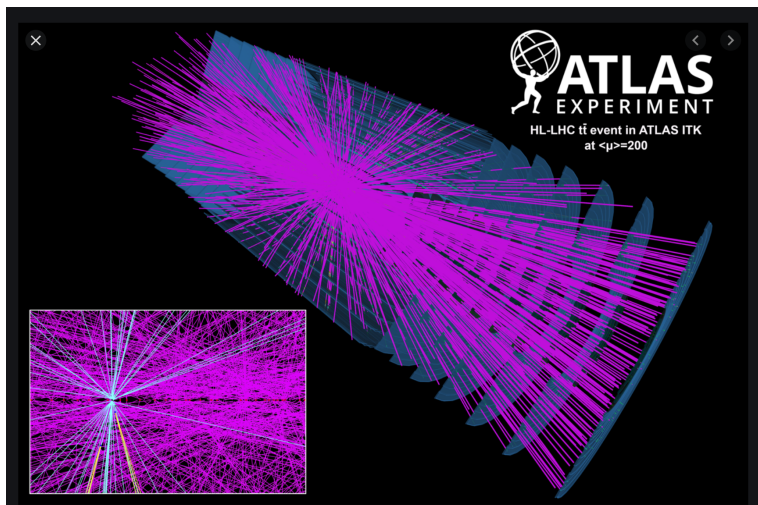
- Summary document for strategy meeting

<https://indico.cern.ch/event/765096/contributions/3295995/>

- Higgs physics performance presentation for study group

<https://indico.cern.ch/event/787473/contributions/3280723/attachments/1780373/2896465/SummaryHiggsHLLHC.pdf>

project group 3	
1	Muller, Rasa
2	Balasubramanian, Rahul
3	Federica Pasquali
4	Féo, Mauricio
5	Geertsema, Robbert
6	Stylianidis, Christos



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# Project B – Higgs self-couplings at the FCC-hh

100 TeV pp circular collider

- Physics topic: **Higgs self-couplings at the FCC-hh**

- How can we constrain Higgs self-couplings from a measurement of di-Higgs prod?
- How and how well can you measure these at the 100 TeV FCC proton-proton collider?

- Links to documentation

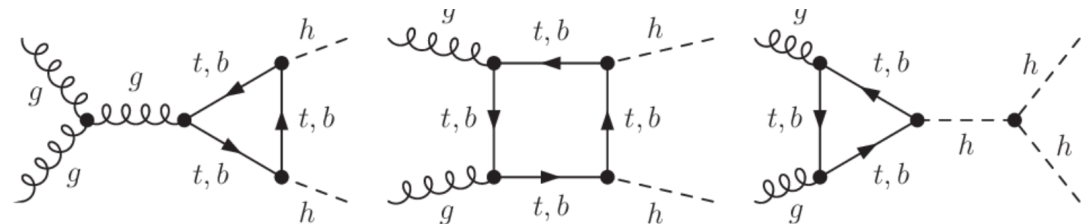
- Summary document for strategy meeting

<https://indico.cern.ch/event/765096/contributions/3298184/>

- Higgs physics performance presentation for study group

<https://indico.cern.ch/event/787474/contributions/3281442/attachments/1784237/2904189/HiggsFCChh.pdf>

project group 2	
1	Walet, Rob
2	Alfonsi, Alice
3	Moskvitina, Polina
4	Jung, Bouke
5	Doremalen, Lennart van
6	



# Project C – Higgs couplings at lepton colliders

250 GeV ee circular collider

- Physics topic:  
**Higgs coupling measurements at lepton colliders**

- What is the complementarity in measuring Higgs couplings at lepton colliders and at hadron colliders

- Links to documentation

- Summary document for strategy meeting

<https://indico.cern.ch/event/765096/contributions/3298137/>

<https://indico.cern.ch/event/765096/contributions/3295627/>

- EPPSG working group report comparing Higgs sensitivity of all future colliders

<https://arxiv.org/pdf/1905.03764>

- Higgs physics performance presentation for study group

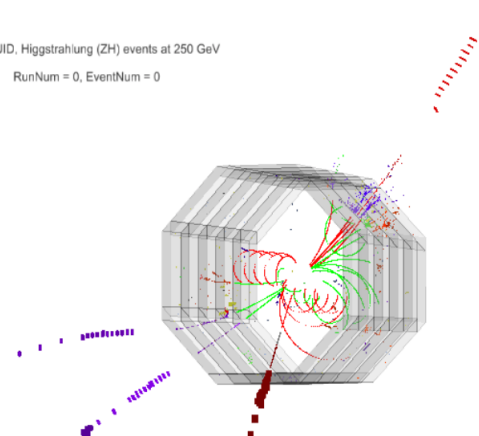
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<https://indico.cern.ch/event/787476/contributions/3280945/attachments/1791696/2920146/Higgs-Physics-Performance-CEPC-ESPP.pdf>

project group 5	
1	Gaemers, Peter
2	Kortman, Bryan
3	Seneca, Jordan
4	Greeven, Lex
5	Qiu, Shi
6	



DRUID, Higgsstrahlung (ZH) events at 250 GeV  
RunNum = 0, EventNum = 0

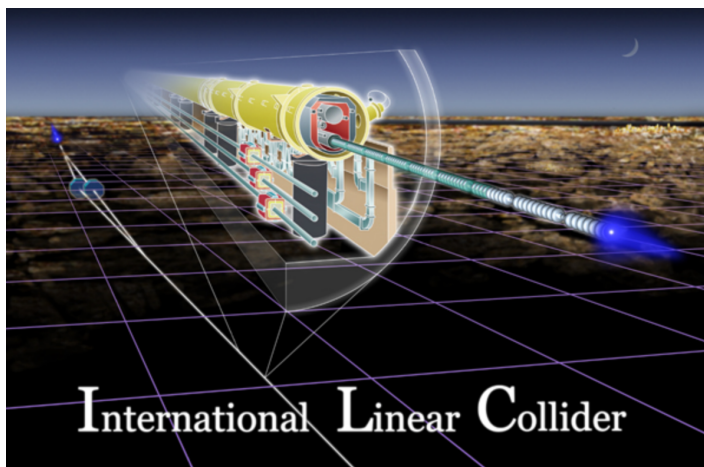


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# Project D – Higgs width measurements at lepton colliders

- Physics topic:  
**Higgs width measurement at the ILC**
  - How can you make assumption-free measurements of the Higgs width at lepton colliders.
  - Why is this important, and what precision can the ILC reach?
- Links to documentation
  - Summary document for strategy meeting  
<https://indico.cern.ch/event/765096/contributions/3295702/>
  - Higgs physics performance presentation for study group  
[https://indico.cern.ch/event/787477/contributions/3281445/attachments/1796004/2927801/jlist\\_ecfaHiggsWG\\_190214.pdf](https://indico.cern.ch/event/787477/contributions/3281445/attachments/1796004/2927801/jlist_ecfaHiggsWG_190214.pdf)

	project group 1
1	Puecher, Anna
2	Aggarwal, Anamika
3	Moser, Brian
4	Eeden, Thijs van
5	Butter, Jordy
6	Snoch, Aleksandra





# Project E – Higgs at CLIC at high energy

250-3000 GeV ee linear collider

- Physics topic: **Higgs physics at 3 TeV**
  - At high-energy linear colliders like CLIC Higgs bosons are produced using WW scattering:  $e^+e^- \rightarrow WW \rightarrow H\nu$
  - What can you learn from this type of Higgs production?

- Links to documentation

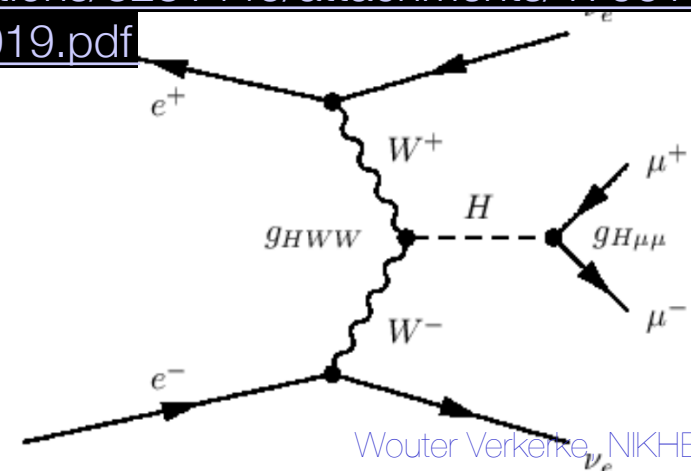
- Summary document for strategy meeting

<https://indico.cern.ch/event/765096/contributions/3295976/>

- Higgs physics performance presentation for study group

[https://indico.cern.ch/event/787477/contributions/3281446/attachments/1796101/2927993/clic\\_higgs\\_philipp\\_roloff\\_14\\_02\\_2019.pdf](https://indico.cern.ch/event/787477/contributions/3281446/attachments/1796101/2927993/clic_higgs_philipp_roloff_14_02_2019.pdf)

	project group 6
1	Lukashenko, Valeriia
2	McDougall, Ashley
3	Pothast, Mart
4	Vermunt, Luuk
5	Stamenkovic, Marko
6	



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# Project F – Quartic couplings at muon colliders

30 TeV GeV  $\mu\mu$  circular collider

- Physics topic: **Higgs Quartic Couplings**
  - Why are Higgs quartic self-couplings interesting and different from Higgs trilinear self-couplings
  - Can a future 30 TeV muon collider possibly measure these?

- Links to documentation

- Summary document for strategy meeting

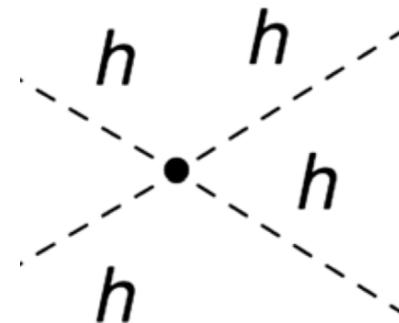
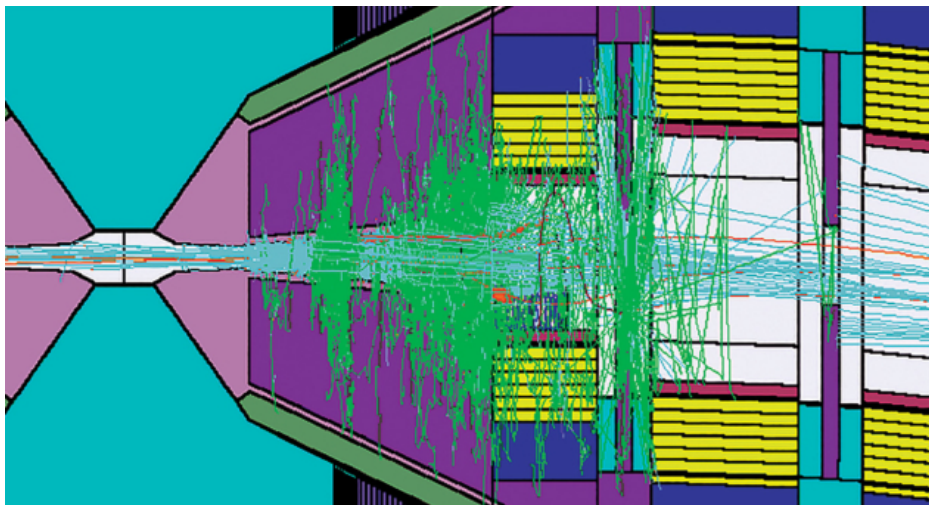
<https://indico.cern.ch/event/765096/contributions/3295784/>

- Higgs physics performance presentation for study group

[https://indico.cern.ch/event/787486/contributions/3272294/attachments/1831930/3000673/1904\\_Vidyo\\_Mele.pdf](https://indico.cern.ch/event/787486/contributions/3272294/attachments/1831930/3000673/1904_Vidyo_Mele.pdf)

[https://indico.cern.ch/event/787486/attachments/1832190/3000816/talk\\_wulzer.pdf](https://indico.cern.ch/event/787486/attachments/1832190/3000816/talk_wulzer.pdf)

project group 4	
1	Brían Ó Fearraigh
2	Degens, Jordy
3	Pizzini, Alessio
4	Ferreres, Sylvia
5	Veen, Michiel
6	



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# Schedule for projects

## **Wednesday (today)**

- 15.30-17.00 Time to get organised / do research on your project
- 16.00-16.30 Q&A on Zoom

## **Thursday**

- 14.00-17.00 Work on your project / prepare presentation
- 16.00-16.30 Q&A on Zoom

## **Friday**

- 14.00-15.30 Project presentation & questions (10'+5' each project)