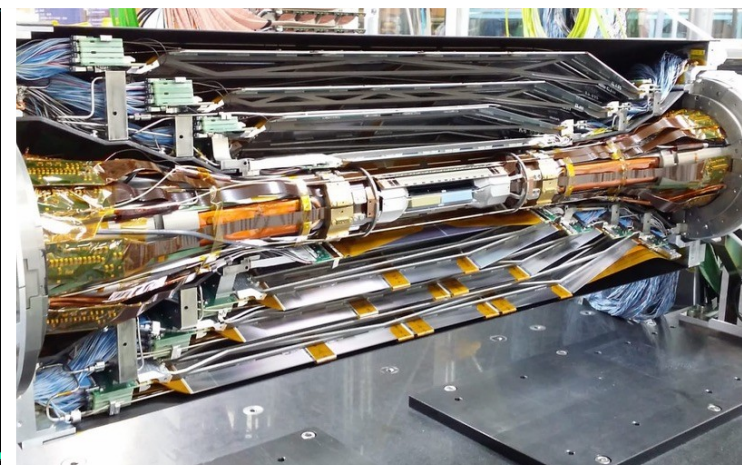
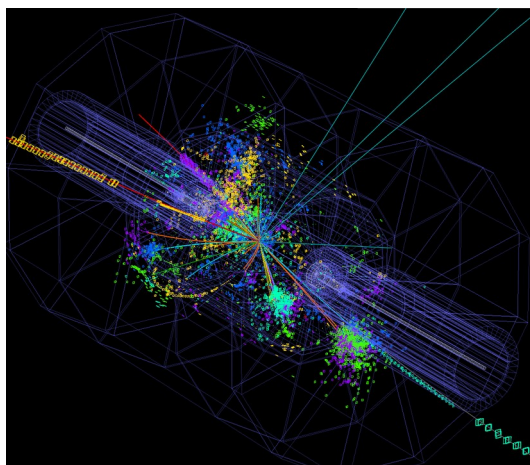
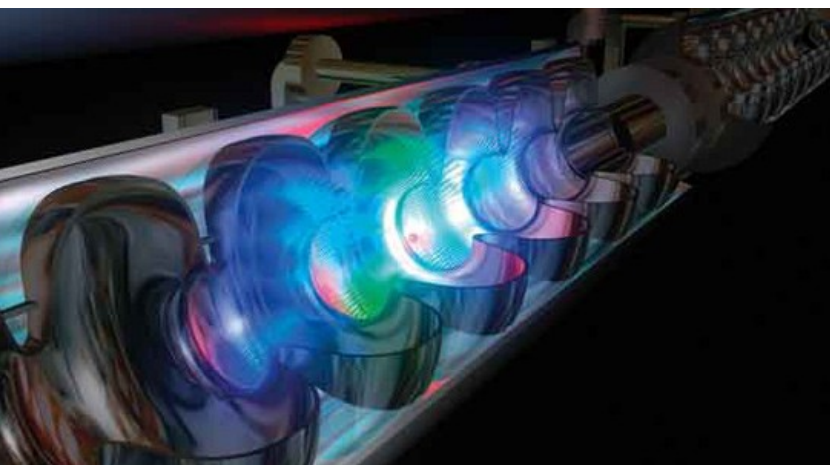


## DEPFET and future colliders



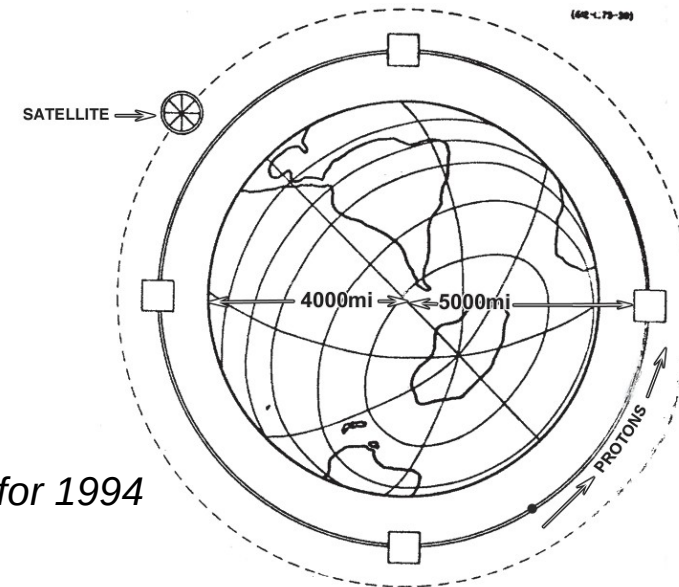
*Marcel Vos (IFIC, UV/CSIC Valencia)  
DEPFET workshop, Ringberg, 13 March 2019*

# Which future collider?

After the discovery of the Higgs boson, high-energy physics has no obvious target (no further SM particles, no broadly accepted BSM scenario)

There is a broad consensus that the next large facility should be a Higgs factory an  $e^+e^-$  collider with moderate energy reach ( $\sim 250$  GeV)

Beyond the thresholds of SM processes (ttH, di-Higgs production) we enter a phase of real exploration (possibly up to the Planck scale)



*From Fermi's 1954 Nobel prize lecture: a vision for 1994*

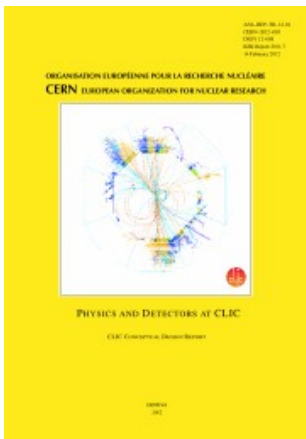
# Which future collider?

LCC (= ILC + CLIC) has prepared detailed plans for a linear collider:  
250 GeV Higgs factory + energy upgrade for top, ttH, di-Higgs

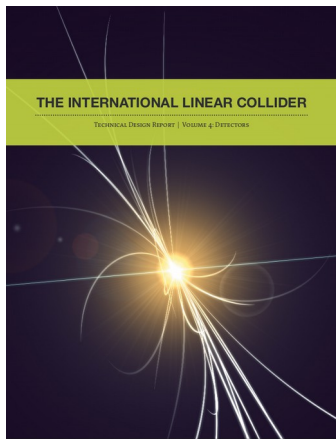
A DEPFET vertex detector is a competitive candidate for the ILC

*A DEPFET vertex detector for a future linear e+e- collider, IEEE TNS 60, 2, 2 (2010!)*

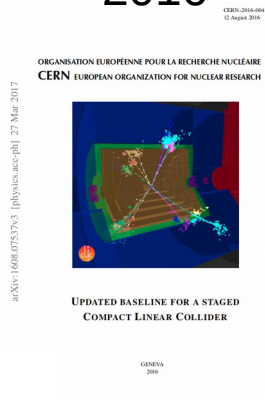
CLIC CDR 2012



ILC TDR 2013



CLIC baseline 2016



CLIC summary 2019



ILC status 2019



ArXiv:1812.06018

ArXiv:1903.01629

# Circular $e^+e^-$ colliders?

Two projects for very large circular colliders have published conceptual designs



FCCee-FCChh (CERN)  
CEPC-SPPC (China)

90-160-250-(350) GeV  $e^+e^-$  collisions  
100 TeV pp collisions in the same tunnel

## Participants

Updated as of January 23, 2019

Ali AKIL  
HKUST

Ladislav ANDRICEK  
Semiconductor Laboratory of the Max Planck Society



CEPC CDR review

Similar detector concepts,  
but... DC machine

DEPFET candidacy has  
been made, but implication  
in CEPC/FCCee is limited

Ringberg, 13 March 2019

# European Strategy meeting



CERN Council Open Symposium on the Update of

## European Strategy for Particle Physics

13-16 May 2019 - Granada, Spain



### Physics Preparatory Group

Halina Abramowicz (Chair)  
Shoji Asai  
Stan Bentvelsen  
Caterina Biscari  
Marcela Carena  
Jorgen D'Hondt  
Keith Ellis  
Belen Gavela  
Gian Giudice  
Beate Heinemann  
Xinchou Lou  
Krzysztof Redlich  
Leonid Rivkin  
Paris Sphicas  
Brigitte Vachon  
Marco Zito  
Antonio Zoccoli

### Local Organizing Committee

Francisco del Águila  
Antonio Bueno (Chair)  
Alberto Casas  
Nicanor Colino  
Javier Cuevas  
Elvira Gámiz  
María José García Borge  
Igor García Irastorza  
Eugení Graugés  
Juan José Hernández  
Mario Martínez  
Carlos Salgado  
Benjamin Sánchez Gimeno  
José Santiago

An open symposium in Granada in May to draft the European roadmap for particle physics

Decision on preferred Higgs factory?

<https://cafpe.ugr.es/eppsu2019/>

[eppsu2019@pcgr.org](mailto:eppsu2019@pcgr.org)



Sponsored by:



# Spanish input to European Strategy

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Prepared by Toni Pich & Teresa Rodrigo on the basis of community meetings

[Document](#) + [Addendum](#)

## **From the executive summary:**

o The LHC program and its upgrade HL-LHC benefits from the highest investment of the Spanish resources. Therefore, **we believe that the full LHC/HL-LHC operation and the exploitation of its physics program should be the first priority of Europe for the next years.**

## **The ranking of priorities established by the community are as follows:**

o The full LHC/HL-LHC operation and the exploitation of its physics programme are fully supported. Further steps of the community towards **a future new collider need to be compatible with the planned LHC activities.**

# Spanish input to European Strategy

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Prepared by Toni Pich & Teresa Rodrigo on the basis of community meetings

Document + Addendum

## From the executive summary:

o The present Linear Collider proposals, conceived as **a Higgs factory at 250 GeV centre-of-mass energy with potential upgrades to higher energies**, are positively seen by the community.

## The ranking of priorities established by the community are as follows:

o Given the latest LHC physics results and those of the field, it is generally agreed the need of an  **$e^+e^-$  collider extendable in energy** to access the top-quark properties and in particular the Higgs self-couplings.

# ILC vs. CLIC

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**The ranking of priorities established by the community are as follows:**

o Between the two present Linear Collider projects, ILC and CLIC, the ILC is the most mature and affordable project worldwide. Having more labs in addition to CERN distributed in other regions and having central roles in the development of collider high energy physics is noticed as a positive feature to strength our field. **The present ILC proposal, conceived as a Higgs factory at 250 GeV centre-of-mass energy with potential upgrades to higher energies, is the preferred option (ILC250). If the Japanese government proposes to construct and to host the ILC250, the Spanish community will be in favour of a participation in this new endeavour.** A possible future contribution from Spain to ILC250 should be negotiated in close collaboration with the rest of interested European countries, including a possible CERN participation in technology, science and logistics.



# The German input to the EU strategy

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## Running and approved Collider Projects

The physics potential of the experiments at the LHC and its upgrade, the HL-LHC, as well as at SuperKEKB must be fully exploited.

## Future Collider Projects

An electron-positron collider, upgradeable to a centre-of-mass energy of at least 500 GeV, should be realised, with the highest priority, as the next international high-energy project.

The physics case for such a project is well defined and underlined by the state-of-the-art results from collider experiments. The SM, and possible deviations from it, will be probed to unprecedented precision with an electron-positron collider by operating it as a Higgs factory and by studying the top quark, W and Z boson production, and the Higgs potential.

We strongly support the Japanese initiative to realise, as an international project in Japan, the ILC as a "Higgs-Factory" with an initial centre-of-mass energy of about 250 GeV.

# So what about the ILC in Japan?



Revisiting a slide from last year

**250 GeV ILC is in government review in Japan**

**NEW:** report by Science Council of Japan

<http://newsline.linearcollider.org/2018/12/21/executive-summary-of-the-science-council-of-japans-report/>

**Looking for international contributions**

- high-level US-Japan meetings
- successful visits to Germany and France
- other European countries (ES, IT, UK) planned

<http://newsline.linearcollider.org/2018/02/01/successful-visit-to-europe-one-big-step-for-ilc-realisation/>

**KEK director: Japanese decision is “an input to the European strategy update”**

# So what about the ILC in Japan?

Revisiting a slide from last year

<b>English</b>	decision
<b>Type</b>	noun
<b>Japanese</b>	決着
<b>Hiragana</b>	けっちやく
<b>Pronunciation</b>	kecchaku
<b>Example</b>	<b>indecisive decision</b> 煮え切らない決着

**KEK director: Japanese decision is “an input to the European strategy update”**

# So what about the ILC in Japan?

In the ICFA meeting on the 7th of March, the Japanese government finally made a statement about the ILC:



**Hitoshi Murayama**

6 de marzo a las 13:19 · 🌐



Here is my personal English translation.

Government will start international discussions with US and Europe concerning hosting next generation accelerator ILC

The Japanese government decided to enter international discussions with US and Europe to explore the possibility to host ILC in Japan. The next-generation accelerator ILC, or International Linear Collider, is a huge experimental facility to study the origin of the Universe. Ministry of Education, Culture, Sports, Science and Technology will announce this decision at an international meeting on March 7th in Tokyo. This is the first time for the government to announce its policy concerning the ILC.

# So what about the ILC in Japan?

From PhysicsWorld: “Officials in Japan said that their government has formally “expressed an interest” in the 20 km-long particle smasher but has not decided whether to host the machine. The final go-ahead will only be given if enough international support and funding can be found to construct the machine and there is a consensus within the Japanese scientific community that the project is worth pursuing.”

 **Sabine Hossenfelder**  
8 de marzo a las 08:26 · 🌐

Japanese government decides to not make a decision on the ILC.



SCIENCEMAG.ORG  
**Japanese government punts on decision to host the International Linear Collider**

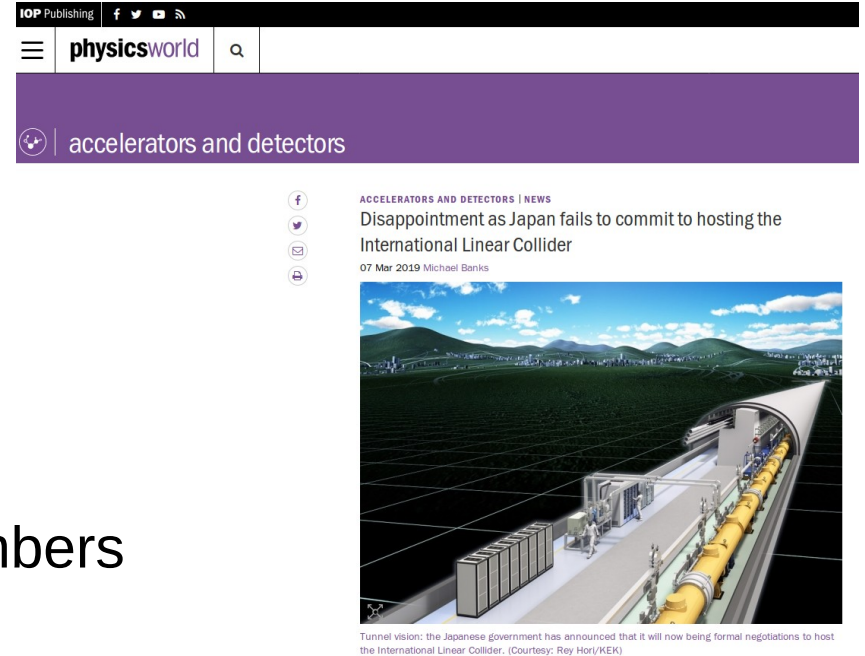
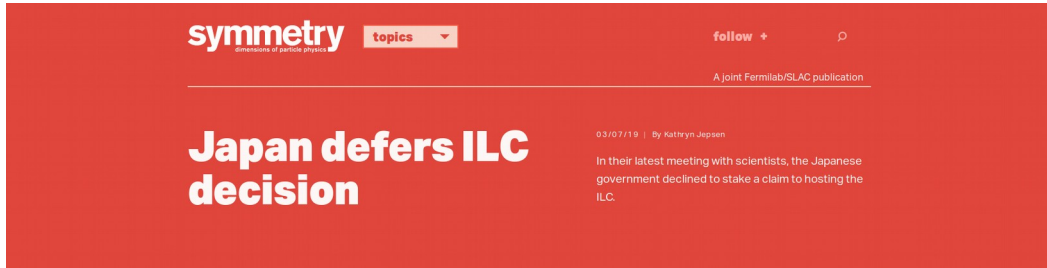
👍🤔🙄 Tú y 47 personas más 20 comentarios 12 veces compartido

👍 Me gusta Comentar Compartir

Ver 2 comentarios más

 **Steffen A. Bass** That's a very Japanese way of saying no...  
Me gusta · Responder · 4 d 4

# So what about the ILC in Japan?



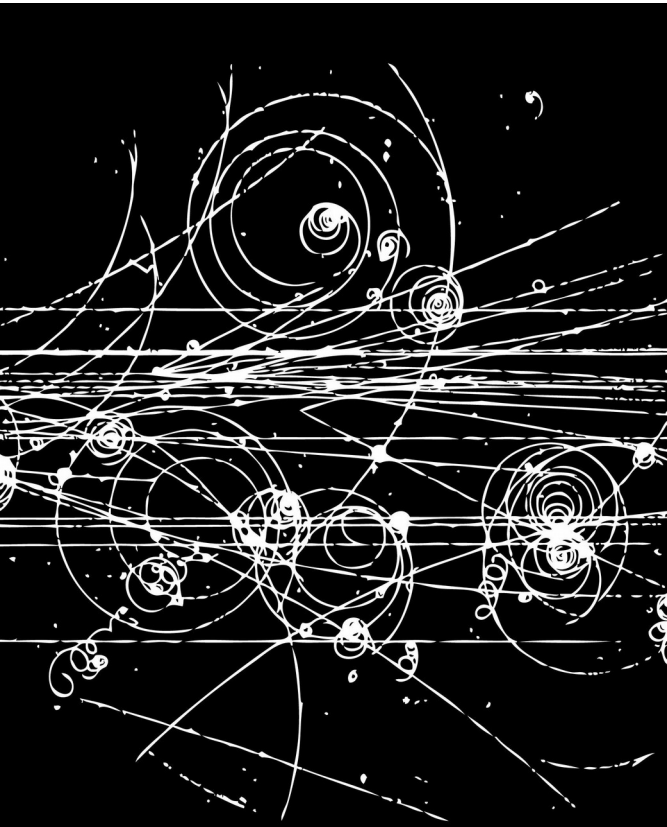
ICFA chair Geoff Taylor:

“there was dissapointment among the members of the committee”, ...

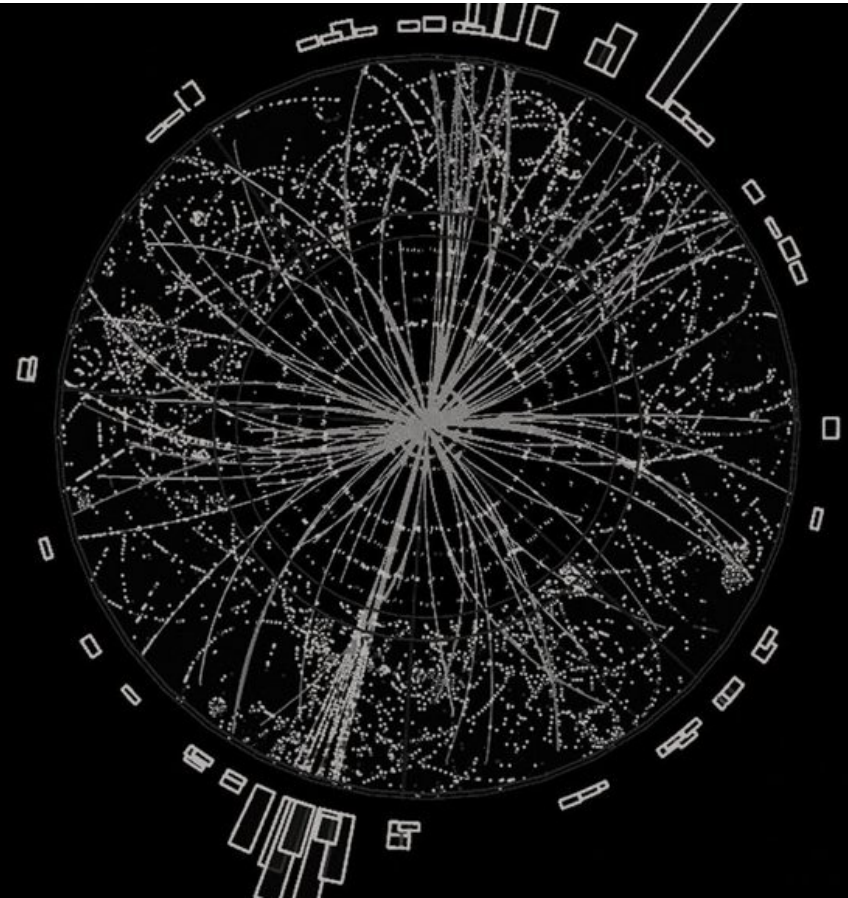
But also: “this is not a dead end”.

# Detector R&D

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Detector R&D:  
a crucial tool  
for discovery

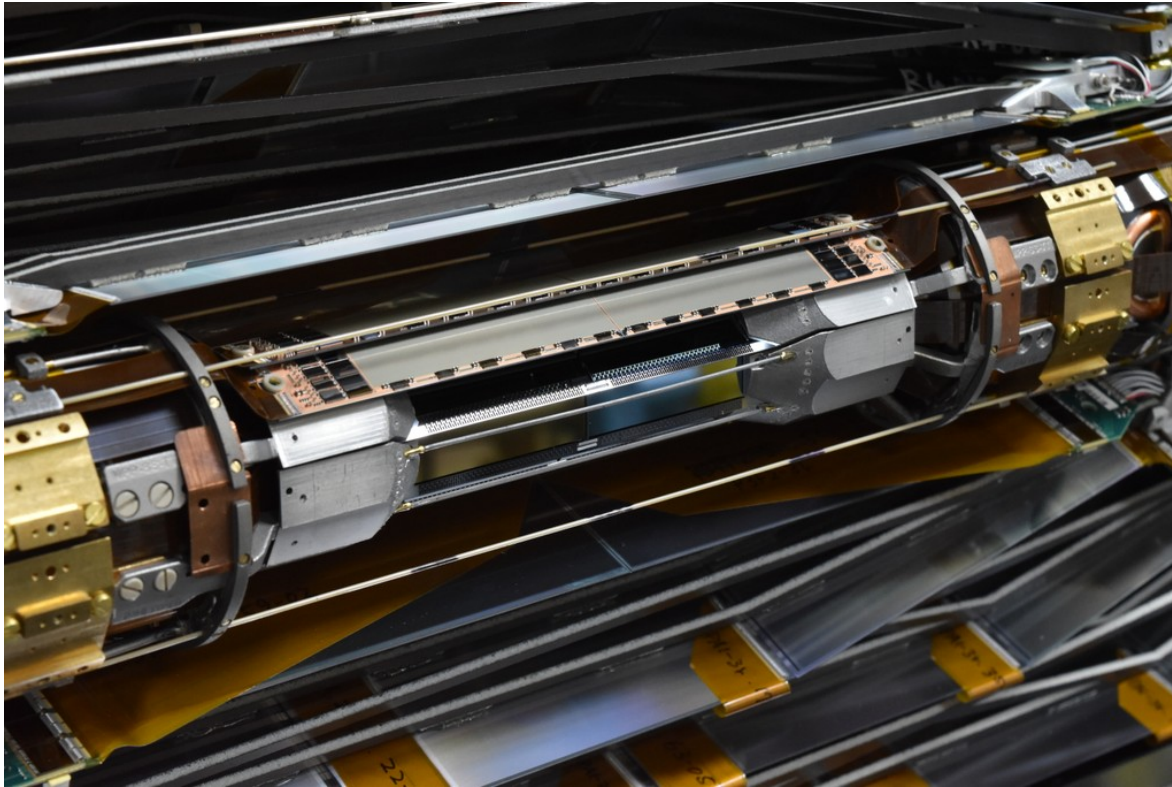


# DEPFET vertex detector

DEPFET



2018: the 1<sup>st</sup> DEPFET active pixel detector installed and in operation



## Belle II vertex detector

*Belle II physics book, arXiv:1808.10567*

*The best argument is success in Belle II*

*DEPFET is a candidate for all Higgs factories*

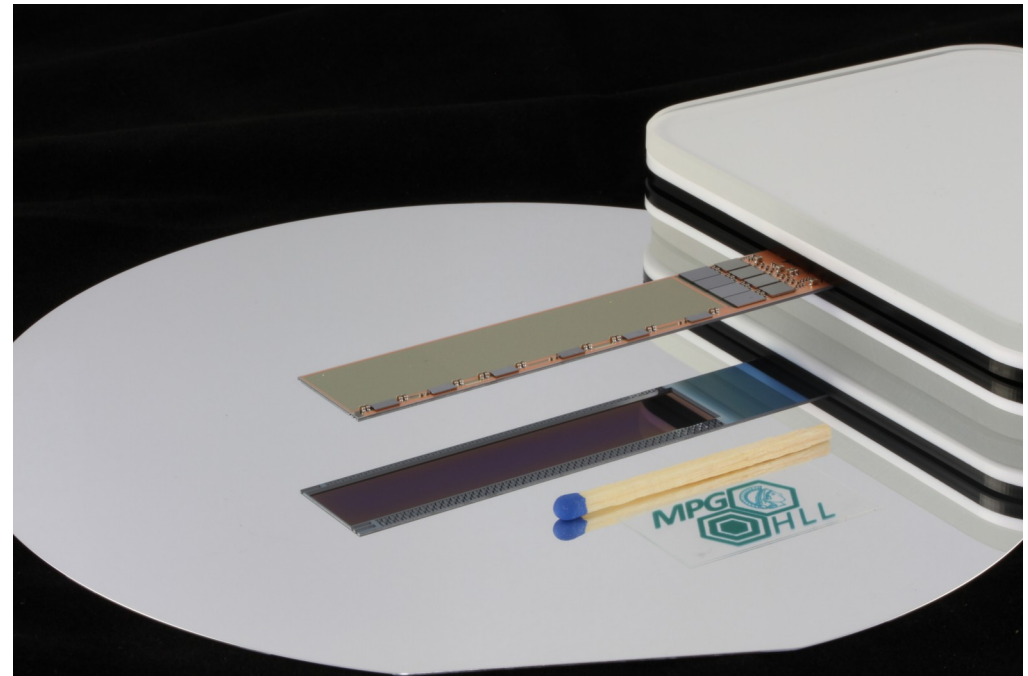


# DEPFET: are we competitive?

## Don't underestimate our strengths

The main DEPFET assets:

- The sensor, of course
- Integrated all-silicon ladder
- Large collaboration



# DEPFET: are we competitive?

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## **Don't take it for granted**

While DEPFET was busy building the PXD, the competition has made progress:

- MAPs are “proven” technology now, depleted MAPs are fast
- (double) SOI has working small-scale prototypes

Technology for the Higgs factory vertex detector(s) decided in ~2025

## **We must continue to evolve:**

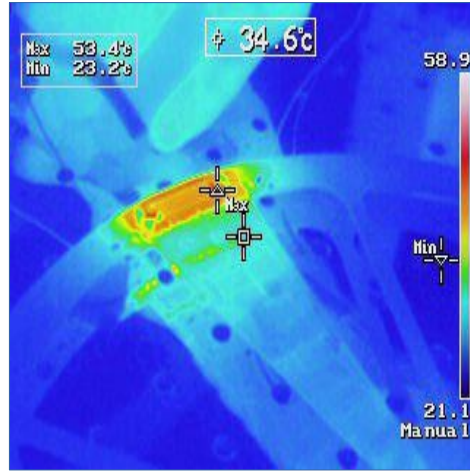
Renewed R&D for Belle II upgrade (see Laci's talk) and Higgs factory

- improved core performance: super  $g_q$ , improved r.o. speed
- integrated detector design, micro-channel cooling

# Detector R&D: ultra-transparent mechanics



Ringberg, 13 March 2019

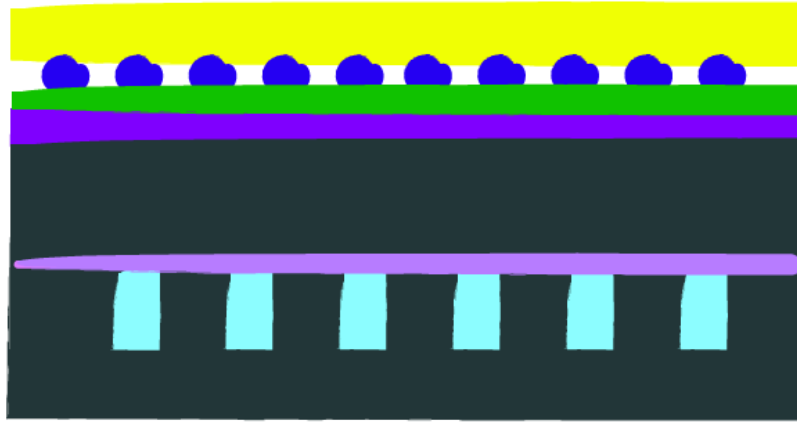


## Advanced support structures

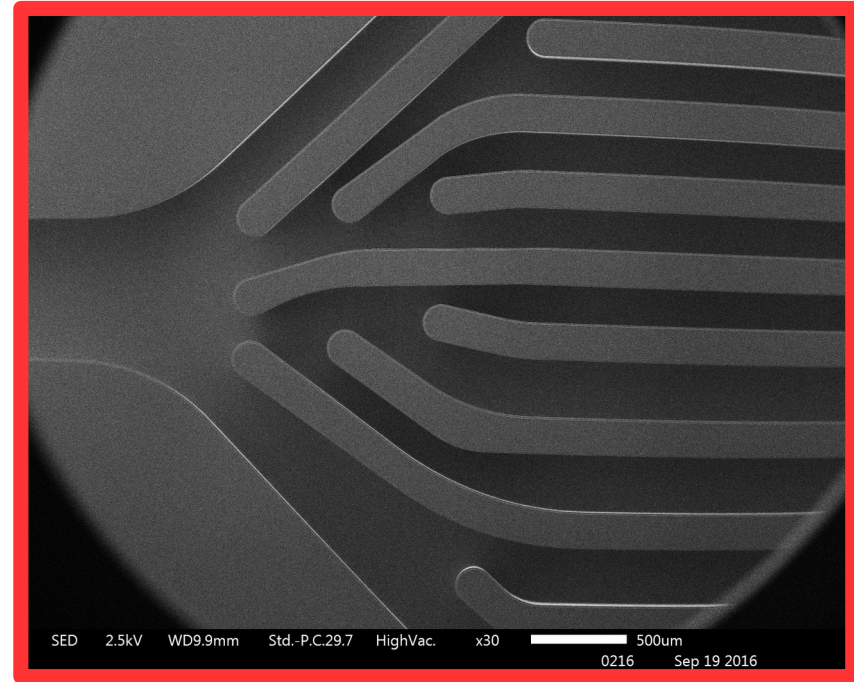
Design of ILC forward tracker & full-size thermo-mechanical model  
Excellent thermo-mechanical performance with a fraction of an  $X_0$   
HLL-MPG/IFIC/INTA/IFCA/NTC

See talk by Guillem Vidal

# Detector R&D: Micro-channel cooling



See next talk by M.V.



IFIC/HLL-MPG/U.Bonn: develop a micro-channel solution where the cooling circuit is integrated in the silicon sensor, *IFIC/HLL/Bonn, JINST 11 (2016) P06018*

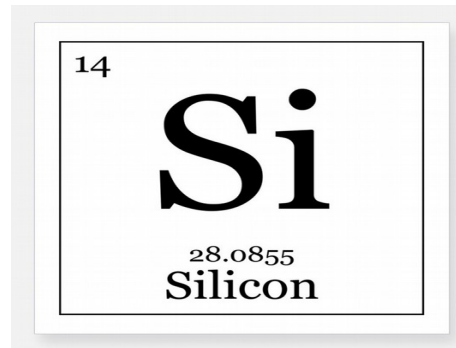
# Detector R&D: organizational

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Detector R&D for future  $e^+e^-$  colliders suffers from continuing uncertainty about the fate of Higgs factories

- Belle II upgrade → clarify DEPFET candidacy
- AIDA2020 → new proposal being drafted
- CERN R&D program → mechanics open to outside groups
- CERN RDNN → tracker mechanics forum

PRE



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# Summary

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- Situation around next large facility at the energy frontier remains unclear
- Count on a Higgs factory; prepare for decision in European strategy upgrade
- DEPFET candidacy for Belle II and Higgs factory must be renewed urgently