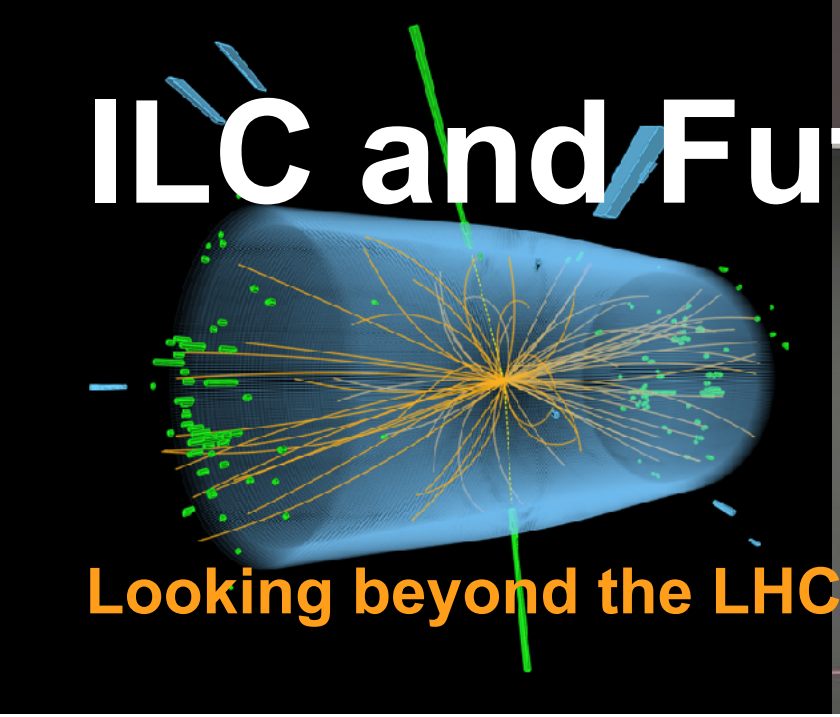
ILC and Future Accelerator Projects



Looking beyond the LHC

Helmholtz Program: Matter and the Universe (MU)

PoF III Topic: Fundamental Particles and Forces

DESY Research Unit: Experimental Particle Physics

Felix Sefkow
Center Evaluation DESY, 5 – 9 February 2018

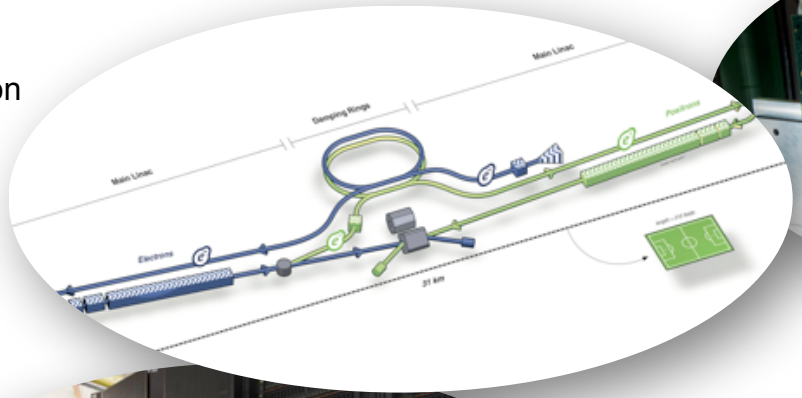
HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

DESY

Lifecycle Competence

From conception to exploitation.

Conception
Design
Decision

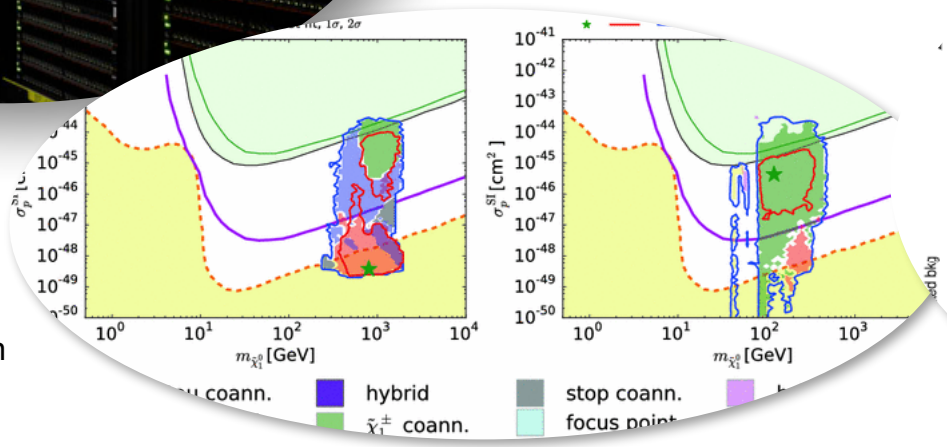


R&D

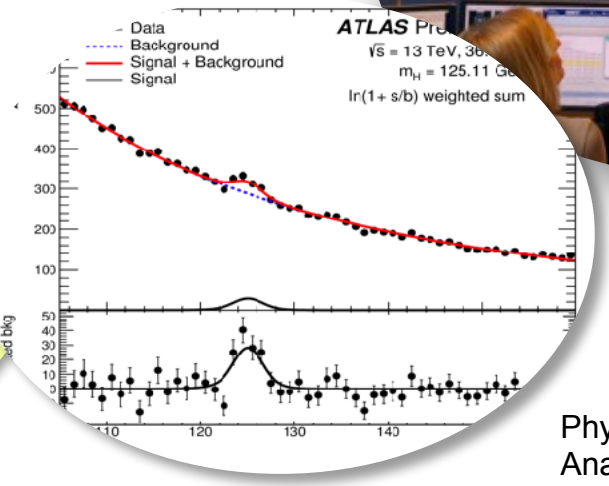
Construction
Commissioning

Data preservation
Outreach into society

Operation



Interpretation
New ideas



Physics analysis
Analysis Strategy

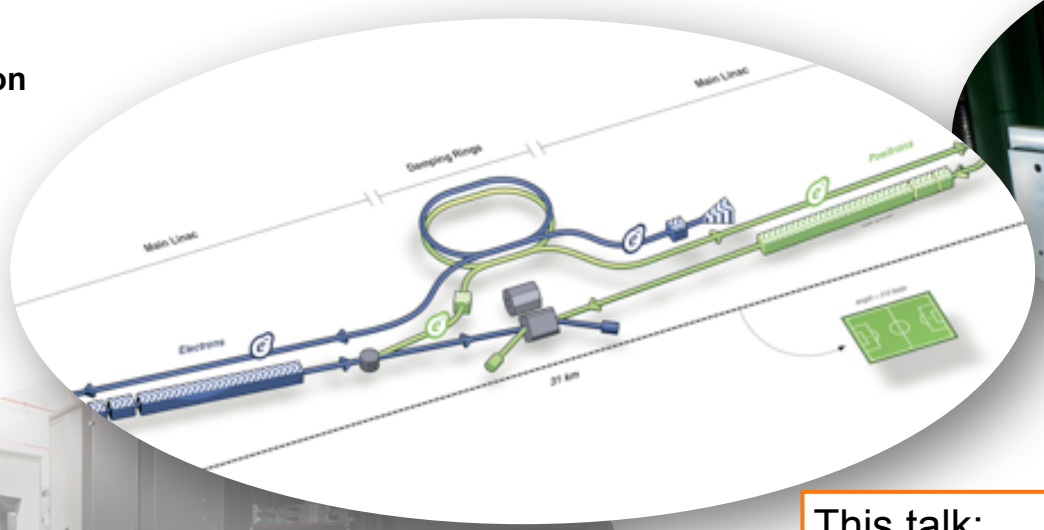
Lifecycle Competence

From conception to exploitation.

R&D

Construction
Commissioning

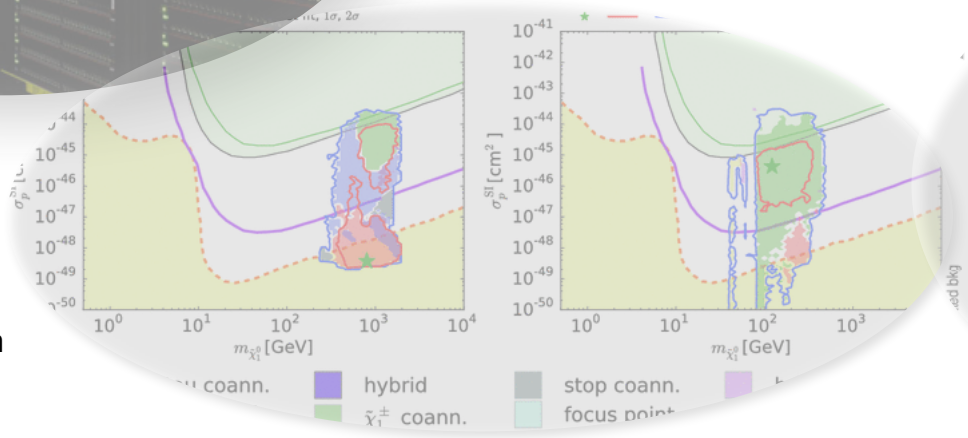
Conception
Design
Decision

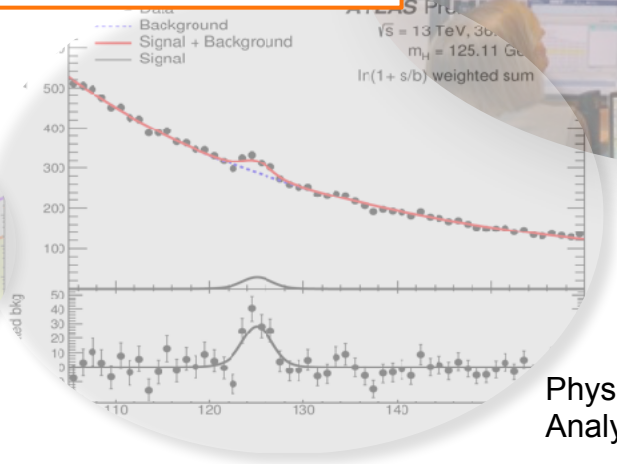


This talk:
ILC: Physics and detectors
Future projects: example opportunities

Data preservation
Outreach into society

Operation



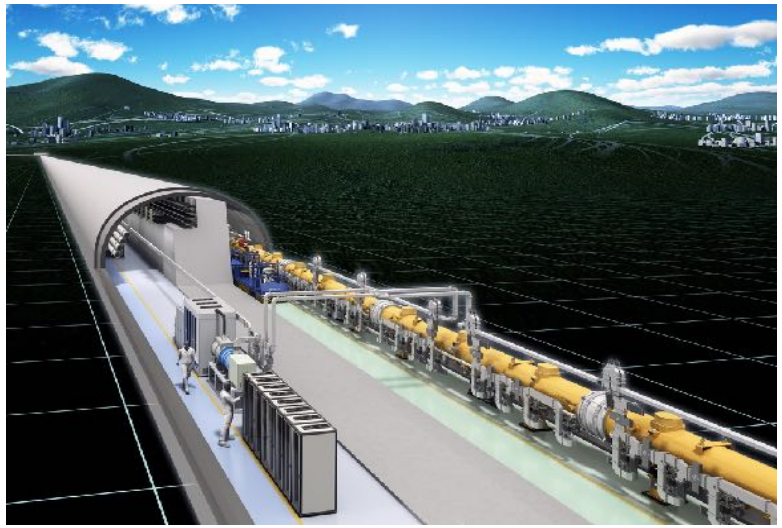


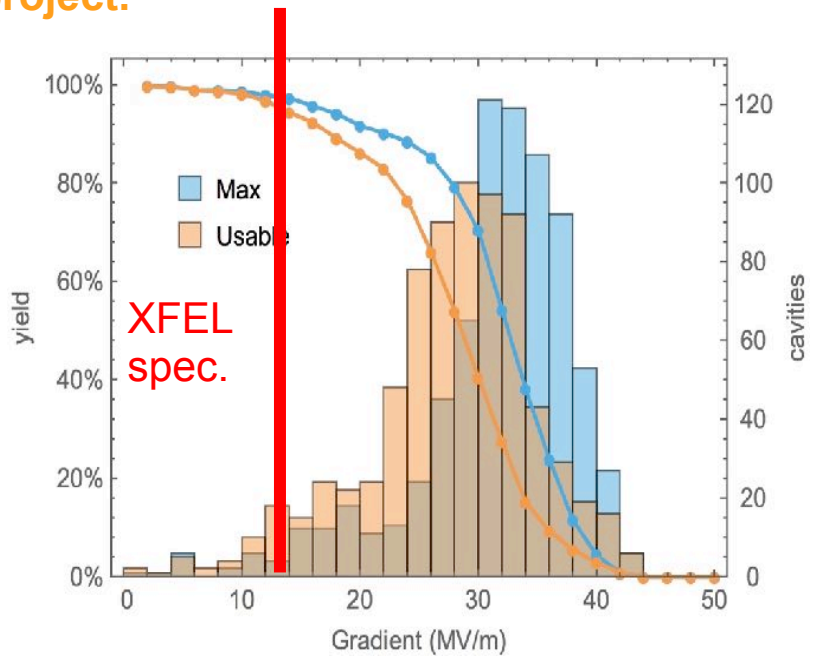
Interpretation
New ideas

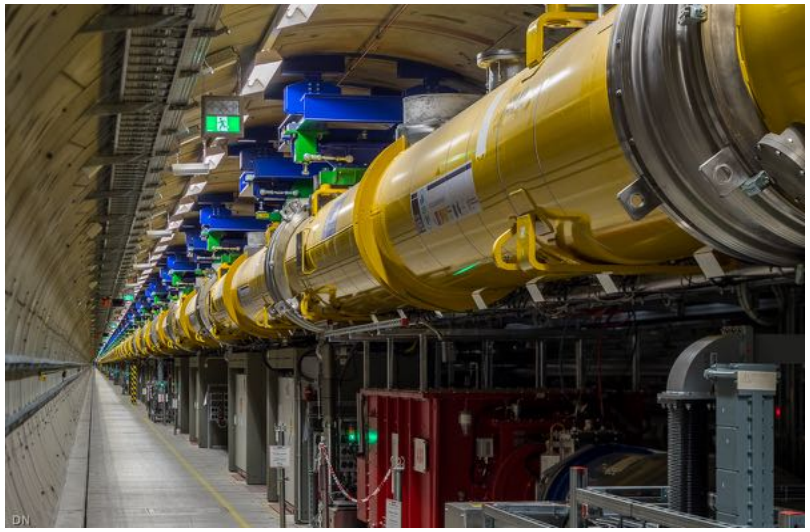
Physics analysis
Analysis Strategy

The International Linear Collider

The most advanced and mature future project.







e^+e^- collider with E_{CM} from 90 GeV to 1 TeV, Initial stage of 250 GeV

- Expect input from Japan for European Strategy update 2019

Supported by ICFA (Ottawa, November 2017):

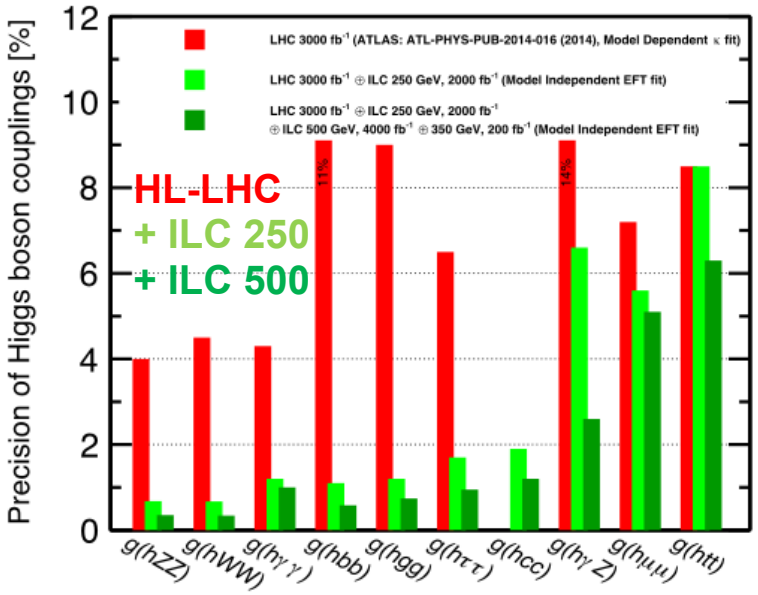
- *"ICFA (…) very strongly encourages Japan to realise the ILC in a timely fashion as a Higgs boson factory with a centre-of-mass energy of 250 GeV as an international project, led by Japanese initiative."*

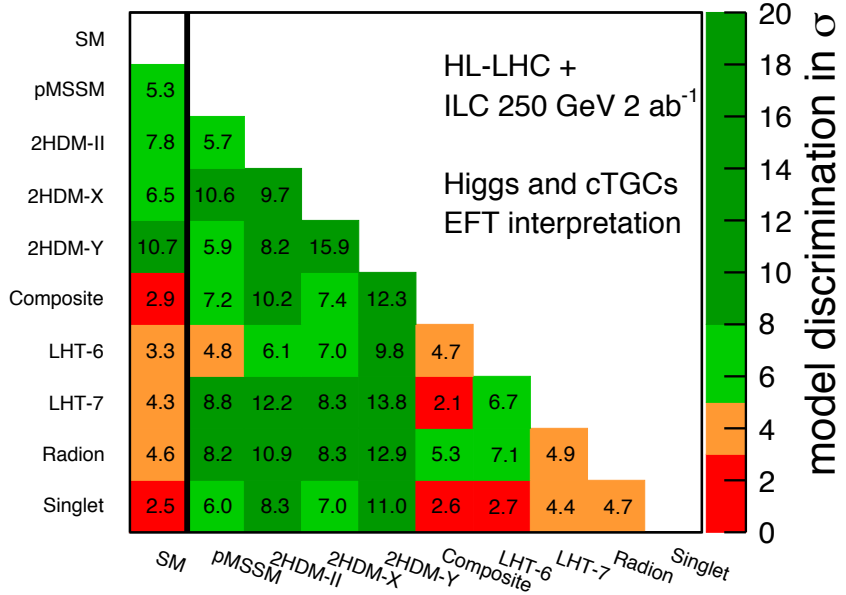
Based on superconducting RF technology

- Industrialisation successful with XFEL – a "10% prototype" of ILC
- Cavity production according to ILC specs (31.5 GeV/m)

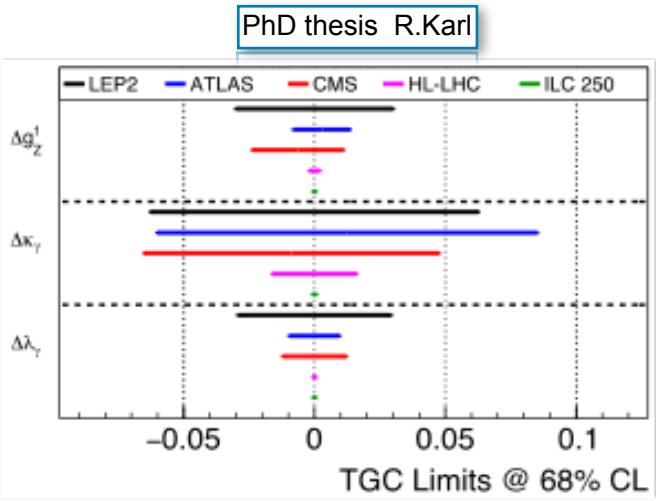
Physics Case for ILC 250

Precision and discovery potential.





Leading involvement of DESY physicists (experiment and theory)



DESY-17-155, hep-ex/1710.07621

Already at 250 GeV precision of model-*independent* Higgs coupling measurements exceeds HL-LHC projections

- Fully exploit EFT formalism, include angular dependences
- Absolute coupling measurements at the ILC using inclusive Zh cross section remain key element
- Percent-level deviations expected in many extensions of the Standard Model – precision *does* matter

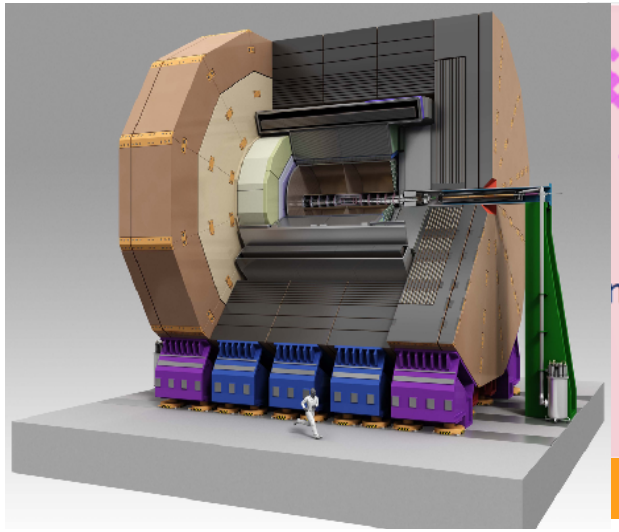
Use Higgs and Triple Gauge Couplings from $e^+e^- \rightarrow W^+W^-$ to distinguish between SM and different BSM points

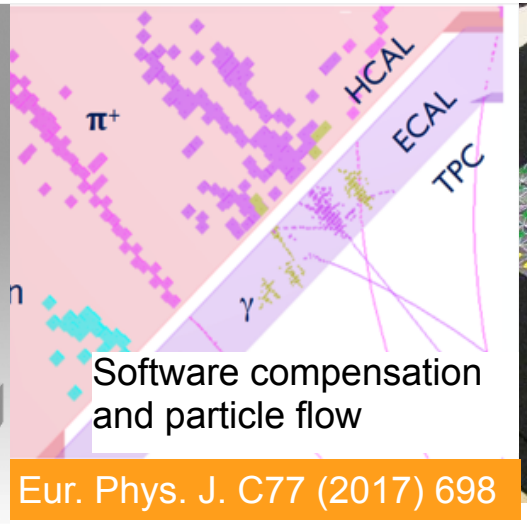
- Example points: no new particles would be seen at HL-LHC

J.List

ILC Detector Concepts and Development

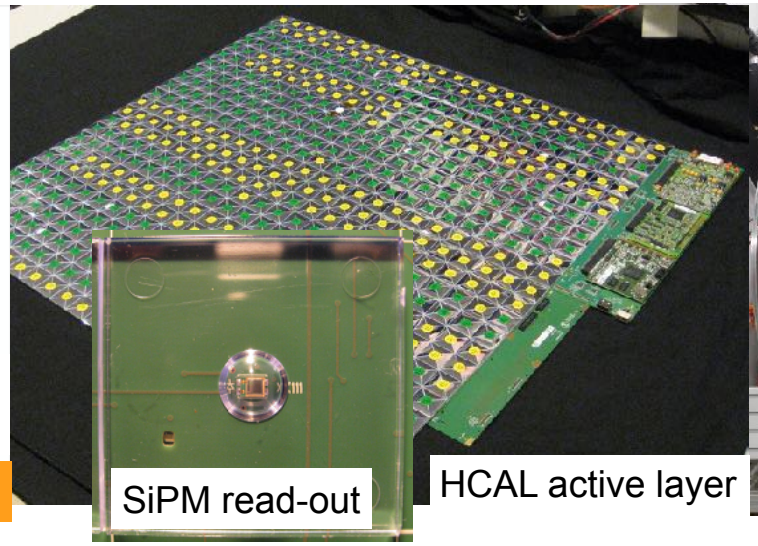
Precision experiments for precision physics.

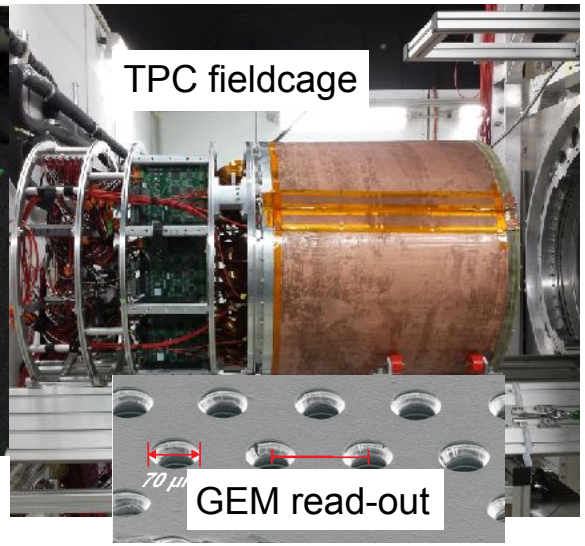




Software compensation and particle flow

Eur. Phys. J. C77 (2017) 698





DESY leads world-wide LC detector effort

- Physics analysis and software, coordination (ILD Spokes, SiD Co-spokes: DESY)
- Detector overall integration and interface with machine
- All linear collider (ILC, CLIC) detector concepts based on **particle flow**
  - Ultra-light tracking systems, Highly granular calorimeters, software algorithms

Leading detector R&D: Hadron Calorimeter and Time Projection Chamber

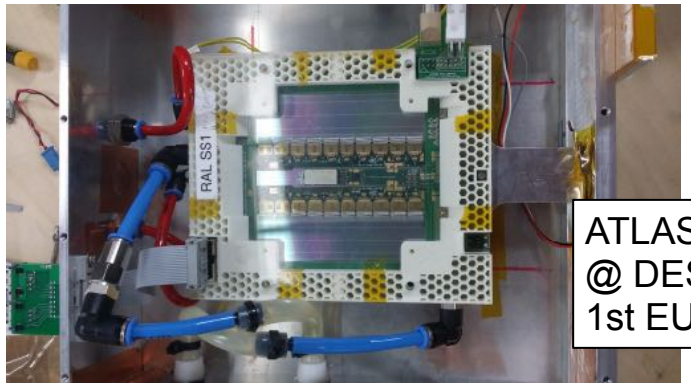
- Realistic prototypes built – POF-III goals achieved

T.Behnke

M.Stanitzki

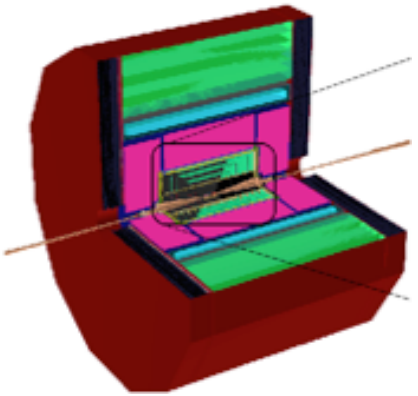
Preparing Future Experiments

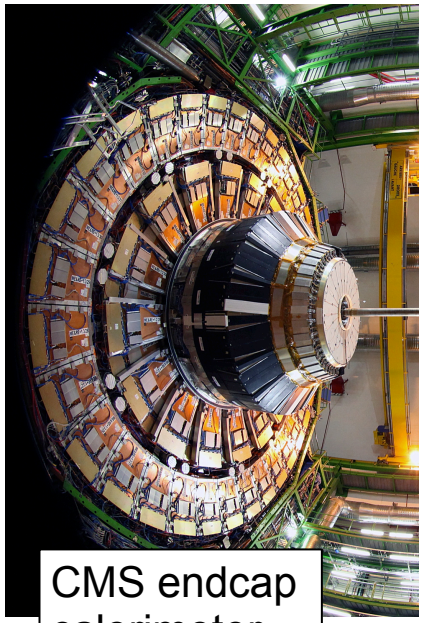
Detector R&D and software frameworks.



ATLAS ITK module @ DESY test beam: 1st EUDAQ2 user

DD4HEP Geometry kit Here: CLICdet





CMS endcap calorimeter

K.Krüger

ILC-motivated detector activities serve a wide range of future projects

- HL-LHC upgrades and future collider projects
- Supported by EC funded initiative AIDA-2020; scientific coordination: DESY
- Examples:
  - Test beam support and instrumentation using LC technologies
    - MAPS pixel telescope, precision Si strip telescope
  - Common test beam DAQ system EUDAQ
  - Software frameworks for ILC, CLIC, FCC

Application of LC technologies for HL-LHC upgrade

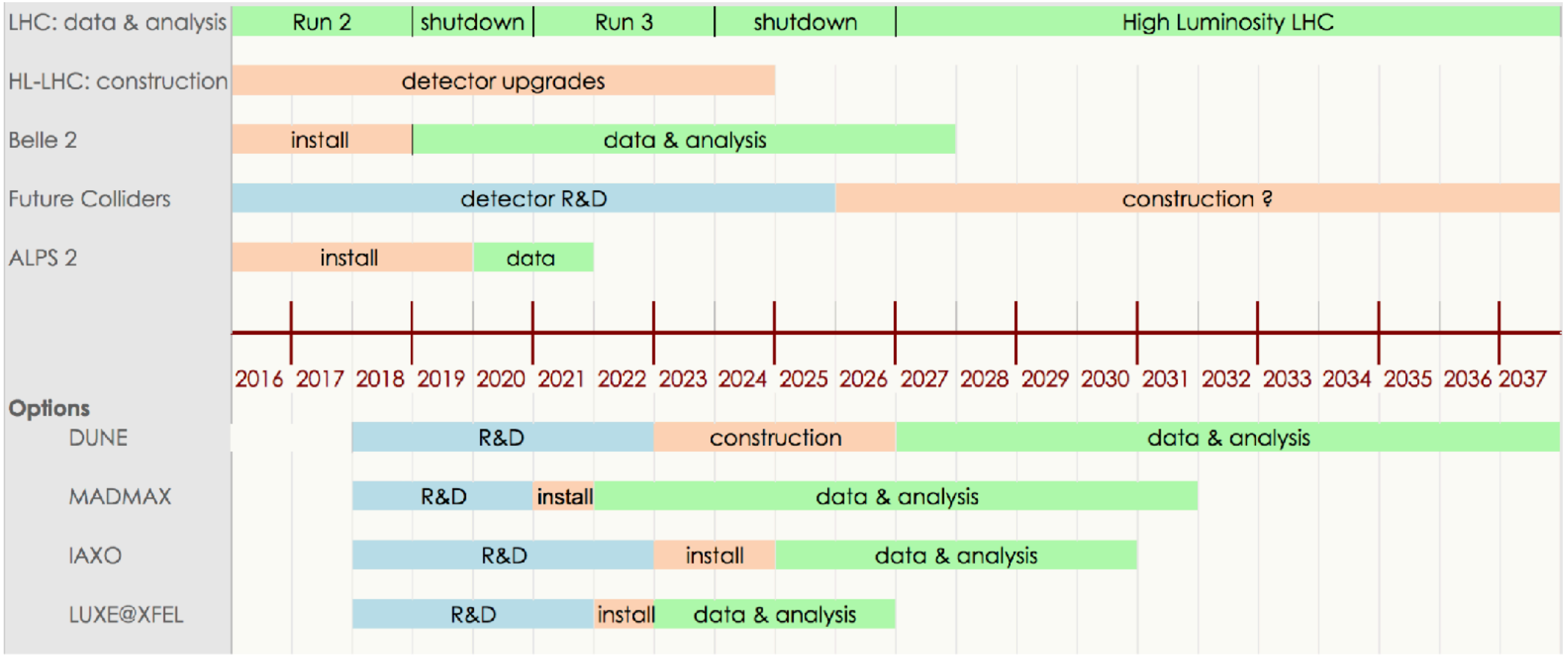
- Example: SiPM-on-tile technology for CMS HGCAL endcap calorimeter

AIDA 2020

F.S.

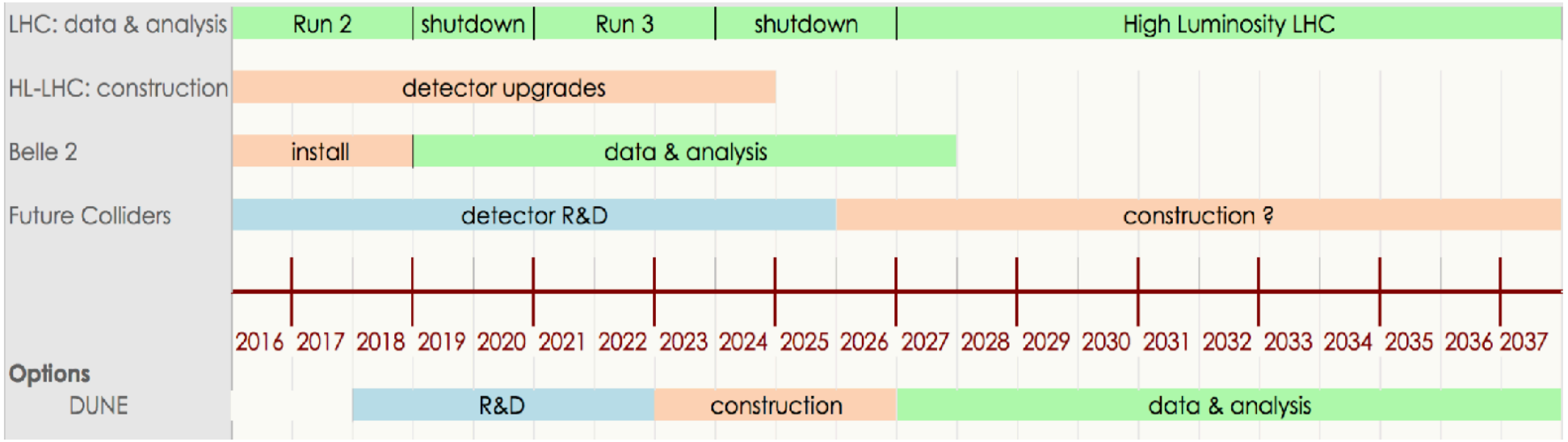
Future Accelerator Projects

Overview.



Future Accelerator Projects

Overview.



Particle physics has many options for the future

- European Strategy update 2019 will guide the way
- CLIC: linear e^+e^- collider at CERN with E_{CM} from 380 GeV to 3 TeV
  - Existing cooperation in software and SiPM-on-tile HCAL
- CEPC: circular linear e^+e^- collider in China with E_{CM} from 90 to 250 GeV
  - Existing cooperation in software, interest in TPC and SiPM-on-tile HCAL
- FCC: circular collider (100 km) at CERN, ee E_{CM} = 90 – 350 GeV, pp E_{CM} = 100 TeV (later)
  - Existing cooperation in physics and software

All except FCC-hh could start construction in the next decade

C.Grojean

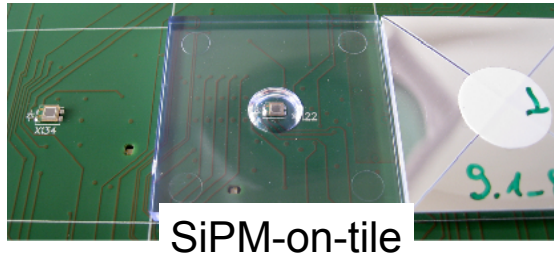
Expand in Quantum Universe framework with UHH: Future Collider Platform

Opportunities at Future Accelerators

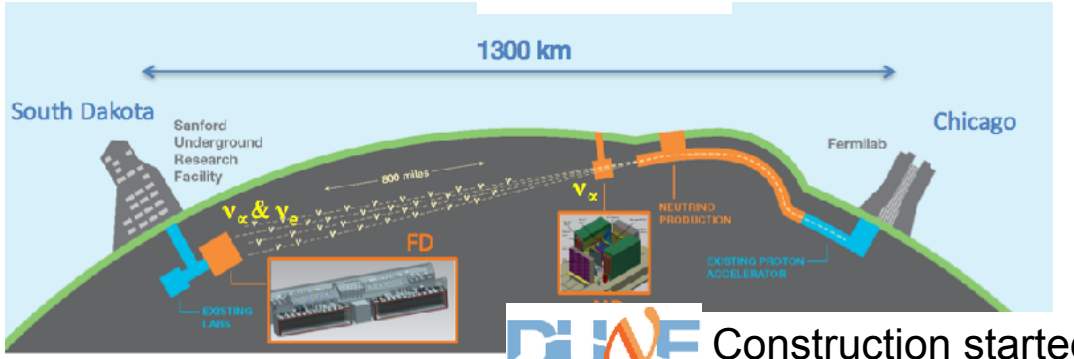
Application of DESY competences and technologies.

Example: possible applications of highly granular calorimeters

- CMS end-cap calorimeter upgrade: on-going (R&D)
  - strong interest in CMS to use DESY SiPM-on-tile technology
- DUNE @ LBNF: long baseline neutrino experiment at FNAL
  - Highly granular ECAL in Near Detector needed
  - strong interest in German community (universities & MPG)
- Calorimetry at Future Colliders
  - FCC-ee: high granularity for particle flow precision
  - FCC-hh high granularity pile-up rejection



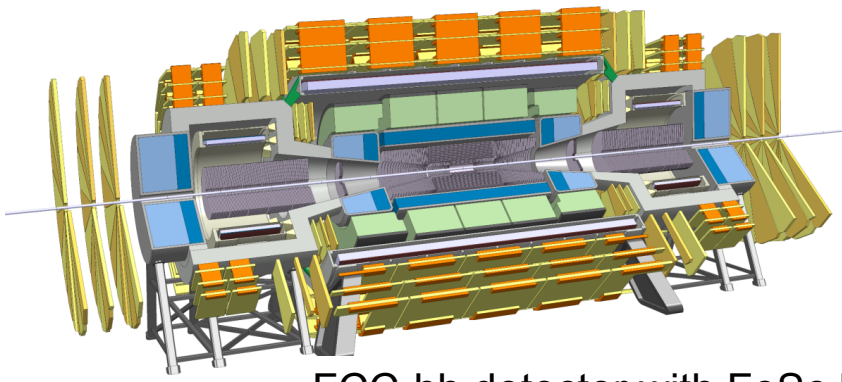
SiPM-on-tile



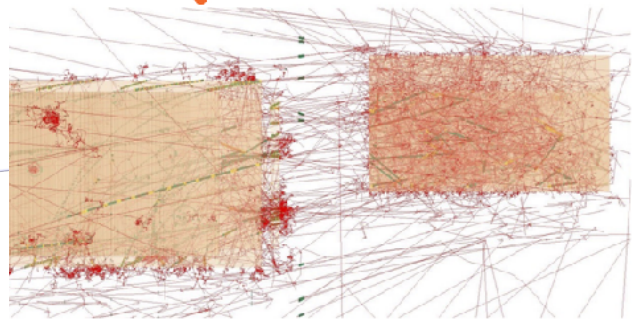
Construction started

Similar for other detector technologies, e.g. silicon tracking

Central role of DESY for coherent German contributions to LHC and BELLE detector upgrades as a model



FCC-hh detector with FeSc HCAL



Pile-up in DUNE Near Detector

Summary

ILC and Future Accelerators

The ILC - based on DESY's super-conducting RF technology - is ready to be built and offers excellent precision physics and discovery potential beyond HL-LHC already at its initial 250 GeV stage.

DESY is leading the world-wide ILC physics and detector effort with conceptual design, HCAL and TPC technologies, software and management.

DESY's life-cycle early-stage competences already now bear fruit in a wide range of on-going R&D and future accelerator studies; focus will be discussed in line with the European Strategy for Particle Physics update, to which we actively contribute.