ECFA linear collider physics and detector study
(status report 2015)

LINEAR COLLIDER COLLABORATION

Juan A. Fuster Verdú, IFIC-Valencia

Plenary ECFA Meeting, CERN November 19-20 2015

Thanks for providing material and discussions to:

T. Behnke, I. Bosovic-Jeliasavcic, Ph. Burrows, J. Cvach, G. Eigen, S. Komamiya, M. Idzik, F. Le Diberder, T. Lesiak, A. Levy, L. Linssen, G. Moorgat-Pick, M. Stanitzki, J. Timmermans, V. Telnov, A. White, H. Yamamoto

LINEAR COLLIDER COLLABORATION

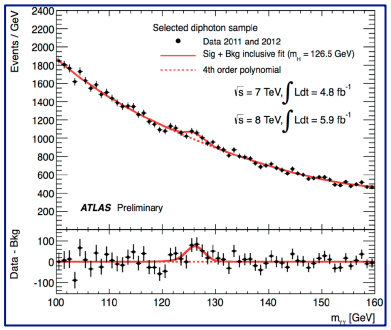
Outline

- The LCC structure, (end-extension of mandate)
- Situation of ILC in Japan
- ILC/CLIC accelerator highlights
- Activities 2015: Physics and detector R&D
    - Physics (see talk by Ch. Grojean)
    - ILC/CLIC detector activities
- Conferences 2015-2016:
- Summary
- **Back-up:** European participation in Linear Collider R&D

ILC: From Design to reality

1980 ~
- Basic Study started

2004
- SCRF Technology selected



Higgs discovered

LHC

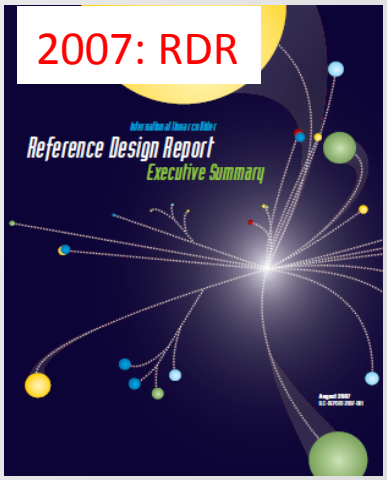
2005 2006 2007 2008 2009 2010 2011 2012 2013

ILC - GLOBAL DESIGN EFFORT (GDE)

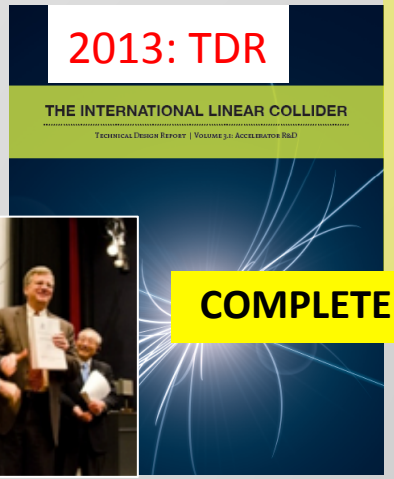
LCC

Ref. Design Report (RDR)

2007: RDR



2013: TDR



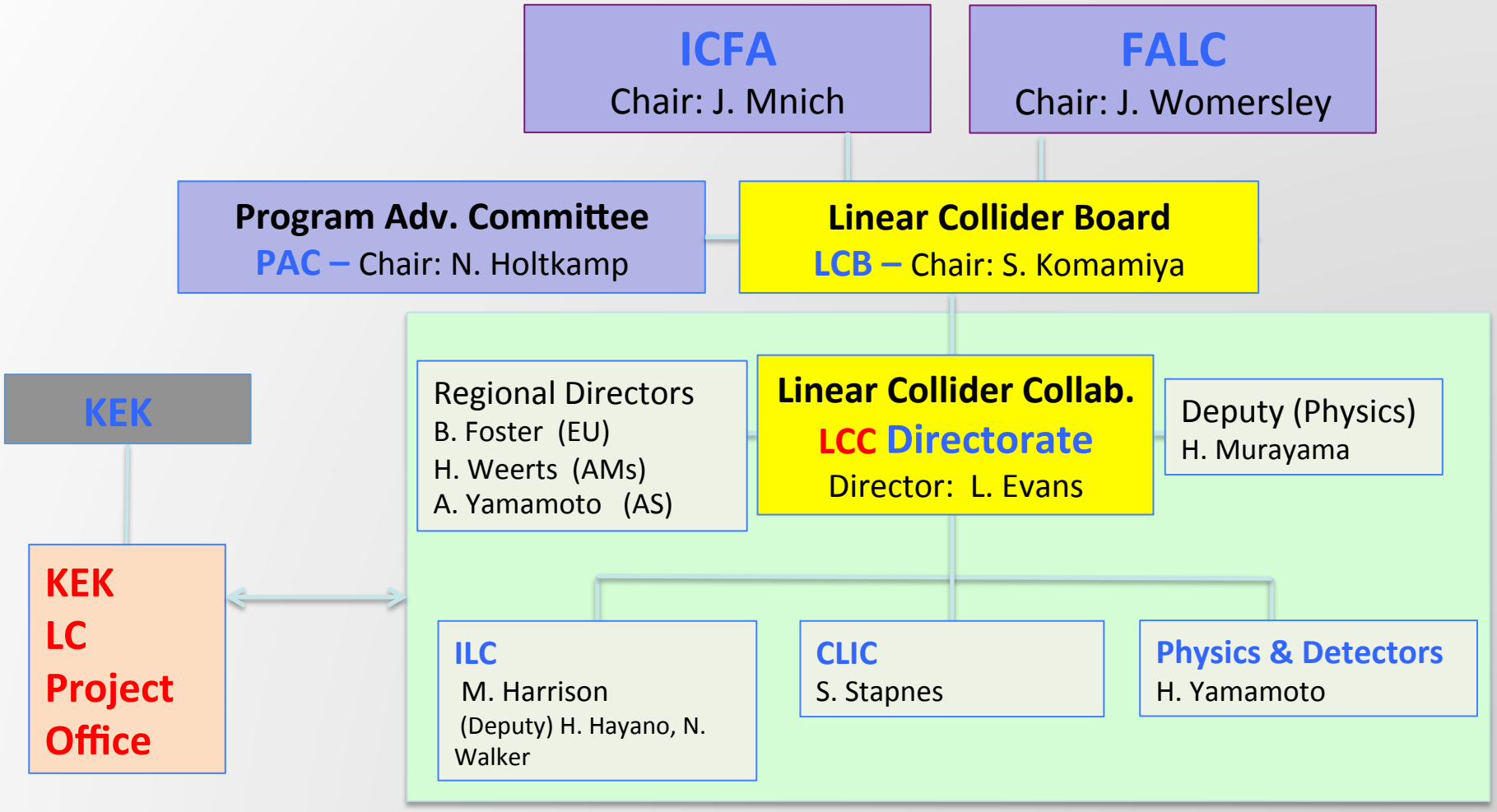
COMPLETED

Linear Collider Collaboration

A. Yamamoto - ICHEP 2014

J. Fuster

The Linear Collider Collaboration



The new Linear Collider Collaboration: LCB members

5 members x 3 regions + chair = 16 members + secretary

Chair — Sachio Komamiya (The University of Tokyo)

Americas
- Jonathan Bagger (TRIUMF)
- Nigel Lockyer (Fermilab Director)
- David MacFarlane (SLAC)
- Lia Merminga (TRIUMF)
- Hugh Montgomery (Jefferson Lab)

Asia
- Jie Gao (IHEP, Beijing)
- Rohini Godbole (Indian Institute of Science)
- Sunkee Kim (RISP)
- Atsuto Suzuki (KEK Director)
- Yifang Wang (IHEP Director)

Europe
- Rolf Heuer (CERN Director-General)
- Joachim Mnich (DESY Director of Particle Physics)
- Victor Mateev (JINR Director)
- Francois Le Diberder (IN2P3)
- Lenny Rivkin (PSI)

} Nominated by ECFA

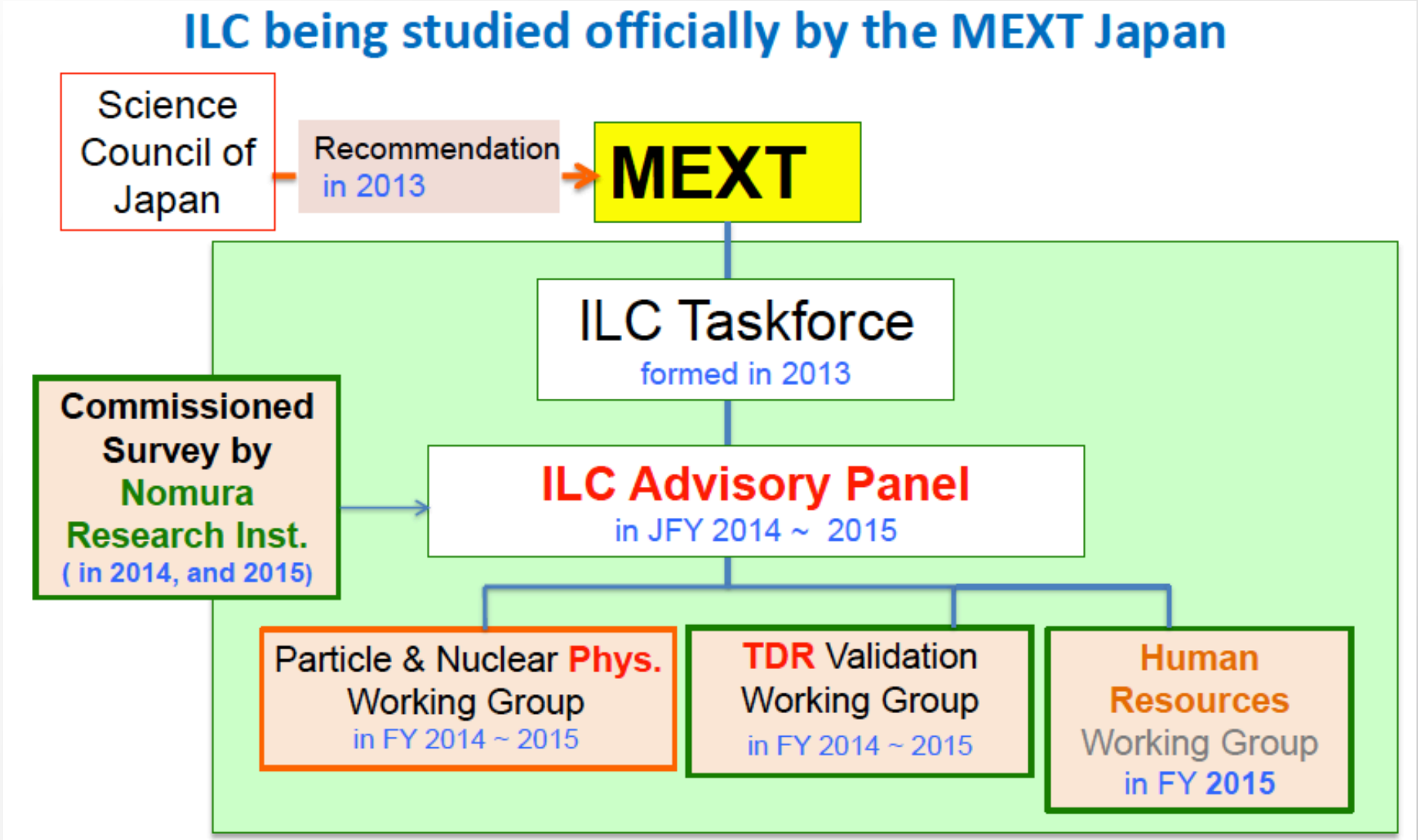
Secretary — Roy Rubinstein

Present LCC/LCB mandate and structure has been extended by ICFA to end of 2016. Common fund was also approved by FALC till 2016.

**** ECFA should position itself and think on the next step and possible organization**

Japan: MEXT and Japanese Government towards ILC

Sachio Komamiya (LCWS 2015)



Japan: MEXT and Japanese Government towards ILC

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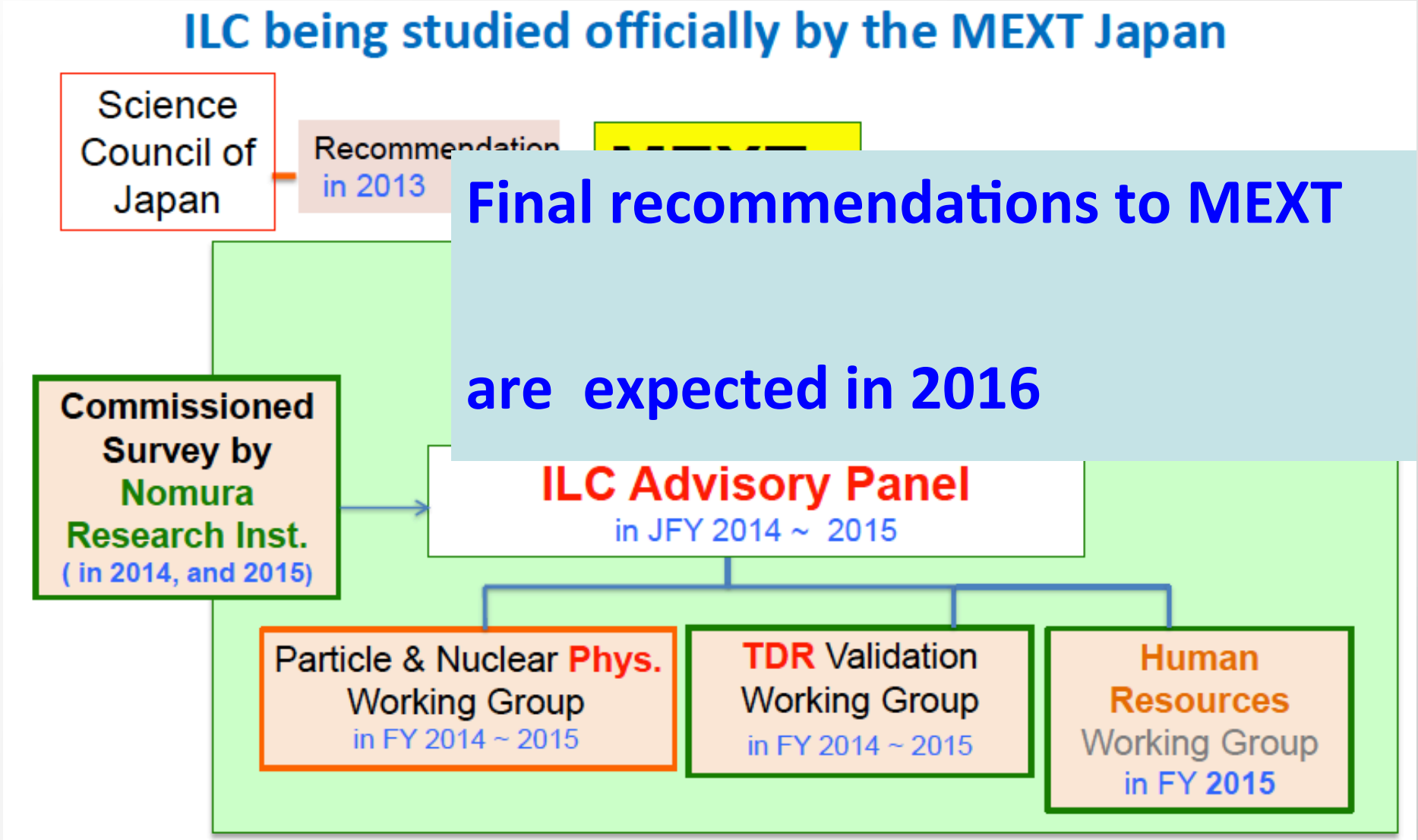

Japan: MEXT and Japanese Government towards ILC

Sachio Komamiya (LCWS 2015)

"Summary of the ILC Advisory Panel's Discussions to Date"

with English translation August 2015

As an official process of the Japanese Government towards the approval

⇒ ICFA will respond to this report

1. Discussion background …
2. Overview of discussions

(1) Science Merit of the ILC Project

The ILC is considered to be important because of its capability to investigate new physics beyond the Standard Model by exploring new particles and precisely measuring the Higgs boson and top quark. It should be also noted that the ILC might be able to discover a new particles which are difficult to be detected in LHC experiments…….

ILC experiments are able to search for new particles, different from the ones that LHC experiments have been searching for. In case these new particles are supersymmetric particles, ILC and LHC experiments can study them complementally. On the other hand ILC experiments can carry out more precise measurement of the Higgs boson and the top quark, which are beyond the reach of LHC experiments.....

…

(2) Validation of TDR

(3) International Collaboration

(4) Social effect of the ILC Project **Economic effects, Industrial Spin-off**

Japan: MEXT and Japanese Government towards ILC

Sachio Komamiya (LCWS 2015)

Recommendation 1: The ILC project requires huge investment that is so huge that a single country cannot cover, thus it is indispensable to share the cost internationally. From the viewpoint that the huge investments in new science projects must be weighed based upon the scientific merit of the project, a clear vision on the discovery potential of new particles as well as that of precision measurements of the Higgs boson and the top quark has to be shown so as to bring about novel development that goes beyond the Standard Model of the particle physics.

⇒ Discovery is not guaranteed at any frontier machines , but clear vision of discovery potential have been already demonstrated for ILC.

Recommendation 2: Since the specifications of the performance and the scientific achievements of the ILC are considered to be designed based on the results of LHC experiments, which are planned to be executed through the end of 2017, it is necessary to closely monitor, analyze and examine the development of LHC experiments. Furthermore, it is necessary to clarify how to solve technical issues and how to mitigate cost risk associated with the project.

⇒ Surely we will monitor LHC physics.

MEXT is contacting governments during the LHC 13 TeV Run.

Recent "ILC Progress Report" by LCC answers most of the technical items.

Recommendation 3: While presenting the total project plan, including not only the plan for the accelerator and related facilities but also the plan for other infrastructure as well as efforts pointed out in Recommendations 1 & 2, it is important to have general understanding on the project by the public and science communities.

⇒ Public relation will be reinforced by international team and by KEK and the Industry Supporters (AAA).

Discussions with scientists of the other fields have been undertaken by KEK DG.

ICFA/LCB are preparing a document to clarify the issues in the report of the ILC Advisory Panel by the end of this year.

Japan: MEXT and Japanese Government towards ILC

Sachio Komamiya (LCWS 2015)

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⇒ Discovery i

potential h

Recommenda
achievements
experiments, w
closely monitor
is necessary to
with the projec

This recommendations have enabled MEXT to start negotiations with other countries

⇒ Surely we will monitor LHC physics.

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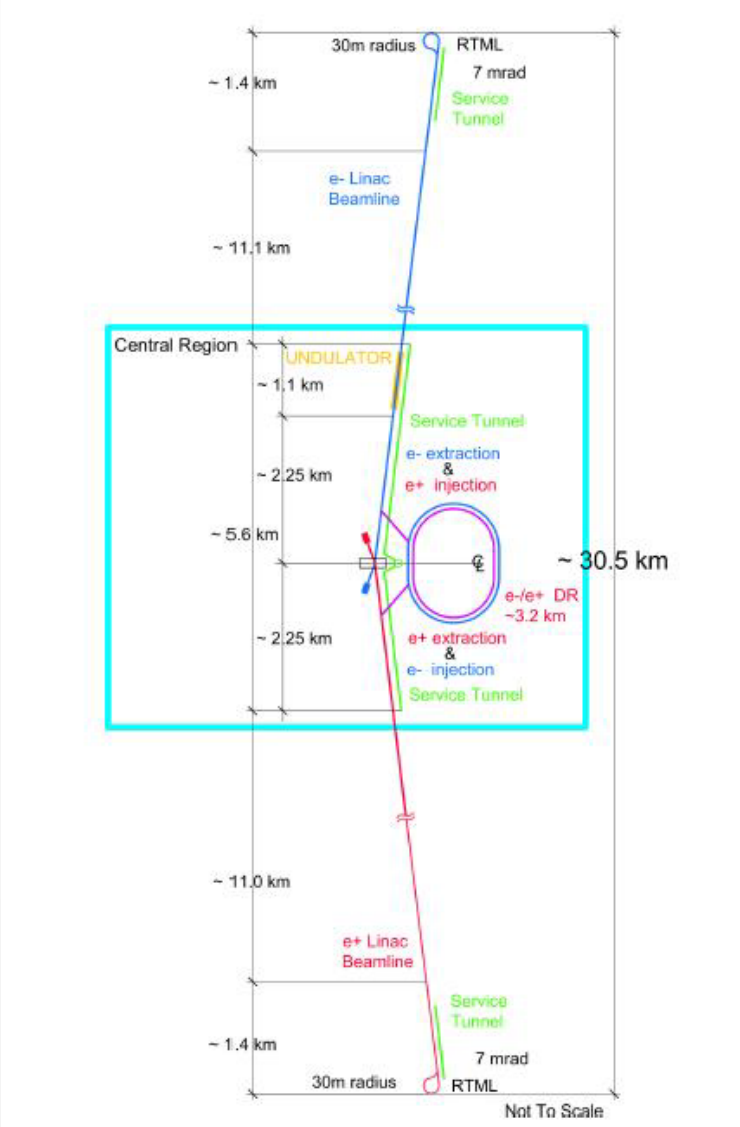


- Main advantages (linear colliders):
  - No energy loss due to synchrotron radiation ($\Delta E \sim (E/m)^4 R^{-1}$)
  - Extendibility (Length ~ Energy)
  - Polarization
  - Energy scanning

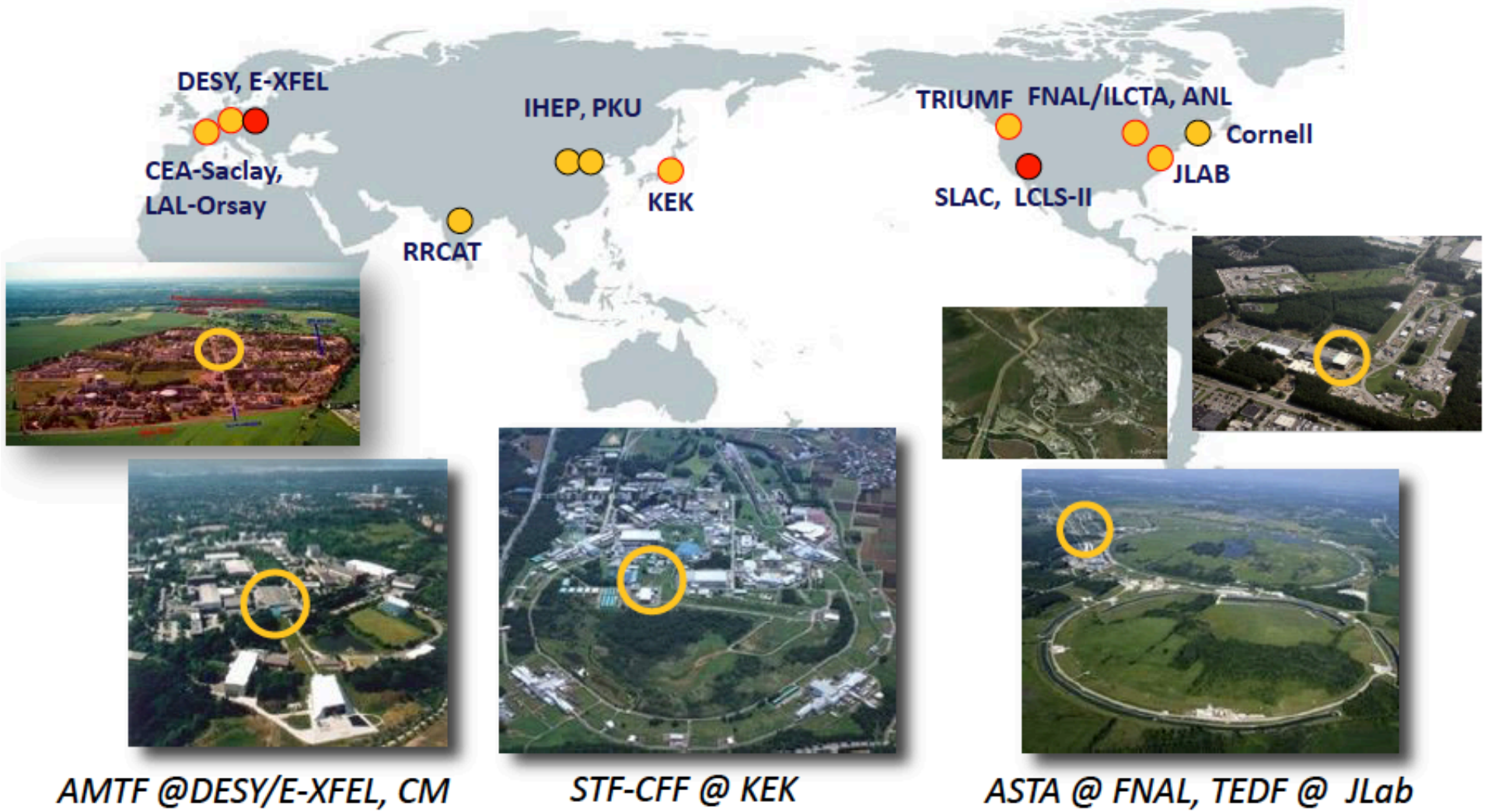
Demonstrated in TDR

Progress in 2014-2015

Parameters	Value
C.M. Energy	500 GeV
Peak luminosity	1.8×10^{34} cm^{-2}s^{-1}
Beam Rep. rate	5 Hz
Pulse duration	0.73 ms
Average current	5.8 mA (in pulse)
FF beam size (y)	**5.9** nm
E gradient in SCRF acc. cavity	**31.5** MV/m +/-20% Q_0 = 1E10

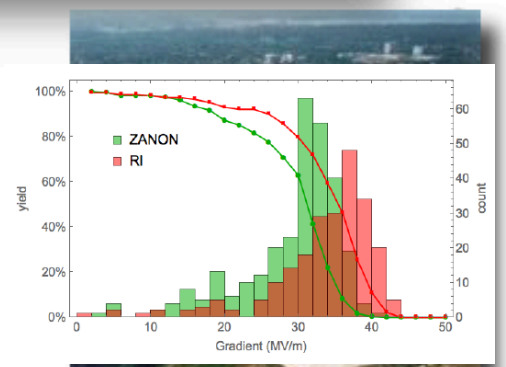
S. Komamiya - LP 2015

The ILC accelerator: SRF facilities worldwide



The ILC accelerator: SRF facilities worldwide

Technology globally matured to realize the ILC



AMTF @DESY/E-XFEL, CM

700 out of 800 cavities completed <30 MV/m>

S. Komamiya - LP 2015

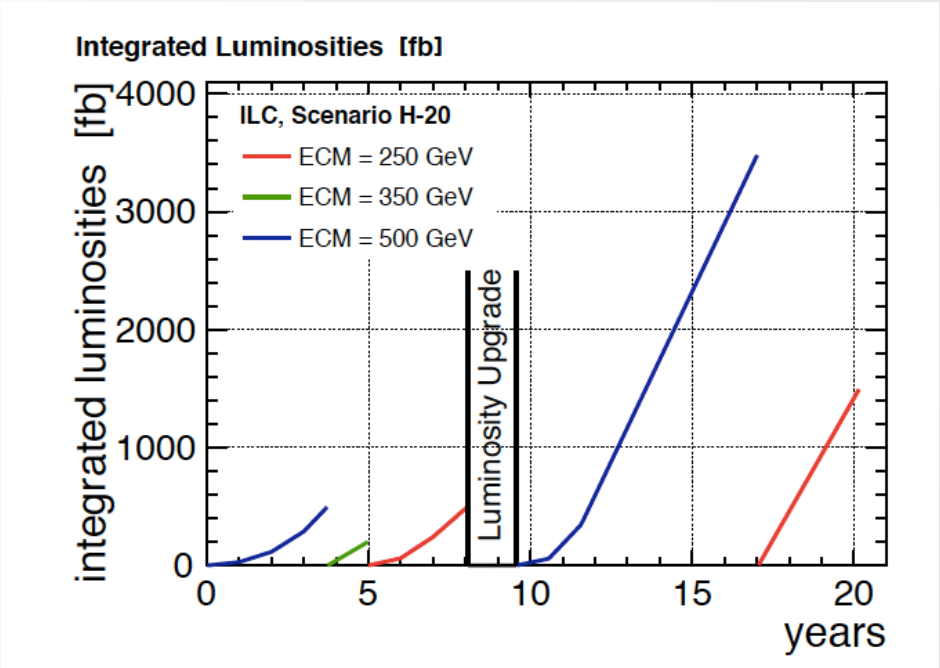
STF-CFF @ KEK

Individual cavity gradient of 35 MV/m

ASTA @ FNAL, TEDF @ JLab

Crymodule test facility at Fermilab reached <31.5 MV/m> exceeding ILC expects

	Stage	500			500 LumiUP		
Scenario	$\sqrt{s}$ [GeV]	500	350	250	500	350	250
G-20	$\int \mathcal{L} dt$ [fb^{-1}]	1000	200	500	4000	-	-
	time [years]	5.5	1.3	3.1	8.3	-	-
H-20	$\int \mathcal{L} dt$ [fb^{-1}]	500	200	500	3500	-	1500
	time [years]	3.7	1.3	3.1	7.5	-	3.1



T. Barklow et al., arXiv:1506.07830

Recommended scenario (~20 years scientific program):

- Starting at 500 GeV (500 fb^{-1}), then 350 (200 fb-1) and 250 GeV (500 fb^{-1}).
- Luminosity upgrade (1312 → 2625 bunches per pulse) then 3500 fb^{-1} at 500 GeV and 1500 fb^{-1} at 250 GeV.

Obviously, actual running scenario will depend on physics outcomes from LHC and ILC, and other factors

Phil Burrows (LCWS 2015)

Lucie Linssen (LHCP 2015)

- e^+e^- collisions √s up to 3 TeV
- Luminosity: a few 10^{34} $cm^{-2}s^{-1}$
- Physics operation 350 GeV - 3 TeV
- 2-beam acceleration scheme
- At room temperature
- Gradient 100 MV/m
- Conceptual Design Report published in 2012

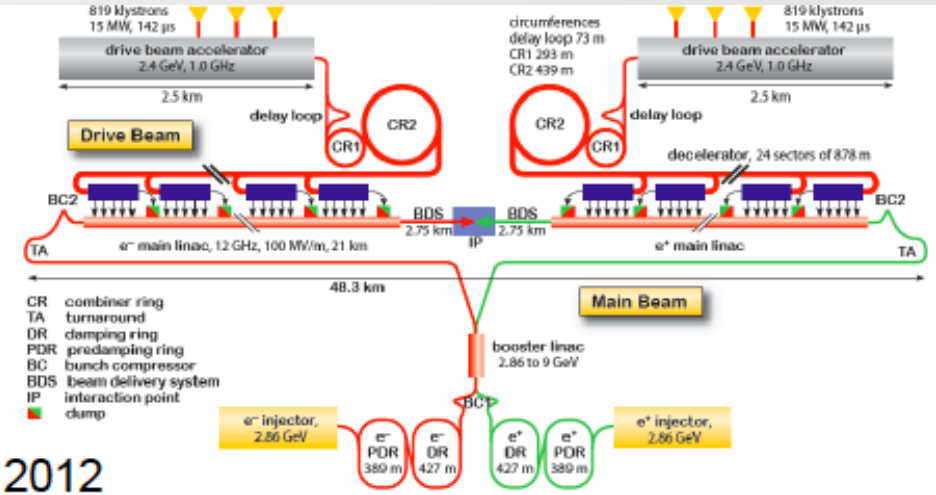
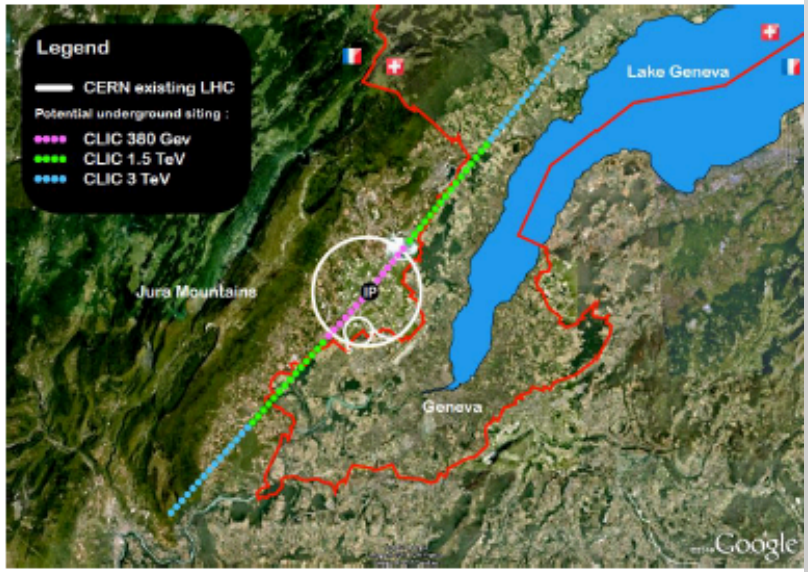


Fig. 3.1: Overview of the CLIC layout at $\sqrt{s} = 3$ TeV.

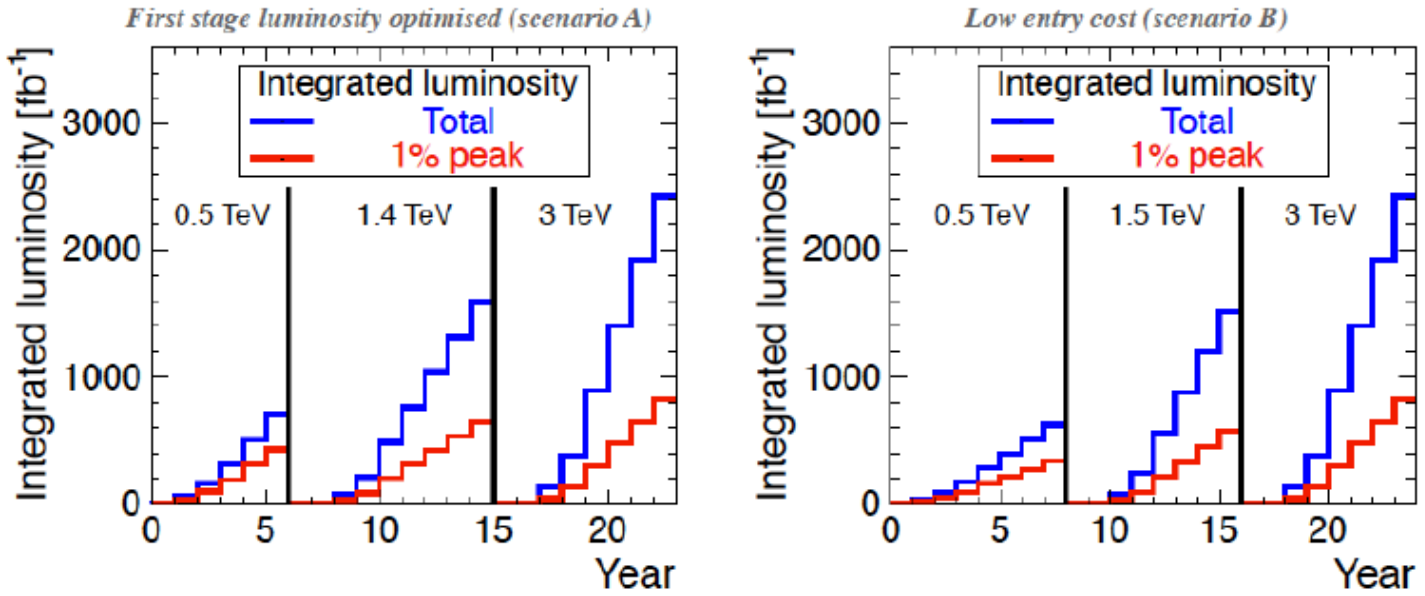
Parameter	Unit	380 GeV	3 TeV
Centre-of-mass energy	TeV	0.38	3
Total luminosity	$10^{34}cm^{-2}s^{-1}$	1.5	5.9
Luminosity above 99% of √s	$10^{34}cm^{-2}s^{-1}$	0.9	2.0
Repetition frequency	Hz	50	50
Number of bunches per train		352	312
Bunch separation	ns	0.5	0.5
Acceleration gradient	MV/m	72	100
Site length	km	11	48



Phil Burrows (LCWS 2015)

CLIC energy staging (CDR)

Energy-staging exercise started for CDR



Aidan Robson (LCWS 2015)

CLIC foreseen as a staged machine:

Stage 1: precision SM physics

Higgs and top

Energies of subsequent stages motivated by physics

– unique for high-precision

-> considered optimum energy for first stage

HZ production

⇨ $\sqrt{s} \sim 250$–450 GeV

Top at threshold

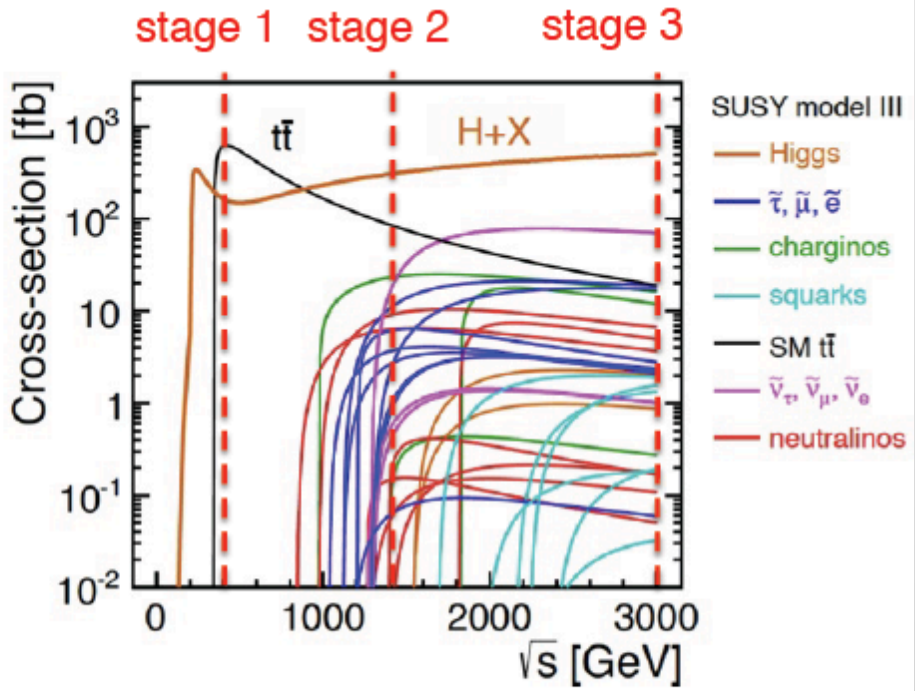
⇨ $\sqrt{s} > 350$ GeV

Top pair production

⇨ $\sqrt{s} > 360$ GeV

Recoil mass (HZ, Z->qq)

⇨ $\sqrt{s} < 400$ GeV

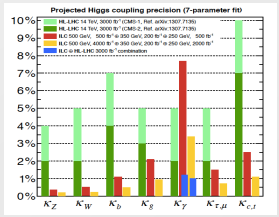


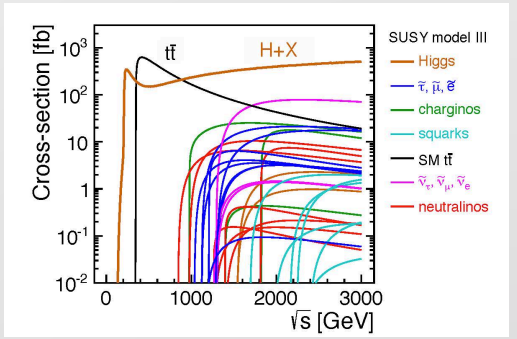
- $\sqrt{s} \sim 380$ GeV

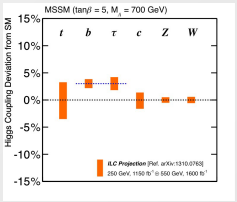
for first stage is good for both HZ and top physics programme – chosen as new baseline

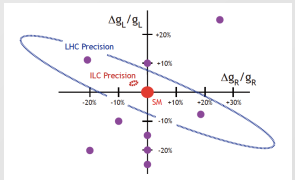
ILC and CLIC physics potential (see talk by Ch. Grojean)

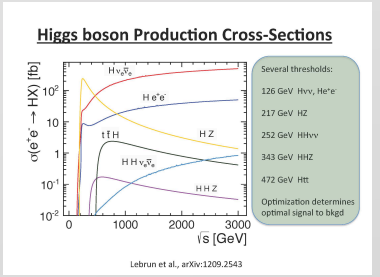
- **Physics case for the Linear Collider:**
  - Higgs physics (SM and non-SM)
  - Top
  - SUSY
  - Dark matter
  - Higgs strong interactions
  - New Z' sector
  - Contact interactions
  - Extra dimensions
  - ....
- **ILC and CLIC physics case is very similar,**
  (energy range, technical readiness are the issue)

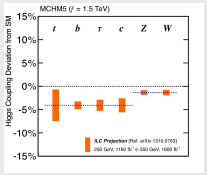


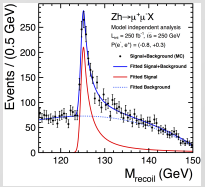


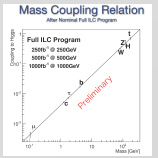


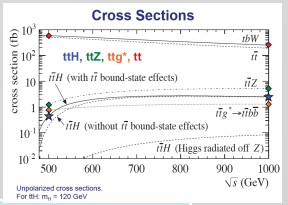










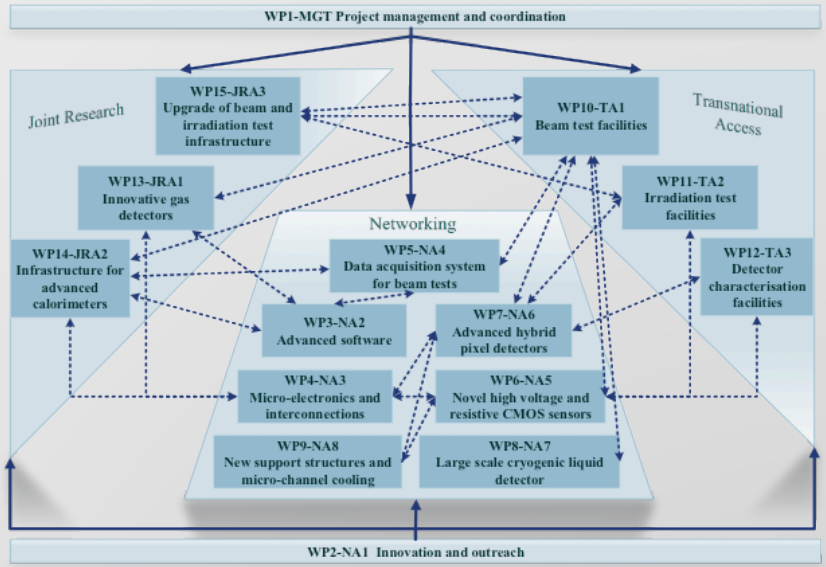


J. Brau et al.	The Physics Case for an e+e- Linear Collider, arXiv:1210.0202
K. Fujii et al.	Physics Case for the International Linear Collider, arXiv:1506.05992
L. Linssen et al **P. Lebrun et al**	CLIC CDR, arXiv:1202.5940,1209.2543
H. Baer et al.	ILC Technical Design Report, Volume 2, Physics at the International Linear Collider, , arXiv:1306.6352

LC detector R&D: AIDA-H2020

The AIDA-2020 proposal was approved (L. Serin)

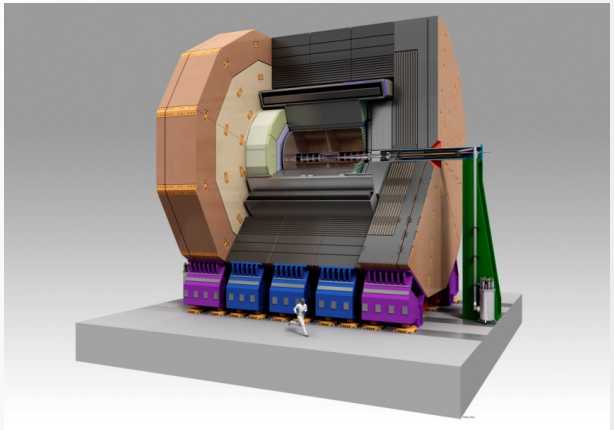
Key R&D issues	WPs related to activity
HL-LHC	
Radiation hard detectors : - New pixel and tracker detector - Forward Calorimeter - Micro-Electronics Beam and irradiation prototypes testing, Industrialisation process, Software simulation and reconstruction	WP 2, 3, 4, 6, 7, 9, 10, 11, 12, 13, 14, 15
ILC	
Low mass pixel and track detectors, High granularity calorimeters, Low power electronics, Industrialisation, Combined system performance, Software simulation and reconstruction	WP 2, 3, 4, 5, 6, 7, 9, 10, 12, 13, 14, 15
CLIC (Compact Linear Collider)	
As for ILC, plus the need for nano-second time stamping in all systems	WP 2, 3, 4, 6, 7, 9, 10, 11, 12, 13, 14, 15
Long-baseline neutrinos	
Large-scale cryogenic detectors, electronics Beam test	WP 2, 3, 8, 10
FCC (Future Circular Collider)	
See HL-LHC	WP 2, 3

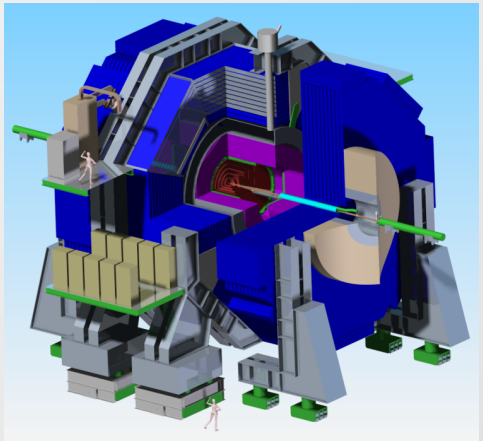


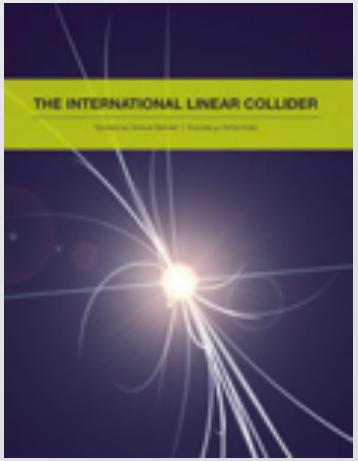
- About 25% include Linear Collider R&D related activities. Extremely helpful to the LC European community

- An application to the EU-RISE program, called RANDALF, was submitted in 2015 but was not selected. It included exchange of researchers between Europe, Japan and USA. The possibility for a new proposal is being discussed and if agreed a new version of RANDALF will be submitted next year 2016.

ILC Detectors: SiD & ILD







Major accomplishment was achieved to produce the Detailed Baseline Design report of the detectors for the ILC-TDR

Successful cooperation between ILC and CLIC

http://www.linearcollider.org/ILC/Publications/Technical-Design-Report

ILC Detectors: SiD & ILD

Compact, pure Silicon based tracking, large B-field

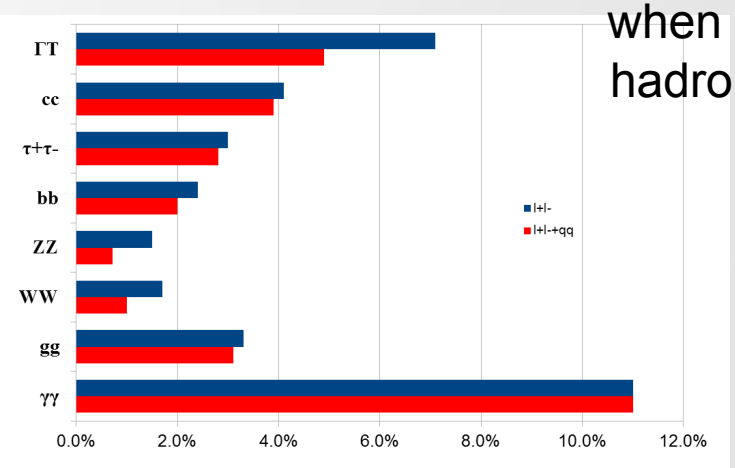
Two Detector Concepts for the ILC: SiD and ILD

All driven by Particle Flow paradigm

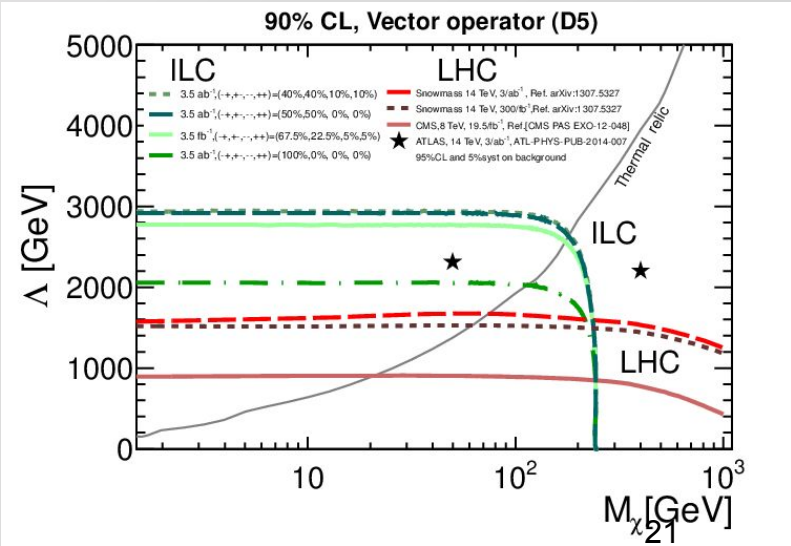
Large, gaseous & Si tracking, moderate B-field

- Consolidation of the detector designs (re-optimization)
- Intense studies of the physics reach

Potential improvement on Higgs couplings when including hadronic recoil



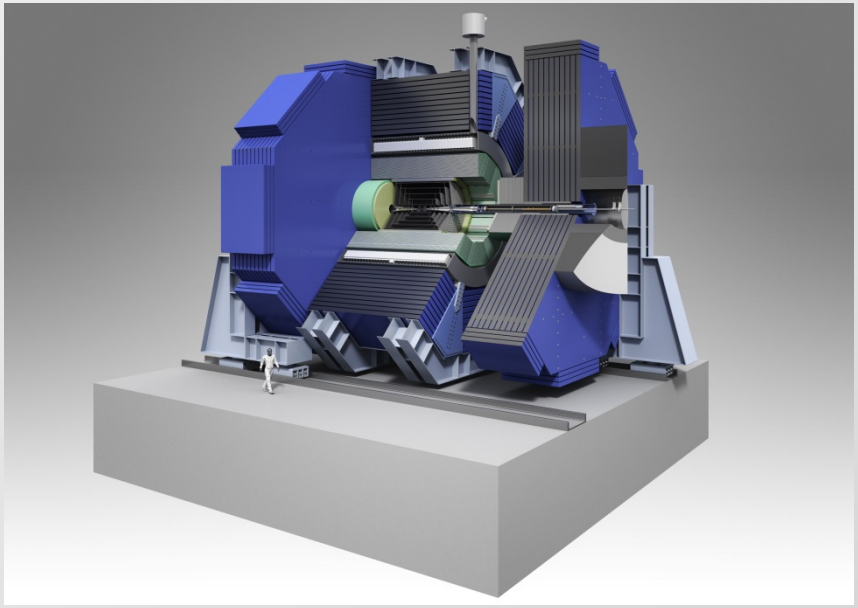
WIMP reach at ILC and LHC

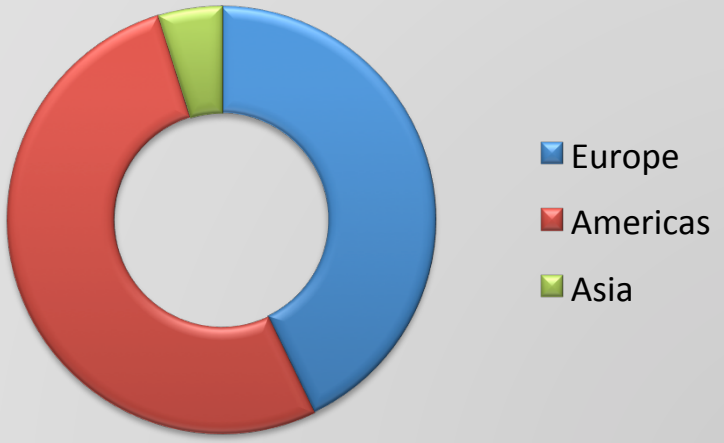


SiD detector concept

SiD Consortium

- Has been established, byelaws in place
- Spokespersons:
  Marcel Stanitzki
  Andy White
- Institute Board chair:
  Philip Burrows
- 22 Groups have signed on
- www.silicondetector.org





SiD detector concept

SiD is moving ahead towards TDR

- Organization is in place
- Clear plan what “needs to be done” for a TDR

Severe lack of funding is slowing down progress

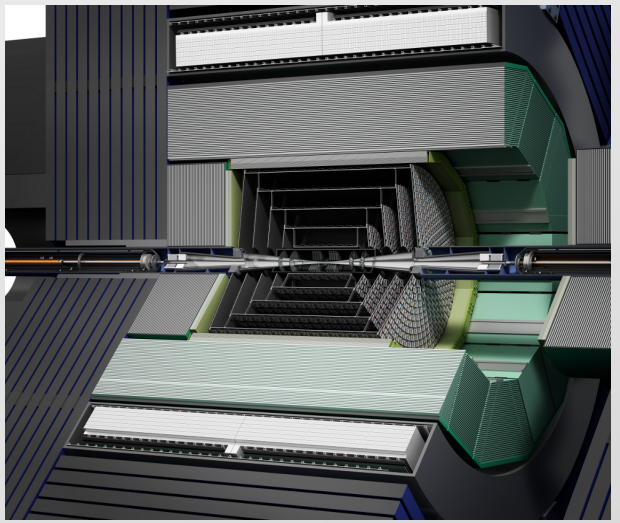
Consortium is growing

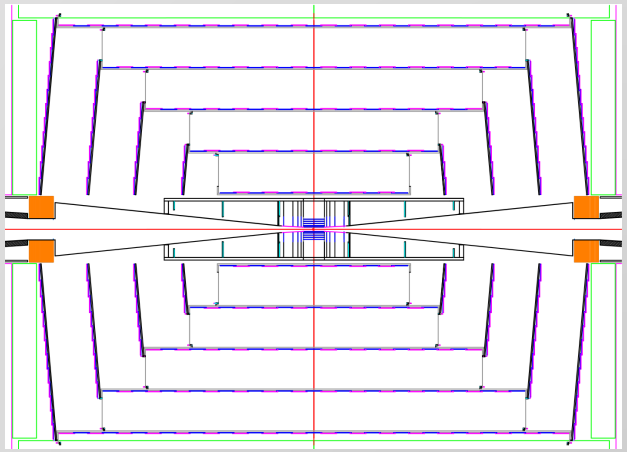
Successful Workshops at SLAC, KEK and Whistler,BC

SiD remains committed to deliver a detector for the ILC

Latest Developments

- HCAL Task Force
  - ➢ Clear recommendation for changing the HCAL technology baseline
  - ➢ Currently under Consortium review
- SiD Software
  - ➢ SiD has decided to adopt the DD4HEP suite developed by CERN
- Optimizing SiD
  - ➢ Actively reviewing all sub-detector choices





ILD detector concept

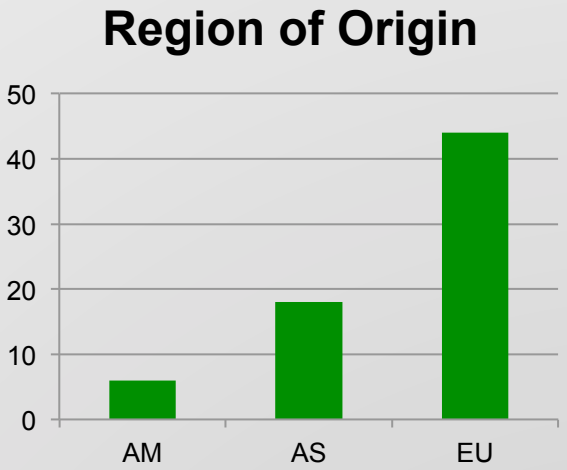
ILD Detector

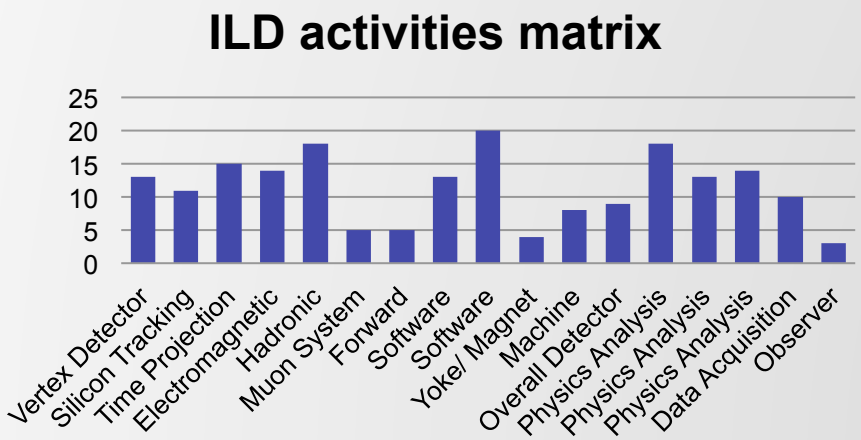
- Spokesperson: Ties Behnke
- Deputy spokesperson: Kiyotomo Kawagoe

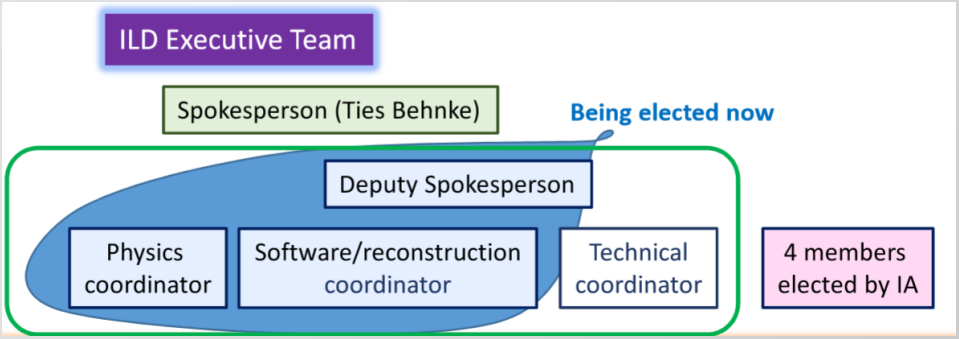
- Institute Assembly chair: Jan Timmermans
- Deputy chair: Tohru Takeshita

- 68 Groups have signed on

- http://www.ilcild.org/







ILD detector concept

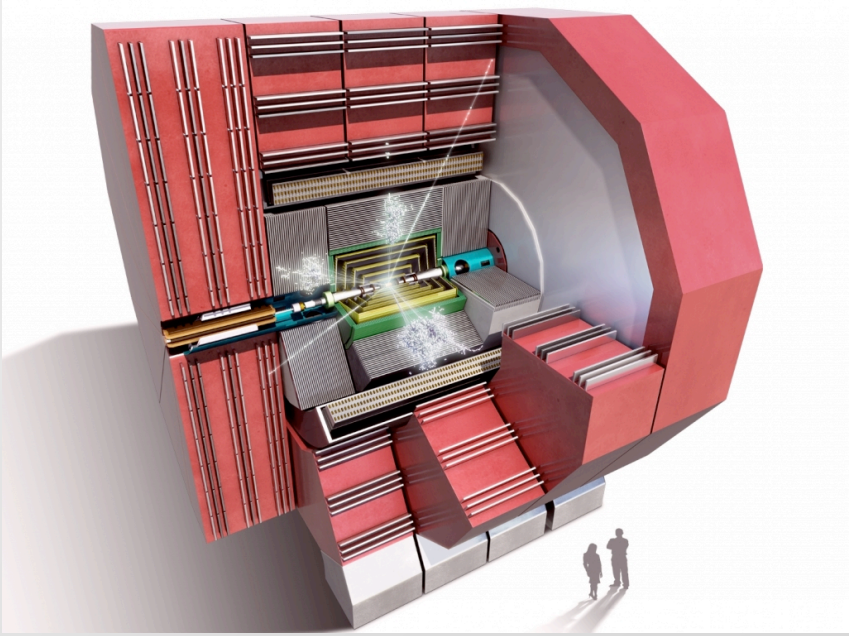
Goals and Strategies:

- Make the scientific case for the ILC
  - Move forward as one community
  - Join forces with SiD
  - Integrate theory and experiment
  - Interact with the Japanese review process
- Adapt the ILD design for the Japanese site
- Re-optimize the detector (cost – performance optimization)
  - ➢ Careful study needed of cost vs. performance
  - ➢ Strong focus on making the connection between the detector design and the physics performance explicit.
- ILD continues to be carried by a strong community
- Support however for work on ILD is marginal at best
- To make real progress significantly larger resources are needed

CLICdp

CLIC detector and physics (CLICdp)
Light-weight collaborative structure
based on "best effort", with CERN as host lab
~130 members from 23 institutions

http://clicdp.web.cern.ch/



Many activities in common with ILC
(in particular hardware R&D, software developments, physics studies)

CLIC-specific activities:
- Detector optimisation for CLIC
- Detector R&D where CLIC sets special requirements
- CLIC physics studies, staged approach

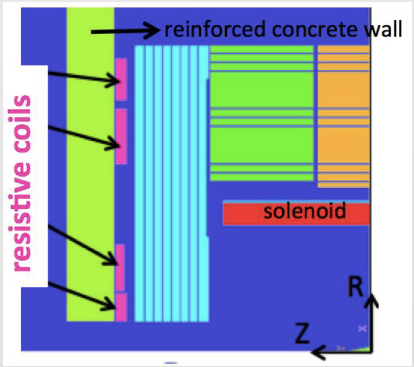
CLIC new detector concept

Re-optimising the detector concept for CLIC (from studies of CLIC_ILD & CLIC_SiD performance and optimization):

- Reducing occupancies
- Extending coverage in forward region

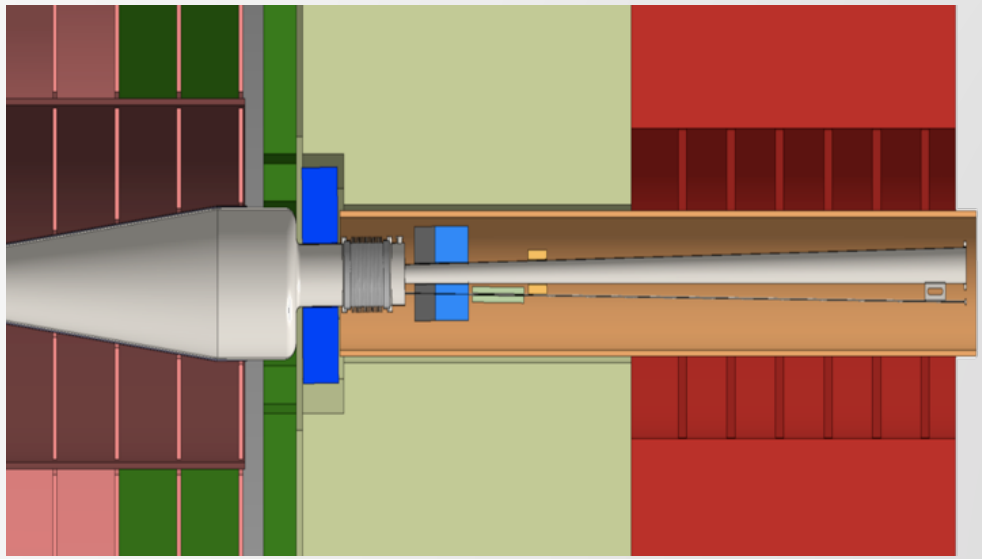
Main actions:

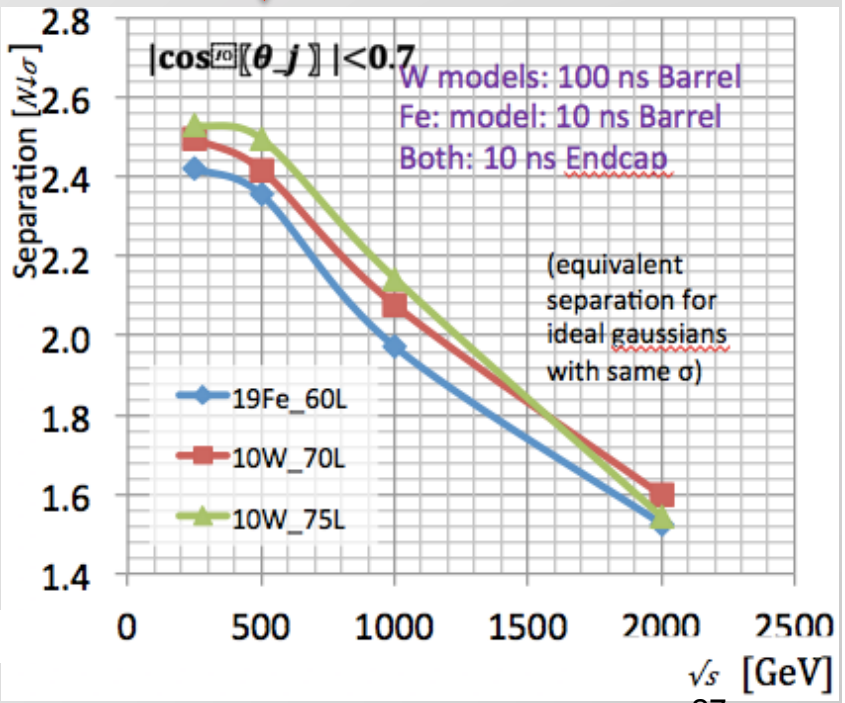
- Move QD0 to L*=6m outside detector yoke
- Number of muon layers reduced from 9 to 6
- Extend HCAL closer to beampipe



W ⇔ Z separation for different HCAL absorbers

New detector model to be used in future studies

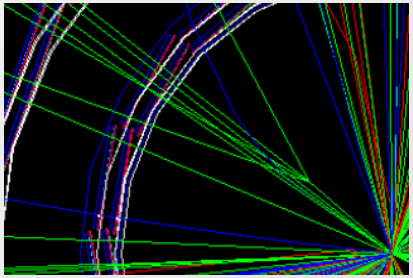


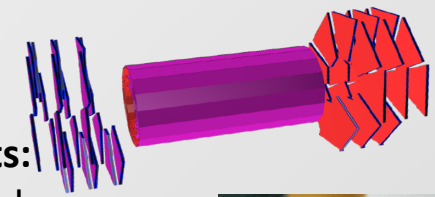


CLIC vertex R&D

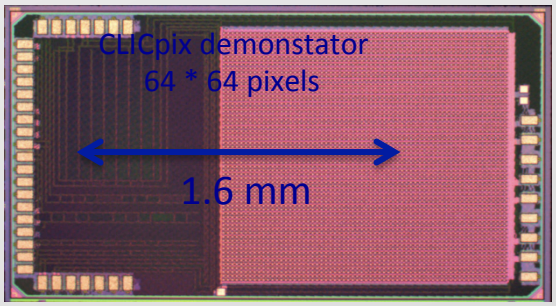
CLIC sets challenging requirements:

- Very small pixels (25×25 μm^2)
- Pulseheight measurement
- Timing ~10 ns
- Ultra-light, <0.2% X_0 per layer
- Power pulsing, air cooling





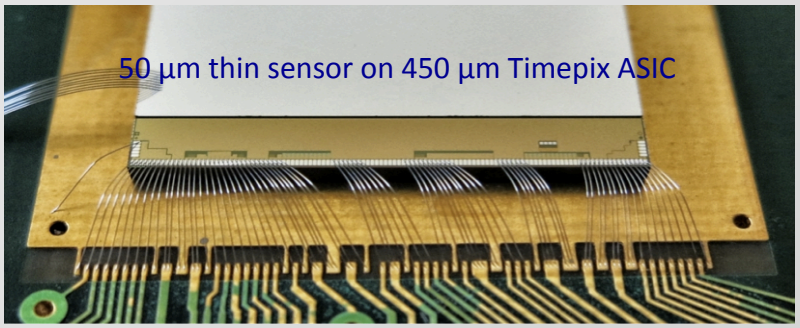
Readout ASIC (65 nm)



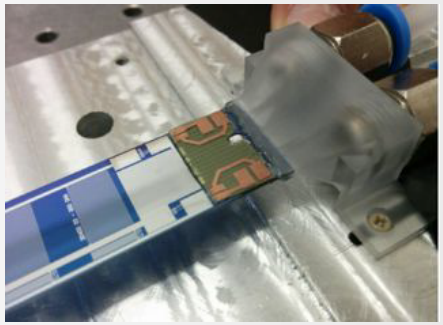
Integrated R&D efforts, recent developments:

- First test-beam & lab measurement with planar CLICpix assembly
- Systematic studies of capacitively-coupled HV-CMOS assemblies
- Simulation of HV-CMOS sensors

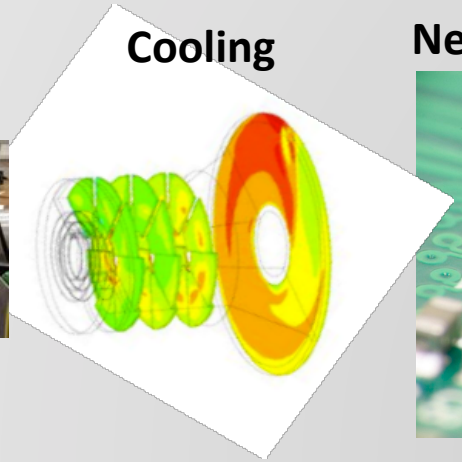
Very thin sensors



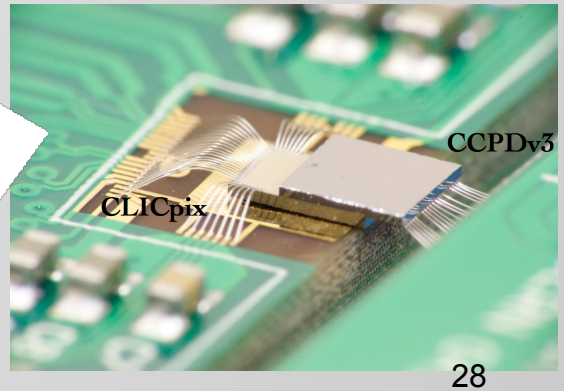
Engineering, integration and assembly



Cooling



New HV-CMOS technologies



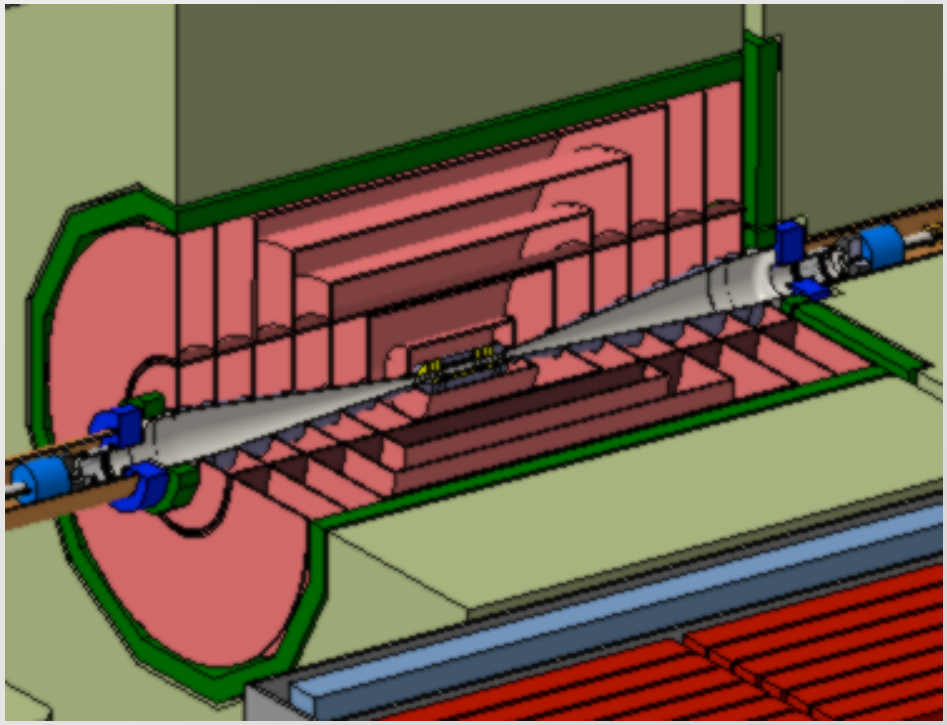
CLIC Tracker

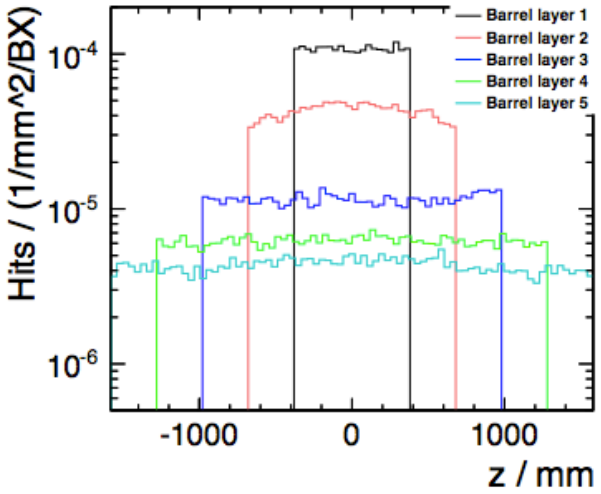
CDR studied two ILD and SiD options :

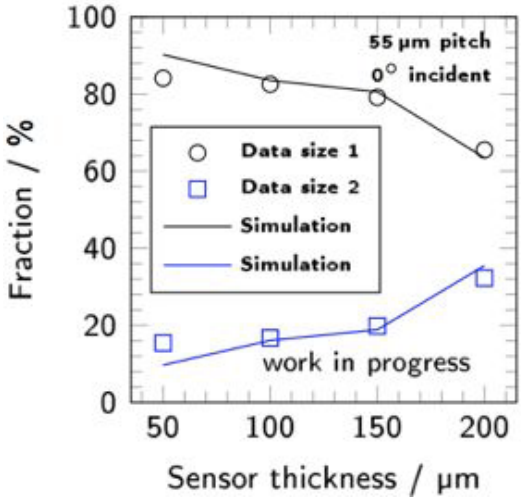
- At 3 TeV TPC had 30% occupancy
- Develop a full silicon tracker approach
- Systematic optimization of geometries

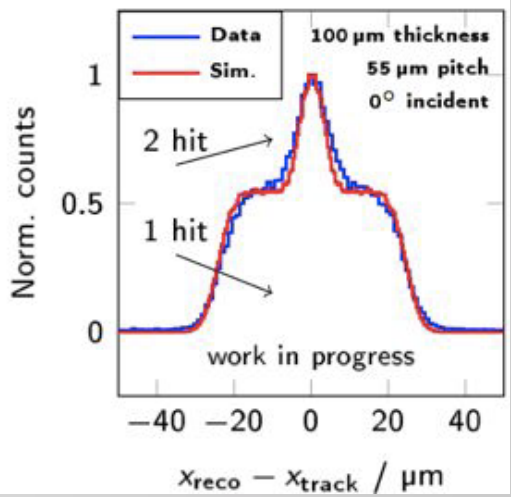
Requirements:

- 7 μm single-point resolution
- 1-2% X_0









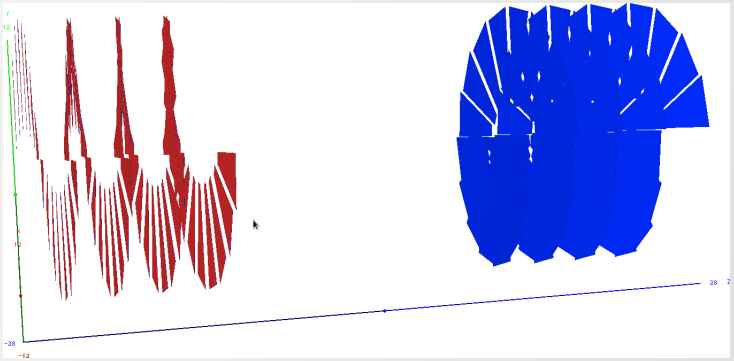
CLIC software development

Development of LC software chain for detector optimisation, physics simulations, hardware R&D

=> Common to all Linear Collider detector concepts

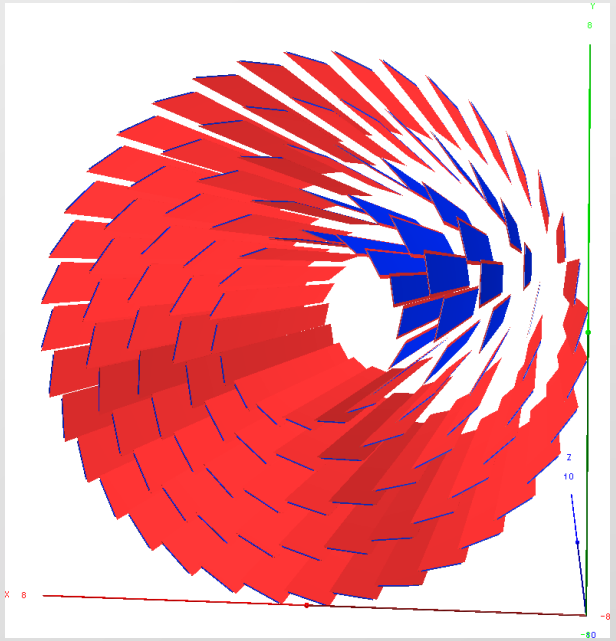
Current work focus:

- a new **geometry package (DD4hep) implemented**:
  - single source of detector information for simulation, reconstruction, visualisation
- extended **ILD vertex tracking reconstruction software**

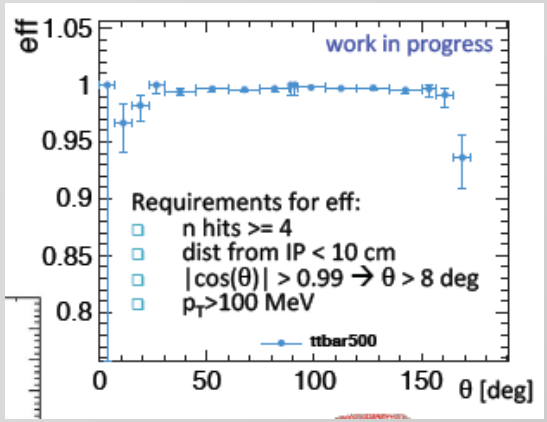


Broad scope of application:

- *Linear Collider*
- *Synergies with FCC software development*
- *Development in framework AIDA2020*



DD4hep visualisation



European participation in LC R&D

Outlook (non-homogenous) to LC landscape by countries/labs:

- Czech Republic
- CERN
- France (IN2P3/CNRS and IRFU/CEA)
- Germany
- Holland
- Israel
- Norway
- Poland
- Serbia
- Spain
- United Kingdom

See back-up slides for detailed participation of each country

Apologies for rest of countries having LC activities and not being mentioned. Please send me information if that is the case.

LC workshops 2015

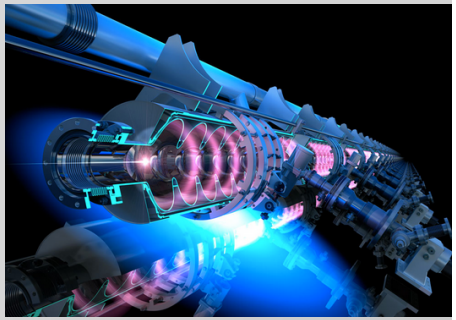
- **CLIC workshop 2015, 26-30 Jan. , CERN, Geneva (Switzerland)**
  https://indico.cern.ch/event/336335/
  Attendance >200 participants

ALCW 2015 Asian Linear Collider Workshop
20-24 April '15 KEK Tsukuba, Japan

- **Asian Linear Collider Workshop 2015, 20-24 April 2015, KEK (Tsukuba) and Tokio, Japan**
  http://www-conf.kek.jp/alcw2015/index.html
  Chair: Y. Okada. Local chair: A. Miyamoto
  Special separated event (April 22) with Japanese authorities in Tokio was very successful. About 300 participants. Very much ILC oriented.

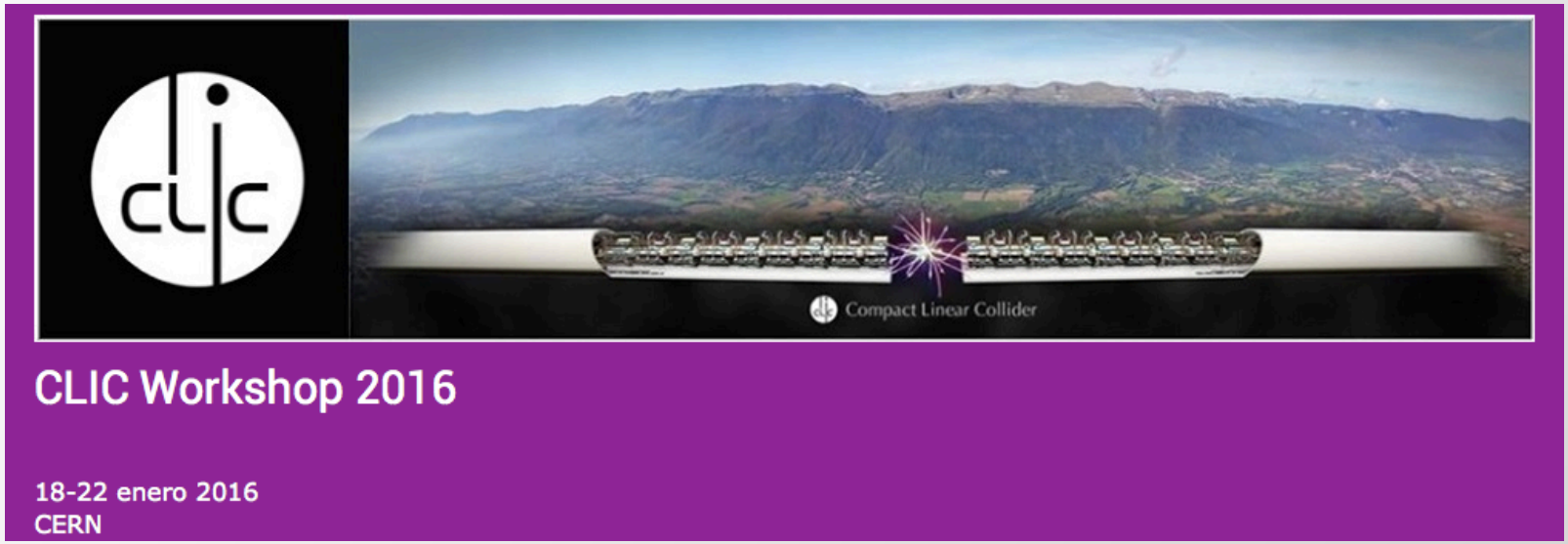
INTERNATIONAL LINEAR COLLIDER
TOKYO EVENT
WEDNESDAY, APRIL 22, 2015

- **International Workshop on Future Linear Colliders, Whistler (Canada), 2-6 Nov. 2015**
  http://lcws15.triumf.ca/index.html
  Chair: D. Denisov. Local Chair: Shane Koscielniak
  Attendance ~200 participants.



LC workshops 2016

- **CLIC workshop 2016, CERN, 18-22 Jan.**
  https://indico.cern.ch/event/449801/



- **ECFA - Linear Collider Workshop 2016, 30 May – 5 June**
  Santander (Spain)
  Local chair: Alberto Ruiz
  "Omnibus" type workshop: Accelerator, ILD, CLICdp, SiD, R&D Collaborations, Plenaries, etc..

- **LCWS16, Asia, place and date to be decided**

LC School of Physics

- **Linear Collider School, 21-27 July 2016**
  Frauenchiemsee (about 100 Km from Munich)
  http://lcschool.desy.de
  Local Chair: G. Moortgat-Pick (Helmholtz Alliance)

- The school is aimed at PhD students and postdoctoral researchers working on linear collider research. The programme consists of lectures covering the following topics:
  - Accelerators
  - Detectors
  - Standard Model
  - Higgs
  - Top physics
  - Supersymmetry
  - Relation to LHC Physics

Summary

- The Linear Collider Collaboration (LCC/LCB) finishes its mandate and a new structure needs to setup during next year 2016. This new structure has to adapt to the situation and expected activites on the future of LC projects. ECFA is expected to play an active role.

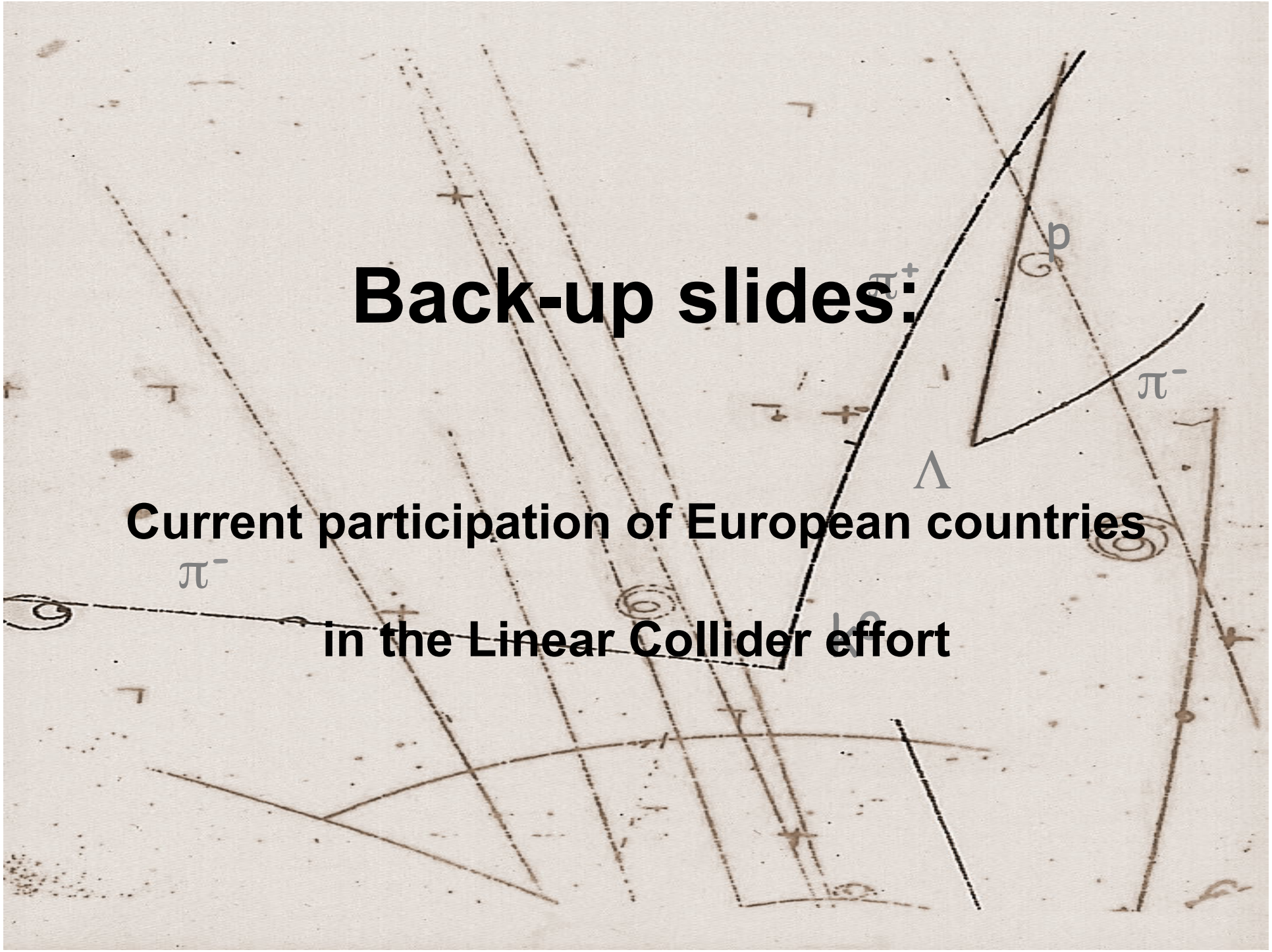
- In 2016 MEXT will announce the result of the studies and recommendations of the working groups with respect to built the ILC in Japan. Contacts between Japanese MEXT authorities and interested countries have started.

- The ILC linear collider accelerator technology is mature and ready. CLIC will have its TDR in the coming years.

- The physics programme of a future Linear Collider (ILC/CLIC) is extremely rich and attractive covering Higgs physics, top physics and searches beyond the SM complementary to LHC.

Summary

- The Linear Collider is a solid technological possibility “either” for the next accelerator at CERN (in the case of CLIC) “or” to provide the “best bridge” to the next accelerator at CERN after LHC (in the case of ILC).
- Progress on the Linear Collider physics case and detector R&D for both ILC & CLIC is being made despite the small funding and few resources. The community is very motivated and determined.
- Getting EU funding is crucial for the next years. ECFA can help offering formal recognition and support to the LC activities.
- Cooperation between ILC and CLIC is excellent in common work and development.



Back-up slides:

Current participation of European countries

in the Linear Collider effort

EU in LC R&D: Czech Republic

- **Activities (CALICE, ILD, AIDA 2020)**
  - Calibration systems for scintillation hadron calorimeters
  - DAQ for hadron calorimeters, for beam tests of calorimeters
  - Micro-chips for pixel detectors (LC and ATLAS)
- **Groups**
  - Institute of Physics of the Academy of Sciences of the Czech Republic (IPASCR)
  - Czech Technical University, Faculty of Nuclear Science and Physical Engineering
- **Funding in 2015**
  - Ministry of Education, Youth and Sports, grant INGO II (2014-6), 38 k€, travel, material, services
  - EU grant AIDA 2020 (2015-9), 12 k€
  - IPASCR, 1 k€, material, services

EU in LC R&D: CERN

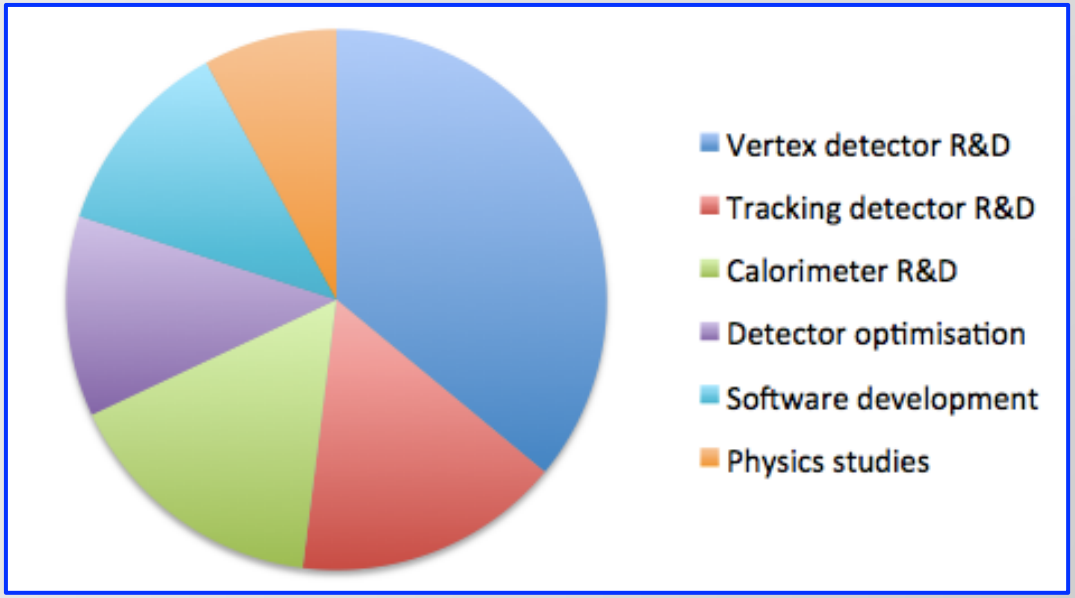
CERN LCD –Linear Collider Detector project- activities focus on CLIC, exploiting synergies with other projects (ILC, FCC, also HL-LHC in some cases):

- CLIC **physics** benchmark studies
- **Software development** for simulation/reconstruction (common with ILC; also FCC synergies)
- **Detector optimisation** => new CLIC detector model
- **Silicon vertex and tracking R&D** (e.g. synergies with RD53 and ATLAS upgrade R&D)
- **Fine-grained calorimeter R&D** (participation in CALICE and FCAL)

CERN LCD participates in **FCC** (e.g. participation in WG's, sharing physics samples with FCC-ee, FCC-hh vertex detector optimisation and flavour tagging)

CERN LCD will participate in **CMS high-granularity endcap calorimetry** (e.g. beam tests)

Current repartition of CERN LCD activities



EU in LC R&D: France

Achievements in Instrumental R&D and Physics Studies

- **General remarks :**
  - 9 IN2P3 labs + Irfu active since $>$ 10 years in VD (CMOS pixels), ECAL (SiW), HCAL (RPC, μMegas), TPC, beam control
  - Present detector R&D addresses full scale prototype realisation and issues
  - All detector R&D pushed towards cross-fertilisation of non-ILC forthcoming/upcoming sub-systems (e.g. LHC)
  - Trend $>$ 2014 : R&D community tends to get committed in spin-off applications $\Rightarrow$ ILC (human) resource mitigation
- **PFA calorimetres :**
  - ECAL : towards fully equipped detection units & real size layers
  - HCAL : from m^3 stack to real size layers
  - μelectronics (Omega) : R&D on issues and support to various calorimetre international R&D
  - Plan : combined ECAL + HCAL beam tests
- **Vertexing/tracking devices using CMOS pixel sensors :**
  - Primor : successful STAR-PXL physics run with CMOS pixel sensors
  - Goal : bunch tagging via sensors developed for ALICE-ITS upgrade
- **TPC with μMegas & Ingrid read-out :** leading role in LC-TPC & RD-51 collaborations
- **Accelerator related achievements (part of):**
  - Nanobeam tuning : ATF2 beam size monitoring (44 nm achieved in July)
  - XFEL : all couplers (IN2P3) & cryomodule assembly (Irfu) set in production mode
- **Physics studies :** contributions to Snowmass studies on top-quark characterisation & Higgs-couplings determination

EU in LC R&D: France

France-Japan contacts in 2015:

April 2015 : France representatives of the ILC community had discussion on ILC with:

- Scientific Advisor in French Embassy in Japan
  - ready to informally discuss ILC with MEXT, if wish so expressed by Japan.
  - Informed French ministries of Foreign Affairs and of Research of our visit.
- Mr. Kosaka-san, head of a diet members delegation visiting EU
  - personal contact established
  - follow-up in September : meeting with Council of Japan & JSPS, in Strasbourg
- French “diet member” who visited Japan in 2014
  - pleased to discuss ILC when a visit in Paris of Japan diet members is organized

October 2015 : Visit of Japanese delegation (Nomura)
CEA+IN2P3+Industries : Alsyom, Air Liquide, Aperam Nickel Alloys, Thales

End of 2015 : Annual meeting of France ILC community

Other visits have been made to Germany and UK as well.

EU LC R&D: Germany

Projects

- Hadronic Calorimeter (CALICE)
- Time projection chamber (LCTPC)
- Forward Calorimeter (FCAL)
- Vertex Detector
- Polarimeter

Strong contribution to Concept work:

- Mostly ILD
- SiD
- MDI integration

Strong foundation through contributions to common tools / services to the community

- Central Software support
- Test Beam
- General Integration support (HCAL, TPC)

Bonn, DESY (HH + Zeuthen), Hamburg, Heidelberg, Mainz, MPI Munich, Siegen, Wuppertal

New round for BMBF (research ministry) funding :

- 1.6 Meuros R&D for ILC detector (3 years, 6 universities)
- 1.4 Meuros R&D for ILC machine (SCRF, e+ source

EU in LC R&D: Holland/Nikhef

- **ILD related activity**
  - Pixelised readout of TPC, including a lot of generic R&D (TimePix1/3, Ingrid, Discharge protection etc.)
  - Precision Tracking Analysis of Pixelised testbeam data
  - Incorporated in LCTPC and RD51 collaborations
- **Theory:**
  - Development of FORM and GRACE (with KEK)
  - LC event generation with higher order EW and QCD corrections
- **Funding:**
  - Small funding for experimental physics studies and production of engineered TPC pixel modules imminent; to be decided soon

EU in LC R&D: Israel

Tel Aviv University:

- Participate in the FCAL and CLICdp collaborations
- 6 FTE, 2 PhDs

- Building prototype of the LumiCal detector, tracker in front of LumiCal
- Participate in and analyse test-beam data
- Study polarization issues

Supported by EU (EUDET, AIDA, AIDA-2020), German-Israel Foundation (GIF), Israel Science Foundation (ISF), Israel Commission of HEP (ICHEP and I-CORE (Israel excellence center)

Hebrew University, Jerusalem:

- Participate in the CTF3 collaboration
- Study the basic material science aspects of key issues of high-gradient acceleration.

EU in LC R&D: Norway

Oslo

Member of CLIC since October 2006 (funded by NFR and CERN). Present manpower: 5 FTE, 4 PhDs.

Steinar Stapnes director of CLIC-LCC

Activities:

- Preserve beam quality including lattice design, alignment algorithms, X-band wakefield monitor development, stabilization studies
- Perform mix of simulation and theory in Oslo and experimental work at the CLIC facility

➔ Many of these activities are also relevant for the ILC

Bergen

Conducts detector R&D for ILC/CLIC within the CALICE collaboration since 2004 (presently funding from AIDA plus some matching from University). Present manpower: 2 FTEs

Activities:

- Gain stabilization studies of SiPMs in collaboration with Prague (ASCR) at CERN
- SiPM detector characterizations in Bergen
- Light collection and readout of crystals and plastic scintillators

➔ This work is performed in relation to the analog hadron calorimeter

EU in LC R&D: Poland

Institutes:

1. **AGH:** University of Science and Technology, Kraków
2. **IFJPAN:** The H. Niewodniczański Institute of Nuclear Physics, Polish Academy of Sciences, Kraków
3. **UW:** The Warsaw University

	AGH	IFJPAN	UW
# of people	5+4(PhD)	7+1(PhD)	4
FTEs	4	4	1
Detector R&D	YES (FCAL)	YES (FCAL)	NO
Software development	NO	YES	NO
Physics studies (expt & theory)	NO	YES (A_{FB} in $e^+e^- \rightarrow$ bbar, gamma-gamma physics)	YES ($t \rightarrow cH$ decays (*), H^{+-} production in Inert Doublet Model)

EU in LC R&D: Poland

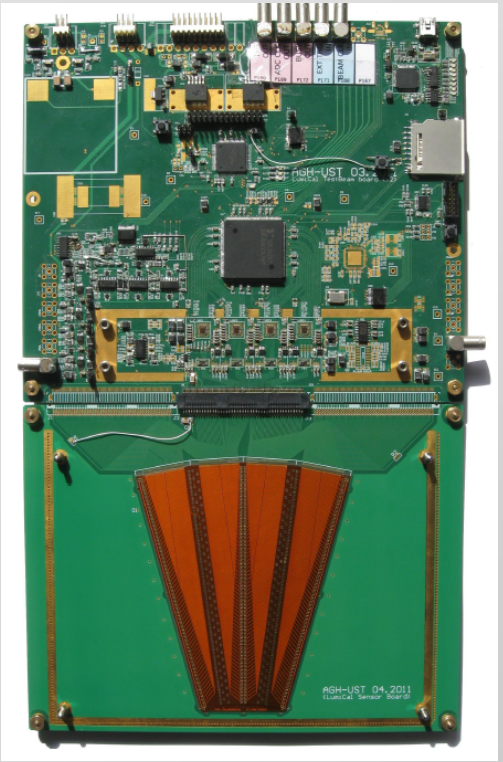
Funding:

1. European funds: AIDA-2020, AIDA, EUDET **(AGH & IFJPAN)**
2. National funds: major difficulties in getting recognition from the National Science Centre (NSC). The recent application to the NSC, proposed by the **UW**, is not yet evaluated

Activities and interests:

- Development of silicon sensors
- dedicated multi-channel front-end ASIC
- dedicated multi-channel ADC ASIC
- FPGA-based readout board for the luminosity detector in the forward calorimeter (FCAL).

The completed detector module, containing all these components, has been used several times in FCAL test-beams.



EU in LC R&D: Serbia/Vinca Belgrade

-Vinca Experimental HEP Group is so far the only participant from Serbia to the future linear collider projects;
- In total 8 FTEs, including 3 PhD students;
- The group gives relevant contribution to LC studies including physics and detector R&D;
- Funded through the national project by the Ministry of Education and Science;
- Long active, since TESLA;
- Hosted LCWS in 2014.

Physics studies:

1. Luminosity measurement at LC, beam-induced effects;
2. Higgs couplings @ CLIC (6 analyses in total, 3 completed, 1 ongoing, 2 to be started);
3. Higgs couplings @ ILC: Higgs to WW decay @500 GeV in the hadronic channel.

Detector R&D:

1. FCAL: Forward electron tagging, test-beam simulation software;
2. ILD: Particle ID and reconstruction – common software tools combining information from
3. TPC and calorimeters;
4. Scintillator technology for muon identification (in collaboration with Fermilab)

EU in LC R&D: Spain

Spanish Network on Future Linear Colliders
Chair: Alberto Ruiz (IFCA)

Scope:

The main objective of this Thematic Network is to coordinate the Spanish activities on physics studies and development of new technologies in view of future linear colliders, (ILC & CLIC).

Active since 2007

Organizes 1-2 national meetings every year
New grant awarded for next two years 2016-2017

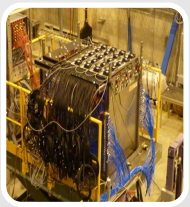
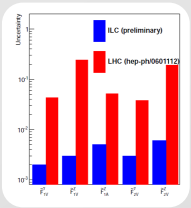
Includes:

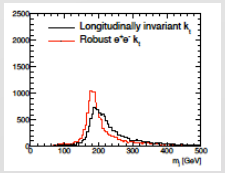
Accelerator groups
Theory groups
Experimental groups
Technological groups

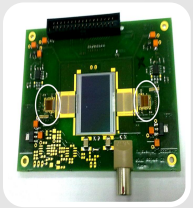
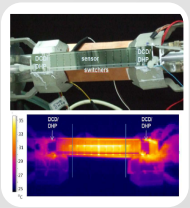
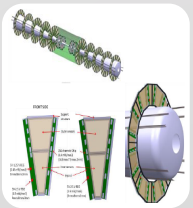
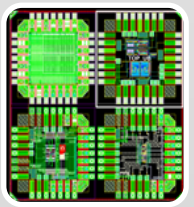
EU in LC R&D: Spain

- Grant request in 2015. Waiting for results. Goal is to maintain current activities.

Main activities and interests



- **Detector and Physics**:
  - Vertex detectors (DEPFET)
  - Innovative mStrip detectors
  - Ultra-high mechanics for trackers
  - Forward tracking optimization
  - ASIC design
  - Particle flow calorimetry
  - Physics analysis (top physics, jets)

- **Accelerator:**
  IFIC-CIEMAT-ALBA signed 3 **K**nowledge and **T**ransfer contracts with CERN
  -> CLIC technology developments (covering 3 years)

- Santander will host the next LC European Regional workshop ECFA-LC 2016

EU in LC R&D: UK

Financial & Political

Funding 2015-2016 : symbolically significant allow

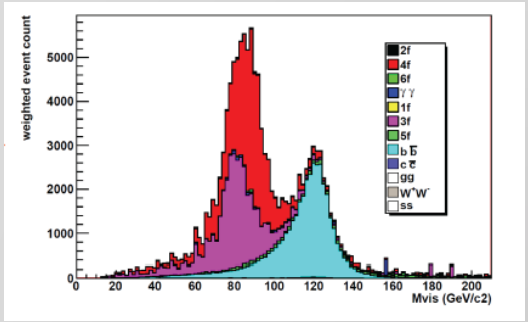
- groups to re-engage with ILC R&D activities on the physics & detector side
- staff to travel to LC workshops and conferences (April Tokyo : 15 UK people [x5])

Funding beyond 2016 : unclear if no positive signal from Japan

Remark on the machine side:
LC accelerator R&D continues via the CLIC-UK programme : £11M over 6 years. Jointly supported by CERN and STFC involves around 40 people from 6 UK institutes. The second phase is in full swing and runs until 31/3/17 (most of the R&D is applicable to both ILC and CLIC).

Main areas of UK interest:

- physics/detector optimisation
- silicon tracking, DAQ, calorimetry



Physics Research

- UK academics active in physics studies for ILC and CLIC
  - studies of Higgs physics at CLIC
  - hadronic recoil mass at CLIC and ILC