ILC and Europe

Steinar Stapnes, CERN
- LC study leader CERN, LCC member, EJADE scientific coordinator -

- Context
  - European Strategy and the ILC project status, request from KEK concerning future planning for ILC
- ILC action plan for Europe
  - European involvement until 2018
  - Plan for European involvement in ILC beyond 2018
- Summary

The European Strategy for Particle Physics

High-priority large-scale scientific activities

After careful analysis of many possible large-scale scientific activities requiring significant resources, sizeable collaborations and sustained commitment, the following four activities have been identified as carrying the highest priority.

Points 1,2,4:

- Exploit LHC and implement HiLumi. Well underway.
- High field magnets and high gradient acceleration, project planning for CLIC and FCC/He-LHC. Studies being summarized for the European Strategy update in 2019-20.
- Develop a neutrino programme at CERN. Neutrino platform implementation.

Today focus on point 3:

- There is a strong scientific case for an electron-positron collider, complementary to the LHC, that can study the properties of the Higgs boson and other particles with unprecedented precision and whose energy can be upgraded. The Technical Design Report of the International Linear Collider (ILC) has been completed, with large European participation. The initiative from the Japanese particle physics community to host the ILC in Japan is most welcome, and European groups are eager to participate. ***Europe looks forward to a proposal from Japan to discuss a possible participation.***

ILC Layout

Polarised electron source

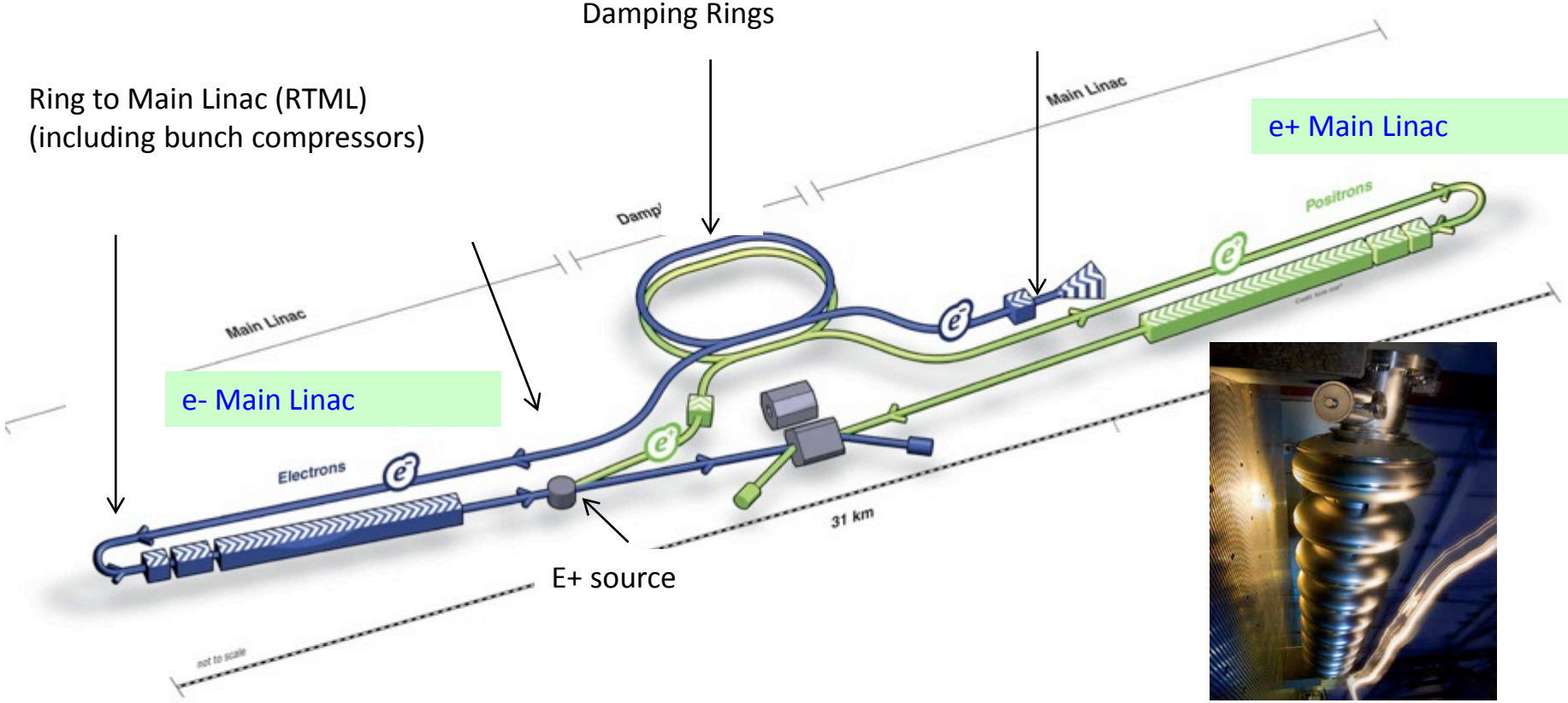
Damping Rings

Ring to Main Linac (RTML)
(including bunch compressors)

e+ Main Linac

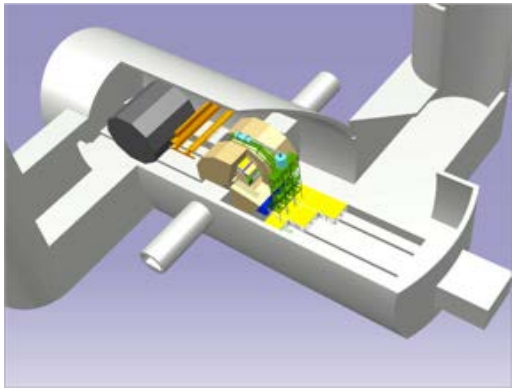
e- Main Linac

E+ source



Technical Design Report (TDR) 2012-13:

- 500 GeV collisions
- 1.8 x 10^{34} $cm^{-2}s^{-1}$
- 31 km length



Technical focus and changes

Site specific studies

Technical developments for most accelerator systems - high Q improvements for example

E-XFEL at DESY successfully constructed and put into operation – a key technology demonstration

Recent proposal to start with an initial energy of 250 GeV (physics impact report) – key issues:

- Higgs precision depends significantly on HiLumi performance and theory assumptions (link)
- Below ttbar threshold
- Reduced search capabilities

Nevertheless, provides impressive precision, and remains upgradable

TDR costs of ~8 BILCU for 500 GeV (ILCU = 2012 US$ estimate used in the TDR) can be reduced by up to ~40%

Situation in Japan (MEXT)

ILC Advisory Panel

- Setup by MEXT in May 2014
- Activities in the first year (May 2014-June 2015)
  - Elementary particle and nuclear physics WG, TDR-validation WG
  - 1st Nomura Research Institute survey (Spin-off and research trend)
  - Summary of the ILC advisory panel's discussions to date
- Activities in the second year (June 2015-July 2016)
  - Human resource securing and developing WG
  - Report on measures to secure and develop human resources for the ILC
  - 2nd Nomura Research Institute survey (technology issues)
- Activities in the third year (July 2016-July 2017)
  - Management and organizational structure WG, 3rd survey on large international projects
  - Report on ILC management and organizational structure (English translation being prepared)
- The Panel activity will continue.

MEXT-DOE discussion group

1st meeting in May 2016 in Washington, A meeting in August 2016 during ICHEP 2016
2nd meeting in October 2016, decided to start US-Japan cooperative R&Ds for ILC cost reduction.
Discussion group meetings will continue.

Slide from Y.Okada

KEK-ILC Action Plan

KEK-DG Yamauchi set up a WG to develop a KEK-ILC action plan in May, 2015.

The KEK-ILC Action Plan was released in January 2016. It contains technical preparation tasks and a human resource development plan for the pre-preparation phase (current efforts) and the main-preparation phase (after "green sign" from MEXT). It focuses mainly on a development plan for KEK.

"Producing a EAP (European Action Plan) for the ILC in timely manner is very important."

"After having established a discussion group with DOE, discussions with Europe are likely to become the next important topic for MEXT."

Extracted from slides of Y.Okada, KEK – EJADE meeting 6.9.16

On the European side it was suggested to use the EJADE H2020 MC project to prepare the EAP – the effort was started October 2016

E-JADE

Europe-Japan Accelerator Development Exchange Programme

Programme 2015-2018:

- Three main technical WPs
- Supports extended stays of European Researchers in Japan
- Recently adapted to include detector and physics studies for ILC (new partners)

Technical WPs: WP1: LHC with upgrades/FFC/ SuperKEKb, WP2: ATF2, WP3: ILC/CLIC

Partners: CERN (coord), DESY, CEA, CNRS, CSIC, RHUL, OXF with Uni. Tokyo and KEK -> WG for EAP

New partners: VINCA, AGH-Cracow, Tel Aviv University, Liverpool University, Université de Strasbourg, Université Paris-Sud, Tohoku University and Kyushu University.

Authors of EAP:
For EJADE institutes:
CERN: S.Stapnes, CEA: O.Napoli, DESY: N.Walker/H.Weise/B.List, CNRS: P.Bambade/A.Jeremi, UK: P.Burrows, CSIC: A.Faust-Golfe

EJADE WP3 and centrally: T.Schoerner-Sadenius, M. Stanitzki
TDR: B.Foster

ILC Project Phases

2017–2018: Pre-preparation phase

The on-going activities with relevance to the ILC in Europe are reviewed.

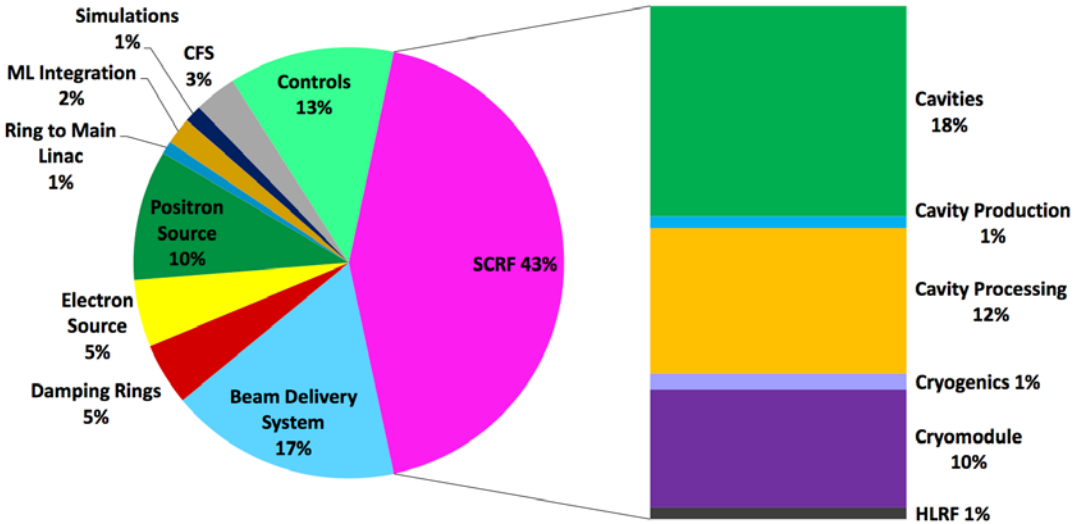
2019–2022: Preparation phase

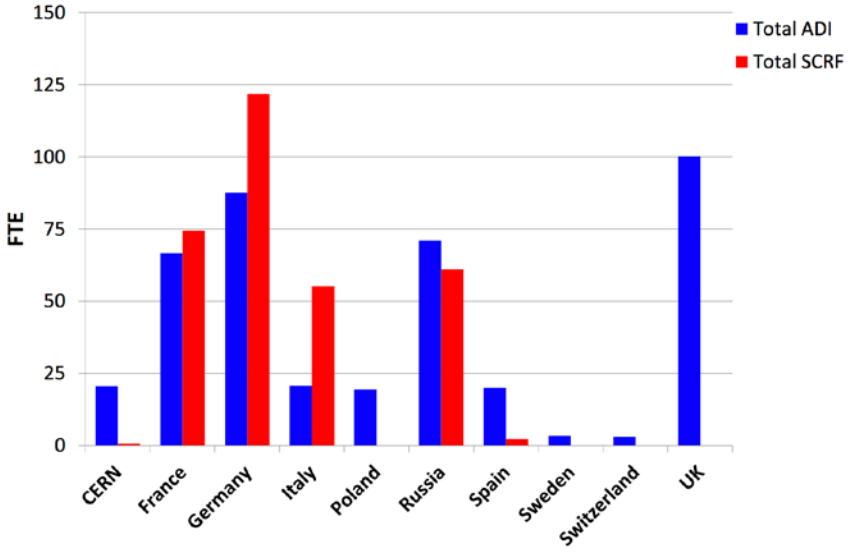
This period needs to be initiated by a positive statement from the Japanese government about hosting the ILC, followed by a European strategy update that ranks European participation in the ILC as a high-priority item. The preparation phase focuses on preparation for construction and agreement on the definition of deliverables and their allocation to regions.

2023 and beyond: Construction phase

The construction phase will start after the ILC laboratory has been established and inter-governmental agreements are in place. At the current stage, only the existing capabilities of the European groups relevant for this phase can be described

Preparing the TDR: Global Design Effort (2007-2013)





Pre-preparation phase – current focus areas (2017-2018)

Item/topic	Brief description	CERN	France CEA	Germany DESY	Time line
SCRF	Cavity fabrication including forming and EBW technology,	✓			2017-18
	Cavity surface process: High-Q &–G with N-infusion to be demonstrated with statics, using High-G cavities available (# > 10) and fundamental surface research		✓	✓	2017-18
	Power input-coupler: plug compatible coupler with new ceramic window requiring no-coating	✓			2017-19
	Tuner: Cost-effective tuner w/ lever-arm tuner design	✓	✓		2017-19
	Cavity-string assembly: clean robotic-work for QA/QC.		✓		2017-19
Cryogenics	Design study: optimum layout, emergency/failure mode analysis, He inventory, and cryogenics safety management.	✓			2017-18
HLRF	Klystron: high-efficiency in both RF power and solenoid using HTS	✓			2017- (longer)
CFS	Civil engineering and layout optimization, including Tunnel Optimization Tool (TOT) development, and general safety management.	✓			2017-18
Beam dump	18 MW main beam dump: design study and R&D to seek for an optimum and reliable system including robotic work	✓			2017- (longer)
Positron source	Targetry simulation through undulator driven approach			✓	2017-19
Rad. safety	Radiation safety and control reflected to the tunnel/wall design	✓			2017 – (longer)

Focused R&D on some key areas (cost, power, technically critical)

Pre-preparation phase – European XFEL and ESS

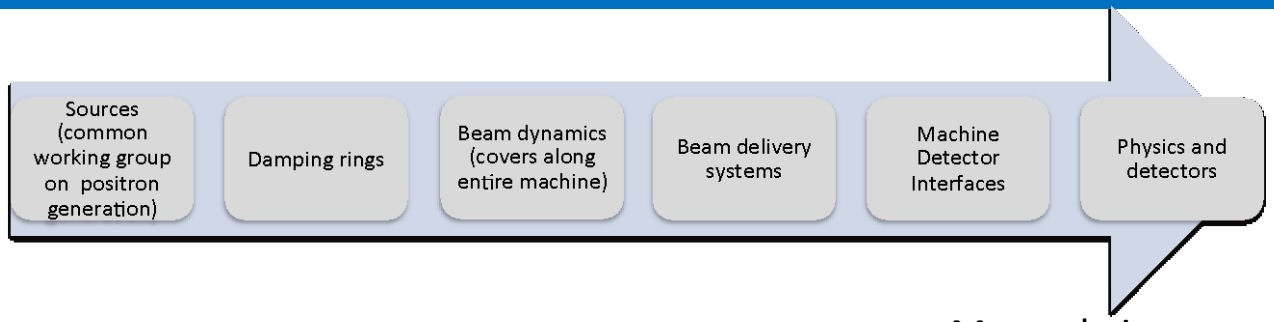
	Germany DESY	France CEA Saclay	France LAL	Italy INFN Milan	Poland IFJ PAN	Poland WUT	Poland NCBJ	Russia BINP	Spain CIEMAT
Linac									
Cryomodules	✓	✓		✓					
SCRF Cavities	✓			✓					
Power Couplers	✓		✓						
HOM Couplers							✓		
Frequency Tuners	✓								
Cold Vacuum	✓							✓	
Cavity String Assembly	✓	✓							
SC Magnets	✓				✓				✓
Infrastructure									
AMTF	✓				✓	✓		✓	
Cryogenics	✓								
Sites & Buildings									
AMTF hall	✓								

- Expertise across all essential parts of ILC
- Facilities set up in Europe
- Industrial capacity in Europe
- E-XFEL: ~7% of a 250 GeV ILC (~100 modules)

- ESS cryo-module production next
- Expertise/facilities being maintained and developed

	Germany DESY	France CEA	France IPNO	Italy Elettra	Italy INFN-LASA	Poland IFJ-PAN	Spain ESS Bilbao	Sweden ESS	Sweden Uppsala	UK STFC
RF systems				✓			✓	✓		
LLRF									✓	
Cryomodules		✓	✓							
SCRF Cavities		✓	✓		✓					✓
Power Couplers		✓	✓							
HOM couplers										
Frequency Tuners		✓	✓							
Cold Vacuum		✓	✓					✓		
Cavity String Assembly		✓	✓							
RF Tests (Cavites)	✓									✓
RF Tests (Cryomodules)		✓	✓			✓		✓	✓	

Pre-preparation phase – Common studies w/CLIC, ATF2 KEK



Many obvious common areas for ILC/CLIC, beyond RF technologies:

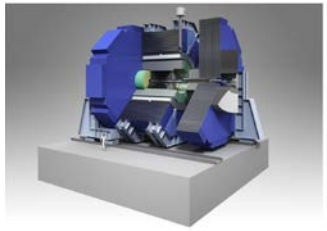
- Common WGs on Beam-dynamics, Sources, MDI, DRs, RTML, BDS (yearly LC workshops built around these WGs/topics – all with CLIC co-conveners)
- Cost and power studies and comparison

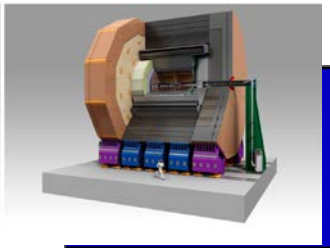
ATF2: International collaboration with many European groups:

- Final focus studies (crucial for LC luminosities)
- Extensively used for Ph.D training

	CERN	France		Germany	Spain	UK	
		LAL	LAPP	DESY	IFIC	Oxford	RHUL
Goal 1							
Very-low β	✓						
Ultra-low β	✓						
Halo control		✓			✓		
Wakefield/Intensity	✓				✓		✓
Instrumentation	✓	✓			✓		✓
Ground motion	✓		✓				
Background				✓			✓
Goal 2							
Stabilisation/Feedback		✓				✓	

Pre-preparation phase – Detector studies and final overview





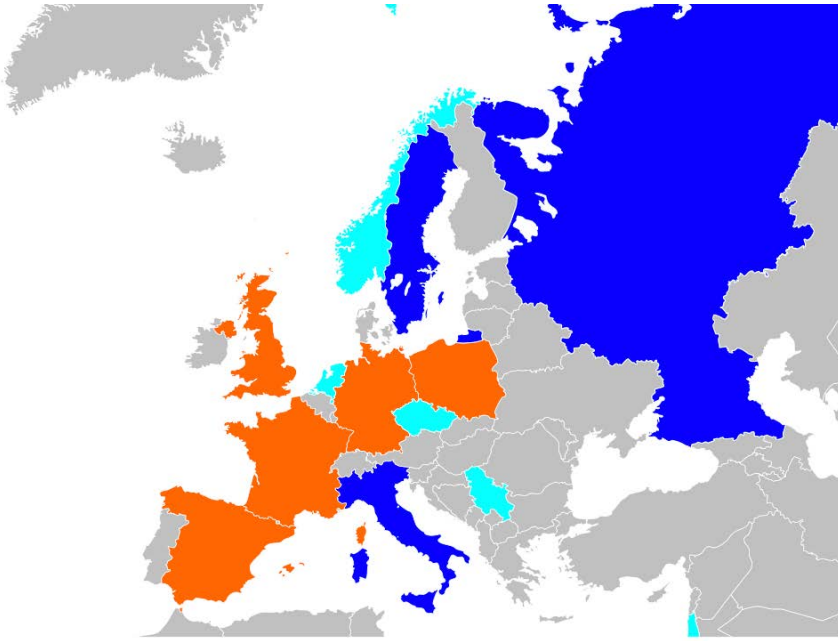
	CERN	DESY	Czech Republic	France	Germany	Israel	Netherlands	Norway	Poland	Serbia	Spain	UK
Vertexing	✓	✓	✓	✓	✓				✓		✓	✓
Tracking	✓	✓		✓	✓		✓				✓	✓
Calorimetry	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
MDI	✓	✓						✓				✓
System Integration	✓	✓		✓							✓	

Pre-preparation summary:

Europe has played – and continues to play – a central role in development of the ILC project

Large European projects are being implemented where the ILC/SCRF technology is being put to use and is being validated

European Industry is well prepared to construct parts for ILC



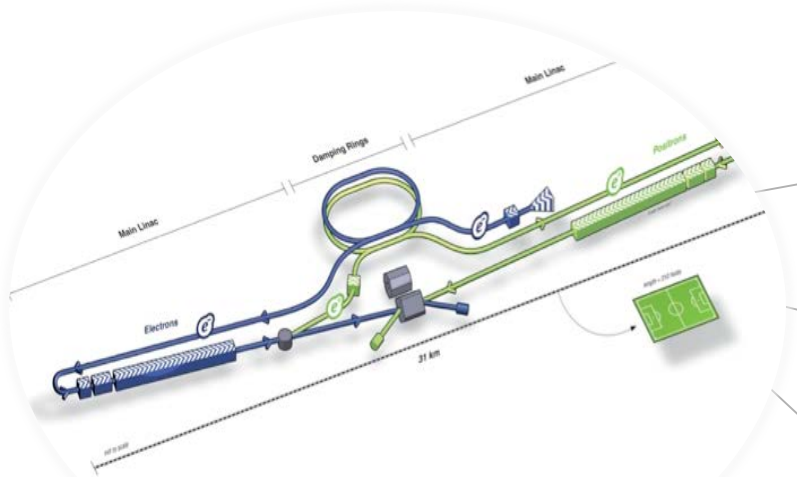
Preparation Phase 2019-22: Key activities

This period needs to be initiated by a positive statement from the Japanese government about hosting the ILC, followed by a European strategy update that ranks European participation in the ILC as a high-priority item. The preparation phase focuses on preparation for construction and agreement on the definition of deliverables and their allocation to regions.

- The European groups will concentrate on preparation for their deliverables, including European industry.
- Europe and European scientists, as part of an international project team, will also participate in the overall finalization of the design, while in parallel contributing to the work of setting up the overall structure and governance of the ILC project and of the associated laboratory.

Key activities in Europe	More details
SCRF activities	
	Cavity fabrication and preparation, Power Couplers, Automation of assembly, E-XEL -> ILC
High efficiency klystron R&D	
Cryogenics system	LHC system similar in size to ILC
Accelerator Domain Issues	
	Positron source, Damping Rings, Beam Delivery Systems, Low emittance beam transport, Beam dumps, Positron source
Detector and Physics	
	Design optimization, MDI, Technical prototypes, TDR, physics studies
Documentation system	Experience from E-FEL
"Regional" Design office	Naturally at CERN, linking to other European National Labs

Preparation Phase 2019-22: Organization and resources



ILC prep. phase project:

CERN coordination of European effort

R&D contracts

MoU annexes or similar (with MS and NMS collaborators)

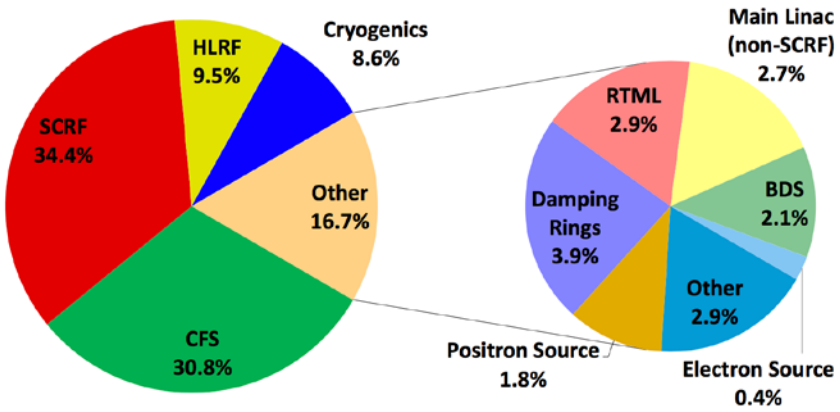
Techn. Transfer agreements, EU projects.

A European ILC project in the preparation phase 2019-22:

- Resources needed estimated to ~25 MCHF/year (material) and 60 FTE/year (personnel), ramping up from 2019
- Move towards more engineering personnel
- The organisational model above is used for existing studies at CERN, e.g. CLIC/FCC

Construction phase 2023 and beyond

The construction phase will start after the ILC laboratory has been established and inter-governmental agreements are in place. At the current stage, only the existing capabilities of the European groups relevant for this phase can be described.



As mentioned above, the detailed contributions will have to be defined during the preparation phase and formalized by inter-governmental agreements. Some contributions from Europe are imperative for the project - most prominently superconducting RF modules.

So premature to plan in detail, however some comments can be made:

- Focus on technical items for ILC (not CE and infrastructure)
- E-XFEL ~7% of a 250 GeV ILC – and more than 10% of the cryo-modules needed
- Detector construction expected to follow LHC detector model
- Spending significantly above the levels mentioned on previous page only by ~2025-26

Summary

Key messages:

- Europe is well set up/prepared (researchers, facilities, industry) for participation in the construction and exploitation of ILC for physics
- A 2018 statement is needed from Japan
- Final sharing of responsibilities and governance to be decided in the preparation phase 2019-2022
- Resources needed are quite modest until ~2025-26, construction spending then picks up
- The EAP document will be concluded now in October 2017
- An extended and updated document is being prepared for the European Strategy process, taking into account the development in Japan the coming ~year

All summaries prepared by my EAP author colleagues