Lessons of the Global Effort for the ILC

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Lessons of the Global Effort for the ILC

- Work toward realizing a high energy electron-positron linear collider, the ILC, has been coordinated globally since 2005.

- Following the demise of the SSC the global community realized the largest projects (>1B$) needed for advances in high energy physics could only be realized through global cooperation.

- Advantages gained through organizing globally early:
  - Global community takes ownership of **one** common concept and design,
  - Effort and resources toward realizing the chosen design is shared globally,
  - Governments and funding agencies recognize community's effort to optimize value from precious public resources.

Outline - Lessons from the ILC

- LHC and ILC - science drivers motivating both
- International coordination - ICFA
- Lessons from the SSC
- History of regional efforts and global collaboration
- ILC's view of elements needed for project success - Project Implementation Plan

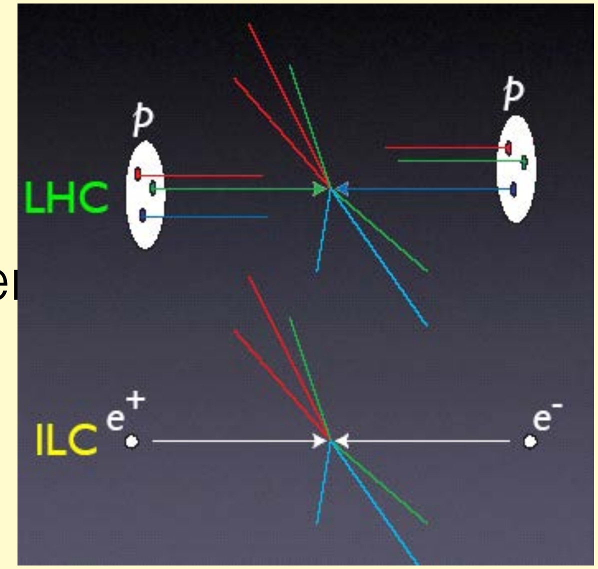
LHC and the ILC

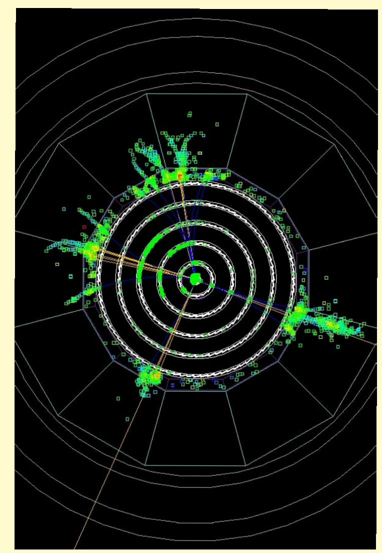
- LHC addresses physics at the Energy Frontier:
  - Higgs boson(s) and Electroweak Symmetry Breaking,
  - Understanding the Higgs - mass, decay modes, self-coupling, …
  - Other open questions:
    - Dark matter, grand unification, extra dimensions, …

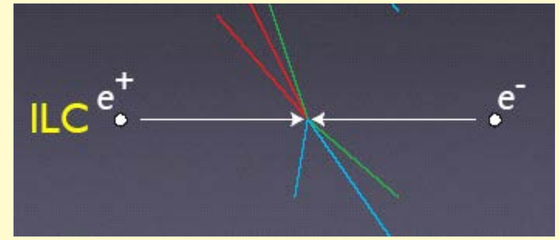
- LHC exists; why do we need the ILC?

Why the ILC?

- LHC collides protons ..
  - Complex systems of quarks and gluons
  - Interesting interactions between sub-compone
    - a fraction of the total energy.
- ILC collides electrons and positrons
  - Fundamental particles
  - Interesting interactions between beam particles
- LHC collisions involve **strong interactions**
- ILC - **no strong interactions** at collision - cleaner
- Consequence - ILC offers much **higher precision**
- Need for a high energy electron-positron collider as next major HEP project endorsed globally by 2001
  - and supported by HEPAP, NRC, overseas studies

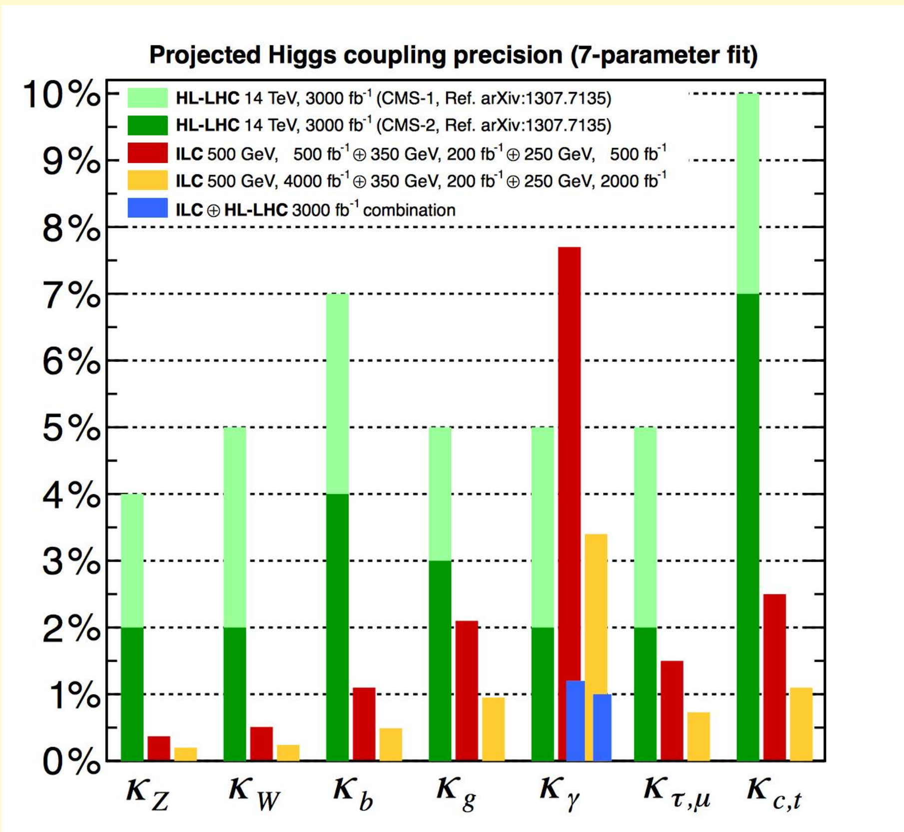


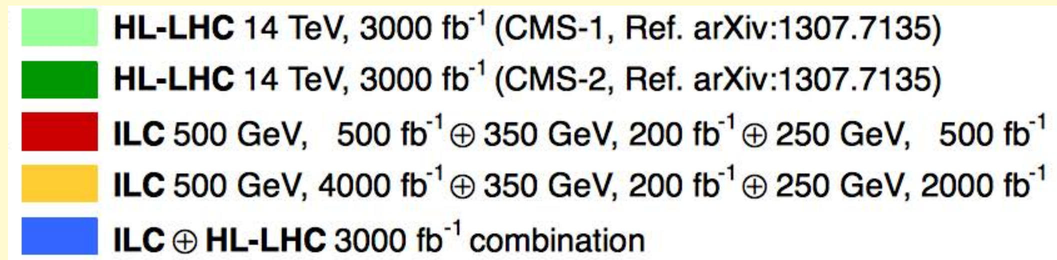


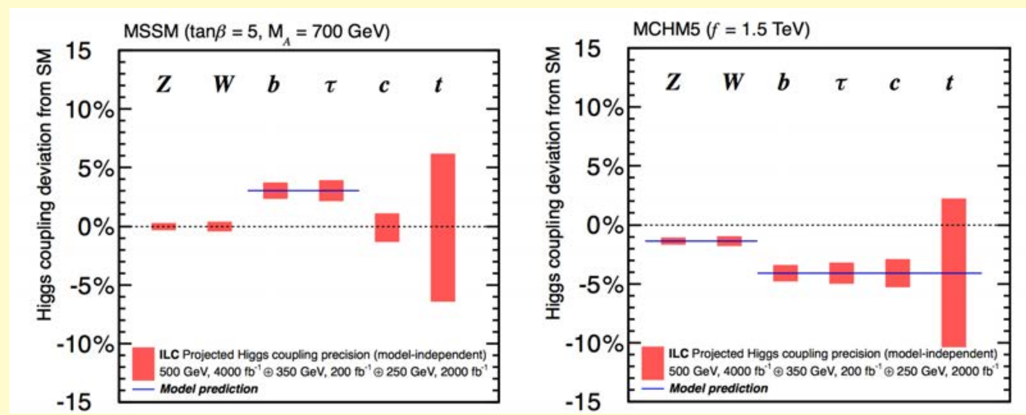


Why the ILC?

- ILC offers much **higher precision**
    - including invisible and LHC-difficult, like charm channel,







- **and** discovery potential - clean, electroweak dominance - e.g. low mass electroweak states (e.g. Higgsinos).

ICFA - Future Planning

- International Committee for Future Accelerators (ICFA)
  - Created in 1976 by the International Union of Pure and Applied Physics.
  - Facilitates international collaboration in construction and use of accelerators for high energy physics.
  - Committee of 15 members, selected primarily from the regions most deeply involved in high-energy physics.
    - CERN member states (3), USA (3), Japan (2), Russia (2), Canada (1), China (1), Other Countries (3)
- GW counterpart to ICFA is WG11: GRAVITATIONAL WAVE INTERNATIONAL COMMITTEE (GWIC) with a number of members who are LSC and Virgo collaborators

ICFA policy on participation

- *ICFA Guidelines for the Interregional Utilization of Major Regional Experimental Facilities for High-Energy Particle Physics Research* - 9 June 1980.
  - **Host laboratory** provides facilities.
  - Scientists **from world** welcome to propose experiments.
  - **Each region hosts facilities and welcomes scientists world-wide.**
    - IUPAP adapted these guidelines for other large-science fields.
- This strategy worked well for many years, but by 2000 there was growing realization that large future projects require global planning.

Superconducting Supercollider

- After huge buildup, SSC failed in 1994 from many mistakes:
  - US bypassed global planning to propose the SSC
  - Project was gigantic step in size and complexity
  - Debate in Congress on foreign participation
  - Costs rose, in part due to design enhancements
  - Cost & schedule tracking never fully implemented
  - National interest in federal budget reduction
  - Opposition in broader scientific community

LESSONS FROM FAILURE OF

Superconducting Supercollider

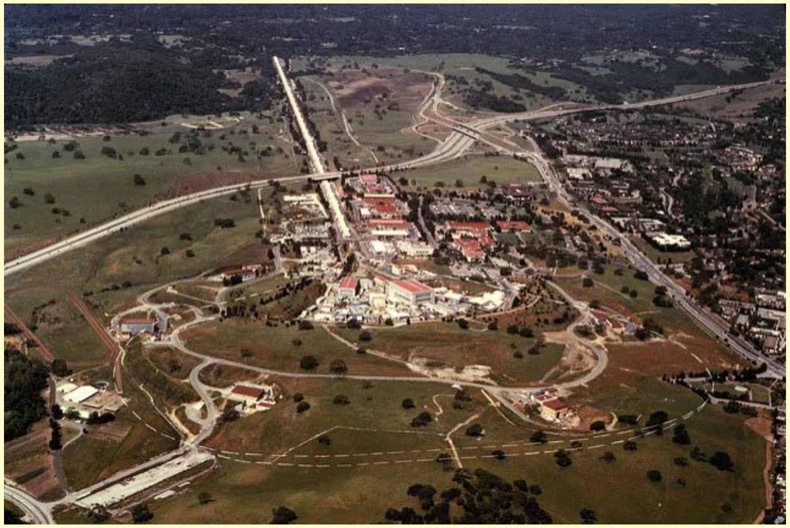
- After huge buildup, SSC failed in 1994 from many mistakes:
  - US bypassed global planning to propose the SSC
    Plan globally
  - Project was gigantic step in size and complexity
    Respond to requirements for large project
  - Debate in Congress on foreign participation
    Obtain political support for global plan
  - Costs rose, in part due to design enhancements
    Maintain cost budget
  - Cost & schedule tracking never fully implemented
    Provide good auditing of cost and schedule
  - National interest in federal budget reduction
    Explain value of project in era of austerity
  - Opposition in broader scientific community
    Convince other fields of scientific importance

Towards Global Planning

- After the SSC failed, ICFA urged global support for the LHC to establish world-wide unity.
  - US community transferred SSC expertise and experience to global effort on LHC experiments.
- In 2003, as efforts toward a linear collider grew, the global funding agencies established an informal venue to share information on future particle collider accelerator projects.
  - Funding Agencies for Large Colliders (FALC).
    - Canada, U.S., France, Germany, Italy, Spain, UK, CERN, China, India, Japan, Korea.
    - FALC meets regularly - ILC has been primary focus - modest common fund for central infrastructure.

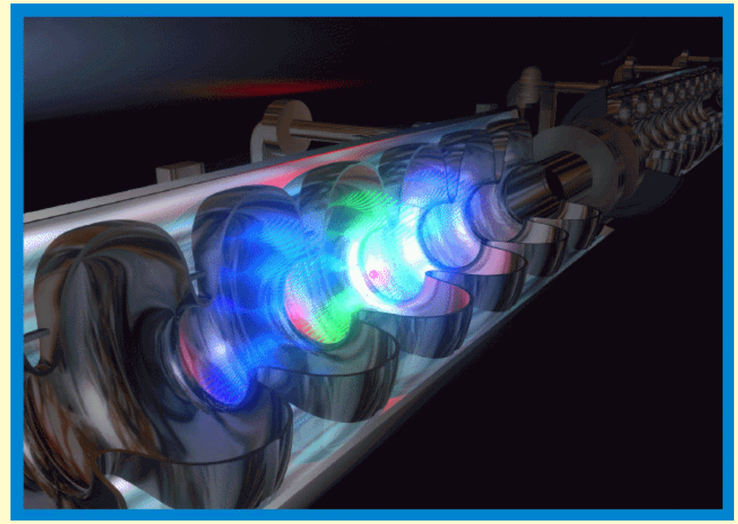
History of the ILC

- Following the demise of the SSC and global progress on the LHC, around the turn of the century, a world-wide consensus emerged among particle physicists that the next collider after the LHC should be a high energy linear collider.
    - Stanford Linear Collider (SLC) at SLAC successfully pioneered concept.
    - Continued progress in the field called for a high energy electron-positron collider to complement the LHC.



- The physics motivation was strong, but there were several competing technologies in different regions of the world:
    - TESLA (Germany), JLC (Japan), NLC (US), and others

TESLA, NLC & JLC



- circa 2001 - Europe, US & Japan all had linear collider projects
  - Europe: TESLA (TeV Energy Superconducting Linear Accelerator).
    - 2001 - DESY published TDR & proposed to German government.
  - US: Next Linear Collider (NLC)
    - X-band, warm accelerating technology - higher gradient.
  - Japan Linear Collider (JLC)
    - similar concept to the NLC.

NLC The Next Linear Collider
STANFORD LINEAR ACCELERATOR CENTER

Moving toward global effort

- By 2002, ICFA's attention focused on a future electron-positron linear collider - **regional proposals were competing, not advancing.**
- ICFA established *International Linear Collider Technical Review Committee (ILCTRC)* to study various concepts and make recommendations.
  - Reviewed TESLA (SuperRF), JLC-C (C-band), JLC-X/NLC (X-band), CLIC (2 beam)
    - All 4 could be realized - only **SuperRF and X-band** mature enough now.
    - Proposed, assuming continued success, technology choice from two in 2004.
      - weigh technical differences and challenges.
      - main linacs, injectors, positron sources, damping rings, beam delivery systems and interaction regions
      - energy reach, luminosity reach, reliability, and probable cost.
- In 2004, ICFA established the *International Technology Recommendation Panel* (ITRP) to weigh the two and make a recommendation.
- Aug 20, 2004, ITRP announces a recommendation for **SuperRF**
  - Despite differing regional interests and commitments, the global community came together to advance **one recommended technological approach.**

Global Design Effort

- Following the ITRP recommendation and the global acceptance, ILCSC/ICFA initiated the Global Design Effort (GDE).
  - In March 2005, ILCSC and ICFA selected a director for the GDE (B. Barish)
    - The director coordinated activities worldwide, without a centralized organization, with regional leaders reporting to the GDE director.
  - Science agency budgets (US, Japan, Europe) included R&D activities in support of proposed ILC for a number of years.
    - FALC common fund for central infrastructure
  - One critical aspect of the GDE's effort was developing credible estimates for the scope and cost of the project.
    - Rigorous and transparent reviews of costs.
    - Agreed-upon/transparent costs conversion in each country
      - personnel costs and contingency treated differently.

- GDE effort culminated in detailed Technical Design Report in 2013.
  - 5 vol. - physics, accelerator design (2 vols) and detectors
- Detailed cost est.: 7.8 billion ILCU + 22.6 Mperson-hrs (ILCU = 2012 US$)

ILC Project Implementation Plan

- **ILC Governance Committee chaired by Brian Foster (Hamburg/DESY/Oxford)**
  - **http://ilcdoc.linearcollider.org/record/62116/files/PIP_complete_IssueC.pdf**
- 2015 Report (52 pgs.) proposes solutions to important aspects of running and foundation of a new international laboratory, seen to be acceptable and viable by the particle physics community, for consideration and as an aid to discussions.
  - 2015 update of earlier report,
  - Informed by:
    - Japanese proposal to host and site choice in Japan of Kitakami.
    - Significant experience gained in the past few years with international projects of comparable size to the ILC, such as ITER, the European X-FEL and the European Spallation Source (ESS).

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  - Governance.
  - Funding models.
  - Project management.
  - Host responsibilities.
  - Siting issues.
  - In-Kind Contribution Models
  - Industrialisation and Mass Production of the SCRF
  - Linac Components
  - Project Schedule
  - Intellectual Property
  - Interface between ILC Laboratory & the Detectors
  - Transitional arrangements
  - Future Technical Activities

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- **Governance.**
  - **Mission.**
    - Scientific mission clearly stated.
  - **Legal status.**
    - International treaty organisation similar to ITER - zero VAT, import ratings and similar privileges, achieving aims in the most cost effective, flexible and transparent way possible.
  - **Management structure.**
    - Council with ultimate decision-making authority (as CERN).
    - Management vested by Council in Director General and Directorate.
    - Council representation and voting structure, esp. finances.
  - **Duration of agreement**
    - 8 years construction plus at least 20 years operation

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- **Funding Models and Financial Control.**
  - **Contingency.**
    - Director has authority to call on central contingency (>10% project).
  - **Common Fund.**
    - Covers items not of specific technical interest.
    - Covers salaries for top management.
  - **Host contribution**
    - > 50%
  - **Operational Costs.**
    - ECFA guidelines modified - division of costs reflect relative usage and value to participants.

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- **Project management.**
  - **Consortium responsible for construction**
    - Central Project Team and Host
  - **Recommend strong-host model**
    - Align interests of Project and the Host while maintaining collaborative effort.
    - strong host with collaborative approach important to success.
  - **Project Team.**
    - Led by Director-General.
    - Responsible for technical design, component specifications, high-level Q/A, installation, commissioning, and management of the project-related functions.
  - **Member States.**
    - Provide support through in-kind hardware and cash.

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- **In-Kind Contribution Models**
  - Large fraction total of cost can be component in-kind contribution.
  - Flexible approach should be adopted.
  - Support both large and small stakeholder contributions.
  - Make contribution packages attractive to potential bidders.
  - High-volume components must be divided between contributors, with the SCRF being the most attractive technology.
  - Integrated systems (e.g. damping rings) possible contributions.
  - Although difficult, distribute some responsibility for the infrastructure to reduce the host burden.
  - Clearly define technical interfaces and responsibilities for the central integrating and design team resources (host lab).

Status of ILC

- 2005 - Global Design Effort formed.
- 2011 - Japanese Expression of Interest to host.
- 2013 - Completed Technical Design Report based on successful R&D with detailed cost estimate.
- 2013 - Japanese site evaluation committee announced preferred site - Kitakami - northern Japan
- NOW
  - Japanese MEXT prepares for decision with study groups
    - physics, TDR and cost, manpower, impact and spin-offs
  - International discussions between funding agencies
  - Anticipate formal decision by 2018

Summary of ILC Lessons

- Billion $ scale facilities too large for single country
  ⇒ require global planning and approval.
- Significant scientific motivation must be clear, strong and widely appreciated by public, broader scientific community and government leaders.
- Work together globally early enough to build global ownership of design and effort, toward mature system design based on key element prototyping, industrial readiness and reliable, validated cost estimate with plan for cost risk mitigation.
- Important elements of global plan:
  - Management and governance.
  - Host responsibilities.
  - Cost sharing and in-kind contributions.
  - Plan contingency (other than cash).