

*Shin MICHIZONO (KEK/IDT-WG2)*

*(Nov.03, 2020)*

# IDT-WG2 organization

Bi-weekly **Tuesday** meeting: Sep.22, Oct. 6, 20,...

**IDT WG2**  
Shin Michizono (Chair)  
Benno List (Deputy)

<https://agenda.linearcollider.org/category/256/>

SRF

**Bi-weekly Tuesday**  
**Oct.13,27,...**

DR/BDS/Dump

**Bi-weekly Tuesday**  
**Oct.13,27,...**

<b>Yasuchika Yamamoto</b>	<b>KEK</b>	<b>Toshiyuki Okugi</b>	<b>KEK</b>
Nuria Catalan	CERN	Karsten Buesser	DESY
Dimitri Delikaris	CERN	Philip Burrows	U. Oxford
Rongli Geng	JLAB	Angeles Faus-Golfe	LAL
Hitoshi Hayano	KEK	Jenny List	DESY
Bob Laxdal	Triumf	Thomas Markiewicz	SLAC
Matthias Liepe	Cornell	Brett Parker	BNL
<b>Peter McIntosh</b>	<b>STFC</b>	David L. Rubin	Cornell
Olivier Napoly	CEA	Nikolay Solyak	FANL
Sam Posen	FNAL	Luis Garcia Tabares	CIEMAT
Robert Rimmer	JLAB	Nobuhiro Terunuma	KEK
Marc C. Ross	SLAC	Glen White	SLAC
Akira Yamamoto	KEK	Kaoru Yokoya	KEK

## Charges of Sub-groups

- Discuss and coordinate the topics for
  - technical preparation (remaining topics) at Pre-lab
  - preparation for mass production at Pre-lab
  - possible schedule at Pre-lab
  - international sharing candidates of these activities

## ■ Report to the IDT-WG2

All members belong to some sub-group(s).

Sources

**Bi-weekly Monday**  
**Oct.12,26,...**

<b>Kaoru Yokoya</b>	<b>KEK</b>
<b>Jim Clarke</b>	<b>STFC</b>
<b>Steffen Doebert</b>	<b>CERN</b>
Joe Grames	JLAB
Hitoshi Hayano	KEK
Masao Kuriki	U. Hiroshima
Benno List	DESY
Gudrid Moortgat-Pick	U. Hamburg

Civil engineering

<b>Nobuhiro Terunuma</b>	<b>KEK</b>
John Andrew Osborne	CERN
Tomoyuki Sanuki	U. Tohoku

Note: Summer to Winter time transition will be specially considered at next sub-group meeting.

1pm (->2pm) UTC (6am US Pacific, 8am US Central, 2pm U.K., 3pm Geneva, 10pm (->11pm) Japan)

# Accelerator activities at ILC Pre-lab phase



## **Technical preparations /performance & cost R&D [shared across regions]**

- **SRF** performance R&D, quality testing of a large number of cavities (~100), fabrication and shipping of cryomodules from North America and Europe (for validating shipping)
- **Positron source** final design and verification
- **Nanobeams (ATF3 and related)**: Interaction region: beam focus, control; and Damping ring: fast kicker, feedback
- **Beam dump**: system design, beam window, cooling water circulation
- Other technical developments considered performance critical

Technical preparation

## **Final technical design and documentation [central project office in Japan and possibly regional project offices]**

- **Engineering design** and documentation, WBS
- **Cost confirmation/estimates**, tender and purchase preparation, transport planning, mass-production planning and QA plans, schedule follow up and construction schedule preparation
- Site planning including environmental studies, CE, safety and infrastructure (see below for details)
- Review office
- Resource follow up and planning (including human resources)

Engineering Design Report (EDR)

## **Preparation and planning of deliverables [distributed across regions, liaising with the central project office and/or its satellites]**

- Prototyping and qualification in local industries and laboratories, from SRF production lines to individual WBS items
- Local infrastructure development including preparation for the construction phase (including Hub.Lab)
- Financial follow up, planning and strategies for these activities

Planning and preparation of Hub lab.

## **Civil engineering, local infrastructure and site [host country assisted by selected partners]**

- Engineering design including cost confirmation/estimate
- Environmental impact assessment and land access
- Specification update of the underground areas including the experimental hall
- Specification update for the surface building for technical scientific and administrative needs

Civil engineering

## **For Engineering design**

- 1<sup>st</sup> year:** Work on TDR-based **cost-estimate confirmation**, started by an international team centered on the Pre-lab.
- 2<sup>nd</sup> year:** Complete the cost-estimate confirmation, and an **internal review** in the latter half of the 2nd year.  
The review also reports on the progress of technical issues during the preparation period.
- 3<sup>rd</sup> year:** Conduct an **external review** and completed scrutiny of costs and risks.  
Complete the **draft of Engineering Design Report (EDR)**.
- 4<sup>th</sup> year:** Publish **EDR (in first half yr)**, report progress on technical issues, and prepare each large bid.

## **For technical preparation (example of SCRF and positron)**

- 1<sup>st</sup> year:** Extend SCRF cost reduction R&D, Start a pre-series SCRF cavities production preparing for industrialization  
Continue positron survey
- 2<sup>nd</sup> year:** Complete SCRF cost-reduction R&D, and extend the work to assemble the cavities with cryomodule (CM),  
Select positron scheme
- 3<sup>rd</sup> year:** **Demonstrate “Global** CM transfer, aiming at HPG legal-process, shipment, and SRF QA test after transport  
Mature Lab. planning and preparation  
Prototyping of critical items (such as positron target)
- 4<sup>th</sup> year:** Evaluate CM performance based on CM shipment, and prepare for Hub Lab. functioning  
Progress prototyping of critical items (such as positron target)

# Meetings

- AWLC “Discussion of potential US accelerator contributions”

<https://agenda.linearcollider.org/event/8622/timetable/#20201020>

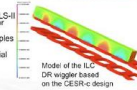
FNAL	Sam Posen
Jefferson Lab	Andrei Seryi
Oak Ridge National Lab	Marc Doleans
Cornell University	Georg Hoffstaetter
SLAC	Glen White
Argonne National Laboratory	John Byrd
Brookhaven National Lab	Mark Palmer
Lawrence Berkeley National Laboratory	Thomas Schenkel
Facility for Radioactive Isotope beams	Ting Xu
Session summary	Sam Posen

## Beam Physics, Simulation, Damping Ring Dynamics, Beam Delivery System, & Sources

- Use of high performance computing, design, and other resources to tackle key ILC deliverables

### BNL Accelerator Engagement

- Interaction Region
  - Strong basis for interaction region magnet design
  - Unique Direct-Wind capability for developing highly custom IR magnets
- Damping Rings
  - High brightness storage ring capabilities at NSLS-II match well to ILC DR needs and construction needs
  - Superconducting magnet expertise enables industrialization of the ILC DR wiggler design
- Other areas
  - Broad experience in electron accelerators (ATF, NSLS-II and ILC electron source) provides deep expertise for beam physics and technology development
  - Accelerator instrumentation and laser expertise couples to a range of baseline efforts
  - Advanced accelerator capabilities couples to potential ILC follow-on steps
    - Options
    - Energy upgrades



### ARGONNE IS THE HOME OF THE elegant CODE

- Code of choice for modeling storage rings and lines. Continuously updated with new physics and algorithms. Many new features added for design of APS-U.
- Advanced design optimization targeting key performance metrics
- Benchmarked simulation tools – against current APS data
- Combined single and multi-bunch modeling
- Detailed machine error simulations
- Direct simulation of different beam loss mechanisms including synchrotron radiation
- Coupled vacuum & physics modeling. New module includes comprehensive ion modeling
- SR masking modeling for high-current electron rings
- Automated machine commissioning simulation → AI / ML

### THE APS UPGRADE IS SIMILAR TO ILC DAMPING RINGS

- Uses multiple technologies envisioned for ILC DR
- Shared new 400-200-m-long, including
  - Advanced multi-sensometer lattice-42 pm
  - High-precision vacuum systems
  - On-axis injection with fast-shutter valves
  - 1200 superconducting permanent magnets
  - Superconducting 4th Harmonic Cavity for BLU
  - Orbit correction system with 1-Hz bandwidth
  - Well-exposed capabilities of today's storage ring light sources by 2-3 orders of magnitude



### Berkeley Lab Accelerator Modeling offers Expertise Applicable to ILC

- Linac design & simulation
  - Design optimization – conventional and AI/ML
  - Space-charge effects
  - High-order optics effects
  - Realistic beamline elements (fringe fields, overlapping fields, ...)
  - Multi-physics modeling (e.g. WARP+KODOL)
- High performance computing
  - Start-to-end modeling (code integration, standards for I/O...)
  - Developers of widely used community codes within the Berkeley Lab Accelerator Simulation Toolkit (BLAST)
    - Including: IMPACT suite, Warp, BeamBeam3D.



- Accelerator design
  - a) Electron source optimization
  - b) Electron beam-transport optimization, including space charge, CSR, micro-bunching, positron
  - c) Damping ring design / simulation / optimization
- SRF topics
  - a) SRF material qualification
  - b) Vertical bare cryogenic cavity tests
  - c) Horizontal dressed cavity testing in Cornell's HTCC
  - d) SRF component testing, e.g. cold-tuners, HOM absorbers, couplers
  - e) HCM absorber material studies
  - f) SRF simulations, cavity design, RF component design
- Damping ring dynamics
  - a) Permanent magnet optics (from CBETA experience)
  - b) Superconducting wigglers (from CESR experience)
- Positron production
  - a) Helical undulators (from optical stochastic cooling experience)

### Potential contributions from Cornell

- On CDRF/IDR stage Fermilab team actively participated in ILC design, incl. lattice design and beam physics studies
  - Lattice design:
    - DR to RTML injection/extraction lines; RTML and ML lattices;
    - Bunch compressors; Turn-up selection lines
  - Low Emittance transport studies for RTML and ML
    - Static and dynamic misalignments, jitter, ground motion;
    - Effect of cavity wakefields (bunching signal) and coupler kicks; Development of GBA algorithms to mitigate emittance preservation
  - Dark current dynamics and radiation in ML
- Fermilab scientists are ready to restart these ILC activities for pre-Lab and post ILC upgrades

- SLAC can also make intellectual contributions in other key areas
  - Beam Delivery Systems
    - Experience in BDS design & FFS
      - e.g. contributed design, operations & hardware to ATF2 program
  - Many participating personnel still at SLAC
  - Beam physics
  - Considerable experience in electron injectors, Linac and ring operations

### Jefferson Lab and ILC

- Jefferson Lab has made important contribution to R&D on ILC cavities and continuing to contribute to ILC efforts
- Jefferson Lab contributes to ILC Global Design Efforts
  - tech transfer, vendor qualification, gradient program, and now the cost-reduction program
- Jefferson Lab is participating in International Development Team
  - SRF R&D, sources (polarized positrons)
  - Can contribute to other IDT WGs – e.g. beam delivery / beam transport / damping ring
- ILC SRF cryomodule production
  - Jefferson Lab together with Fermilab will lead the ILC cryomodule production in US
  - Jefferson Lab would aim to cover 50% of the US cryomodule production
  - Infrastructure exists but assembly and testing facilities would have to be augmented to achieve the rate of 1 CM/week (total with FNAL)
  - ILC production timeline is a good match for ongoing and future production activities (LCLS-II/HE, EIC)
  - JLab has all of the technical lead staff in place

- DoE meeting was held on Oct.27 organized by Andy Lankford.
  - I explained mainly “technical preparation” at Pre-lab phase.
  - Around 35 people (DoE, Lab. Representatives, IDT-WG2 in Americas, IDT-WG2 in KEK (S. Michizono, A. Yamamoto, K. Yokoya, N. Terunuma, Y. Yamamoto) joined this meeting.

## *Intended IDT goals for this year*

- Try to establish
  - a preliminary list of Pre-lab tasks and deliverables and national/regional laboratories which might be interested in contributing to those
  - Pre-lab resource needs for the regional activities and central office (a few % of the ILC cost)
  - a preliminary proposal for the Pre-lab organisation and governance by the end of this year.
    - ⇒ Needed for the Pre-lab Japanese funding request preparation by KEK in 2021 to obtain funding in 2022: a similar requirement for the other countries expected.

(for details, see S. Stapnes and A. Lankford's talk)





## *Rough timeline of the ILC under discussion*

### ILC IDT (~1.5 years)

- Prepare the work and deliverables of the ILC Pre-laboratory and workout with national and regional laboratories a scenario for their contributions
- Prepare a proposal for the organisation and governance of the ILC Pre-laboratory

#### In parallel:

Positive “signs” from the host country (Japan) government and agreements by the national/regional laboratories for providing their contributions.

### ILC Pre-laboratory (~4 years)

- Complete all the technical preparation necessary to start the ILC project (infrastructure, environmental impact and accelerator facility)
- Prepare scenarios for the regional contributions to and organisation for the ILC.

#### In parallel:

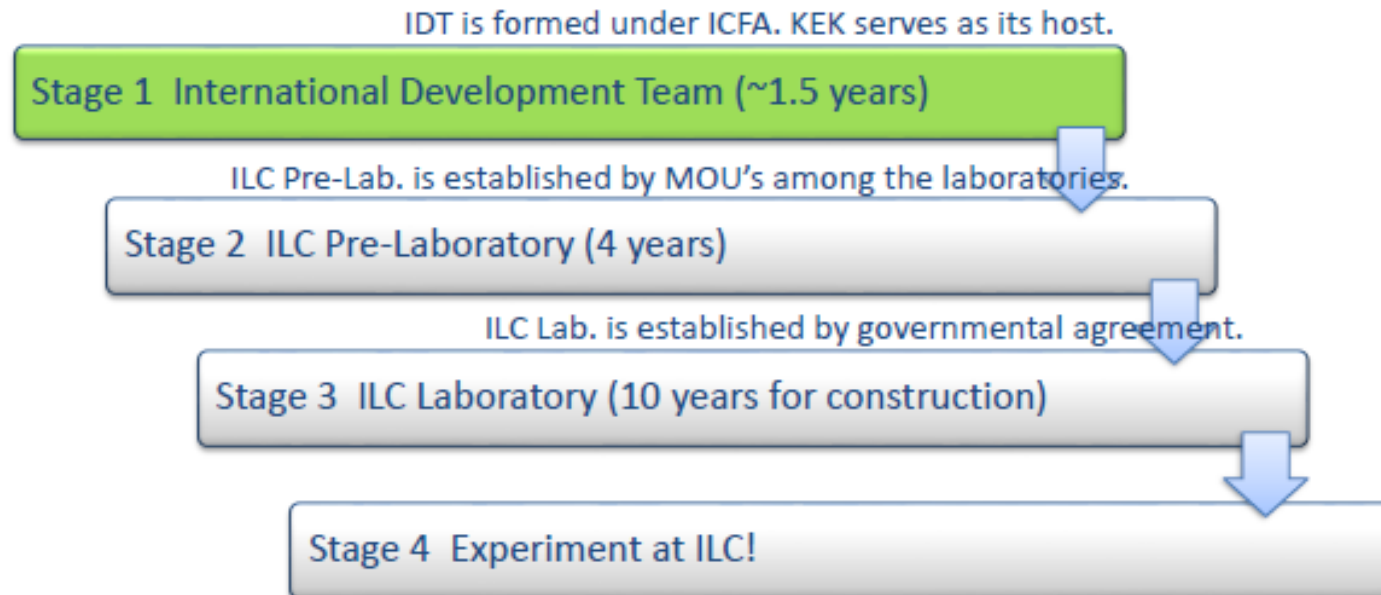
Positive outcomes of the inter-governmental negotiation for the responsibility and cost sharing among the host (Japan) and partner countries

### ILC laboratory

- Construction and commissioning of the ILC (~10 years)



## Stepwise realization of ILC



## Planning for Pre-lab accelerator activities in U.S.

In addition to participation in WG2 and subgroup activities,  
I will invite U.S. WG2 members to participate in development of a  
collaborative funding proposal for Pre-lab accelerator activities in the U.S.

**Goal:** Strong U.S. involvement in Pre-lab activities,  
which will technically enable start of ILC Construction in ~4 years,  
which will signal strong U.S. support for the ILC.

I anticipate that proposal will be for 4-year directed accelerator R&D project.

**Role of U.S. WG2 members, with assistance from others:**

- Understand the scope and nature of Pre-lab technical activities.
- Help identify tasks for which U.S. participation is critical,  
as well as other areas for strong U.S. participation (incl'g. design for EDR).
- Transform WG2 descriptions to level of detail required for a U.S. project.
- Estimate U.S. costs for performing prospective U.S. responsibilities.
- Help id a set of U.S. responsibilities that matches DOE budget guidance.

I expect to establish an advisory body consisting of laboratory directors (or  
designates) to advise on development of U.S. responsibilities and proposal.

Partnering with Canada is to be investigated.

Recall that IDT is preparing Pre-lab, not ILC construction.



## Pre-lab 2022-25: Accelerator core activities

### Overall:

Technical preparations /performance & cost R&D [shared across regions]

- SRF performance R&D, positron source, nanobeam (ATF3), etc

Final technical design and documentation [central project office in Japan with the help of regional project offices (satellites) ]

- Engineering design and documentation, WBS, costs, schedule, review, resource planning and follow up, etc

Preparation and planning of ILC deliverables [distributed across regions, liaising with the central project office and/or its satellites]

- Prototyping and qualification in local industries and laboratories

CE, local infrastructure and site [host country assisted by selected partners]

### European priorities:

Pursue R&D interests and capabilities, requires material and personnel, link to "local" strategic interests

*For some countries and groups this is the easiest entry point to Pre-lab contributions*

European Project Office(s) – mostly personnel

Identification and preparation of ILC deliverables – one main one is a European SFR module line, then other individual WBS items

*SFR module production line requires a multinational approach, other deliverable are a good entry point for countries and groups*

*For deliverables:*

*1) R&D required at some level 2) Final specifications, technical documentation, tender documents, 3) Prototyping and qualification in (local) industry, followed by tests and verifications in industry or labs*

Contributions by single person/groups with special skills