

ITN contribution of KEK in the areas of DR and BDS

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ICWS2023

ILC technology network (ITN)

- At March 2022, ICFA extensively reviewed the current situation surrounding the ILC and decided that "ICFA will continue over the next year to coordinate the activities of the global community of researchers aimed at further advancing and realizing the ILC in Japan within the framework of the IDT".
- The IDT will continue to coordinate the activities of the global research community to further develop and realize ILC in Japan within the framework of the IDT over the next year.
- With this statement, the IDT will enter a new phase, and as a major task, a new framework, the **"ILC Technology Network (ITN)"** will be established to promote the development of ILC-related technologies selected for engineering design and to study the potential for multifaceted applications of the accelerator.
- This program is based on the work package described in the ILC Pre-lab Proposal and focuses on items of technical importance.
- The ITN is envisioned to be built on the basis of cooperative agreements between KEK and relevant laboratories around the world.

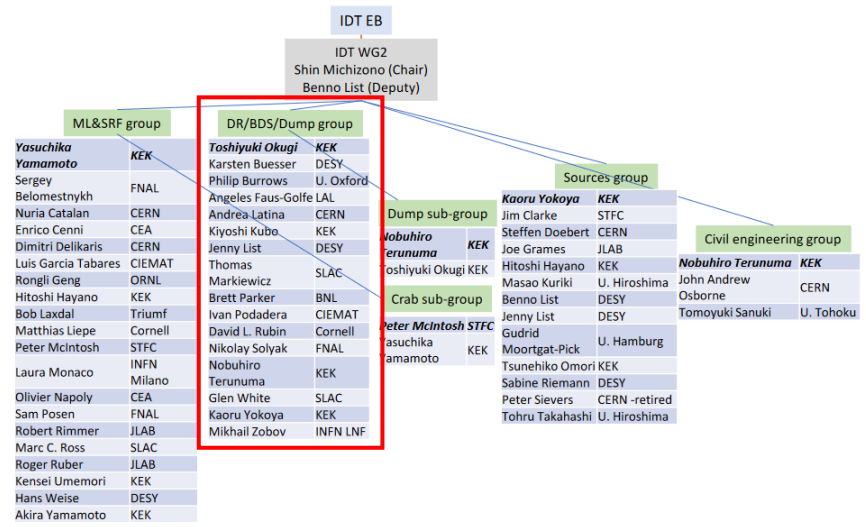
Technical Preparation for ILC Construction (2021 May)

- Under the IDT (International Development Team), the Technical Preparation items required for the ILC Pre-Lab period were listed up and positioned as 18 work packages.
- Totally 6 WPs were nominated as technical preparation within Pre-lab period.

Time-critical work packages (2022 March)

- The MEXT advisory panel's report stated that the ILC Pre-Lab is premature.
- However, positive reactions were received regarding the promotion of technical preparation through international cooperation.
- Then, high priority topics from the work package will be selected as time-critical work packages.

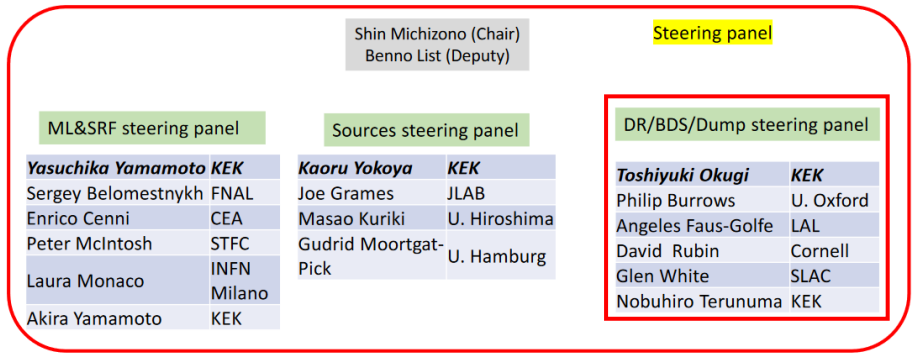
IDT-WG2



Prioritizing the essential and time-consuming work packages

- ✓ Establish IDT-WG2 steering panel
- ✓ Steering panel members will be assigned with the discussion to IDT-EB.
- ✓ Each group's steering panel will discuss about the prioritization.

IDT-WG2 with steering members



- Establish IDT-WG2 steering panel (group leader (SRF, Sources, DR/BDS/Dump)+ steering panel members will manage each group.)

We selected the following 5 work packages as the time-critical WPs for DR/BDS/BUMP area.

WP-prime 12: System design of ILC DR

WP-prime 14: System design of ILC DR injection/extraction kickers

WP-prime 15: System design of ILC FFS

WP-prime 16: Final doublet design optimization

WP-prime 17: Beam Dump

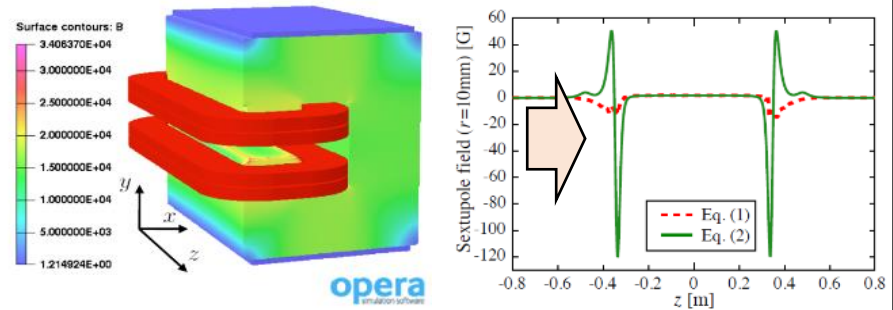
The ITN will also focus on these items for international cooperation.

The budget for the five years from JFY2023 includes more funds than were previously allocated **for the development of advanced accelerator technology (MEXT grant).**

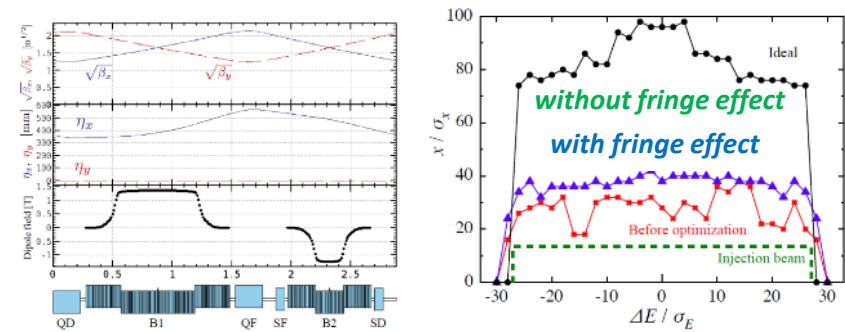
WP-prime 12: System design of ILC DR

- ◆ The ILC damping ring (DR) is required to satisfy the low emittance and the large dynamic aperture simultaneously.
- ◆ The ILC DR will be further improved by incorporating the findings of the latest light source design. Increasing the dynamic aperture is also important in the design of DR.
- ◆ By quantitatively evaluating the effect of fringe field to the dynamic aperture of magnets in ILC DR, the method for evaluating fringe field to the dynamic aperture in accelerator design will be established and the design of ILC DR will be optimized.

Modeling of the fringe field for SuperKEKB DR



Dynamic aperture evaluation with fringe effect (SuperKEKB DR)



- *In March 2023, a meeting was held with Australian light source regarding possible international cooperation on this item.*
- *We would like to discuss the possibility of international cooperation with the U.S. and European regions in near future.*

WP-prime 14: System design of ILC DR injection/extraction kickers

WP-prime-14 related items conducted by KEK on ITN

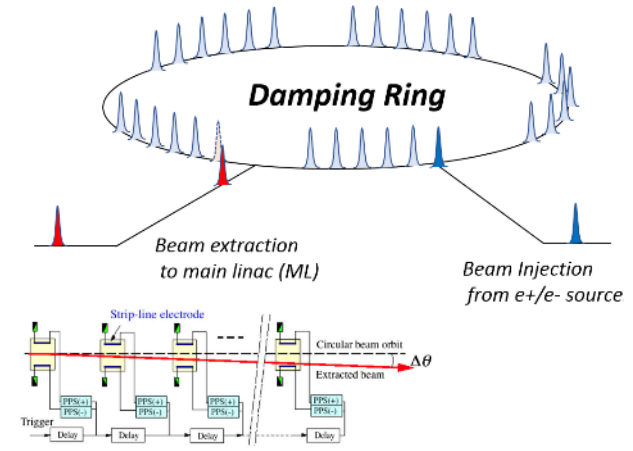
JFY2025 : Development of a prototype of the fast kicker power supply for the ILC

JFY2026 : Improvement of the prototype fast kicker power supply

JFY2027 : Evaluation of the performance of the prototype fast kicker power supply

- ◆ A fast kicker system using a semiconductor pulse power supply with nanosecond response was confirmed as proof of principle at KEK ATF about 10 years ago.
- ◆ Semiconductor technology has been evolving, and it is now possible to advance nanosecond response beam injection/excitation systems using the recent semiconductor technology.
- ◆ The technical evaluation of the fast kicker power supply using the recent semiconductor technologies.

ILC fast injection/extraction system

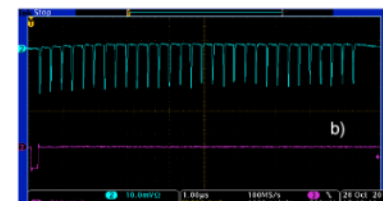


Beam extraction test at KEK ATF

Stored beam in DR



Extracted beam from DR



Timeline described in the time-critical work package document

Priority	Items	Y1	Y2	Y3	Y4
B+	Confirmation of existing pulse power supply technology based on drift step recovery diode pulsar				

The same contents as WPP-14 will be carried out, However, we decided to delay the implementation year in order to give priority to other research topics.

WP-prime 15: System design of ILC FFS

WP-prime-15 related items conducted by KEK on ITN

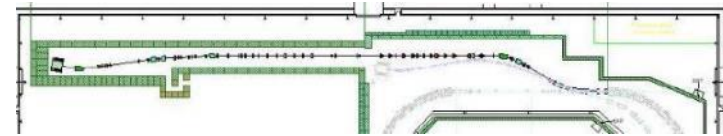
- The research will be conducted with the following 3 main topics
 - ✓ Improvement of beam tuning techniques for nano-beam
 - ✓ Long-term stabilization of nano-beam
 - ✓ Upgrading of beam diagnostic devices
- The first 2-3 years will be mainly devoted to procurement of the necessary equipment to implement the research items listed in the time-critical WP, and performance tests using the latest accelerator technologies, such as machine learning, will be carried out at the ATF accelerator as needed.

◆ ATF2 beamline is the only existing test accelerator in the world to test the final focus system (FFS) of linear colliders.

◆ The following 3 research topics are important topics to be pursued at the ATF.

- ◆ wakefield mitigation
- ◆ correction of higher-order aberration
- ◆ training for ILC beam tuning

ATF2 beamline



Timeline described in the time-critical work package document

Priority	Items	Y1	Y2	Y3	Y4
A	wakefield mitigation				
	mitigation and correction of higher-order aberration				
	training for ILC beam tuning (machine-learning etc.)				

The research topics will be conducted consistent with the content and timeline of WPP-15.

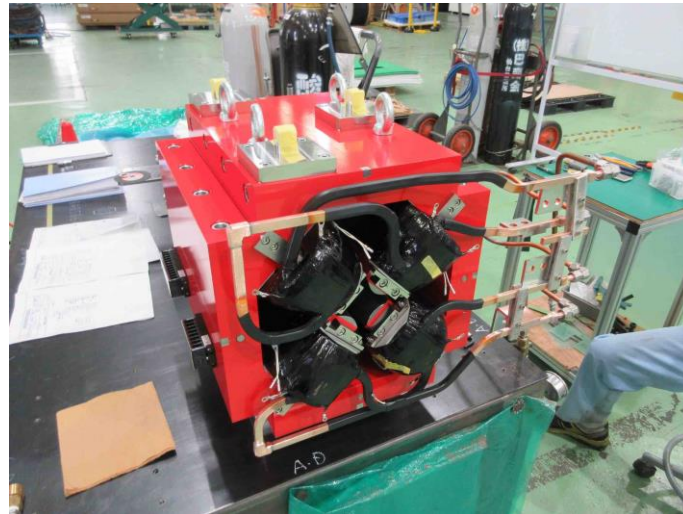
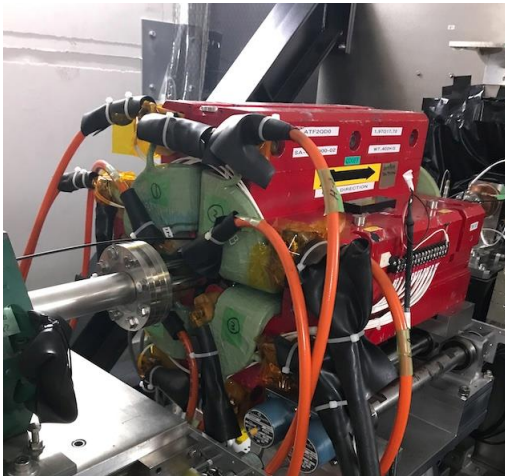
Hardware Upgrade based on MEXT grant

■ Magnets

- **Improve the magnetic fields and its positioning**
- New QD0 was delivered and to be replaced in this summer.
- Skew sextupoles (4) in 2023
- Others (some sextupoles, quadrupoles,...) will be subject to renewal after 2024.
- Renew the controll of Magnet Movers

■ Beam pipes

- **Minimization of the Wakefield sources**
- Remove steps at the connection to the Cavity BPMs; diam.24 mm → 20 mm (CBPM)
- Shielded bellows and flanges with diam.20 mm



New quadrupole which will be used for QD0FF, was delivered to the ATF on 23 March, 2023.

Hardware Upgrade based on MEXT grant (cont.)

■ Timing System

- **Stabilize the beam and its monitoring**
- Renew the old CAMAC based system to the VME based Event Generator/receiver system which is applied for SuperKEKB.
- Some of the White Rabbit system developed at CERN will be included (by Kaji).
- Renew the optical signal distribution system for reference clocks; 2,856MHz (LINAC) and 714MHz (DR).

■ IPBSM Laser

- **Renew the laser system** but scheduled for FY2025.
- Current laser system is no longer manufactured and maintenance parts will be difficult to obtain in a few years.
 - Overhaul of the current laser unit and transport line was done in 2021-2022. It makes recent beamsizes measurements stable.

■ Kicker system

- **Stabilize the beam extraction to ATF2(3)**
- Keep maintain the current extraction kicker but availability of modules is getting worse.
- Prepare the spare kicker system using the units for KEK-PS.
- Hope to get this system in 2025.

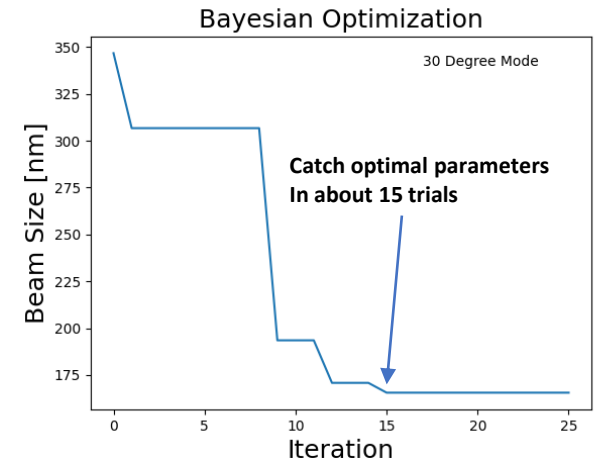
Machine Learning Study @ATF

M.Kurata will report in the next presentation.

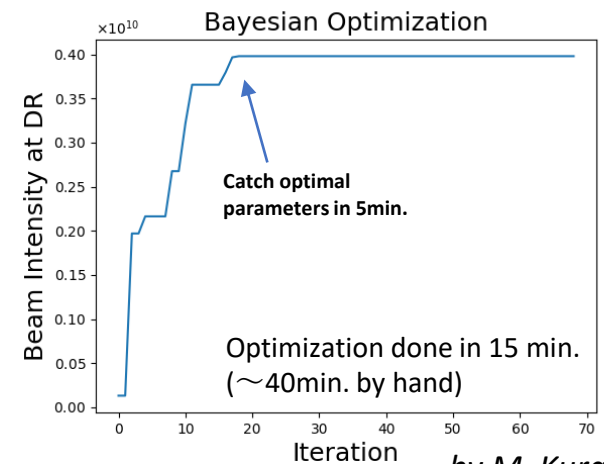
- Final Focus: Nano-beam tuning for the ILC
 - Simultaneous optimization of multiple parameters
 - Search for better parameters, including correlation
 - 3-parameter tuning: can obtain optimal value
 - Aiming for small beam by adjusting more parameters simultaneously



- Linac: Beam transportation to Damping ring
 - Maximize transport efficiency to the damping ring
 - Realize the auto-parameter optimization



by M. Kurata



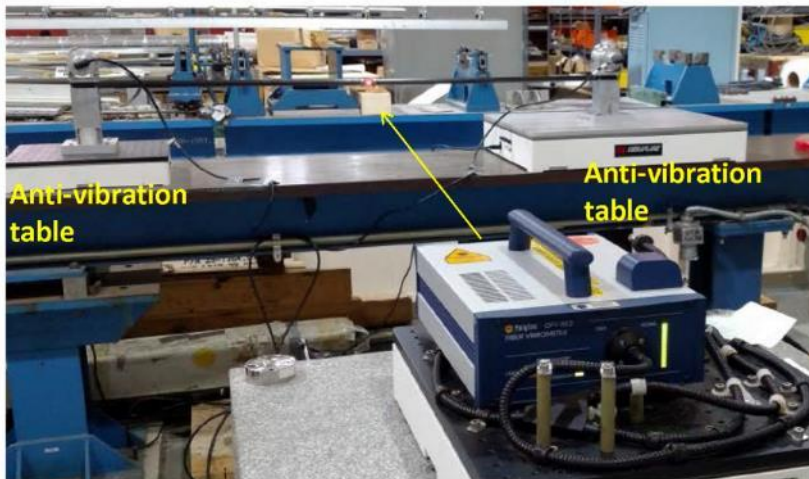
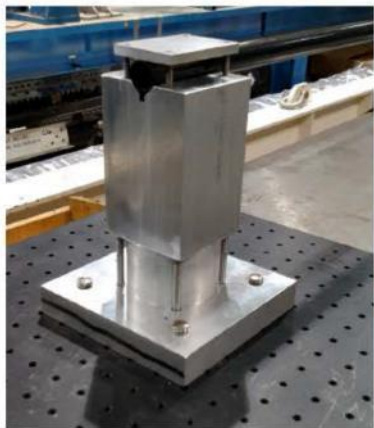
by M. Kurata

For more information on the ATF3 project, see Angeles Faus-Golfe's presentation in Accelerator plenary session on 5/16 (Tue).

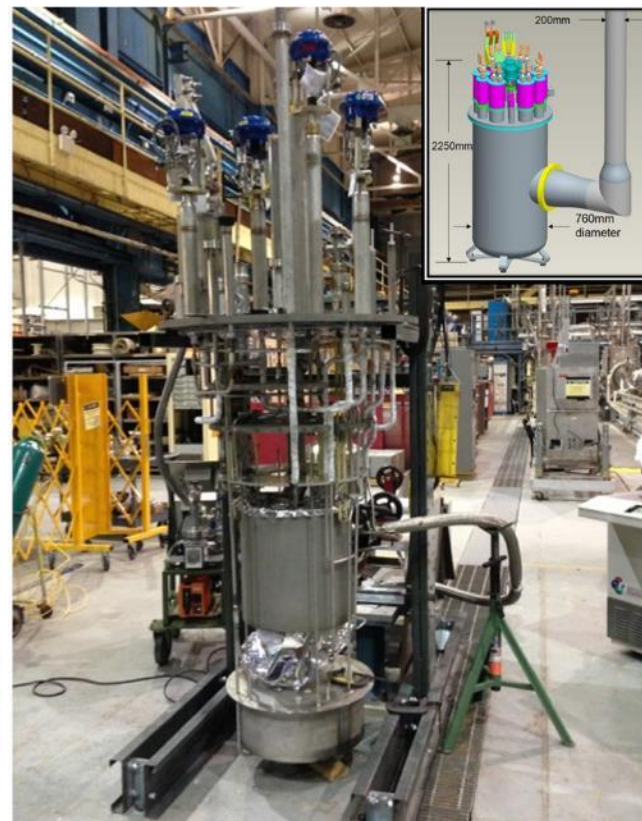
WP-prime 16: Final doublet design optimization

- ◆ Cooling of the superconducting ILC final focus magnets will be performed using 2K superfluid helium to realize superconducting magnets with high oscillation stability.
- ◆ Quantitative evaluation of the **vibration generated by the 2K cooling system** located on the side of the final focus magnets has not been completed.
- ◆ We will **measure and evaluate the vibration generated by the 2K cooling system** by using the prototype.

Vibration measurement system for SuperKEKB final focus magnet (KEK)



Prototype of ILC service cryostat (2K cooling system ; BNL)



BNL initiative will be essential for this item, and KEK is willing to cooperate.

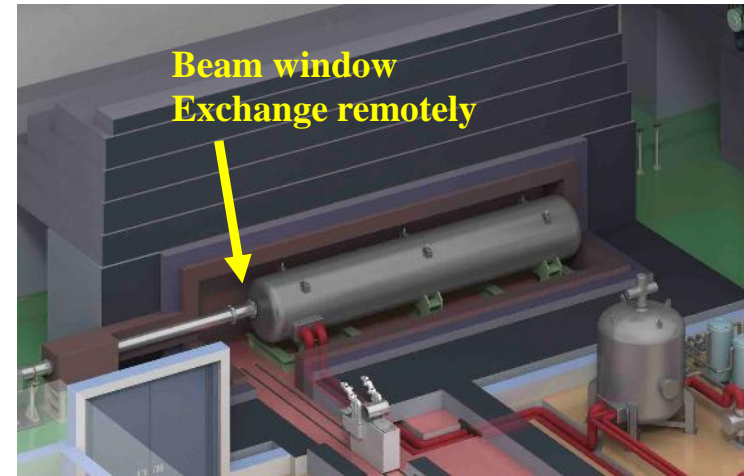
WP-prime 17: Beam Dump

WP-prime-17 related items conducted by KEK on ITN

- Design of earthquake-resistant structures
- Design of the water flow system, including the water vortex flow mechanism in the beam dump
- Design of the beam window exchange system
- The performance of the vortex flow mechanism and beam window exchange system will be evaluated using a prototype for functional verification.

Finalize the engineering design of the main beam dump system

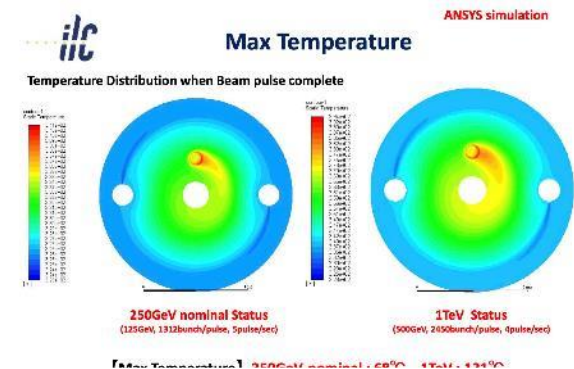
- Vortex water flow in the dump vessel
- Cooling water circulation and heat exchange
- Remote exchange of the beam window
- Countermeasure for failures / safety system



Timeline described in the time-critical work package document

Priority	Items	Y1	Y2	Y3	Y4
A	Engineering design of water flow system				
A	Engineering design and small-scale prototyping of vortex water flow system in the dump vessel.				
A	Engineering design and small-scale prototyping of beam window and its remote exchange system.				
A	Design of the countermeasure for failures / safety system				

The contents and timeline are roughly consistent with those of WPP-17.



ITN Tasks to be done with MEXT grant in JFY2023

WPP-15

- Renewal and upgrade of the ATF magnet system.
- Development of prototype vacuum chamber for ATF2 beamline to reduce wakefield.
- Development of prototypes of high-precision magnet mover control system.
- Partial renewal of the ATF beam timing control system.
- Design a prototype of a highly stable power supply for the ATF extraction kicker, and start procurement of necessary parts.
- Selection of high-power pulsed laser for the IP beam size monitor.
- Development of peripheral equipment for the IP beam size monitor.

In addition to upgrading and renewal of the above equipment at the ATF, we will verify the effect of the upgrade using the latest accelerator technology such as machine learning.

WPP-17

- Conceptual design of the water flow system for the ILC beam dump.
- Conceptual design of a beam window exchange system for the ILC beam dump.

I thank all of you for your cooperation with the ITN.

And also, I look forward to new contributions, and new other WPs for the ITN.