Future Direction for Industry-Academia Collaboration

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ALCW 2018
Asian Linear Collider Workshop 2018
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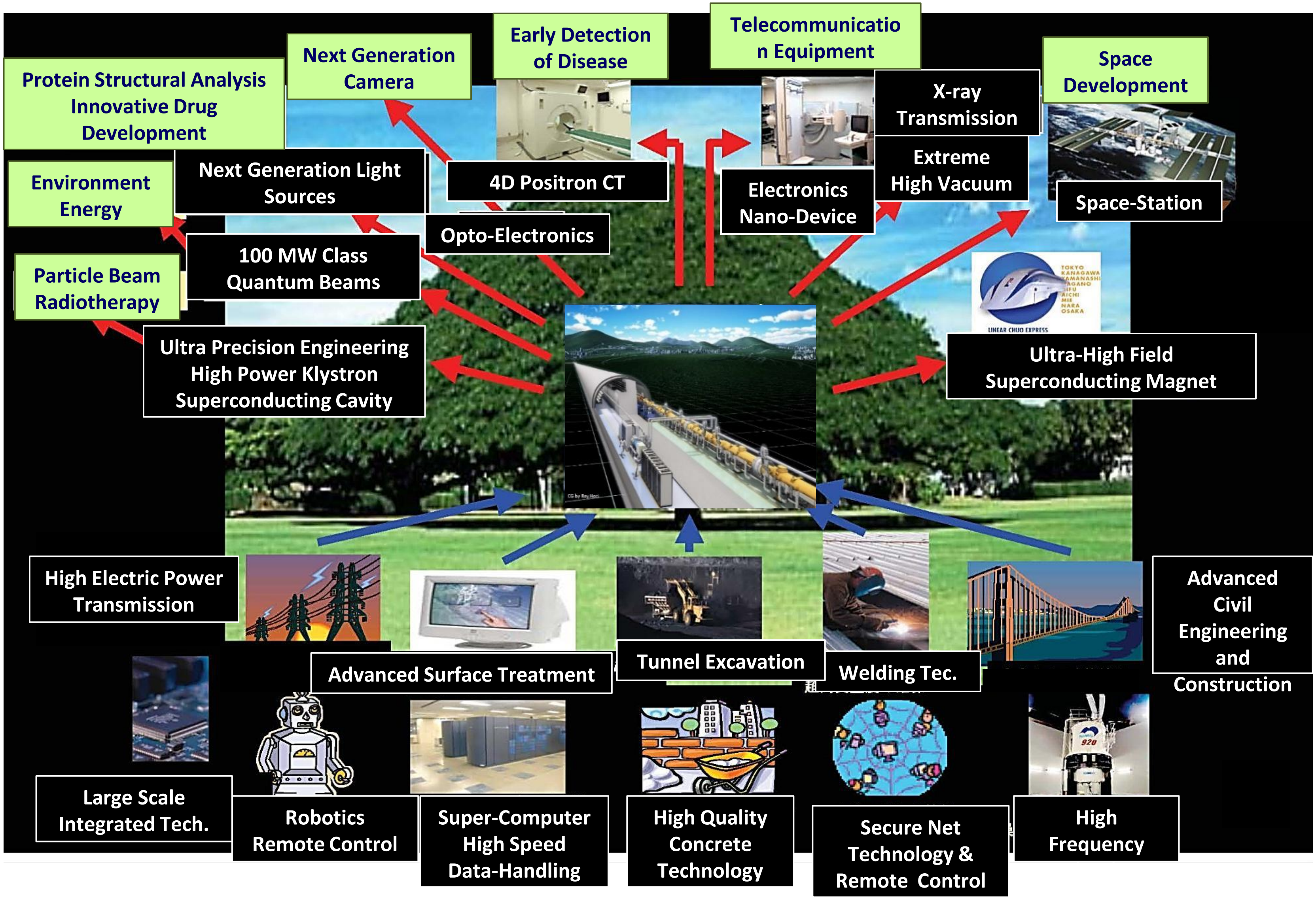
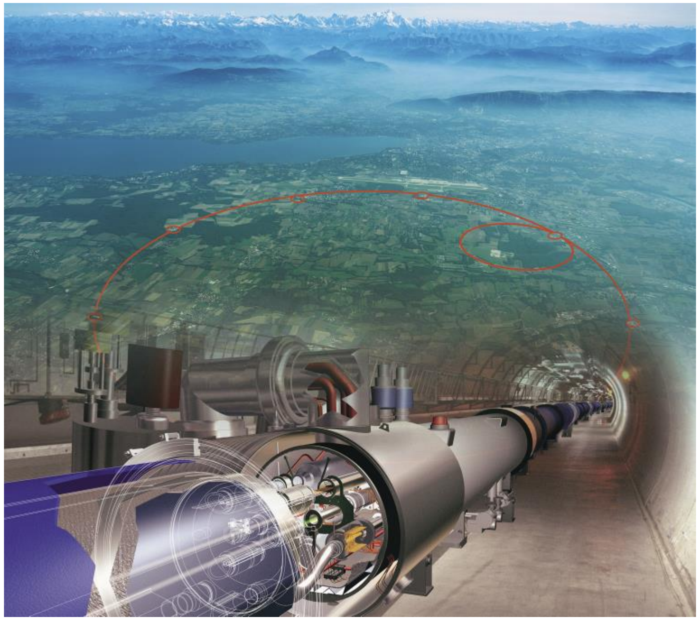
1. Rich Sources of Technological Innovation in ILC

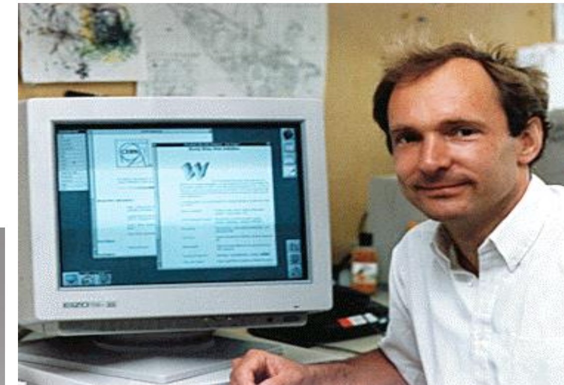


CERN



World Wide Web (WWW) in 1989

by Tim Berners-Lee (CERN)



IOT Society

Worldwide LHC Computing Grid (**WLCG**) :
international collaborative project that consists of a grid-based computer network infrastructure incorporating over 170 computing centers in 36 countries, as of 2012.

KEK

Few Innovative Technology Spin-Offs from KEK

CERN Staff Constitution (2011)

Researcher : 77 (3%)

Engineer : 1959 (78%)

Administrative : 388 (16%)

KEK Staff Constitution (2012)

Researcher : 362 (53%)

Technician : 160 (23%)

Administrative : 162 (24%)

collaborate

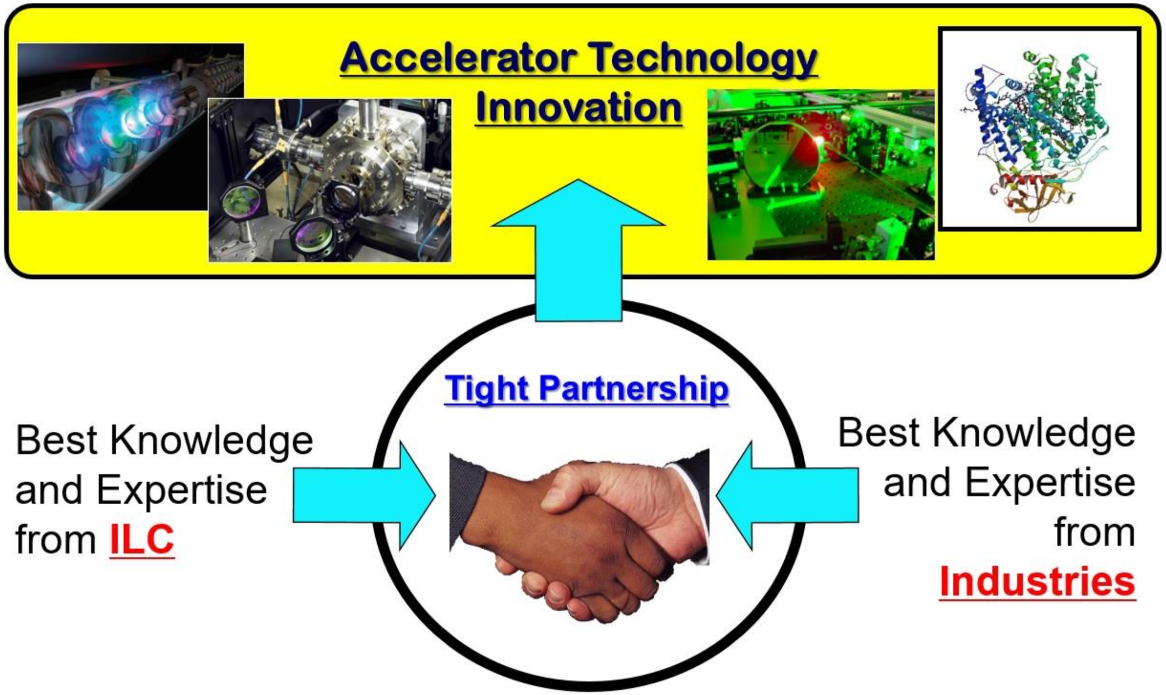
KEK Researchers

Industries Engineers

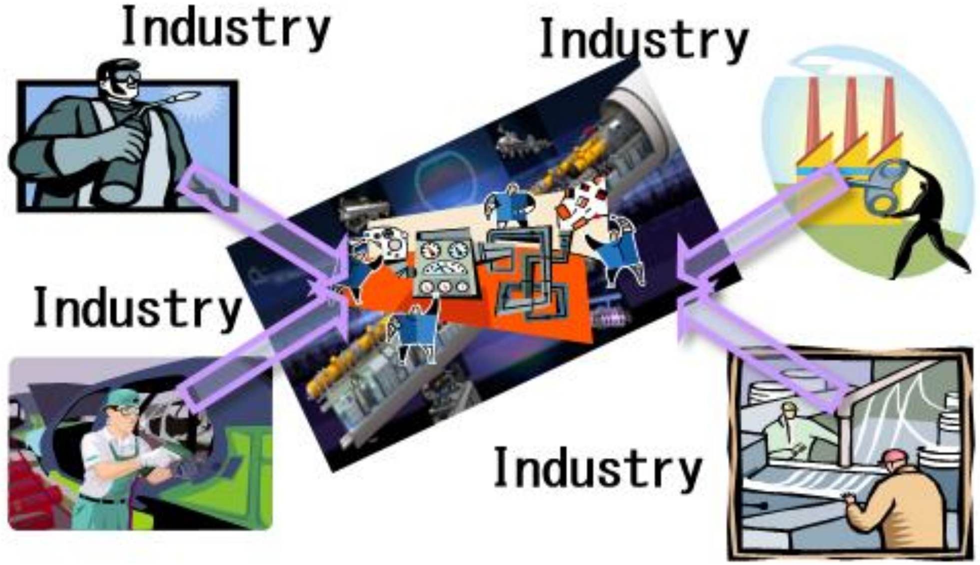
Central research labs. in industries are dwindling down

How to Encourage Technological Innovation in ILC

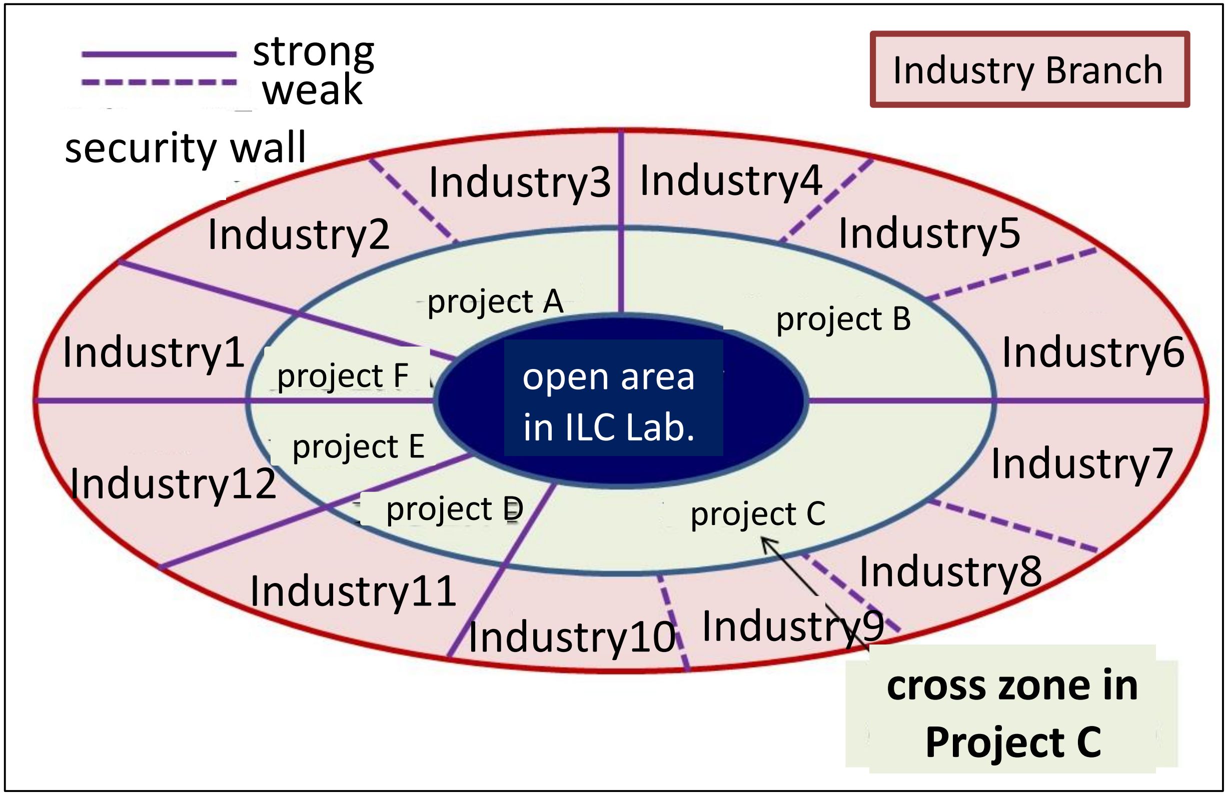
Feb. 21, 2008



Industry – ILC Lab. as One of ILC Facilities



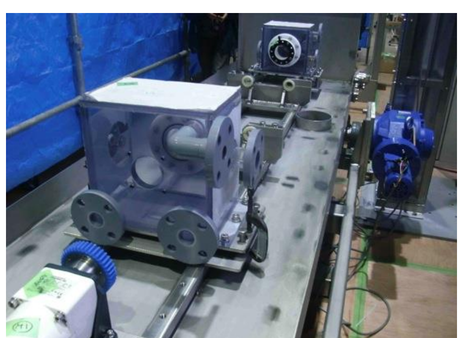
Possible Scheme of Industry-Academia Collaboration



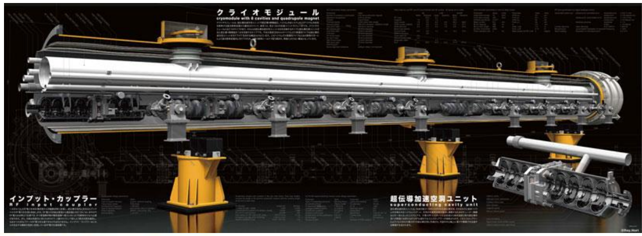
Industry – KEK Lab.

Possible Scheme of
Industry-Academia International
Collaboration in ILC

Feb. 2015



2. One Proposal : Port-Facility



- Cryomodule-process from manufacturing to installation inside the ILC tunnel

Euro-XFEL

Production in Overseas

overseas:

- manufacturing, composition, inspection・・・
- ↓ assembling
- ↓ high-pressure-gas inspection
- ↓ cooling & power test
- ↓ packaging into container

↓ shipping

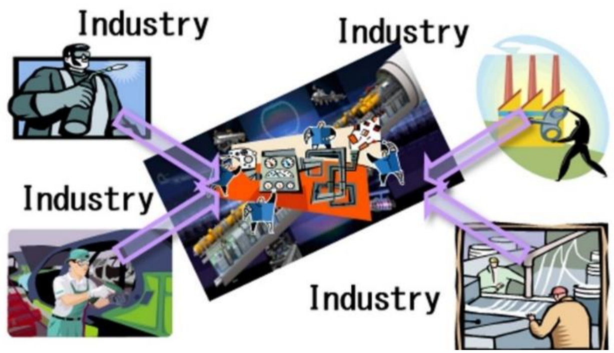
↓ ***Port Facility***:

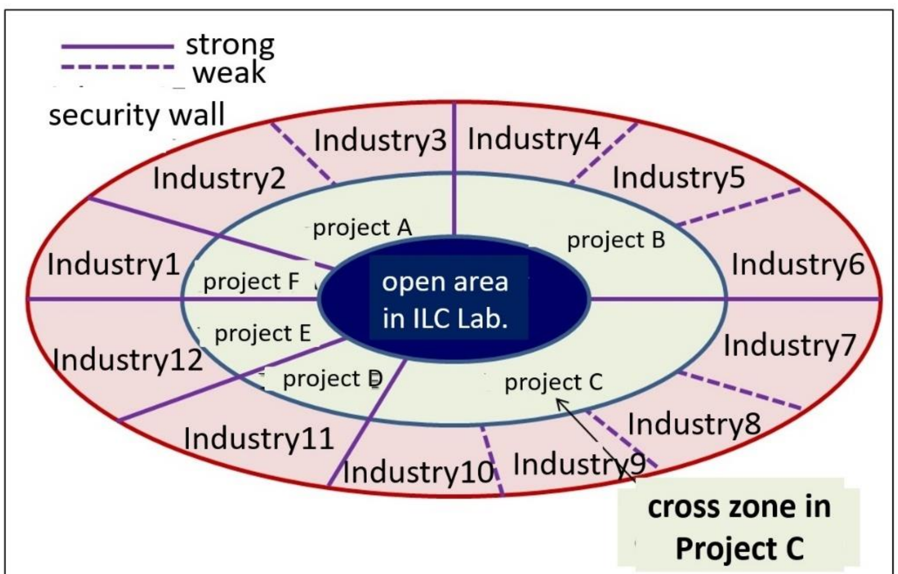
- import procedure & unpacking
- inspection, assembling & storage

↓ installation

Port Facility → **International Industry –ILC Lab. for Technology R&D and Innovation**

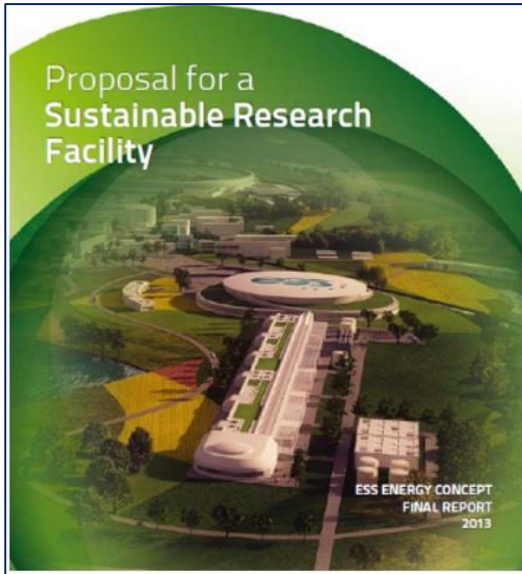
Industry – ILC Lab. as One of ILC Facilities

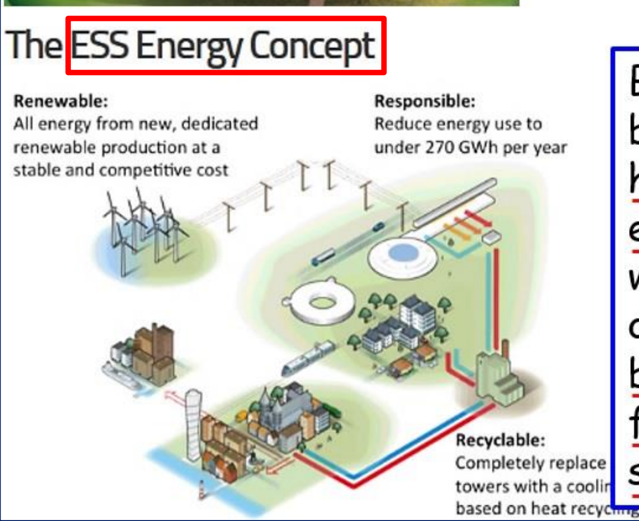




3. Essential Task for ILC

Environmentally Sustainable Research Facility





Foreword from the CEO of ESS

Not so long ago – but before it was settled that the European Spallation Source, ESS will be built in Lund, Sweden – two scientists, of which I had the fortune of being one, were discussing over lunch how to power such a facility in an environmentally friendly manner. On a napkin, that I still have in my drawer, we wrote down the outline to what has now been refined and will make ESS not only the world's leading research facility using neutrons, but also the first large-scale research facility that will be environmentally sustainable.

Back then, six years ago, society had recognised the necessity of using new methods in industry to prevent global warming. Since humans have tended to use more and more electricity over time, big hopes were set on technical development and scientific breakthroughs. Facilities like ESS would, in the future, enable scientists to understand and create new materials that, in turn, would ensure future products left a smaller environmental impact than products of the day.

Less thought has been given, however, on how to power research facilities, since they will actually need large amounts of electricity. If we connect them to the electrical grid without considering the source of the power, and if we just vent their waste heat out in the air or into water, a serious paradox appears: meeting the need for new and better products with increased air pollution and CO_2 emissions would clearly contradict the aim of the science performed at the research facilities.

When it came to deciding where to place ESS, the preferred bid, from Lund, would give the facility an environmentally sustainable design, using available knowledge and innovative techniques to make it CO_2 neutral within its life expectancy. This would also have a positive impact on operational costs, giving us more science for each euro spent.

Before it is settled that the ESS will be built in Lund, Sweden・・・We discussed how to power such a facility in an environmentally friendly manner・・・and wrote down to what will make ESS not only the world's leading research facility, but also the first large-scale research facility that will be environmentally sustainable.

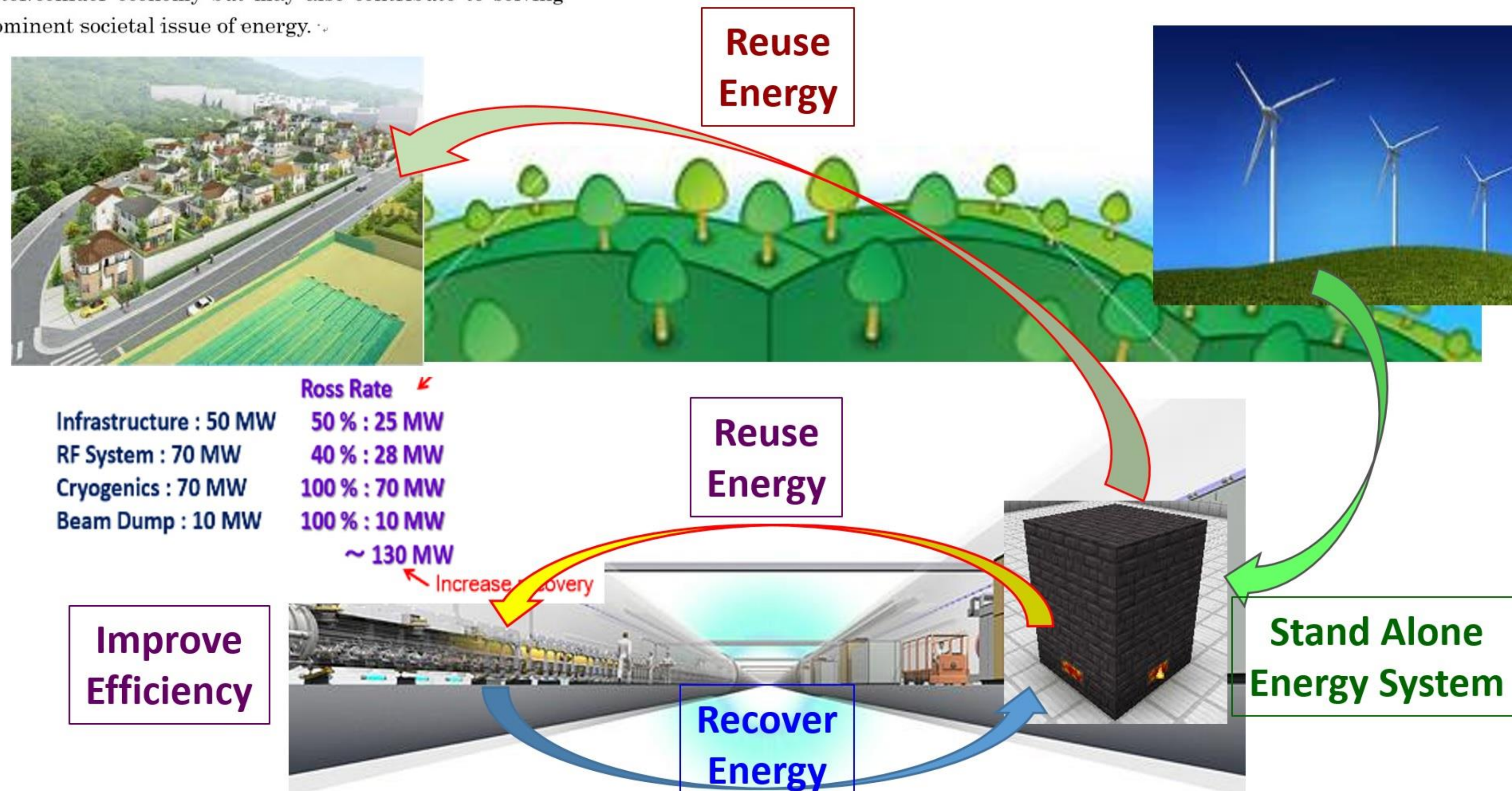
Request for ICFA Panel of Sustainable Accelerator/Collider

(2013 or 2014 ?)

1. Context

- Energy consumption and related running cost are major issues for many on-going and future accelerator/collider projects ranging from medical and industrial equipment to the highest energy or most intense research machines.
- The feasibility of HEP future infrastructures is strongly depending on the efficient implementation, both at the design and operation level, of energy saving/recovery/recycling schemes as well as on the injection of sustainable energies in the energy mix.
- Any progress done in the framework of flagship projects whose electrical consumption come close to large cities not only will impact the accelerator/collider economy but may also contribute to solving the most prominent societal issue of energy.

GREEN ILC

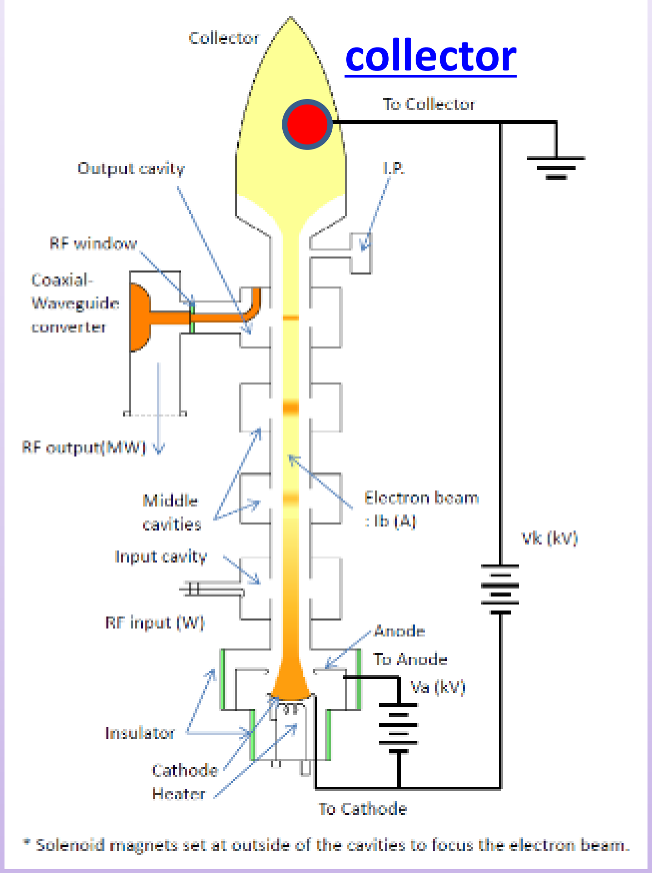


How to Improve RF Efficiency

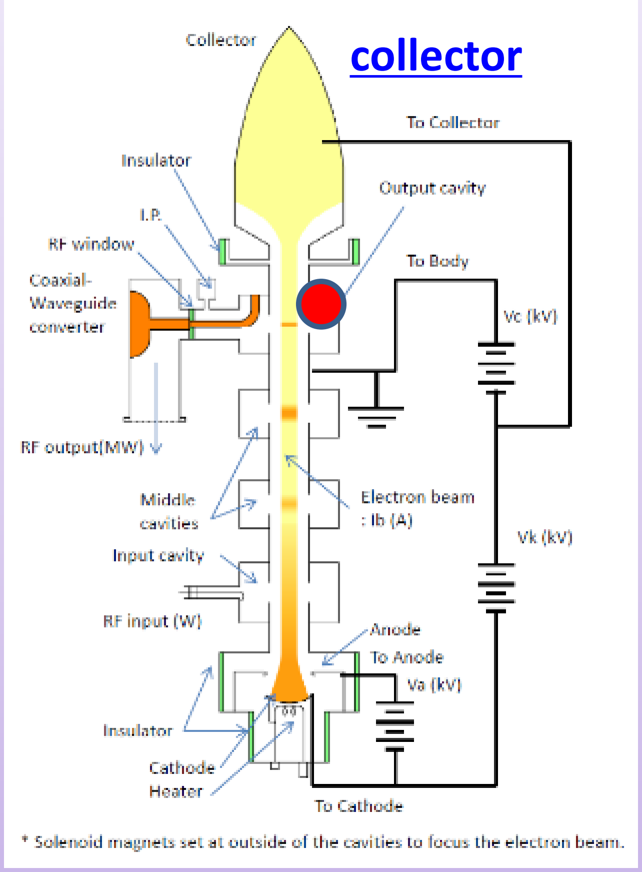
R&D of CPD (Collector Potential Depression) Klystron

CPD is an energy-saving scheme that recovers the kinetic energy of the spent electrons after generating rf power.

Conventional



Schematic diagram of CPD

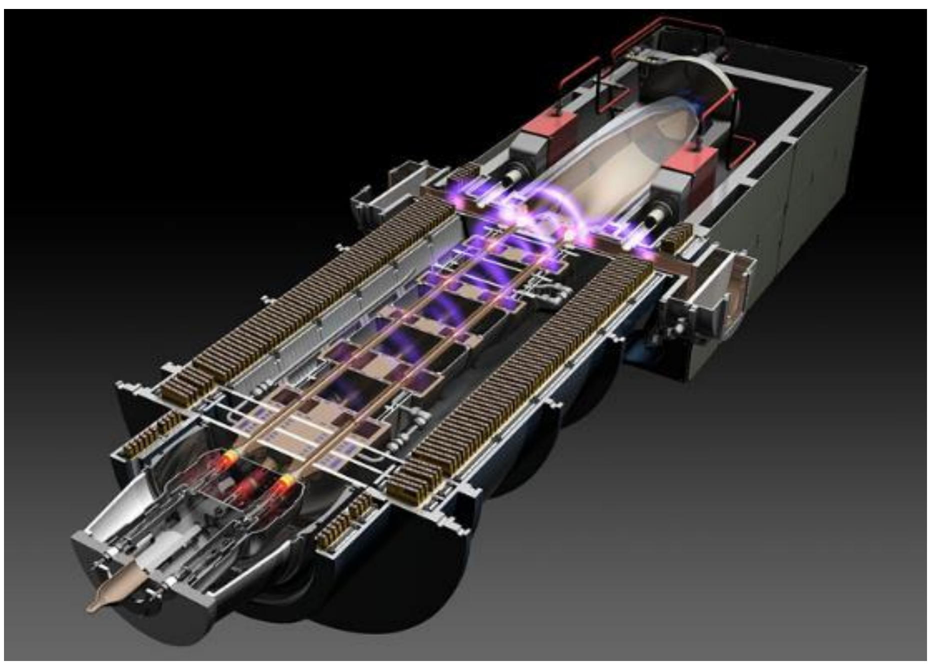


Multi(6) – Beam Klystron (MBK) for 26 Cavities for ILC

DEVELOPMENT OF TOSHIBA L-BAND MULTI-BEAM KLYSTRON FOR EUROPEAN XFEL PROJECT

Y. H. Chin, KEK, Tsukuba, Japan,
A.Yano, S. Miyake, TOSHIBA ELCTRON TUBES & DEVICES Co., Ltd., Ohtawa-shi, Japan,
S. Choroba, DESY, Hamburg, Germany

- **The design goal is to achieve 10 MW peak power with 65 % efficiency at 1.5 ms pulse length at 10 Hz repetition rates.**
- **MBK has 6 low-perveance beams operated at low voltage of 115 kV for 10 MW to enable a higher efficiency than a single-beam klystron.**

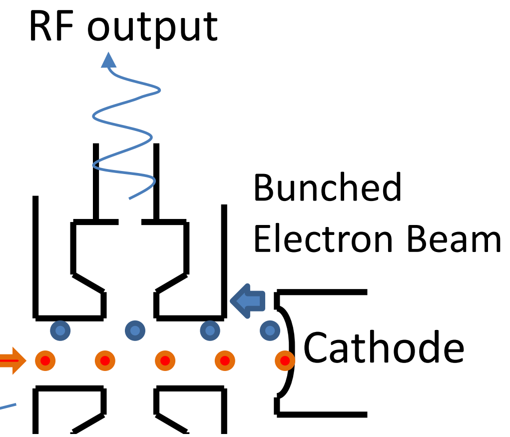


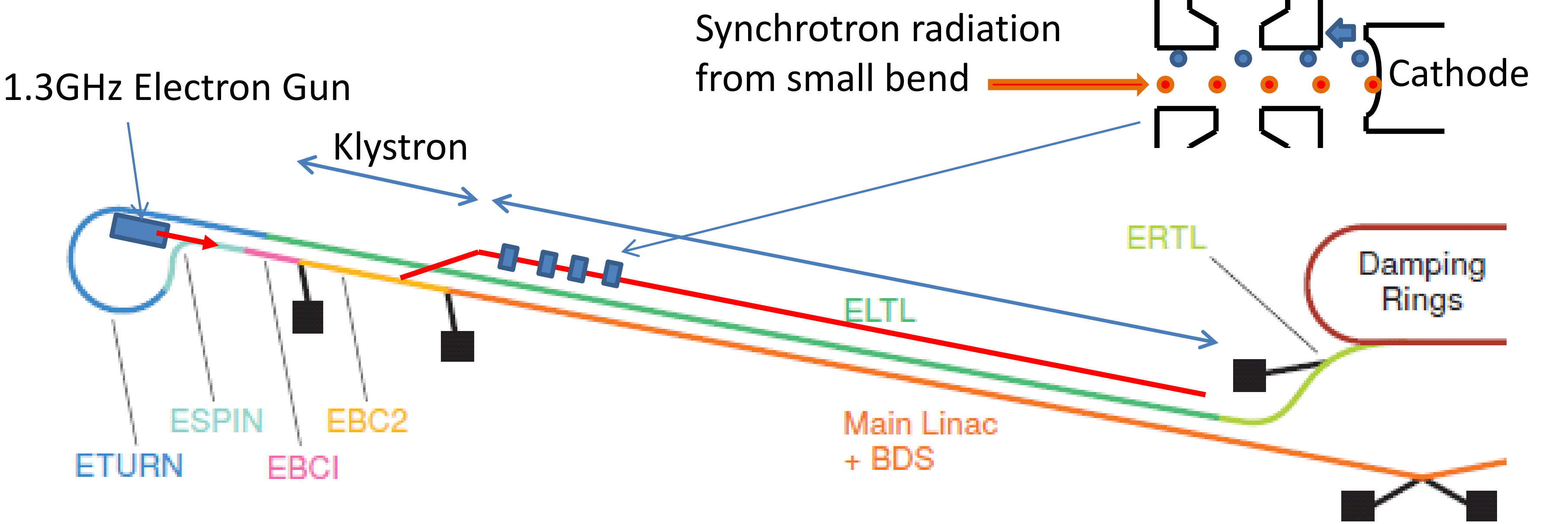
e 2: Electron Gun of the E3736.

Frequency	1.3 GHz
Peak power	10 MW
Pulse width	1.6 ms
Rep. rate	5 Hz
Average power	78 kW
Efficiency	65 %
Gain	47dB
BW (- 1dB)	3 MHz
Voltage	120 kV
Current	140 A
Lifetime	40,000 h

Completely Old/New Idea for Klystron

- **Synchrotron Radiation Electron Tube**





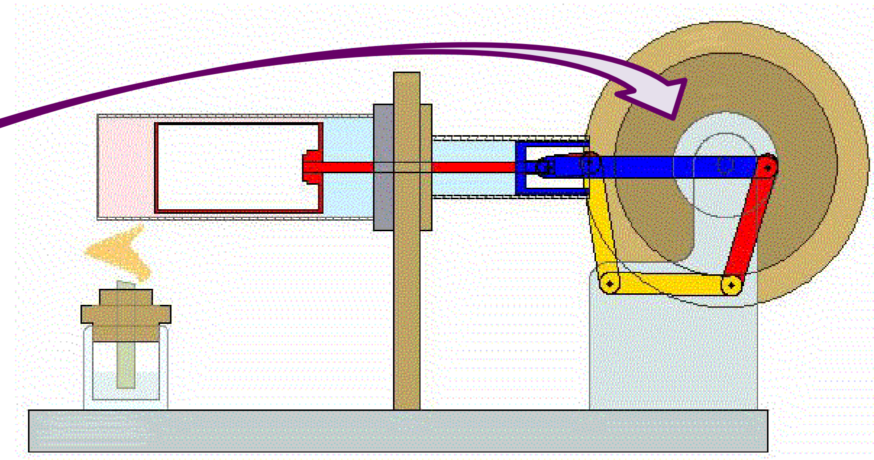
Advantages

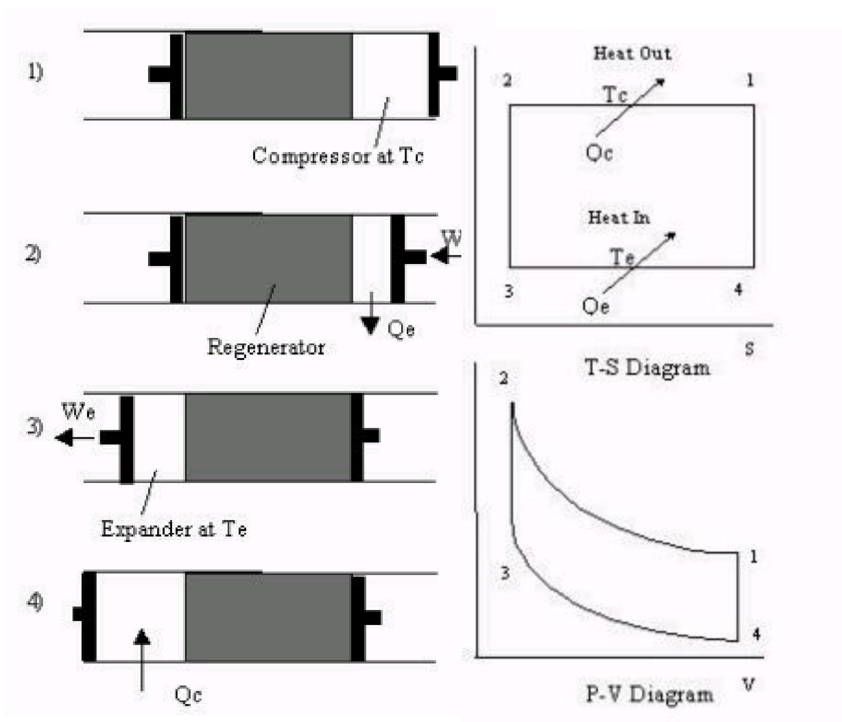
- > 90% efficiency (small transient time factor by short bunch)
- Stabled by space charge limit operation
- Drivn from low charge low energy 1.3GHz electron beam (1/10 klystron ?)
- Very low cost and long lifetime
- Low cost beam line
- No switch, only HV & capacitor

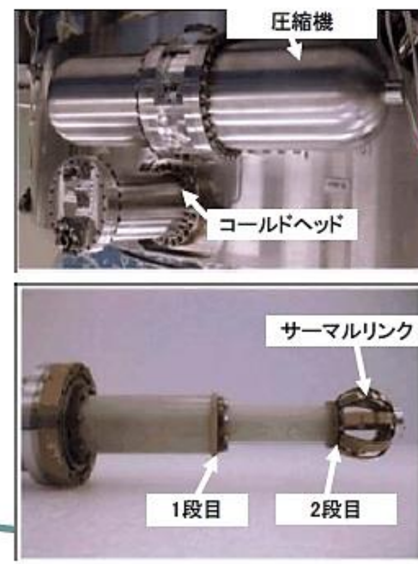
How to Save Power in Cryogenics

Cryogenics/Stirling Cryocooler

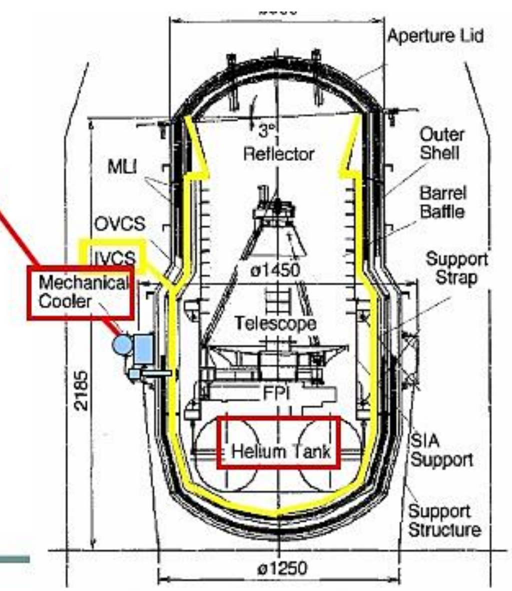
- High temperature operation
  - Klystron collector
  - RF Dummy load





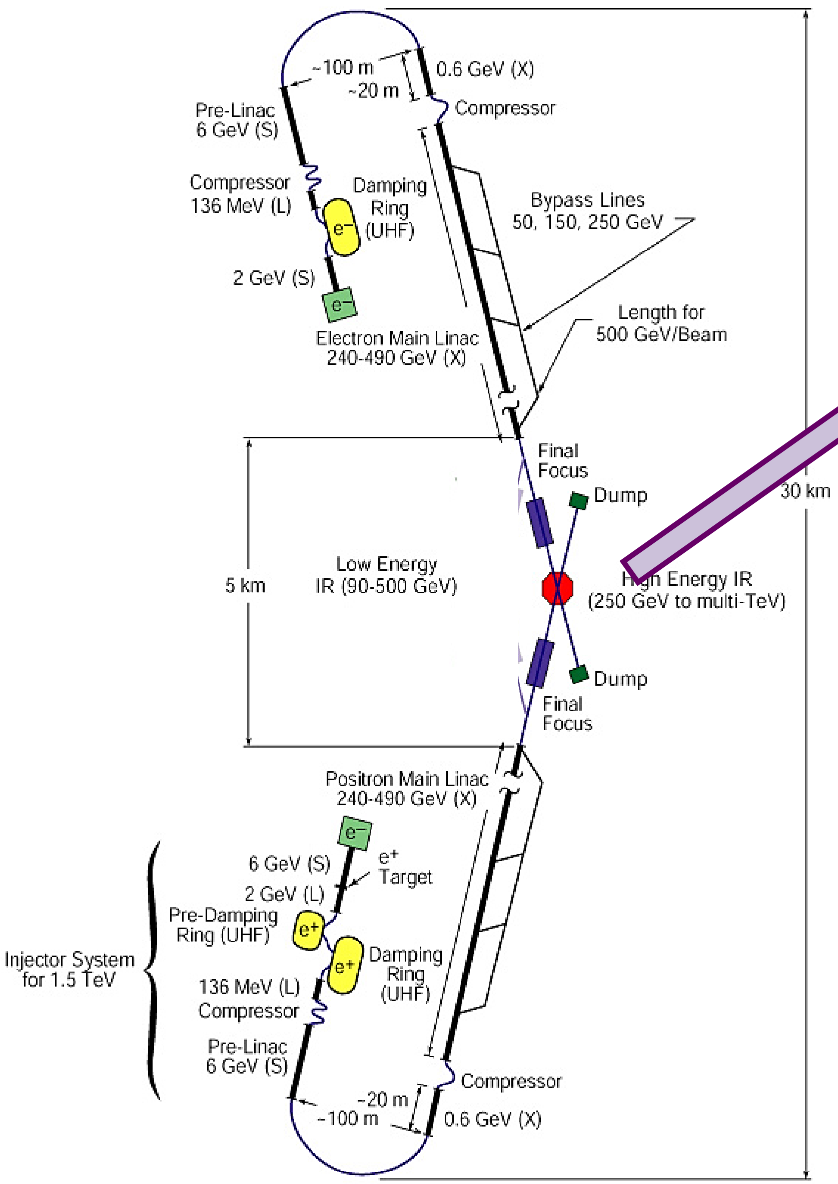


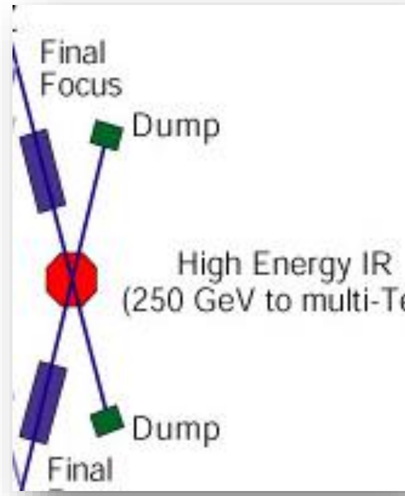
2段スターリング冷凍機



あかり(ASTRO-F)のミッション部

Recover Beam Dump Energy (~10 MW)





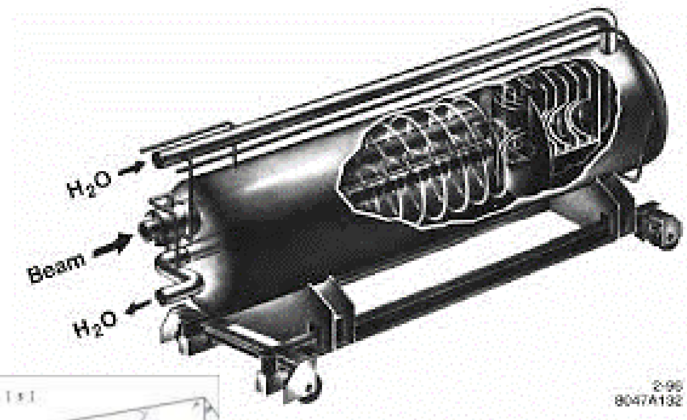
- Reuse Beam Energy
- Reduce Radio-Activation

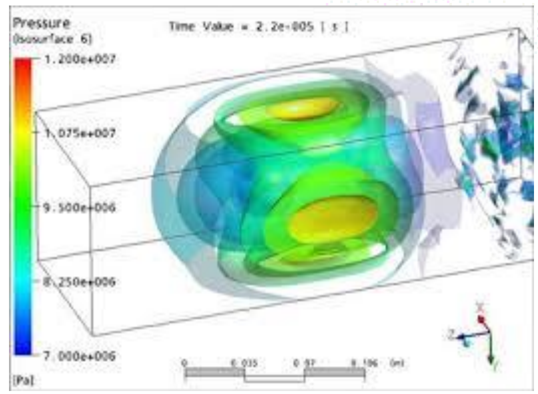
Water Dump

Water Vortex Dump
(25 m long x 15 m height for 1 TeV)

- Issue : shock wave management
- Issue : management of tritium gas and tritiated water in vapor form

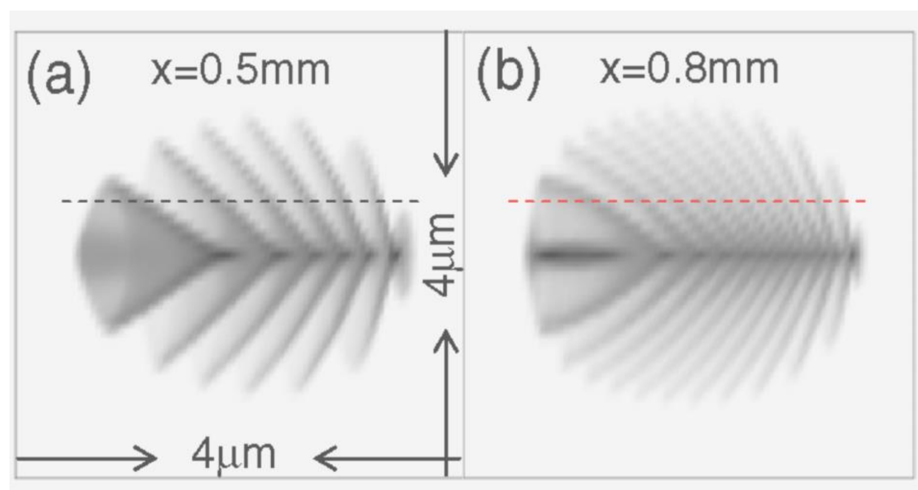
SLAC Dump for 800 kW





Noble Gas Dump

- About 1km of a noble gas (Ar looks the most promising) enclosed in a water cooled iron jacket (transport the heat).
- This gas dump design may ease some issues such as radiolysis and tritium production.
- Issue : particle beam heating of the gas and ionization effects.



Waste Heat Recovery and Utilization

- Back-end Energy Flow

  Cooling Water → **Heat Recovery** → Cooling Tower

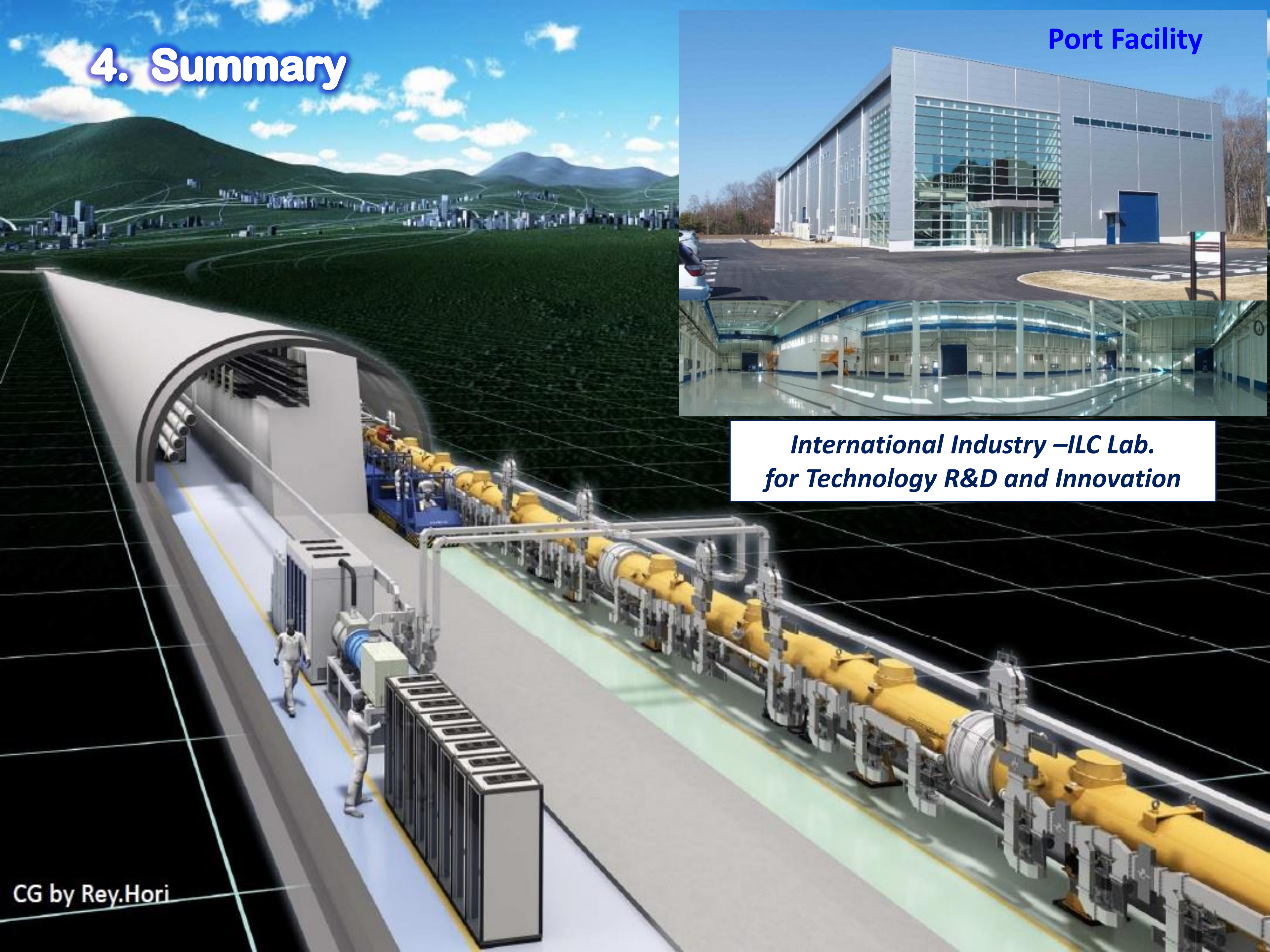
- Heat Recovery

  HASClay : inorganic porous material for low grade heat source

some projects in alliance with local companies

Agriculture, Forestry & Fishery

4. Summary



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