ILC
International Linear Collider

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1. Future Colliders
2. ILC physics motivations
3. ILC Accelerator Overview
4. ILC, the global project

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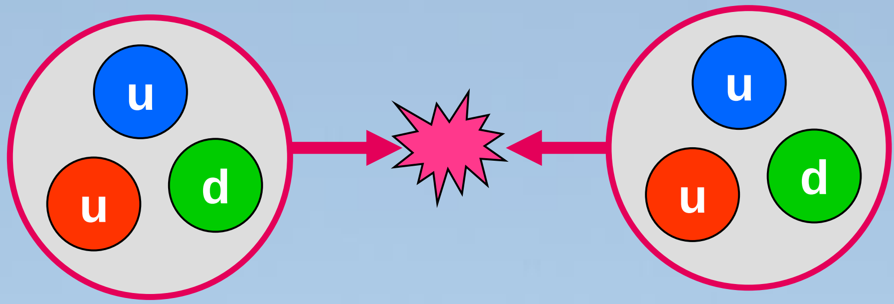
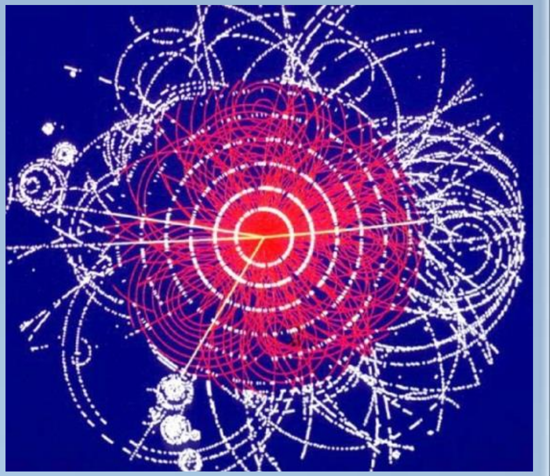
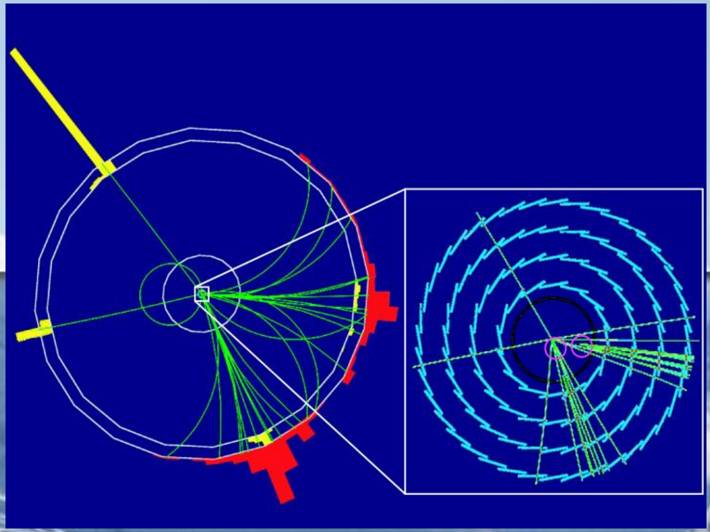
Hadron Collider and Lepton Collider

Proton Collider





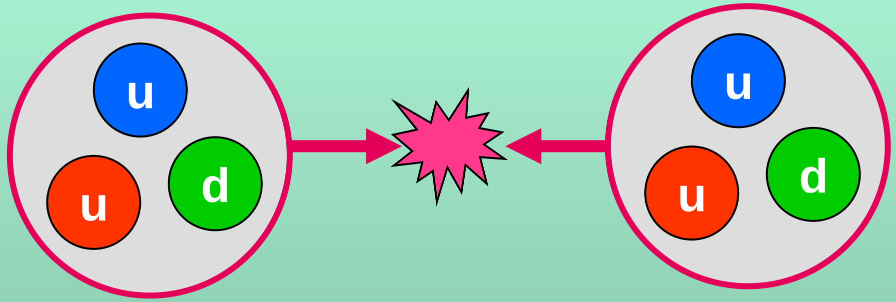
Lepton Collider

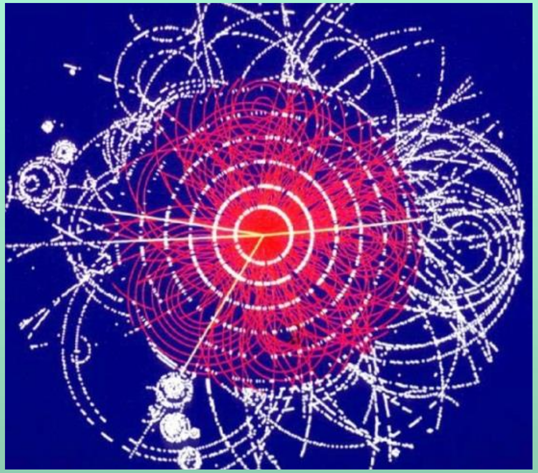


Hadron Collider

- Proton is a composite particle.
- Actual collision is made by partons (quarks and gluons).
- Each collisions have different initial states which we do not know.
- Interaction is complicated.
- Potential energy reach is very high.

Hadron Collider

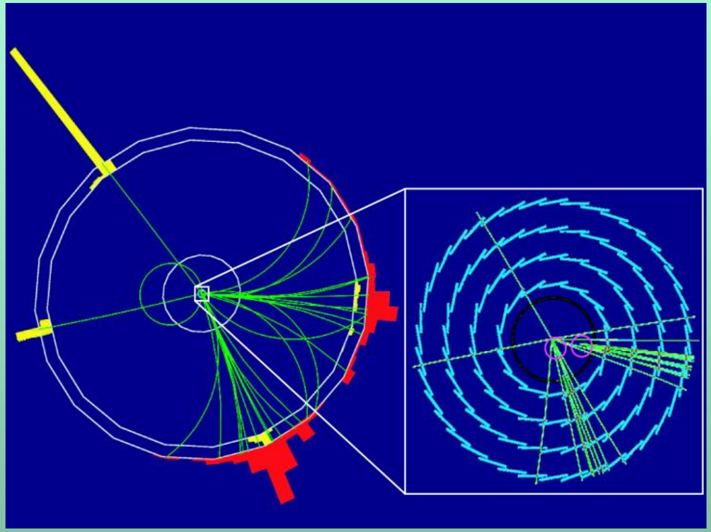




Lepton Collider

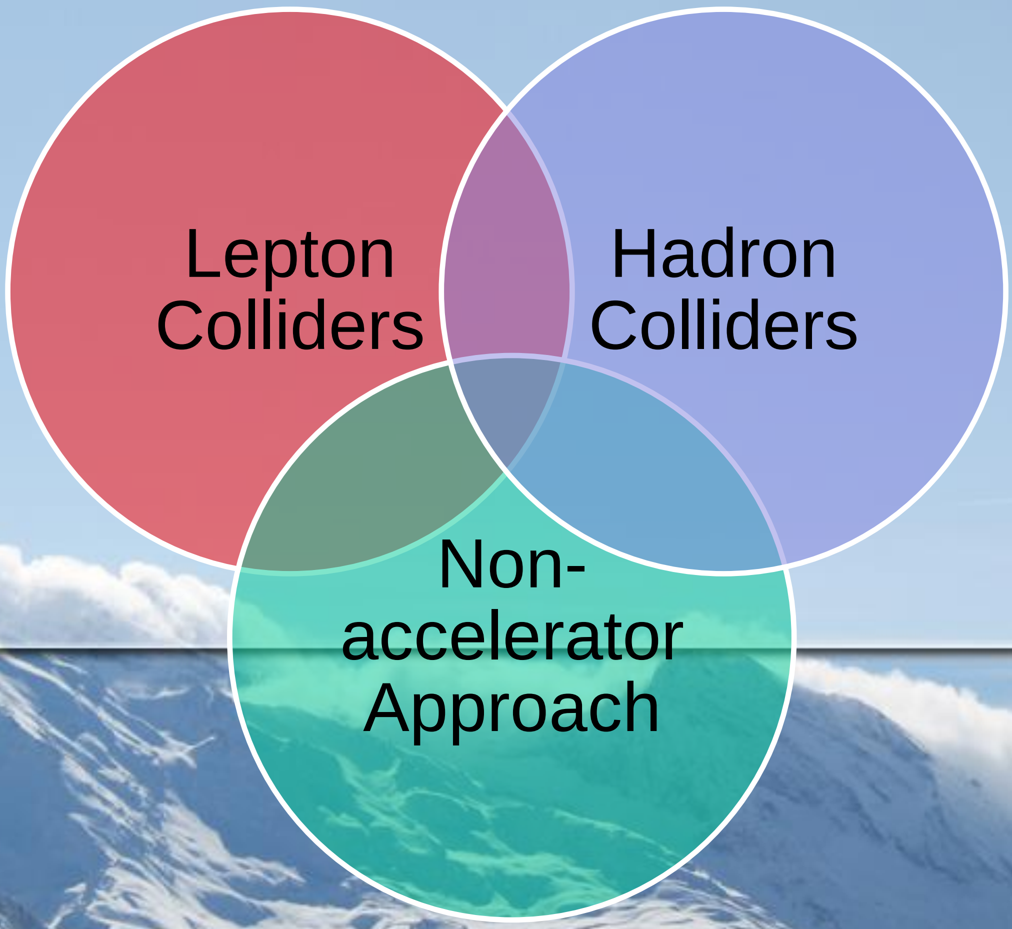
- Lepton is an elementary particle.
- Each collisions have same initial states. Full reconstruction of the event is possible.
- Interaction is simple.
- No energy reach beyond CME (Center of Mass Energy).

Lepton Collider



Lepton Colliders and Hadron Colliders

Both colliders are inseparable and important.



Era of Huge Ring Colliders: Tevatron

FNAL

Proton-antiproton

circumference 6.3km

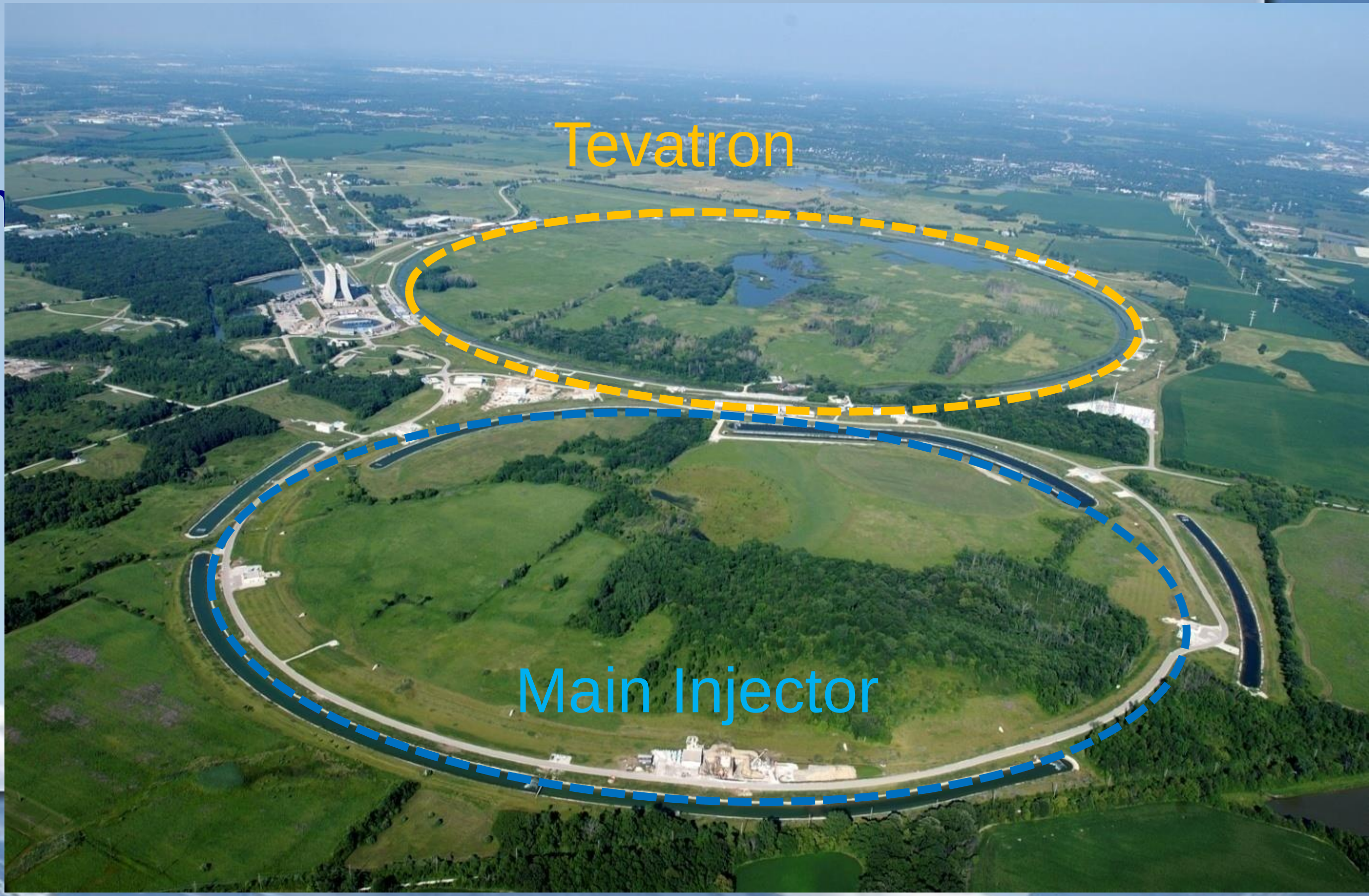
up to ~1TeV

Completed in 1983

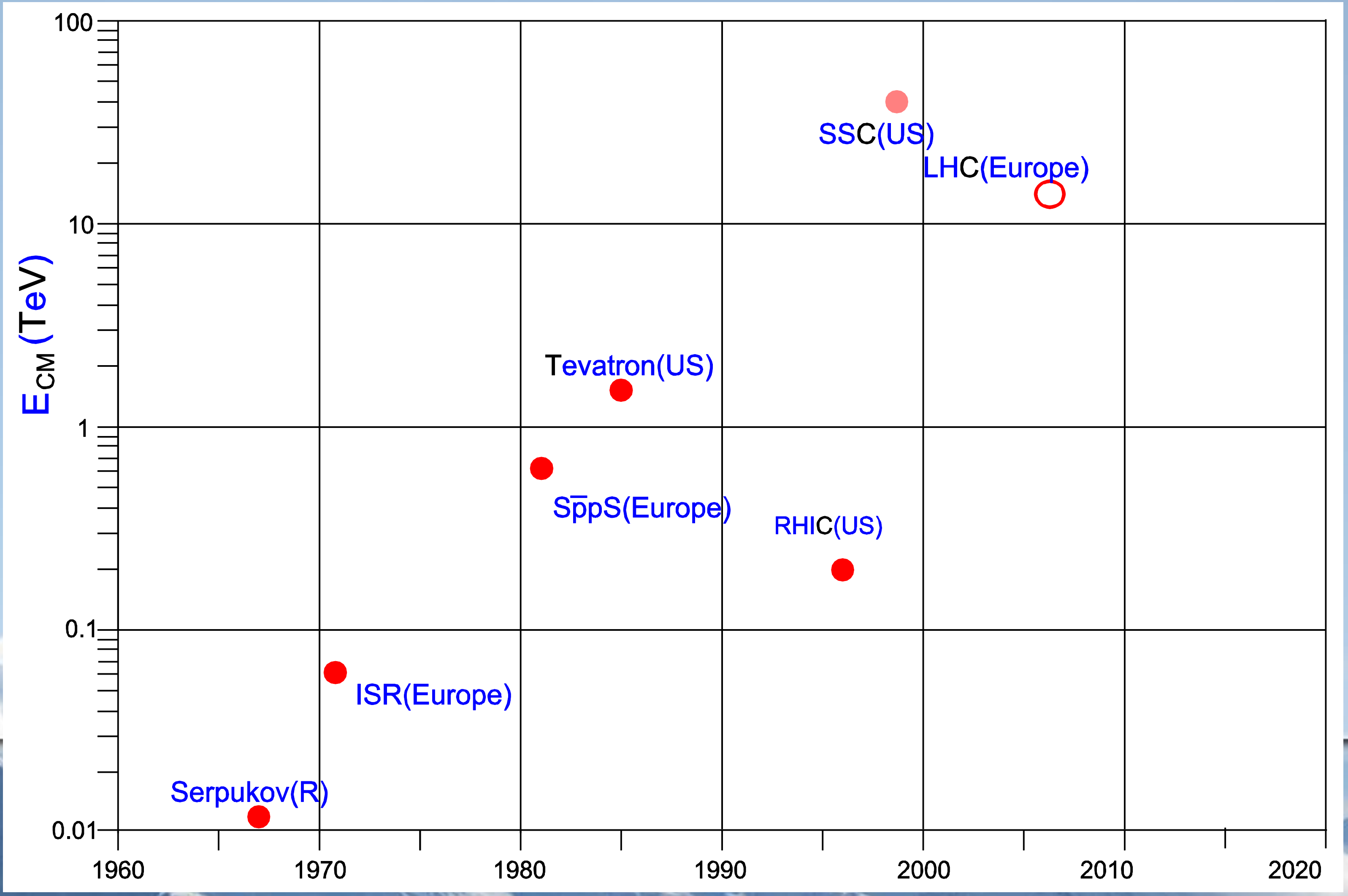
Superconducting magnet 4.2Tesla

1995 Top Quark

2009 shutdown



Evolution of Proton/Antiproton Colliders



Era of Huge Ring Colliders: LEP

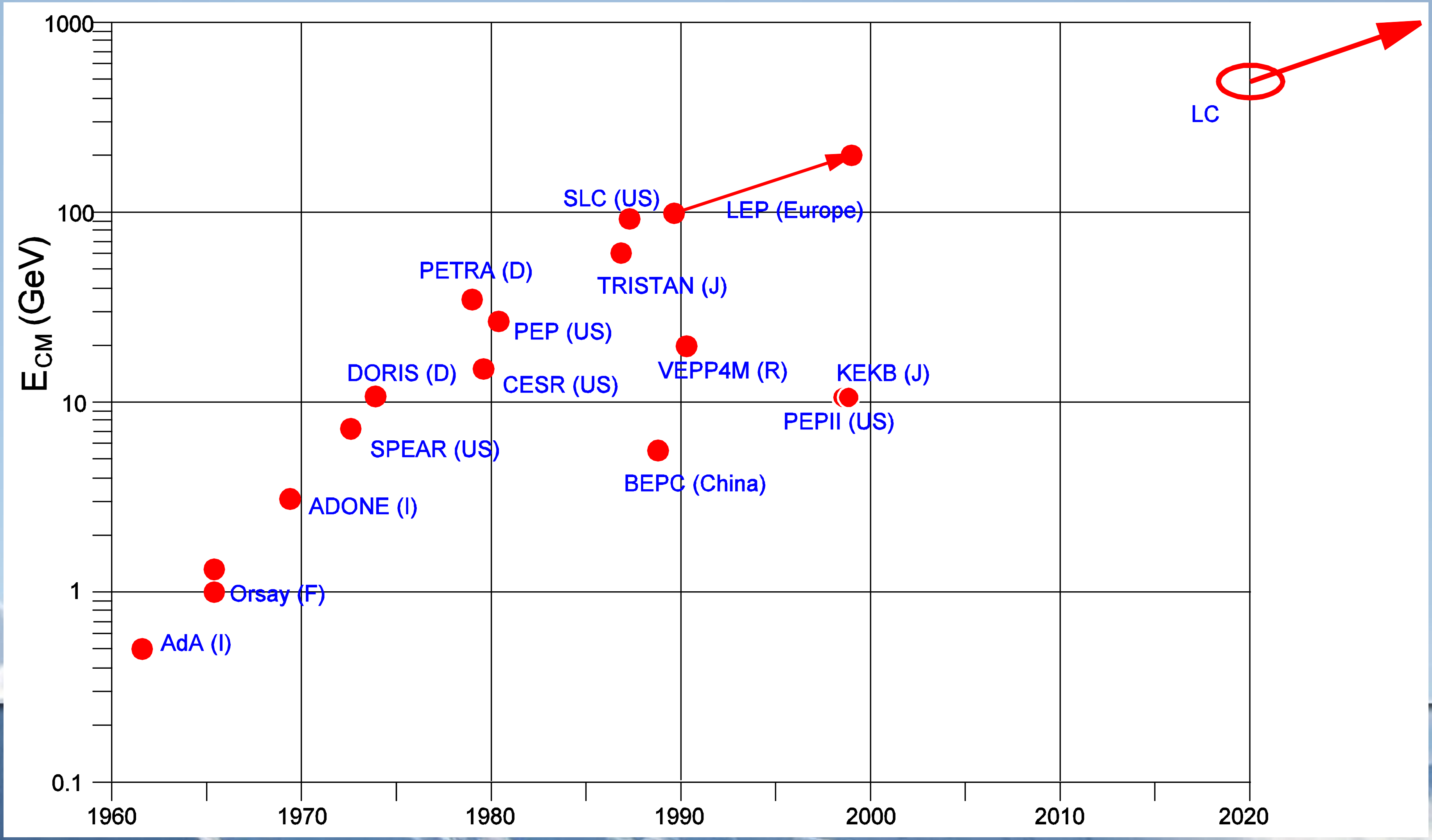
LEP (Large Electron-Positron Collider)

CERN

Construction started in 1983, operation in 1989

- circumference 27km
  - First target Z^0 at 92GeV
  - Final beam energy 104.5GeV
  - end in 2000

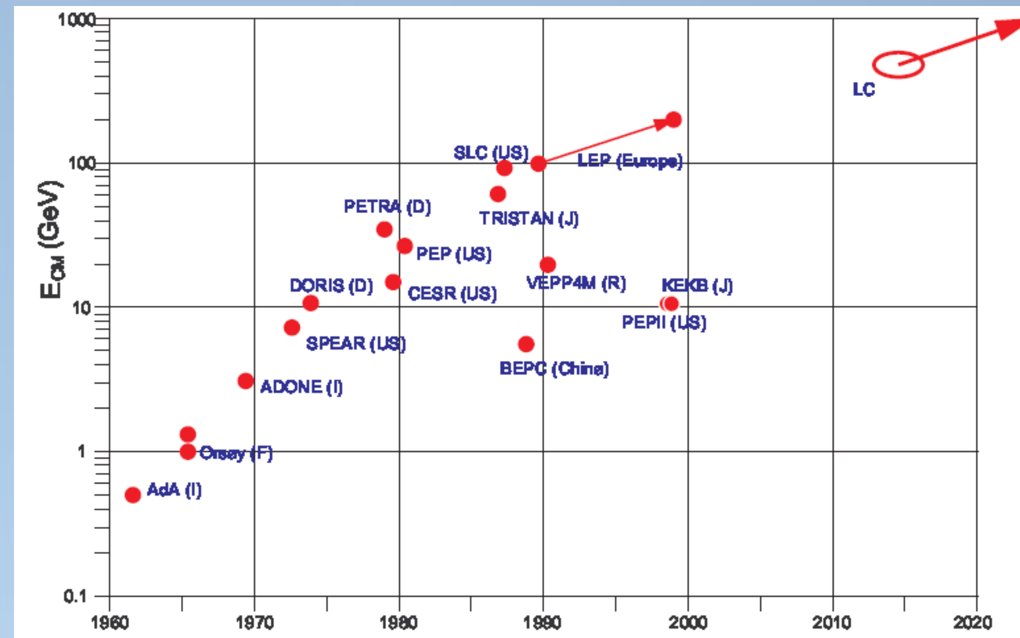
Evolution of Electron-Positron Colliders

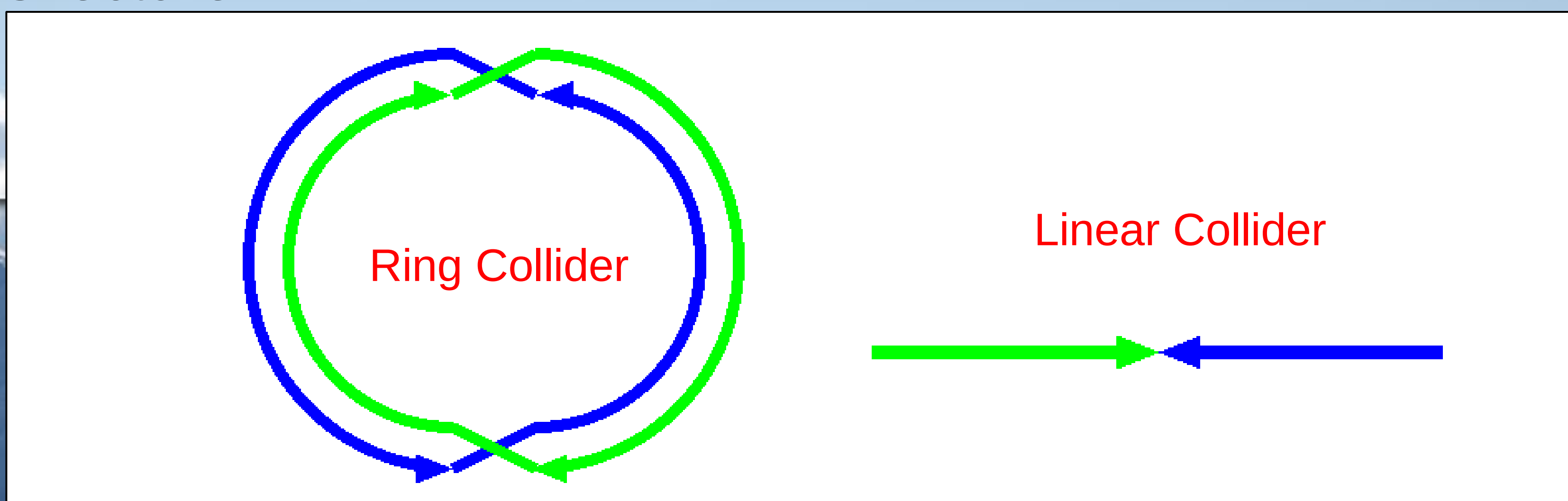


Many Ring Colliders

and a Linear Collider

- History of collider is history of high energy physics in the last half of 20th century.
- They are ring colliders except one (SLC).
- The reason is a key issue of this lecture.





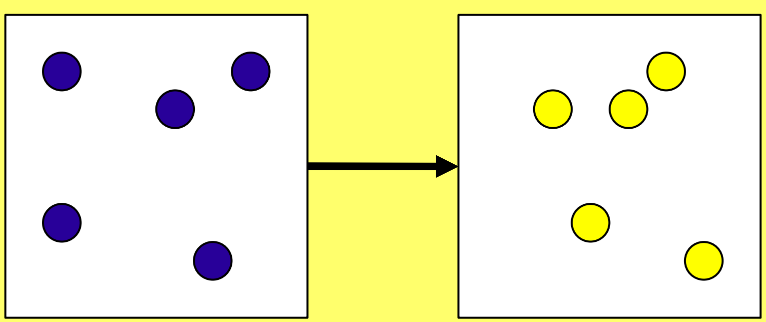
Luminosity Is essential for Colliders

- Event rate ＝ Performance of Collider

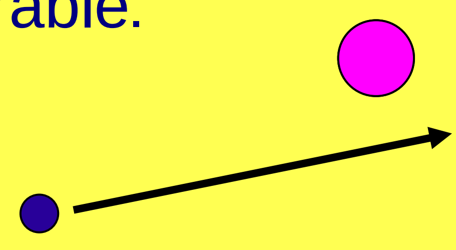
$$N[s^{-1}] = L[cm^{-2}] \times \sigma[cm^2]$$

L: Luminosity, particle flow rate. Operable.

$$L = \frac{f\,N^2}{4\pi\sigma_x\sigma_y}$$

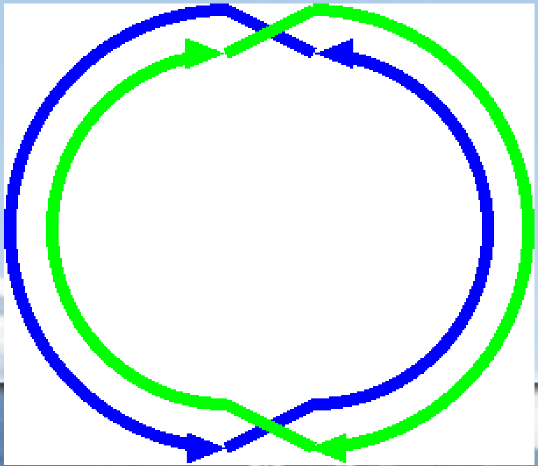


σ: cross section. Effective area for interaction. Not operable.



Why Ring Collider?

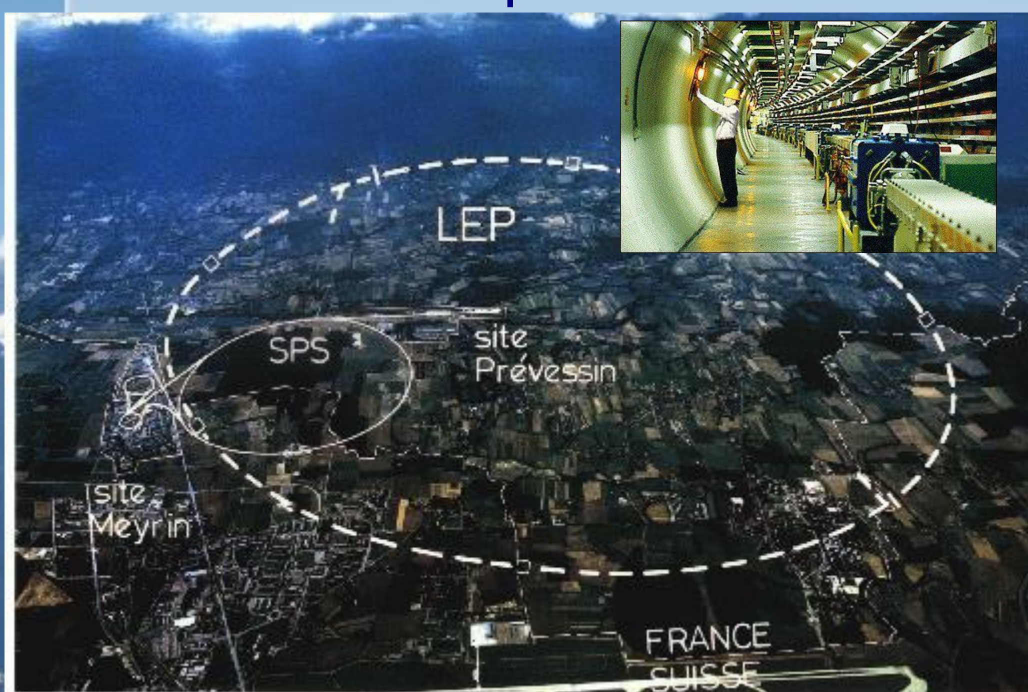
- All colliders ever built are ring colliders except SLC.
- The same bunch beam cycles many times in the orbit, the crossing rate can be very large.
- A large luminosity can be easily obtained because of high *f*.



$$L = \frac{f N^2}{4\pi\sigma_x\sigma_y}$$

LEP accelerator

- Circumference 27km. It was at CERN, Geneva, Swiss.
- Operation started in 1989. The energy was 45 GeV x 45 GeV at Z^0.
- The operation ended in 2000. Maximum energy was 104 GeV x 104 GeV.
- LHC is now placed in this tunnel.



Keep Going?

- Ring hadron colliders and lepton colliders have been constructed.
- SM of particle physics has been established by many experiments at these facilities.
- Can we keep this way in this 21st century?
- If we have to change our strategy, why?

Synchrotron Radiation

- Why LEP stopped the operation at CME 209GeV? The was very close to see the 125GeV Higgs. （Z^0H production threshold energy is 215 GeV).
- 209GeV was the maximum energy which was possible with LEP.
- The reason ： Synchrotron Radiation

$$P[turn^{-1}] = \frac{4\pi}{3} e^2 \frac{\beta^4 \gamma^4}{\rho}$$

- 2GeV of 104 GeV is lost per turn. Huge power is required to recover this loss.

Synchrotron Radiation

- Huge energy loss by the synchrotron radiation is a big obstacle for e+e- ring colliders.

$$P_e\left(\frac{GeV}{turn}\right) = 8.86 \times 10^{-5} \frac{E^4(GeV^4)}{\rho(m)}$$

- The Synchrotron radiation is much less for proton

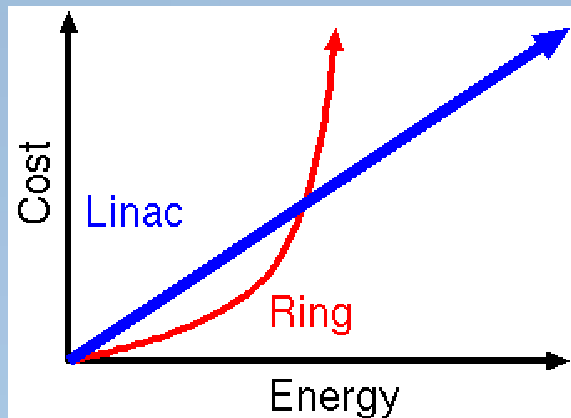
$$\frac{P_p}{P_e} = \left(\frac{m_e}{m_p}\right)^4 = 8.80 \times 10^{-14}$$

- Thanks for the heavy mass of proton, proton collider energy is not currently limited by SR. Actual limitation is B field.
- That is also true for muon colliders. In case of muon collider, cooling method and its short life are the biggest issue.

Brake!

- Due to the huge energy loss by SR, lepton (e+e-) ring collider is not realistic above 100 GeV beam energy.
- Required power to maintain the circulated beam is increased as fourth order of the beam energy.
- Construction and operation cost is dominated by this recover power. It is also proportional to 4^{th} order of the beam energy.
- Lepton Ring collider is now in dead-end. We have to find another way.
- That is Linear Collider.

Ring collider and Linear collider



not at all

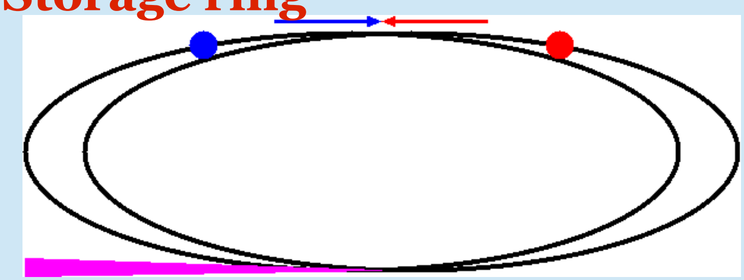
Energy loss

$$\Delta E = \frac{C_\gamma E^4}{\beta \rho}$$

Huge loss
at high energy

LINAC

Storage ring



Electron-Positron Linear Collider

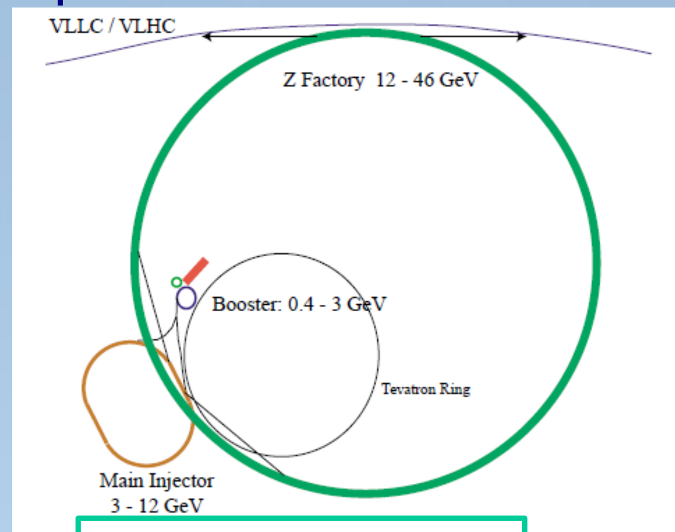
- Electron and positron will be accelerated by linac.
- Because of the one path topology, the issues are
  - Acceleration gradient: accelerator length has to be reasonable.
  - Enough Luminosity: Can we recover the small f?

Revival of e+e- Ring Colliders ?

To create Higgs by e+e- → ZH requires E_{CM}~240GeV

This is not too high compared with the final energy 209GeV at LEP

FNAL site filler (16km)



VLCC (233km)

SuperTRISTAN (40km, 60km)

pp collider

e^-e^+ Higgs Factory

CHF (China) (50km, 70km)

LEP3 (27km), TLEP (80km)

Synchrotron Radiation Loss

$$U = 0.088 \frac{E^4[\mathrm{GeV}]}{\rho[\mathrm{m}]} \quad [\mathrm{MeV}]$$

- This (almost) determines RF voltage per turn
  - ~7GeV in LEP tunnel
  - Still possible owing to the improvement of superconducting cavity technology
- But, the required electric power is huge! Real limitation comes from the wall-plug.
- US power consumption : 400GW.

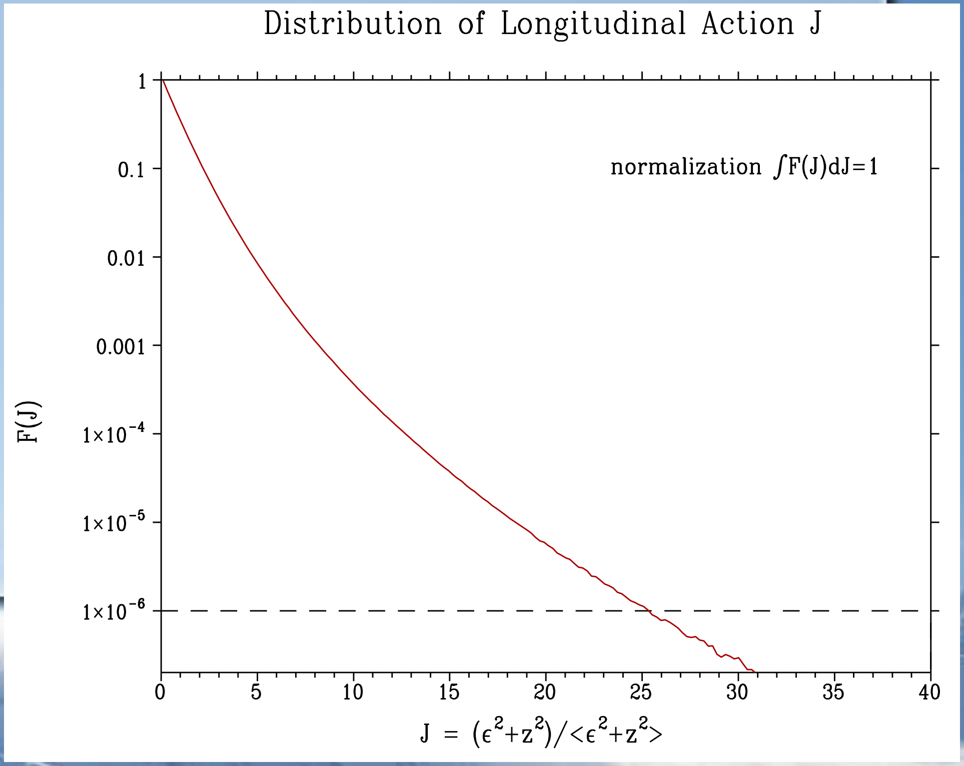
Beamstrahlung of e⁺e⁻ Ring Colliders

Beamstrahlung causes significant energy loss

$$\Upsilon_{max} \approx \frac{2Nr_e^2\gamma}{\alpha\sigma_z(\sigma_x+\sigma_y)}$$

$$\frac{dW}{d\omega} \propto \exp\left[-\frac{2\omega}{3\Upsilon(E_e-\omega)}\right]$$

- Particles with large energy loss will be lost.
- Short beam lifetime.
- Hence, ring colliders are much more fragile than LCs.

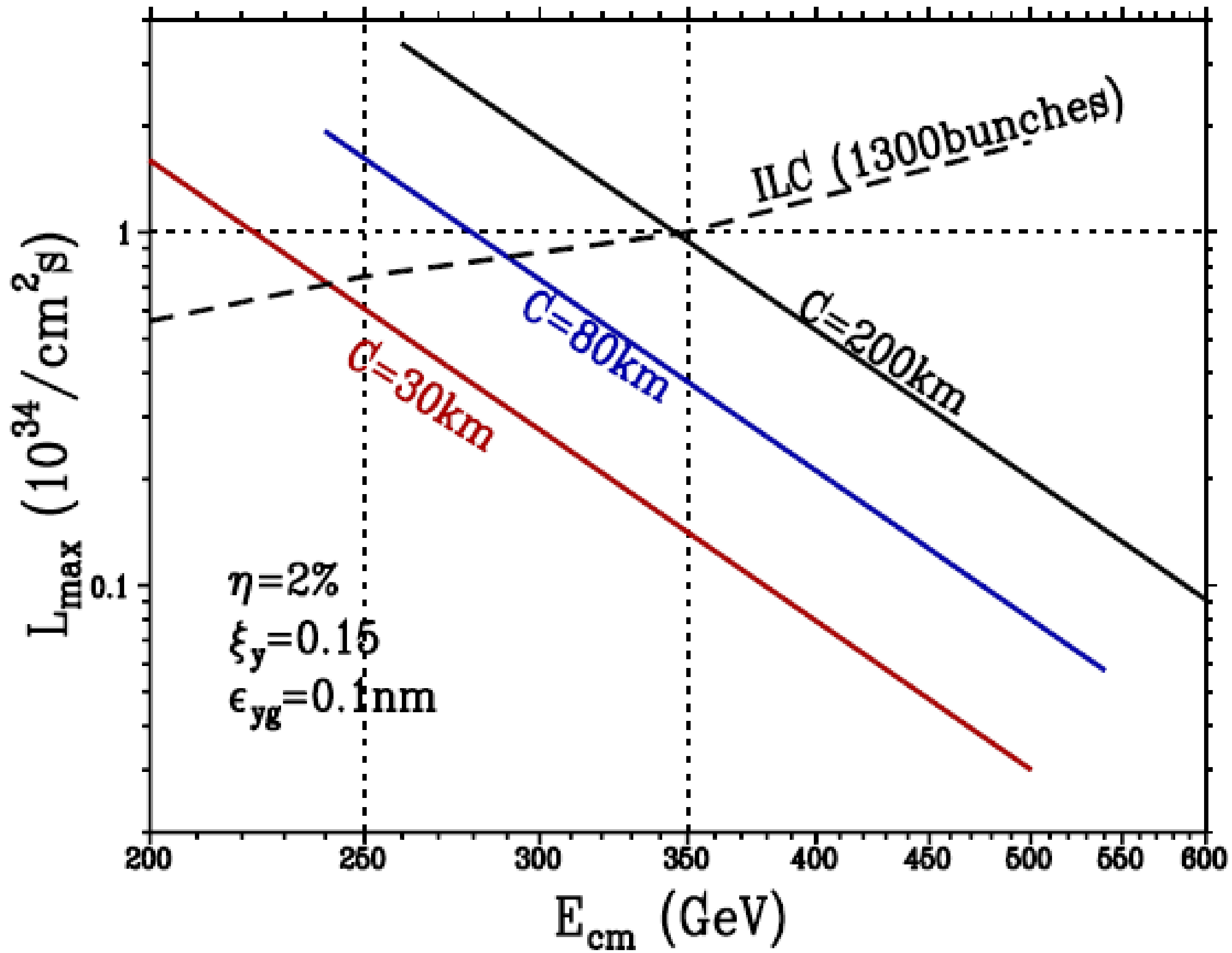


Luminosity vs. Energy

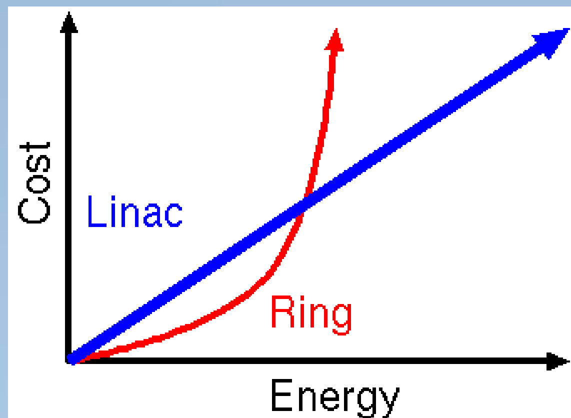
- Key parameters: momentum band width, vertical emittance, beam-beam tune-shift
- If e+e- at >~350GeV, there is no possibility at all.

example with

- η=2%
- ξ_y=0.15
- ε_{gy}=0.1nm



Ring collider and Linear collider



not at all

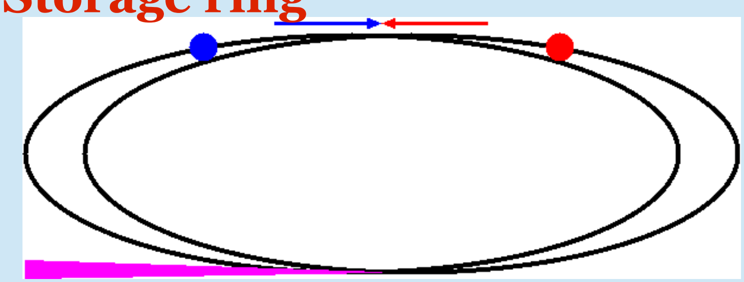
Energy loss

$$\Delta E = \frac{C_\gamma E^4}{\beta \rho}$$

Huge loss
at high energy

LINAC

Storage ring

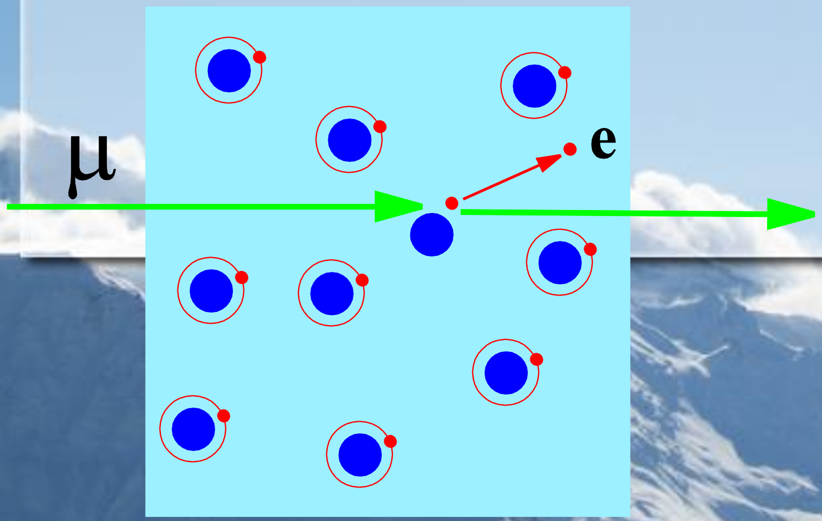


Electron-Positron Linear Collider

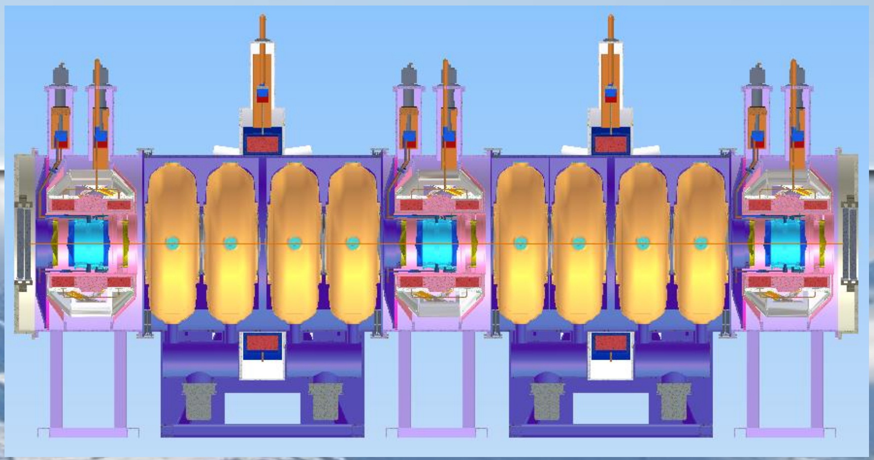
- Electron and positron will be accelerated by linac.
- Because only one path topology, the issues are
  - Acceleration gradient: accelerator should be reasonable length.
  - Enough Luminosity

Muon Collider

- Properties of muons are quite similar to electron/positron, but heavier mass (200 times of e-mass). SR is not serious.
- $\mu^+\mu^-$ collider is much cleaner than e+e- (beamstrahlung negligible)
  - except the problem of background from muon decay
- But muons do not exist naturally
- “Ionization cooling” invented by Skrinsky-Parkhomchuk 1981, Neuffer 1983

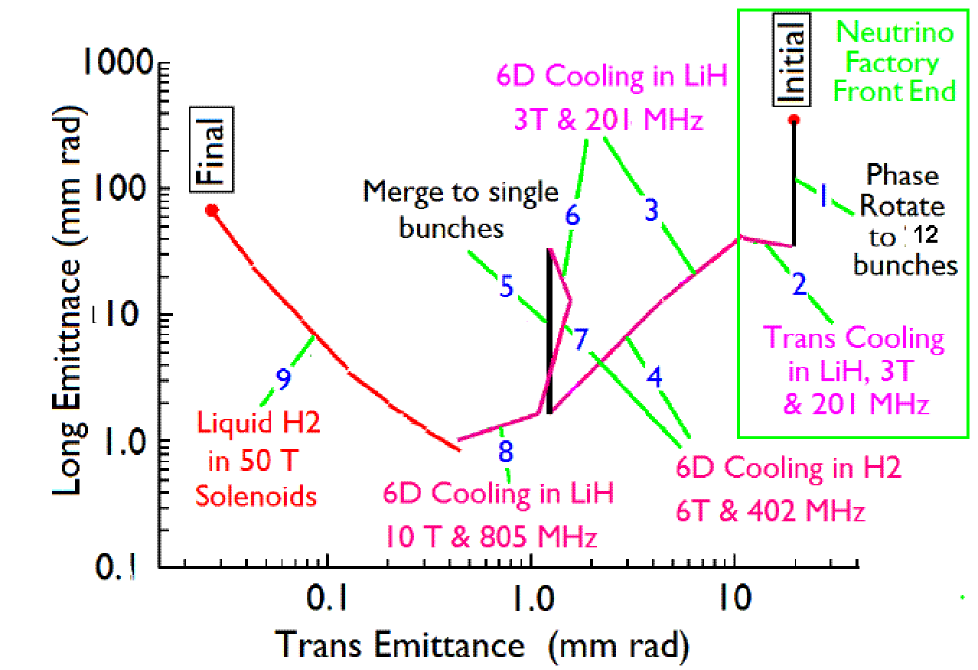


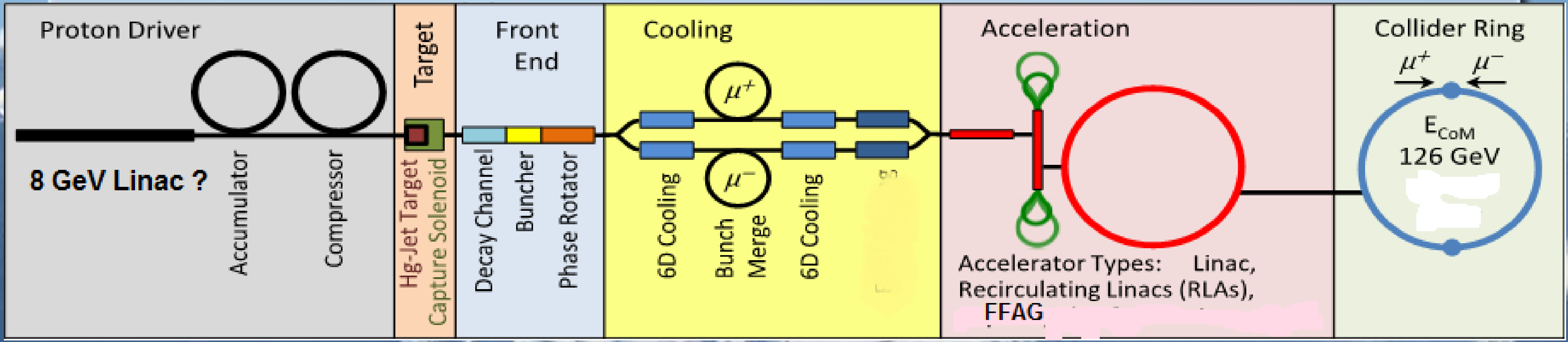
Ionization cooling test at MICE



Create and Cool Muon Beam

- Can be created by hadron collision
- Muons decay within 2μs in the rest frame; must be accelerated quickly
- Staging
  - Higgs factory at E_{cm}=126GeV
  - Neutrino factory
  - TeV muon collider





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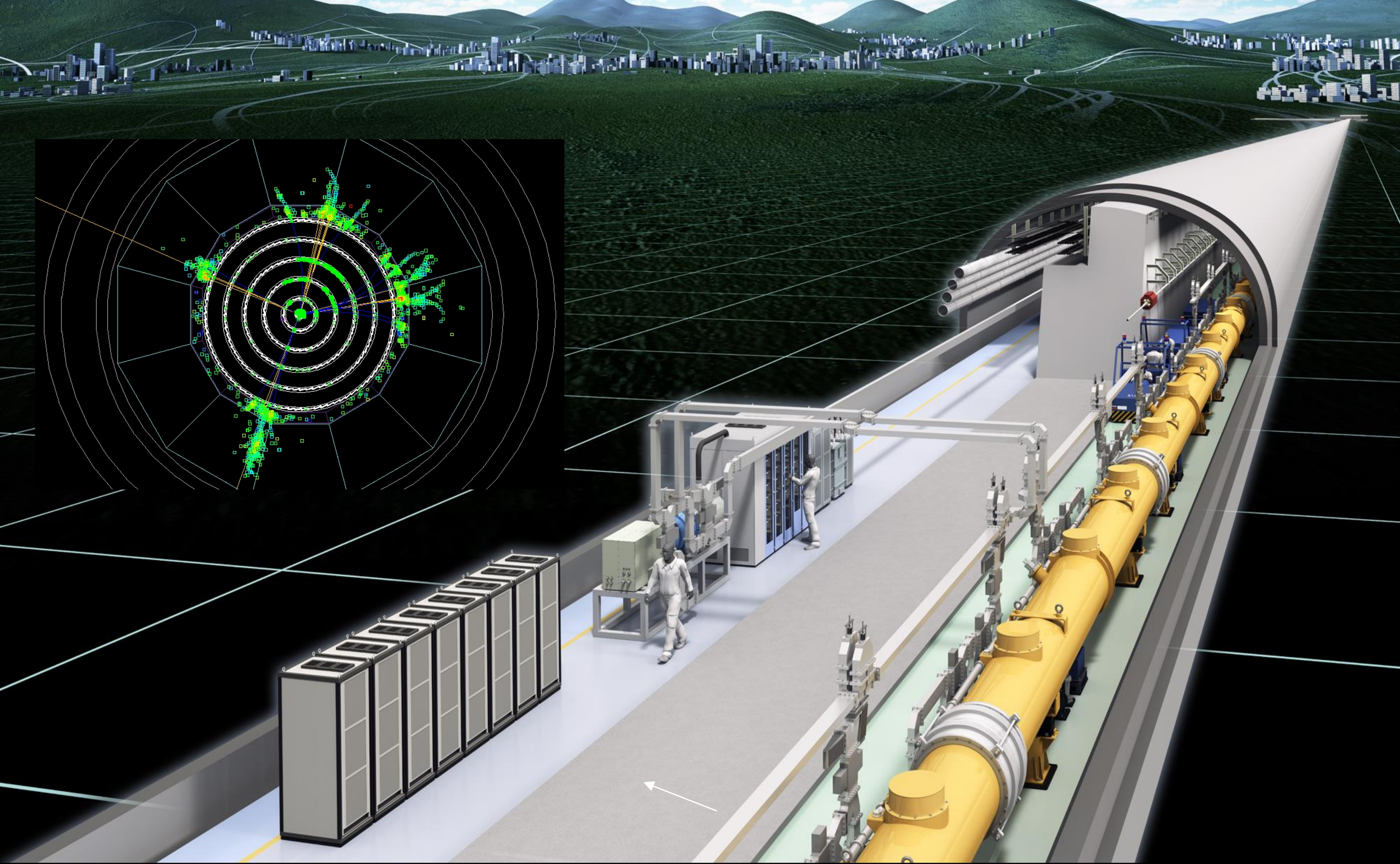
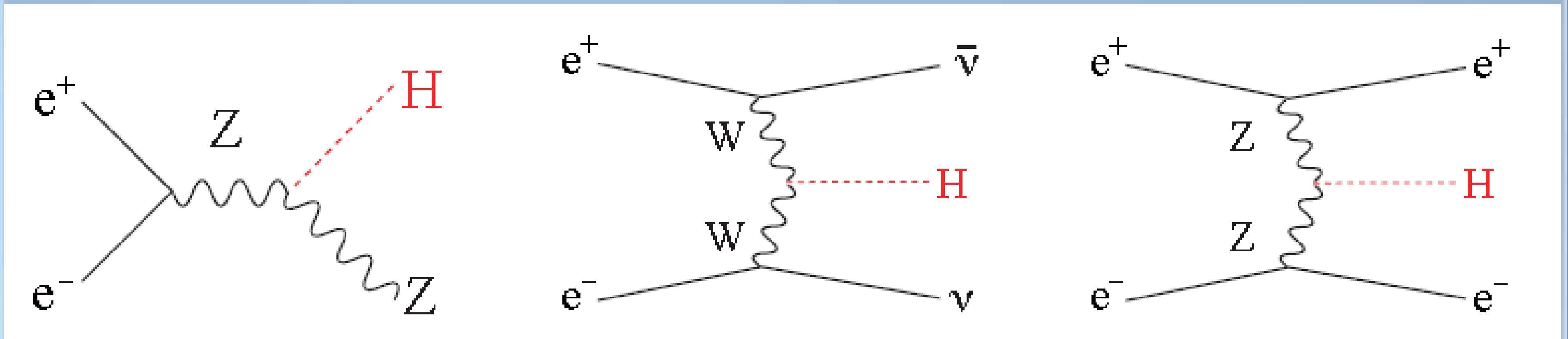
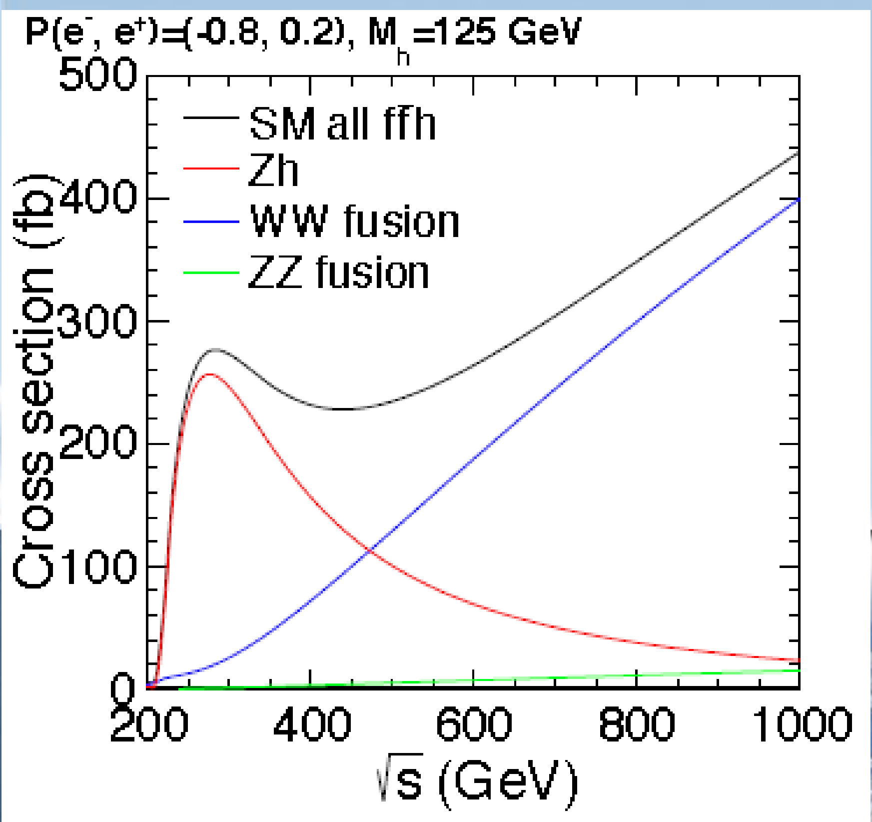
Internationa Linear Collider

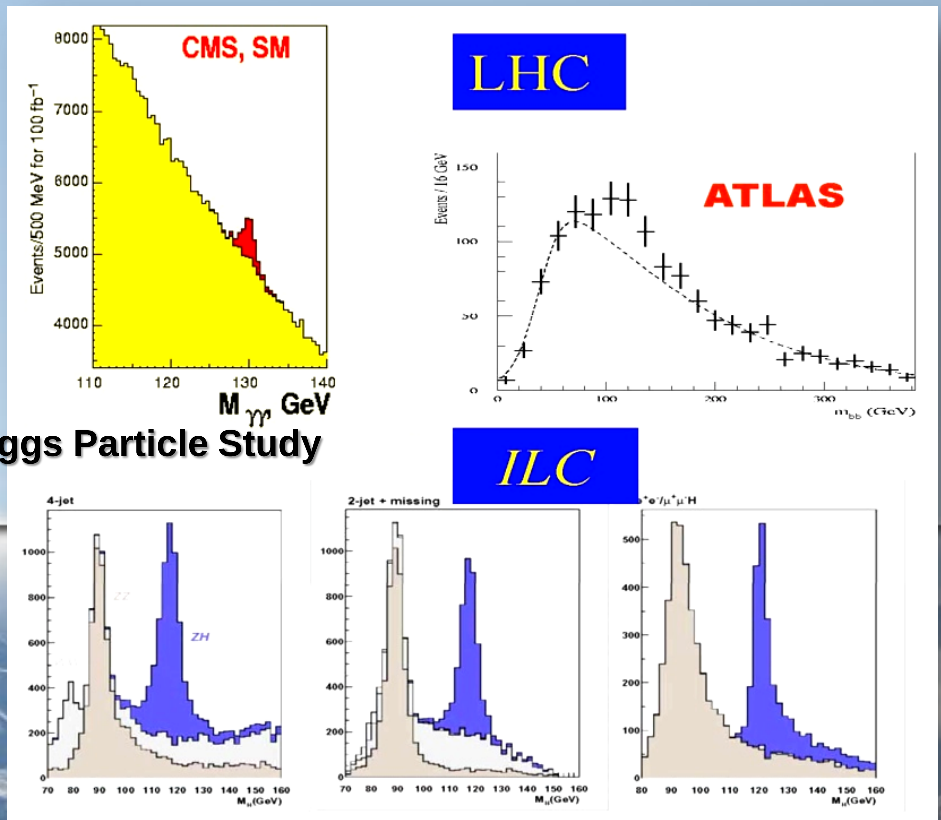
CME - 250-500 GeV



LC as Higgs factory

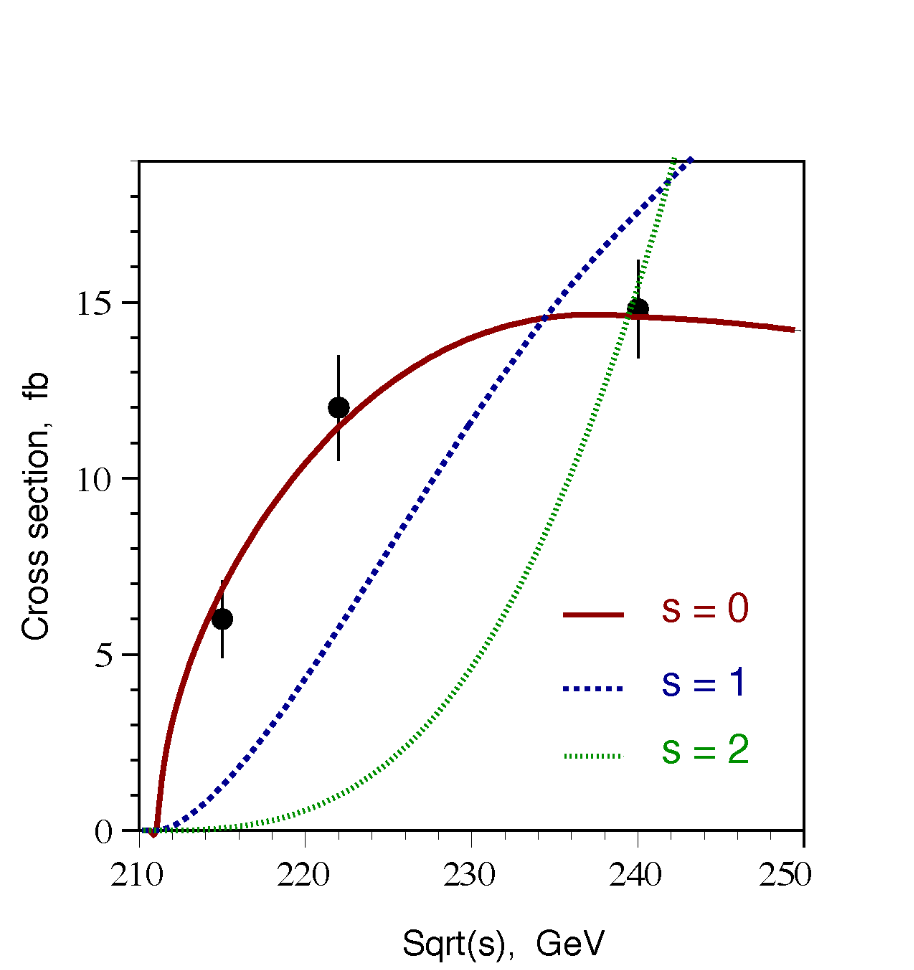






Higgs Particle Study

ILC: Is it really the Higgs ?

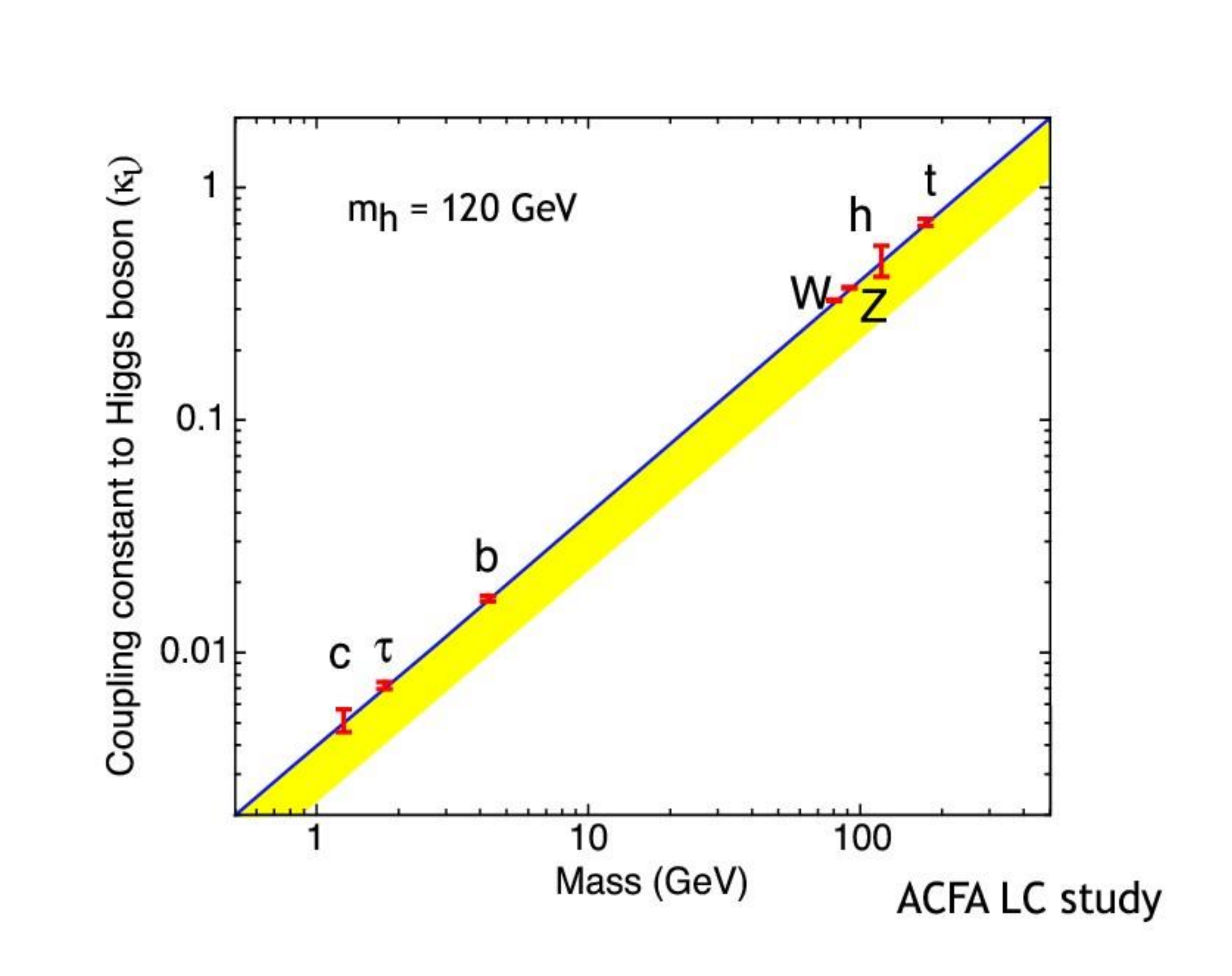


Measure the quantum numbers. The Higgs must have spin zero !

The linear collider will measure the spin of any Higgs it can produce by measuring the energy dependence from threshold

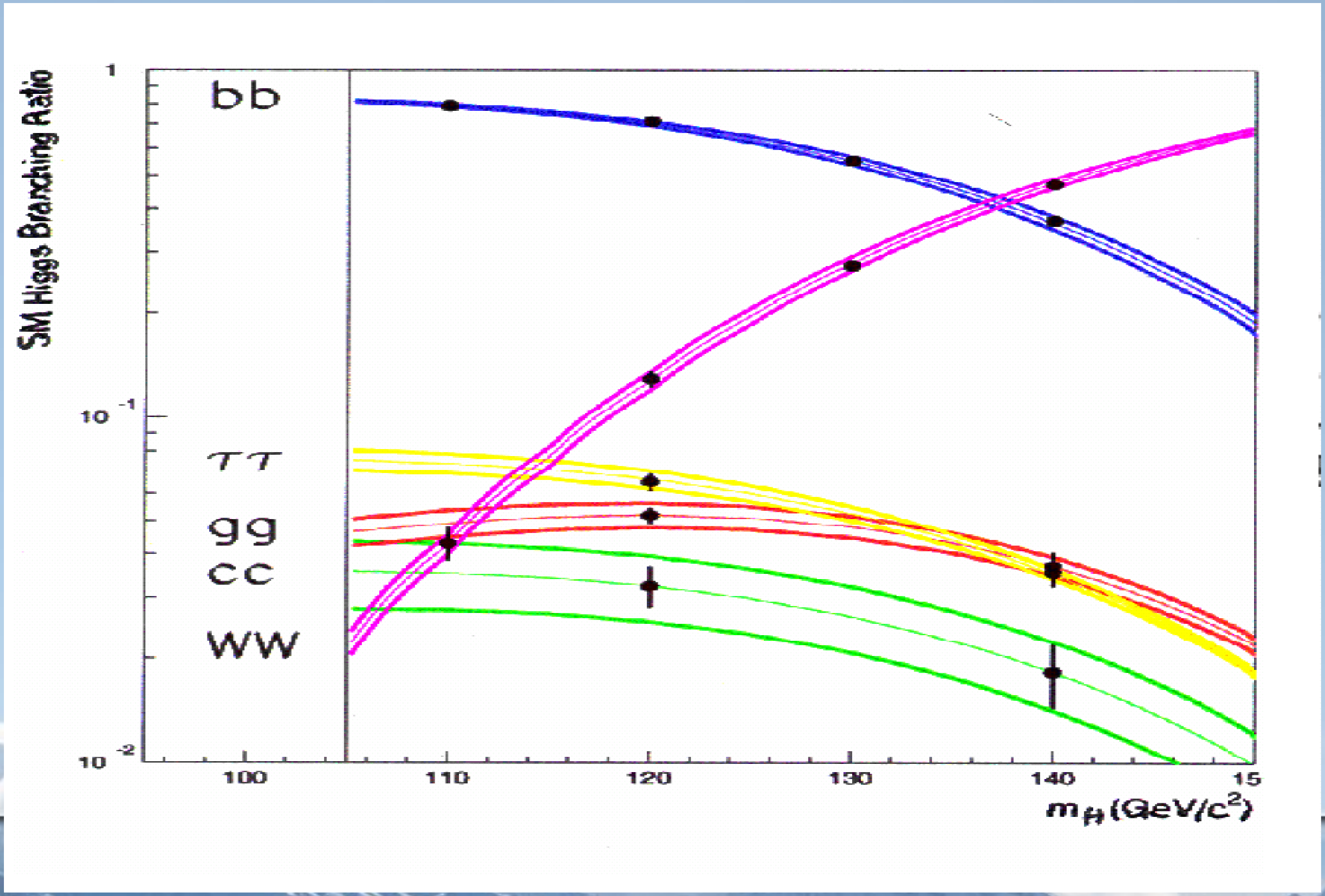
What can we learn from the Higgs?

Precision measurements of Higgs coupling



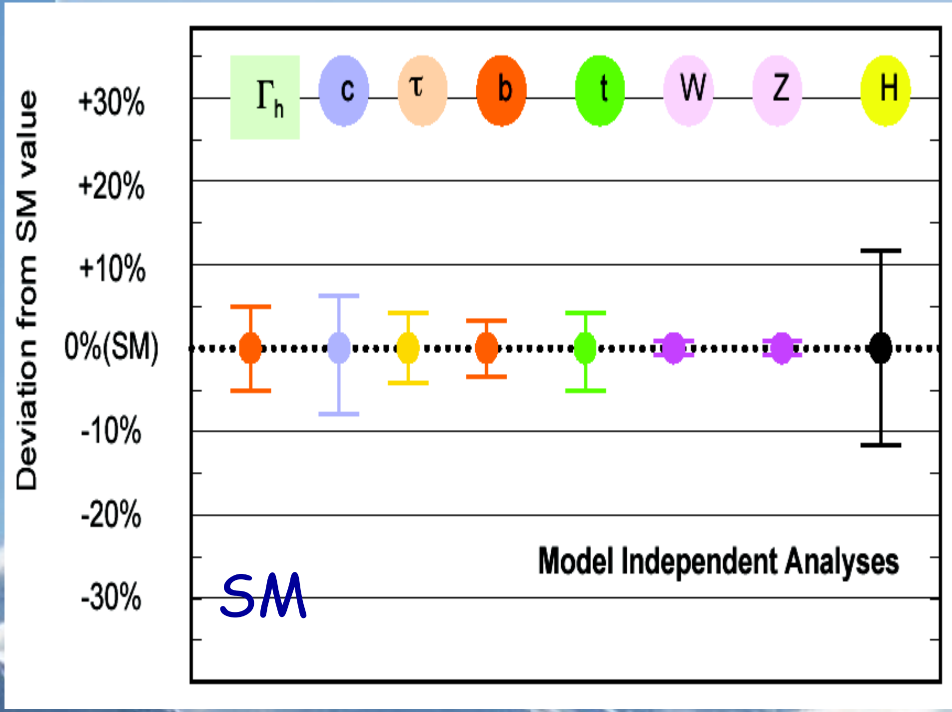
Higgs Coupling strength is proportional to Mass

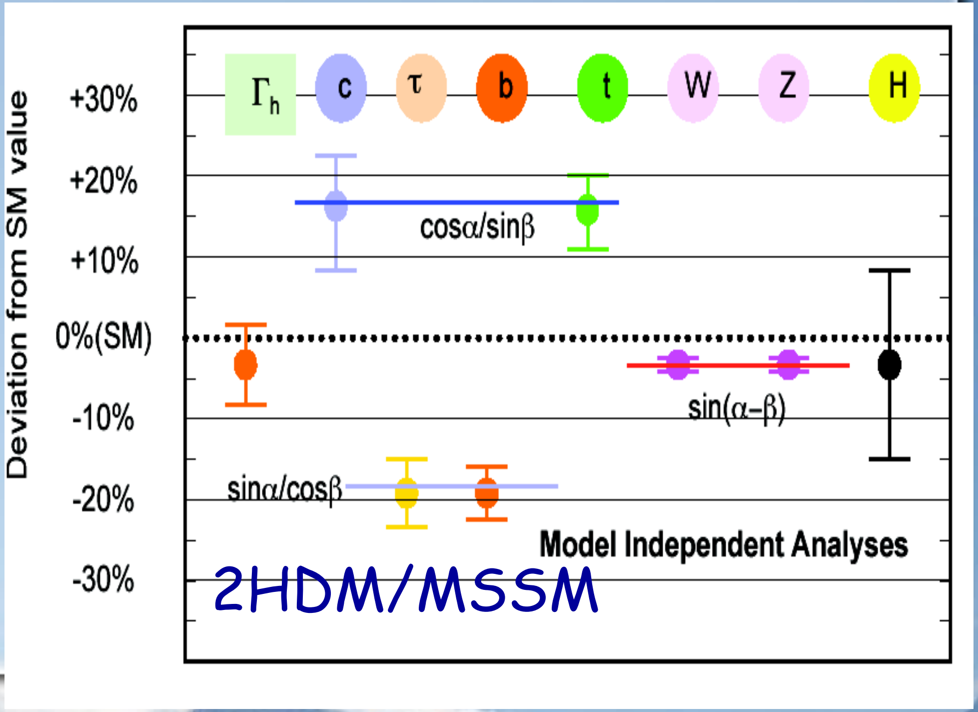
Higgs Branching Ratios



e^+e^- : Studying the Higgs

determine the underlying model

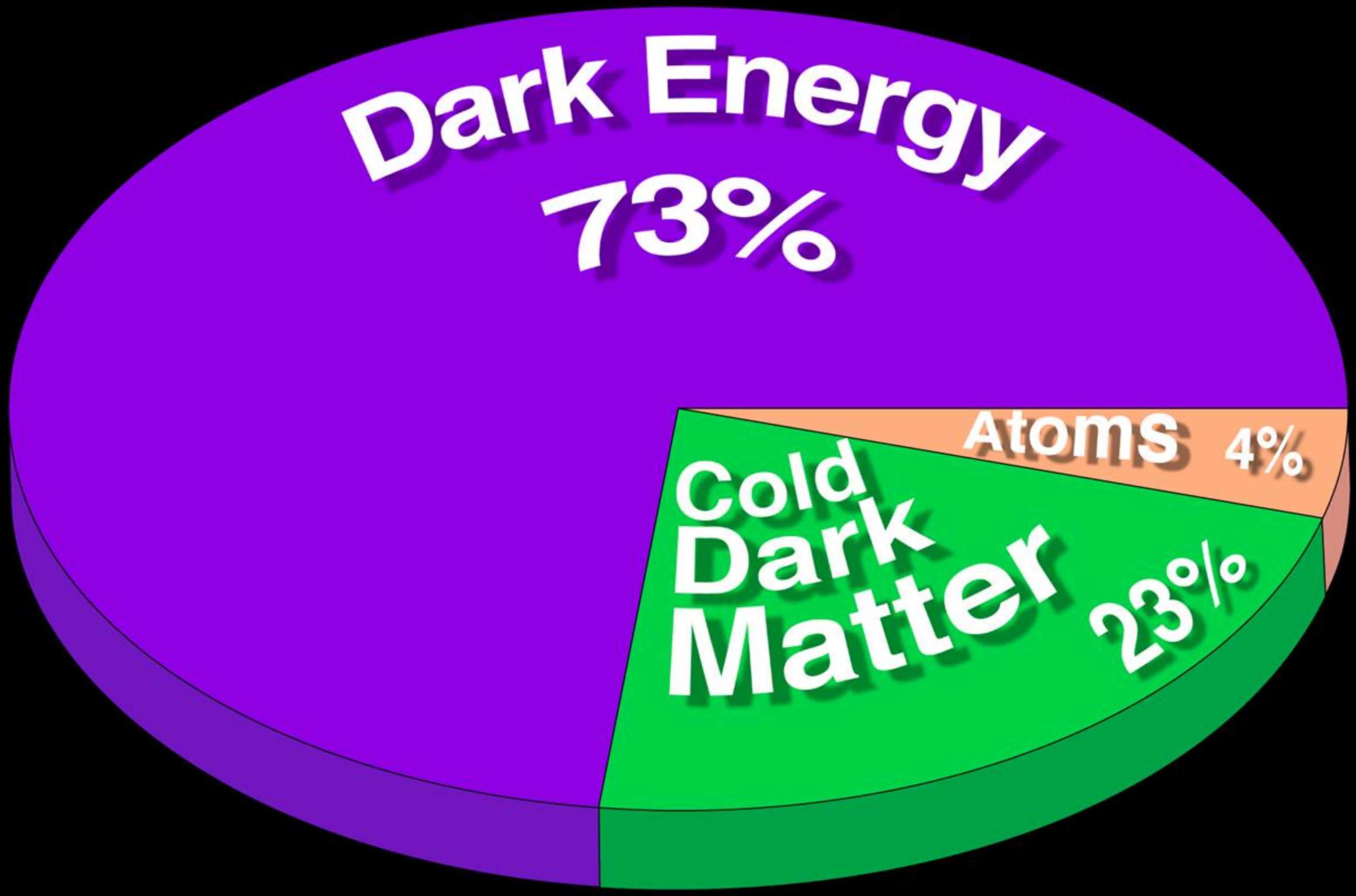




Yamashita et al

Zivkovic et al

Universe is ruled by Darkforce!



Supersymmetry

LHC is suitable for colored particle search .

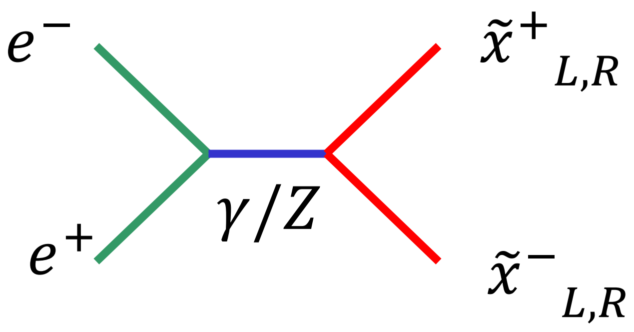
LSP (Lightest Supersymmetry Particle) Is a candidate of Dark Matter.

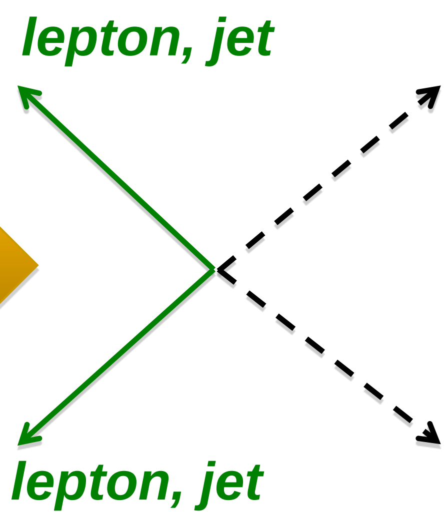
ILC can look also colorless particle.

ILC : A New Particle Factory

SUSY

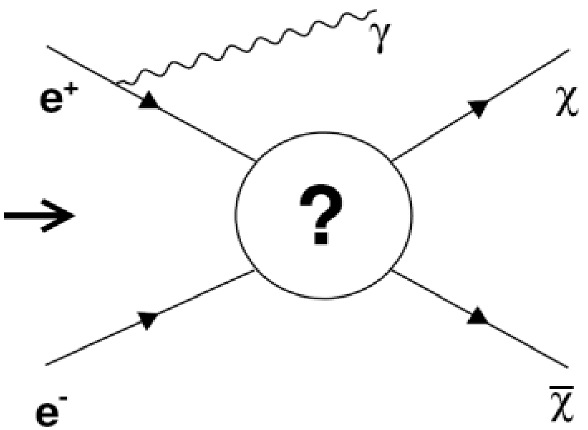
$$e^+e^- \rightarrow \tilde{e}_R\tilde{e}_R,\ \tilde{e}_L\tilde{e}_L,\ \tilde{e}_R\tilde{e}_L,\ \tilde{\nu}_e\bar{\tilde{\nu}}_e$$
$$e^+e^- \rightarrow \tilde{\mu}_R\tilde{\mu}_R,\ \tilde{\mu}_L\tilde{\mu}_L,\ \tilde{\nu}_\mu\bar{\tilde{\nu}}_\mu$$
$$e^+e^- \rightarrow \tilde{\tau}_1\tilde{\tau}_1,\ \tilde{\tau}_2\tilde{\tau}_2,\ \tilde{\tau}_1\tilde{\tau}_2,\ \tilde{\nu}_\tau\bar{\tilde{\nu}}_\tau$$
$$e^+e^- \rightarrow \tilde{\chi}_1^+\tilde{\chi}_1^-,\ \tilde{\chi}_1^+\tilde{\chi}_2^-,\ \tilde{\chi}_1^0\tilde{\chi}_2^0$$

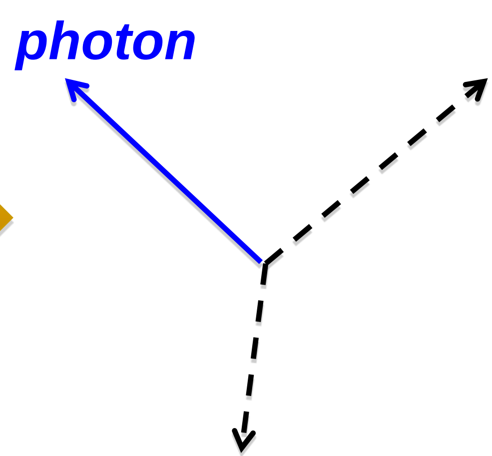




Direct search for new particles!

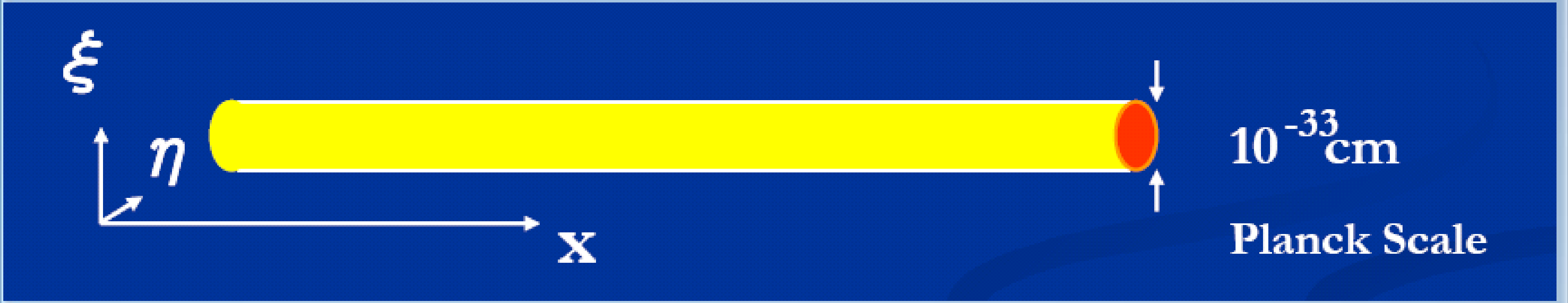
Dark Matter
Pair Creation





Superstring Theory
extra dimensions

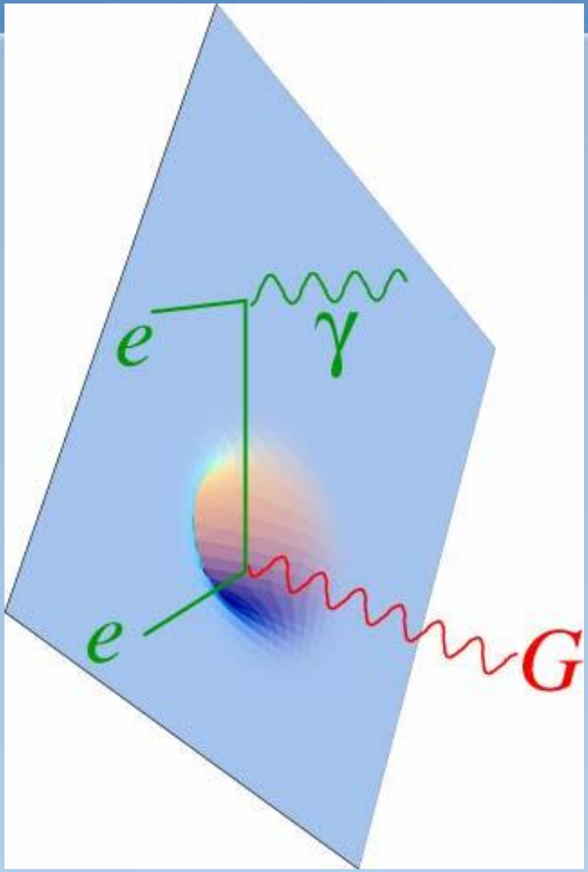
In addition to the 3+1 dimensional space-time, extra space-dimensions exist, presumably curled into a small space size.



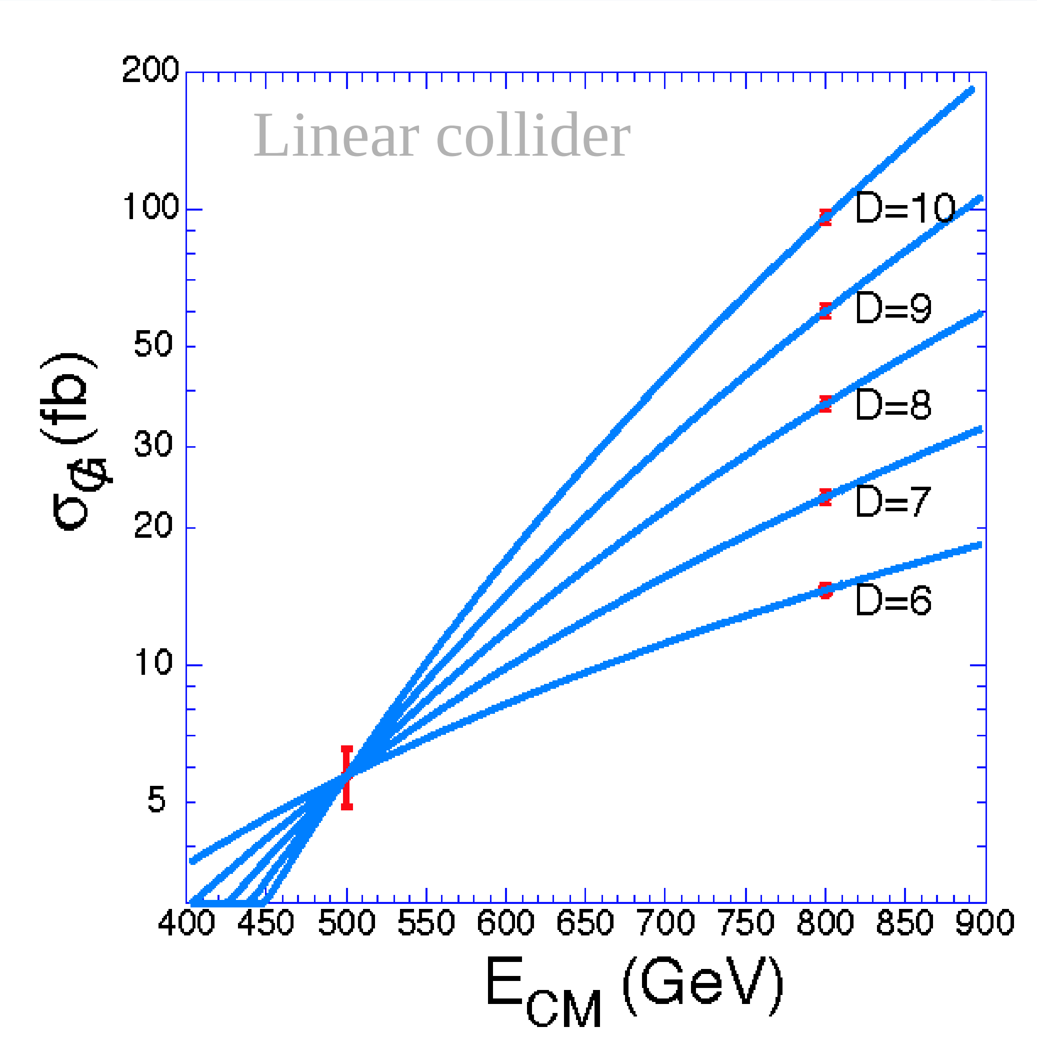
Internal quantum numbers of elementary particles are determined by the geometrical structure of the extra dimensions

Kaluza-Klein - Bosonic partners

Direct production from extra dimensions ?

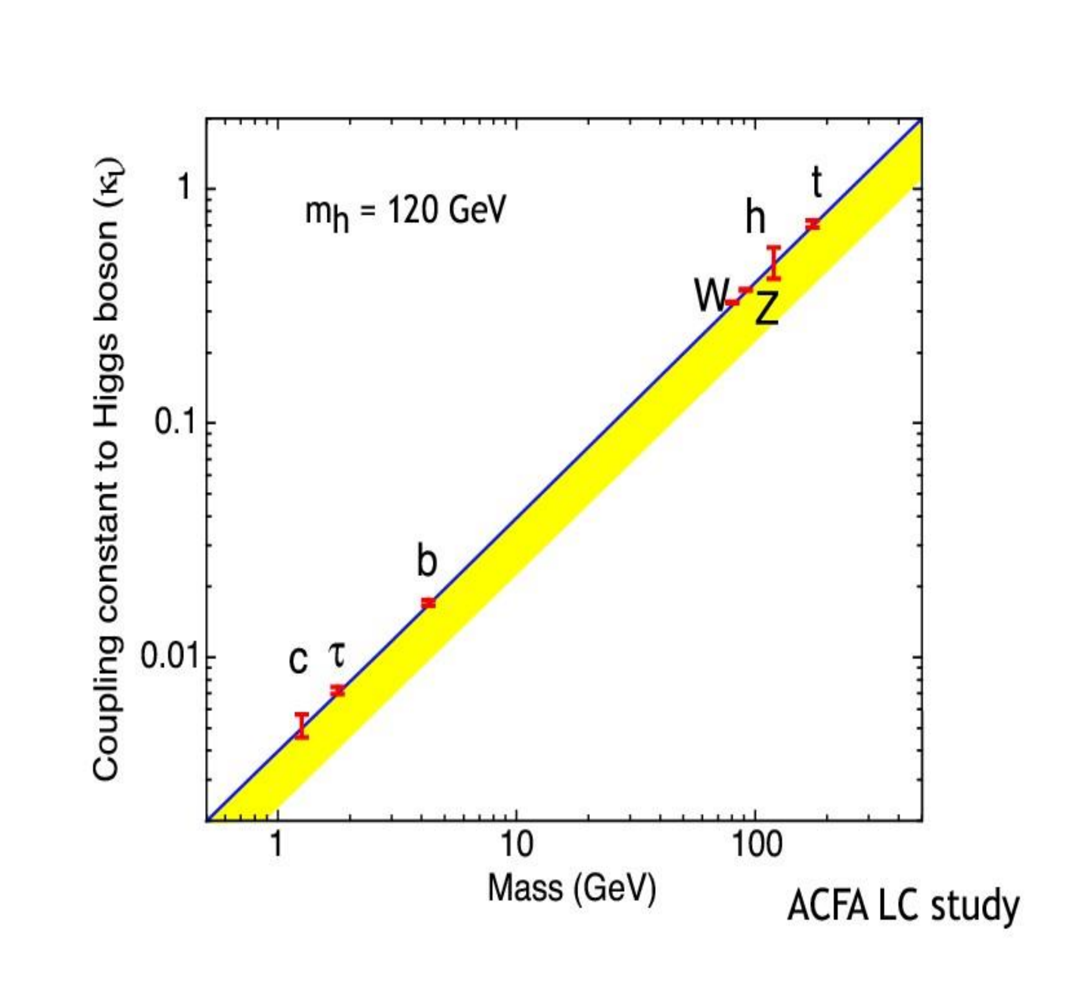


Total dimensions can be mapped by studying the emission of gravitons into the extra dimensions.



Extra dimensions and the Higgs?

Precision measurements of Higgs coupling can reveal extra dimensions in nature



- Straight blue line gives the standard model predictions.
- Range of predictions in models with extra dimensions -- yellow band, (at most 30% below the Standard Model
- The red error bars indicate the level of precision attainable at the ILC for each particle

Target for each energy range

Energy	Reaction	Physics Goal
91 GeV	$e^+e^- \to Z$	ultra-precision EW
160 GeV	$e^+e^- \to WW$	ultra-precision Wmass
250 GeV	$e^+e^- \to Zh$	precision Higgs coupling
350-450 GeV	$e^+e^- \to tt$ $e^+e^- \to WW$ $e^+e^- \to \nu\nu h$	top quark mass and coupling precision W coupling precision Higgs coupling
500 GeV	$e^+e^- \to ff$ $e^+e^- \to tth$ $e^+e^- \to Zhh$ $e^+e^- \to \chi\chi$ $e^+e^- \to AH, H^+H^-$	precision search for Z' Higgs coupling to top Higgs self coupling search for super-symmetry search for extended Higgs sector

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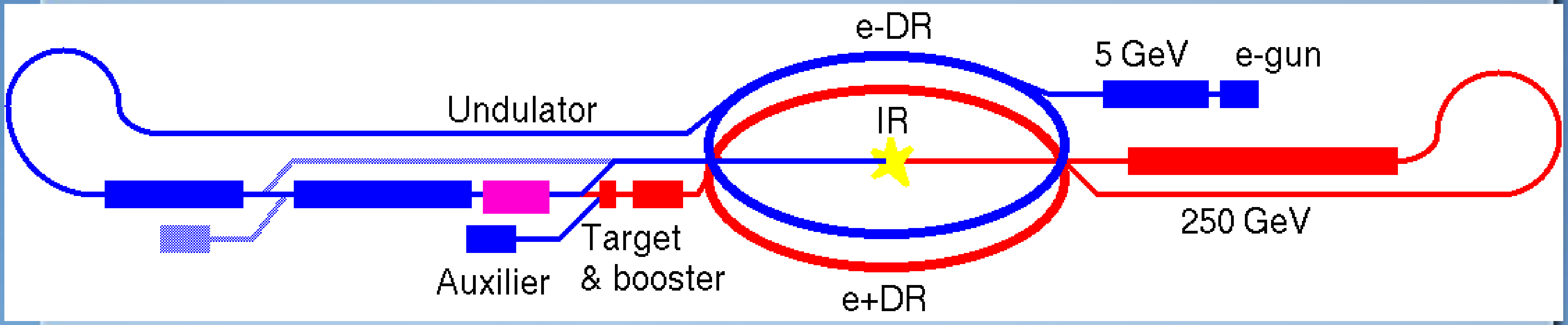
ILC accelerator Overview



- High gradient acceleration with super-conducting accelerator.
- High luminosity is obtained with the high aspect ratio beam made up with Damping ring and final focus.
- Polarized electron by NEA photo-cathode.
- Potential polarization of positron.

Can we obtain enough Luminosity with Linear Collider?

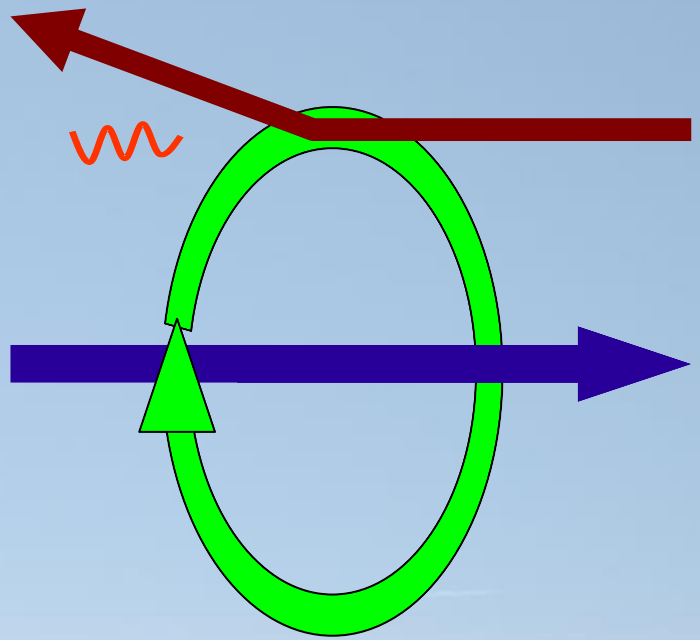
- Repetition *f* can not be large in LC.
- It works with an extremely small spot size.

$$L = \frac{f N^2}{4\pi\sigma_x\sigma_y}$$

  - Beamstrahlung : Synchrotron radiation with magnetic field generated by the collision partner. It makes the energy spread large and the experimental resolution bad.
  - Distruption: Beam deformation by Coulomb force.
- These effects becomes also significant with the extremely small spot size.

Beamstrahlung

- Synchrotron radiation with magnetic field induced by the beam.



$$B=\frac{\mu_{0I}}{2\pi r}\sim\frac{\mu_0 eN}{2\pi\sigma_x\sigma_z/c}$$

$$\frac{\Delta E}{E}\propto\frac{B^2E^2\sigma_z}{E}\propto\frac{N^2E}{(\sigma_x^2+\sigma_y^2)\sigma_z}$$

Beam-Beam effect

- Coulomb interaction between the beams.

$$\ddot{x}+K_x x=0, \qquad \ddot{y}+K_y=0$$

- Distruption parameter charcterizes the motion

$$D_{x,y}\equiv\frac{2Nr_e}{\gamma}\frac{\sigma_z}{\sigma_{x,y}(\sigma_x+\sigma_y)}$$

- If this parameter becomes too large, the beam control would be very difficult.

Asymmetric Beam

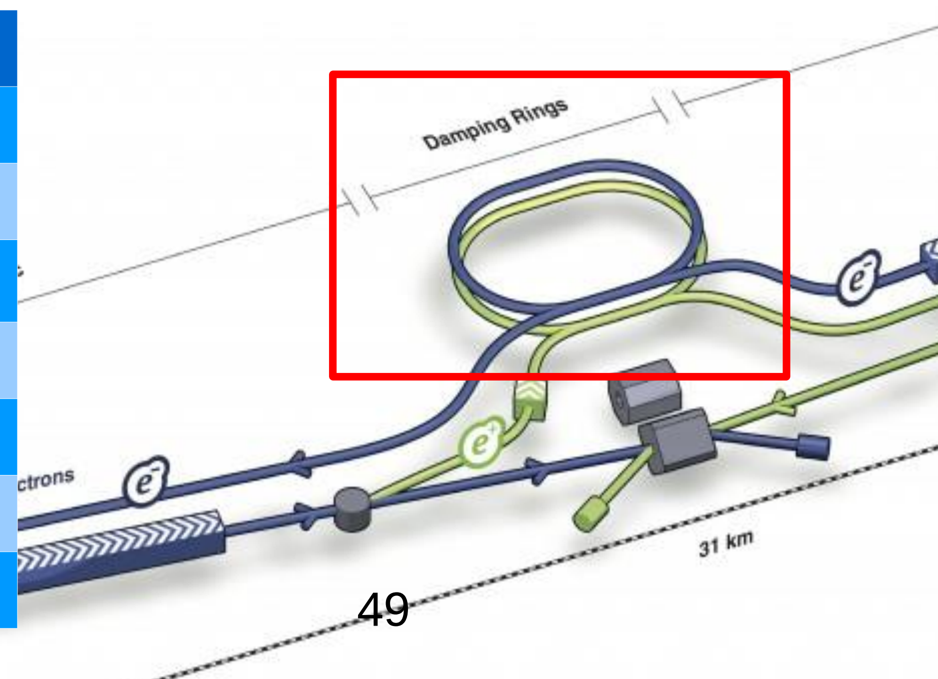
Asymmetic Beam
σy«σx

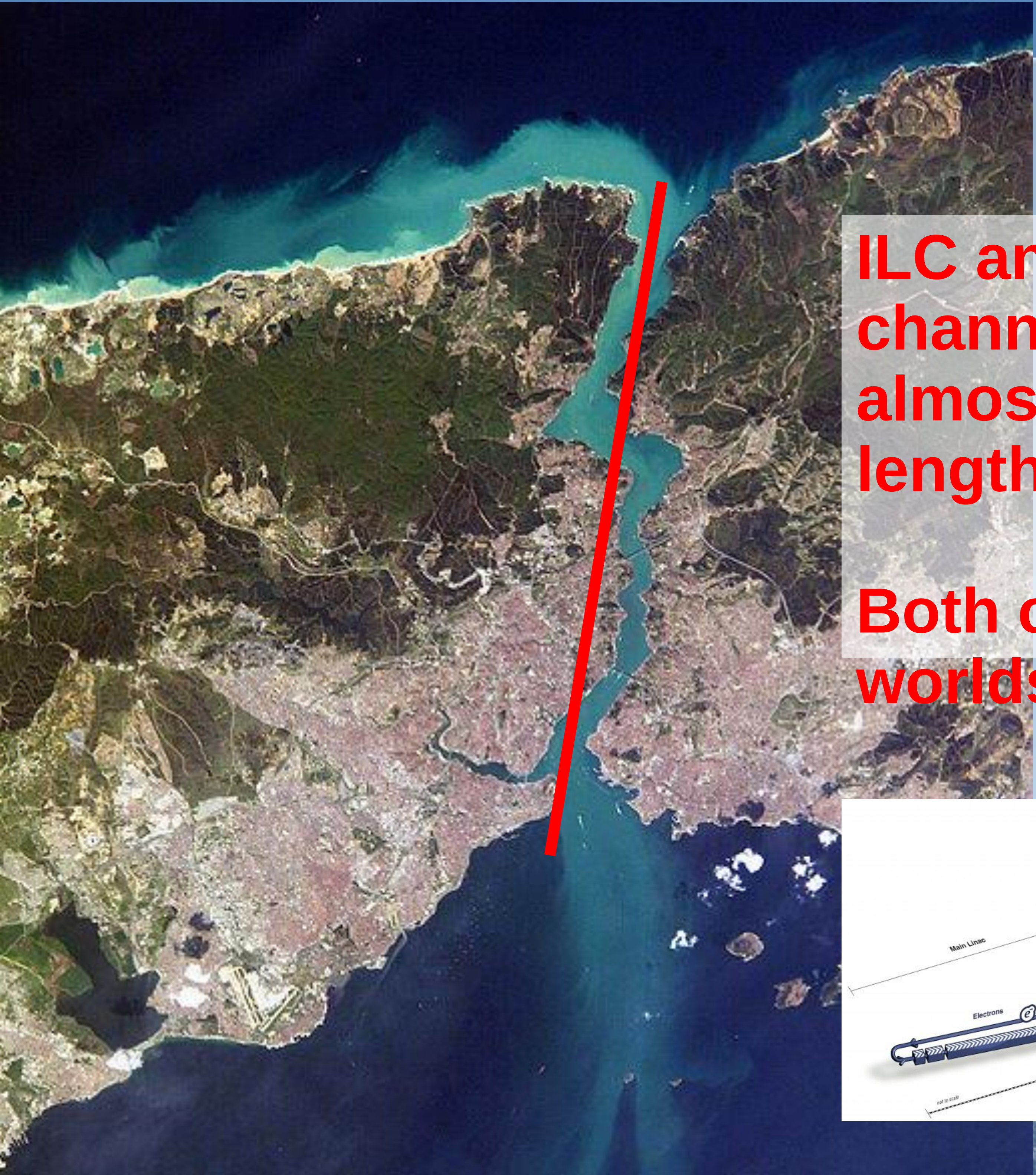
Luminosity $$L = \frac{f_{rep} n_b N^2}{4\pi \sigma_x \sigma_y}$$

Beamstrahlung $$\frac{\Delta E}{E} \propto \frac{N^2 E}{(\sigma_x^2 + \sigma_y^2)\sigma_z}$$

Disruption $$D_{x,y} = \frac{2Nr_e}{\gamma} \frac{\sigma_z}{\sigma_{x,y}(\sigma_x + \sigma_y)}$$

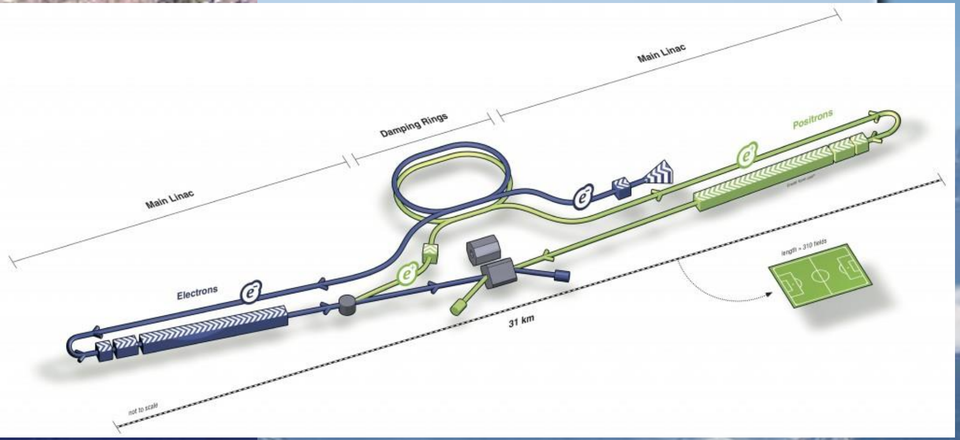
Parameter	Value
Horizontal size	640 nm
Vertical size	5.7 nm
Bunch length	300 μm
Vertical Disruption	19.4
RMS energy by BS	2.4%
Horizontal emi.	10 mm.mrad
Vertical emi.	0.04





ILC and Bosporus channel have almost same length, ~ 30km.

Both connect two worlds!



The leading actor: Spin polarization

- e_L and e_R are different particles in gauge interaction.
- To define the initial states, energy, particles, and spin are essential.

$$P \equiv \frac{N_R - N_L}{N_R + N_L}$$

$$l_L \equiv \begin{pmatrix} \nu_{eL} \\ e_L \end{pmatrix} \quad I_W = \frac{1}{2}, \; Y_W = -1$$

$$e_R \quad I_W = 0, \; Y_W = -2$$

- **Luminosity is effectively enhanced.**
- **Improving S/N ratio.**

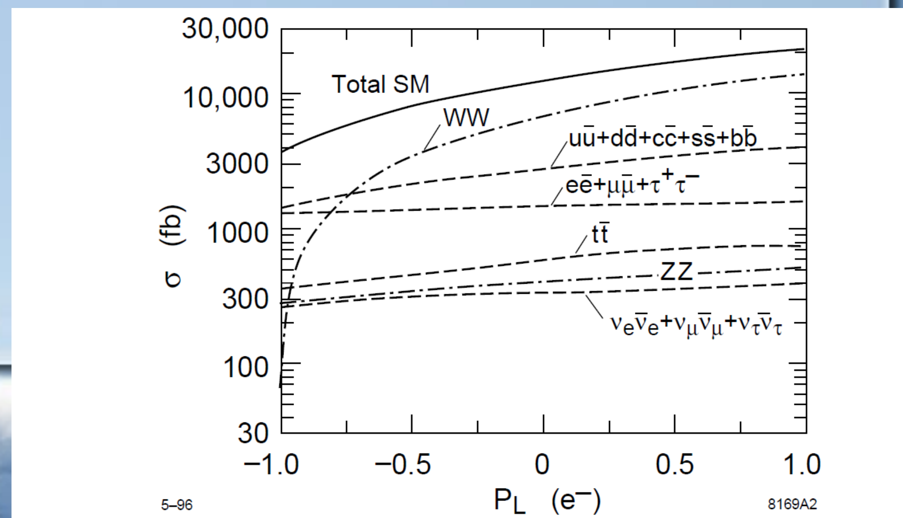


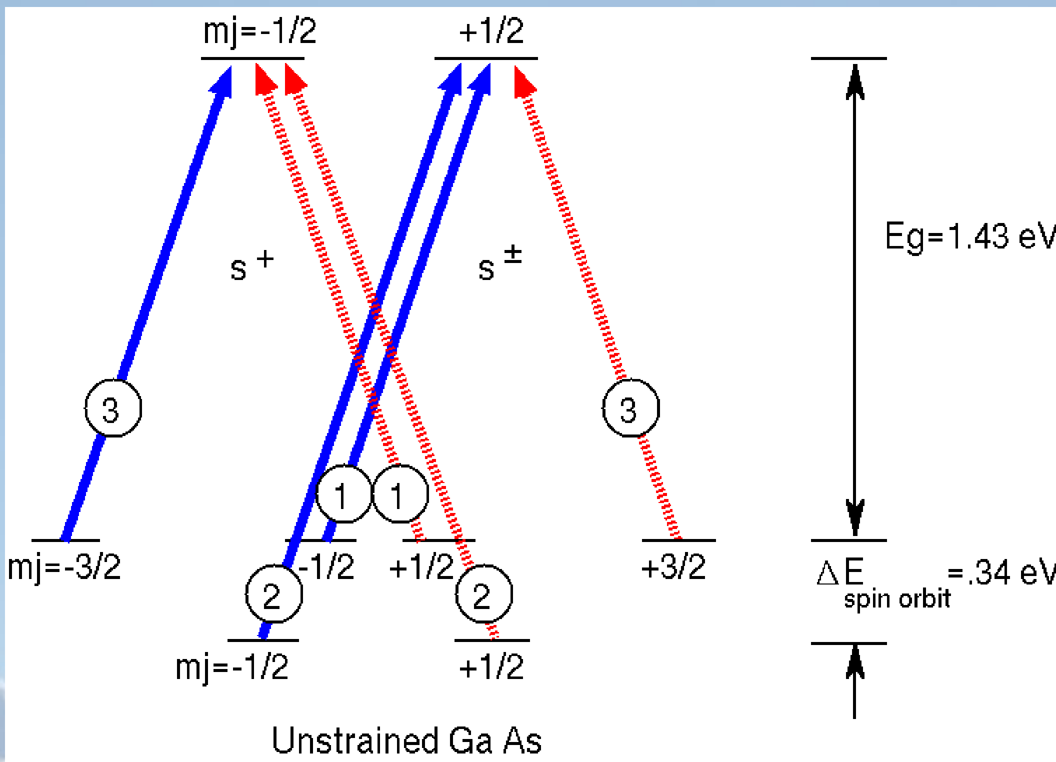
Figure 2.3: Cross sections for Standard Model physics processes in e^+e^- annihilation at 500 GeV, as a function of the electron longitudinal polarization.

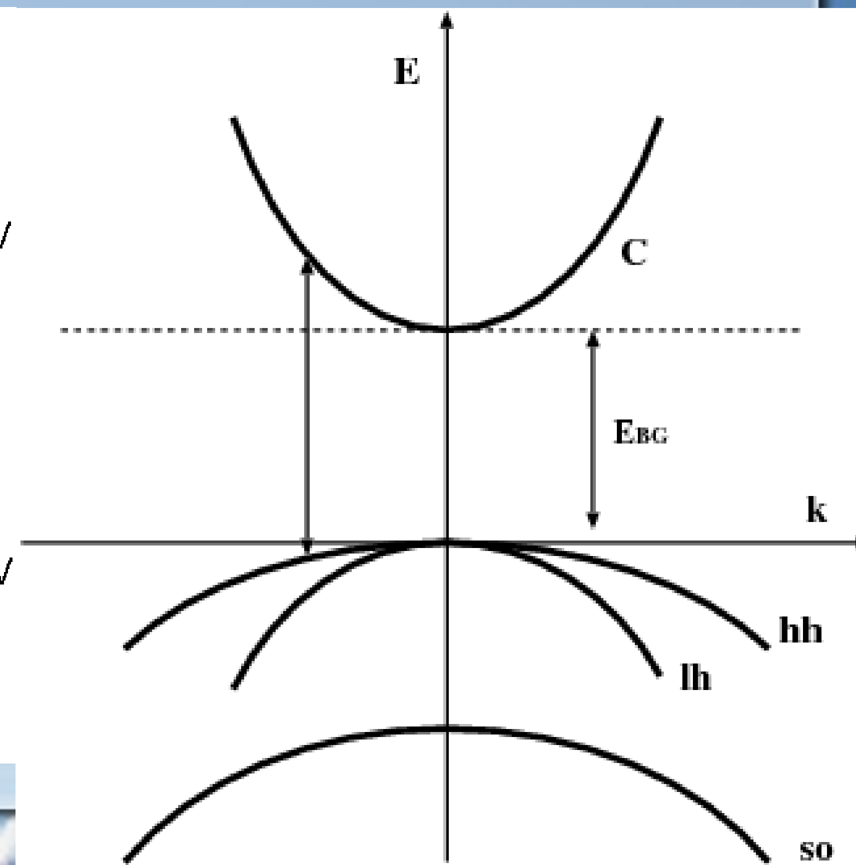
In 1970'

Method	Pol.(%)	Avarage curent (A)	Peak current(A)	Spin Reveral	Brightness
NEA GaAs	40	1e-6	1e-1	Laser	Very High
EuO photo-emission	27	1e-6	1e-4	Mag.	medium
Photo Ion. Pol. Li	76		1e-4	Mag.	medium
Fano effect, Photo-Ion. Cs	90		1e-4	Laser	high
Optical pump He discharge	30	1e-6		Laser	high
EuS field emission	89			Mag.	very high
Electron scattering from Hg beam	27	2e-8		angle	medium
Electron scattering from W.	40	5e-8		angle, E	high

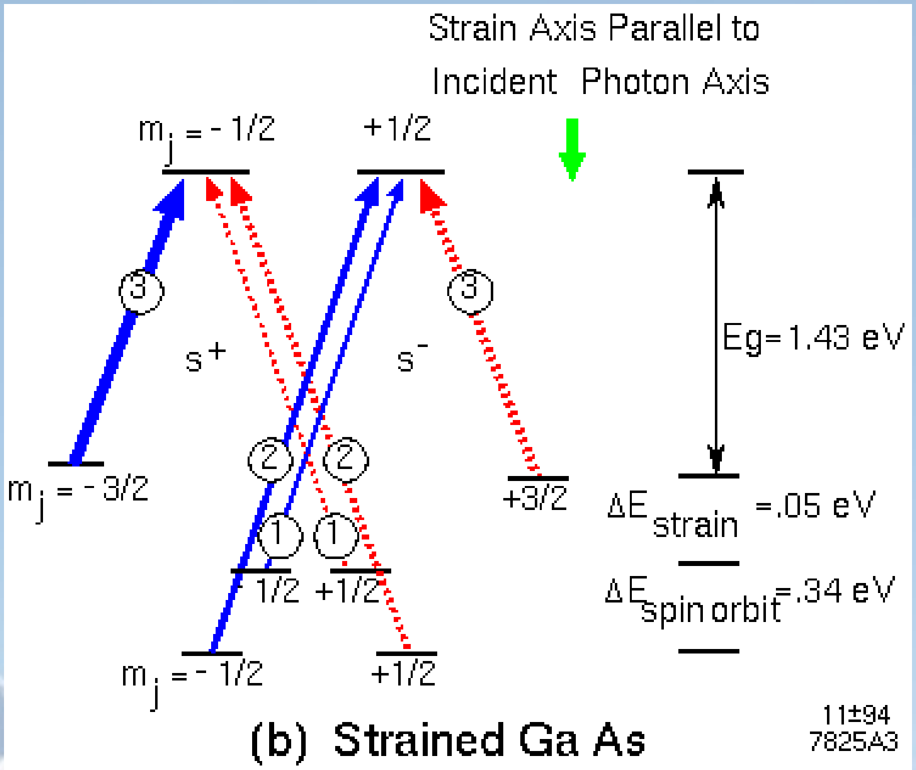
reproduced from D. T. Pierce, Phys. Rev. B 13(1976) 5485

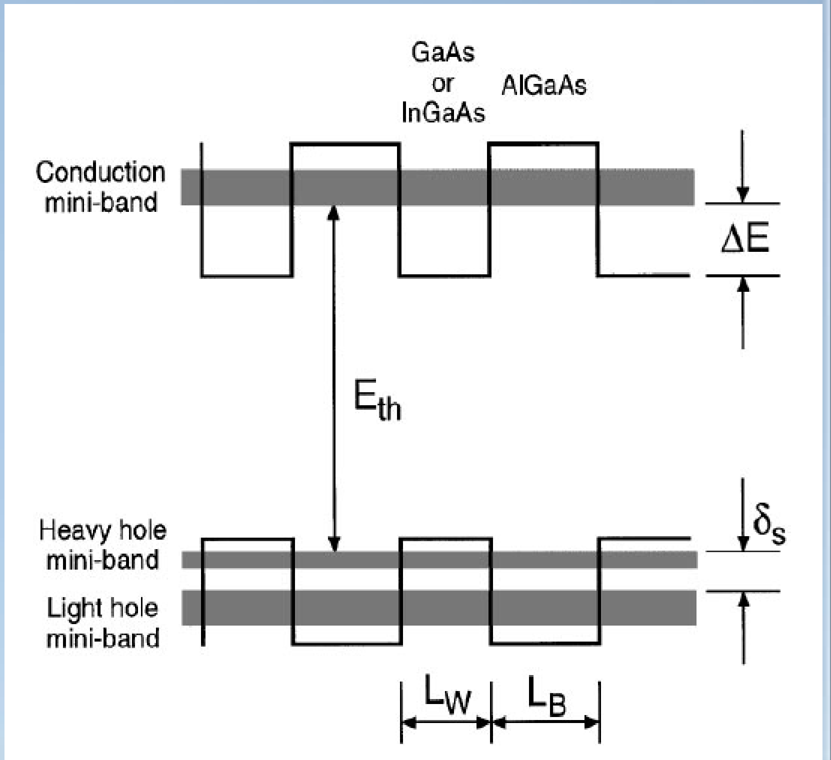
Photo-emission from GaAs





Strained Super-Lattice

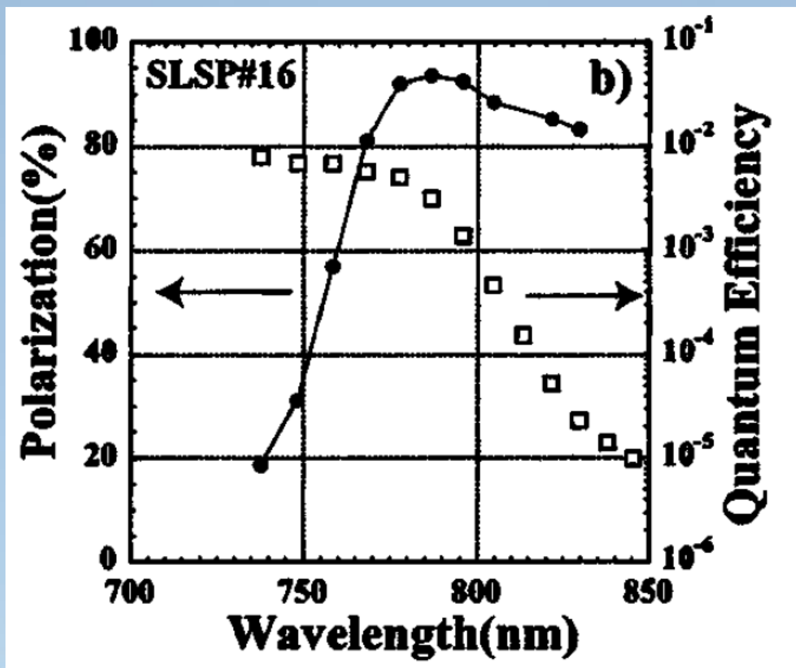




History of NEA GaAs

Year	Type	Pol. (%)	Quantum Eff.	Author
1976	Zn-GaAs	40	1e-4	Tech. H. Zürich
1981	AlGaAs-GaAs SL	49	1e-4	Jülich, Germany
1991	AlGaAs-GaAs SL	71	2e-4	Nagoya, KEK, NEC
	Strained InGaAs	70	1e-5 ~ 1e-4	SLAC, UCB,
	Strained GaAs on GaAsP	86	2e-4	Nagoya, Osaka P., Toyota, Daido
1992	Strained GaAs on GaAsP	90%	1e-3	SLAC
1994	InGaAs-GaAs strained SL	83	1.5e-4	Nagoya, KEK
2005	GaAs-GaAsP strained SL	92+-6	5e-3	Nagoya, KEK

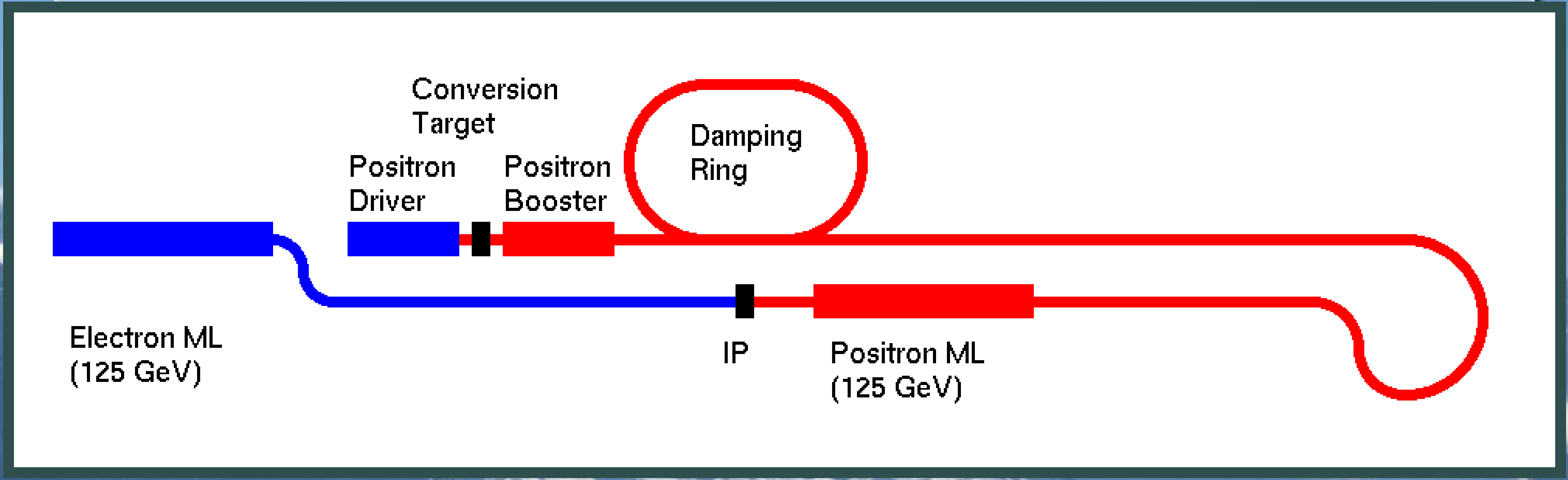
History of NEA GaAs



		(%)	Quantum Eff.	Author
			1e-4	Tech. H. Zürich
			1e-4	Jülich, Germany
			2e-4	Nagoya, KEK, NEC
			1e-5 ~ 1e-4	SLAC, UCB,
			2e-4	Nagoya, Osaka P., Toyota, Daido
		%	1e-3	SLAC
1994	InGaAs-GaAs strained SL	83	1.5e-4	Nagoya, KEK
2005	GaAs-GaAsP strained SL	92+-6	5e-3	Nagoya, KEK

Positron Source

- Positron production is a more complicated business.
- Amount of e+ is 50 times larger than that in SLC (SLAC Linear Collider, the first linear collider in the world).
- Staging approach to minimize possible risks and maximize physics potential.
- 1st stage : Unpolarized e-driven e+ source.
- 2nd stage: Polarized undulator driven e+ source.



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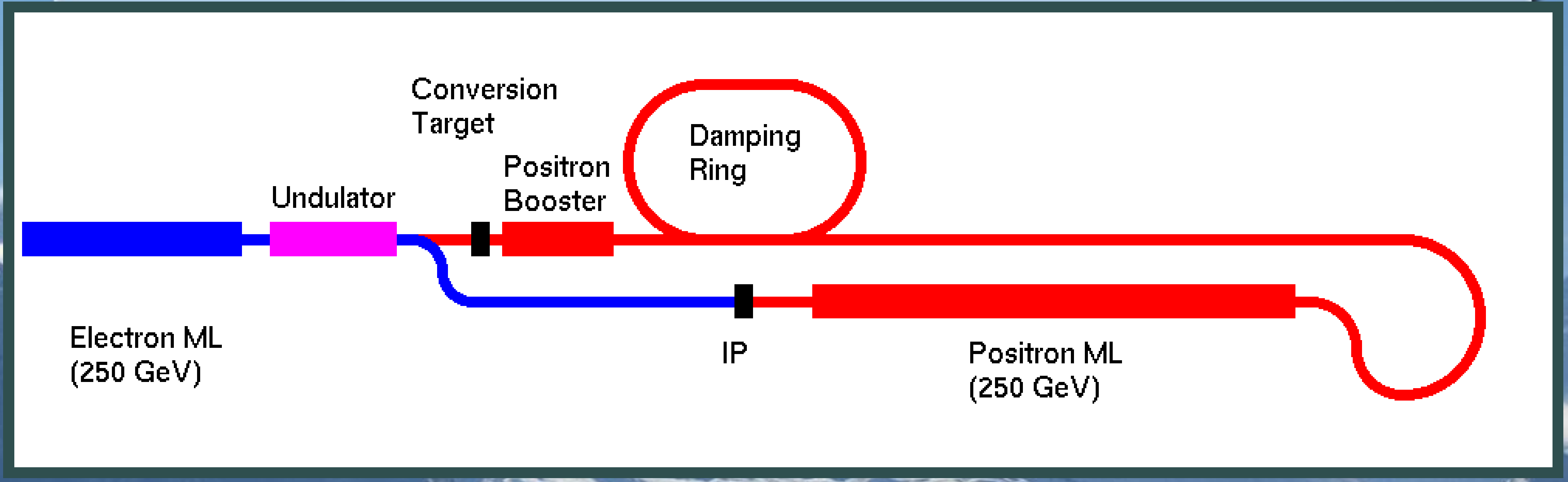
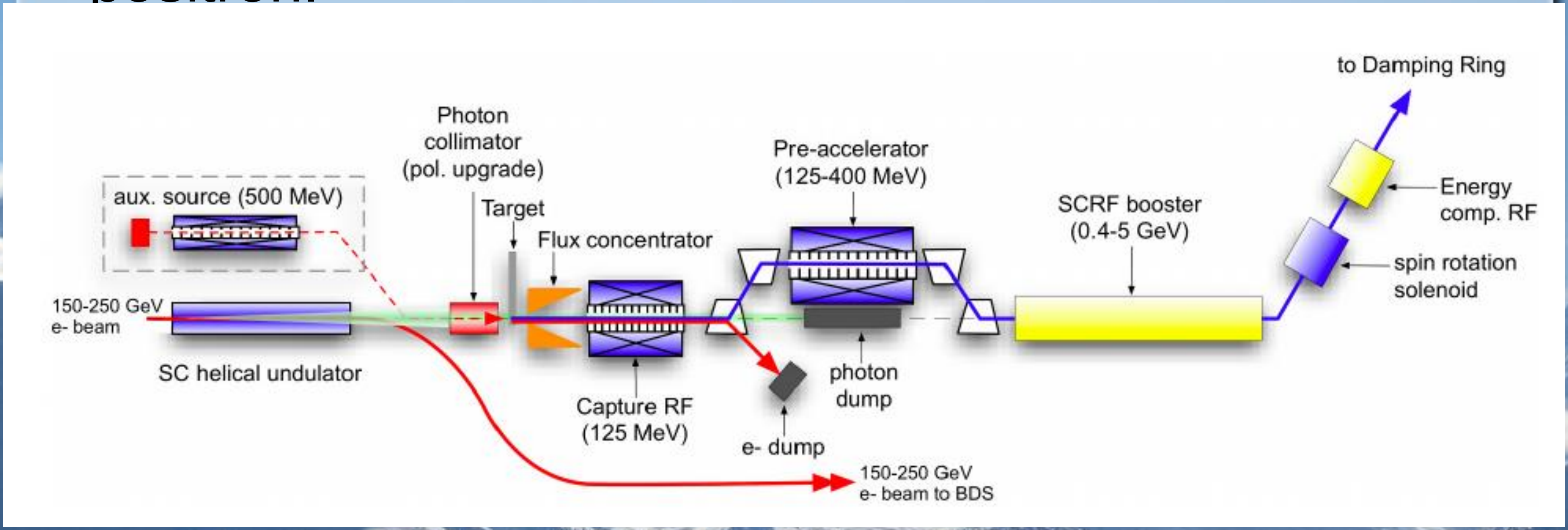


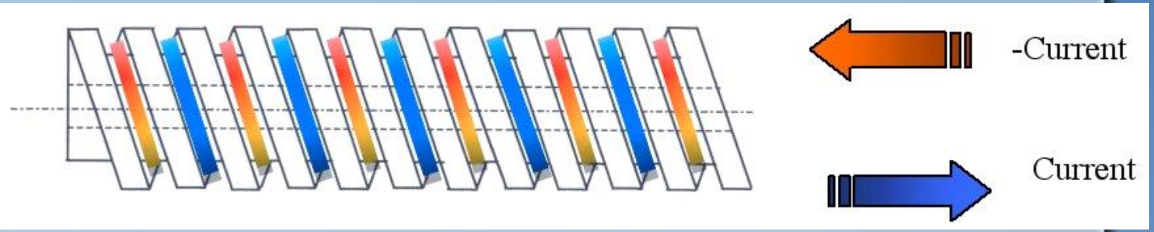
Undulator Positron Source

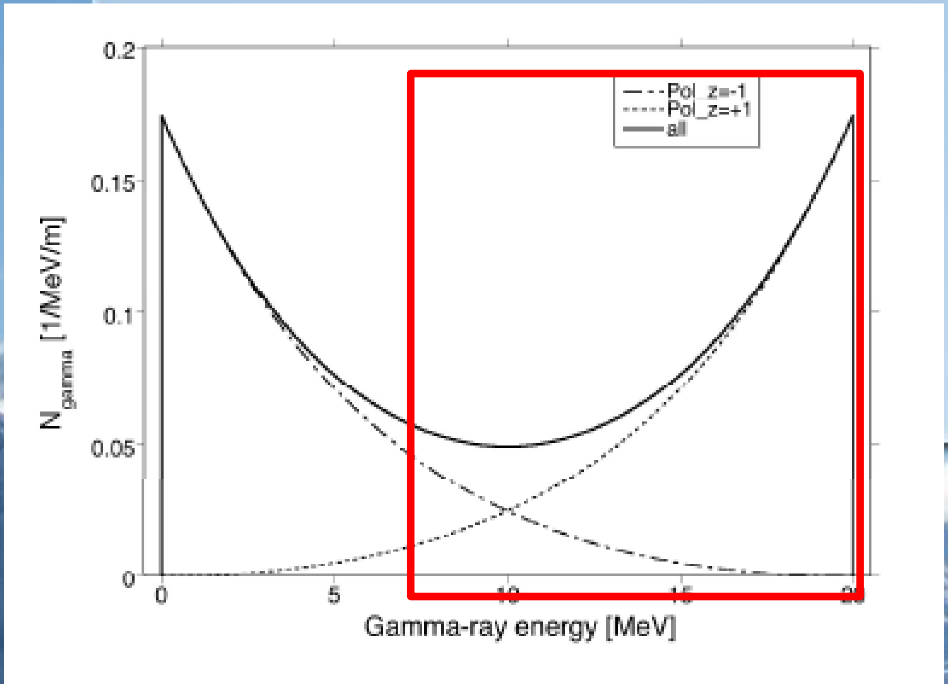
- To generate gamma ray from undulator radiation, >130GeV electron beam for collision is shared.
- Helical undulator for polarized gamma ray generation.
- Polarized gamma ray is converted to the polarized positron.

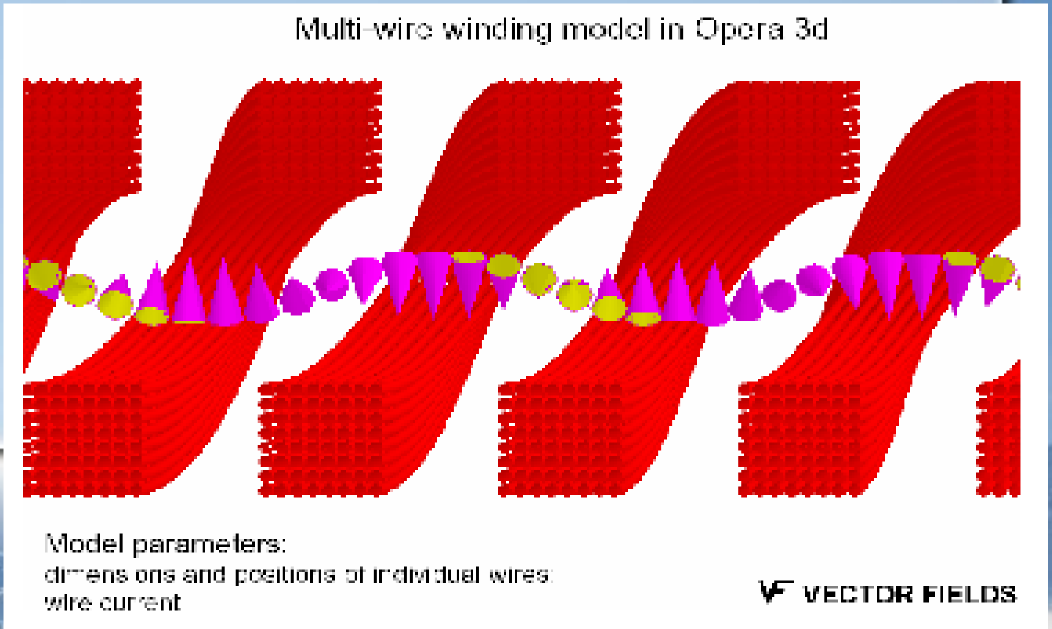


Positron Polarization

Two shifted Helical coils powered by opposite current.
-> Helical magnetic field.

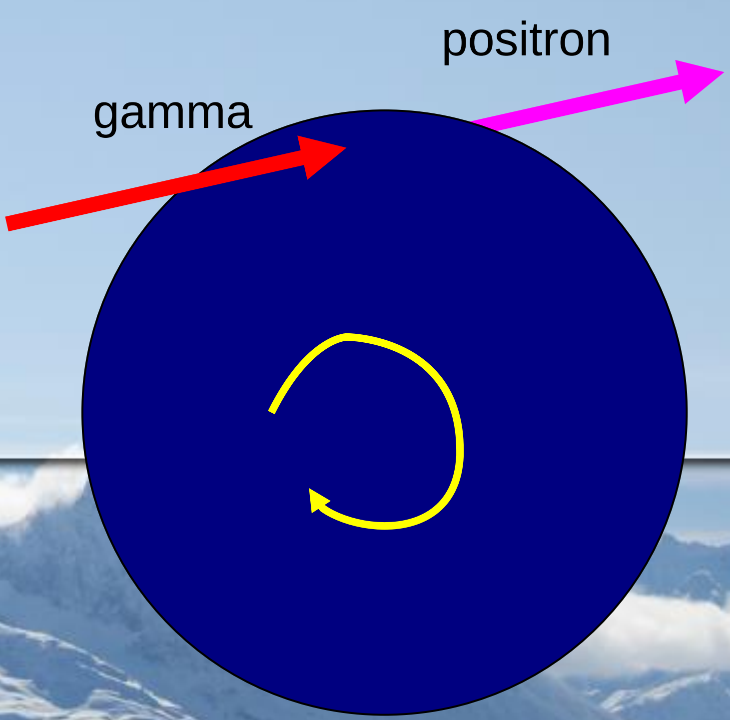






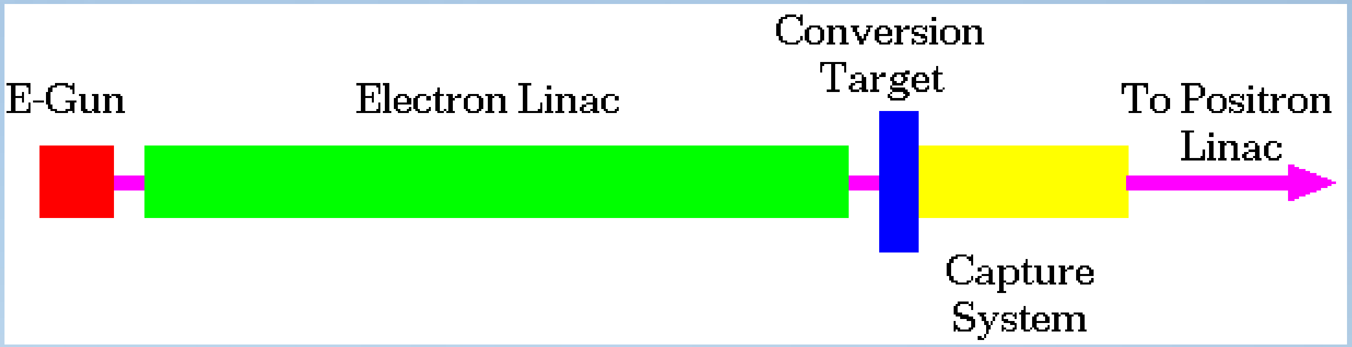
Undulator Positron Source

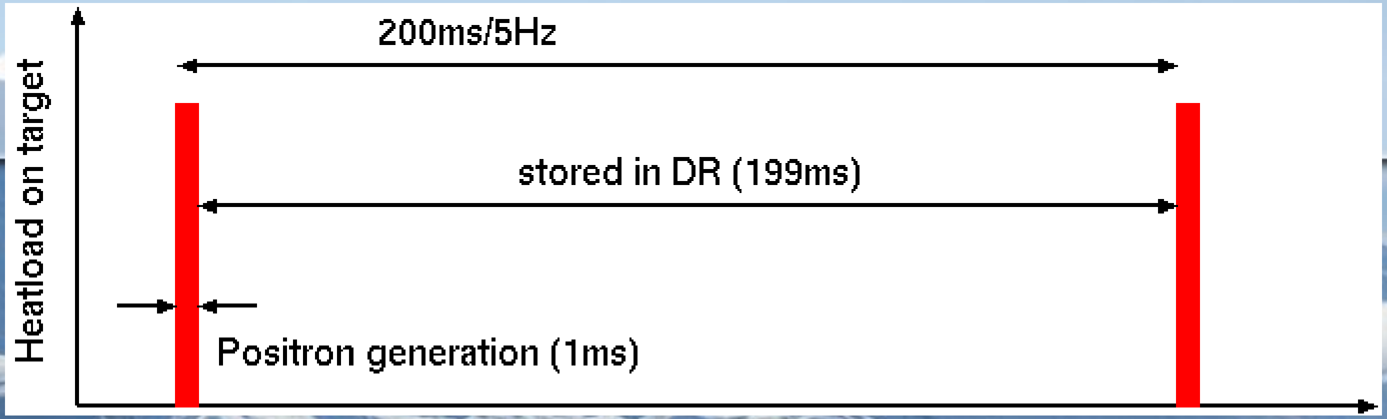
- The beam structure has to be identical to that in ML, i.e. 1ms pulse duration.
- Because a large amount of gamma rays concentrate on the short duration, the production target destruction is feared.
- To mitigate the effect, 100 m/s target rotation speed is required.



Electron Driven Positron Source

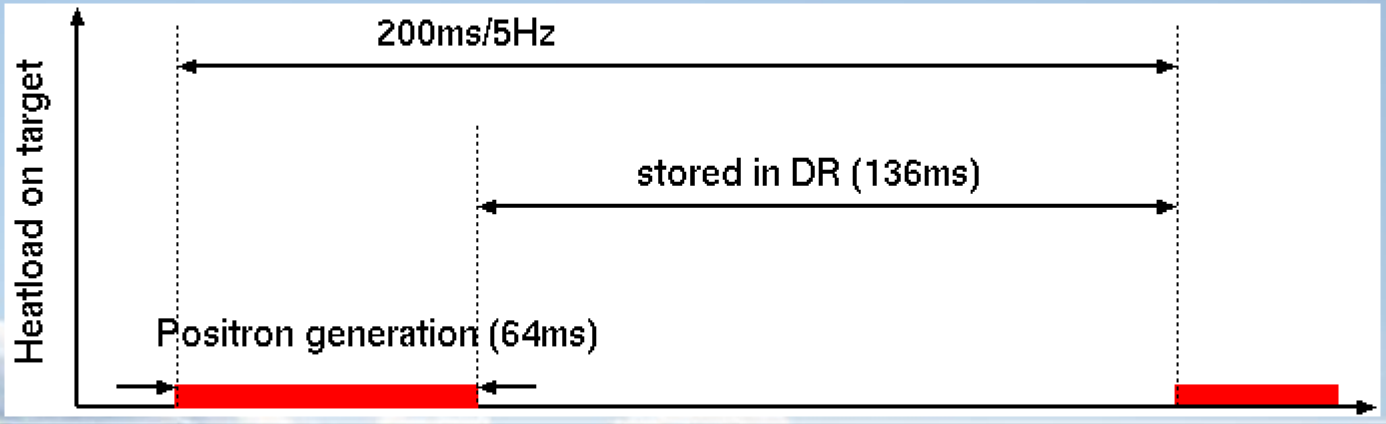
- 6 GeV e- beam on W-Re target.
- This is a conventional scheme.
- The energy deposit on the target is much higher than that of gamma ray case. Can we manage it?





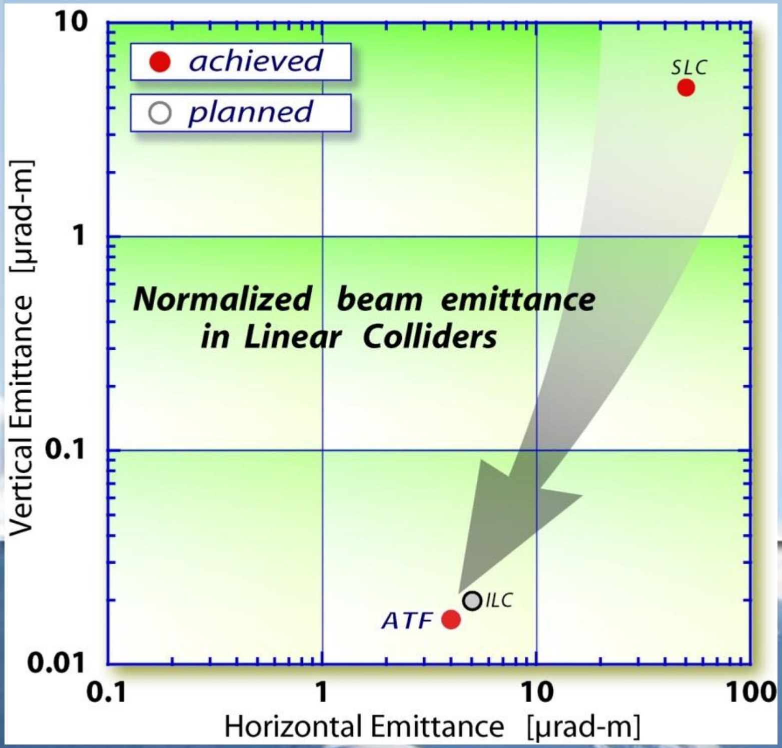
Electron Driven Positron Source

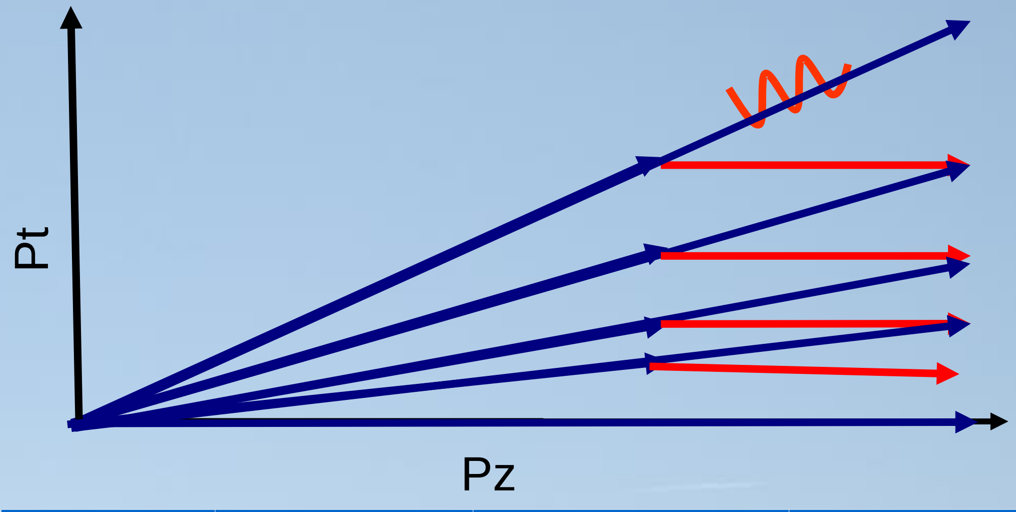
- The elecron driver is independent.
- By manipurating the beam structure, heat load on the production target is manegeable.
- Target rotation 5 m/s is enough for mitigation.



Damping Ring

- DR make up the beam by radiation damping for high luminosity.
- KEK-ATF demonstrated the low emittance.
- Super-B factory will be operated in tougher conditions. It would be a good test for LC.

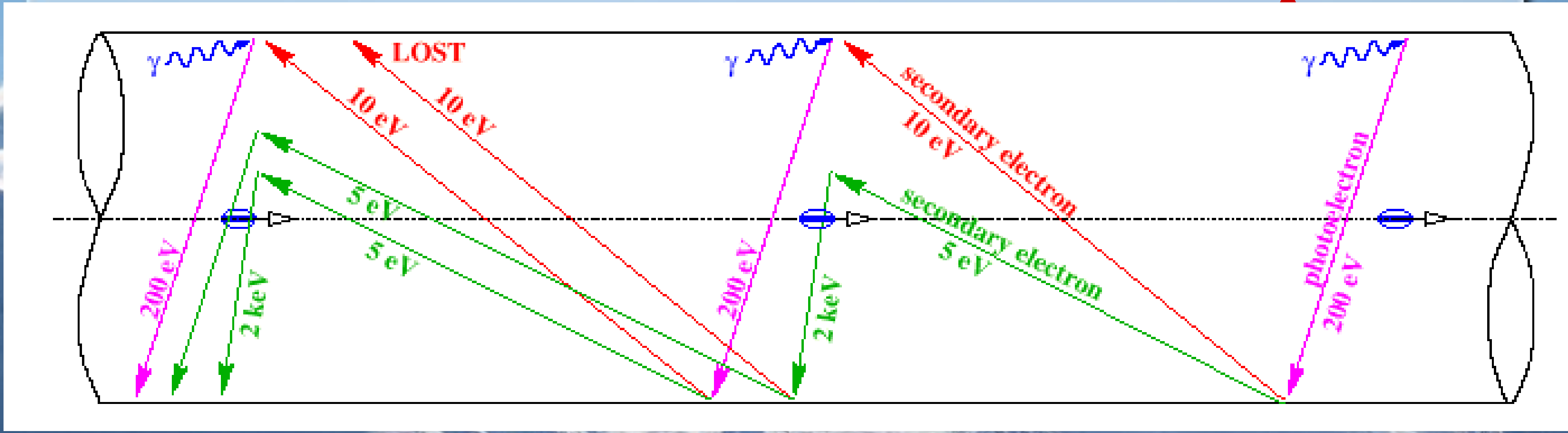




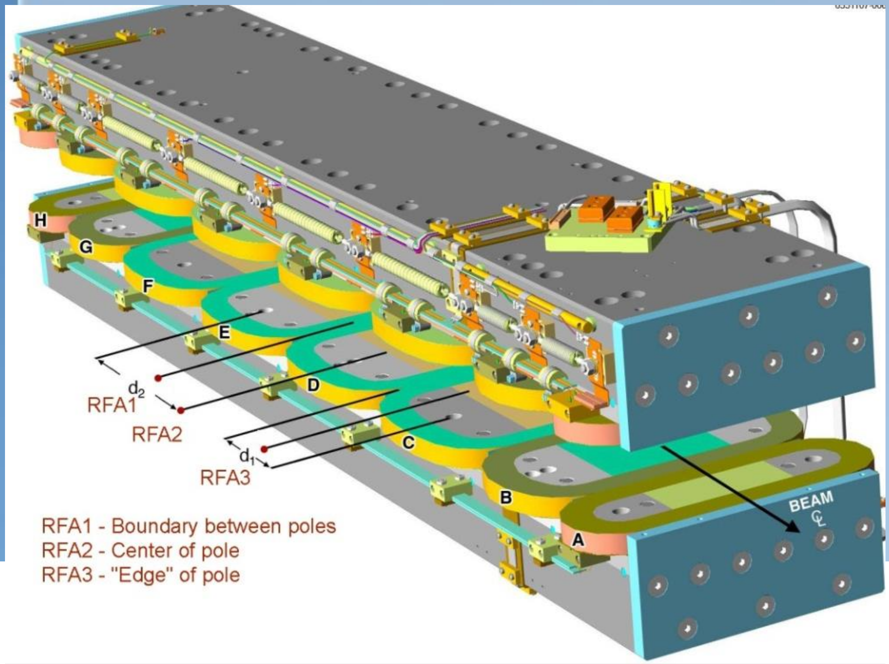
Particle	Axis	Injector (μm)	IP ((μm)
electron	Horizontal	1.0e-5	1.0e-5
	Vertical	1.0e-5	4.0e-8
positron	Horizontal	2.0e-2	1.0e-5
	Vertical	2.0e-2	4.0e-8

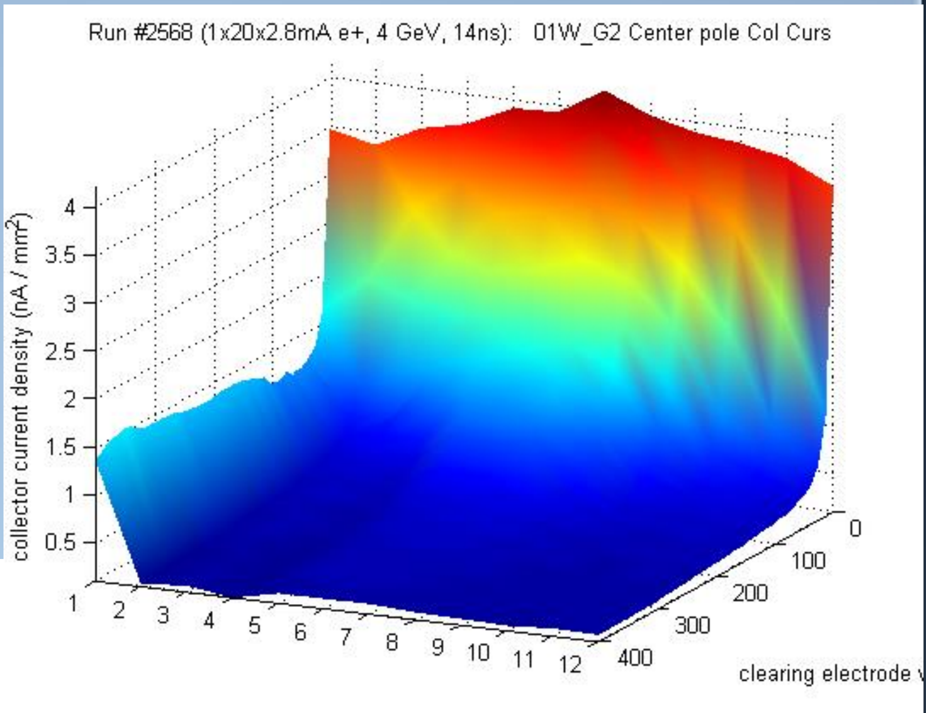
Electron Cloud Instability

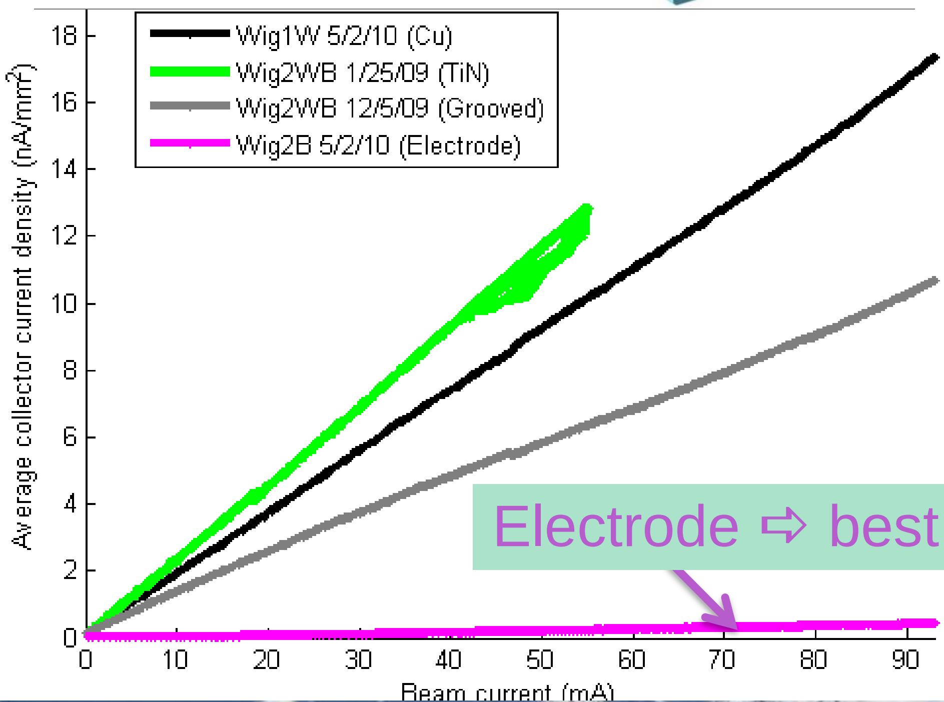
- Coupled bunch instability mediated by electron cloud on positron beam could be serious.
- SR light hits the wall and generates photo-electron.
- The photo-electron hit the wall again and secondary electron is produced.
- Electron density is grown.
- The electron cloud interacts to the positron bunch and causes an instability.



Mitigation Technique



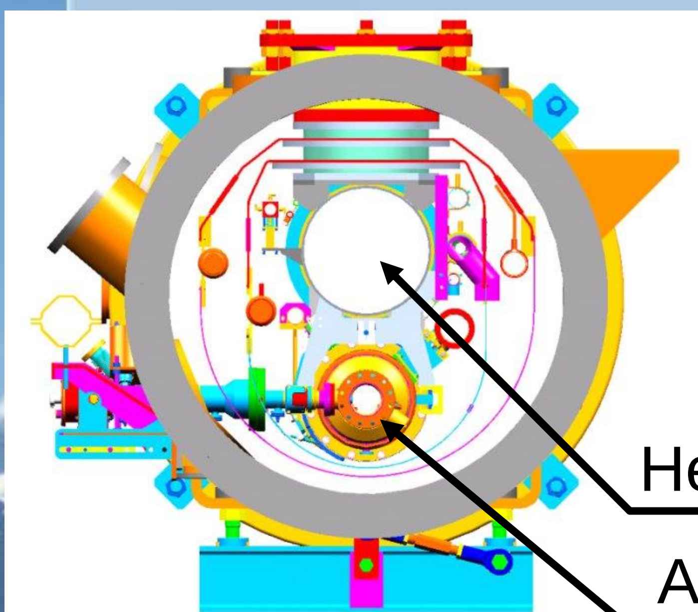




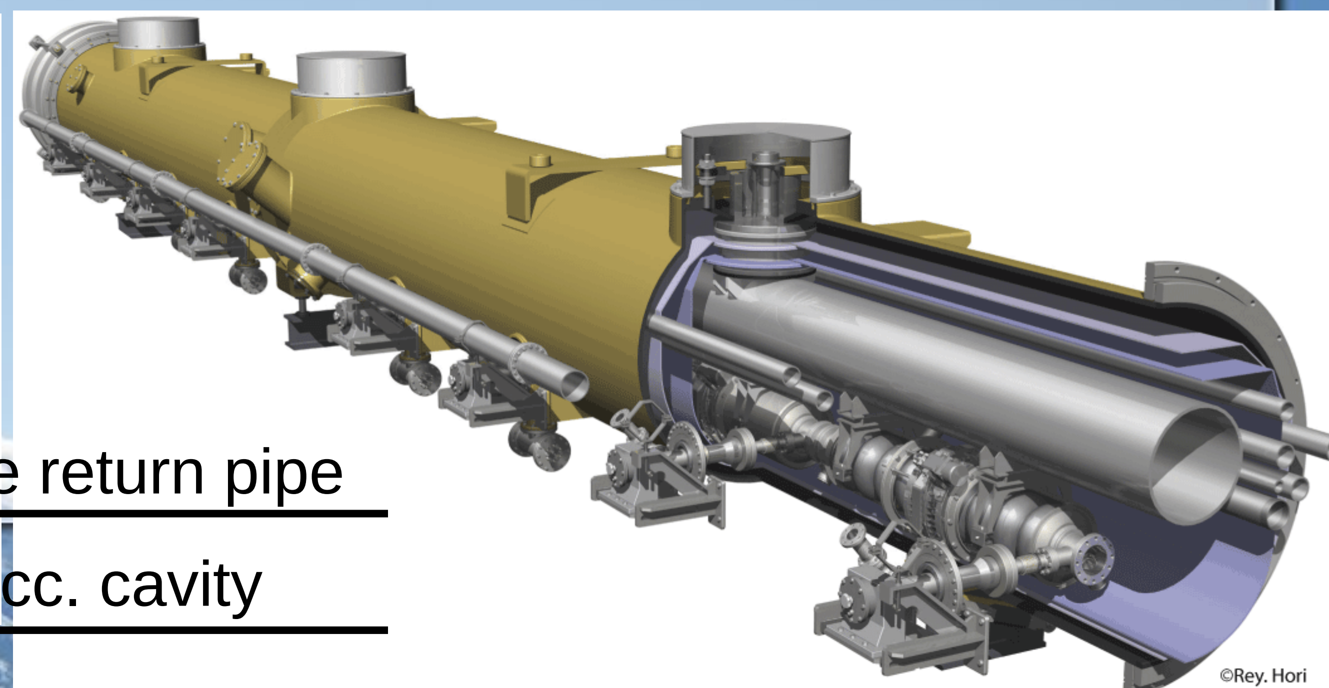
Electrode ⇨ best performance

ILC Main Linac

- Nb super conducting cavity with 2K super-fluid He.
- To maintain 2K, pump out liquid He in Cryomodule.
- 8 or 9 1m accelerator cavities are in a cryomodule.

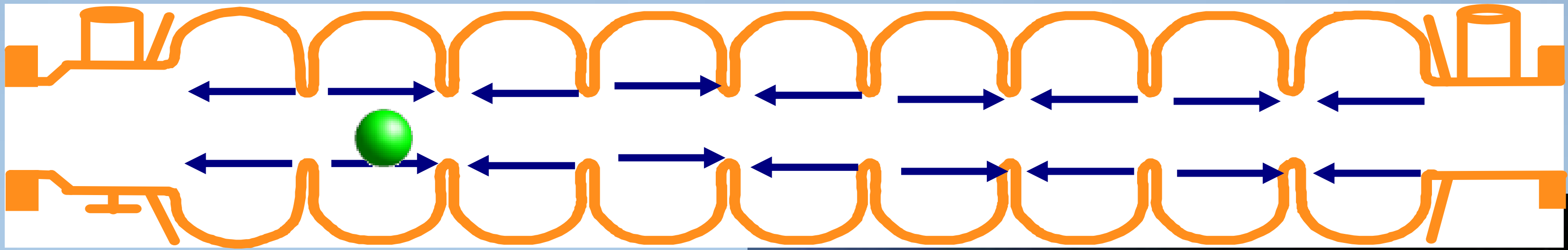


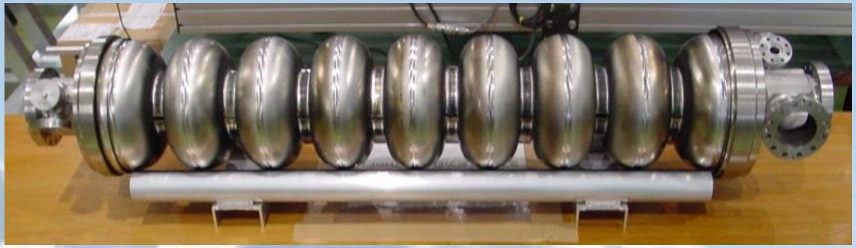
Cross section

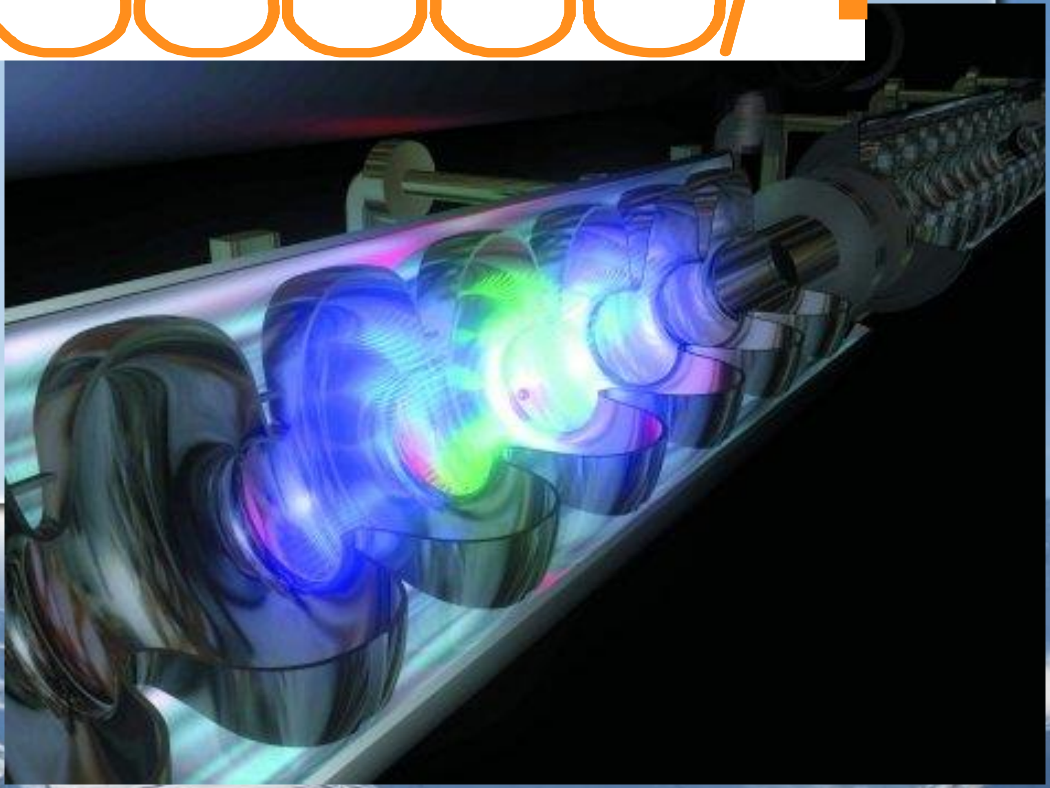


Acceleration in ILC cavity

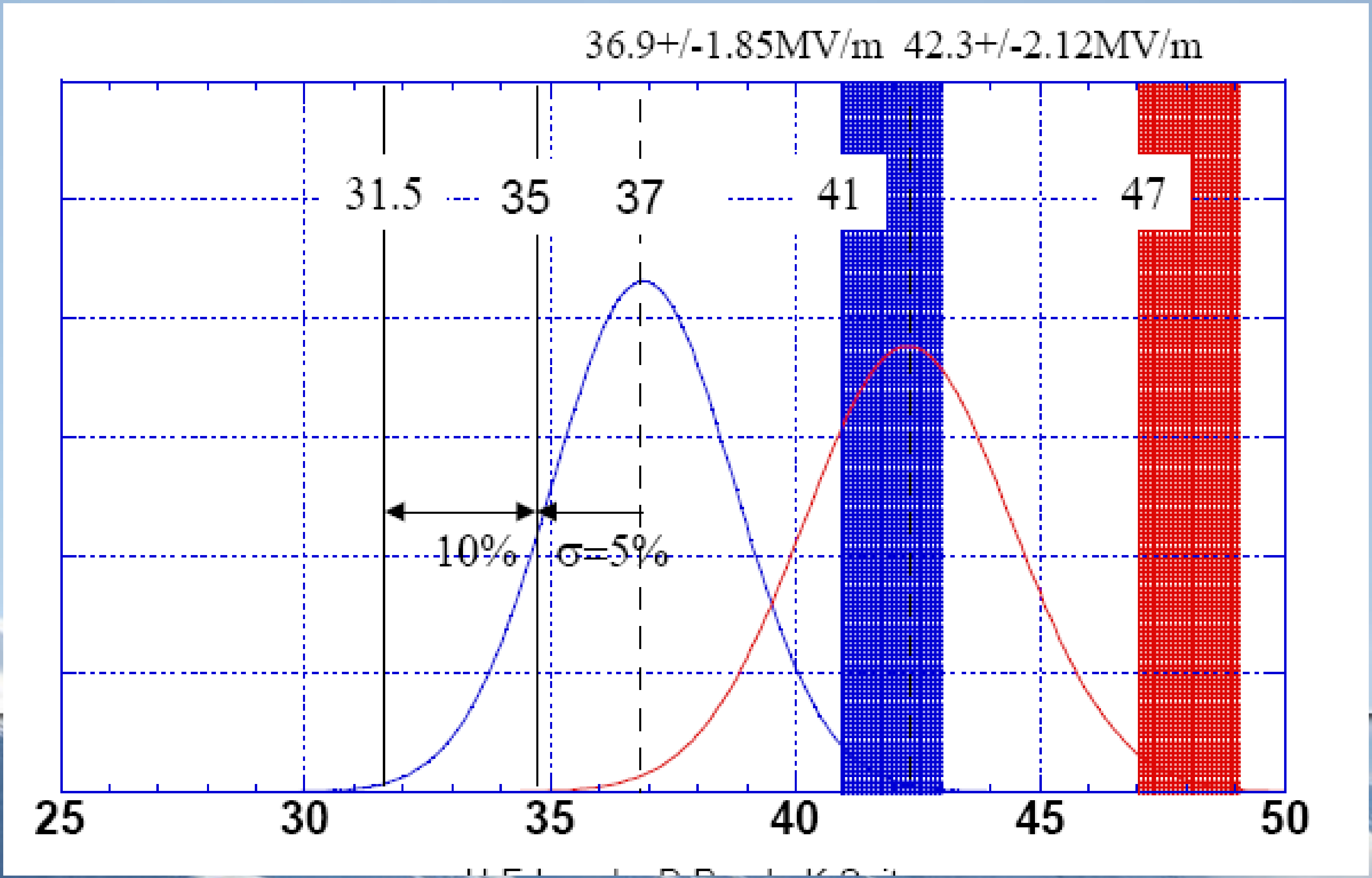
- 1.2m, 9 cells.
- Accelerator gradient：31.5MV/m.
- Standing wave (pi-mode).





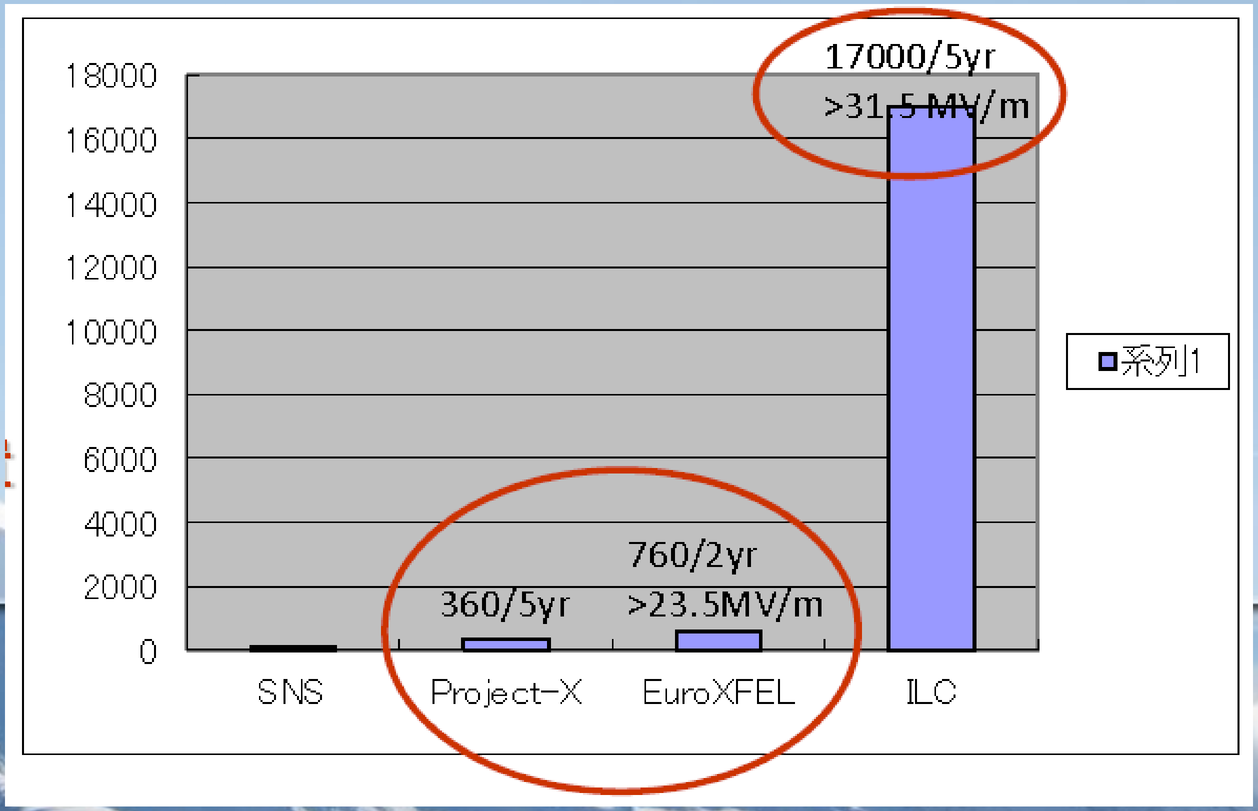


Baseline Gradient



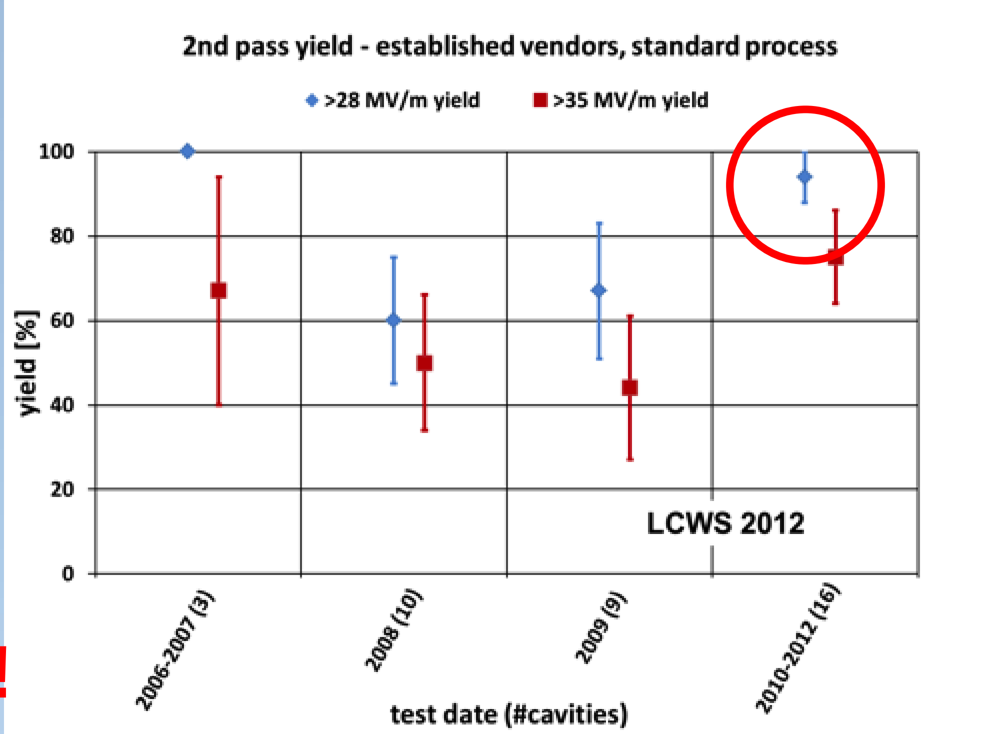
Cavity Fabrication

- 17000 cavities have to be delivered.
- This is 10 times larger than that for Euro XFEL.
- Can we manage this process?



Industorialization

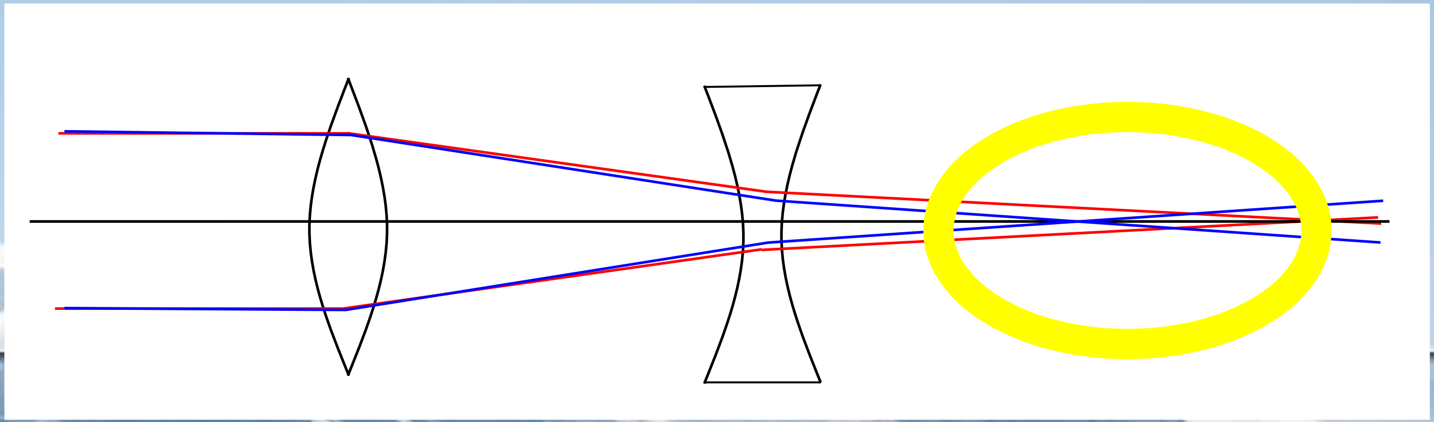
Production yield:
94 % @ > 28 MV/m,
Average gradient:
37.1 MV/m
Design average gradient:
35 MV/m



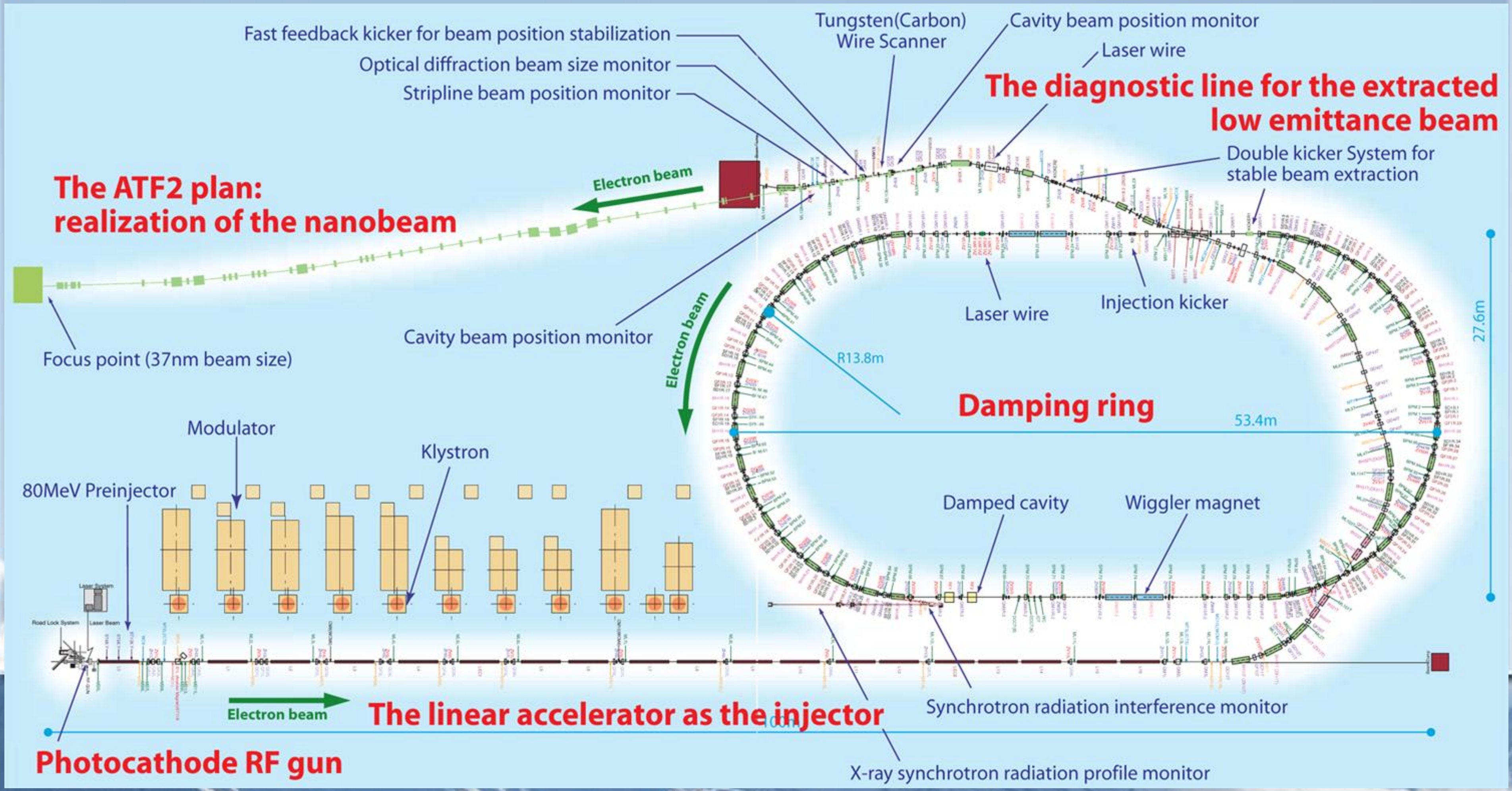
It is ready for production!

What is Final Focus?

- Focus the beam size down to 5.7nm .
- Chromatic correction (correctoin on chromatic aberation) is essential.
- Demonstration of the chromatic correction and tunining method is aim of ATF2.



Final Focus Test (ATF2)



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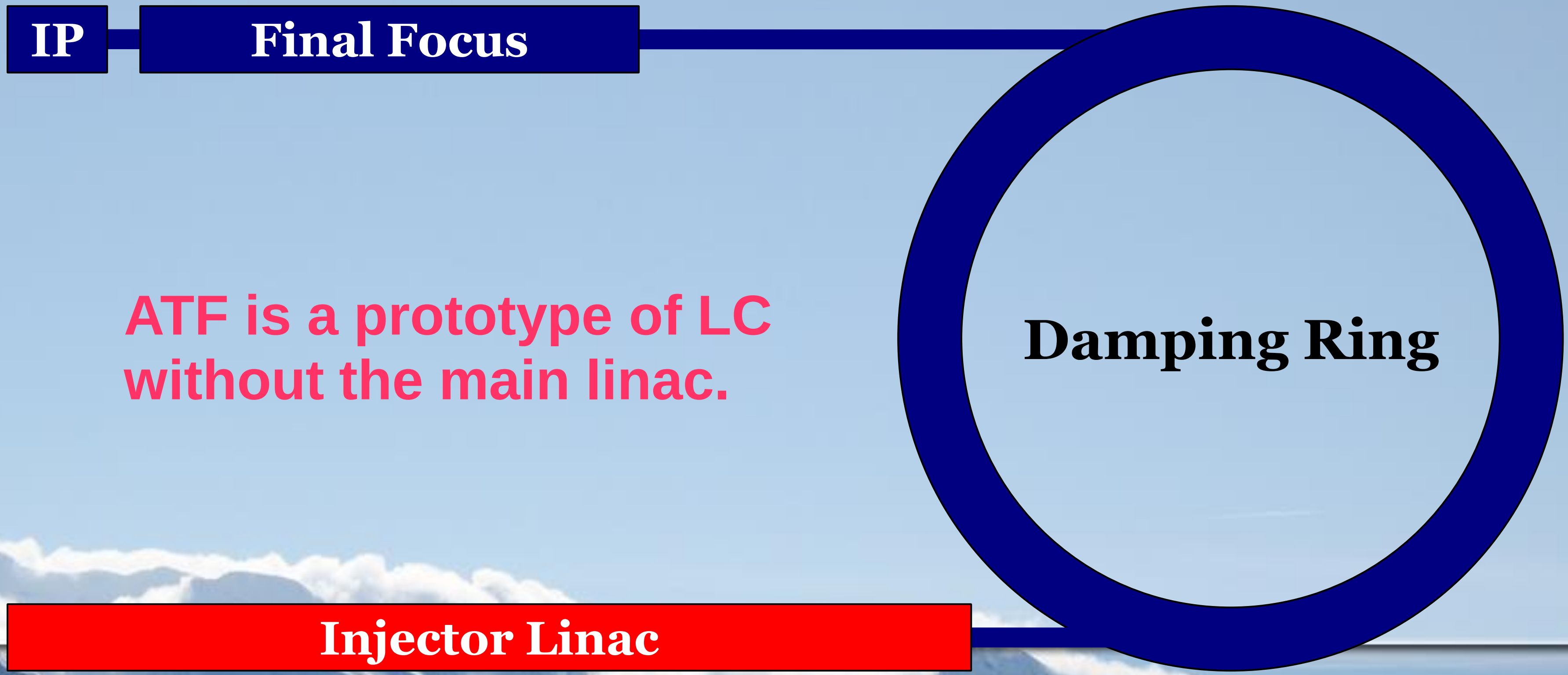
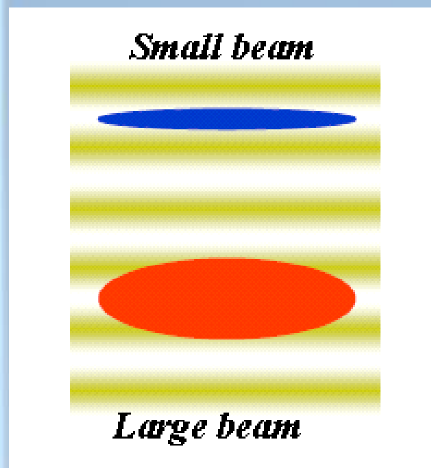
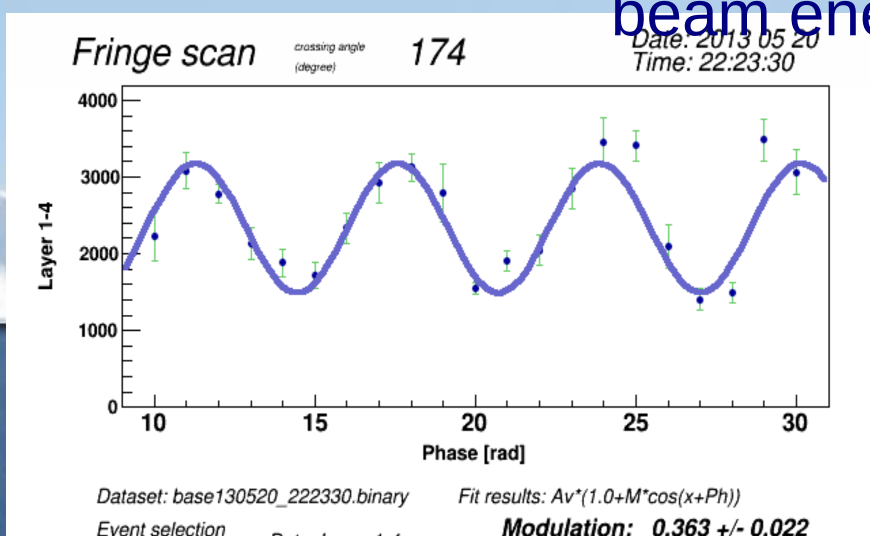


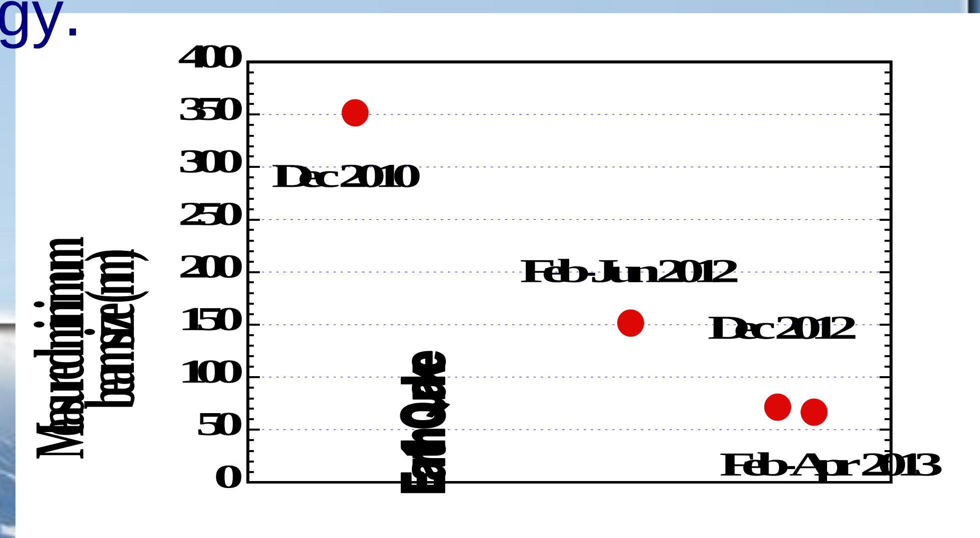
ATF is a prototype of LC without the main linac.

We are approaching!



- The beamsize at the virtual IP is measured as visibility by the laser fringe monitor.
- 60nm is confirmed.
- 35nm at 1.3 GeV is goal of ATF2. This number corresponds to 5.7nm at 250 GeV beam energy.





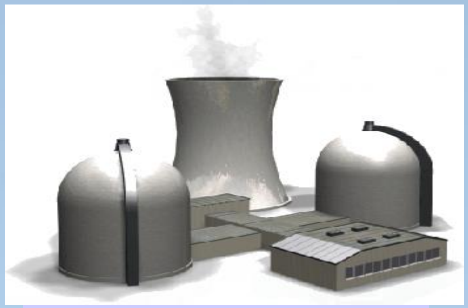
ILC Wall Plug Power

Main Linacs 140 MW **Total 230 MW** **Sub-Systems** 90 MW

RF
100 MW

78%

65%



Cryogenics:
40 MW

60%

Injectors

Damping rings

BDS

Auxiliaries

Beam Power
22 MW

1. Future Colliders
2. ILC physics motivations
3. ILC Accelerator Overview
4. ILC, the global project


ILC,
The first global project
in Asia.
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat
Image IBCAO

Evolution of LCs

- 2004	GLC	NLC	TESLA	CLIC
2004-2013		ILC		CLIC
2013-		ILC		CLIC

ICFA-ITRP (International Technical Recommendation Panel)

- As an united project, Linear collider based on Super Conductive Accelerator (International Linear Collider) should be promoted.

R&D towards the technical design report (TDR) has been led by Global Design Effort of ILC.

Evolution of LCs

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Evolution of LCs

In 2013, ILC TDR is published!

Evolution of LCs

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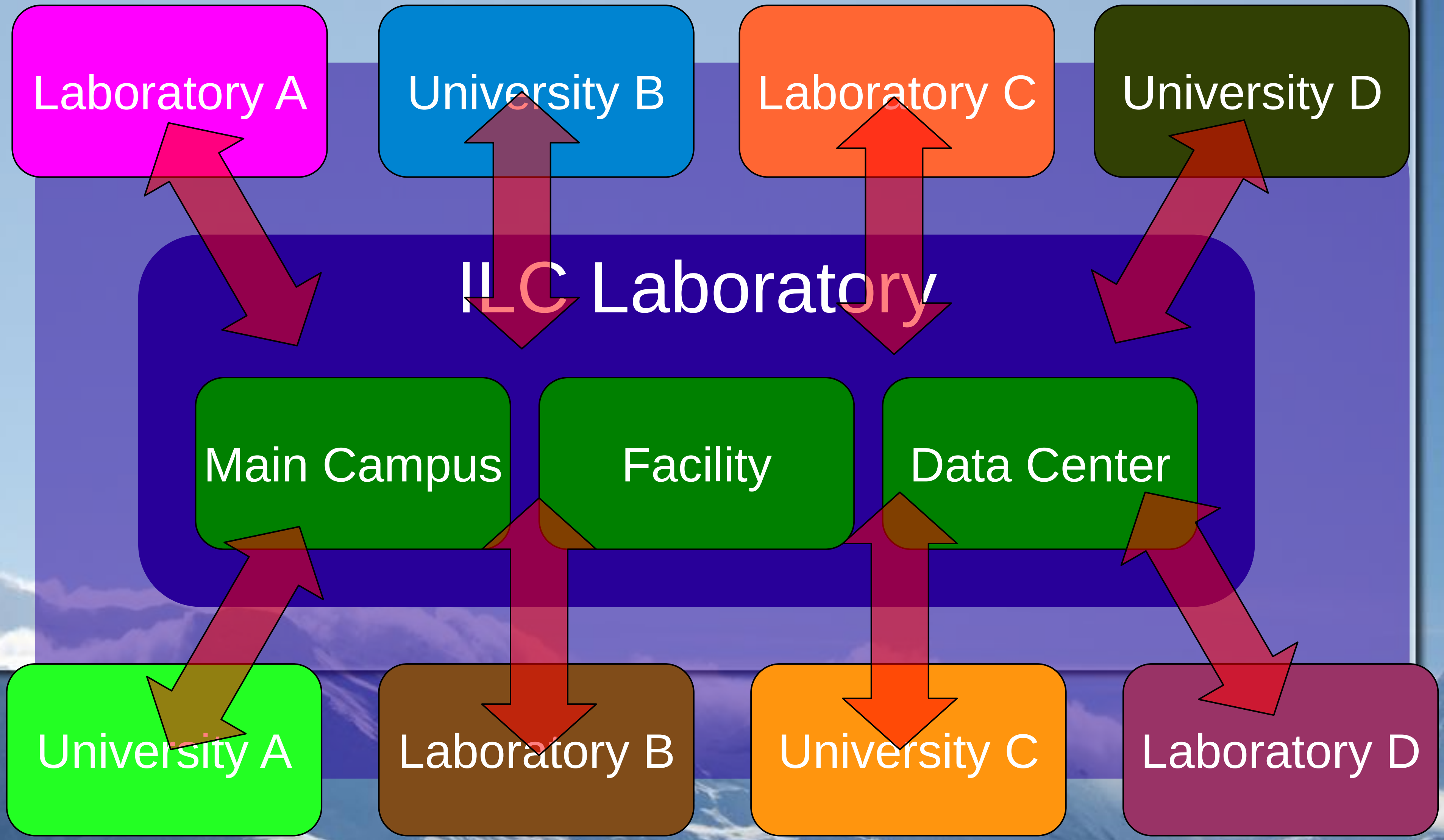
2004-2013		ILC		CLIC
2013-		ILC		CLIC

LCC (Linear Collider Collaboration)

Multilateral Lab

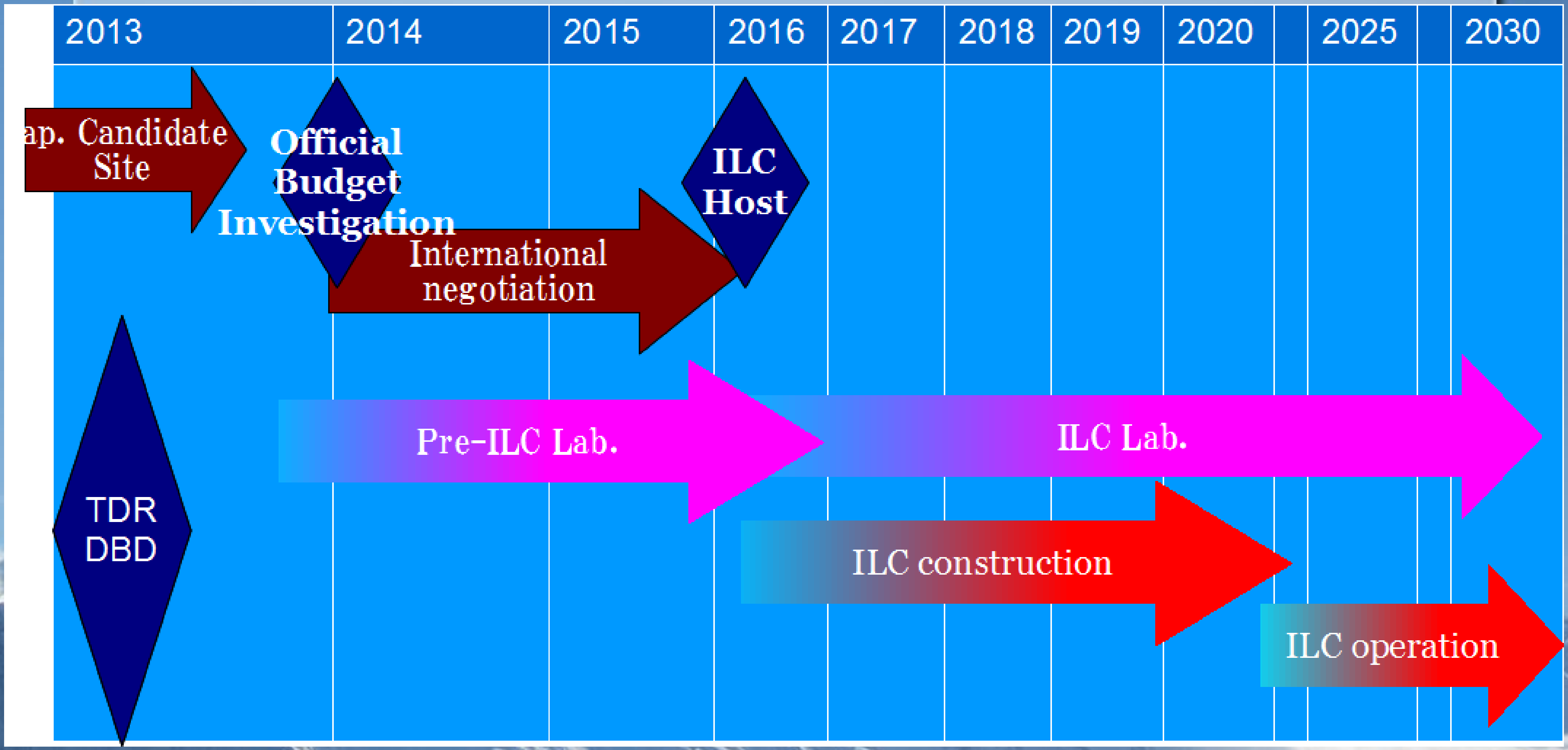


Japan will host ILC (?)

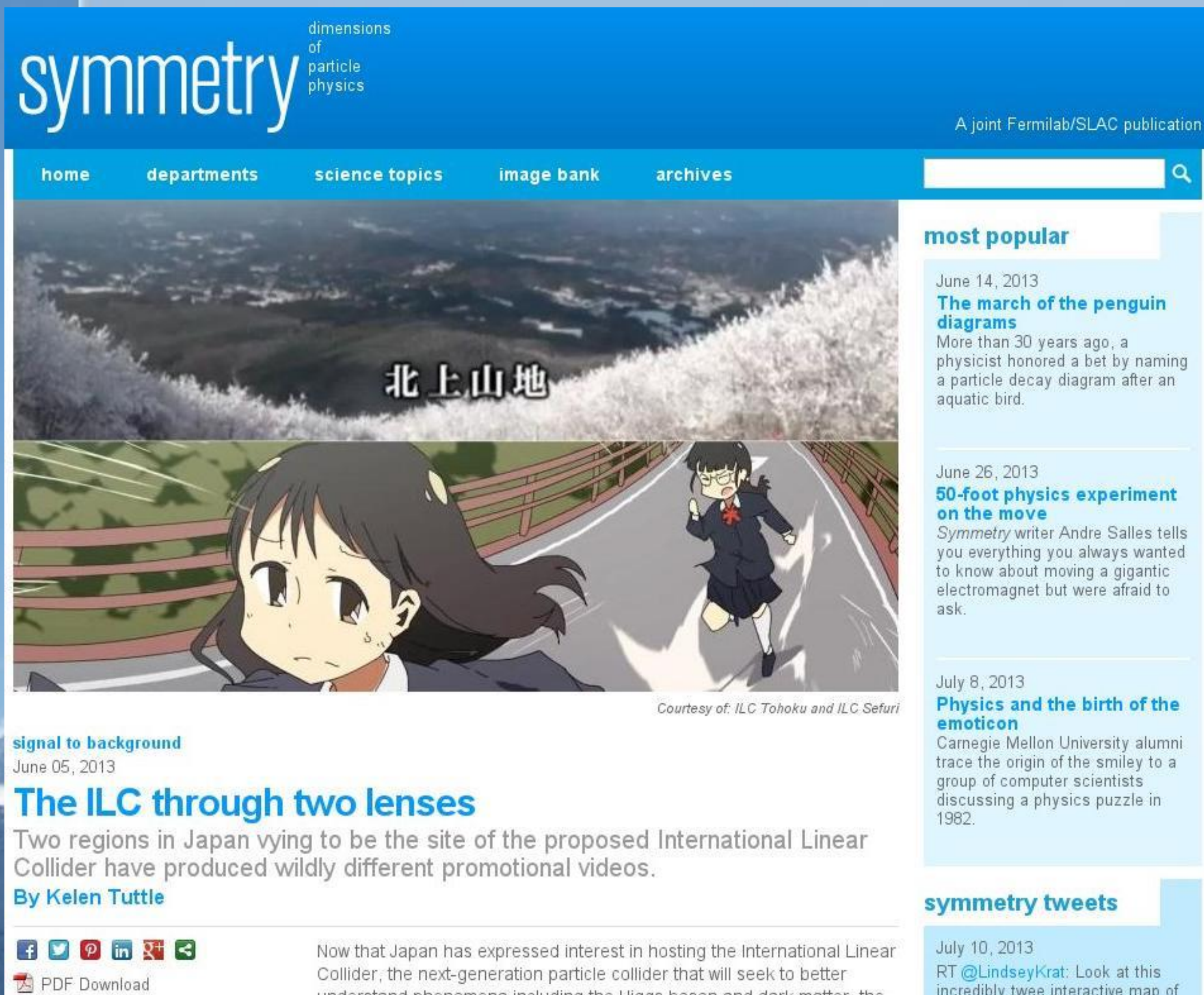
- Japanese society (Japan Association of High Energy Physicists) made recommedations concerning large-scale projects, which comprise the core fo future high energy physics research in Japan
    - Should a new particle such as a Higgs boson with a mass below approximately 1 TeV be confirmed at LHC, Japan should take the leadership role in an early realization of an e+e- linear collider.
- Japanese society (http://www.jahep.org/) proposes a staging approach of LC.
    - Physics studies shall start with a precision study of the "Higgs Boson", and then evolve into studies of the top quark, "dark matter" particles, and Higgs selfcouplings, by upgrading the accelerator.

from a report of subcomittee for future projects of high energy physics.

ILC timetable
Not guaranteed, but realistic



Japanese Candidate Site


symmetry
dimensions of particle physics
A joint Fermilab/SLAC publication

home | departments | science topics | image bank | archives

北上山地

Courtesy of: ILC Tohoku and ILC Sefuri

signal to background
June 05, 2013

The ILC through two lenses

Two regions in Japan vying to be the site of the proposed International Linear Collider have produced wildly different promotional videos.

By Kelen Tuttle

PDF Download

Now that Japan has expressed interest in hosting the International Linear Collider, the next-generation particle collider that will seek to better understand phenomena including the Higgs boson and dark matter, the

most popular

June 14, 2013
The march of the penguin diagrams
More than 30 years ago, a physicist honored a bet by naming a particle decay diagram after an aquatic bird.

June 26, 2013
50-foot physics experiment on the move
Symmetry writer Andre Salles tells you everything you always wanted to know about moving a gigantic electromagnet but were afraid to ask.

July 8, 2013
Physics and the birth of the emoticon
Carnegie Mellon University alumni trace the origin of the smiley to a group of computer scientists discussing a physics puzzle in 1982.

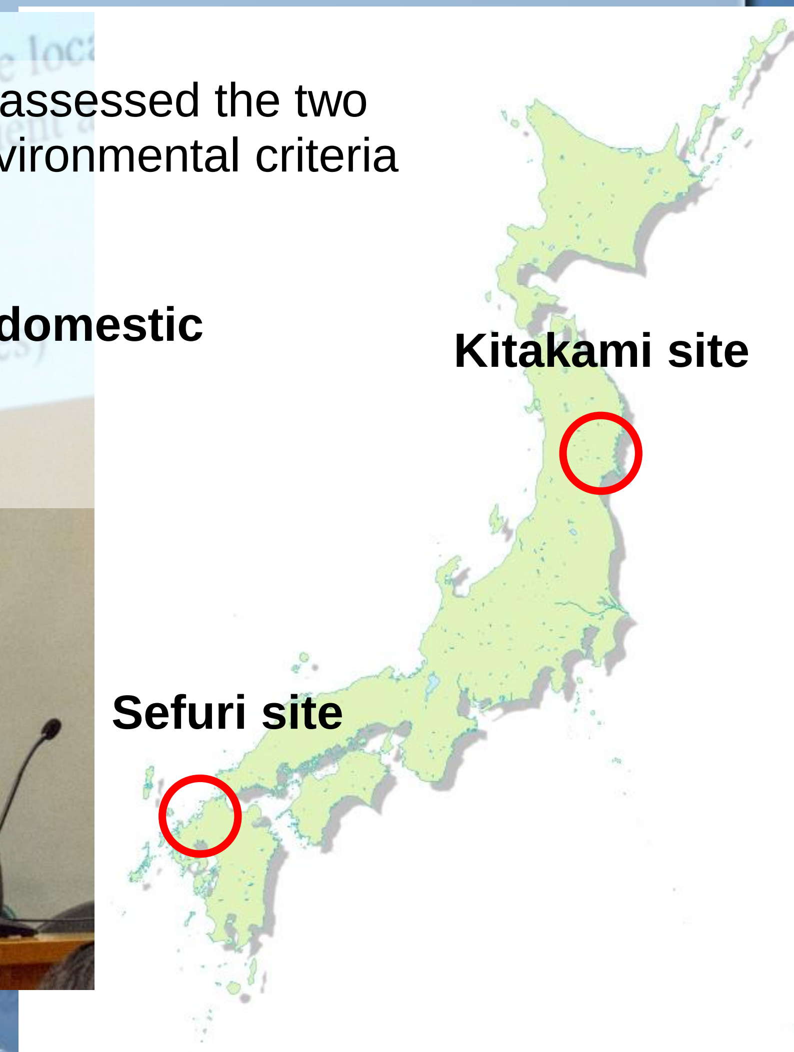
symmetry tweets

July 10, 2013
RT @LindseyKrat: Look at this incredibly twee interactive map of

Japanese Candidate Site

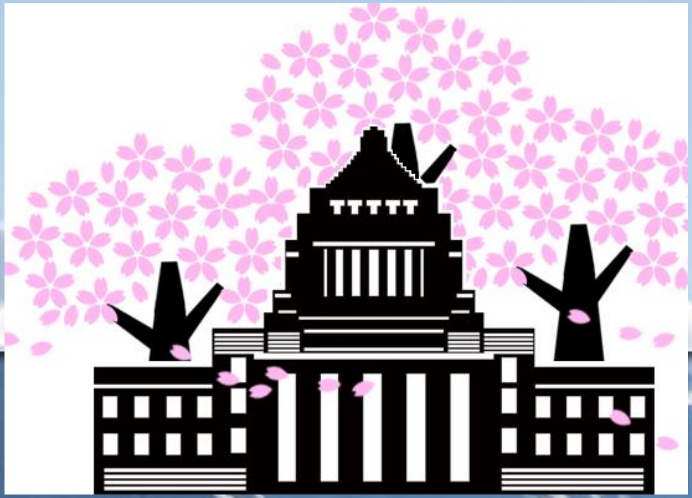
The ILC site evaluation committee of Japan has assessed the two candidate sites based on technical and socio-environmental criteria and unanimously concluded as follows:

The Kitakami site is evaluated to be the best domestic candidate site for the ILC.



Social conditions

- "Japan should contribute to innovation on advanced accelerator technology" (In the policy speeh of the prime minister).
- 150 diet members form ILC promotion alianse. ILC議員連盟
- Advanced Accelerator Science and Technology Association (AAA) is formed by companies, labs, and



LCC director Lyn Evans hands over the ILC TDR to the prime ministor Abe.

Science Council of Japan
日本学術会議

- A report of a series of special session for ILC is published in September 2013.
- ***Science of ILC is significant.***
- ***For the official bid by Japanese goverment, various issues on monetary budget sharing, human resources for detector and accelerator constructions, etc. should be well investigated within several years.***
- ***Budget for this investigation should be funded by Japanese government.***

Translation by the presenter. It is not official

Message from the world

European Strategy for Particle Physics

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 initiative of 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”.

A lepton collider: a decisive asset…

..if

- can be decided/built soon
- It might start at 250 Gev, but it should be upgradable to 500 GeV, with a possible extension to 1 TeV c.m.

Best candidate: ILC

- Mature design
- TDR delivered
- Japanese community has submitted to the government a request to host it.

Japan should put something on the table and then CERN will come.

Message from the world

HEPAP Facilities sub-panel:

Measuring Higgs properties and searching for Beyond the Standard Model effects are of primary scientific significance. **The LHC … upgrades and the 500 GeV ILC in Japan can address these questions in complementary** fashions and are absolutely central to progress in high energy physics. …. **e+e-collider at √s=500 GeV in Japan is only lepton collider ready for construction in next decade**.... Should an agreement be reached the US particle physics community would be **eager to participate in both the accelerator and detector construction.**

Snowmass Energy Frontier WG
Chip Brock

bottom line

This Higgs Boson changes everything.

We're obligated to understand it using all tools.

The Road To ILC

- ILC has to be constructed by a real international effort.
- The world hope that Japan hosts ILC.
- It could be a new type of a global project.

"In the flat world that is taking shape, leadership …no longer consists of single-handed efforts to maintain dominance in a particular field. Rather, leadership emerges from the creativity and initiative needed to organize international teams of collaborators to pursue projects that are beyond the capability of any one country."

Harold Shapiro, Charting the Course for Elementary Particle Physics, NRC, 2006

Host Nation

- We need to think more broadly
  - CERN was founded on the ashes of war by a set of visionary physicists
    - And today, we are beneficiaries of their foresight

est. 1954

CERN

Science for peace!

Host Nation

- So perhaps today, at the dawn of the Asian century, the world needs Japan, China, Korea, India, Vietnam all collaborating on a peaceful endeavor

NPO国際交流推進センター

Summary

- Hadron collider and lepton collider are inseparable partner in the physics.
- Next e+ e- collider has to be Linear collider.
- Rich physics for the Linear collider.
- Accelerator design is ready for construction.
- ILC could be the first global project in Asia. We hope that Japan announces host ILC soon.