Present Status of ERL project
- 3GeV ERL and XFEL-O-

ERL Project
KEK/IMSS

Hiroshi Kawata
ERL Project Office, KEK

3-4/Oct/2012 PF workshop “New research developments at KEK-Slow positron Facility”

Contents

- What is ERL?
- Accelerator development in cERL
- Milestone toward 3GeV-ERL
- Summary
- Possible collaboration to produce high intense positron source

ERL Collaboration Team

High Energy Accelerator Research Organization (KEK)
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JASRI/SPring-8
H. Hanaki

Yamaguchi University
H. Kurisu

Introduce myself

- Accelerator physicist? -> No!!
- Material scientist based on X-ray scattering by means of synchrotron radiation
- Resonant scattering, Resonant magnetic scattering, Compton scattering and XMCD
- One paper with Prof. Hyodo and Prof. Nagashima

- "High-Resolution Compton Scattering Study of Li: A Sphericity of the Fermi Surface and Electron Correlation Effect" Phys. Rev. Lett., (1995) 2252
  By Y.Sakurai, Y.Tanaka, A.Bansil, S.Kaprzyk, A.T.Stewart, Y.Nagashima, T.Hyodo, S.Nanao, H.Kawata and N.Shiotani

Photon Factory

PAST AND FUTURE

2012:
30th Years Anniversary

2013:
First beam
from cERL

2008:CDR of cERL

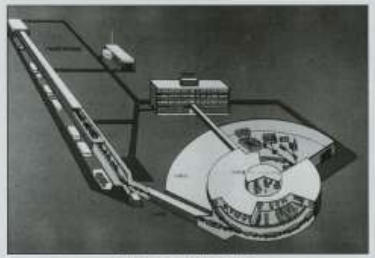
2006:ERL project Office

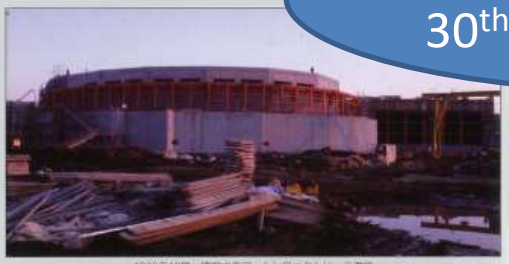
2002:Examination of ERL

3500 users/ year

800 proposals / year

1982:
First X-ray beam





2009.4 コンパクトERL建設地（ ）決定

2006.4 （ ）

2004.4 放射光科学研究施設に名称変更

2003.5 構造生物学研究センター設立

1997.9 PFリング（ ）

1997.4 高エネルギー加速器研究機構 物質構造科学研究所 放射光研究施設に組織変更

1996.12 PFで（ ）mAの大電流蓄積に成功

1991.3 PFで3GeV運転開始

1990.4 PFで単バンチ運転の共同利用実験を開始

1989.4 総合研究大学院大学・放射光科学専攻を設置

1987.4 PF-AR（トリスタン入射蓄積リング）で放射光共同利用実験を開始

1987.2 PFリングで低エミッタンスモード（130nmrad）の共同利用実験を開始

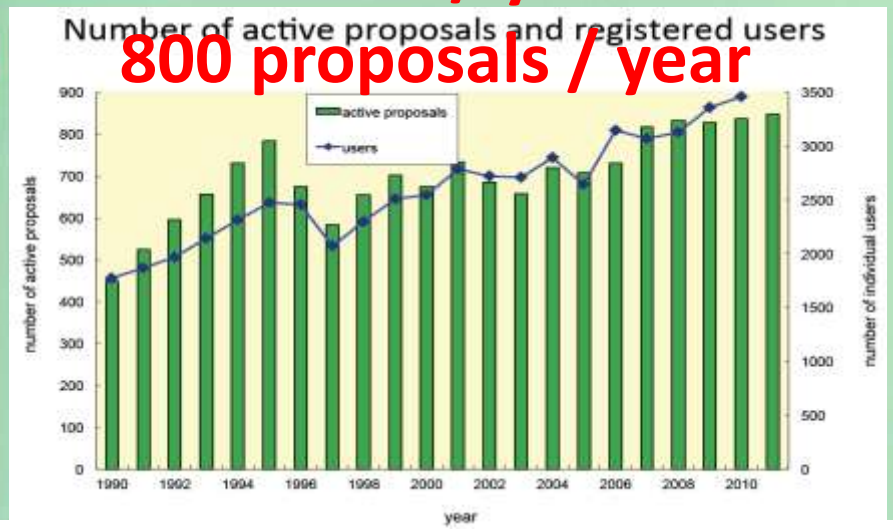
1983.6 （ ）利用実験開始

1982.3 （ ）

1978.4 （ ）設開始

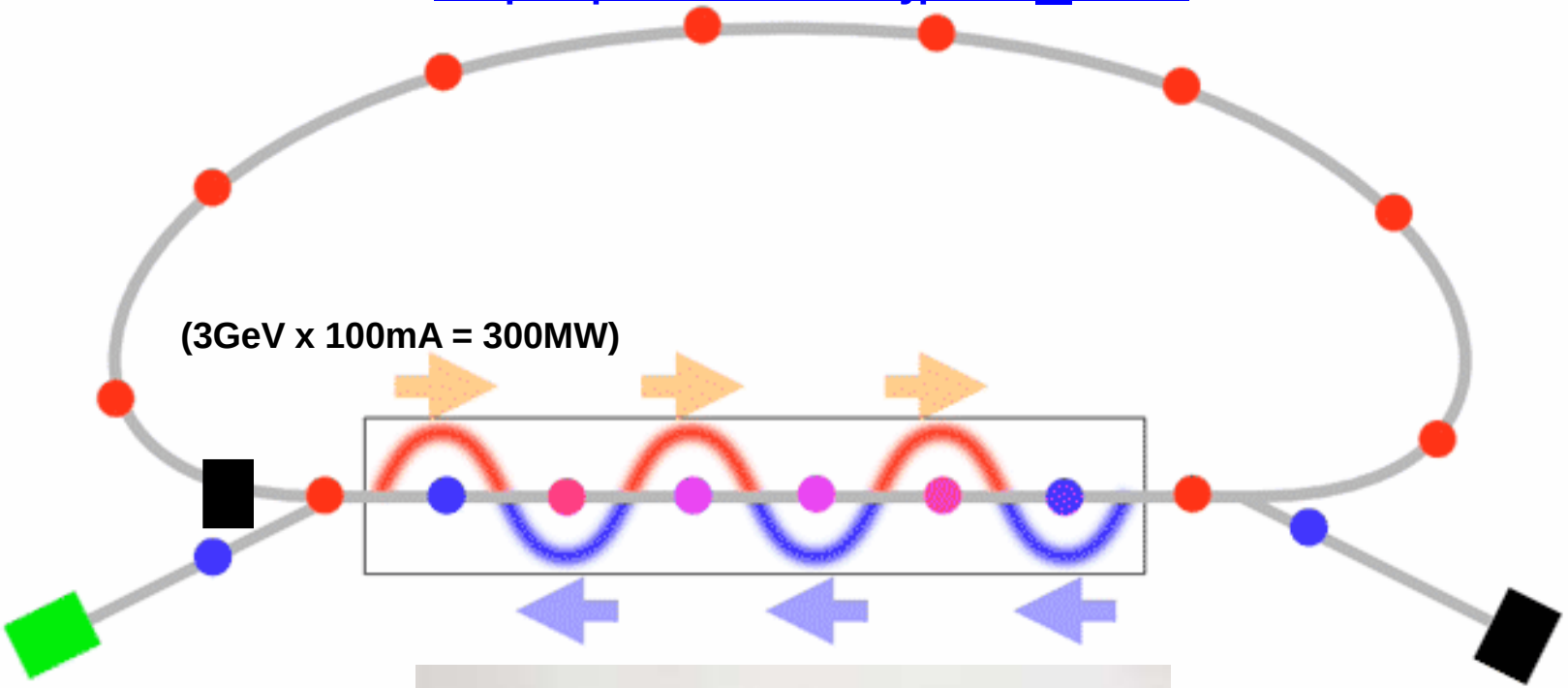
1974.6 日本学術会議「放射光総合研究所」の設置を勧告

1971.11 高エネルギー物理学研究所設立



Outline of the ERL

http://pfwww.kek.jp/erl_info/



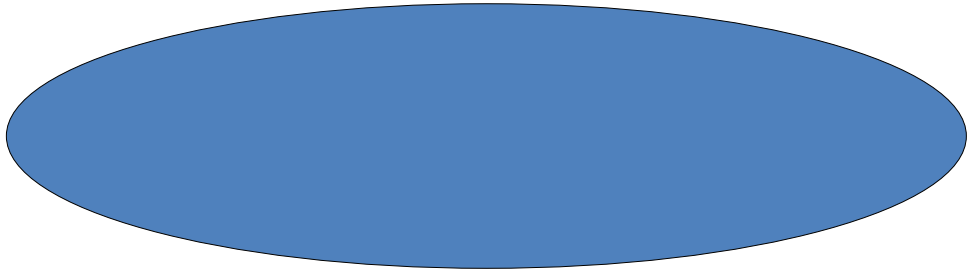
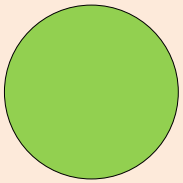
High brilliant electron gun

Super conducting cavity for Acceleration and deceleration

Beam Dump
(10MeV x 100mA = 1MW)

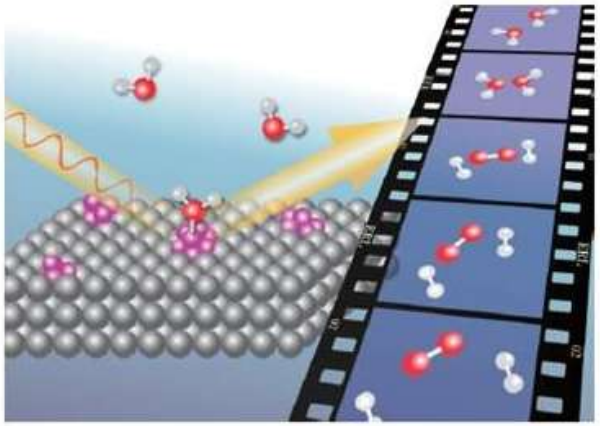
Beam characteristics of ERL

(electron beam size and divergence)

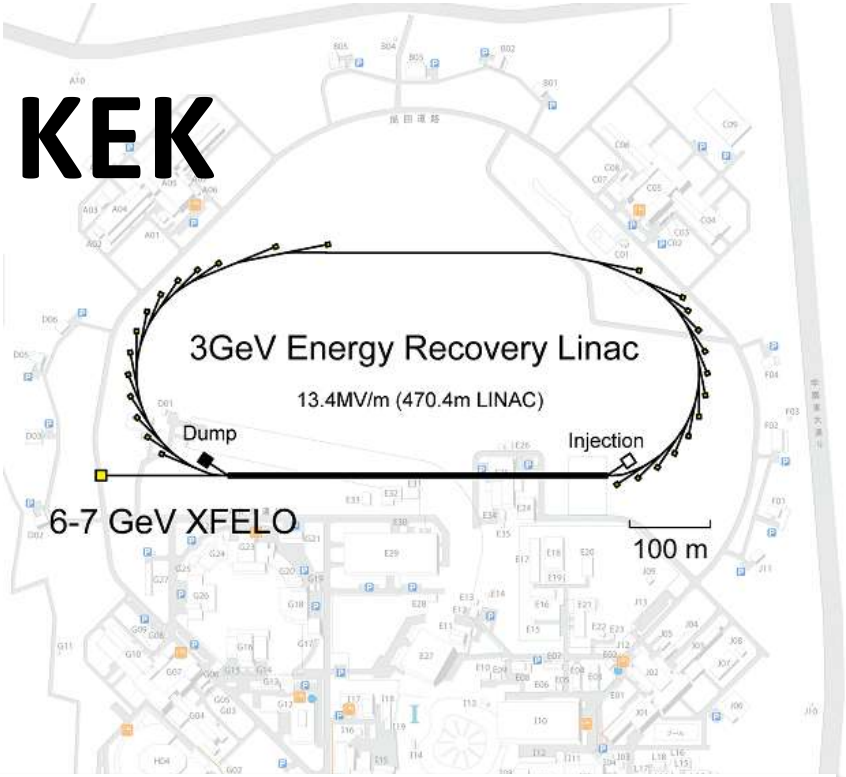
	3rd generation SR	ERL	SASE-XFEL
Beam size (μm)			
	H: 298 (1σ) V: 6.6 (1σ)	H: 7.1 (1σ) V: 7.1 (1σ)	H: 28 (1σ) V: 28 (1σ)
Beam divergence (μrad)			
	H: 12.7 (1σ) V: 3.5 (1σ)	H: 2.3 (1σ) V: 2.3 (1σ)	H: 0.28 (1σ) V: 0.28 (1σ)

KEK

Energy Recovery Linac
Conceptual Design Report



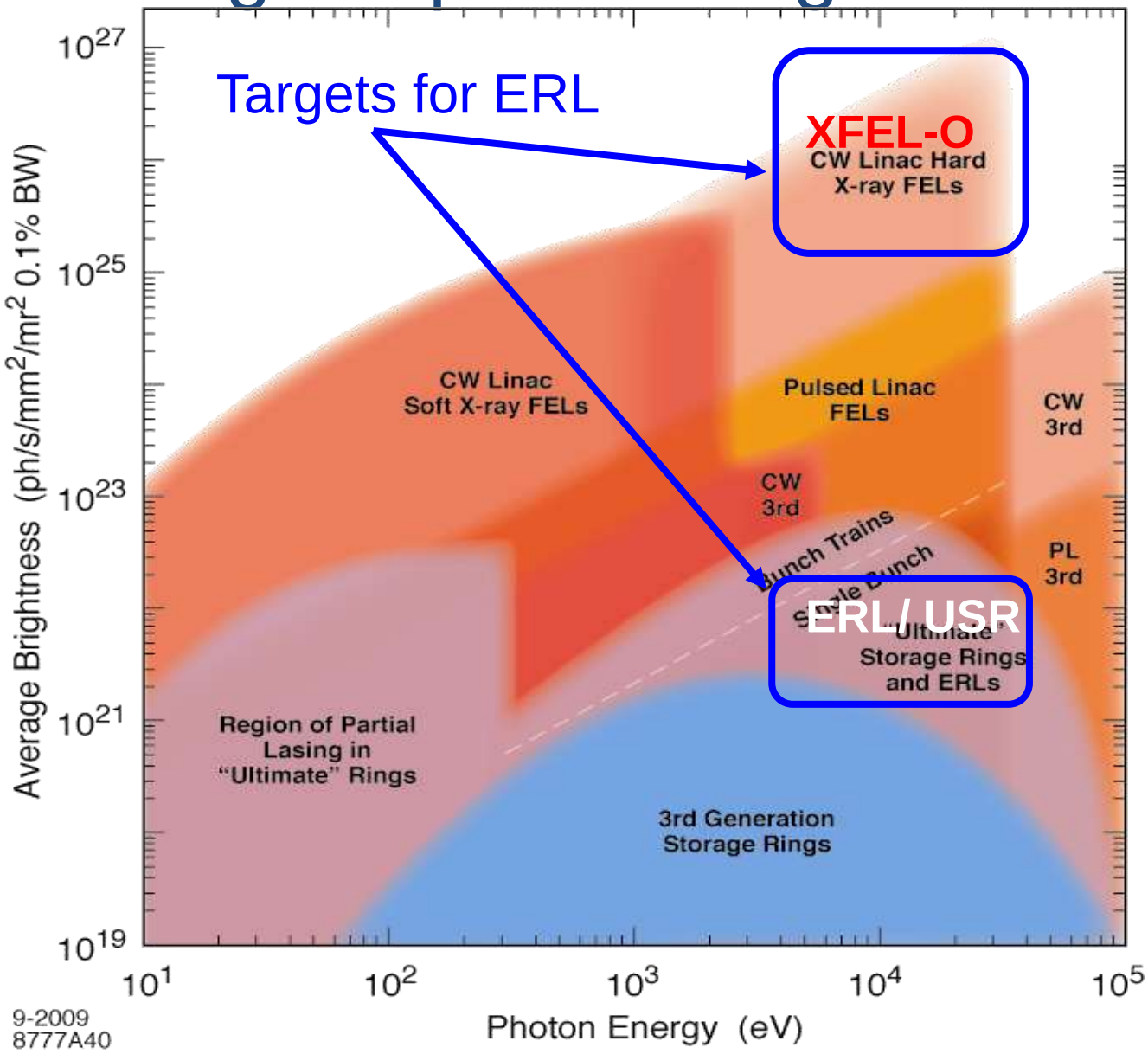
High Energy Accelerator Research Organization (KEK)



- Beam energy
  - Full energy: 3 GeV
  - Injection and dump :10 MeV
- Geometry
  - Linac length : 470 m
- Straight sections for ID's
  - 22 x 6 m short straight
  - 6 x 30 m long straight

http://pfwww.kek.jp/ERLoffice/ERL_IAC/ERL%20CDR_latest%20version.pdf

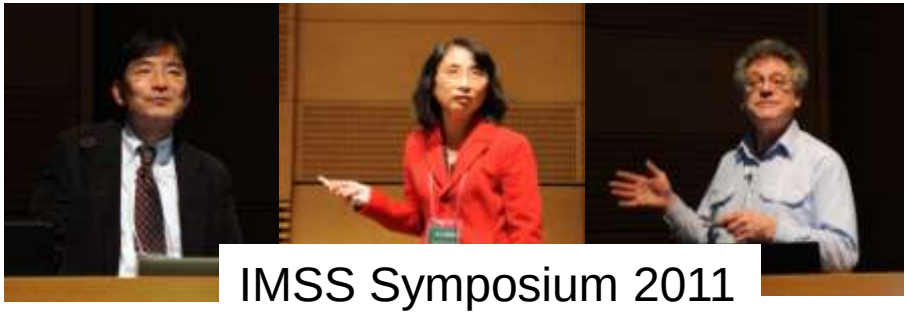
Target: spectral brightness



Figures are cited from: R. Hettel, "Performance Metrics of Future Light 13 Sources", FLS2010, SLAC, March 1, 2010.

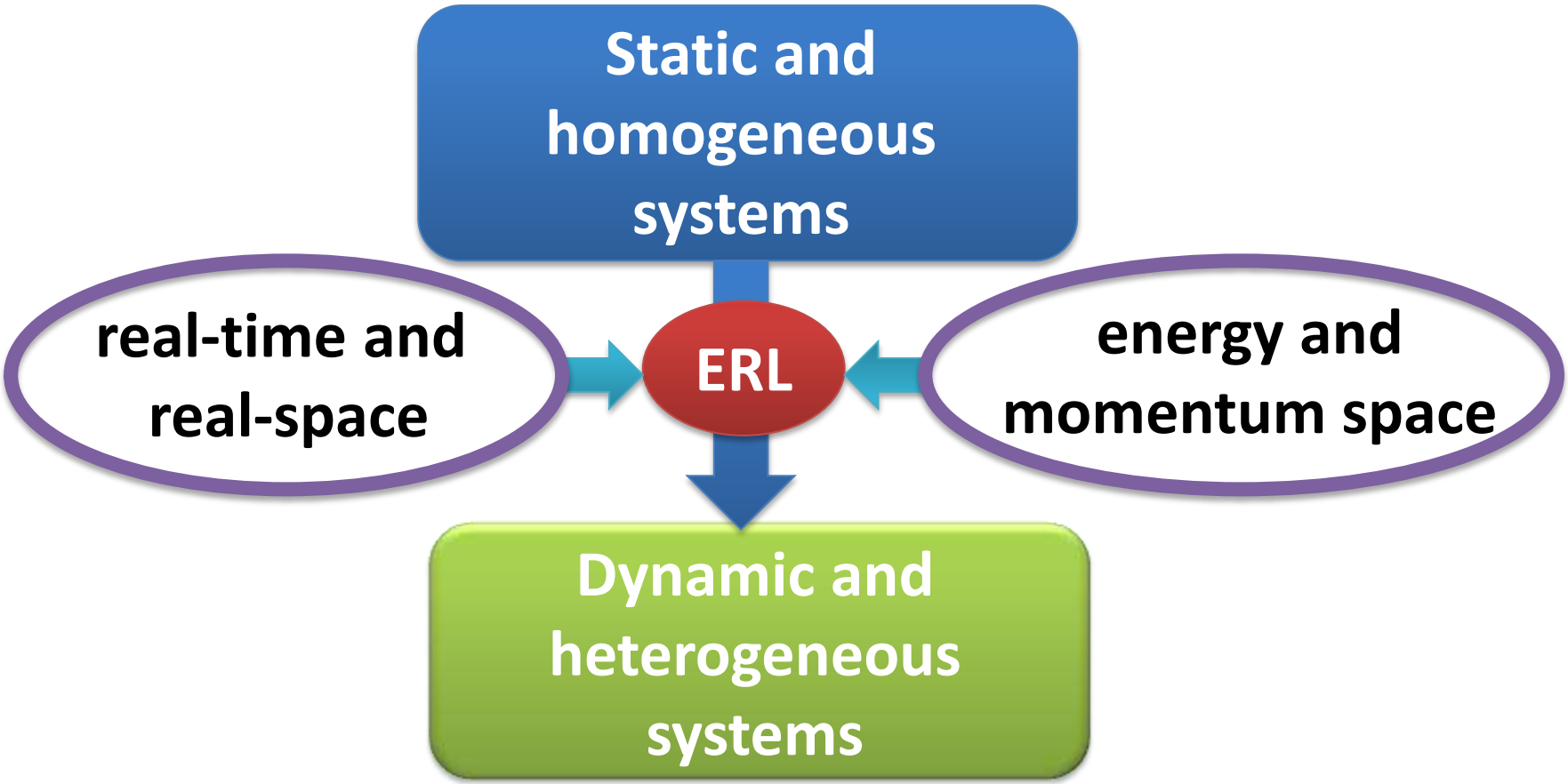
Symposium, Workshop

"ERL Science workshop II": April of 2011
"ERL Symposium 2011": July of 2011
"ERL2011":(Accelerator Tech.) Oct. of 2011
"IMSS Symposium 2011": Dec. of 2011
"2nd ERL Symposium": March of 2012



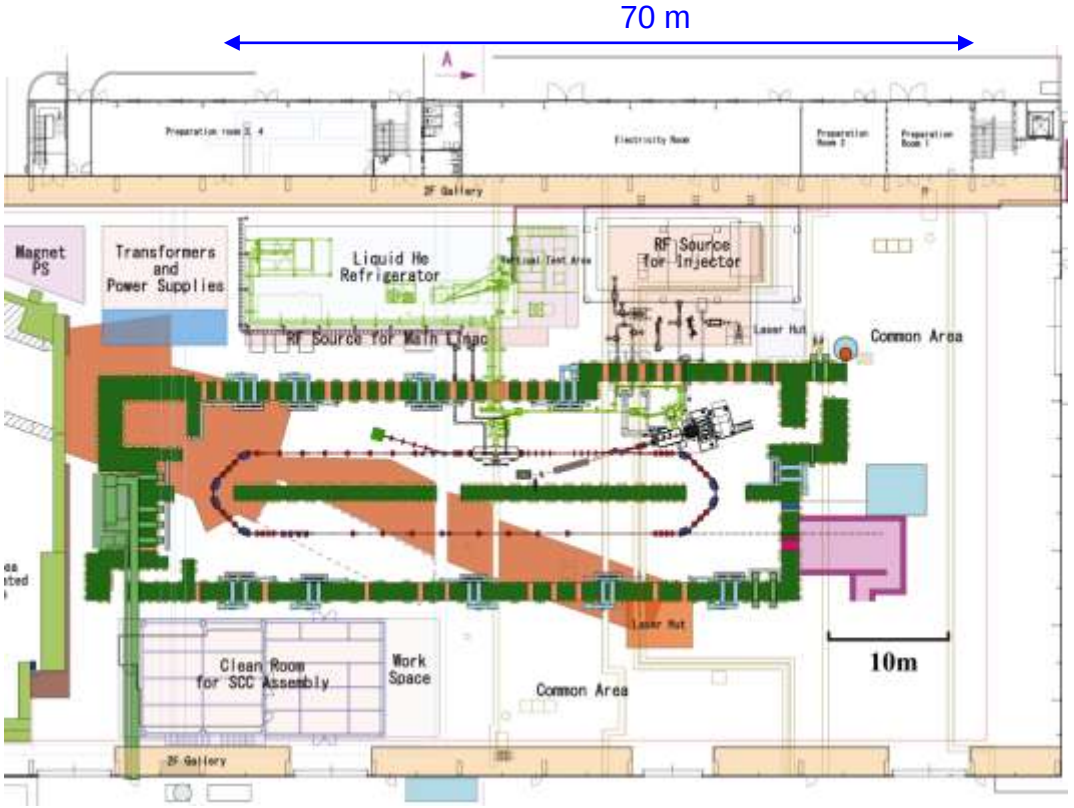
Our Goal:

Characterizing Functional Materials in Action



Compact ERL (cERL)

- **Demonstrating reliable operations of our ERL components (guns, SC-cavities, ...)**
- **Demonstrating generation and recirculation of ultra-low emittance beams at high currents**
- **1st target : 1 mm·mrad for 10mA @ 35 MeV**

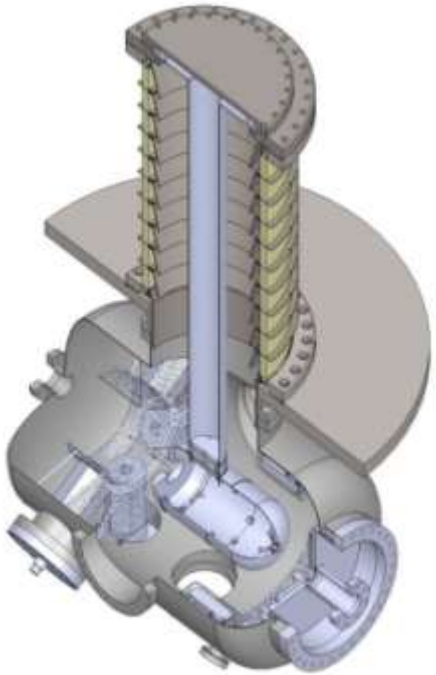


Photocathode DC Gun #1 at JAEA

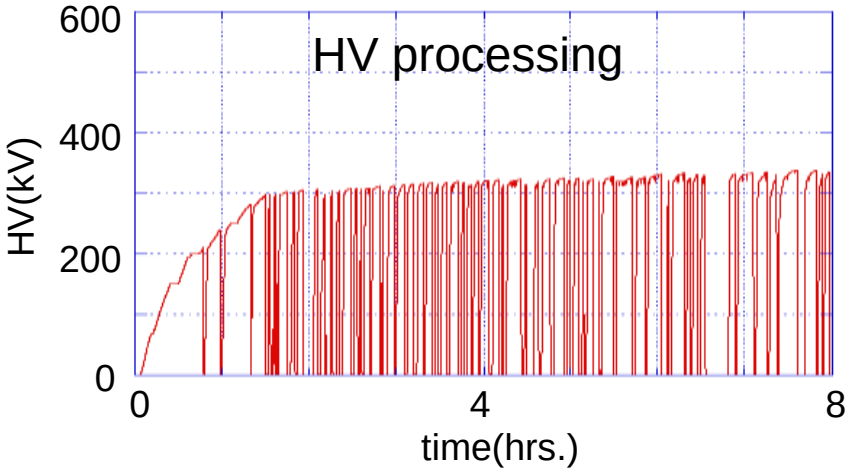
8-hour operation at 510 kV with a segmented ceramic insulator

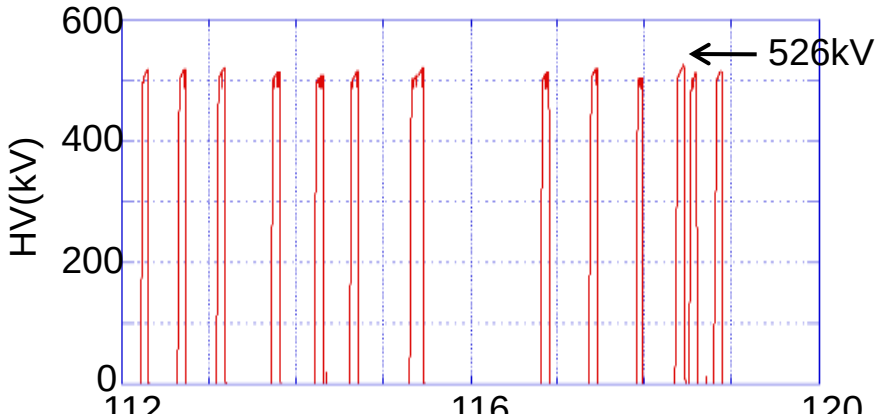
R. Nagai et al., Rev. Sci. Instrum. **81** (2009) 033304

Scheduled to be installed in the cERL beamline this winter



Courtesy: N. Nishimori



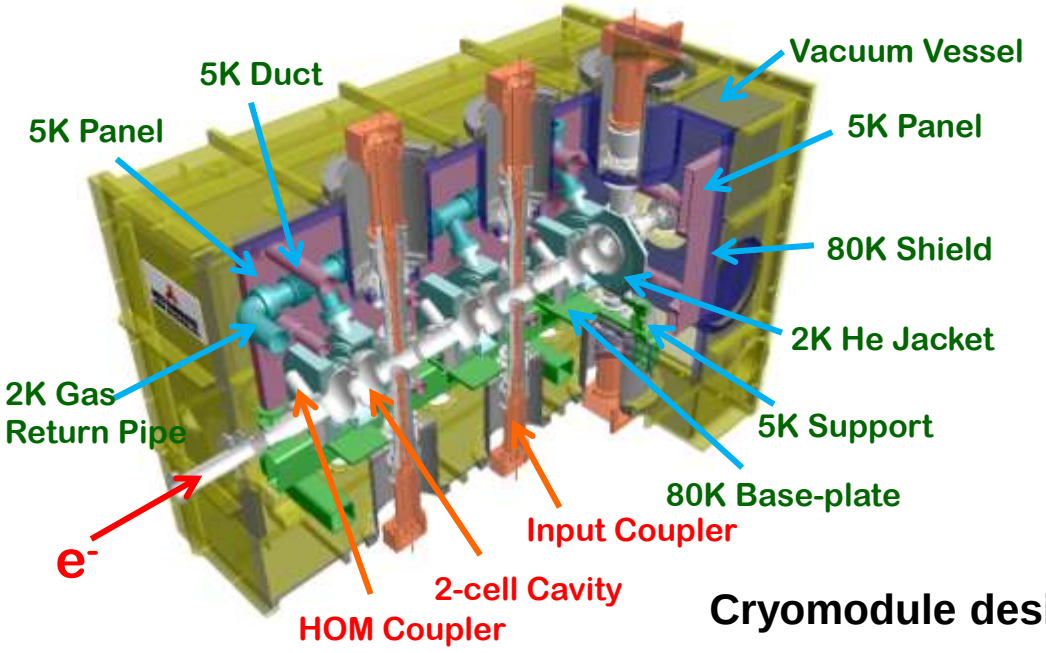


Recently, 10mA beam production has been completed!

SC Cavities for Injector (1)

Courtesy: E. Kako, K. Watanabe

2-cell cavity



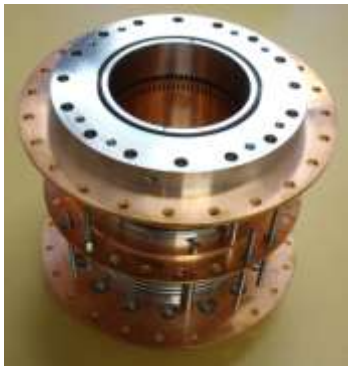
Cryomodule design

Input couplers

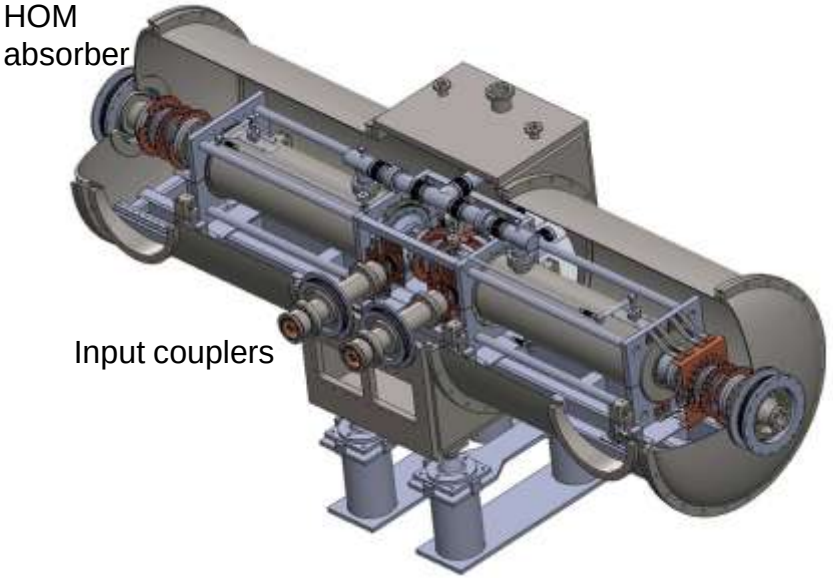
SC Cavities for Main Linac (1)

Courtesy: K. Umemori

9-cell Cavities

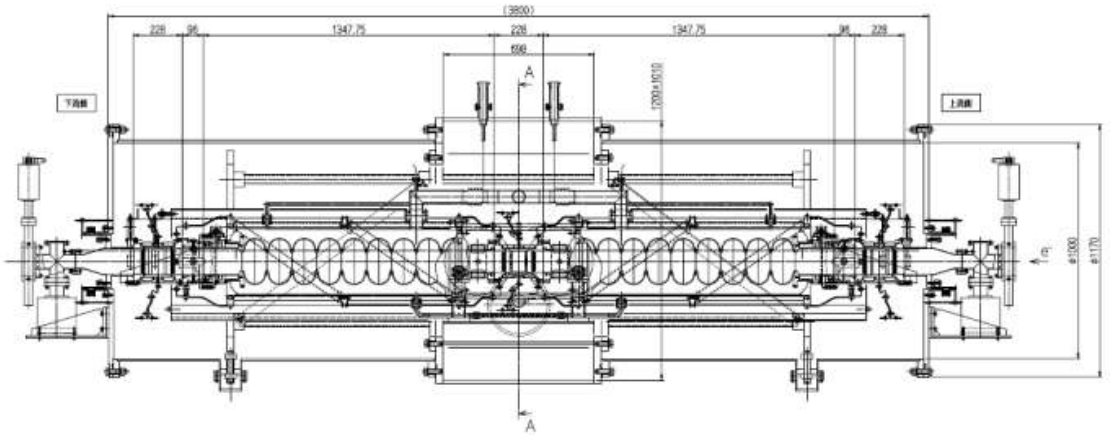


HOM Absorber



Cryomodule design

Input coupler



Cryomodule design (side view)

1.3 GHz CW RF Sources

300kW CW Klystron for injector SCC

30kW CW Klystron for injector SCC

30kW CW IOT for main SCC

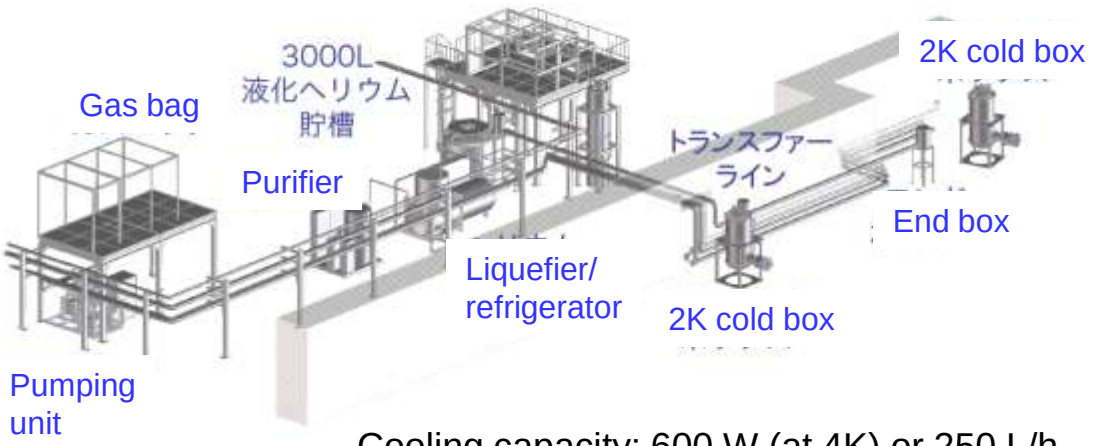
Courtesy: T. Miura

20kW CW IOT for buncher

Liquid-Helium Refrigerator

Overview of the system

Courtesy: H. Nakai



Cooling capacity: 600 W (at 4K) or 250 L/h

3000L liquefied helium storage vessel

2K cold box and end box

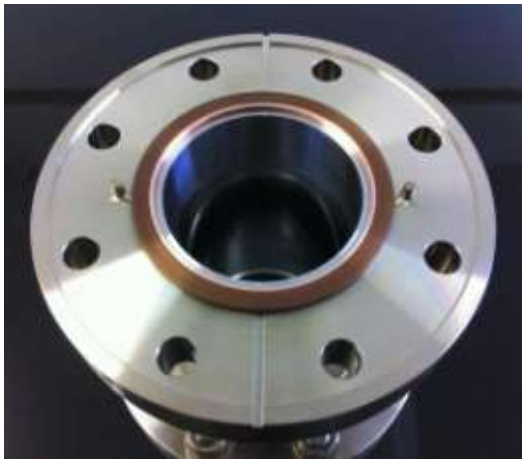
TCF200 helium liquefier/refrigerator

Magnet/Vacuum/Monitor

Courtesy: K. Harada, Y. Tanimoto, T. Honda, T. Obina, R. Takai

Bending magnet

Quadrupole magnet



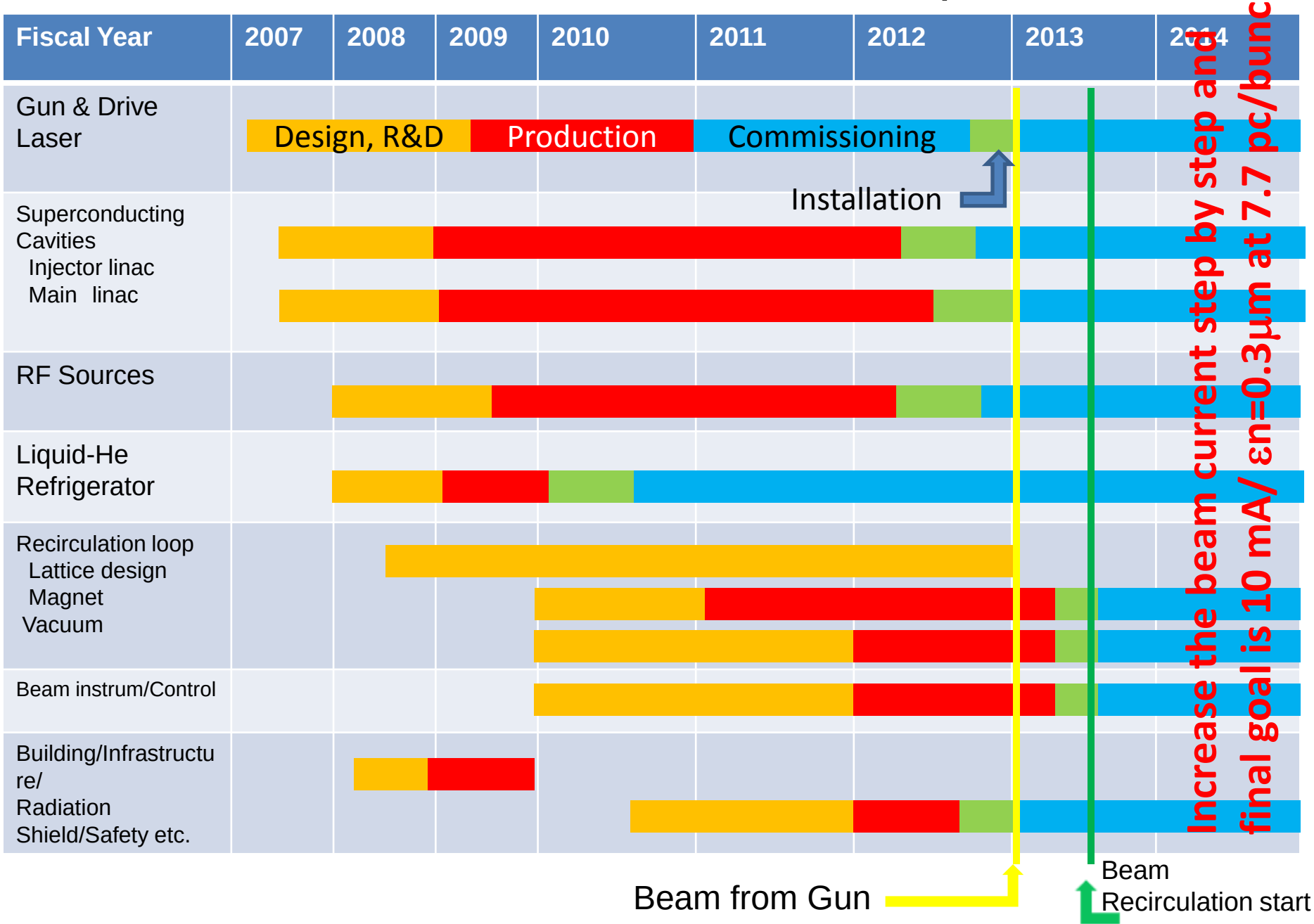
Zero-gap Flange

Stripline BPM with glass-type feedthrough

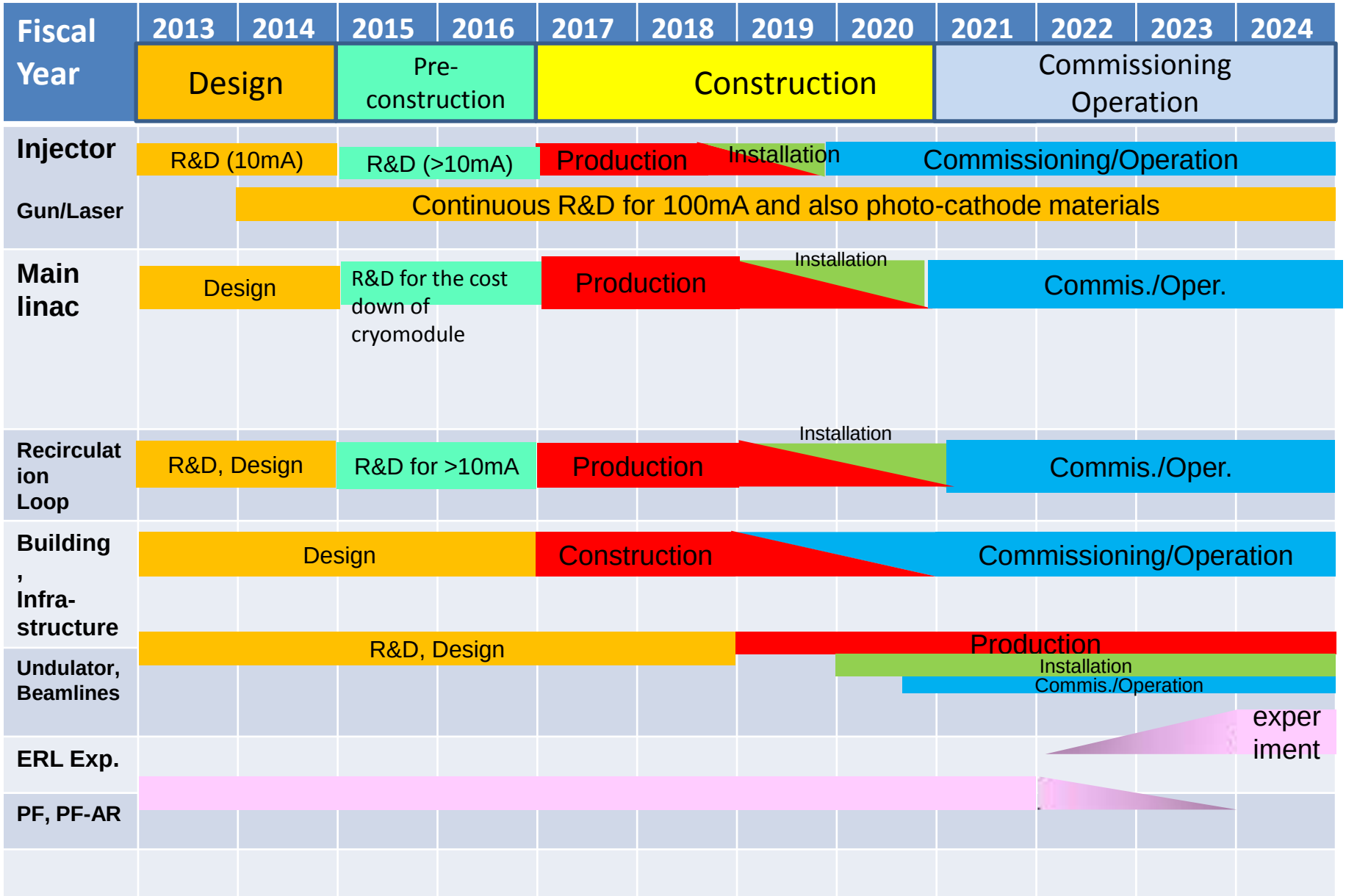
Screen monitor

Slit for emittance measurement

Construction schedule of the Compact ERL



3GeV-ERL construction schedule plan



Summary

- 3 GeV ERL covers wide range of user's demands such as coherent soft and hard X-rays, ultra-fast science using light pules of Δt=100 fsec.
- ERL promises the further revolution of light source such as XFEL-O and EEHG.
- The cERL will start the operation from the end of FY2012.
- In order to progress the 3GeV ERL + XFEL-O project, we have organized several science workshops and symposia symposia, and also start to accomplish the CDR
- After the operation of cERL , checking the performance of the accelerator components, we will finalize the design of 3GeV ERL at the level of TDR.

Collaboration Item with slow positron community

- *cERL and/or 3GeV-ERL have a potential to be a ultra-high intense positron source at the beam dump*
- Present facility: 55MeV, 11 micro A →600W at 50 Hz (220 nC /bunch)→10^6 e+/bunch

($\times 10^{2\text{-}3}$)

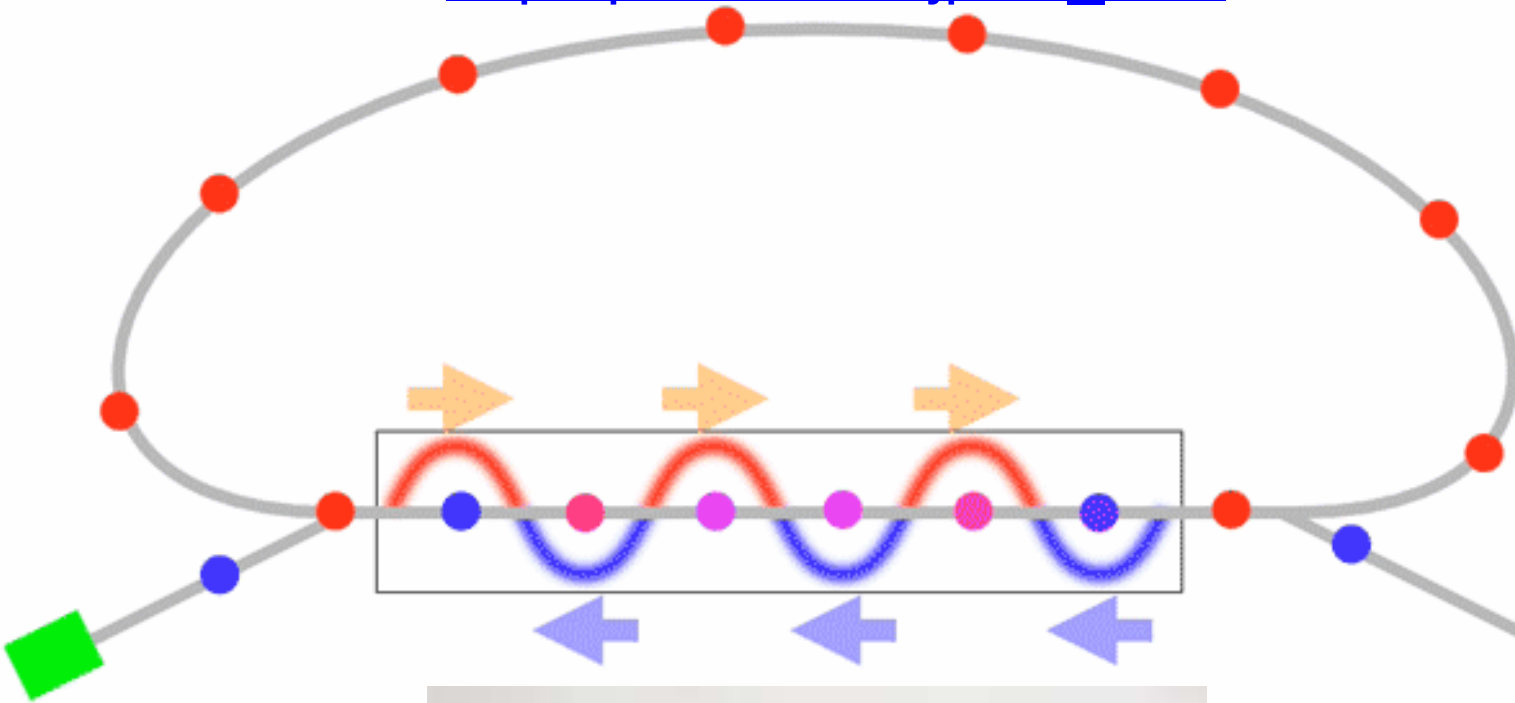
- ERL: 5-10MeV, 10-100mA → 50-1000kW at 1.3 GHz

  (7.7-77pC/bunch) → $10^{2\text{-}3}$ e+/bunch

  Coincidence measurement??

Outline of the ERL

http://pfwww.kek.jp/erl_info/



e+

High brilliant electron gun

Super conducting cavity for Acceleration and deceleration

Beam Dump
(10MeV x 100mA = 1MW)