ERL推進室報告

2012年7月17日

河田　洋

- ERL推進委員会「６月１２日」
- International Advisory Committee for 3GeV ERL project

ERL計画推進委員会アジェンダ案

日時：　6月12日14:30-17:00
場所：　３号館セミナーホール

１）はじめに：委員会規則の確認、委員自己紹介		（10分）
２）機構長からコメント：ERL計画実現に向けて		（10分）
３）cERLの現状と今後		
高輝度電子銃開発	西森信行	（10分）
超伝導空洞開発	阪井寛志　加古永治	（20分）
施設関係	芳賀開一	（10分）
真空系	谷本育律	（10分）
４）3GeV-ERL計画（特別委員会公開シンポジウム報告）村上洋一		（20分）
５）今後の実現に向けて	河田	（15分）
６）総合討論		（45分）

ERL推進委員会のまとめ

3GeV-ERLに向けた作業に関して、cERLでの加速器要素のR＆Dを着実に進めていることに理解を頂いた上で、「3GeV-ERLを進めて行く」ためには以下の点を明確にすべしとの指摘を頂いた。

１）cERLで達成する課題と時期を明確にすべし。
２）それを踏まえて3GeV建設に進むシナリオを作ること。
３）加速器建設へ向けての具体的な戦略（予算とマンパワーを含めたマイルストーン）を示せ。

International Advisory Committee for 3GeV ERL project

Date: 2-3, July, 2012
Place: KEK
Committee members:

Ingolf Lindau (Chair)	Stanford Univ.
Thomas Tschentscher	Euro XFEL
Kwang-Je Kim	APS
Zhao, Zhentang	SSRF
Jun-ichiro Mizuki	Kwansei Gakuin Univ.
Masahiro Kato	UVSOR
Alfred Baron	Riken

3GeV-ERL Advisory committee

Monday, July 2, 2012

08:50-09:00	Welcome (Y. Okada)
09:00-09:25	Charge to the review committee (H. Kawata)
09:25-10:25	ERL Project Overview (H. Kawata）50min+10min
10:25-10:40	Coffee break (15 min)
10:40-11:30	Development of the ERL accelerator technology Overview (Y. Kobayashi) 40min+10min
11:30-12:20	ERL science case overview (S. Adachi) 40min + 10min
12:20-13:30	Lunch
13:30-16:30	Accelerator developments Design concept of 3GeV-ERL Electron gun Super-conducting cavities RF Sources and control Beam dynamics issues Future light source (XFEL-O)
16:30-17:30	Coffee break and Site visit of cERL(60 min)
17:30-18:00	Summary of what we should do towards the 3GeV-ERL construction
18:00-19:00	Discussion <Closed Session>
19:30-	Dinner

Thursday, February 16, 2012

09:00-09:30	Discussion with project managers
09:30-10:30	Discussion <Closed Session>
10:30-11:30	Time for writing a preliminary report <Closed Session>
11:30-12:00	Summary presentation
12:00-13:30	Lunch
13:30-14:00	Discussion with director general of KEK (Ingolf Lindou, Jun-ichiro Mizuki)

http://pfwww.kek.jp/ERLoffice/ERL_IAC/

ユーザー: erliac
パスワード: shiryo

Question 1 – Are the scope and strategies of the 3GeV-ERL project including the further upgrade of XFEL-O satisfactory as the future light source in KEK?
3GeV-ERL+XFEL-Oの組み合わせた次世代放射光源は、他のhigh-gain FELとultimateストレージリングと相補的な性能を有しており、今までにできなかった新しいサイエンスを切り開く。したがって、KEKの次期光源計画として論理的に最もふさわしい候補である。

Question 2 – The Science Case for the 3GeV-ERL project.

A. Is the scope of the science case of the 3GeV-ERL reasonable and also satisfactory?

B. Is the effort to brush up the science case enough?

C. Further recommendation for this item

委員会は委員会で紹介があった3GeV-ERLサイエンスケースやCDRに記述されているサイエンスに関して、新しいサイエンスがERLで生み出されることを確信した。そしてさらなるサイエンスケースの発掘のためのワークショップを開催していくことを勧める。またEEHGの技術的可能性とそのサイエンスに関しても進めて行くことを勧める。

Question 3 – Development for accelerator technologies

A. Is the technical development for the accelerator components for the cERL sufficient?

B. Is there anything to check the technical problem in cERL before construction of the 3GeV-ERL?

コンパクトERLの進展に強い印象を受けた。個々の要素技術に関して進展しており、2012年度末にビームを出すことは問題ない。cERLの建設、運転することによって、多くの加速器要素は確認され3GeV-ERLの建設に必要となるものが確立する。ただし、ビームの安定化に関してさらなる技術開発が必要である。

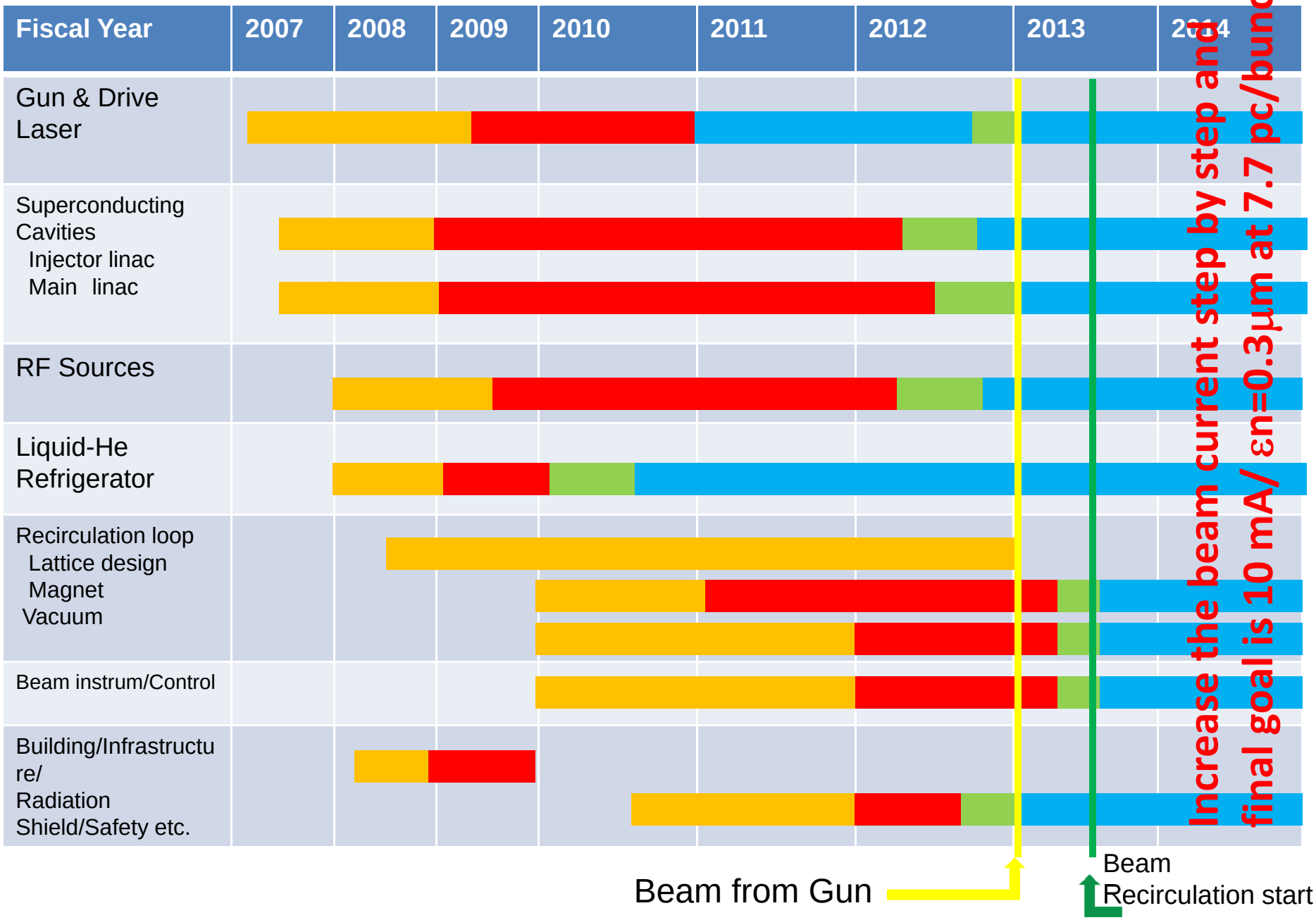
Question 4 – Construction of 3GeV-ERL

A. Is the construction of the 3GeV.ERL feasible under the R&D planning of accelerator development?

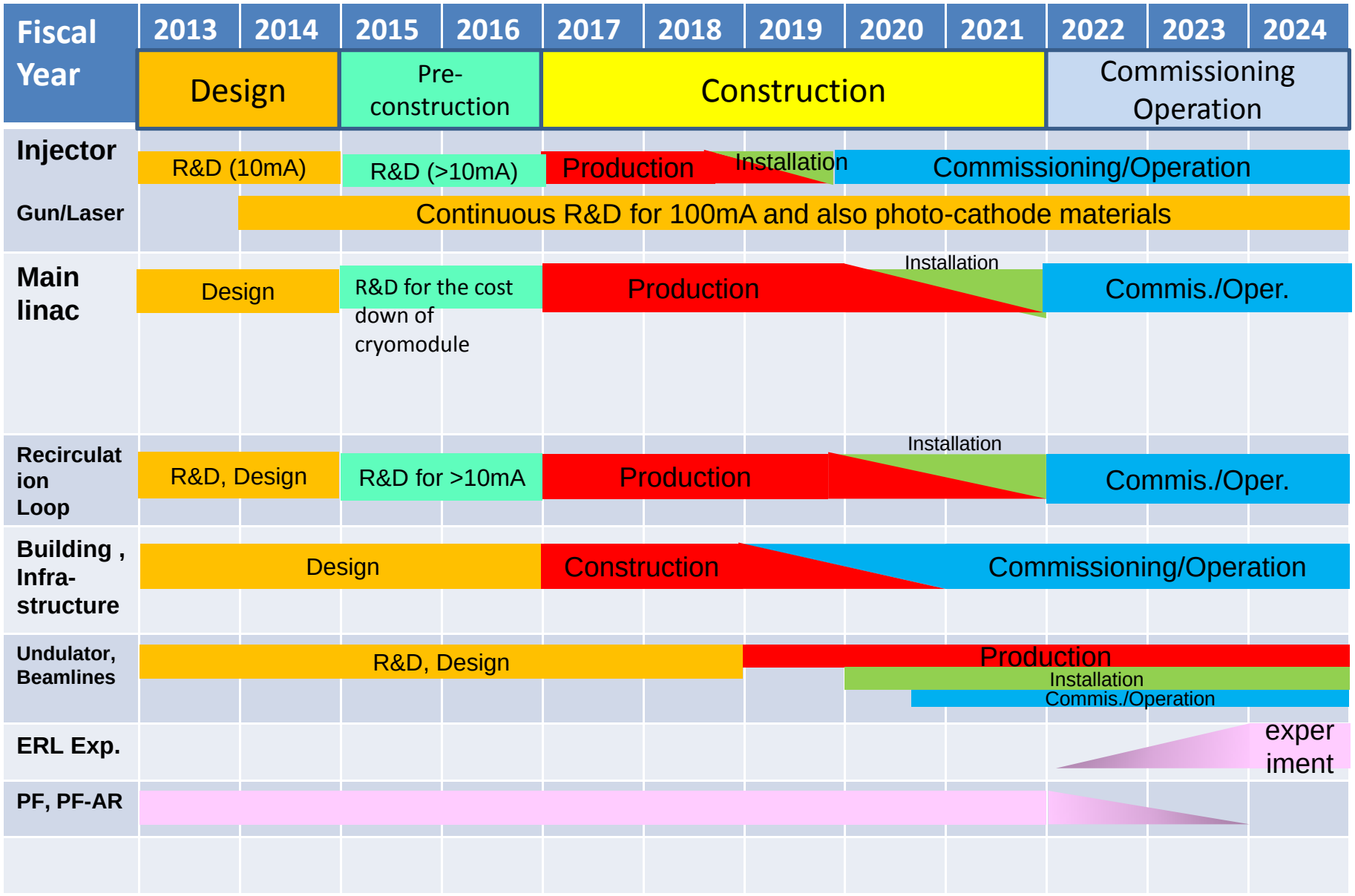
B. Further recommendations for this item.

2012年から運転するcERL経験を生かして2014年度の3GeV-ERLの設計をまとめるという提案を支持する。その設計を外部の評価委員を含めて進めて行くことを勧める。今後行うべきリストが提示されているが、その具体的な予算、マンパワーを含めた計画案を作成することを勧める。また電子銃の開発に関しては、本計画建設と並行して長期に開発を進めるという手順を支持する。2021年に3GeV-ERLの建設を終了するという計画は、それに必要はリソースの投入が行われれば十分に可能である。

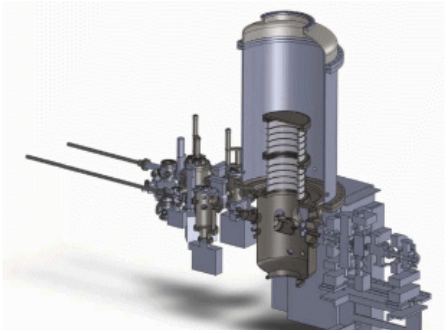
Construction schedule of the Compact ERL



3GeV-ERL construction schedule plan

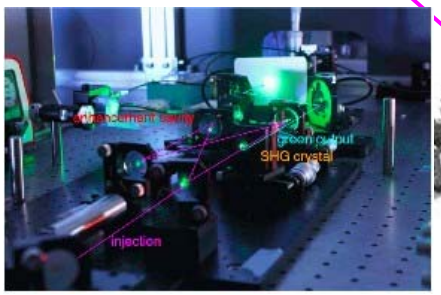


Items to be achieved for 35MeV cERL



High Brilliant DC Electron Gun:

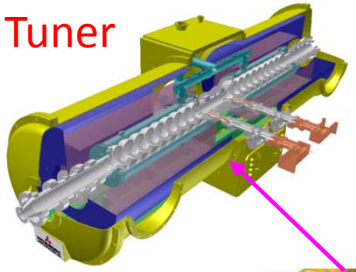
- Stable beam at 500kV, 10mA
- 7.7 pC/bunch: εn = 0.3 mm mrad
- 77 pC/bunch ; εn< 1.0 mm mrad



Laser System

Super Conducting Cavity for Main Linac

- Check the performance of cryomodule, Cavity, input coupler, HOM dumper and Tuner



Super Conducting Cavity for injector

- Stable beam acceleration of CW 10 mA at 5 MeV
- Stability of HOM coupler and input coupler at 10mA CW

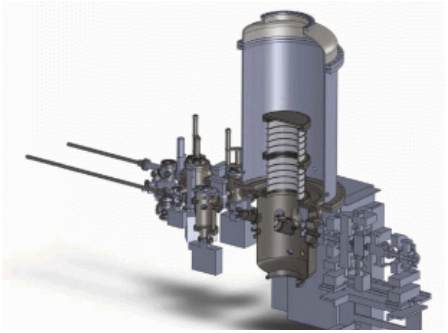
RF Sources

- Evaluation of HLRF system such as 300kW RF source, semi-conductor amplifier, and also LLRF system

Beam Dynamics

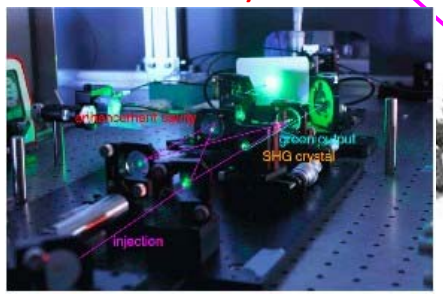
- **1st goal: 1 mm mrad @ 10 mA**
- **2nd goal: lower emittance: < 0.3 mm mrad @ 10 mA**
- **3rd goal:higher current: < 1 mm mrad @ 100 mA (or 77 pC)**

items to be achieved for 3GeV-ERL



High Brilliant DC Electron Gun:

- 500kV, 100mA high voltage power supply
- Development of photo-cathode materials (long life time / small emittance)

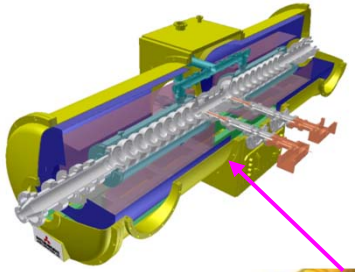


Laser System

- Establish the stability of high power

Super Conducting Cavity for Main Linac

- R&D for cost down of cryomodule
- Improvement of HOM dumper



Super Conducting Cavity for injector

RF Sources

- R&D of the digital feedback system to satisfy the rf stability of 0.01%, 0.01 deg..

Beam Dynamics

- Injector design and optimization for 3 GeV ERL with higher gun voltage and higher injector energy
- Lattice and optics design for main linac and return loop for 3 GeV ERL

- Stable beam acceleration of CW 100 mA at 10 MeV with low emittance.
- High power input couplers with a power handling capacity of CW 170 (100) kW.

items to be achieved in 35MeV cERL (1)

Electron Gun and laser	• Stable electron beam at 500kV • 10mA electron beam (including laser technology) • Life time of photo-cathode • Activation technology of the photo-cathode • Establish the beam instrumentation technologies(emittance, bunch width halo etc.) • Establish the technologies to handle the electron beam • Target values: 7.7 pC/bunch: e_nx = 0.3 pi mm mrad, stdz = 0.9 mm 77 pC/bunch : e_nx < 1.0 pi mm mrad, stdz = 0.3 - 0.9 mm
Super-conducting cavity for injector	• Stable beam acceleration of CW 10 mA electron beams at 5 MeV with low emittance. • High power input couplers with a power handling capacity of CW 10 kW. • HOM couplers and RF feed throughs suitable for CW 10 mA beam operation. • Cryogenic heat loads at 2K and 5K (static and dynamic).
main accelerator	• Check the performance of cryomodule, Cavity, input coupler, HOM dumper and Tuner • Check the stability of the system in operation

items to be achieved in 35MeV cERL (2)

RF source	• Evaluation of the 300kW RF system • Evaluation of the semi-conductor amplifier system • Durability of the high-power waveguide system • Configuration of the waveguide system suitable for the SC cavities • Temperature compensation of the rf cables • Evaluation of the machine protection system • Evaluation of the tuner control system and R&D of the tuner control software • Evaluation of the digital LLRF control system and R&D of the LLRF control software • Evaluation of the total LLRF system
He Cryogenic system	• Purification of helium gas exhausted from the helium gas pumping system with a compressor and a liquid nitrogen heat exchanger • Direct introduction of purified helium gas exhausted from the pumping system into refrigeration cycle of the cryogenic system • Additional heat exchangers to increase the overall refrigeration efficiency
Vacuum	• Improvement of RF shield and suppression of HOM loss at the various vacuum components • Protection of the SC cavities and the DC electron gun from any contamination • High power beam dump • Beam-break up caused by the Ion trapping Influence of the intense CSR power • Machine protection method against accidental beam loss

items to be achieved in 35MeV cERL (3)

Beam Instrumentation	• Beam loss monitor and fast machine protection system • Beam position monitor with two beams (cavity section) • Beam size and emittance measurement with wide dynamic range • Beam current measurement with wide dynamic range • Bunch length measurement below 100fs range
Beam dynamics	• Design and optimization of lattice and optics for generation, acceleration and recirculation of low-emittance and high-current beams at 35 MeV - 1st goal: 1 mm mrad @ 10 mA - 2nd goal for lower emittance: < 0.3 mm mrad @ 10 mA - 3rd goal for higher current: < 1 mm mrad @ 100 mA (or 77 pC if 100 mA is impossible for economical reasons) • Achievement of energy recovery • Automatic orbit correction in cERL (for both acceleration and deceleration beams) • Transverse and longitudinal beam position (and profile) fluctuations and their cures • Beam loss and halo and their cures • Ion trapping effects and their cures • Bunch compression and decompression including handling of ultra-short bunches (~100 fs or less) • Lattice and optics design of high-power dump line

items to be achieved for 3GeV-ERL (1)

Electron Gun and laser	• 500kV, 100mA high voltage power supply • R&D for Cathode life time • establish the stability of the high power drive laser • Development of low emittance photo-cathode materials • improvement of the activation system of the photo-cathode • Continuous R&D for ultimate mode (high current and low emittance) • Establish the reliability of the system
Super-conducting cavity for injector	• Stable beam acceleration of CW >10mA electron beams at 10 MeV with low emittance. • High power input couplers with a power handling capacity of CW 170 (100) kW. • HOM couplers and RF feed throughs suitable for CW >10 mA beam operation. • Cryogenic heat loads at 2K and 5K (static and dynamic).
main accelerator	• R&D for cost reduction system (prototype of the cryomodule which is installed by 4 9-cell cavities) • Further optimization of the cavity, mechanical vibration, and RF power for beam loading from the results of cERL • Improvement of HOM damper • Design of the fabrication Lab for cavities to realize the fabrication of more than 200 cavities

items to be achieved for 3GeV-ERL(2)

RF source	• Reliability of the DC power source for 300 kW klystron • R&D of the semiconductor amplifier • R&D of the digital feedback system in order to satisfy the rf stability requirements of 0.01%, 0.01 deg.. • Temperature compensation of the rf pick-up probe signal. • Generation of high accurate clock and LO (local oscillator) signals • R&D of the high accurate master oscillator system
He Cryogenic system	• A large scale 2K refrigeration system with cold compressors • Development of effective heat exchangers at 2K
Vacuum	• Compatibility of the low-impedance design and the handling of heat load and gas load due to the high SR power • Effective pumping technique for the small-diameter beam pipe - Suitable material of the vacuum duct, heat-resistant copper alloy etc. - Adoption of NEG coating for a greater part of the vacuum duct
Magnet	• Development of common magnet tables (for quadrupole and sextupole magnets in TBA cells and triplets in the main linac) optimized for suppression of beam oscillations • Development of magnet power supplies with very low ripples and drifts
• Beam Instrumentation	• Non-destructive beam size monitor under small beam size • Beam halo measurement and collimation • Large-scale timing distribution and stabilization system • Fast and precise orbit stabilization

items to be achieved in 3GeV-ERL (3)

Beam dynamics	• Injector design and optimization for 3 GeV ERL with higher gun voltage and higher injector energy • Lattice and optics design for main linac and return loop for 3 GeV ERL • Evaluation of BBU threshold current and its optimization • Effects of incoherent and coherent SR and short-range wake fields (due to SC cavities, vacuum chamber structures, wall roughness, resistive walls and so on) on beam energy spread and emittance. • Analysis of beam loss and halo for 3 GeV ERL and their cures including scheme of radiation protection and decision of physical apertures along the ERL • Analysis of beam fluctuations due to possible noises such as power supply drifts and ripples, RF and timing errors, floor and girder vibrations, air-conditioners, cooling water and so on and beam stabilization scheme for ultra-low emittance beams and ultra-short bunches • Ion trapping effects and their cures for 3 GeV ERL • Bunch compression and decompression scheme for 3-GeV ERL • Analysis of undulator effects on beams and their cures (very long undulaors with multi-segments and phase shifters, short-period undulators with short magnetic gaps, variably-polarizing undulators and so on) • Evaluation of resistive-wall heating at undulators and their cures • Switching scheme between ERL and XFEL-O operation modes • Beam physics and simulation of XFEL-O and EEHG

提案

１）cERLでの開発目標の確認とそのタイムラインの検討

２）3GeV-ERL建設に向けてどの技術要素を優先順位を付けて進めて行くか

上記の２点を今後、担当責任者レベルで定期的に検討する。