

Operational Status and Concerns

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ATF is a very unique facility internationally, providing **low emittance beam** for R&D and developing **nanometer beam technology**.

However, since the operating budget is allocated from the common budget within KEK, it is determined by DG by the results of coordination with other R&D, and this common budget itself is becoming tighter year by year.

Accelerator Test Facility (ATF)

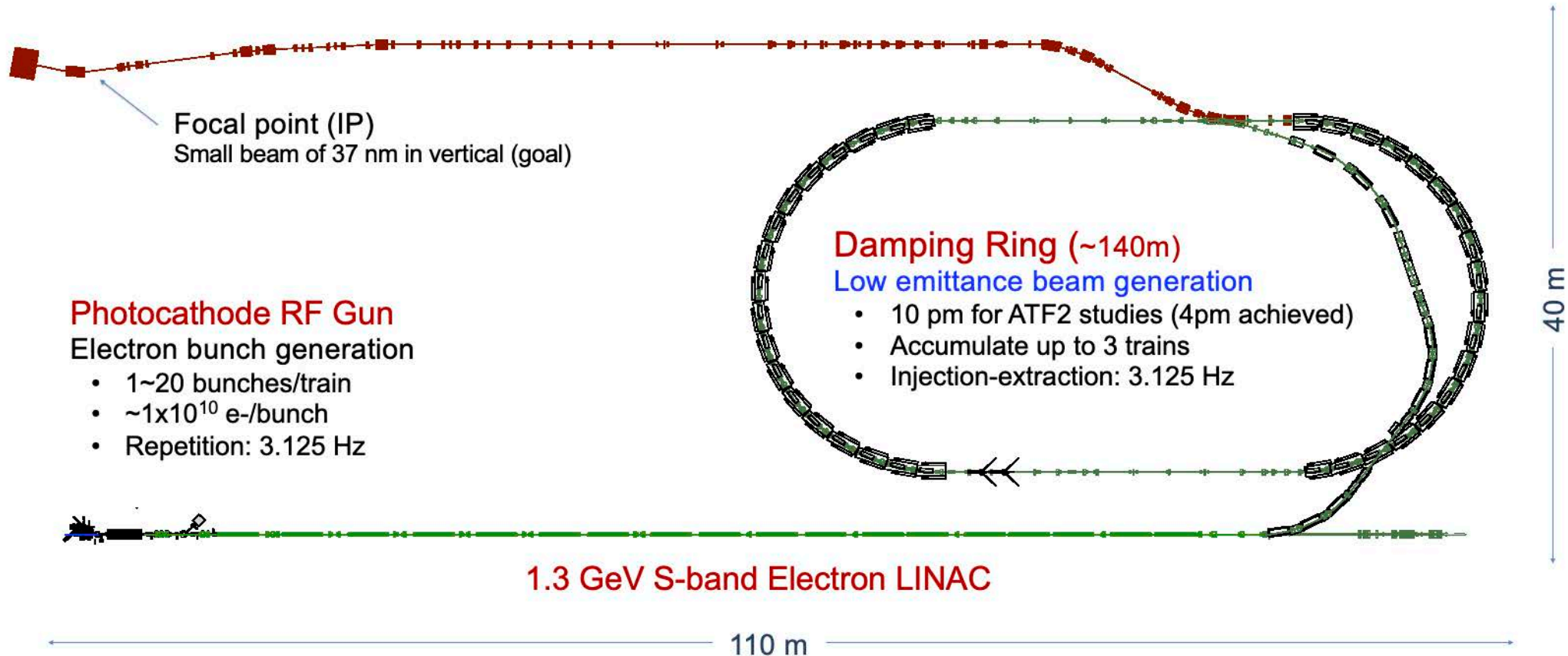
ATF2 final focus test beamline

Nanometer beam development

- Final focus System R&D
- Intra-train ultra-fast beam feedback

Advanced Beam Instruments R&D

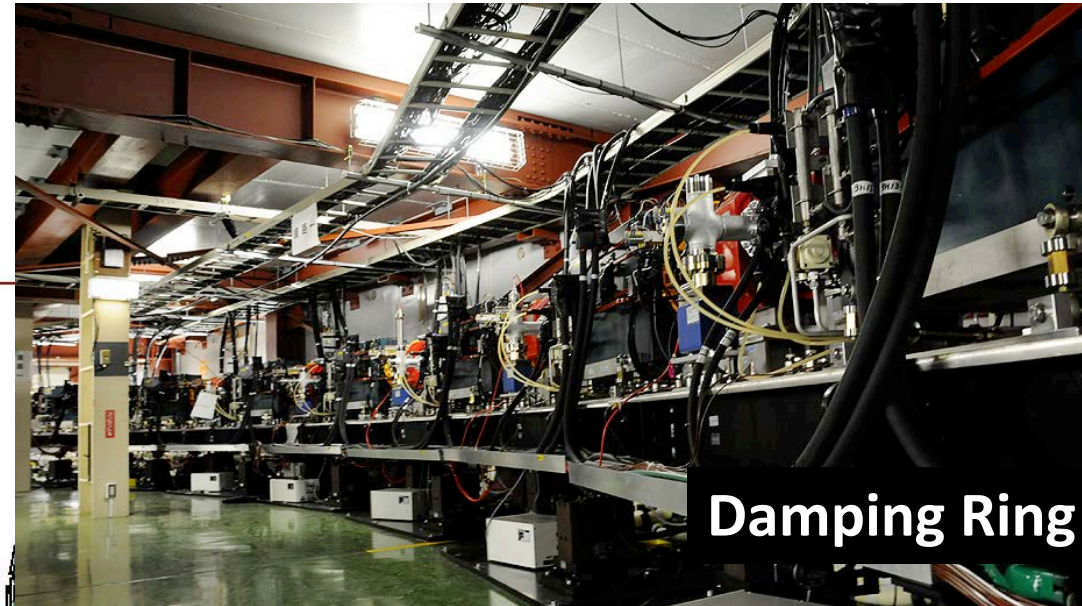
Application of Low-emittance beam



Accelerator Test Facility (ATF)

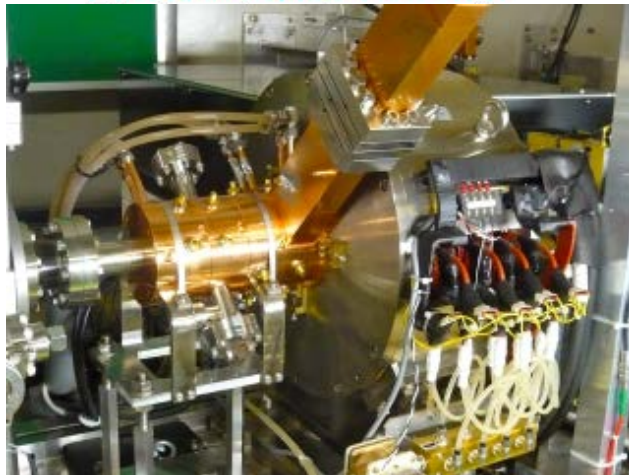


ATF2 Final Focus Test Beamline



Damping Ring

Photocathode RF Gun



1.3 GeV S-band

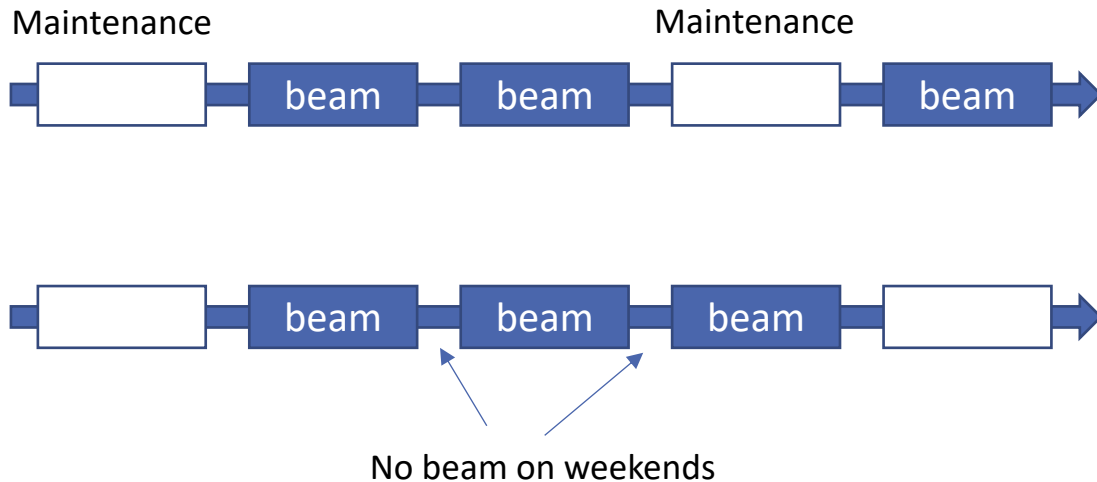
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1.3 GeV S-band LINAC

Beam Operation weeks

Patterns of beam operation weeks



Series of a few beam-weeks and a maintenance week

Beam week

- 24 hours continuous beam operation from Monday afternoon to Friday evening.

No beam on weekend

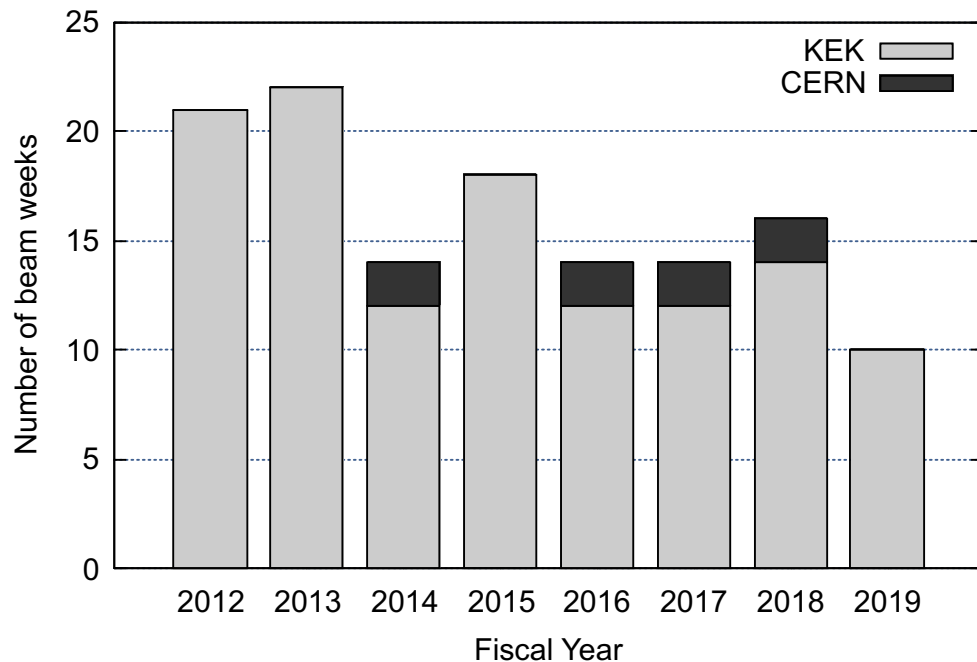
- due to the **manpower** (staff responsible for safety,...)
- Weekends are used to prepare for next week studies.

Maintenance week

- for the preparatory work of R&D,
- installation and improvement of devices for the coming beam studies.

Operation History

The ATF operating budget comes from sharing common R&D resources at KEK.



Beam operation

- 1996 ~ 2013: **21 weeks per year**
- **2014 ~ : reduced about 14 weeks per year**
- Rise of electricity prices (twice!) ← 2011 Great East Japan Earthquake

CERN's budgetary contribution to the ATF operation

- in four fiscal years
- two weeks extension each

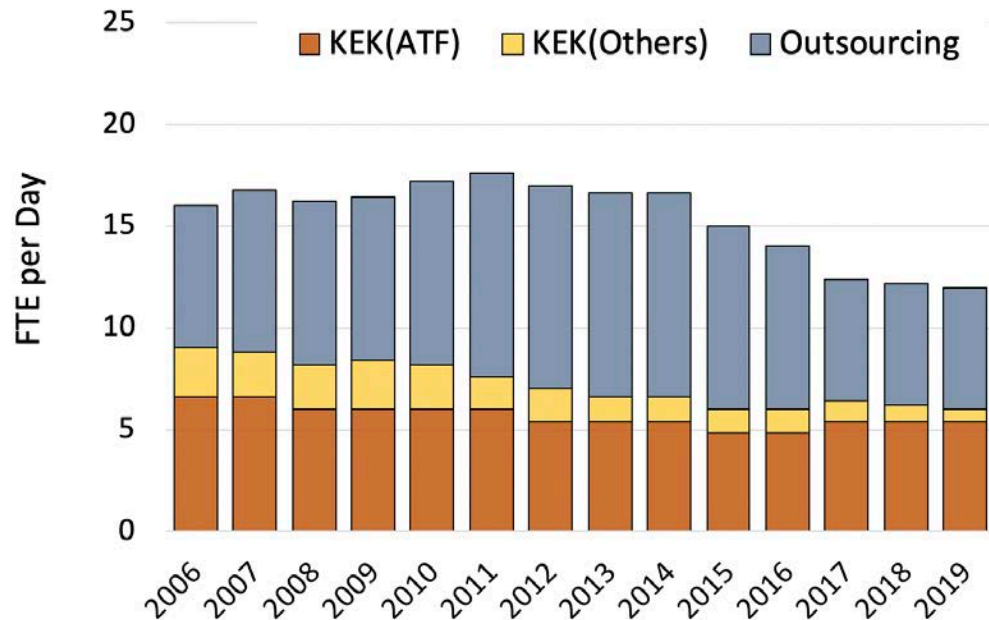
Further budget difficulty on 2019 → 10 weeks

In this year, 2020, five weeks are approved so far, with additional beam weeks possible by the end of March 2021 will be determined, taking into account the recommendation of this ATF review.

Beam operation is postponed by COVID-19 difficulty especially for collaborators.

In addition, the measure of electric breakdown accident in July also postpones the beam **after January 2021**.

Manpower for ATF operation (KEK)



KEK is responsible for the accelerator operation and maintenance.

KEK staff (FTE 60%)

- Scientist (Beam physics) ... 3 persons
- Scientist (hardware) ... 4
- Engineers ... 2

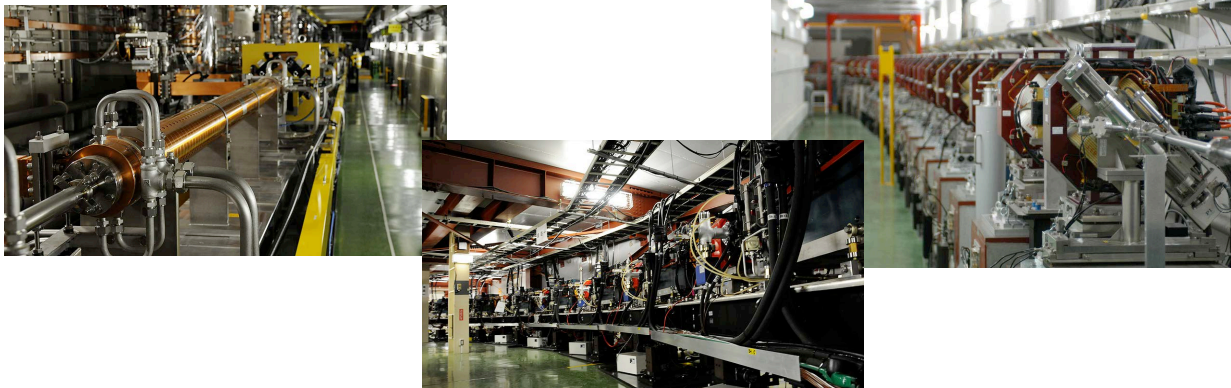
Outsourcing staff (100%) ... 7 persons

- Manpower of KEK staff dedicated to ATF is almost constant but **not sufficient** to manage the whole ATF accelerator system; *LINAC, DR and ATF2 beamline*.

Outsourcing staff is essential to run the ATF.

- But we are facing difficulties on budget.

Keeping the current manpower is an important and serious issue for future ATF operations.



One of the difficulties on the ATF beam tuning



ATF is built in the large building on the ground level and receives environmental temperature effect.

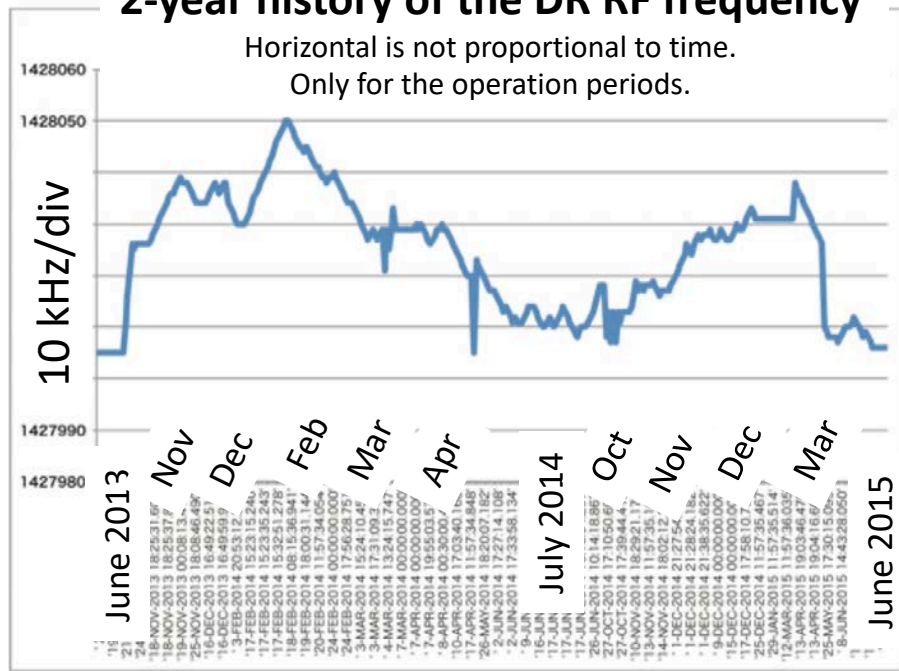
Change of the circumference of Damping Ring

Origin: expansion of the concrete floor by temperature is suspected.

We need to adjust the beam energy (RF frequency) to match the circumference of that time. → frequent re-tuning of the DR is needed.

2-year history of the DR RF frequency

Horizontal is not proportional to time.
Only for the operation periods.



● **Seasonal difference:** bigger ~several mm. *Environmental Temp.*

- *Almost seasonal repetition*
- *Seasonal alignment surveys has been conducted.*

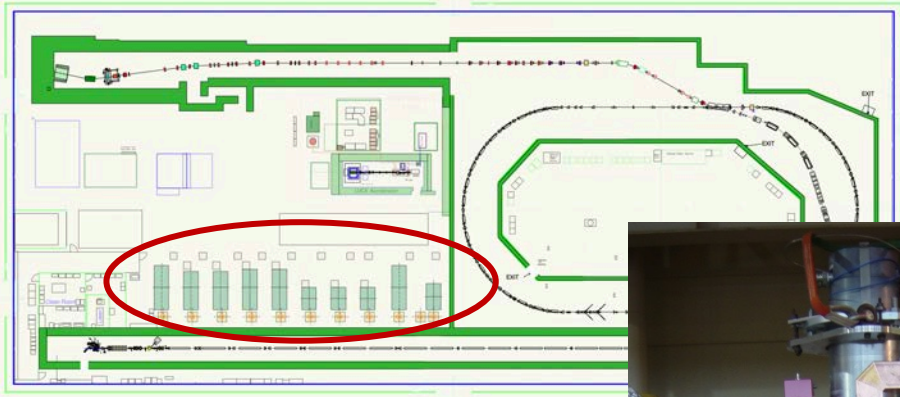
● **Weekly change (drift) :** *heat buildup by magnet power supplies.*

Pre-heating by **DR air control** before the beam operation:
Success to reduce the drift of the DR circumference during the operation weeks in 2019.

Maintenance on a limited budget

- The ATF has a history of **more than 25 years** since its construction.
- **Repair when broken basis** but ...
 - **Lack of spares** especially for particularly **expensive** and **long-lead-time** key components.
 - **LINAC RF source (Klystron)** is a top priority but its procurement has been postponed in recent years.
 - **Out of maintenance**; obsolete technology and **discontinued production** by suppliers. The system wide upgrade and replacement will be needed.
 - **Damping ring RF power source**
 - **Beam injection/extraction kicker systems**
- At this point, in the unlikely event of a serious failure, the beam will probably be unavailable for several months.
- We anticipate the operational budget we have evaluated for technology preparation in the ILC preparation phase.

Operational concerns: LINAC RF source



This 80MW klystron (TOSHIBA) is widely used for other accelerators, Spring8(Japan), PAL(Korea),... but only for ATF at KEK.

80 MW pulse Klystrons:

expensive and long-lead-time key components

(about 0.3M\$/klystron and 8 months to deliver)

- Total 9 klystrons for single bunch operation.
- Some of them, power is already dropped and losing margin on a beam energy.
- No spare at ATF
- **Procurement is a high priority**, but the ATF's operating budget, which primarily targets electricity and outsourcing personnel in recent years, has not been able to afford a new klystron.
- **Expect sufficient budget toward the preparatory phase of ILC.**

What if the klystron stops working?

- **Lost of beam energy:** $1.3 \text{ GeV} - (0.2\text{GeV})x$?
- Need a re-tuning of DR, ATF2 with lower energy, but it is not desired for ATF2 studies.



Operational concerns: DR RF source

714MHz CW 50kW

Obsolete device and not commercially available anymore

This is the **RF generator for broadcasting** equipment

→ The broadcast industry has moved to semiconductor-based systems.

1995 System was installed at ATF

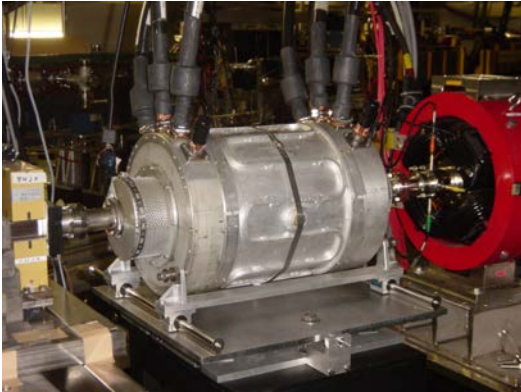
2007 klystron was exchanged

2013 got a spare klystron (brand-new but discontinued)

...

We have a spare klystron to avoid critical situation, but less engineering by support companies.

Operational concerns: Injection/extraction kickers



- Injection and extraction kicker system were **prepared by SLAC in 1995.**
- The special thyatrons in oil tank were used and they were already **discontinued by supplier.**
- We have spare thyatrons which may cover more than ten years operation.
- The control circuit will be a concern to keep the system running. It should be renewed.
- **SLAC no longer uses this power system.** At that time, spare parts are sent to ATF. There is no urgency, but it is advisable to update at the appropriate time.
- **Only ATF outsourcing workers have experience in maintaining this kicker system.**

Recent major failures: Old Final Focus Magnet



- **Water leak on** Quadrupole **magnet** of Final Focus System (QD0) which was reuse of the SLAC FFTB magnet.

Red colored magnet in the picture.

- Leak was from the crack on a connector which was on one of four coils in a quadrupole.
- Fortunately, we had same unused magnet and was able to replace the coil.

Two FFTB quadrupoles were installed for QD0 and QF1 when the ATF2 constructed. The QF1 was exchanged to another PEP-II magnet (yellow in picture) because of the poor suppression of multi-pole components.

- We are worried about the possible failure on other coils.
- We need to prepare a new magnet for QD0 as one of the upgrade of ATF2.
- **It is necessary to take measures against such special and old equipment which has no spares.**

Recent major failures: Human errors and measures



- Electric discharge accident at 6.6kV high voltage station (July/2020)
 - A worker was burned a hand and face by the heat of the arc discharge. Fortunately, his damage was not too serious, but it was really very dangerous.
- What was happened
 - ATF workers usually cover issues on maintenance of ATF widely.
 - It brought misunderstanding of his allowed working area.
 - Lack of knowledge of high voltage station.
 - There were **few notices** that clearly indicated that the voltage was 6.6kV. Could not stop his approach.
- Measures are in progress
 - Fostering **knowledge to maintain safety**, implementing measures in the workplace, **sharing with collaborators**.
 - Improve the signs and add safety circuit breaker system in situ for all works in high voltage yard.
 - **After taking measures for the power station, ATF operation will be resumed in January 2021 or later.**

Summary

- ATF beam operations in recent years are very limited due to the shortage of budget.
- Lack of spares especially for particularly expensive and long-lead-time key components is a major concern.
- In addition, some of the devices are discontinued by suppliers and desired to be updated with a renewal of the system.
- The situation is expected to improve when the main ILC preparatory phase begins, but ongoing efforts to improve ATF are demanded to ensure effective R&D during that period.
- The number of KEK staff is limited. Well-trained outsourcing staff is essential to keep the ATF running.