Homework from ARC

1. **Plan and Schedule for Replacement of Aging Components**
   - •Replacement plans and priorities for aging equipment
   - •Maintenance and replacement strategy for the 37-year-old cryogenic system, particularly the availability of spare turbines

   Answered by Nakanishi-san
2. **Operational Efficiency and Hardware Failures**
   - •Definition of operational efficiency
   - •Breakdown of hardware failures and their impact on accelerator operation
3. **Beam Lifetime and Injection Rate at 1×10^{35} cm^{-2}s^{-1}**
   - •Strategy for maintaining sufficient beam lifetime and injection rate
   - •Main factors limiting the LER beam lifetime
4. **Strategy for Increasing Beam Current**
   - •Plans and countermeasures to achieve higher beam currents

   Answered by Mitsuka-san
   - The details of the operation plans will be presented by Mitsuka-san at the Project Review on Wednesday afternoon.

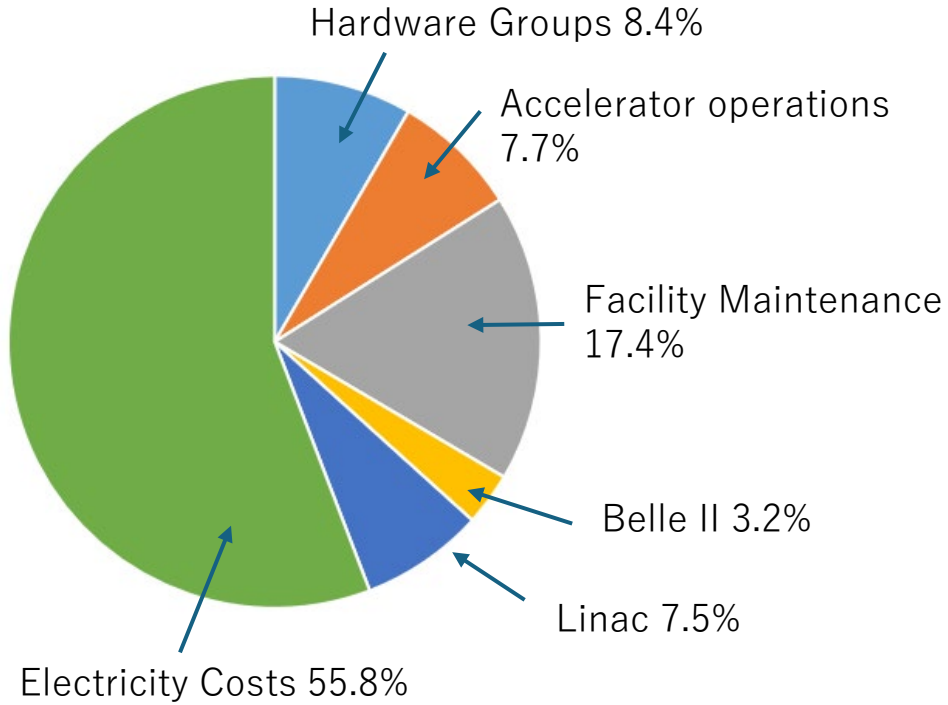
   See Miyahara-san's slides, too.
5. **LER Single-Beam Blow-Up**
   - •Observations of beam blow-up related to collimator impedance
   - •Evidence of the -1 mode instability
   - •Comparison with previous observations and the effects of collimator damage

   Addressed in Sugimoto-san's presentation
6. **Historical Data Storage and Access**
   - •Efforts to maintain historical accelerator operation data
   - •Plans for maintaining data storage systems and tools for accessing historical data
7. **Effects of Vertical Tunnel Deformation on Vertical Emittance**
   - •Impact of vertical tunnel deformation of up to 4 cm
   - •Simulation methods and assumptions
   - •Expected vertical emittance in the LER and HER

   Answered by Asami-san

1.Plan and Schedule for Replacement of Aging Components

- **Current situation**
  - We need to secure the electricity cost for approximately four months of accelerator operation, which significantly limits the budget available for maintenance and equipment replacement.
  - Most of the available Hardware Group Budget is used for maintenance and replacement of aging components.
  - However, the current budget is not sufficient to cover all necessary maintenance and replacement work.
- **Our approach**
  - Each accelerator group identifies aging components that require maintenance or replacement and sets priorities.
  - We carry out maintenance and replacement work according to these priorities, focusing on components that are particularly important for stable accelerator operation.
  - Due to budget limitations, some replacement work must be divided over several years.
  - The replacement schedules for some major equipment depend on funding availability and cannot be finalized at this stage.
- **Additional budget requests**
  - For particularly important equipment, especially aging infrastructure, we request additional funding outside the regular operating budget.
  - These items will be implemented if the additional funding is approved.
- **Future plan**
  - We will continue to prioritize maintenance and replacement work based on its importance for accelerator operation and the available budget.
  - The list of major replacement projects and their priorities is being compiled from the accelerator groups.



Budget Breakdown

Although 17.4% of the budget is already allocated to facility maintenance, we still need to use part of the Hardware Group Budget for particularly important maintenance and repair work.

2. Operational Efficiency and Hardware Failures

- **Definition of Operational Efficiency**
  - Operational efficiency is defined as the fraction of the total accelerator operation time spent on physics runs.
    - Time spent on machine studies, accelerator tuning, and downtime due to hardware failures is not counted as physics run time.
    - Therefore, operational efficiency is affected not only by hardware failures but also by machine studies and tuning activities.
- **Hardware Failures and Their Impact**
  - Major hardware failures include power supply failures, injection kicker accidental firings, BT cooling-water interlocks, ARES pressure rises, and vacuum leaks.
  - Although some failures occur relatively infrequently, some can interrupt accelerator operation for several days.
  - A detailed breakdown of hardware failure category and their impact on accelerator operation is not yet available.
- **Countermeasures**
  - We prioritize countermeasures against failures that occur relatively frequently.
  - Examples include:
    - **Injection kicker accidental firings:** Replacement of thyratrons.
    - **BT cooling-water interlocks:** Replacement of demineralizers and installation of additional temperature sensors.
    - **Vacuum leaks:** Installation of water-cooled bellows chambers.

$$\text{Operational Efficiency} = \frac{\text{Physics run time}}{\text{Total operation time}}$$

Operational efficiency ≈ 60%

Breakdown of remaining 40%

- Aborts and subsequent accelerator tuning: 10%
- Downtime due to hardware failures: 10%
- Startup commissioning (including vacuum scrubbing), maintenance days, and machine studies: 20%

Please note that a different definition is sometimes used.

$$\text{Operational Efficiency} = \frac{\text{Daily int. lumi.}}{\int_0^{1day} L_{\text{peak}}\,\mathrm{dt}}$$

6. Historical Data Storage and Access

- **KEKBLog** and **Archiver Appliance** are already in operation for storing and accessing accelerator operation data.
- The accumulated data are also being used for large-scale data analysis.
- We plan to maintain these systems and replace aging hardware as necessary to ensure continued access to historical data.