

What can we find from failure data of the accelerator? Introduce our reliability monitoring

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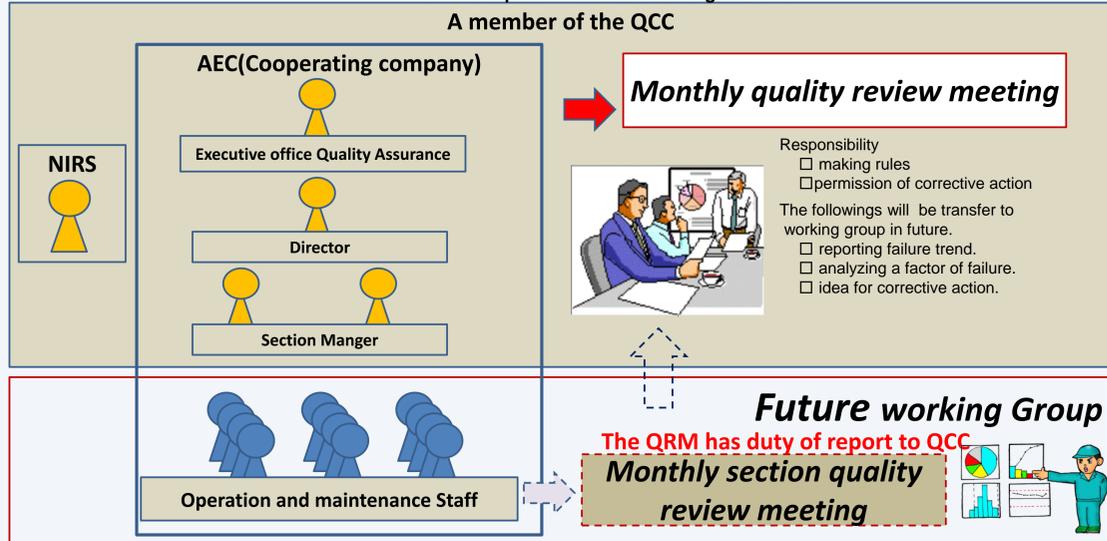
1. Introduction

NIRS, National Institute of Radiological Sciences has just started to monitor the performance of accelerator with parameter of Availability, Failure Rate and Repair time as a index for reliability monitoring. All failures that occurred in a month are listed with cause of failure, defective part and downtime to calculate above parameters. Those parameters are graphed to monitor the trend.

The quality review meeting is held every month. If a parameter of trend shows low quality, the cause would be investigated and corrective action would be discussed in the meeting. This poster will explain how we decide the parameters as a reliability index and how we use those indexes, with the cycle of Monitor-Analysis-Correction- Evaluation that maintains and/or improves the accelerator reliability.

2. Organization

FIG -1 Simplified schematics of organization



This section introduces our organization of the quality management system.(Refer to FIG-1)

The quality Control Committee, QCC, consist of NIRS and our cooperating company named Accelerator Engineering Corporation, AEC,.

Monthly quality review meeting is held with attending QCC member. A section manager report the trend of parameter with list of failure. If a trend shows low quality, results of analysis and idea of corrective actions are also reported by section manager at the meeting. QCC permit corrective actions after discussion. Also QCC has role of a making rules about operation and maintenance for accelerator.

Future plan.
To involve all staff in above activity, some function of QCC will be delegated to working group in the future.

3. Definition of the parameters

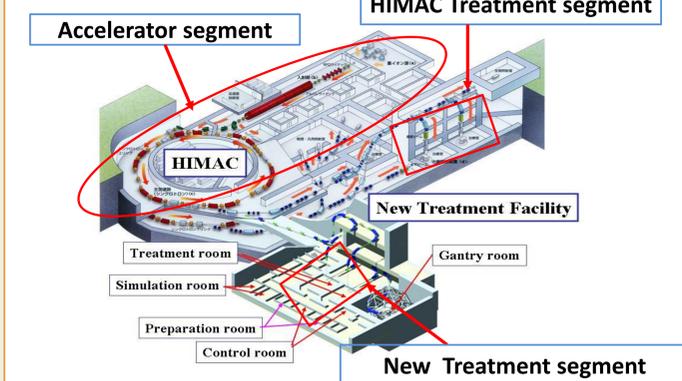
This section introduces the mean of parameters.

A failures are categorized into 3 classis depend on impact. Fig-2 shows relation between the class and parameters. The parameters of accelerator and treatment room are calculated individually. FIG-4 shows segment for calculation range with simplified map.

FIG-2 Relations of the parameter and failure

Failure	Definition	Monitoring Parameters
Interruption	Interruption mean that a failure interrupt the beam supply or schedule.	By availability
Non interruption	Fail Operative mean that a failure does not interrupt the beam supply or schedule . However, repair is necessary as soon as possible Foe example, redundancy such as back up system covers the failed function.	By averaged repair time(MTTR)
Advisory	An advisory message. A failure should be fixed at next scheduled maintenance.	By failure rate

FIG-4 Applicable range



1. The accelerator segment consist of 3 types of ion source, 2 synchrotron and beam transportation line.
2. HIMAC treatment segment has 3 treatment rooms.
3. New treatment segment has 2 treatment rooms.

FIG -3 Definition of time

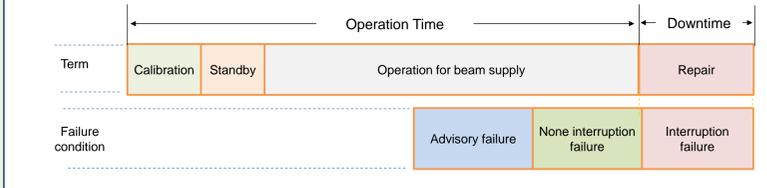


Figure-5 Typical weekly machine time

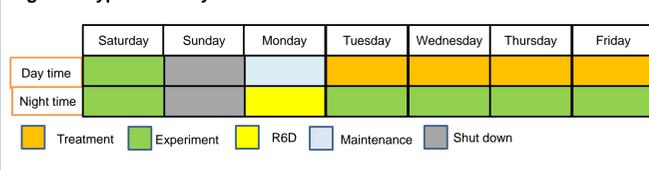


FIG-6 Equation

$$\text{Availability} = \frac{\text{Operation Time}}{\text{Operation Time} + \text{Down Time}}$$

$$\text{Averaged repair time(MTTR)} = \frac{\text{Total repair Time}}{\text{Number of the repaired failure}}$$

$$\text{Failure Rate} = \frac{\text{Total number of failure}}{\text{Operation Time}}$$

4. What we can find from and how we use it.

This section introduces that what we find from and how we use the trend. All graphs shown below are example of interesting case in the period of Apr 2014 thru Jan 2015..

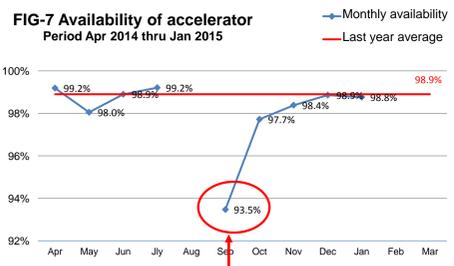


FIG-7 shows trend of availability for accelerator. The trend indicate that availability of September dropped to 93.5%. (Average of last fiscal year was 98.9%)

Electric Discharge Protection, EDP, is unique function and it is developed to protect damage by electric discharge in a tank. EDP disconnect RF power when sensed loss of vacuum in a tank. Anomaly of RF was that EDP disconnected RF power with no evidence of loss of vacuum. As a result of investigation, cause of above nuisance was hi sensitive of EDP. Therefore threshold level is changed to proper level. After implementation of this improvement, nuisance of EDP does not occur.

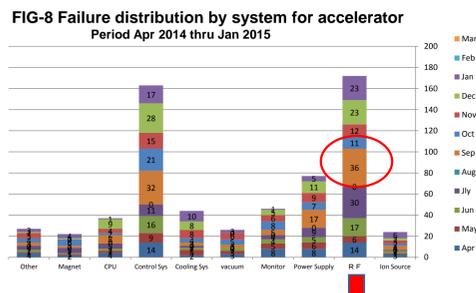


FIG-8 shows break down analysis. FIG-9 shows more break down focused on RF failure

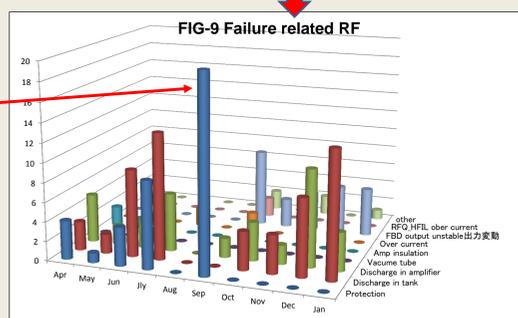


FIG-10 & FIG-11 shows MTTR trend. Green bar mean MTTR for interruption failure. Yellow bar mean MTTR for interruption and non interruption failure. It is possible to say that MTTR of interruption failure for the treatment room is smaller than the accelerator compared with FIG-10 and FIG-11.

FIG-10 MTTR of accelerator

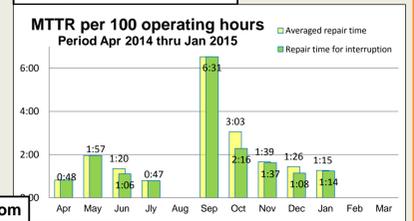
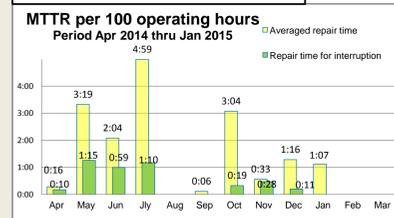


FIG-11 MTTR of new treatment room



There are number of treatment rooms . When one room has a failure, other room is possible to use for treatment.

5. Conclusion

This poster introduce how we decide the reliability index and how we use those indexes, with the cycle of Monitor-Analysis-Correction- Evaluation that maintains and/or improves the accelerator reliability.