

# Trouble-shooting in Initial Operation of the KOMAC 100-MeV Proton Linac

2014. 10. 31

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KOMAC, KAERI

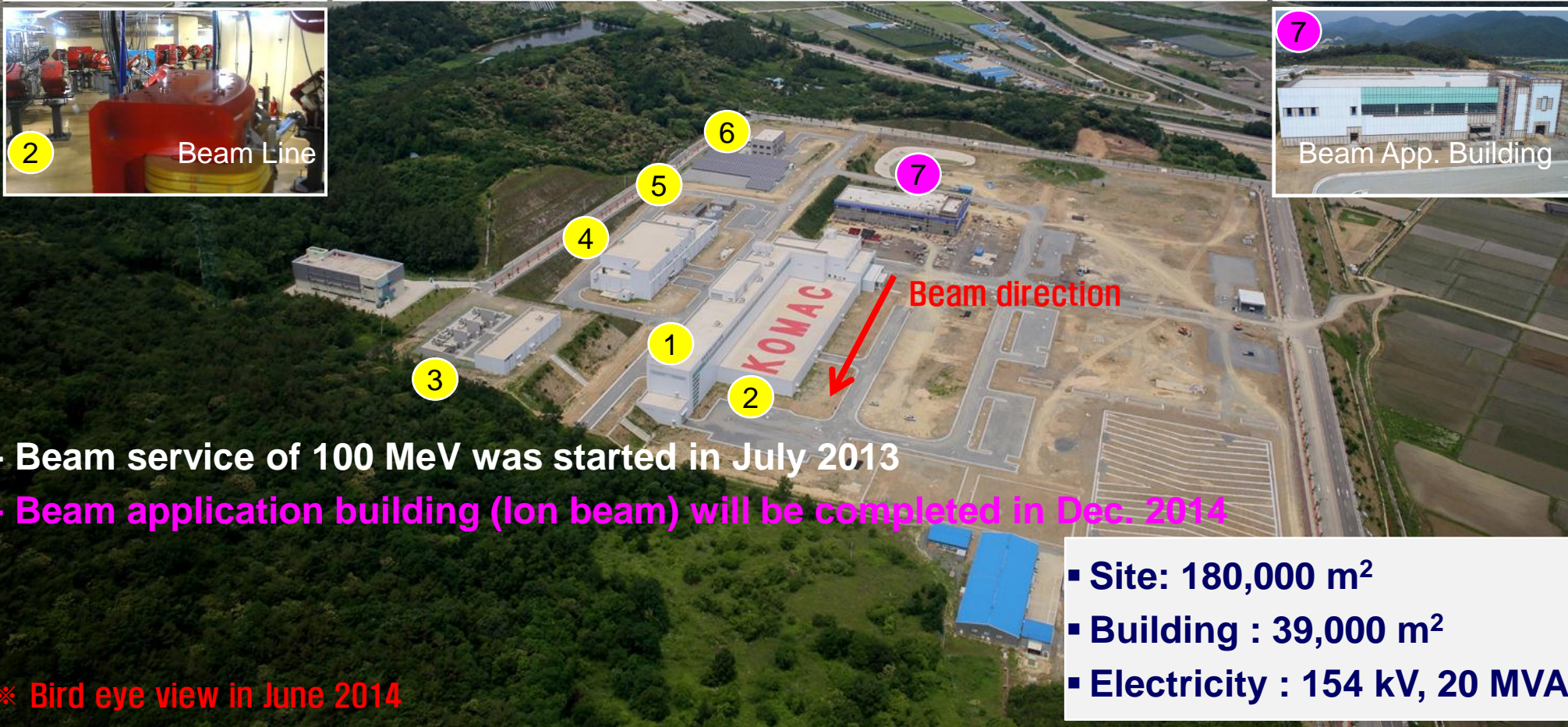


**KOMAC**  
Korea Multi-Purpose Accelerator Complex  
양성지속기연구센터

# KOrea Multi-Purpose Accelerator Complex

- About KOMAC
- Operation Status
- Trouble-shooting
- Plan
- Summary

# Facilities



- Beam service of 100 MeV was started in July 2013
- Beam application building (Ion beam) will be completed in Dec. 2014

- Site: 180,000 m<sup>2</sup>
- Building : 39,000 m<sup>2</sup>
- Electricity : 154 kV, 20 MVA

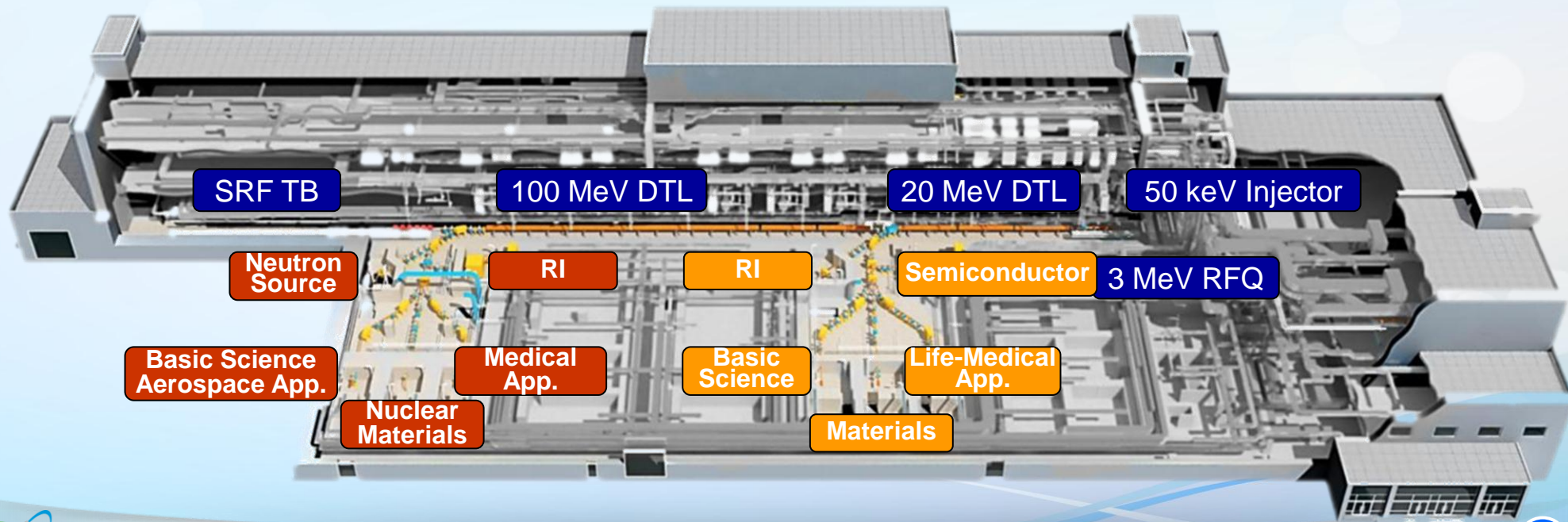
※ Bird eye view in June 2014

# Linac and Beam Lines

## Features of KOMAC 100MeV linac

- 50 keV Injector (Ion source + LEBT)
- 3 MeV RFQ (4-vane type)
- 20 & 100 MeV DTL
- RF Frequency : 350MHz
- Beam Extractions at 20 or 100 MeV
- 5 Beamlines for 20 MeV & 100 MeV

Output Energy (MeV)	20	100
Max. Peak Beam Current (mA)	1 ~ 20	1 ~ 20
Max. Beam Duty (%)	24	8
Avg. Beam Current (mA)	0.1 ~ 4.8	0.1 ~ 1.6
Pulse Length (ms)	0.1 ~ 2	0.1 ~ 1.33
Max. Repetition Rate (Hz)	120	60
Max. Avg. Beam Power (kW)	96	160



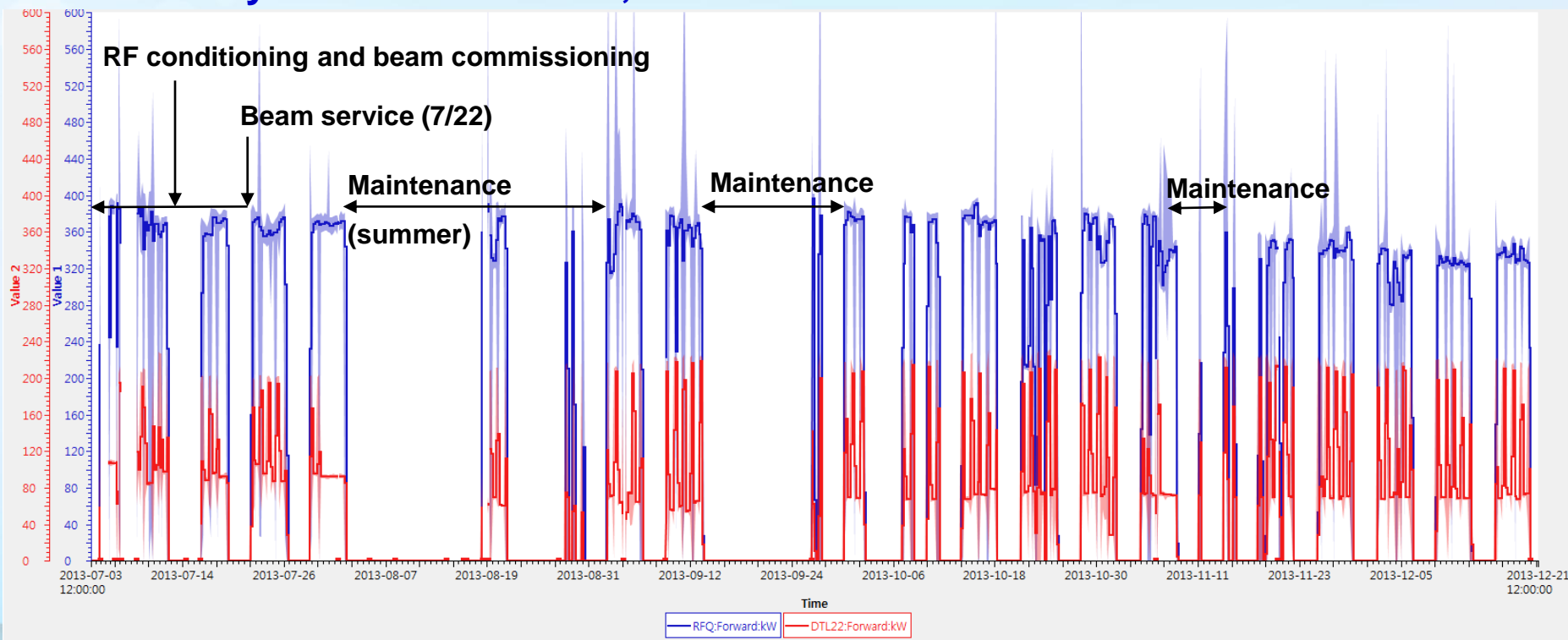
# Control Room & Operator

- **EPICS based control system**
  - Accelerator / Utilities / PSIS / RMS are controlled in the main control room
- **Operators : 2 for accelerator, 2 for beam service in target room**



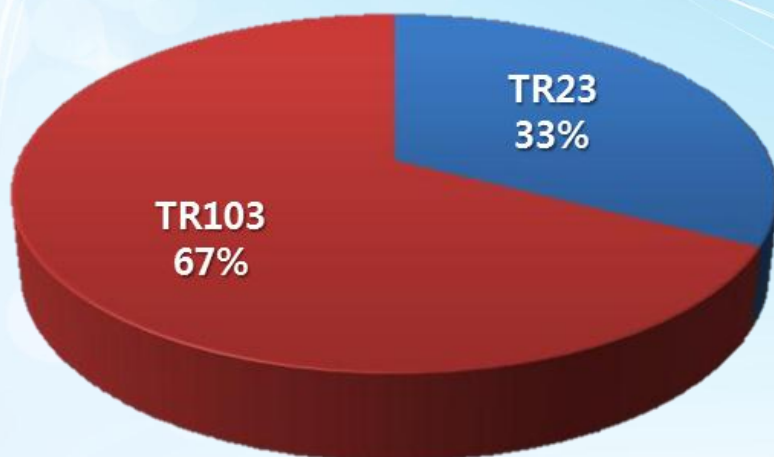
# Operation (July 2013 ~ Sep. 2014)

- Operation plan : Weekly based
- Beam service : Monday ~ Friday
- Operation statistics (accumulated)
  - Operation : 4,092 hours (FY 2013 : 2,290 hours / FY 2014 : 1,802 hours)
  - Beam service : 879.2 hours (FY 2013 : 432.7 hours / FY 2014 : 446.5 hours)
  - Availability : FY 2013 : 82.0% , FY 2014 : 92.6 %

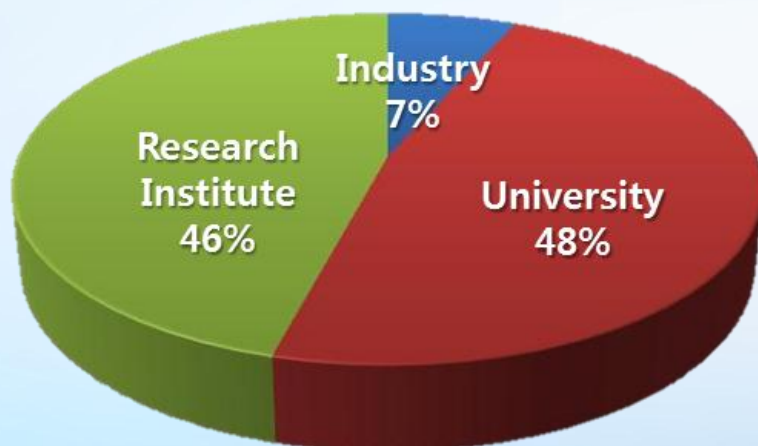


# Beam Service Statistics (2013~2014)

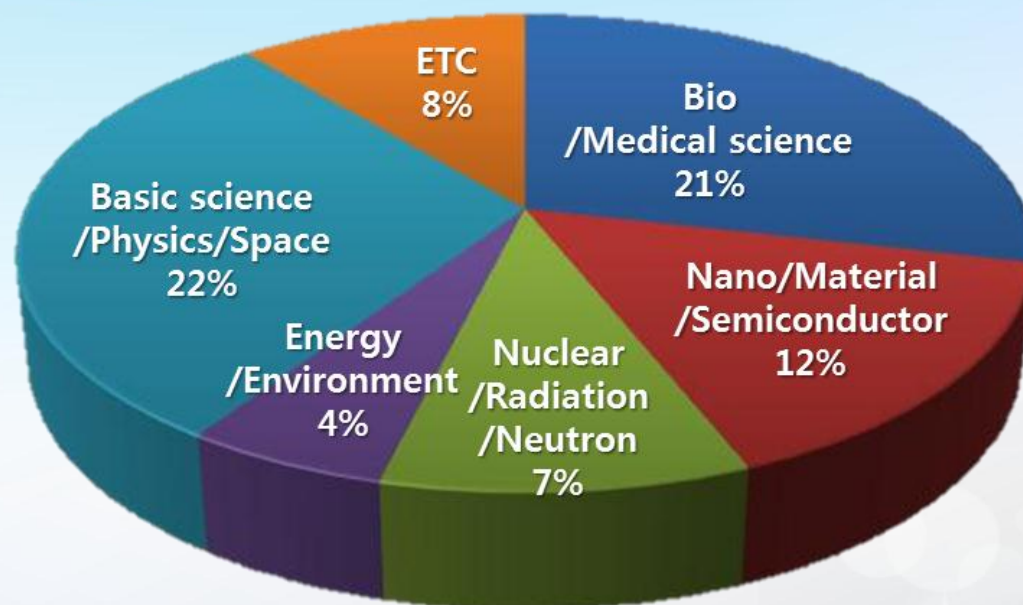
- Total number of charges : 1,894 (2013 : 937 charges / 2014 : 957 charges)



100MeV / 20MeV users



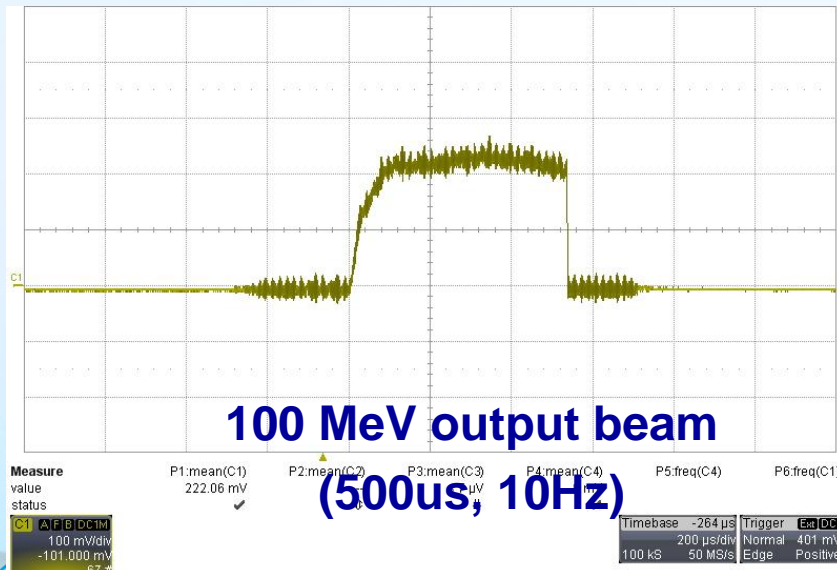
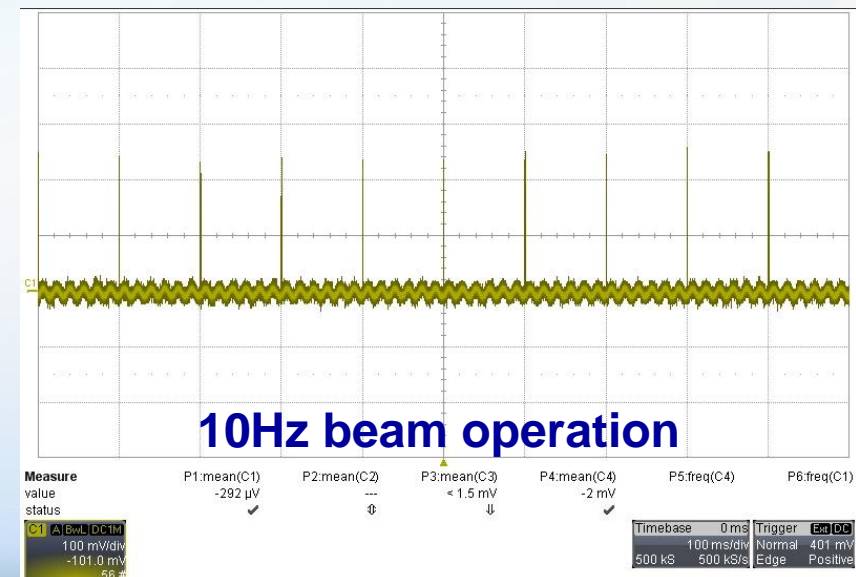
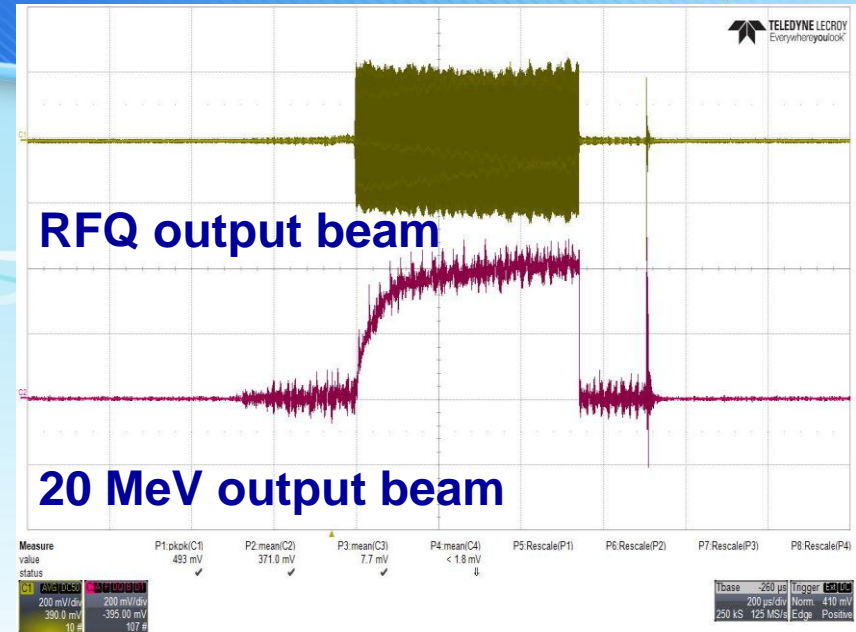
Users in institutions



Users in R&D fields

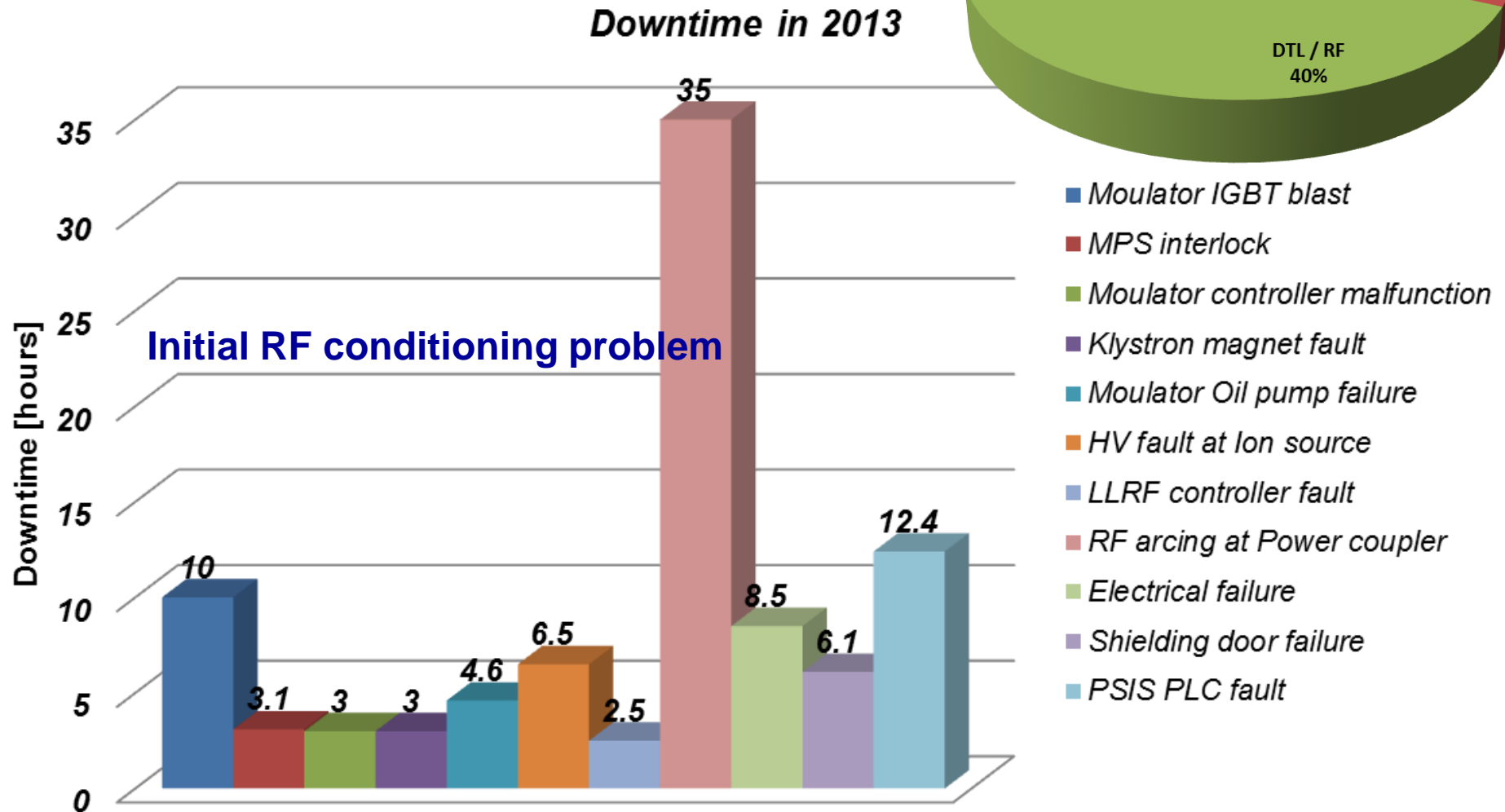
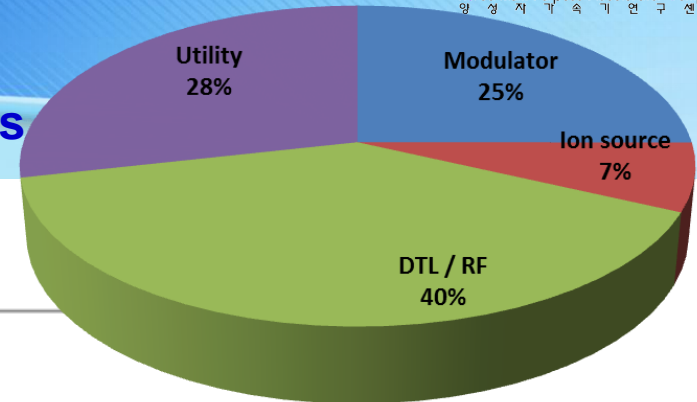
# Commissioning in 2014

- Goal : 10 kW beam @ 100 MeV
- Achieved 10 kW beam in August 2014 : 550us, 10Hz
- Normal operation with 10 kW is to start with revision of operation license



# Downtime Statistics at 2013

- Accumulated down time in beam service : 94.7 hours



- **Utility**

- Equipment wet at klystron gallery
- Cooling pump shut down
- Radiation shielding door failure

- **Modulator**

- IGBT blasting
- Controller failure
- SCR firing circuit failure
- Oil pump failure

- **DTL / RF**

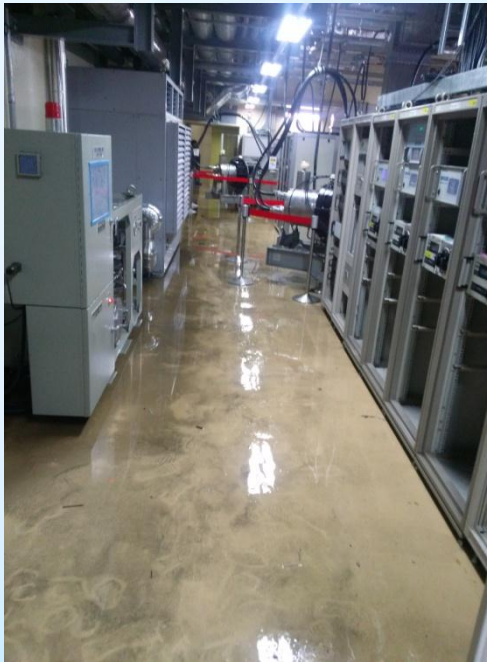
- RF arcing at a power coupler
- RF arcing at a slug tuner of DTL tank
- Dividing resistor failure for klystron

- **Ion source**

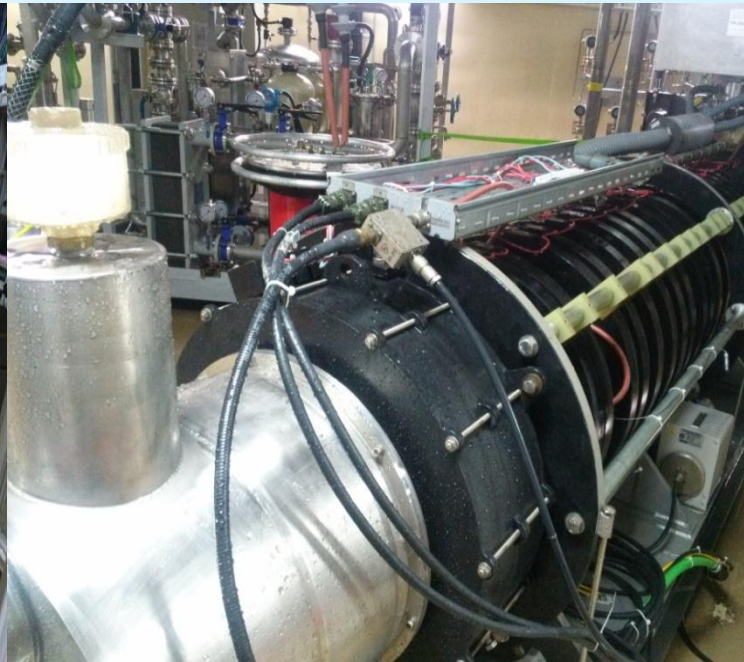
- Solenoid failure
- High voltage switch failure
- Electro-magnetic power supply failure

# Issue : Utilities(1)

- Although completed commissioning of the utility, several troubles
- Long-term
  - Watered electronics in klystron gallery
    - : Due to unexpected triggering the fire extinguisher
    - : Shut down vacuum, RF and control system



**Klystron gallery**



**Klystron**



**Vacuum system**

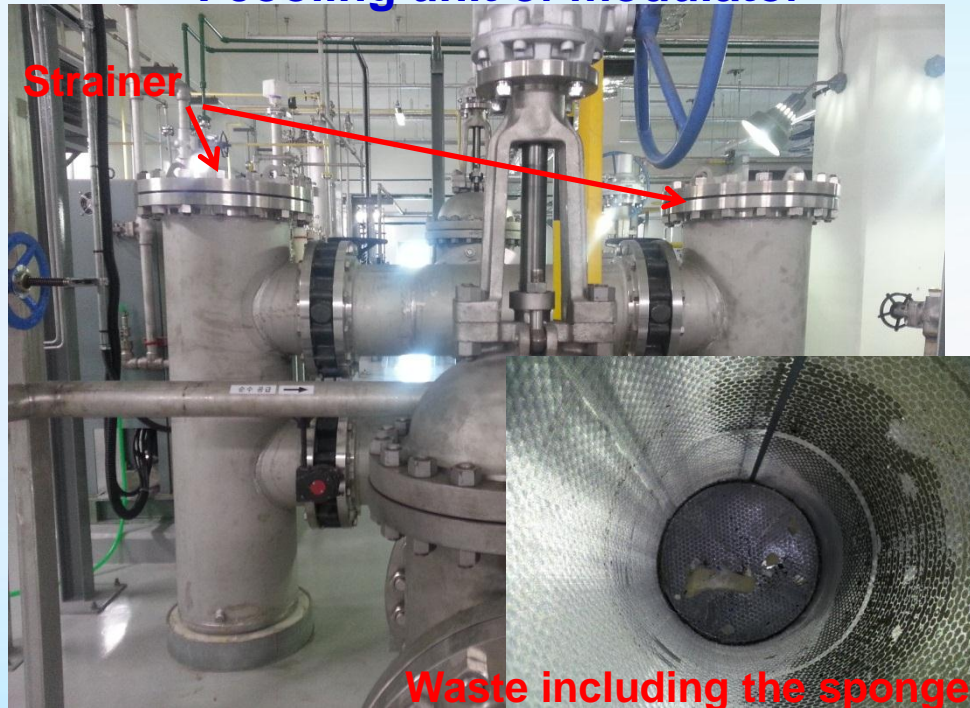
# Issue : Utilities(2)

## Short-term

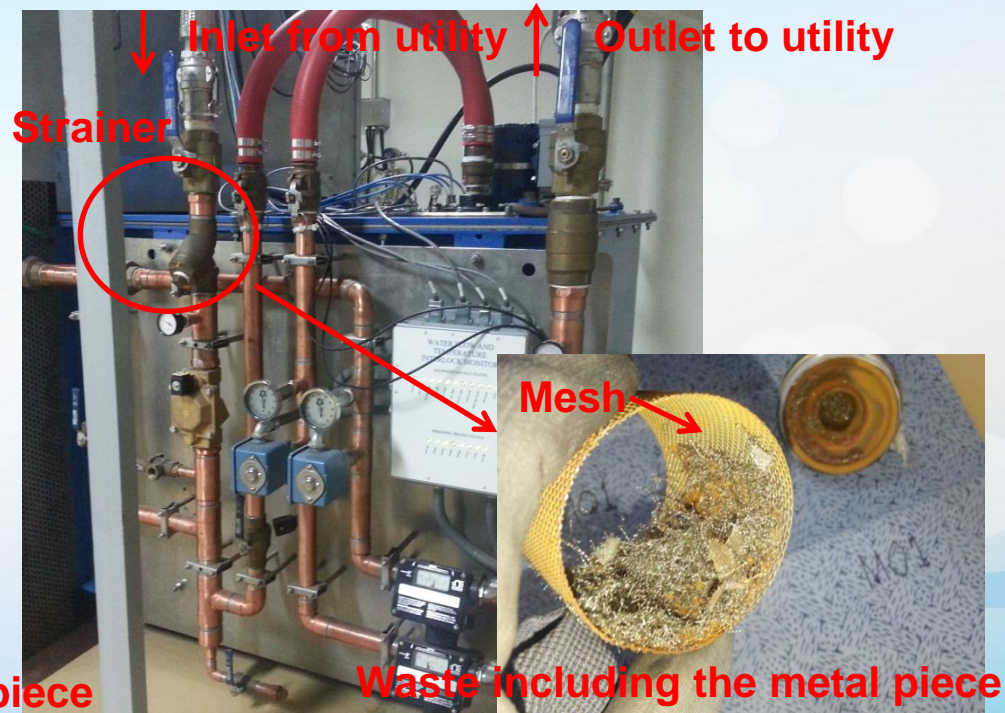
- Abnormal stopping cooling pump caused by momentary electrical power failure
- Tripped off vacuum system due to improper grounding
- Burned LEBT solenoid magnet by malfunction of cooling skid
- Waste in the strainer

: cooling system keeping the temperature of utility

: cooling unit of modulator



cooling system of utility



Cooling unit of 1<sup>st</sup> modulator

# Issue : Linac(1)

## ● Long-term

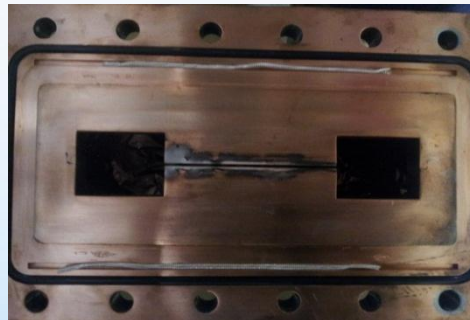
- RF arcing during conditioning of DTL105
  - : frequent full reflections
  - : Forward RF power reached up to 800 kW (300 us, 2Hz) for a while
  - : After that, RF power was fully reflected and never recovered even under 80 kW



During installation



Back of Iris plate after arcing

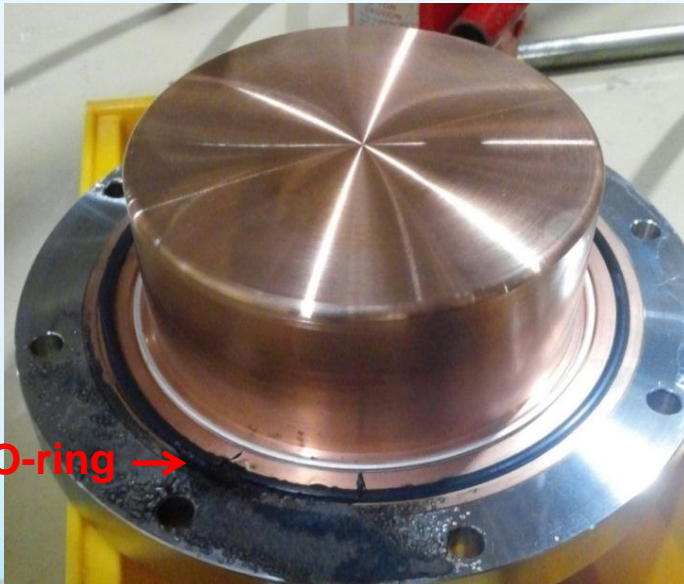


Front of ridge loaded waveguide



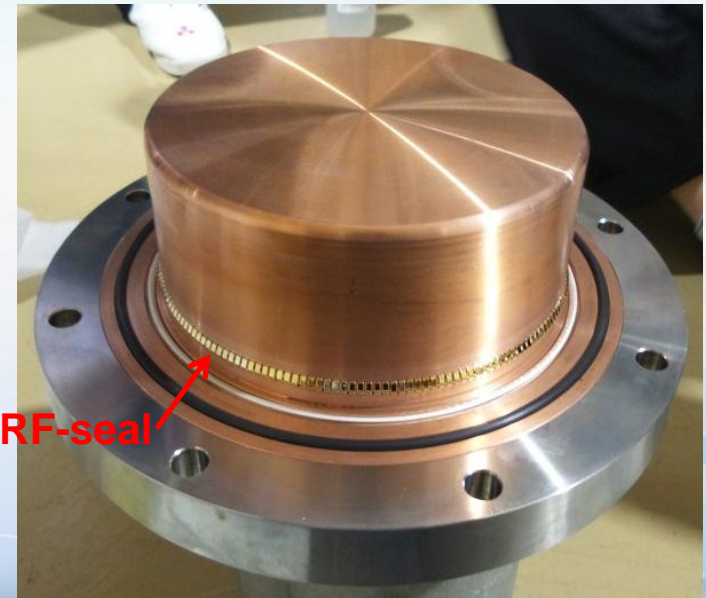
Canted coil RF seal with indium sheet (0.3 mm) to fill the gap

- Long-term
  - RF arcing at a slug tuner of DTL tank
    - : when is increasing the pulse width and repetition (1.2ms, 10Hz @ ~ 1 MW of forward power)
    - : broken vacuum due to burn the O-ring and then added the RF seal
- Short-term
  - RCCS control and klystrons failure
  - Flow-meter failure for DT 's electro-magnet



Burned O-ring →

Before



Added RF-seal →

After

# Issue : Modulator

## ● Long-term

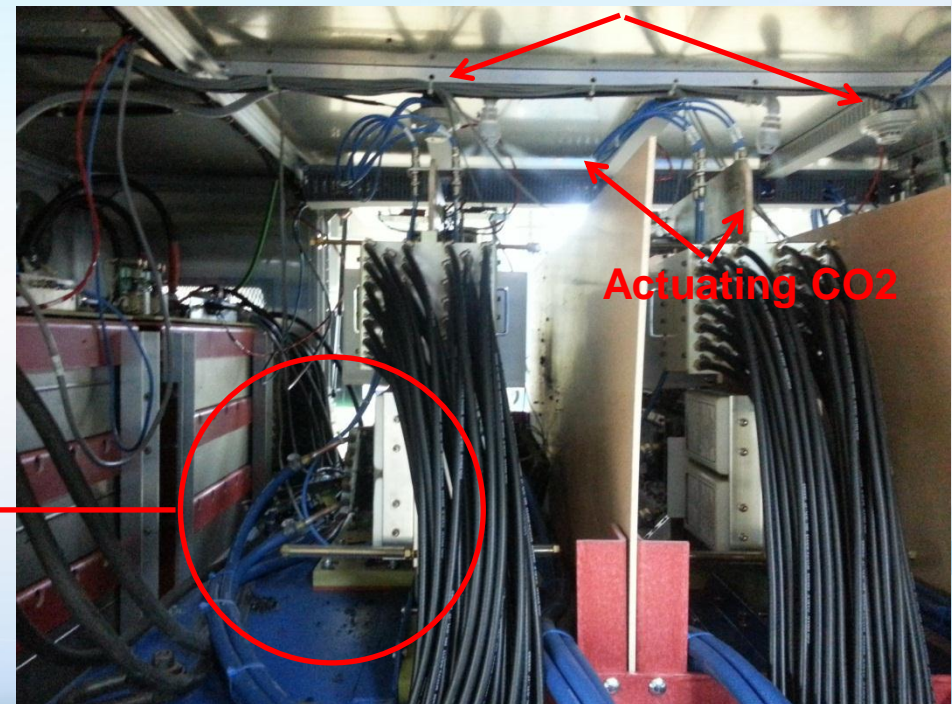
- IGBT blasting at low duty 500us, 2Hz
  - : acted the fire detector and actuated CO2 gas
  - : cleaned the blasting debris on switching plate of A phase
  - : replaced IGBT's, IGBT drive boards
- Controller failure
- SCR firing circuit failure

## ● Short-term

- IGBT over-current set value
- SCR control circuit jumper
- Oil pump hose and so on



**Blasted IGBT**

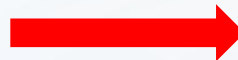


**M02, A phase IGBT blasting**

- Long-term
  - HV switch malfunction by HV arcing
    - : It cannot be repaired due to molded type
    - : long delivery and lead time
    - : changed the HV switch made in domestic company
    - : Although faults in twice, repair time reduced



HV switch : 65kV, BEHLKE, German



HV switch : 60kV, Dong-A Hitech., Korea

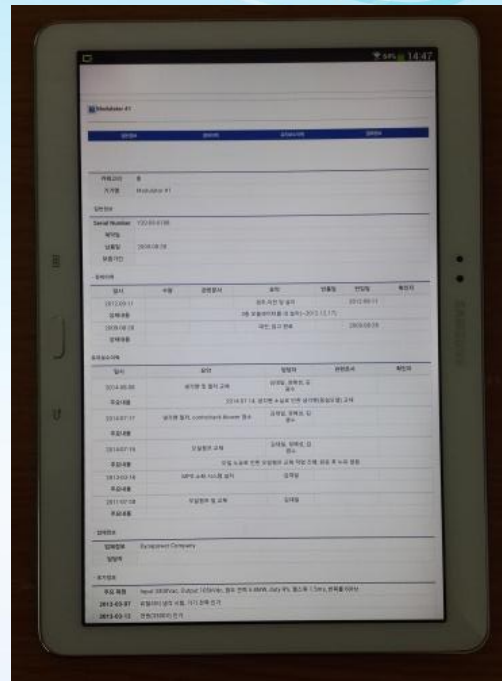
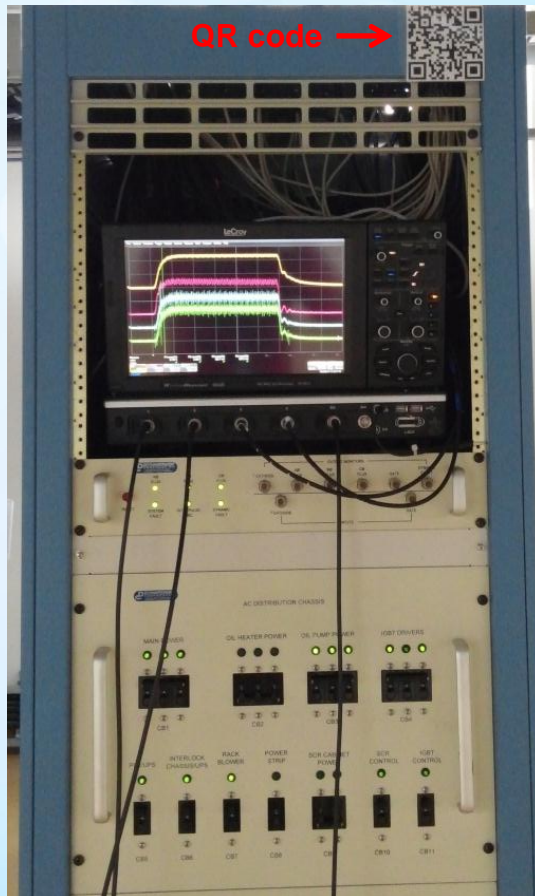
# Reduction downtime (1)

- **MPS (Machine Protection System)**
  - Minimize the damage
    - Add interlock related with MPS
      - : modulator, magnet's P/S
- **Spare parts**
  - Preparation items of long lead time for emergency
    - A type of a wholeness body
      - : klystron, circulator, other RF components, power supplies
    - A type of a partial components
      - : modulator
- **Reduction of repair time**
  - transfer the devices made in domestic company if possible
    - : HV switch

# Reduction downtime (2)

## ● Management of items and spare parts

: set up MIS (Management Information System) which can be known the details of item as check the QR code on machine



Tablet PC

65% 11:01

Modulator #1

입력전압

출력전압

입력전압/출력전압

입력전압

카테고리

종

기기명

Modulator #1

· 일반정보

Serial Number

Y20-09-0188

계약일

납품일

2009-08-28

보증기간

· 장비이력

일시

수량

관련문서

요약

반입일

반출일

확인자

2012-09-11

상세내용

3층 모듈채널의 냉각팬 교체 (~2012.12.17)

2009-08-28

상세내용

대선, 입고 완료

2009-08-28

유지보수이력

일시

요약

담당자

관련문서

확인자

2014-08-08

주요내용

냉각팬 및 필터 교체

김대일, 정태성, 김광수

2014-07-17

주요내용

2014.07.14, 냉각팬 수질로 인한 냉각팬(동일모델) 교체

김대일, 정태성, 김광수

2014-07-16

주요내용

오일뱅크 교체

김대일, 정태성, 김광수

2013-03-18

주요내용

MPS 소화 시스템 설치

김대일

2011-07-28

주요내용

오일뱅크 및 교체

김대일

· 업체정보

업체정보

Dynamower Company

담당자

· 추가정보

주요 제품

Input 3300Vac, Output 105kVdc, 정수 전력 5.8MW, duty 9%, 펄스폭 1.5ms, 인덕터 60Hz

2013-03-07

2013-03-12

유동력 냉각 시험, 기기 전력 인가

전원(3300V) 인가

History of item including spare parts

History of maintenance

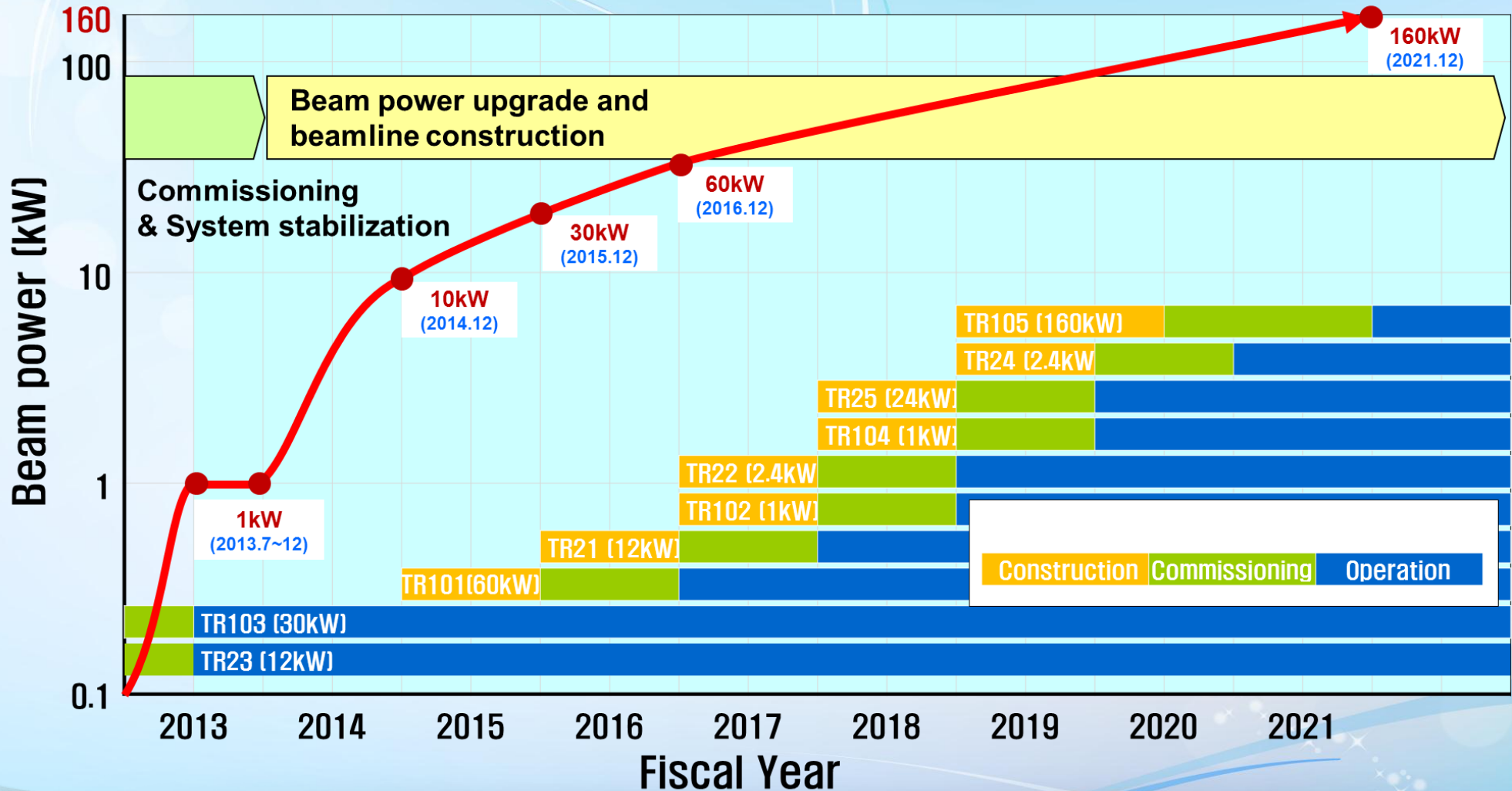
Manufacturer

More information

Tablet screen

# Plan for Beam Power Upgrade

- Beam power upgrade goes with the target room construction



## ● Operation

### ■ 2013

- : Successfully commissioned 100 MeV linac with 1 kW
- : Licensed normal operation (Nuclear Safety and Security Commission of Korea)
- : Started user beam service in July.

### ■ 2014

- : Increased beam power to 10 kW
- : Continued user beam service with improved beam conditions

## ● Reduction downtime

- Add the interlock to continue
- Maintain the sufficient spare parts
- Transfer the devices made in domestic company
- Manage the amount and history of items, systematically

## ● 2014 Plan

- Get the operation license for 10 kW
- Operate 10 kW of beam power in normal

**Thank you**