

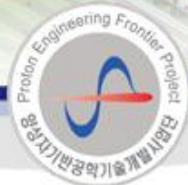
WAO 2012

SLAC National Accelerator Lab.

# Recovery from the Fire Accident at PEFP

2012. 8. 9

Bum-Sik Park



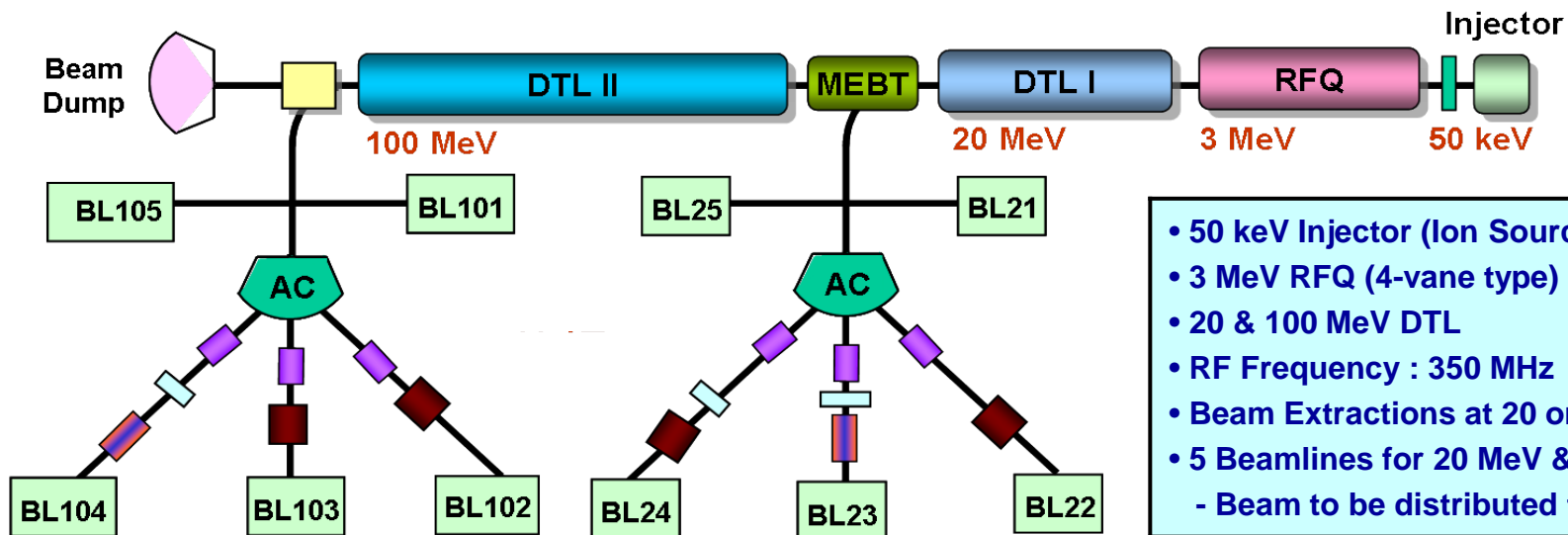
양성자 기반 공학 기술 개발 사업단  
Proton Engineering Frontier Project  
<http://www.komac.re.kr>



- ◆ **About PEFP**
- ◆ **Fire Accident**
- ◆ **Recovery Work for 20MeV Linac**
- ◆ **Installation Status and Plan of 100MeV Linac**
- ◆ **Summary**

# Overview

- **Project: Proton Engineering Frontier Project (PEFP)**
  - 21C Frontier R&D Program, MEST, Republic of Korea
- **Objectives:**
  - To develop a High Power Proton Linac (100MeV, 20mA)
  - To develop Beam Utilization & Accelerator Application Technologies
  - To Industrialize Developed Technologies
- **Period: July 2002 – December 2012**



- 50 keV Injector (Ion Source + LEBT)
- 3 MeV RFQ (4-vane type)
- 20 & 100 MeV DTL
- RF Frequency : 350 MHz
- Beam Extractions at 20 or 100 MeV
- 5 Beamlines for 20 MeV & 100 MeV
  - Beam to be distributed to 3 BL via AC

# Gyeongju Site

2012. 2. 20



**KTX station**  
~2hr from Seoul

Reserved for Future  
650m(L) x 400m(W)

**100 MeV Linac Site**  
450m(L)x400m(W)



- Easy access (KTX & freeway)
- Near to the light source(PLS) (30min by car)
- Good sightseeing
- Near to Busan (No. 2 city in Korea)

Freeway

# 20-MeV Accelerator installed at KAERI site

**Operated**  
: one day per a week  
: Normally, all power turned off except the vacuum system

Waveguide  
WR2300



Klystron for DTL  
350MHz 1MW CW



20MeV Beam Stop



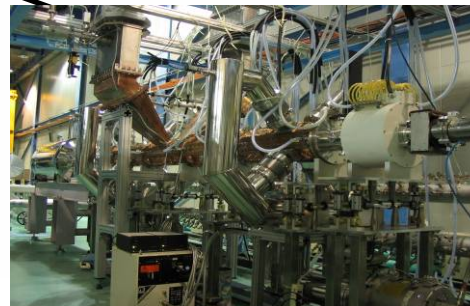
Klystron for RFQ  
350MHz 1MW CW



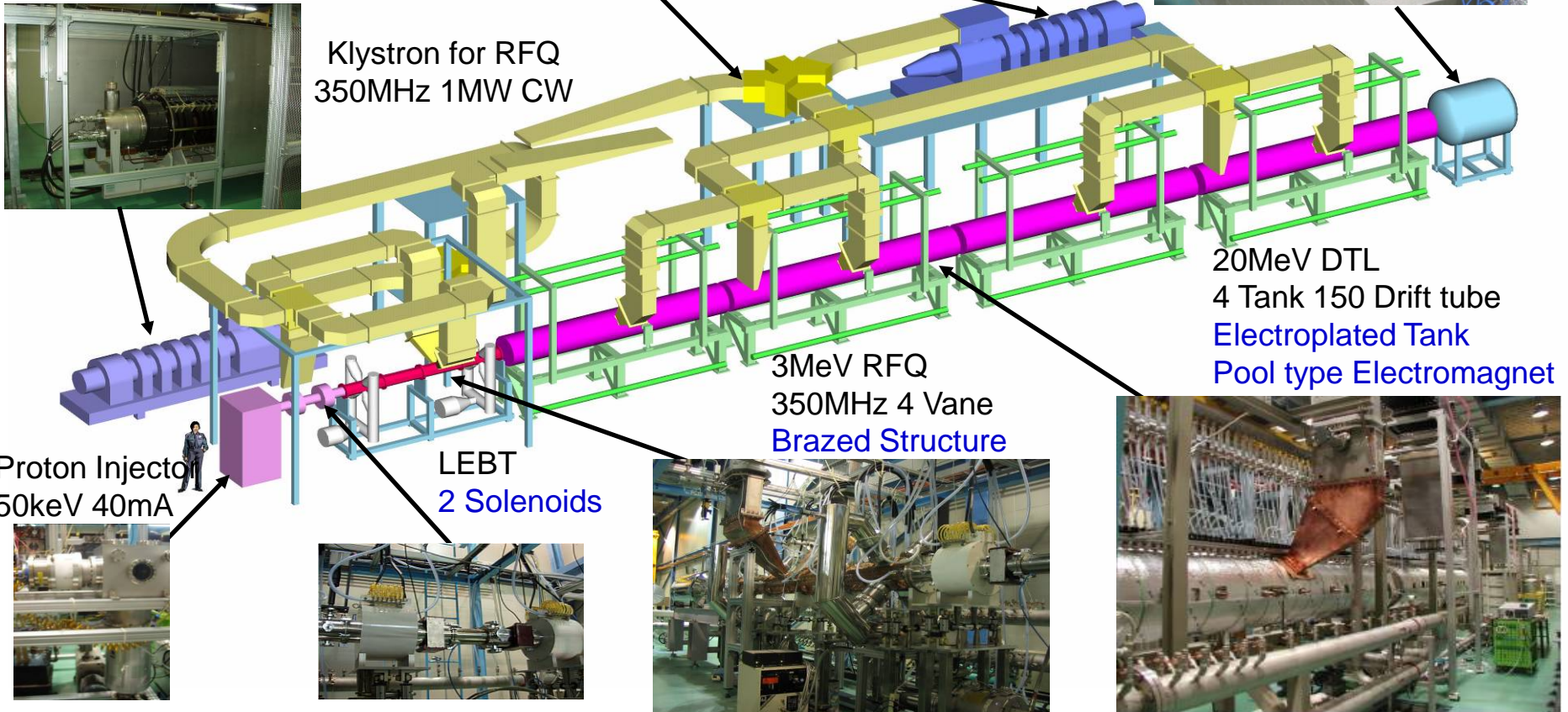
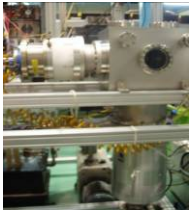
20MeV DTL  
4 Tank 150 Drift tube  
Electroplated Tank  
Pool type Electromagnet

3MeV RFQ  
350MHz 4 Vane  
Brazen Structure

LEBT  
2 Solenoids



Proton Injector  
50keV 40mA



# Fire Accident



There was a fire accident

- : 9<sup>th</sup> April, 2009
- : A short circuit caused a fire in another lab.
- : The fire was got under control before the flame spread to 20MeV accelerator test room.

The 20MeV accelerator system was contaminated with carbon dust

- : Damaged not by flame but by the carbon dust
- : Electric power was cut OFF, Vacuum pump was ON, UPS was ON
- : Access was permitted after one hour later.

# Damaged Part Lists

Equipment	Quantity	Status
<b>DTL QM current lead cooling system</b>	<b>8</b>	<b>Repair</b>
UPS	4	Repair
<b>Klystron</b>	<b>1</b>	<b>Repurchase</b>
DC P/S	7	Repair
<b>Vector Signal Generator</b>	<b>1</b>	<b>Repurchase</b>
<b>Vector Network Analyzer</b>	<b>1</b>	<b>Repurchase</b>
<b>Spectrum Analyzer</b>	<b>1</b>	<b>Repurchase</b>
<b>Oscilloscope</b>	<b>6</b>	<b>Repurchase</b>
<b>Power Meter</b>	<b>1</b>	<b>Repurchase</b>
<b>GPIB Gateway</b>	<b>1</b>	<b>Repurchase</b>
<b>Function Generator</b>	<b>1</b>	<b>Repurchase</b>

Equipment	Quantity	Status
Current Amplifier	1	Repair
<b>TMP</b>	<b>4</b>	<b>Repair</b>
<b>Ion Pump Controller</b>	<b>3</b>	<b>Repair</b>
<b>Ion Pump</b>	<b>8</b>	<b>Repair</b>
Gauge Controller	1	Repurchase
Scroll Pump	10	Repair
Air Conditioner	4	Repair
<b>VME485</b>	<b>1</b>	<b>Repurchase</b>
<b>Electrometer</b>	<b>1</b>	<b>Repurchase</b>
<b>DAQ</b>	<b>1</b>	<b>Repurchase</b>
PC	19	Repair
Monitor	17	Repair

Considering the period of delivery and the price, the biggest damage is klystron and RF devices.

# High Power RF System - Klystron

## High Power Klystron

- Removed the carbon dust and checked the vacuum.
- One of 2 klystrons was damaged as vacuum degradation.
- Damaged one was replaced with a spare klystron.
- New one was repurchased according to the manufacturer's opinion by insurance.



Klystron



Vacuum test



# RF System & Measurement Equipment

Fans of the RF and measurement equipment were operating during the fire accident because of UPS

- Equipment were contaminated with sticky carbon dust.
  - RF system : RF signal generator, network analyzer, oscilloscope
  - Measurement equipment : Electrometer, DAQ(PXI)
- => Repurchased through the manufacturer's opinion.



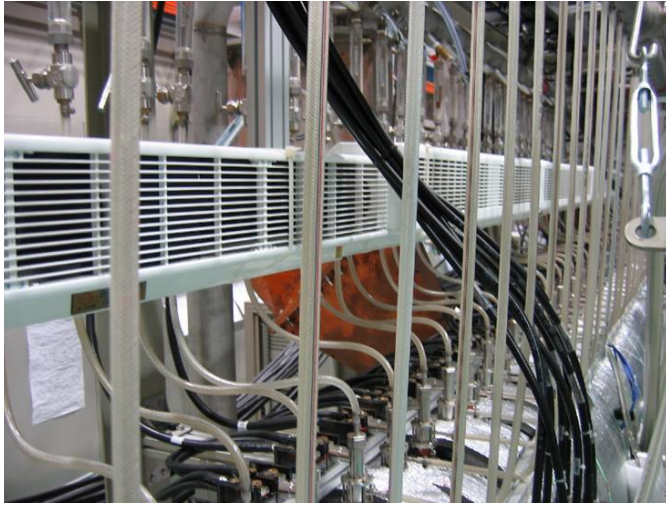
Oscilloscope



Signal Generator

# DTL QM current Lead

- QM current lead (Power loss 800 W/QM)
  - Old one : Forced air cooling (Temperature at current lead ~ 100 deg. C)
  - Revised one : Water cooling (Temperature at current lead ~ 80 deg. C)



Air shower and  
general terminal  
block



Water cooled  
terminal block

# Vacuum System

- All vacuum pumps were working during the fire accident
- Damaged parts were
  - Scroll pump : 10                      => Replaced tip seals and bearings
  - TMP controller : 4                      => Repurchased
  - Ion pump controller : 7                      => Repurchased
  - Vacuum gauge controller : 1                      => Repurchased
- Whether inside the DTL was contaminated or not was more significant issue
  - No problem with visual inspection
  - RF conditioning of the RFQ and DTL were done up to the operating peak power level without any symptom of contamination



Ion pump controller

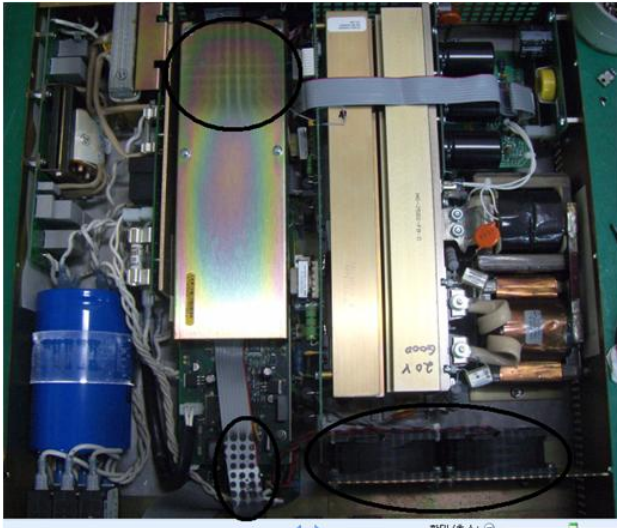


TMP pump controller



Scroll pump

# Power Supply



DC power supply

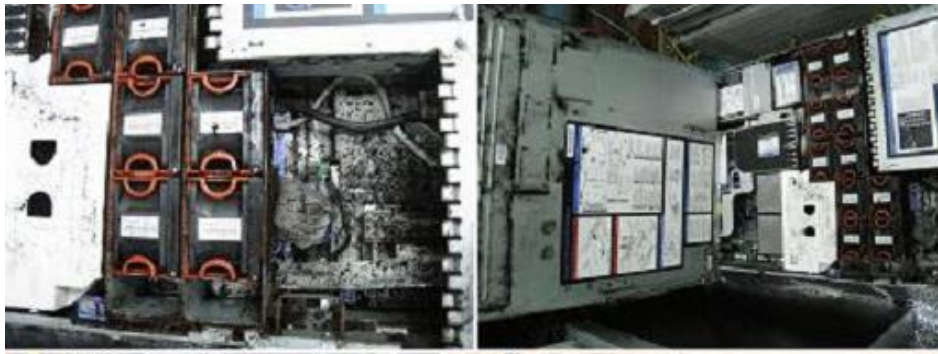
- DC Power supply
  - Turned off during the accident
  - Cleaning method
    - : by using the brush and alcohol.
  - All power supplies were tested before the reinstallation



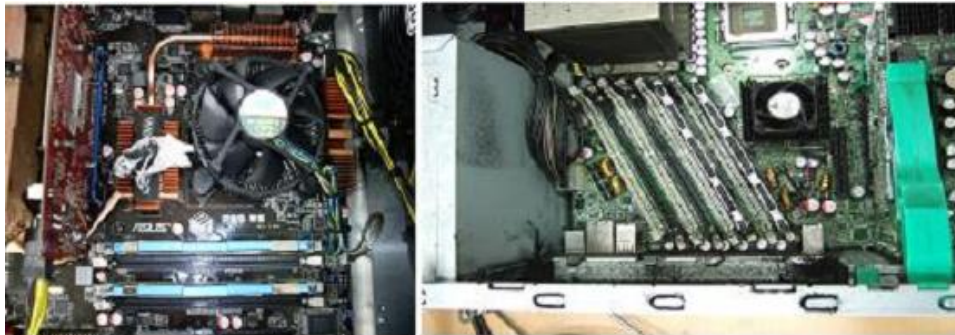
UPS

- UPS
  - Turned on during the accident
  - 6 UPSs were checked and repaired by the manufacturer.
  - Damaged PCB boards and batteries were replaced.

# Control System



Server



Workstation



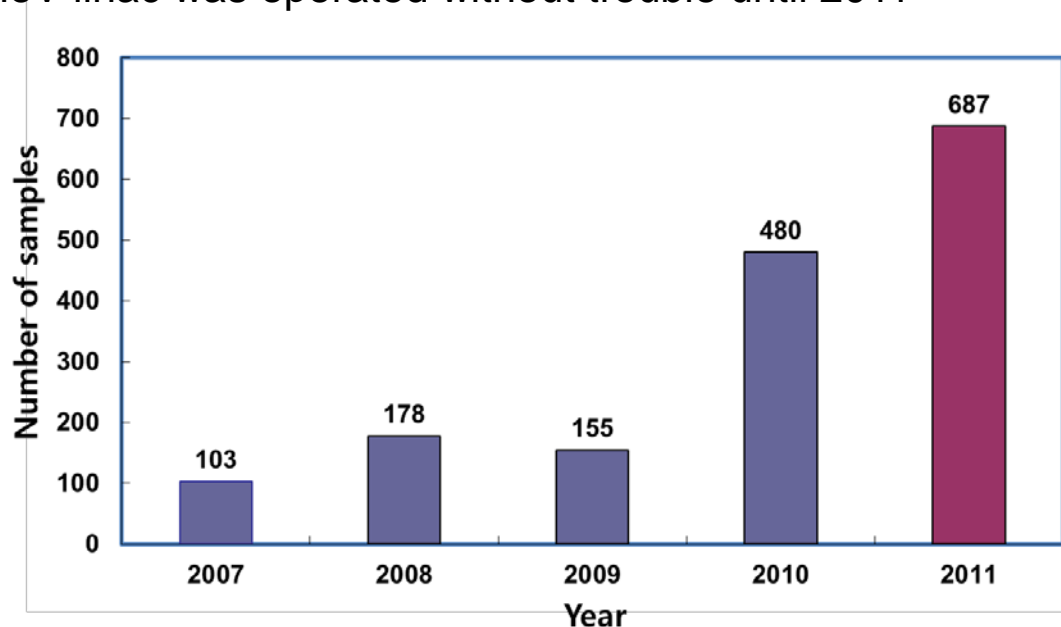
Monitor

PC

- Server and Workstation
  - Impossible to clean up
  - Under corrosion process.
  - Repurchased according to the manufacturer's opinion.
  
- Monitors and PCs
  - Monitors and PCs were repaired by the manufacturer.

# Summary of 20MeV Linac Recovery

- 20MeV accelerator system was recovered from the fire accident
  - Most damaged parts were contaminated with the carbon dust
  - 1 klystron was damaged and replaced (New one was purchased by insurance)
  - RFQ and DTL tank were not damaged
    - Only QM current lead cooling system was damaged and revised with the water cooling type
  - Other RF devices, control servers and vacuum pumps were purchased by insurance
  - First beam after recovery was 14th November, 2009 (7 months later)
  - Since then, 20MeV linac was operated without trouble until 2011



# 20MeV Linac Disassembly and Transportation

- 20MeV linac was operated and supplied proton beam to users at KAERI site until November 2011
- Disassembly of 20MeV linac : January 2012
- Installation of 20MeV linac at project site : February 2012



# Installation Status and Plan of 100MeV Linac



Accelerator in the tunnel



Magnets in the beamline hall

- Accelerator from ion source to beam dump were installed at March 2012.
- Beamline magnets were installed at May 2012.
- RF systems including klystrons, circulators and modulators were fabricated and got ready to install. Installation for klystron gallery and modulator gallery will start when the building is ready.
- The beam commissioning will start from January 2013.



- ◆ The fire accident was occurred in another lab. at 9<sup>th</sup> May, 2009.
- ◆ 20MeV linear accelerator system was damaged not by flame but by the sticky carbon dust.
- ◆ Through the recovery works for 7 months, 20MeV linac was recommissioned and supplied proton beams to users.
- ◆ 20MeV linac was operated until November 2011 and delivered from the KAERI site to Gyeongju site
- ◆ 100MeV linac and beamlines were installed. The beam commissioning will start from the January 2013.
- ◆ We can contribute much more to WAO 2014 on the basis of the commissioning and operation experience for the 100MeV linac and beamlines.



***Thank you for your attentions!***