Japan Proton Accelerator Research Complex

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KEK/J-PARC

Proton Driver Efficiency Workshop
Paul Scherrer Institut
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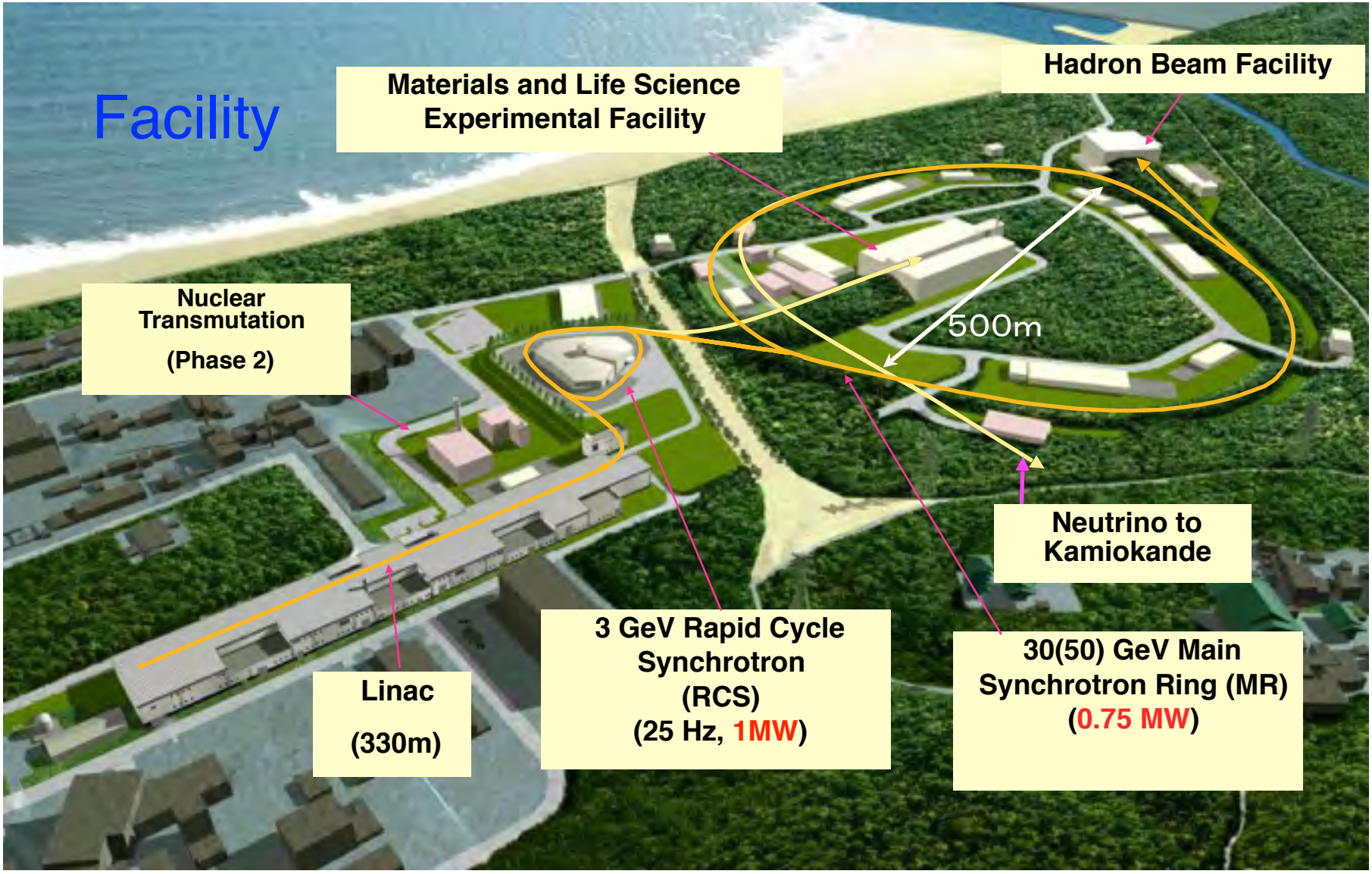
J-PARC

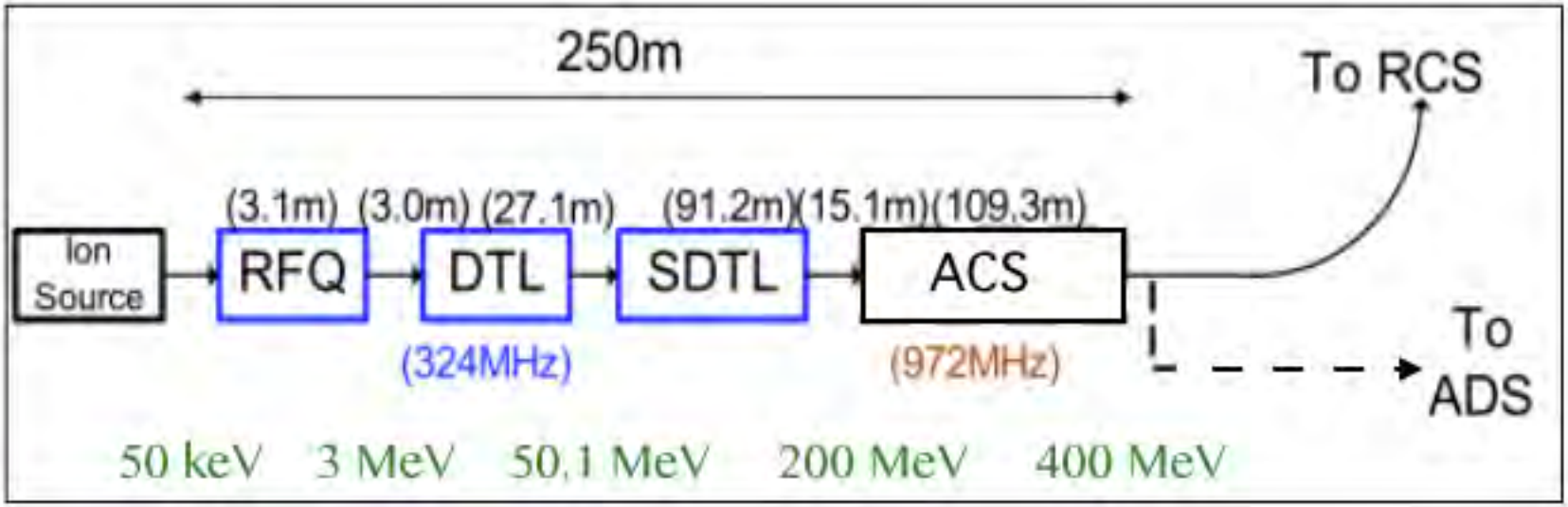
(Japan Proton Accelerator Research Complex)

Joint Project between KEK and JAEA



Proton Linac

- Major Parameters
  - Accelerated particles: H^- (negative hydrogen)
  - Energy: 400 MeV, SDTLs and ACS
  - Peak current: 30 mA ~ 50 mA for 1MW at 3GeV)
  - Repetition: 25 Hz (additional 25 Hz for ADS application)
  - Pulse width: 0.5 ms (beam pulse), 0.65 ms (for RF pulse)



Synchrotron Rings (RCS and MR)

Features

- Transition free lattice: the missing bend struction
  RCS: high transition gamma
  MR: imaginary transition gamma
- Magnetic alloy loaded cavity:
  High field gradient > 20kV/m
  Multi-harmonic forward beam-loading compensation
- MR: Slow and fast extractions for nuclear and particle physics experiments

3GeV Rapid cycling synchrotron (RCS)

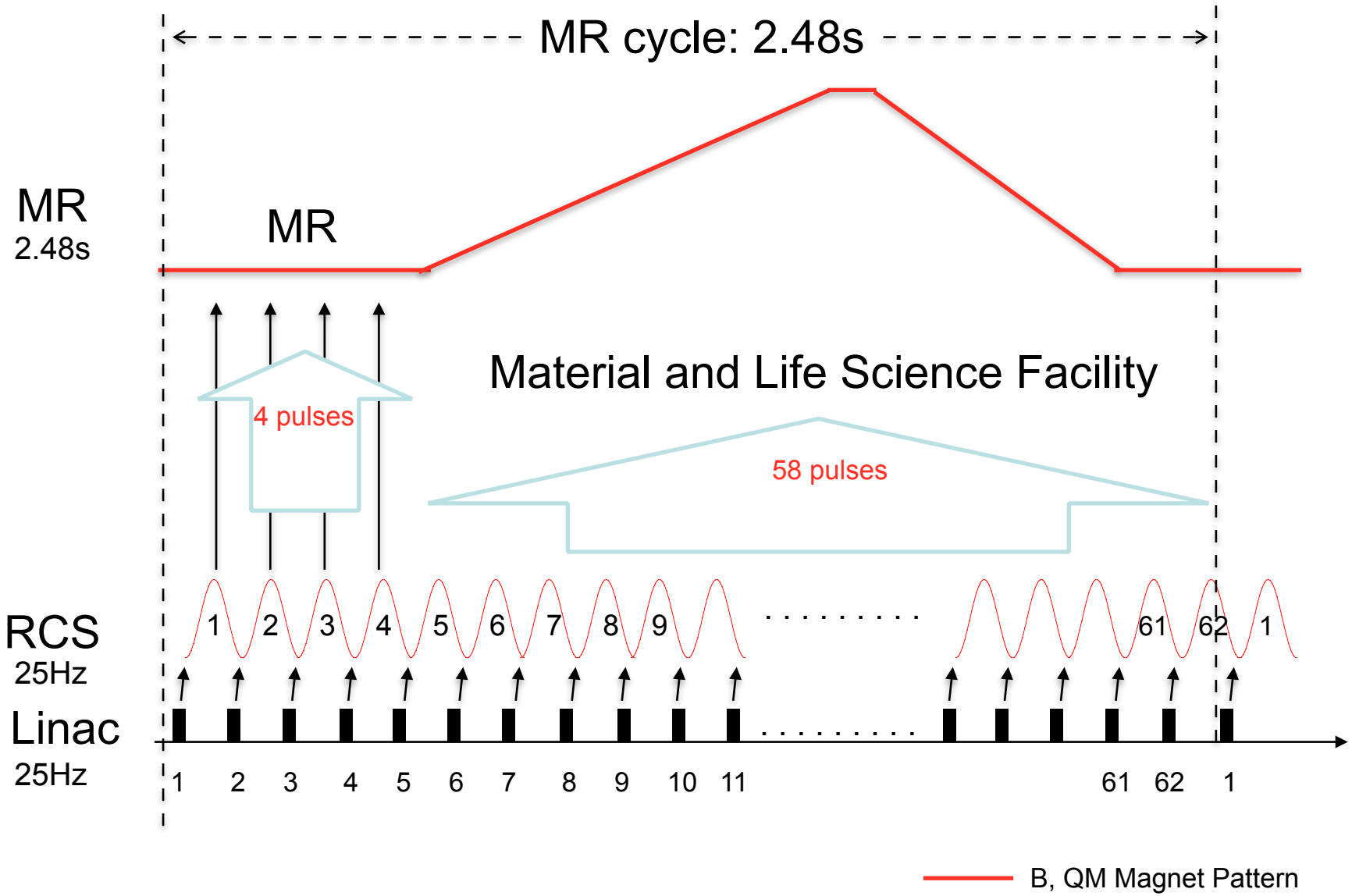
Circumference	348.3 m
Injection energy	400 MeV
Extraction energy	3 GeV
Repetition rate	25 Hz
Output beam power	1 MW
Harmonic number	2
Accel. peak voltage	420 kV

Main ring synchrotron (MR)

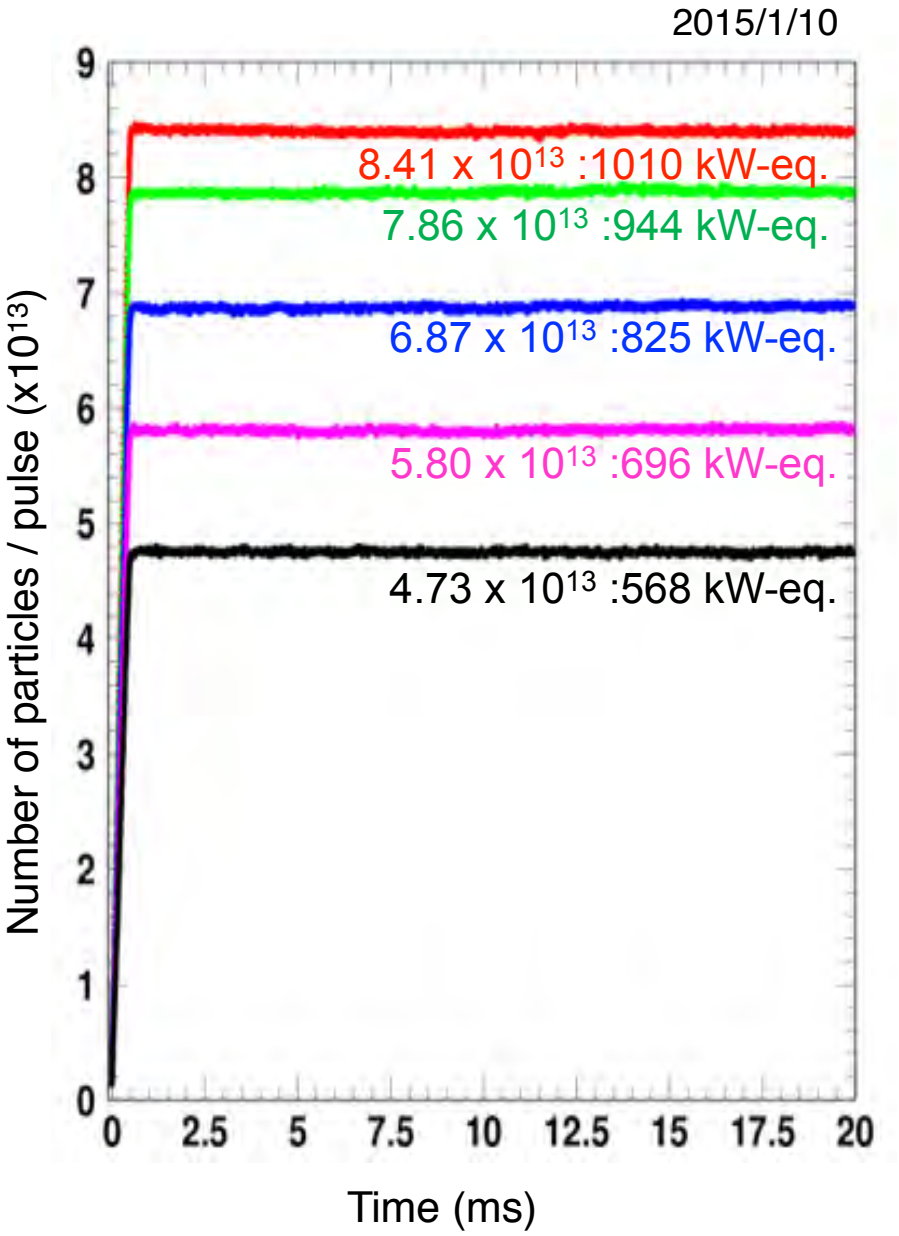
Circumference	1567.5 m
Injection energy	3 GeV
Extraction energy	30 [50] GeV
Repetition rate	$^1/2.48$s [$^1/3.64$s]
Output beam power	0.75 MW
Harmonic number	9
Accel. peak voltage	280 kV

[ ]: original design

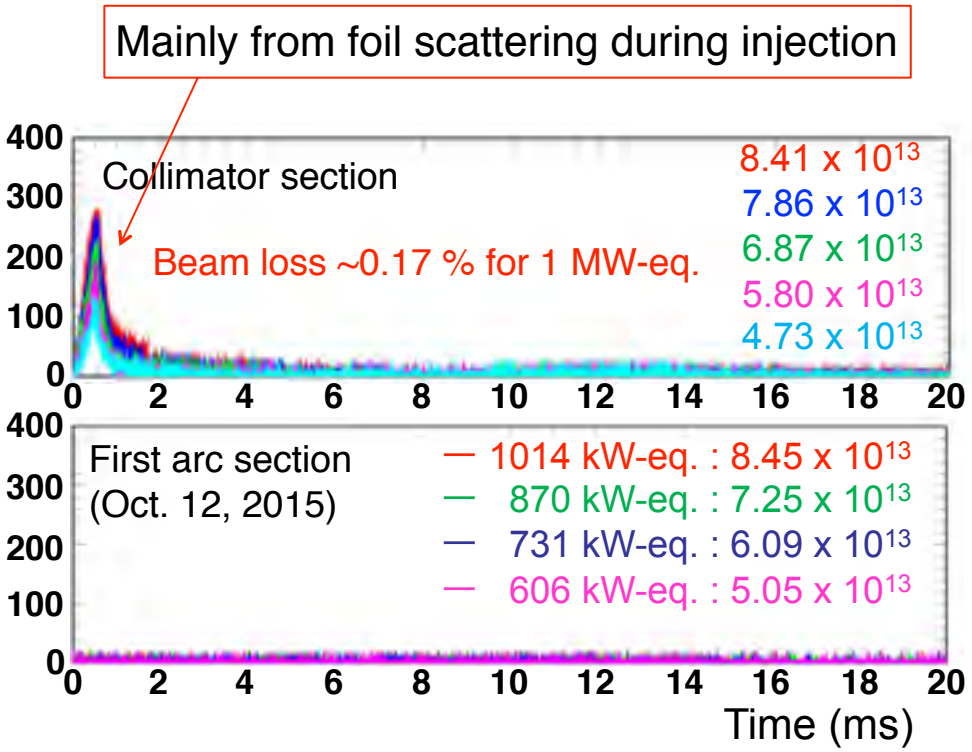
Operation Cycle



Demonstration of 1MW-eq. beam



BLM signals @ collimator & arc sections



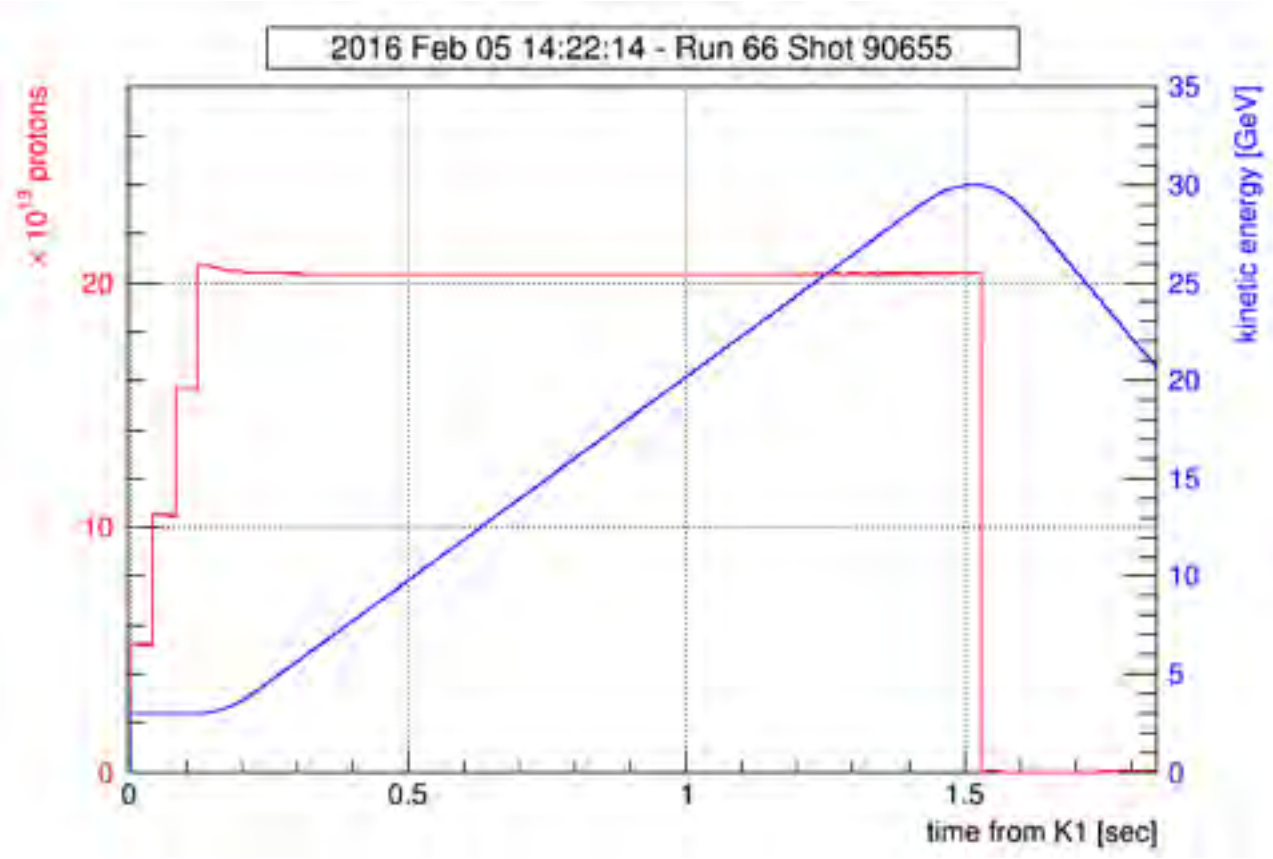
The anode power supplies of the rf power amplifiers were reinforced in the 2015 summer shutdown periods.

→ On Oct. 12, 2015, stable beam acceleration of 1 MW-eq beam was confirmed without the longitudinal losses.

This slide prepared by RCS commissioning group.

Typical Operation Status for Fast Extraction

- Power : 394 kW
- Repetition: 2.48 sec
- Circumference: 1568 m
- Max. accel. voltage: 280kW
- Accel. freqquency: 1.67 MHz - 1.732 MHz
- 4 batch (8 bunch) injection during the 0.13 s period
- 2.6e13 protons per bunch x 8
- 2.04xe14 ppp @ the end of acceleration
- Loss during the injection period: 191 W
- Loss in the beginning of accleration (120 ms): 746 W



Time (s)

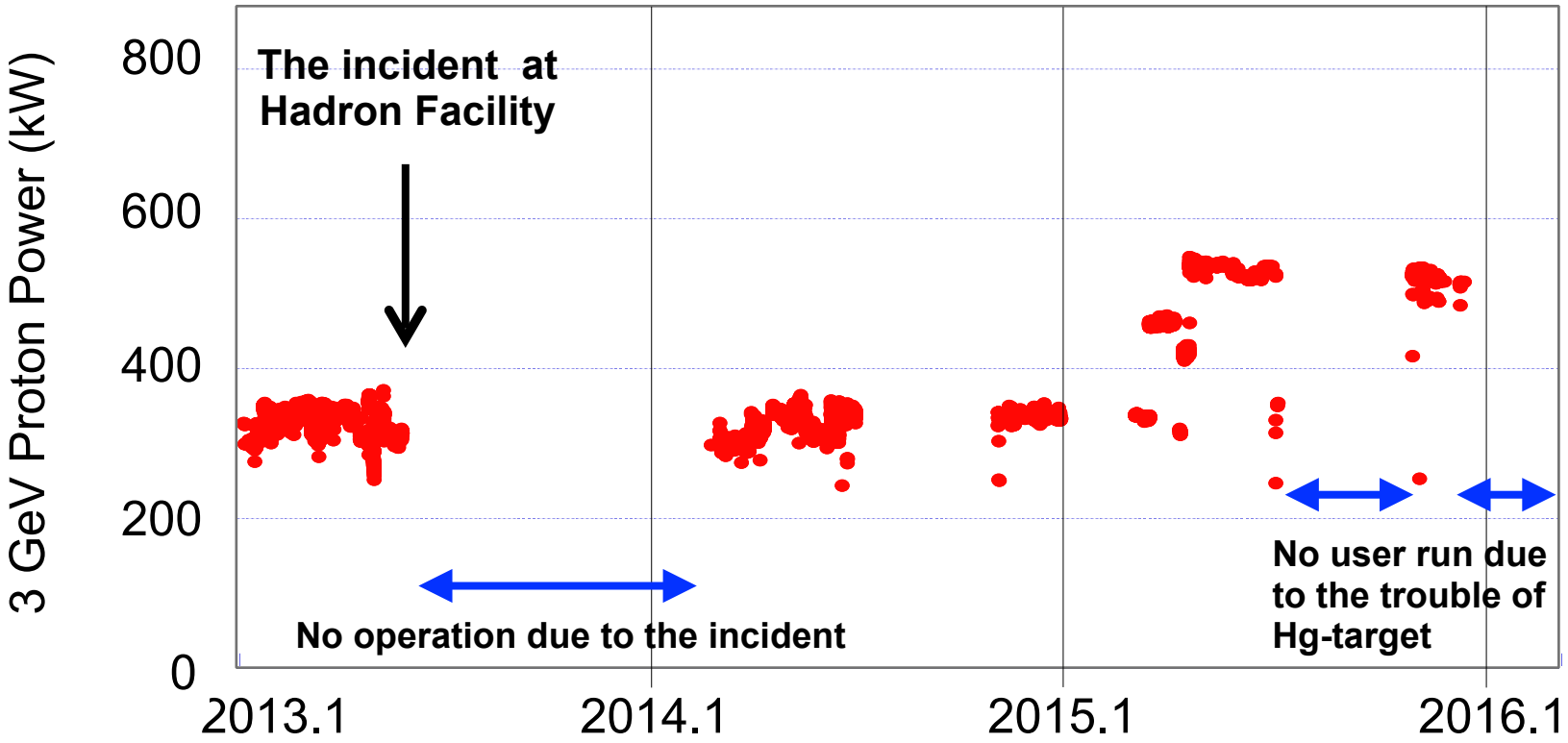
Injection | Acceleration | Extraction | Recovery

0.01 + 0.13 s | 1.4 s | 0.94 s

This slide prepared by MR commissioning group.

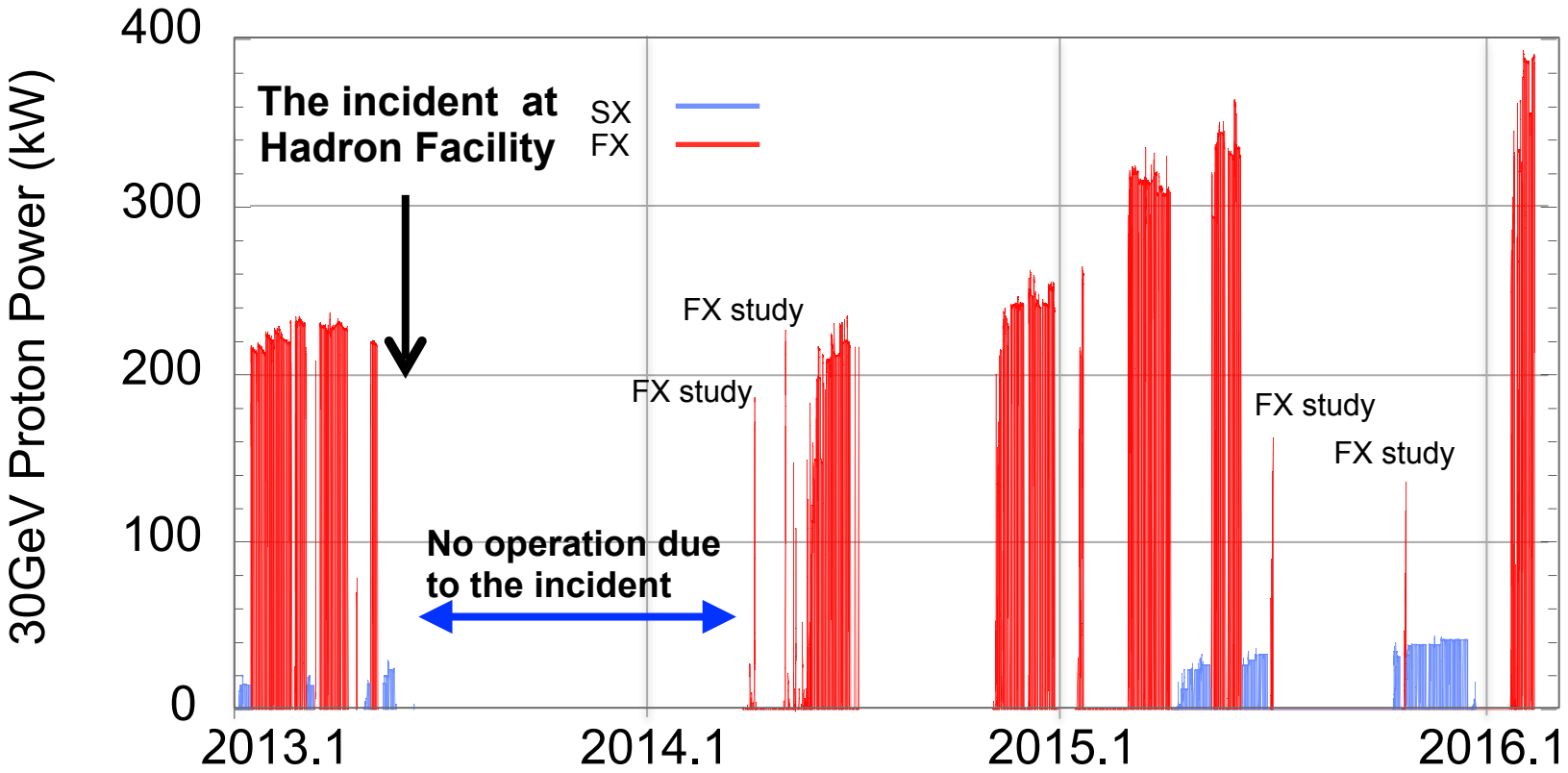
MLF 3GeV Proton Beam Power History

- RCS was beam commissioned in October 2007 and the user program started in December 2008 with a 4kW output beam power.
- Linac energy upgrade were completed in 2013 and the injection peak current was increased from 30 mA to the design value of 50 mA in 2014.

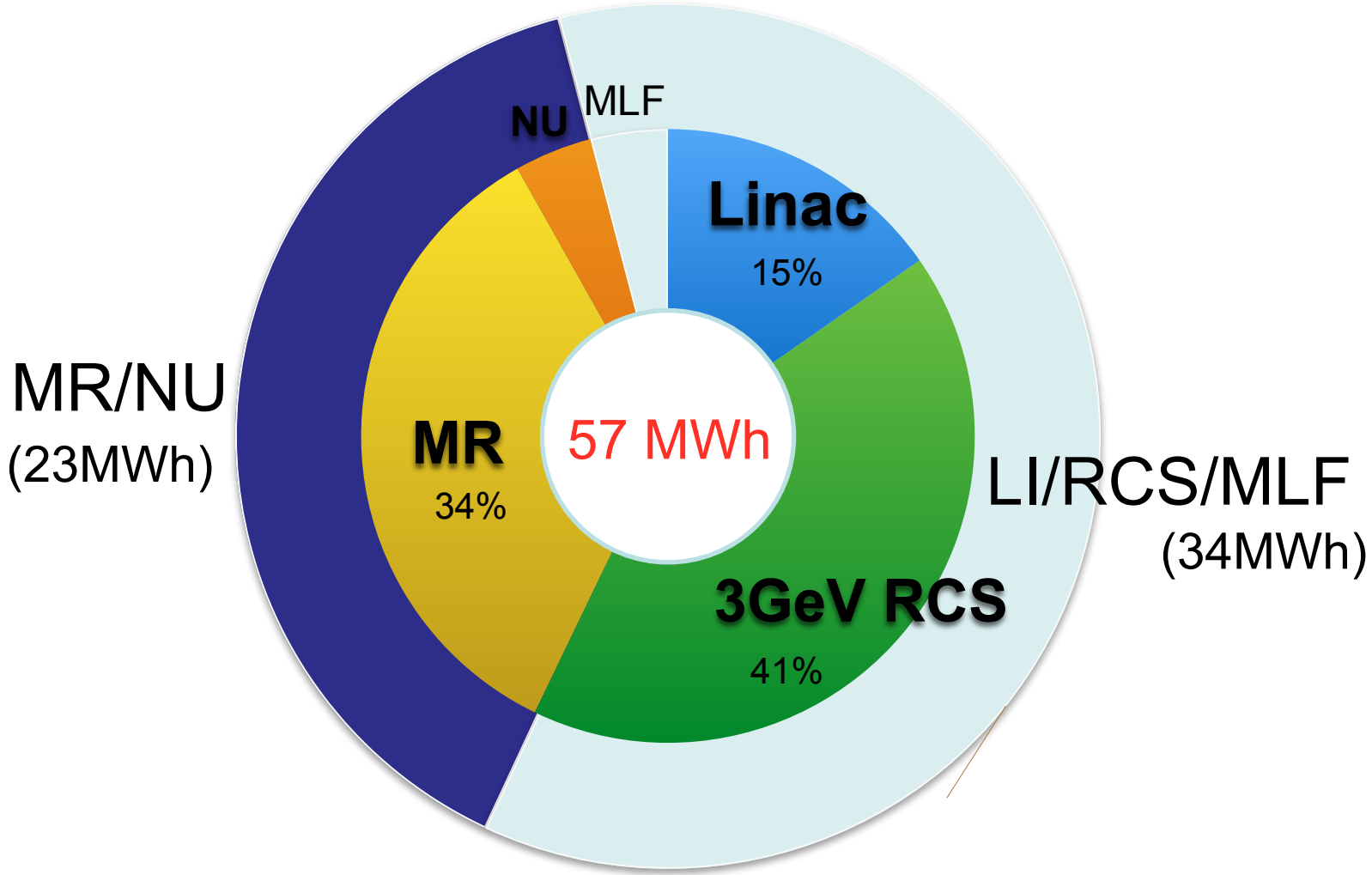


MR 30GeV Proton Beam Power History

- MR beam power is increasing since Dec. 23 2008 (30 GeV Acceleration) and Apr. 23 2009 (First Neutrino Beam).
- We have achieved 390 kW for the user operation after summer 2015.



MLF 500kW / FX 390kW operation



- MR Magnets: **10.4 MWh** per hour
- MR RF: **3.8 MWh** per hour
- RCS Magnets: **9.6 MWh** per hour
- RCS RF: **7 MWh** per hour

Power Upgrade Plan of MR

- To achive the design beam intensity of 750 kW, the high repetition rate scheme is adopted
- MR cycle time will be faster by replacing the following hardwares;
  a. New power supplies for magnets
  b. High gradient rf cavities
  c. New injection and extraction systems
- Repetition rate will be increased from 0.4 Hz to 0.78 Hz.

Summary of J-PARC Status

Linac/RCS

- Beam commissiong for 1MW designed operation has been done with a low beam loss of 0.17%.
- Linac/RCS is ready for the user operation with 1MW.
- Electric demand of Linac+RCS for 500kW user operation is about 34 MWh per hour.

MR

- 30 GeV Main Synchrotron runs with FX mode (2.48s) and SX mode (5.52s).
- 390kW operation with FX mode has been started since Feb.2016.
- Uncontrolled beam loss is kept no more than 900 watts during the user operation.
- Electric demand for 390kW FX user operation is about 23 MWh per hour.
- Power upgrade plan toward 750kW designed is going on.