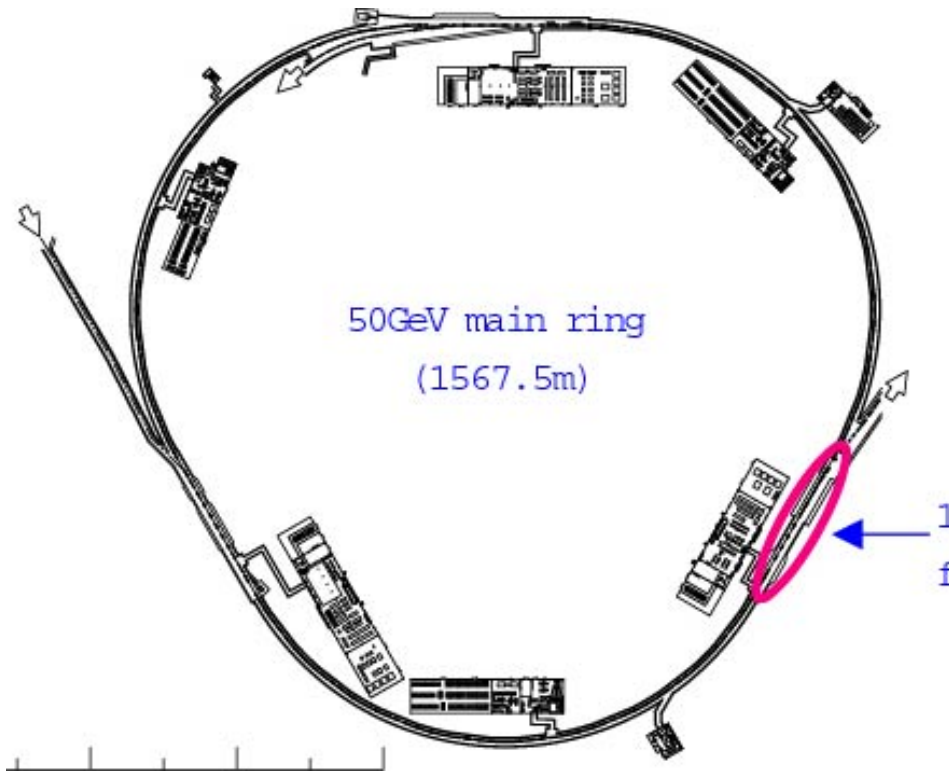


Slow Extraction from J-PARC Main Ring

KEK Acc. Lab. Masahito Tomizawa

- **Overview of Slow Extraction from J-PARC MR**
- **Beam Powers and Acceleration Patterns**
- **MR slow extraction schedule**

J-PARC Main Ring



- 3.3×10^{14} protons per pulse ($15 \mu\text{A}$)
full beam power : 750 kW @ 50 GeV
- Circumference 1567.5 m
with $3 \times 116 \text{ m}$ long straight sections
- Imaginary t lattice
below transition also for top energy
- Energy
Phase I
30GeV slow extraction
40GeV fast extraction
phase II (MR+Lab.)
50GeV

MR Slow Extraction

- full beam power : **750kW @50GeV**

- beam loss: as possible as small
from radiation safety problem

Simulation predicts **1% hit rate** on 100 μ m thick ESS.

Particles scattered from the ESS

Maintenance scenario (ESS,SM)

- third integer resonance

- separatrix : linear

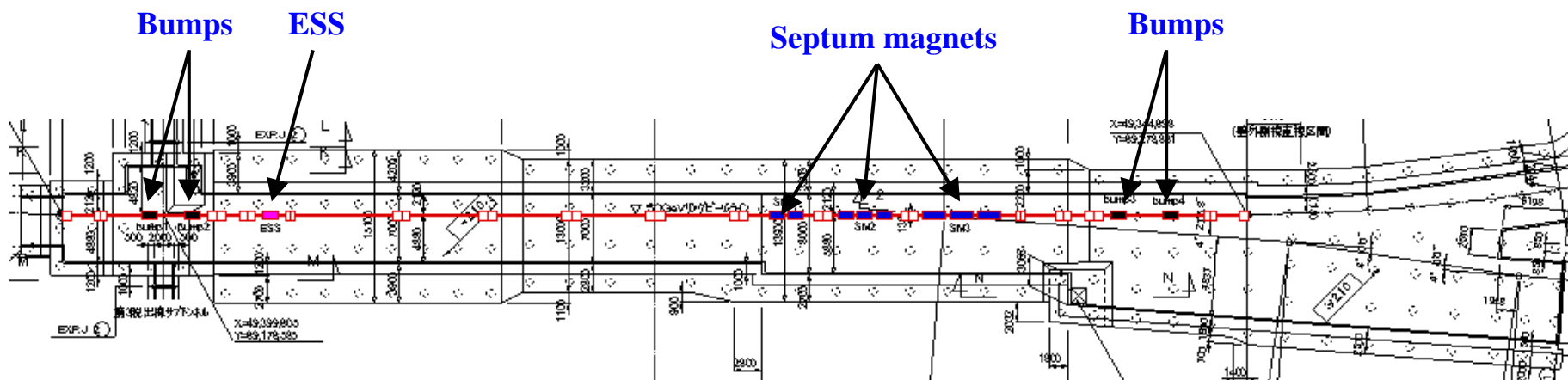
- easy to tune separatrix angle and step size
by adjusting resonant sextupoles

- coasting beam extraction

MR Slow Extraction Device

- **electrostatic septum**
- **septum magnets (4 families)**
- **4-bump magnets**
- **8-resonant sextupole magnets (2 families)**
- **spill control system**
(quadrupoles, monitors, feedback modules)
- **collimators (high intensity)**

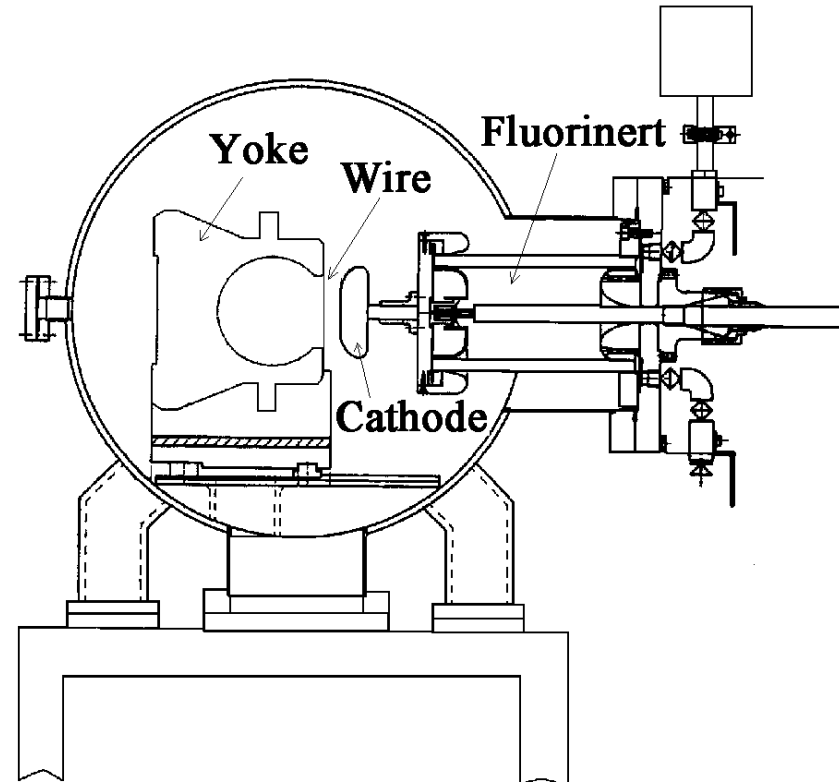
Slow Extraction Straight Section



ESS

$\phi 80\mu\text{m}$ wires, $L=1.5\text{m}$, $\text{gap}=25\text{mm}$, $V=170\text{kV}$ @ 50GeV , $E=6.8\text{MV/m}$

R & D(SUS electrode, $L=0.7\text{m}$)
 $V=100\text{kV}$ @ 30GeV stable
 $V=170\text{kV}$ @ 50GeV intermittent
 small discharges
--> Ti electrode



ESS

thinner ribbon foil

25 μ m ribbon test machine

**Preliminary alignment
measurement
shows promising result!!**



180MeV Linac

Original Design of J-PARC Accelerators

Linac: 400MeV

RCS: 2bunches acceleration

MR: 2bunches \times 4batches Injection(h=9), 3.64s rep.

$15\mu\text{A}$ ---> 750kW @ 50GeV

Day-One

(1) Linac: 180MeV, RCS: 2bunches

MR: 2bunches \times 4batches Injection(h=9), 3.64s rep.

$15\mu\text{A} \times 0.6$ (estimated)= $9\mu\text{A}$

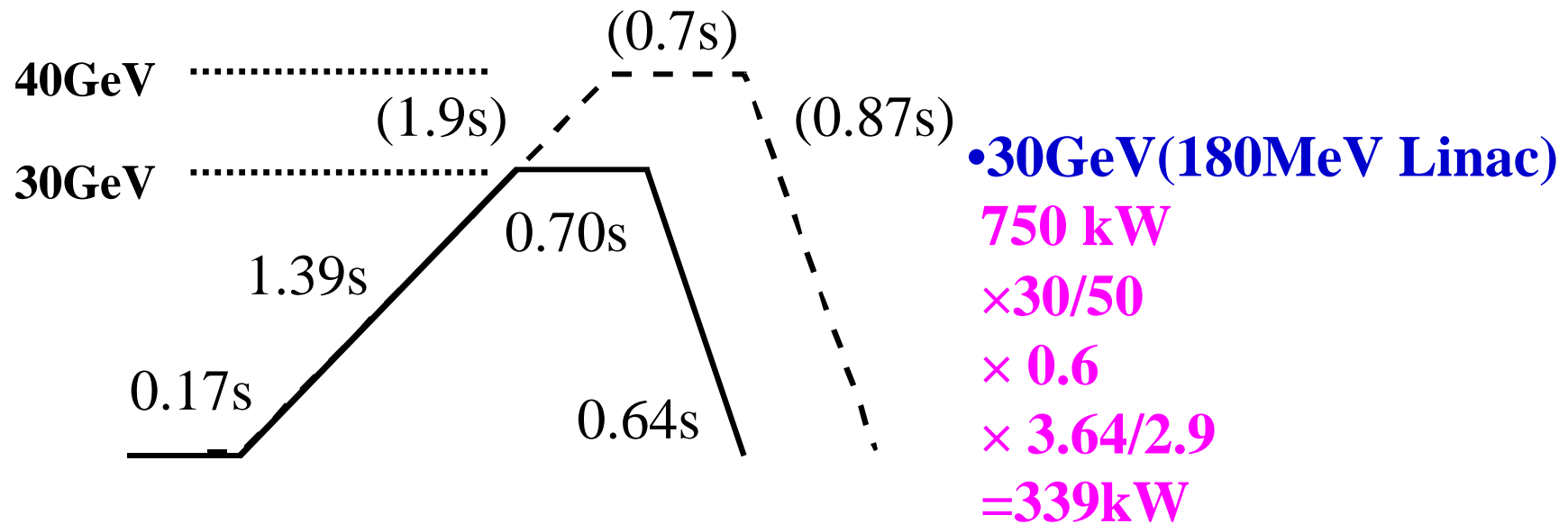
(2) Linac: 180MeV, RCS: one bunch for MR

MR: 1bunch \times 15batches injection(h=18), 4.07s rep.

$15\mu\text{A} \times 3.64/4.07 \times 0.6 \times 15/8$ = $15\mu\text{A}$

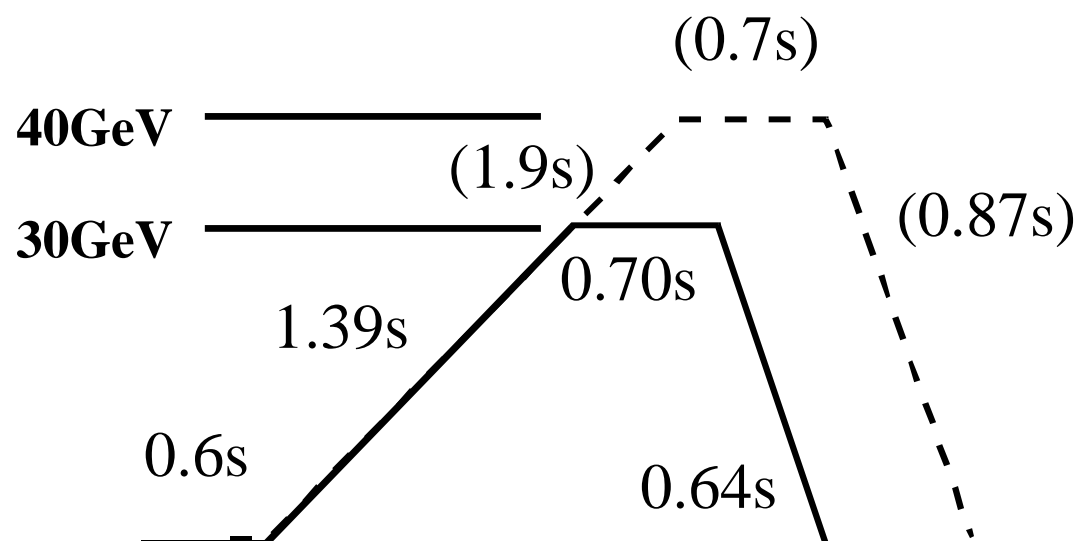
Technical feasibility of (2) is being studied

Acceleration Patterns and Design Beam Power
8 bunches (h=9)
same dB/dt as 40GeV case



repetition period 2.9s (3.64s)
 Slow Duty=0.30 @rise:0.2s, reset0.3s

Acceleration Patterns and Design Beam Power
15 bunches (h=18)
same dB/dt as 40GeV case



•30GeV(180MeV Linac)
750 kW
× 30/50
× 0.6x15/8
× 3.64/3.33
=553kW

repetition period 3.33s (3.64s)

Slow Duty=0.26 @rise:0.2s, reset0.3s

Longer Flat Top for 30GeV Energy Operation

Flat top for 50GeV is 0.7s

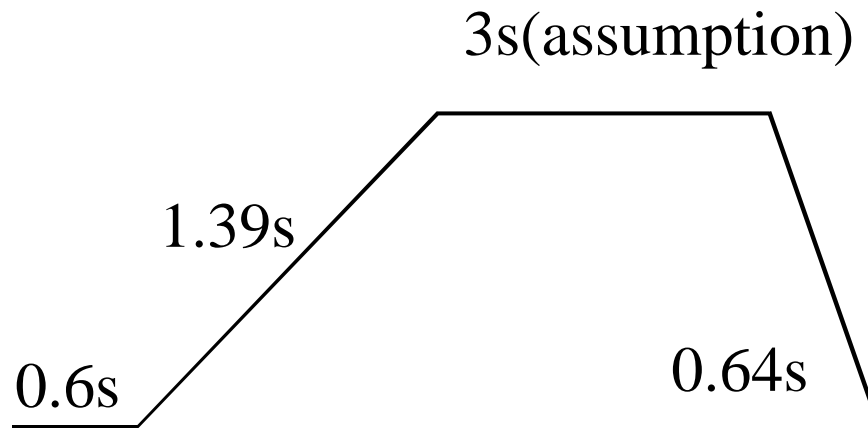
**(1) Power supply of D,Q magnets (existing)
loading for condensers and Hybrid Filters**

(2) Cooling Design of SM coils

Acceleration Patterns and Design Beam Power

15 bunches (h=18)

same dB/dt as 40GeV case



•30GeV(180MeV Linac)

750 kW

× 30/50

× 0.6x15/8

× 3.64/5.63

=327kW

repetition period 5.63 sec.

Slow Duty=0.56 (rise:0.2s, reset0.3s)

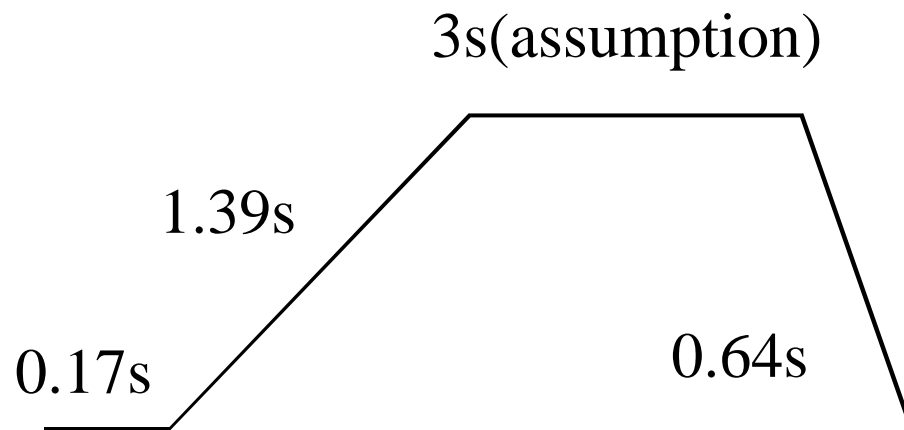
MR Slow Extraction Schedule

- **Production of slow extraction device** **Fy. 2005**
- **Installation in the MR** **Fy. 2006**
- **MR beam Commissioning** **Nov. 2007 ~**
- **Slow Extraction Commissioning** **July 2008 ~**

50GeV Main Ring Slow Extraction Members

**M.Tomizawa, Y.Arakaki, T.Nakagawa,
I.Sakai, F. Kuanjun, M.Shirakata,
S.Igarashi, T.Yokoi, Y. Yuasa
N.Tokuda, T.Kato, H.Kobayashi,
H.Sato, K.Sato, Y.Mori, M. Yoshioka, T. Oogoe**

Acceleration Patterns and Design Beam Power
8 bunches (h=9)
same dB/dt as 40GeV case



•30GeV(180MeV Linac)

$$\begin{aligned} &750 \text{ kW} \\ &\times 30/50 \\ &\times 0.6 \\ &\times 3.64/5.2 \\ &=189 \text{ kW} \end{aligned}$$

repetition period 5.2 sec.

Slow Duty=0.61 (rise:0.2s, reset0.3s)