

Beam Stabilization at the SPring-8 Linac

SPring-8 Linac

JASRI Acc Div. Linac Group

H. Hanaki

- 1 SPring-8 linac
- 2 Beam injection instability
- 3 Stabilization of RF system
- 4 ECS
- 5 New Master Oscillator

Injection Parameters

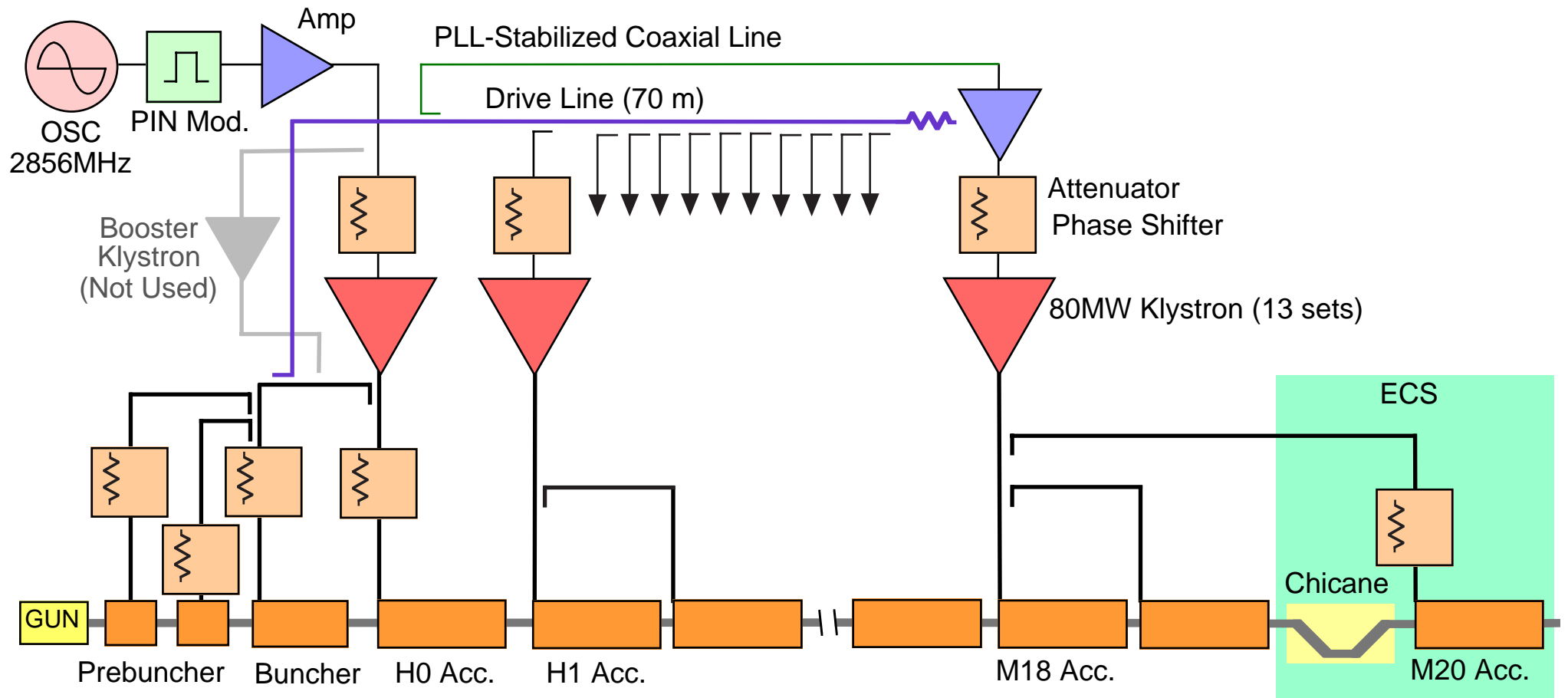
Spring-8 Lina

● Present Injection Parameters (using ECS)

	Synchrotron		New SUBARU	
Beam Energy	1 GeV	1 GeV	1 GeV	1 GeV
Pulse Width	1 ns	40 ns	1 ns	1 ns
Repetition	1 pps	1 pps	1 pps	1 pps
Peak Current	2 A	350 mA	200 mA	200 mA
Average Current	2 nA	14 nA	0.2 nA	0.2 nA
dE/E (full)	0.62 %	1.4 %	0.4 %	0.4 %
Energy Stability	0.02 %rms	-	0.01 %rms	0.01 %rms
ε_n (90% μ mrad)	<240	-	<200	<200

Present Linac RF System

Spring-8 Linac



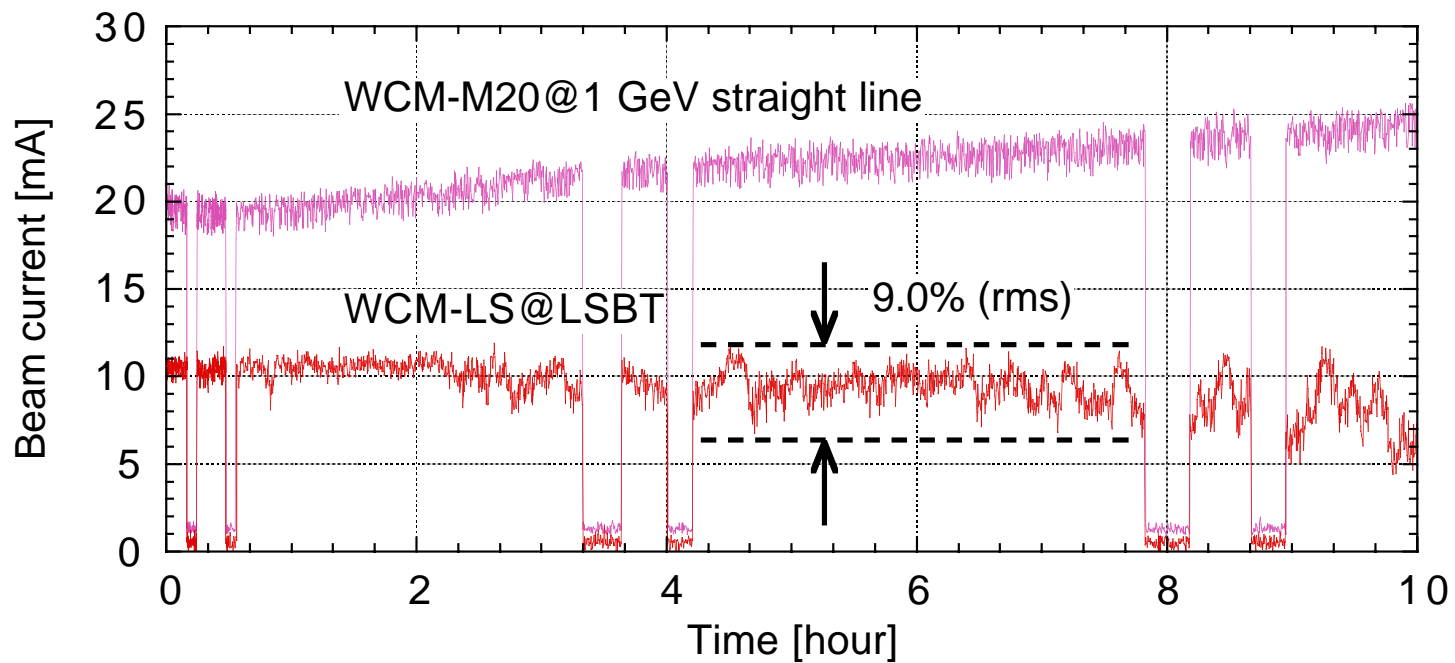
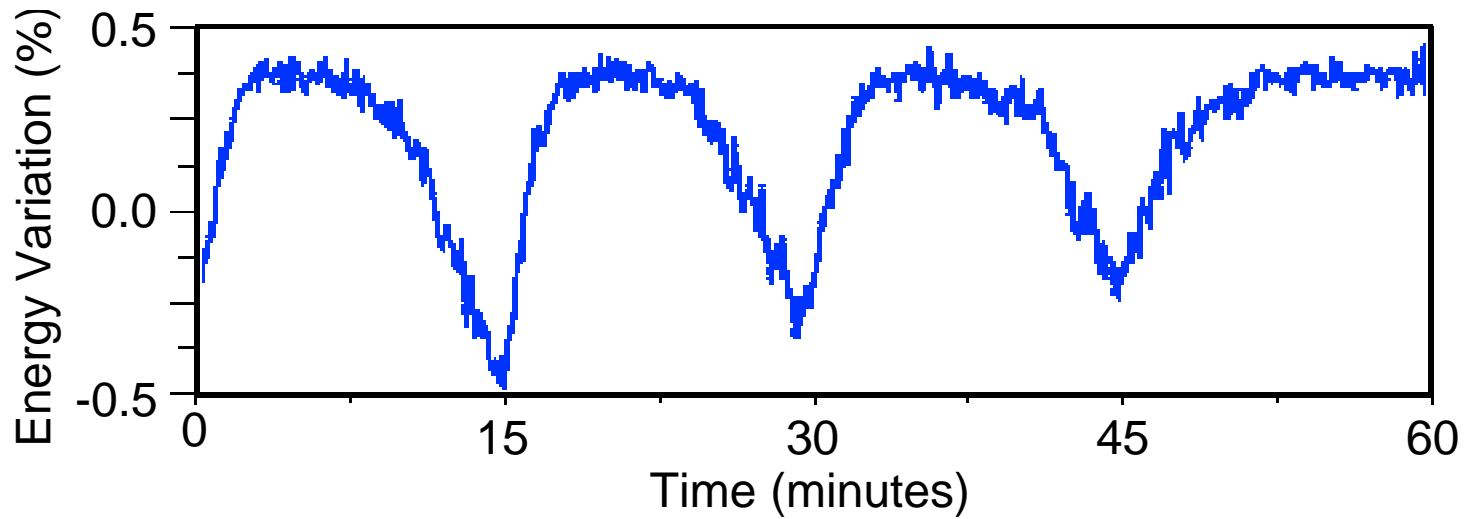
History of Beam Stabilization

SPring-8 Linac

- 1998 *spring* Investigation of beam instability
summer RF system improved
*air conditioner, water cooling system,
klystron modulator*
- 1999 *spring* Design of ECS
summer Design of BPM processing circuit
- 2000 *summer* ECS completed
BPM pickups mounted
Linac control software renewal
- 2001 *summer* New master oscillator installed
Injector's RF system renewal
winter Installation of BPM circuit

Beam Injection Instability

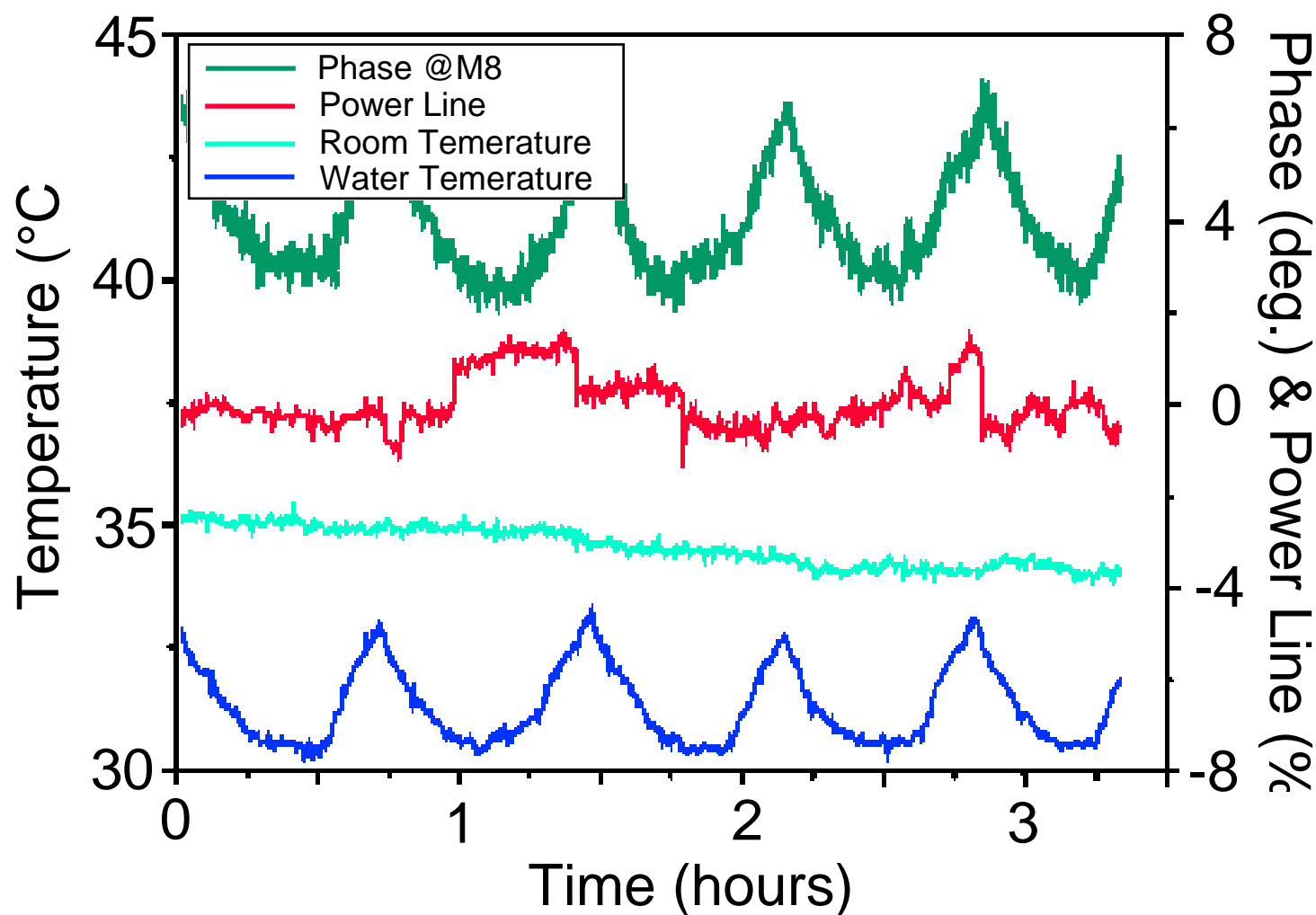
*S*Pring-8 *L*ina



Fluctuation of Parameters

SPring-8 Lina

- RF Phase, Power Line & Temperature on 11 June/1998



Stabilization of Beam Energy

SPring-8 Linac

● Improvement of RF System(1998 ~)

RF phase stabilization

Drive line Adjustment of air conditioner, heat
klystron Improvement of water cooling system

RF amplitude stabilization

Stabilization of PFN voltage by adjustment
de-Q'ing circuit (PFN voltage variation:0.2%)

Energy Stability of 1-ns Beam

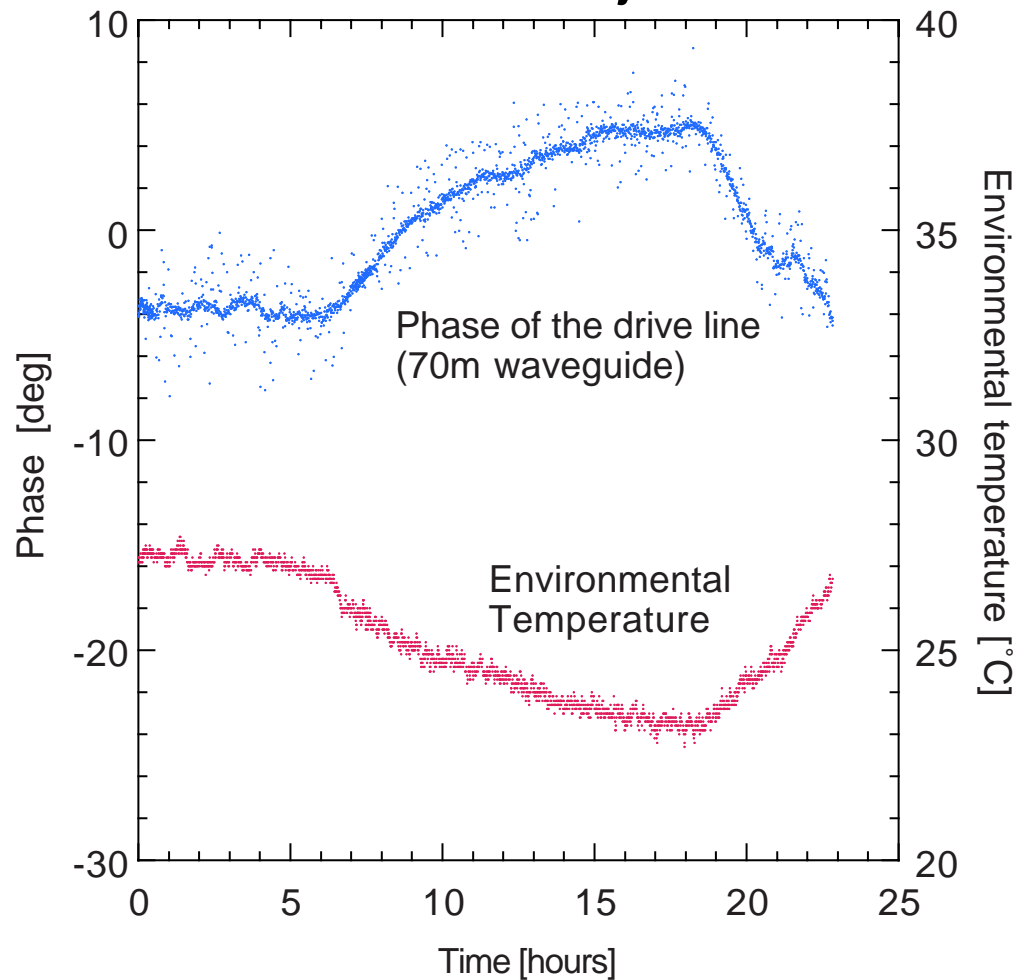
shot-by-shot : $\pm 0.018\%$ (rms)

medium term : $\pm 0.03\%$ (rms)

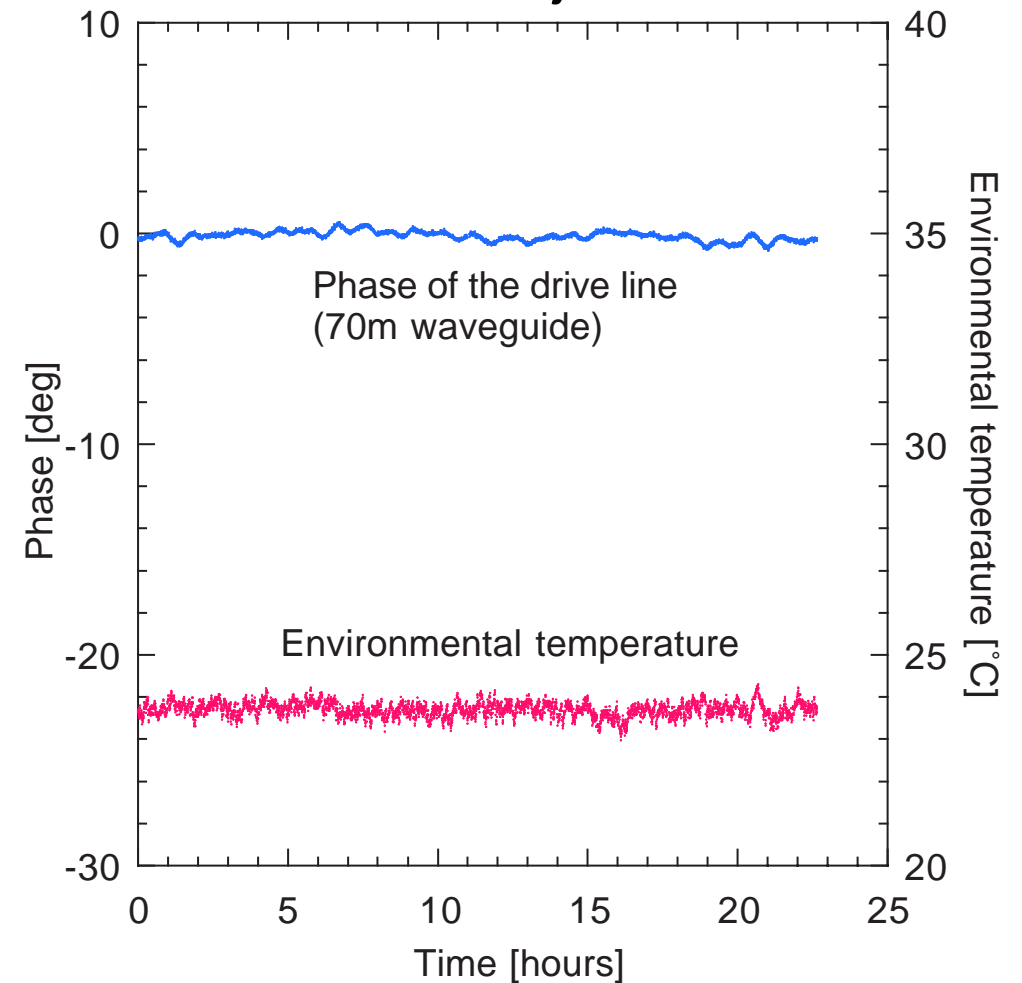
Drive Line Phase Stability

Spring-8 Linac

Before Adjustment



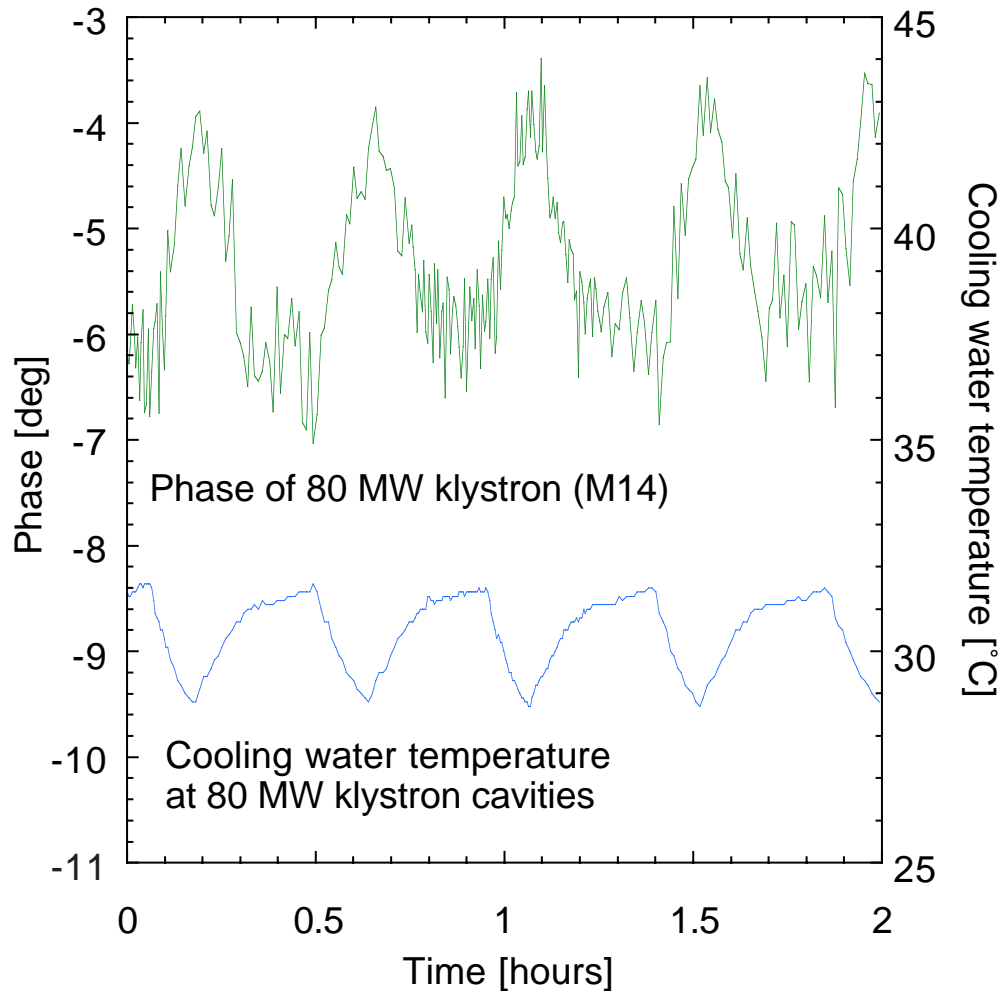
After Adjustment



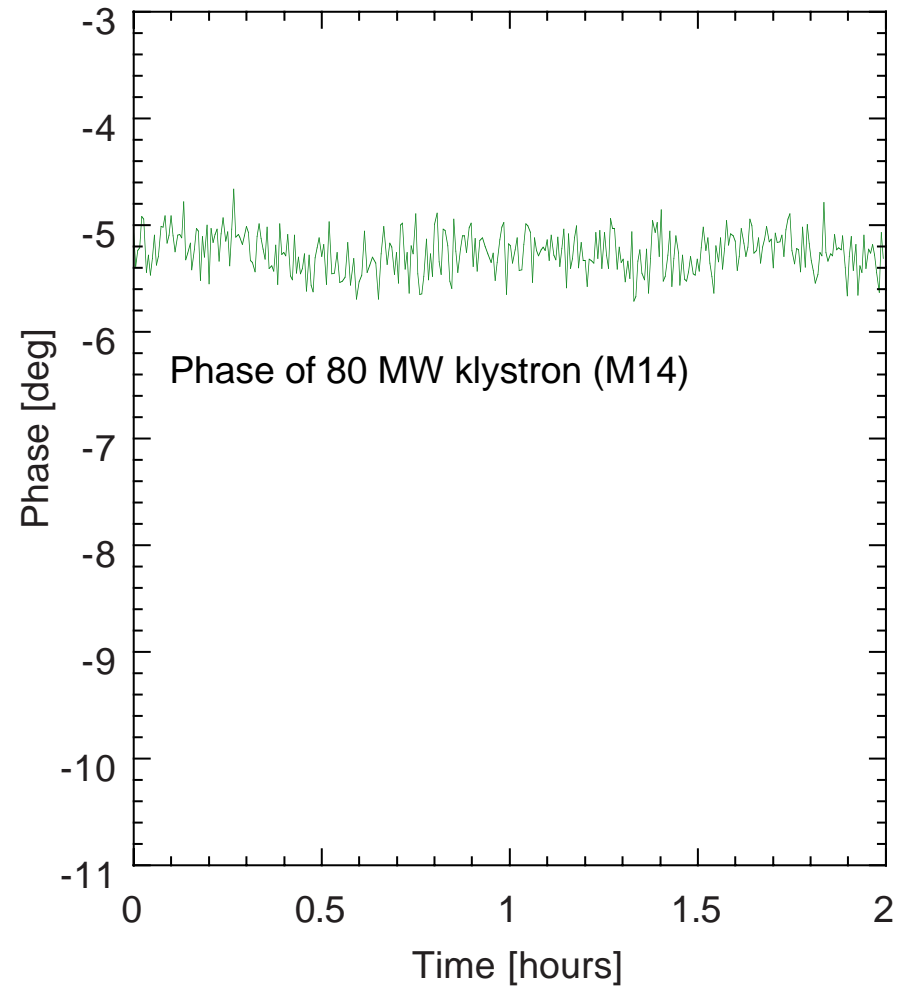
Klystron Phase Stability

SPring-8 Lina

Old Water Cooling System



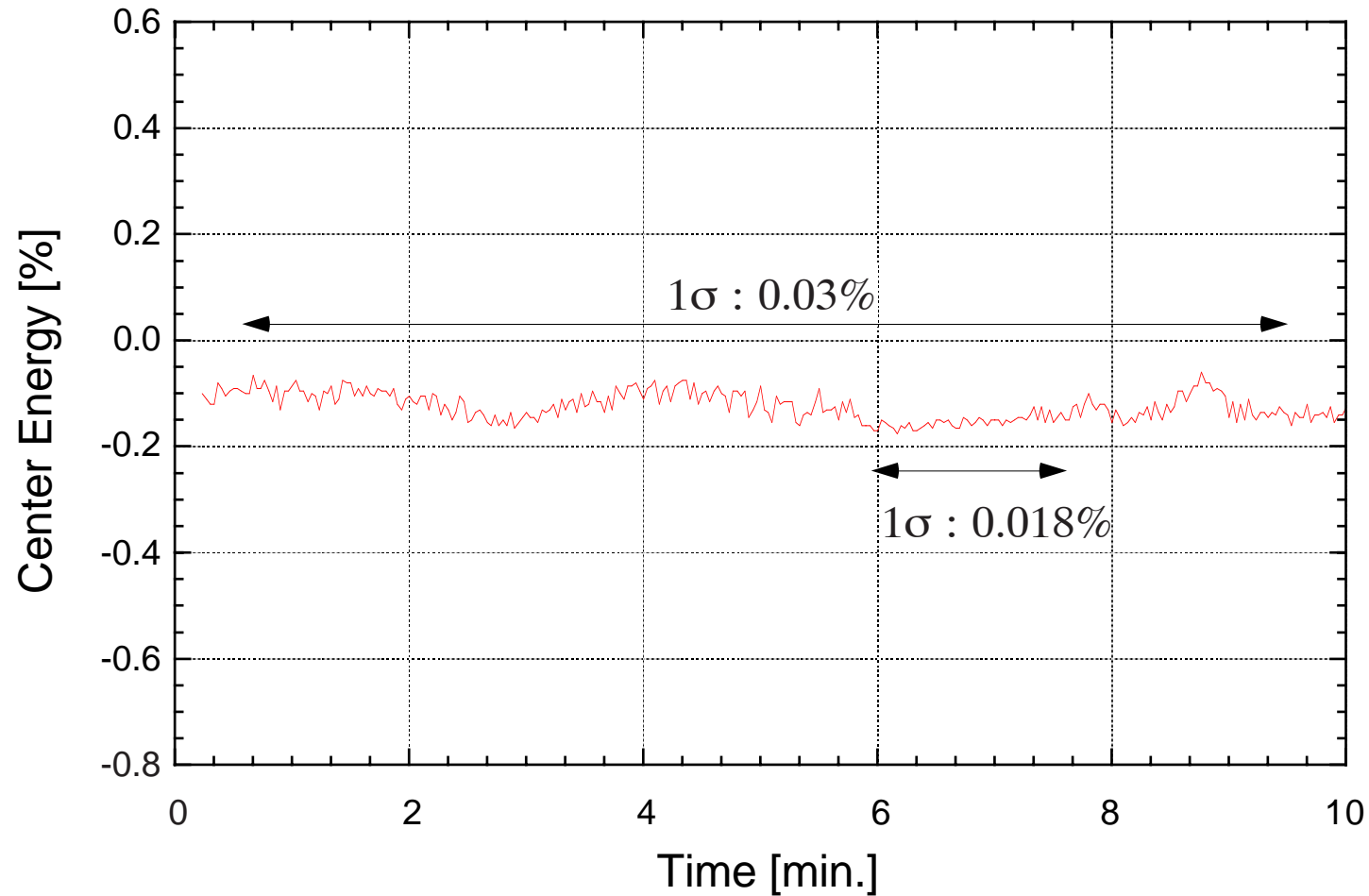
New Water Cooling System



Beam Energy Stability

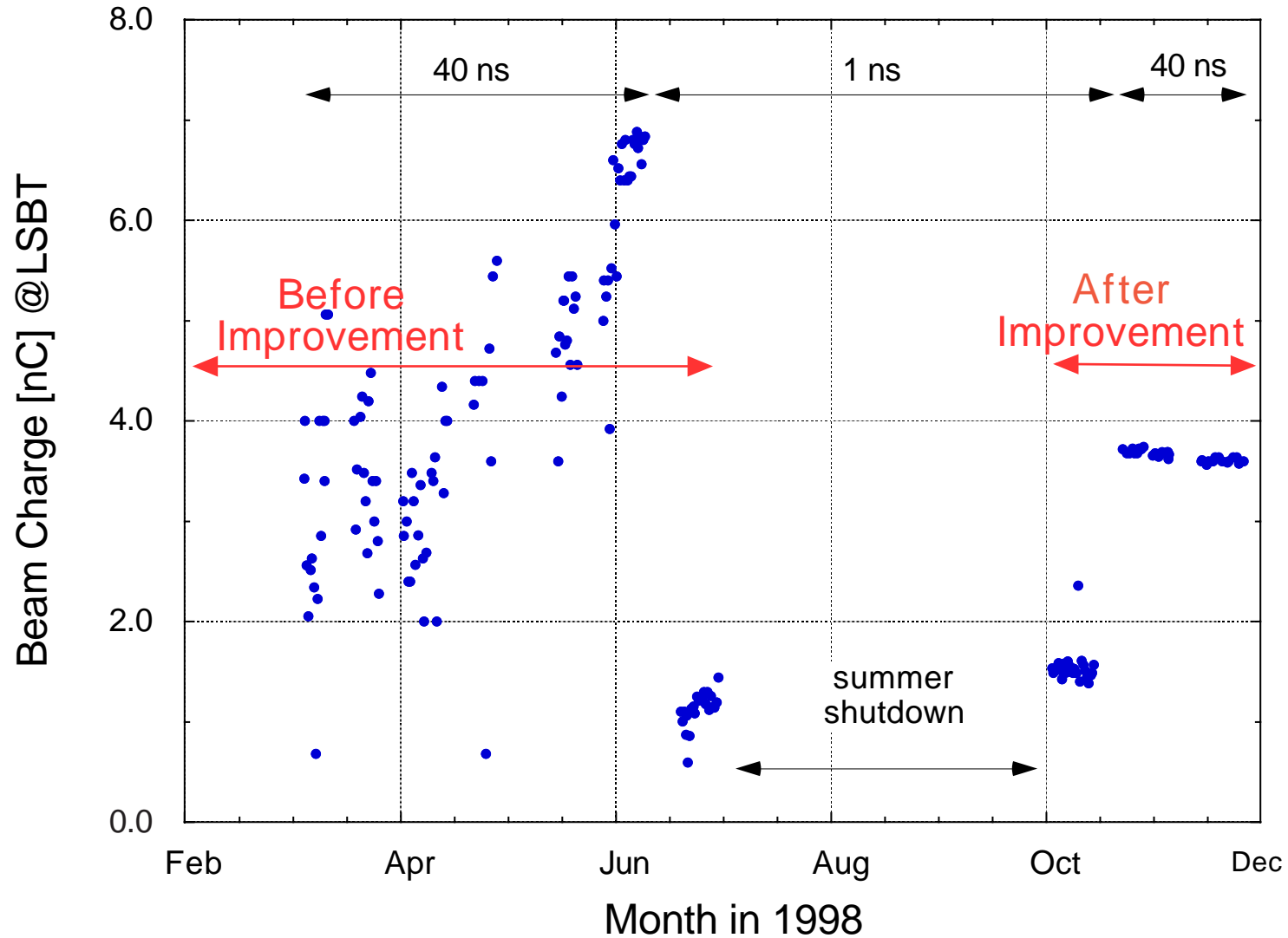
SPring-8 Lina

1ns Beam Energy Stability 10/13/99



Beam Injection Stability

SPRING-8 LINA

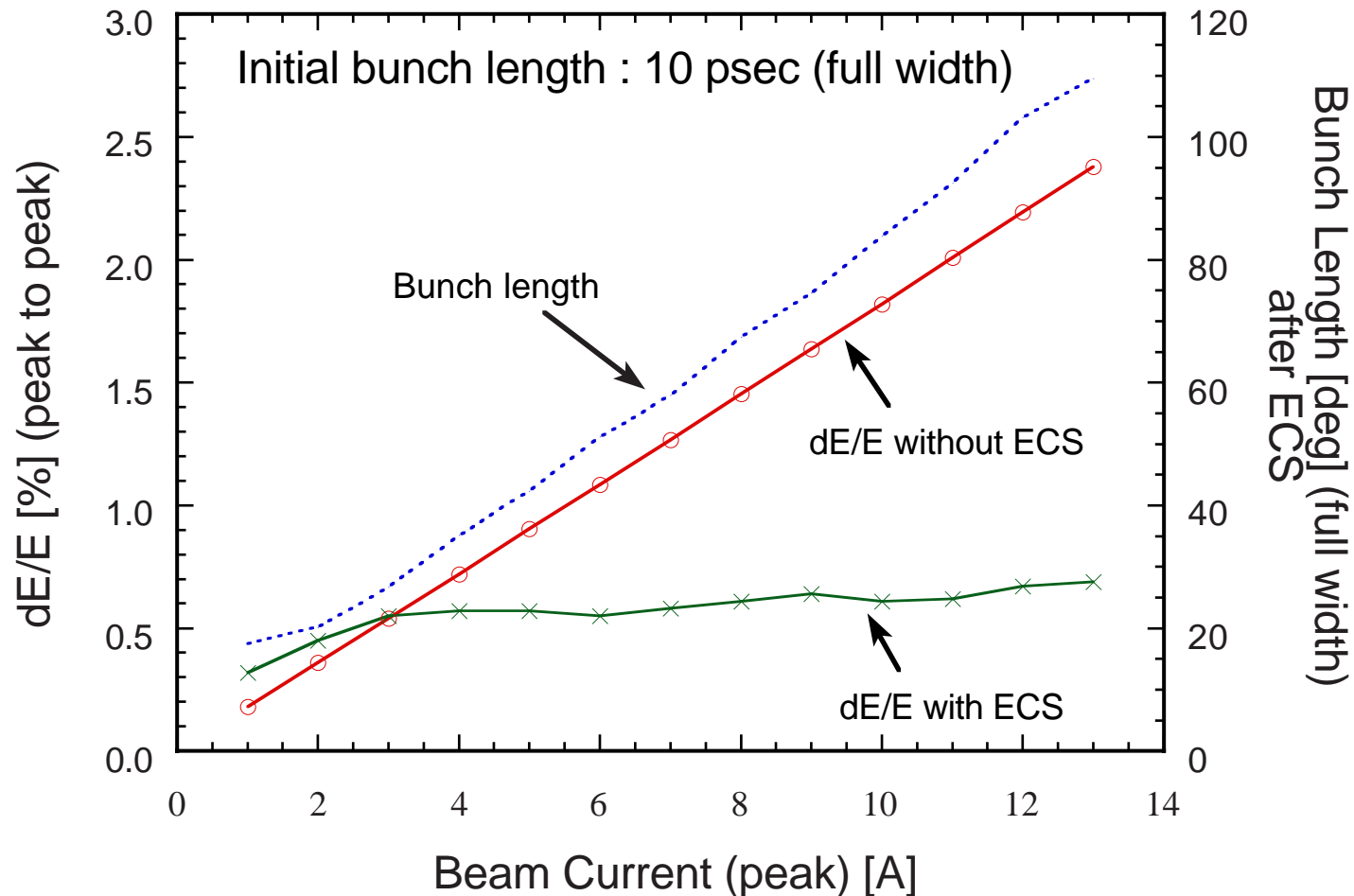


Beam Stabilization by ECS

Spring-8 Linac

● Reduction of Energy Spread Due to Beam Loading

Energy Compression System (1999 ~ 2000)



Beam Stabilization by ECS

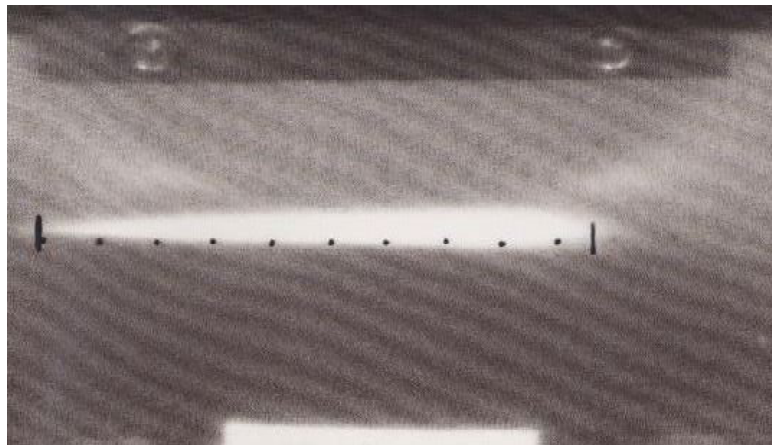
SPring-8 Lina

Energy Spread for Long-Pulse Beam(40ns, 350m)

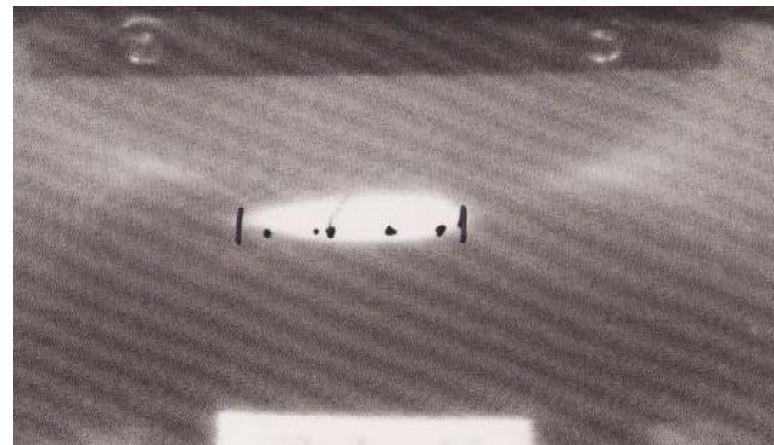
3.5%(full)

1.4%(full)

Energy Spread of 40-ns Beam at 350m
ECS OFF



ECS ON



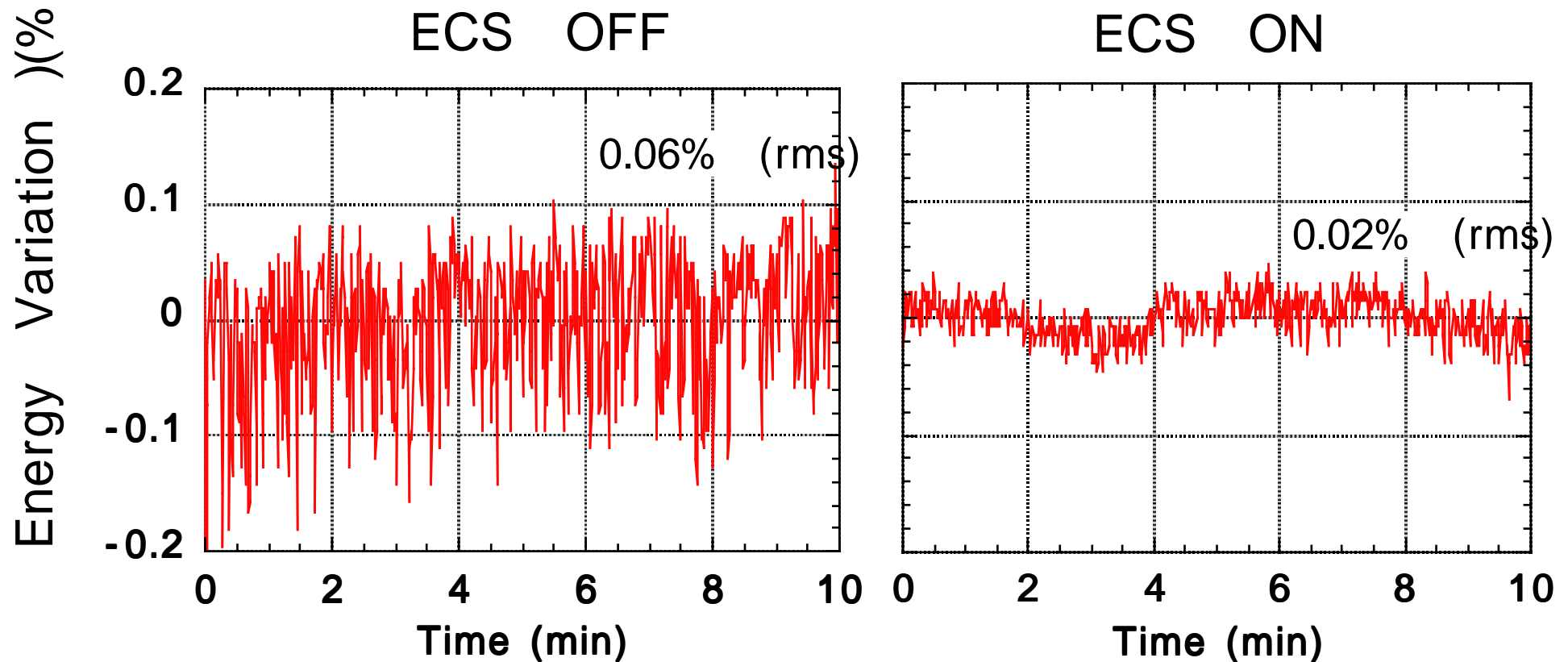
Beam Stabilization by ECS

SPring-8 Linac

Energy Stabilization for High Current Beam(1ns, 1.9

0.06%(rms)

0.02%(rms)



Beam Stabilization by ECS

Spring-8 Lina

Results

Synchrotron:

*High injection current increased **7** times*

NewSUBARU

*High injection efficiency (>**90%**) kept for long term without beam adjustment*

New Master Oscillator

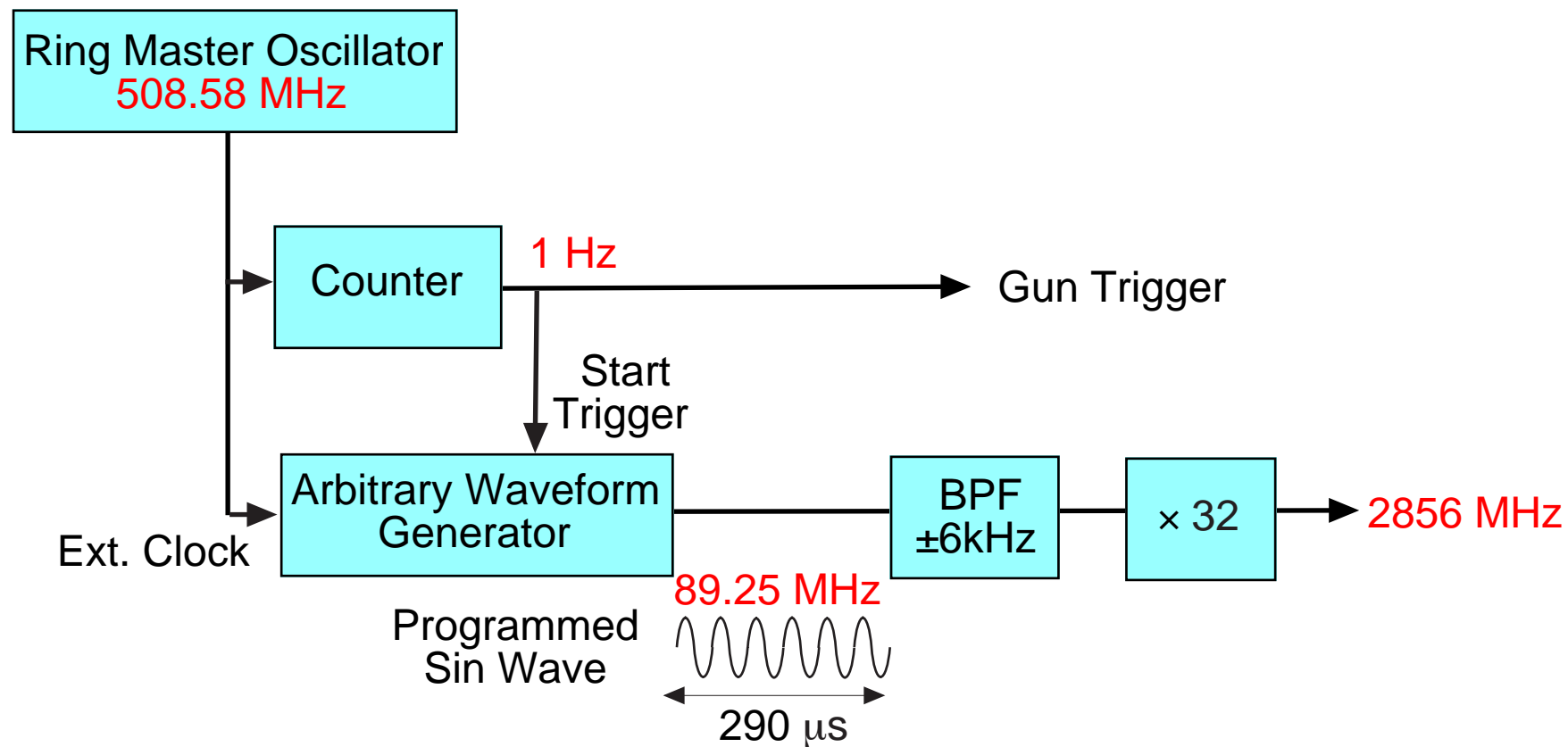
SPring-8 Lina

Synchronization of gun trigger with 2856 MHz
Stable charge distribution for bunches

Stable energy for high current beam(1ns, 1.4nC)
0.03%(rms) 0.015%(rms)

New Master Oscillator

SPring-8 Lina



Summary

SPring-8 Lina

- Stabilization of RF system

Stable beam energy for short and medium

- Introduction of ECS

Narrow energy spread for high current beam

Stable beam energy for long term

- 2856 MHz RF synchronizing with beam trigger

Stable bunches