The Construction Status and Mechanical Engineering for the TPS

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OUTLINE

I. Introduction

II. Status of the TPS Construction

III. The low-emittance engineering at TPS

IV. Summary

NSRRC is constructing the Taiwan Photon Source

TLS (1.5 GeV)

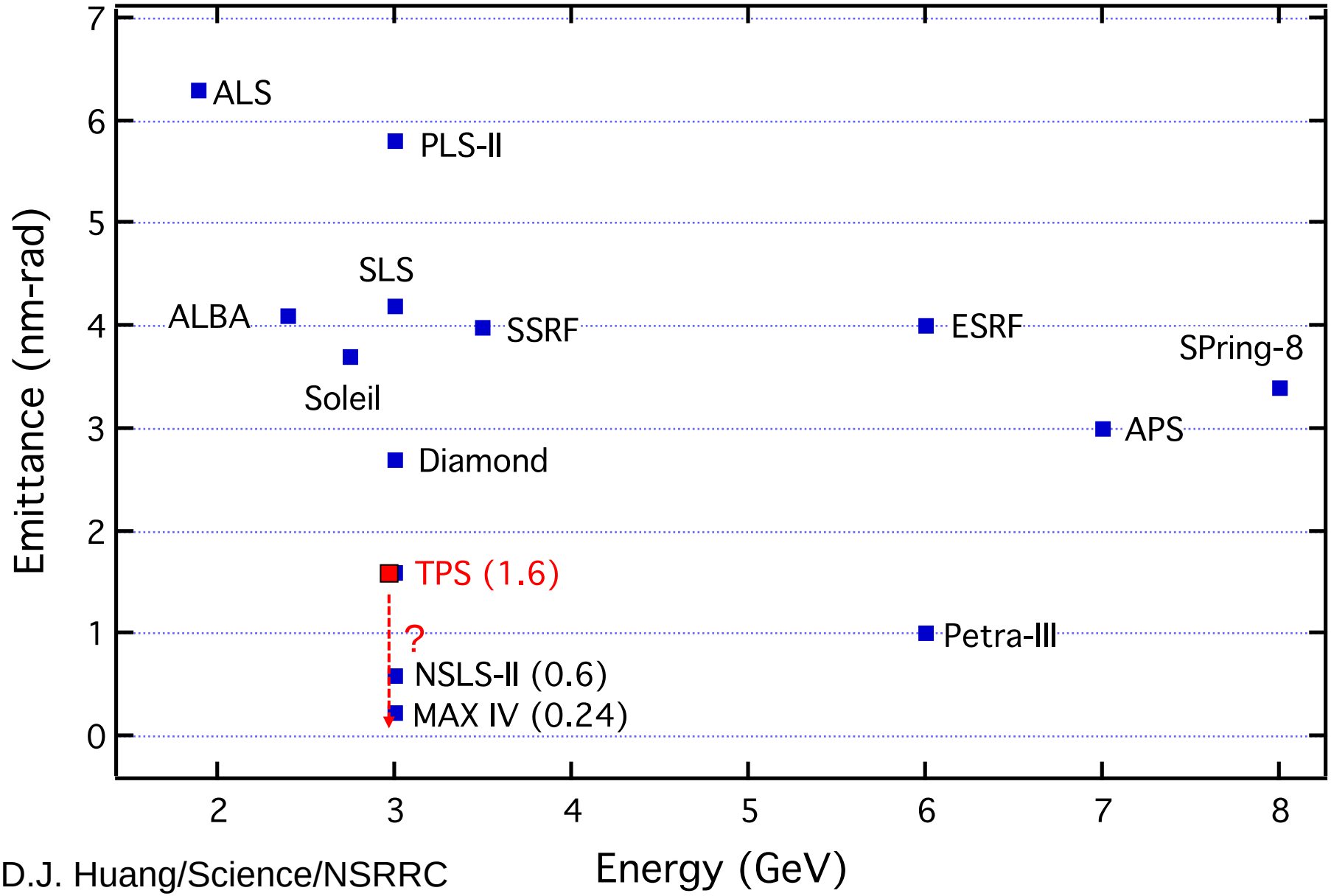
Taiwan Photon Source (TPS)
3 GeV

NSRRC, Hsinchu

Basic Parameters of the TPS

Parameter	TPS
Energy (GeV)	3.0
Current (mA)	500
Circumference (m)	518.4
No. of Straights	24
Emittance (nm-rad)	1.6
Straight Sections	7m x18, 12m x6
Critical Ph. Energy	7.13 keV
Beam size (Ver./Hor.)	5.1/121 μm
RF Frequency (MHz)	500
Booster	0.15→3 GeV, same tunnel
Injection Mode	Top-up

TPS is designed to emphasize on electron beam of small emittance and great brilliance, stability and reliability.



Features of the TPS

- **Low emittance and high brightness**
  -- Brightness ~10^{21} p/s/0.1%bw/mm^2/mrad^2 (@ 10 keV)
  -- Emittance ε < 2nm-rad

- **High stability**
  -- Photon intensity fluctuation <0.1%
  -- Beam orbit fluctuation <0.2μm ($d\sigma/\sigma \approx 5\%$)
  -- Beam size fluctuation <0.1μm

- **High reliability**
  -- High injection efficiency (>90%)
  -- Machine Up-time >98%
  -- Trip rate < 1/week

- **Superconducting RF Cavities**
- **Top-up injection**
- **Same-tunnel Booster**

NSRRC Phase-I Beamline of TPS

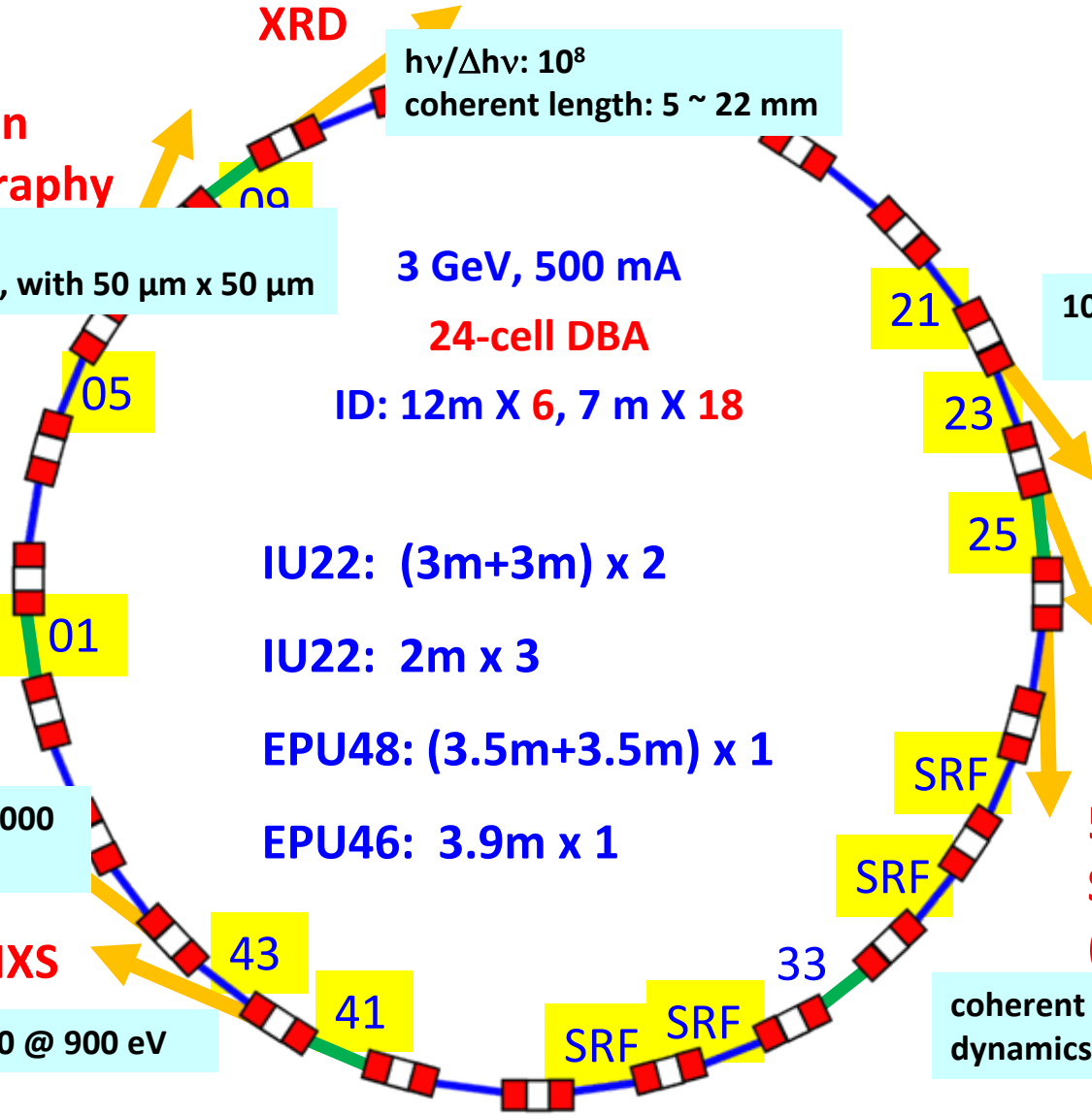
2. Temporal Coherent XRD

$h\nu/\Delta h\nu$: 10^8
coherent length: 5 ~ 22 mm

Total beamlines:
22 ID (odd #)
24 BM (even #)

1. μ Protein Crystallography

1 ~ 50 μm (FWHM)
@ 0.98Å: 1.0×10^{12} ph/s, with 50 μm x 50 μm



3 GeV, 500 mA

24-cell DBA

ID: 12m X 6, 7 m X 18

IU22: (3m+3m) x 2

IU22: 2m x 3

EPU48: (3.5m+3.5m) x 1

EPU46: 3.9m x 1

100 nm x 100nm
3 μrad x 3 μrad

3. Sub-μ XRD

4. Nano-probe

30 nm at 15 keV

5. Coherent Scattering (SAXS)

coherent flux: > 1×10^{10} ph/s
dynamics from ms to μs

6. Soft X-ray RIXS

total $h\nu/\Delta h\nu$ > 40,000 @ 900 eV

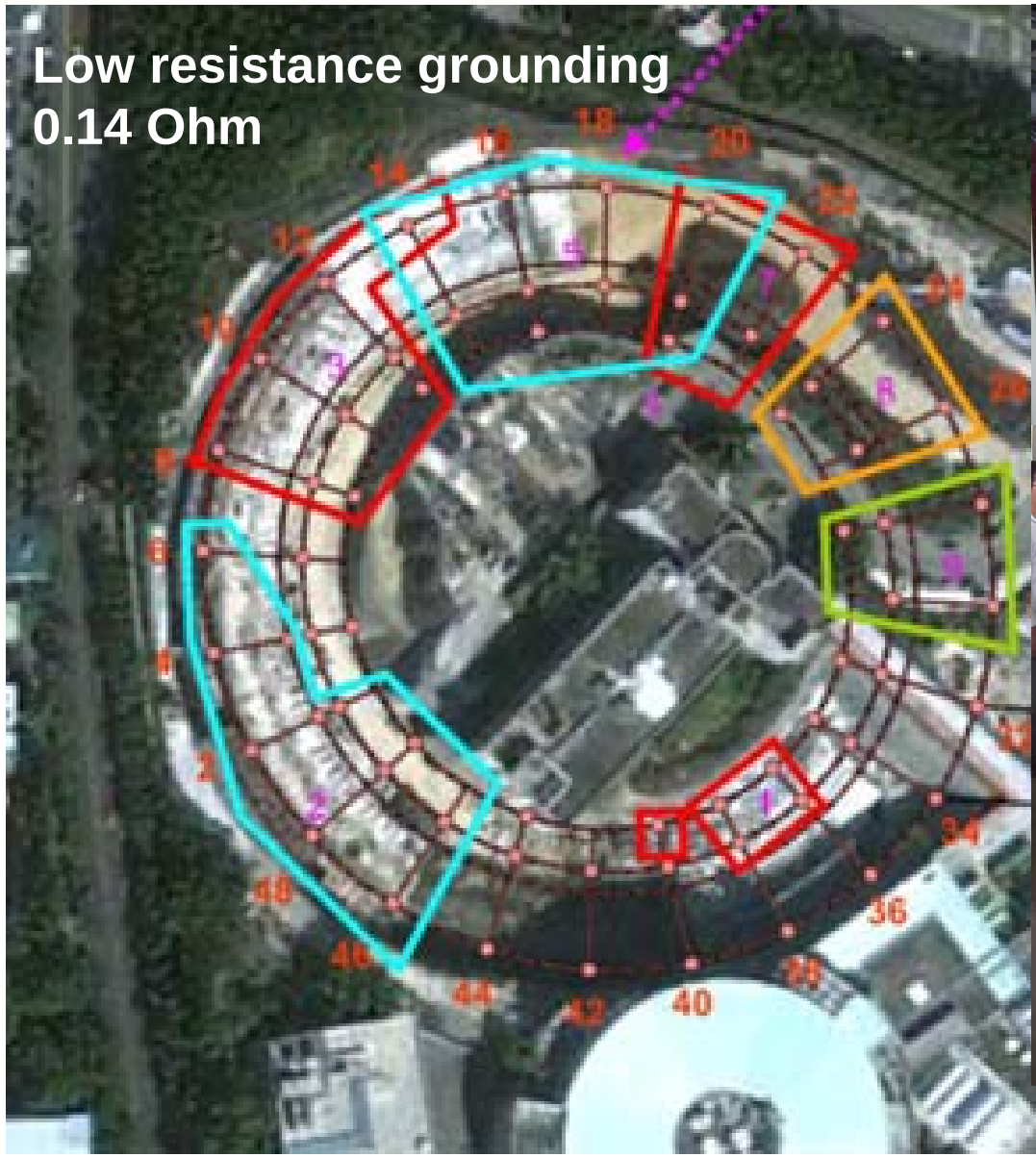
7. μ soft X-ray

E resolving power 35,000
0.6 μm X 0.23 μm

Status of the TPS Construction

TPS Civil Construction

TPS Electrical System

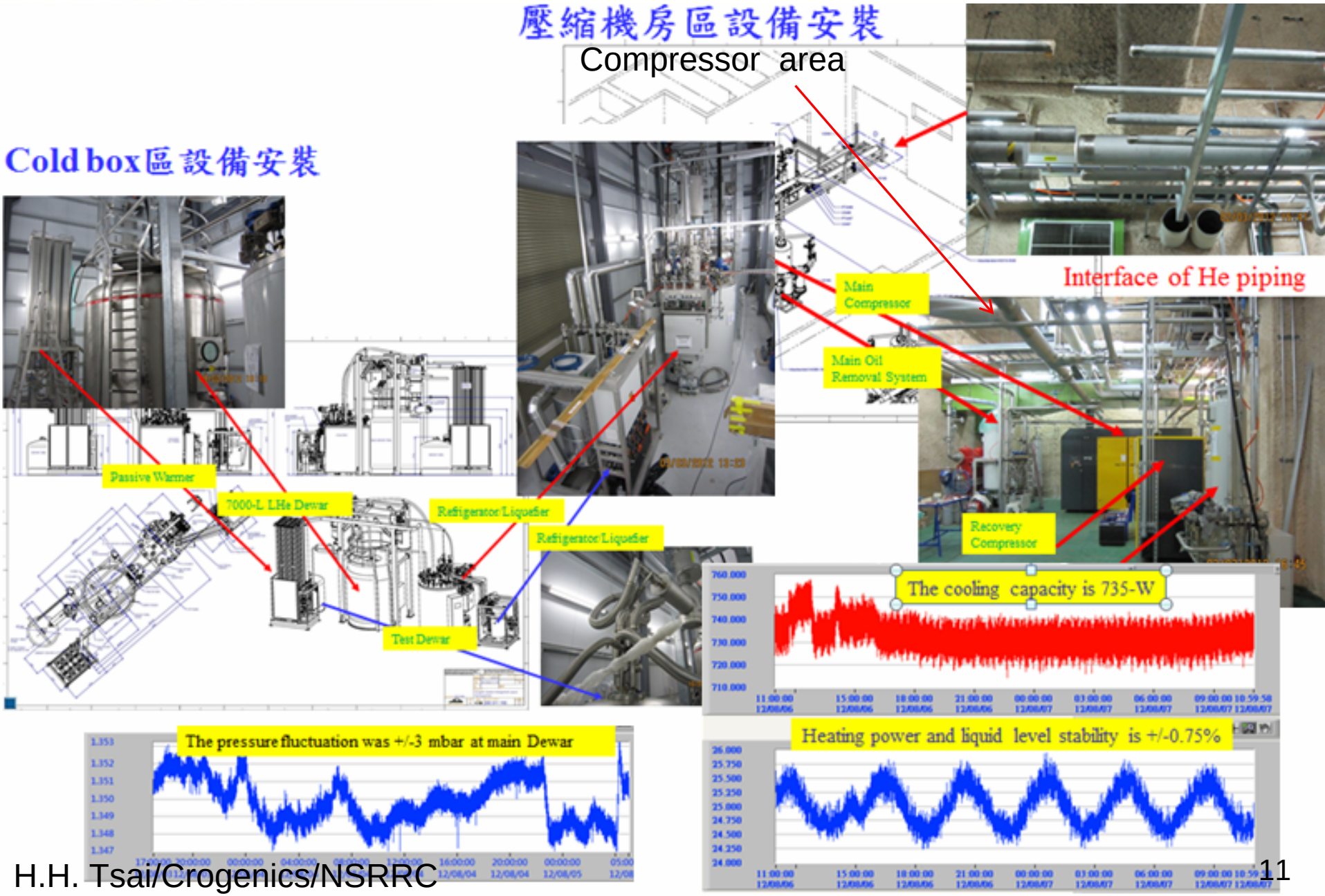


Transformer inspection

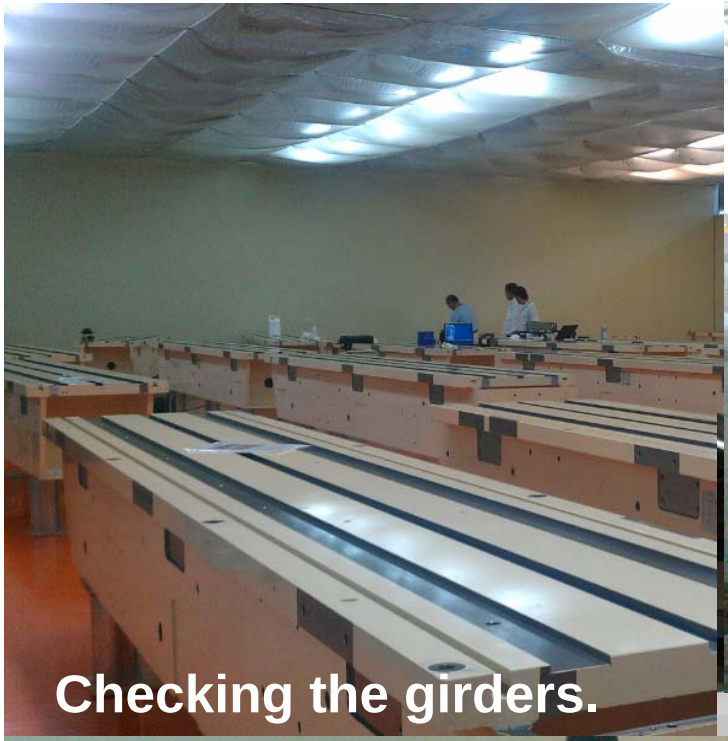
Factory Test for Switch Gears

Cable tray & ac power racks

TPS Cryogenics System



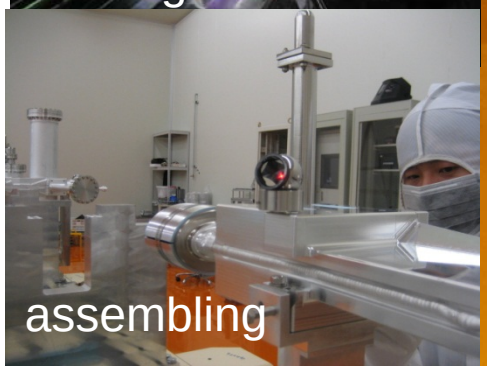
TPS Girder System



Checking the girders.

Pedestals moved into the SR tunnel.

TPS Vacuum System



TPS Magnets

Location	Magnet type	Quantity	Status
Storage ring (SR)	Dipole	50	3 accepted
	Short Q-pole	195	49
	Long Q-pole	50	9
	Sextupole	174	39
Booster (BR)	Short-Dipole	43	prototyping
	Long-Dipole	13	
	Combined Q-pole	49	
	Pure Q-pole	41	
	Sextupole	26	
Transfer line	LTB-DM	2	Most delivered
	LTB-QM	13	
	BTS-DM	3	
	BTS-QM	8	
	DC-septum	3	
Corrector	DC corrector	134	Prototypes completed
	Fast f/b corrector	100	

-- Significant delay in schedule.

--The SR magnets have overcome the technical problems and under mass production.

-- The quadrupole and sextupole components of the BR dipoles need to be optimized to meet the spec.

TPS Magnet Power Supplies

- All quad and sext. power supplies received.
- Corrector power supplies arrive in Q1, 2013.
- Dipole power supplies arrive in Q2, 2013.

四極磁鐵電源供應器

修正磁鐵電源供應器

六極磁鐵電源供應器

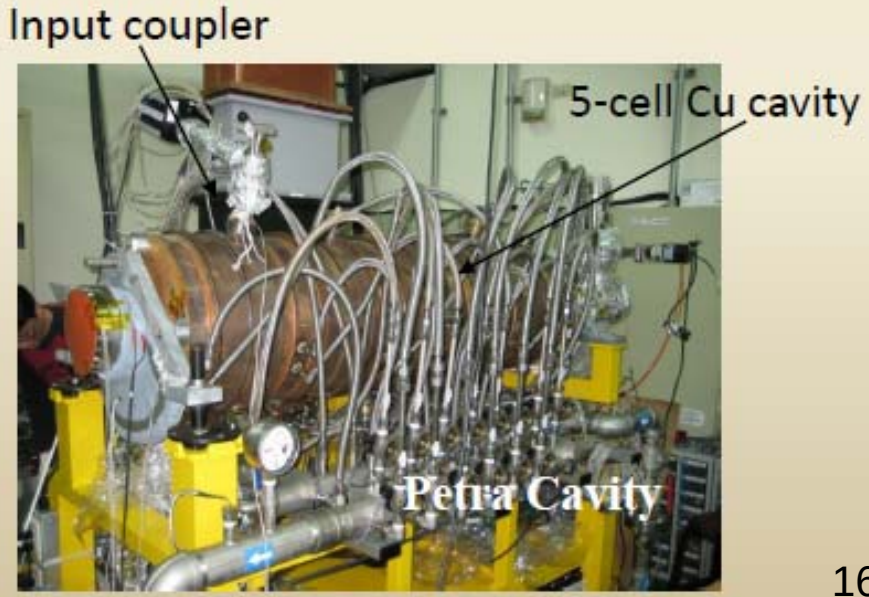
TPS RF System

KEKB type SRF module：

- 3 sets contracted to MHI and technical assistance from KEK.
- One module delivered
- The other two will arrive by the end of 2012.
- All 3 sets will be fully tested by July 2013 at NSRRC.

Petra Cavity module：

3 sets ready for phase-I beam commissioning



Transportation Test (Vacuum)

Leak tight

Chamber deformation: < ± 1mm

Transportation Test

(Girder with Magnets)

Magnet displacement: < 10 μm

The Low-emittance Engineering at TPS

a. High performance components
b. Stable infrastructures
c. Precision alignment system
d. Clean and smooth beam ducts
e. Special components

Sources of Disturbance (External)

Misalignment

Water Temp. Fluctuation

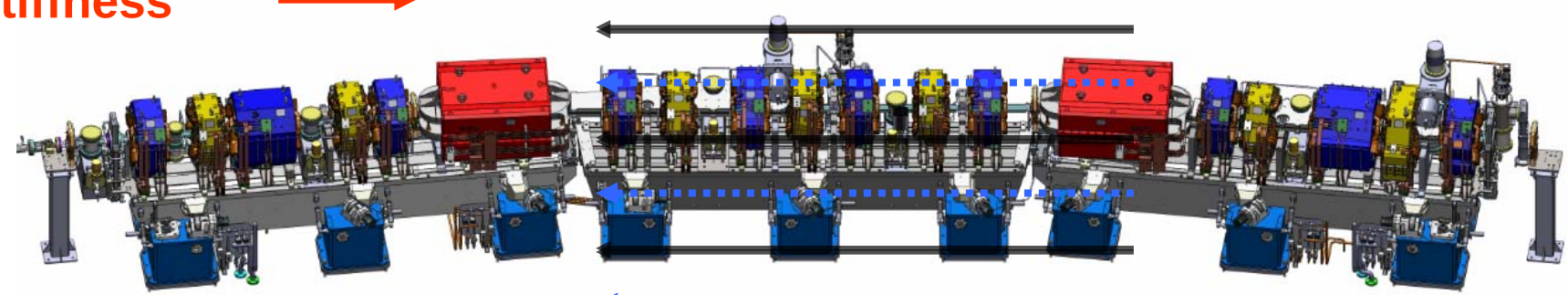
Coolant Vibration

Structure Stiffness

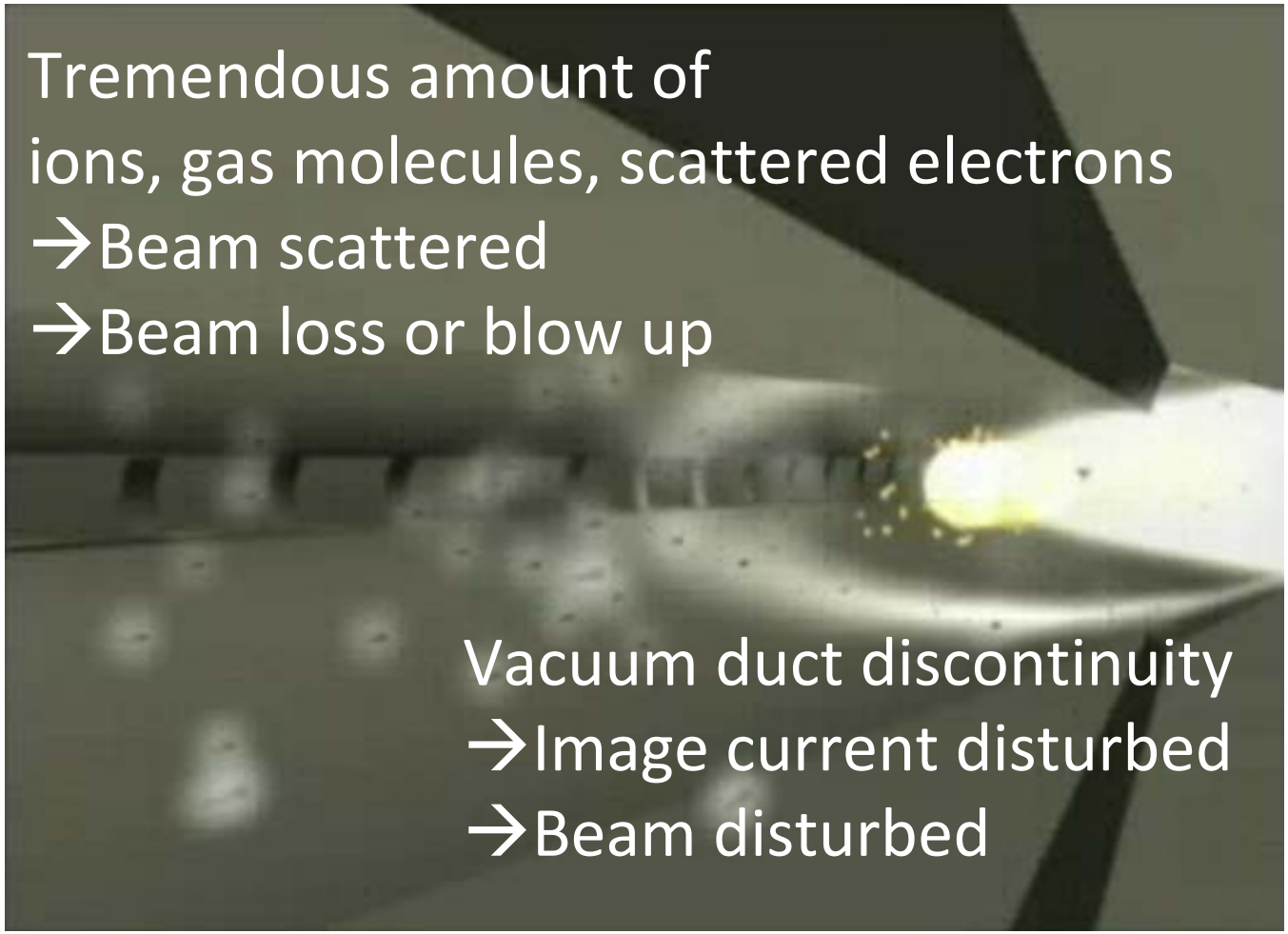
Ground Motion Settlement/Vibration

Air Temp. Fluctuation

Electrical Noises EMI



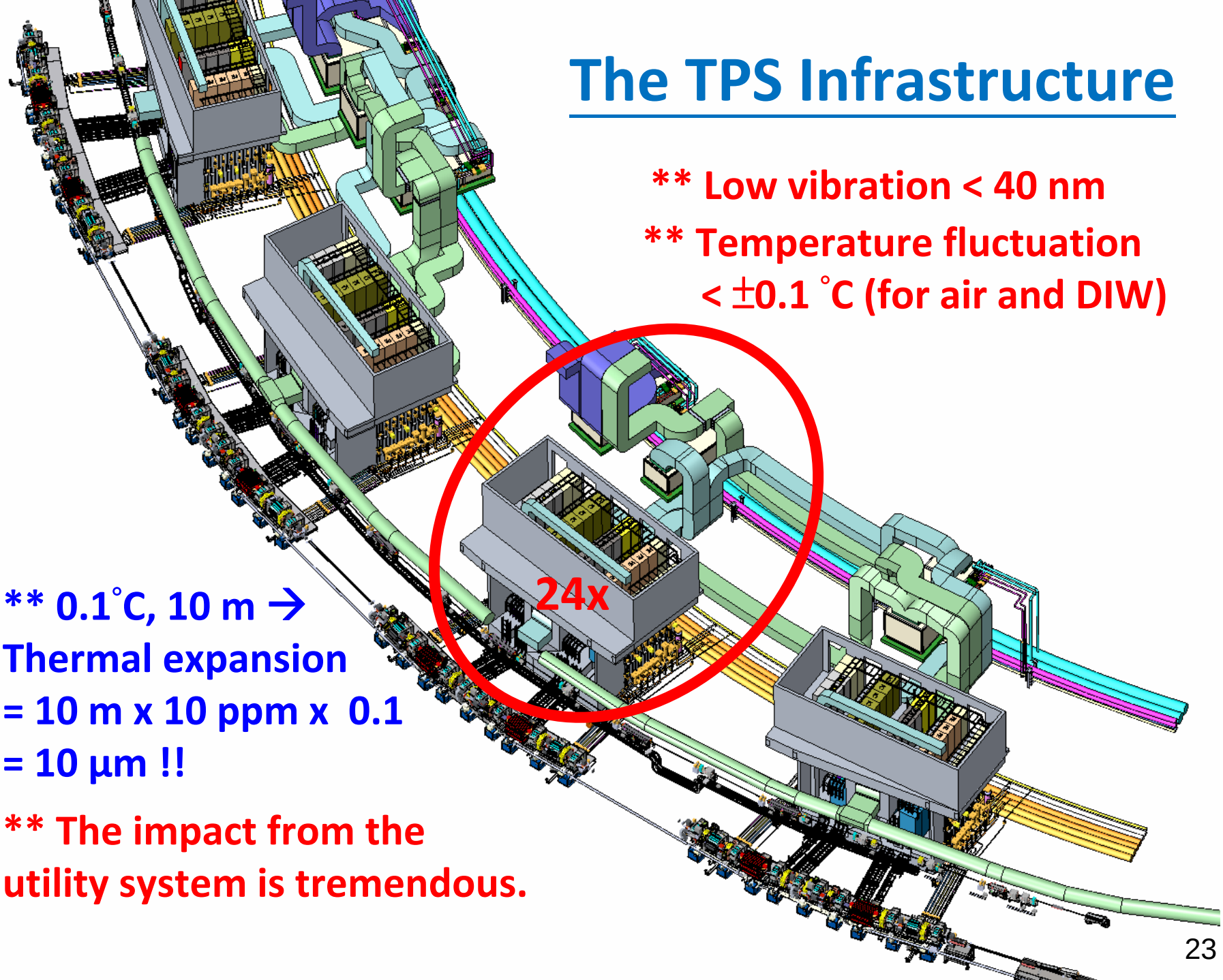
Source of Disturbance (Internal Vacuum) Gas/Ion Scatterring & Beam Impedance



Stable infrastructures

Precision temperature control
(Low vibration equipment)

The TPS Infrastructure



** Low vibration < 40 nm

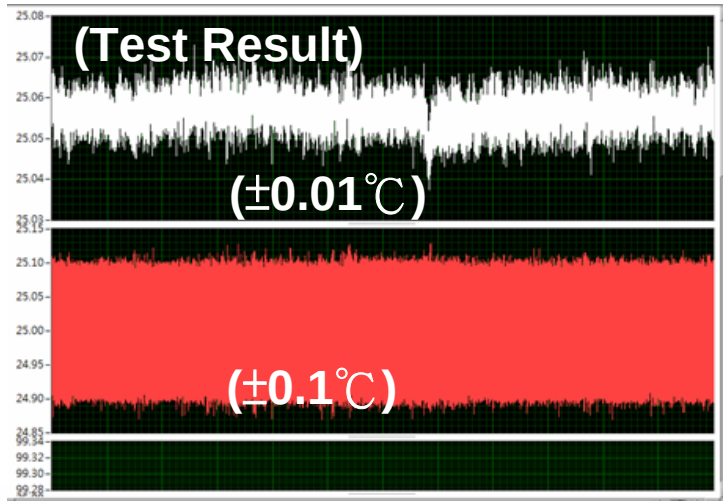
** Temperature fluctuation < ±0.1 ˚C (for air and DIW)

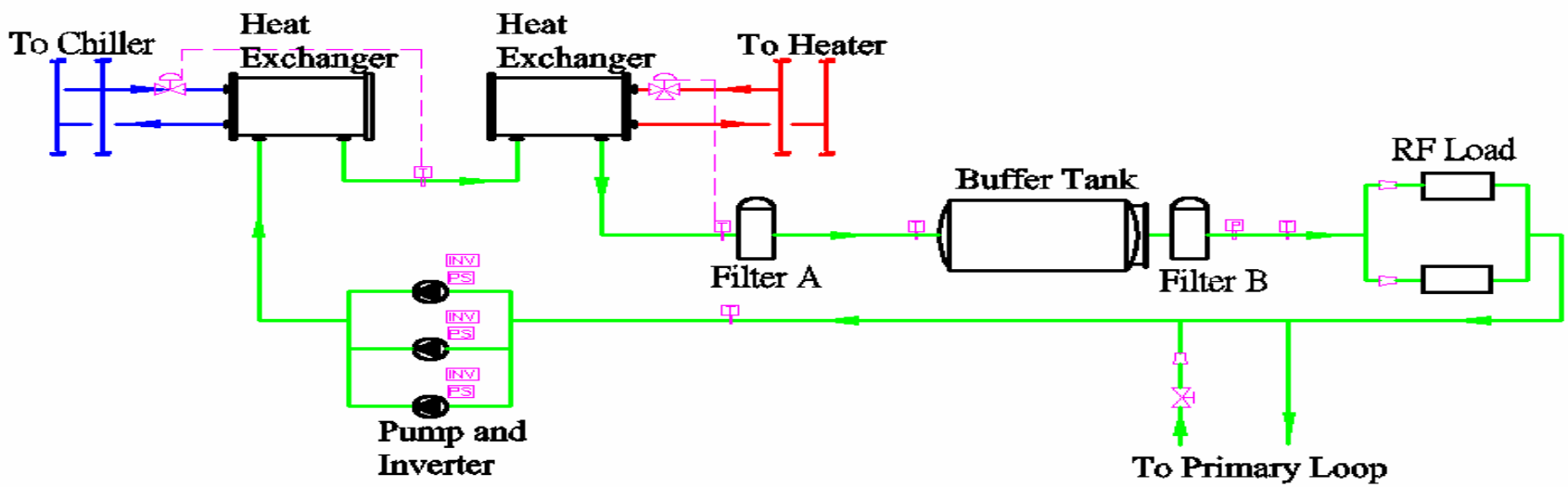
** 0.1˚C, 10 m →
Thermal expansion
= 10 m x 10 ppm x 0.1
= 10 μm !!

** The impact from the utility system is tremendous.

Water Temperature Stability

* Temp. of chilled/hot water (< ±0.5°C)
* Eliminate nonlinear effects on valves
* Buffer tank (±0.01℃)
* High resolution sensor and controller
* Variable frequency controller

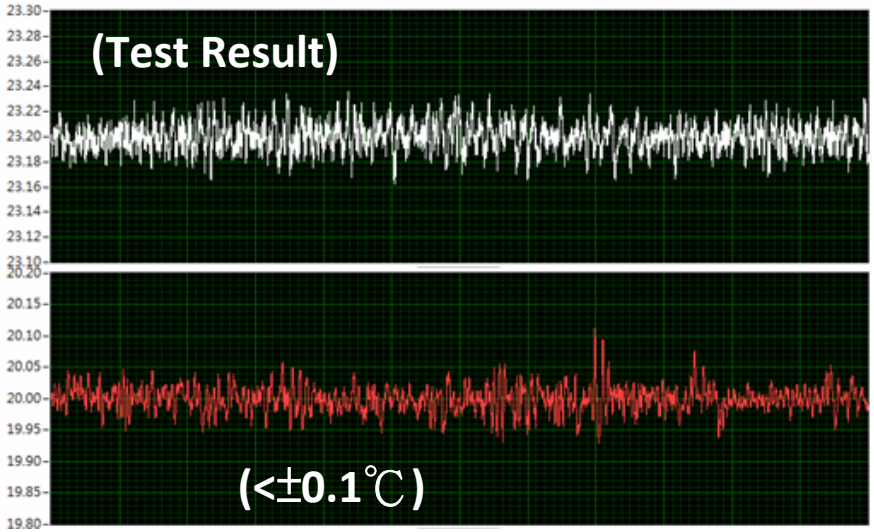


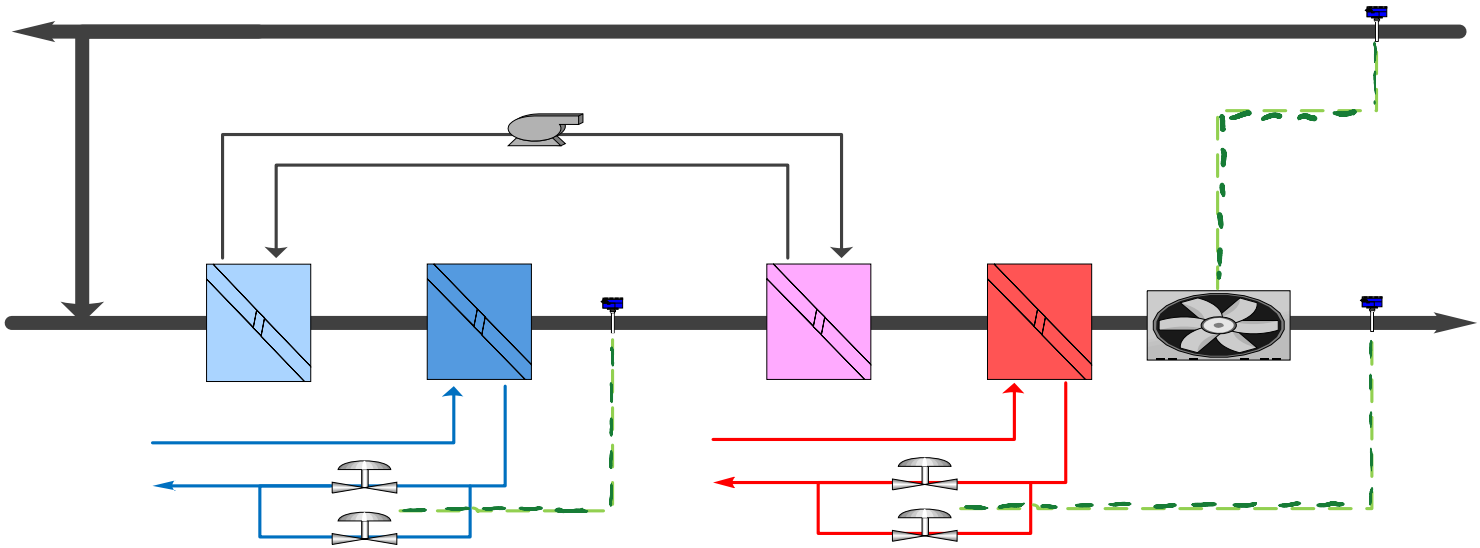


Air Temperature Stability

Inlet temp. control → valves

Return temp. control → flow rate

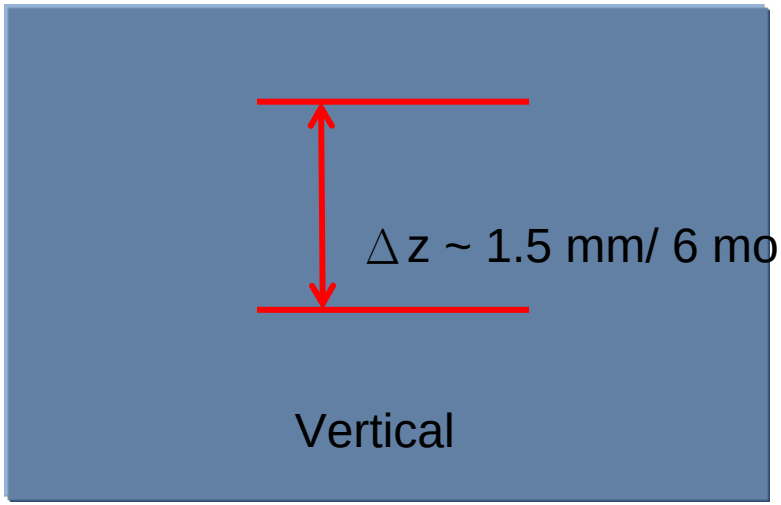




Precision alignment systems

Alignment network and ground motion
Magnet-to-girder alignment
Vibration suppression
Automatic alignment system

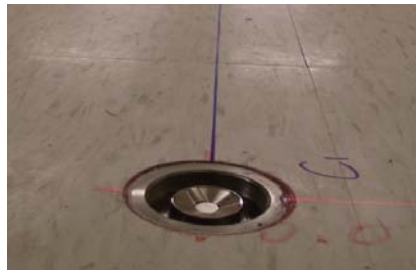
Alignment network and ground motion



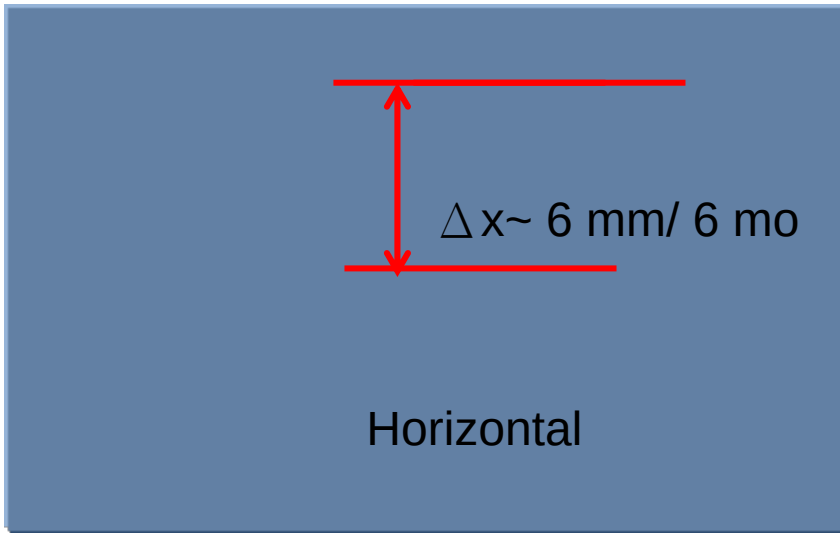
Fiducial point for level measurement.

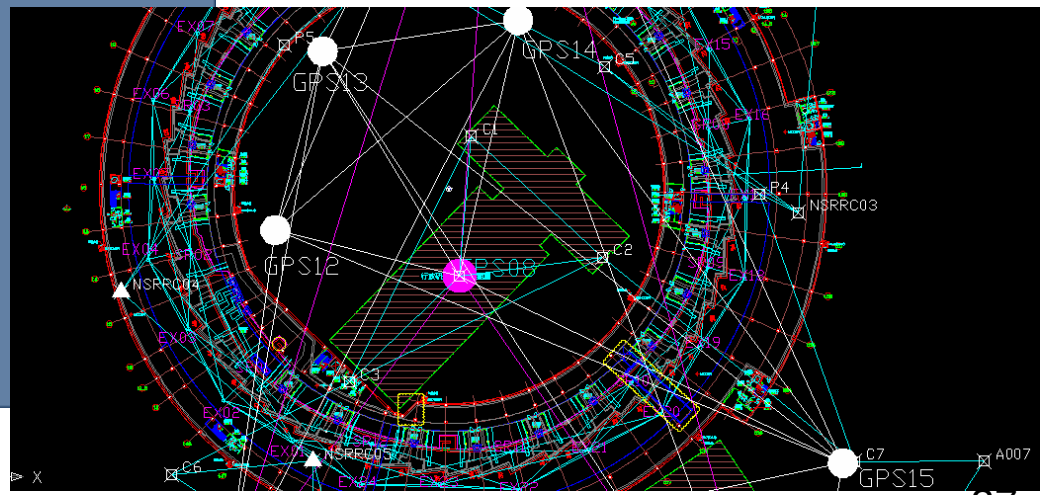
Pillar for GPS

Alignment pillar in SR tunnel



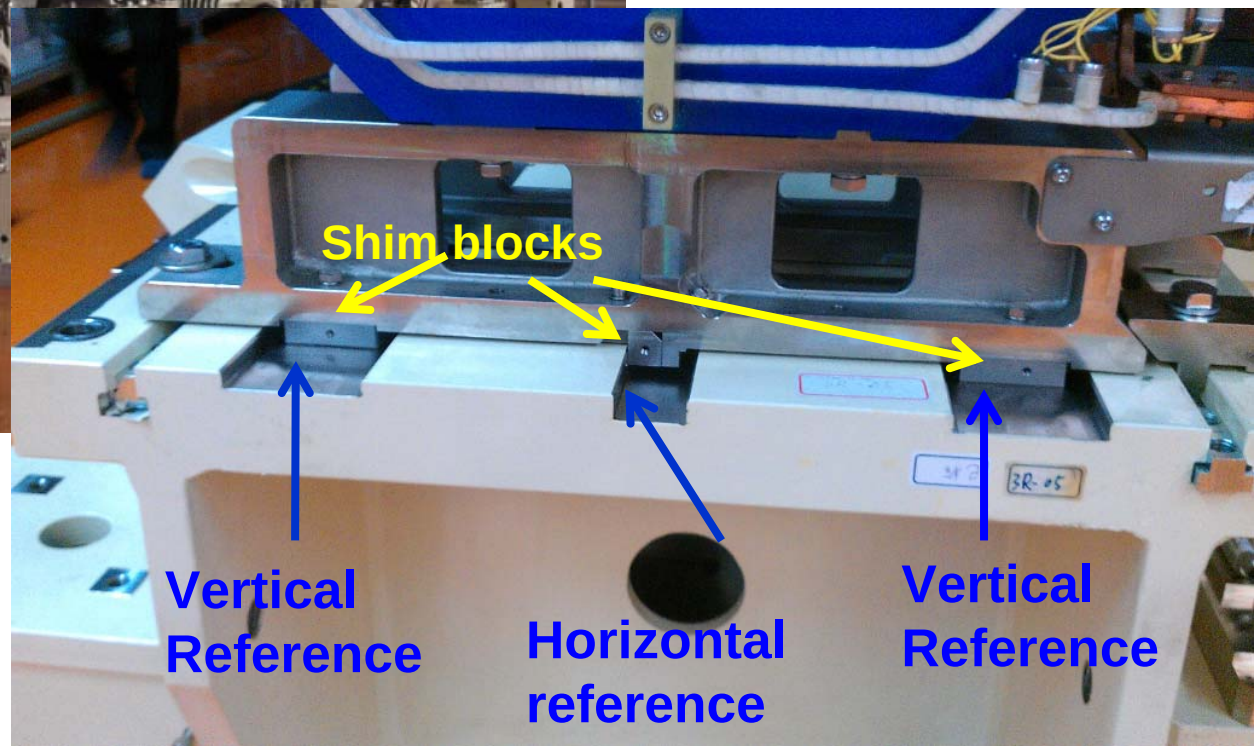
Fiducials in SR tunnel



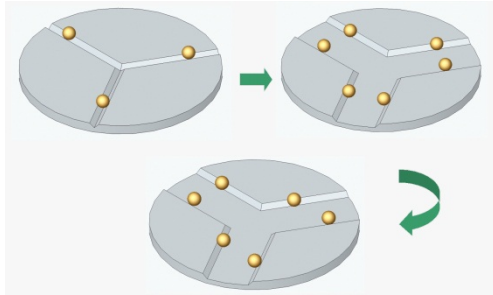


Magnet to Girder Alignment

Girder reference surfaces: flatness <10 μm
Positioning reproducibility: < 3 μm
Open/close upper-half magnet : < 6 μm



Vibration Suppression

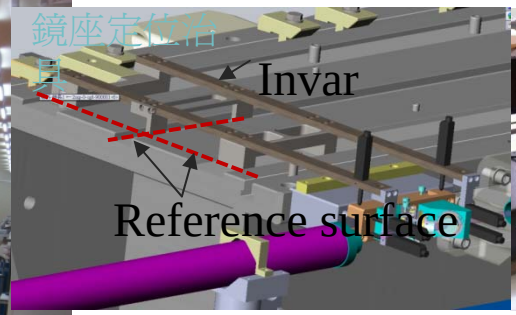


Girder support: Expanded 3-Groove type kinematics mount.

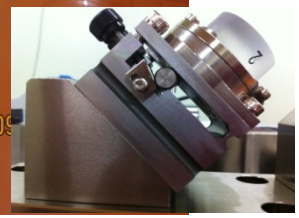
Natural frequency ~30Hz with locking system

Damper → + 2Hz

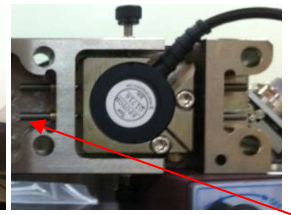
Automatic Alignment System



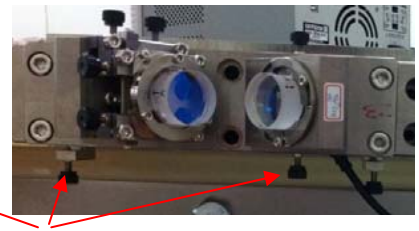
Mirror holder

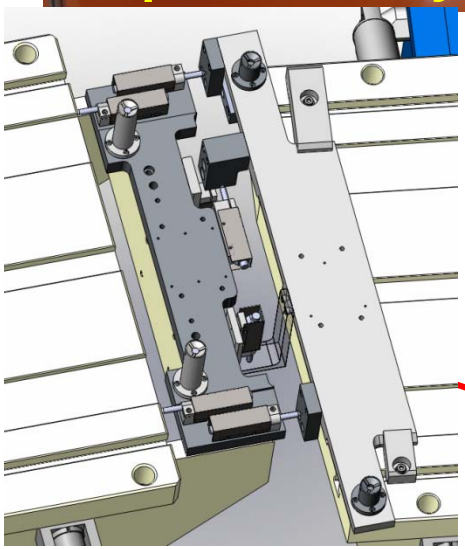


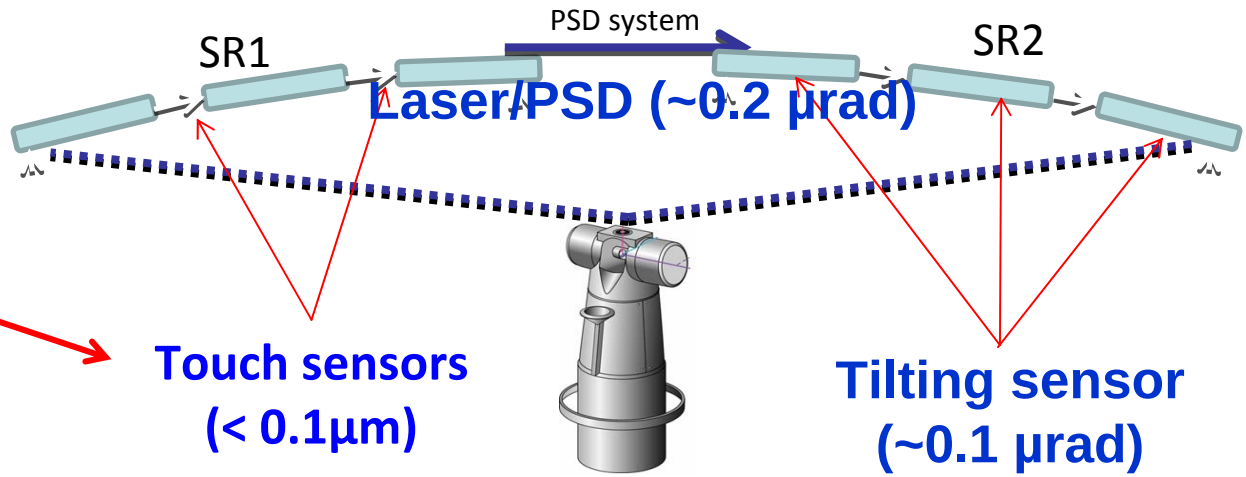
PSD



Mirror & holder







Produce_0.avi

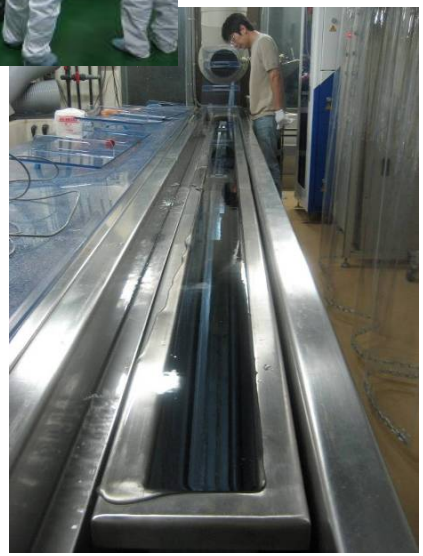
Clean and smooth beam ducts

Low outgas

Low impedance

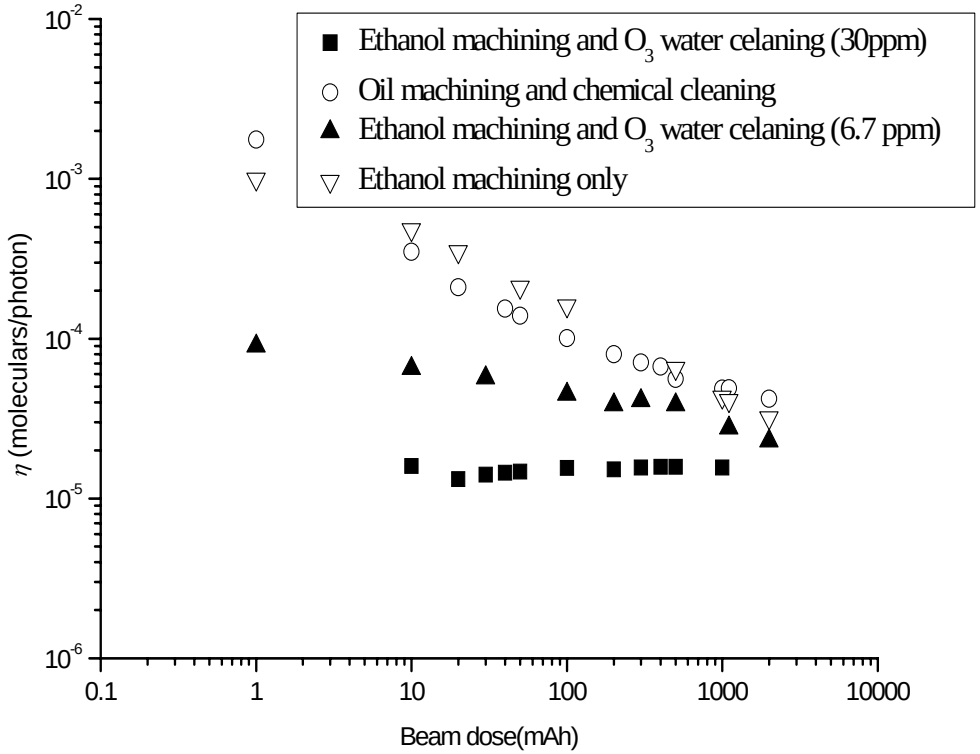
Low-outgas beam duct
(machining and cleaning)

Oil-free CNC Machining in Clean Room



Ozonated Water Cleaning Bath (> 20 ppm)

Photon-stimulated desorption (PSD) with various surface treatments [a b]

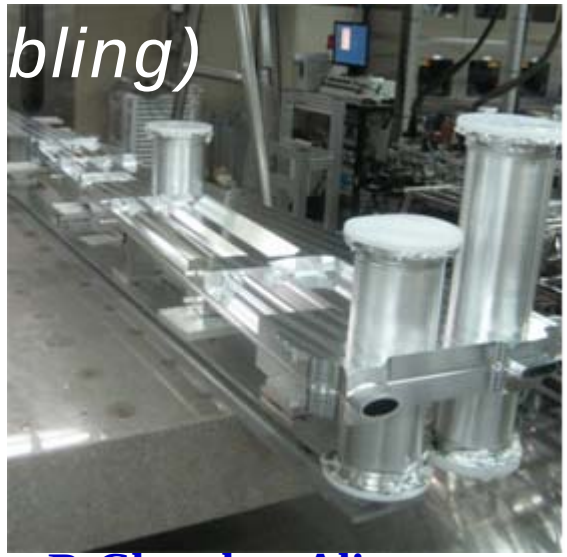


Low-outgas beam duct

(welding and assembling)

Clean Room (Class 1000)
- Temperature: T = 25±1 ˚C
- Humidity: HR < 50%

Pumping Port Welding



B-Chamber Alignment+
Spot weld seams

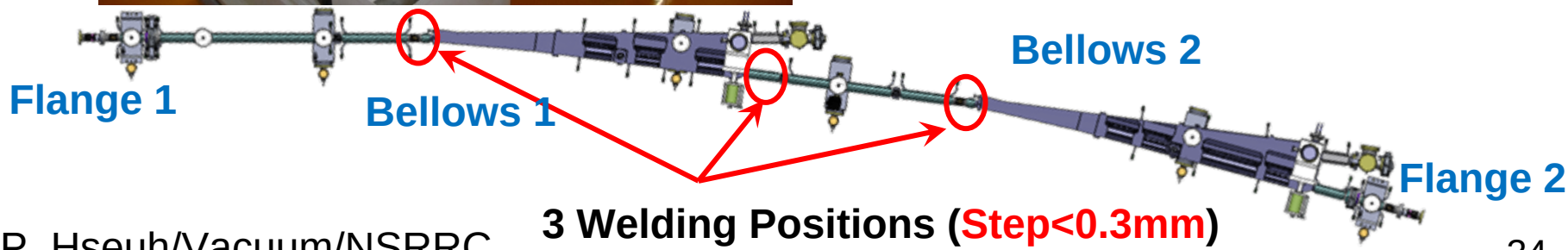
Auto-Welding System

Low-impedance beam duct

(Reduction of Bellows and Flanges)

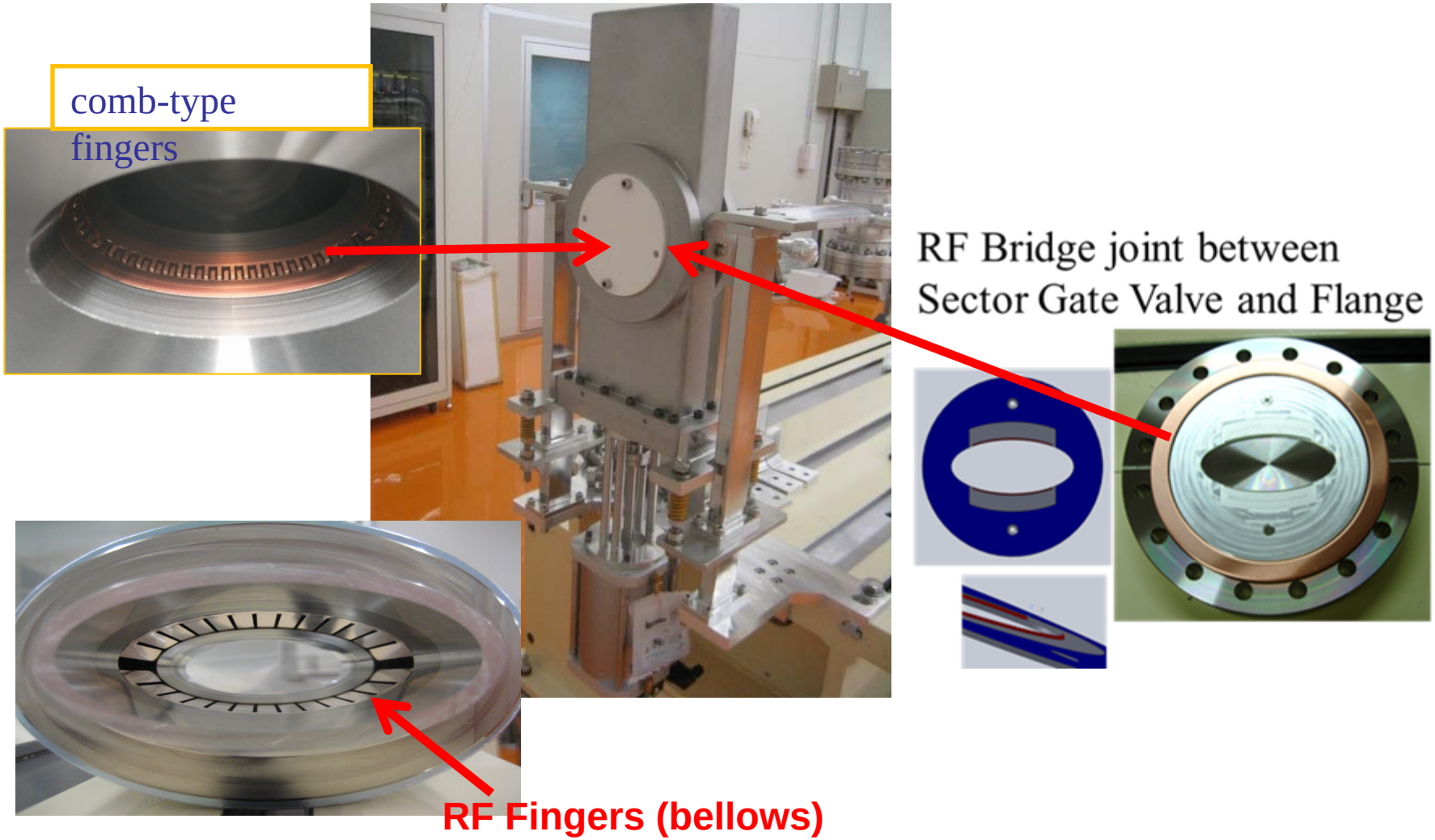
-- To reduce the number of bellows and flanges.
-- Welding step < 0.3mm, to reduce rf impedance
-- Baking at Lab, to reduce the displacement of magnet/girder

In one arc section (14m):
Number of flanges: 2
Number of bellows: 2



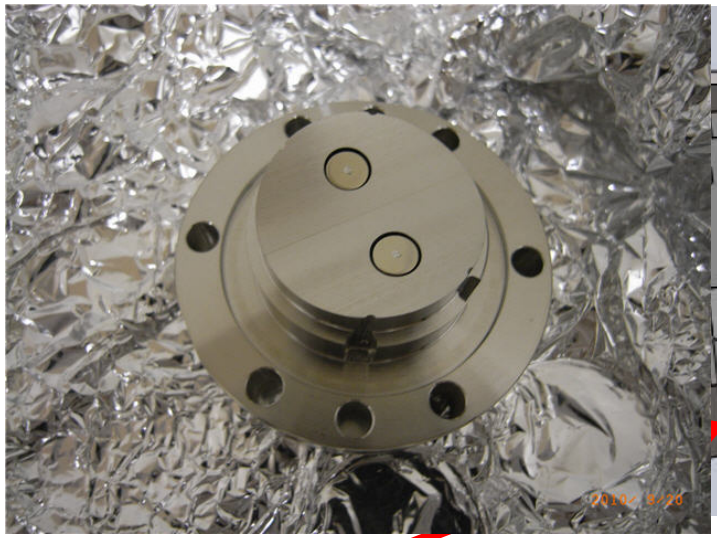
Low-impedance beam duct

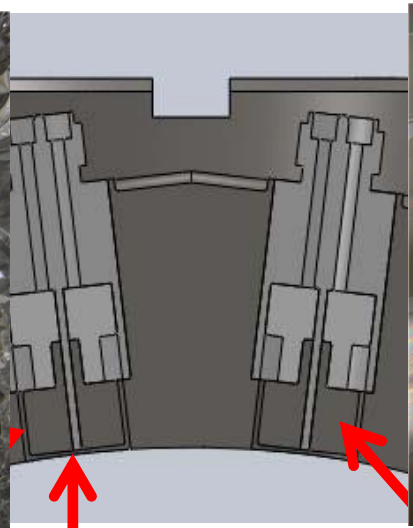
(Sector GV, bellows and flange gap with RF bridge)



Low-impedance vacuum component

(e-beam position monitor)

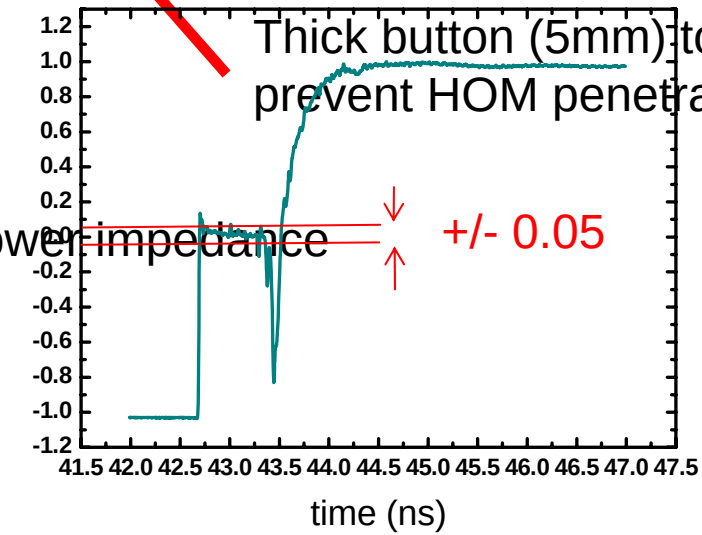




wer impedance

n 0.3mm) for lower impedance

Thick button (5mm) to prevent HOM penetration



Summary

1.The construction status of the TPS, particularly for the low-emittance related mechanical issues, are presented.

2.Certain novel methods are proposed and applied to construct the TPS mechanical engineering systems.

3.The TPS mechanical engineering systems are constructed under stringent QC processes to ensure the high performance.

Thank you for your attention.