國家同步輻射研究中心
National Synchrotron Radiation Research Center

Overview of the accelerator development for light source in NSRRC

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On behalf of Accelerator Div.

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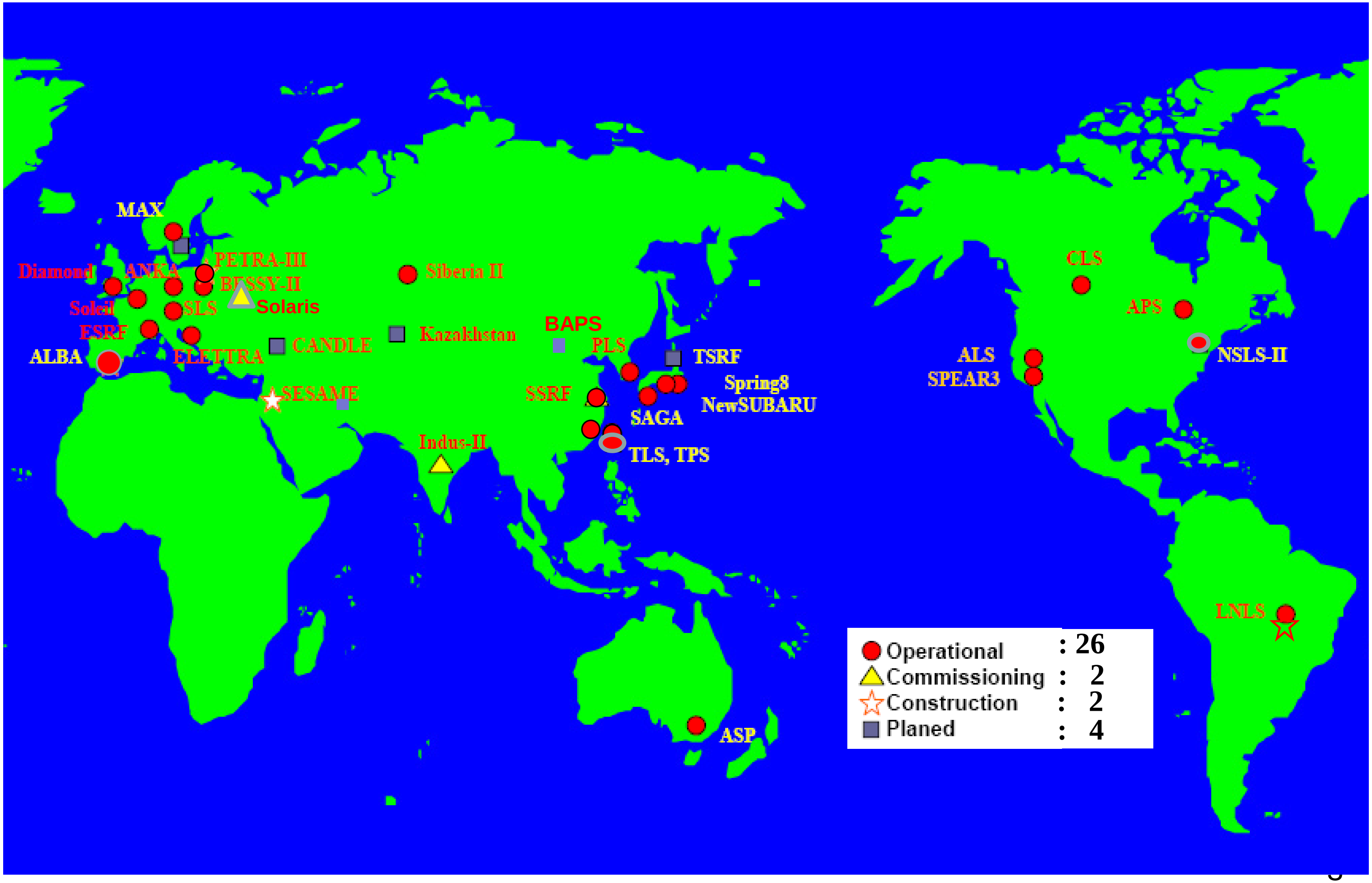
3rd Generation Light Sources around the World



3^{rd} Generation Light Sources in Operation (1)

Light Source	Energy (GeV)	Circumference (m)	Emittance (nm.rad)	Current (mA)	Straight Section	Status
1. ALS	1.9	196.8	6.3	500	12×6.7m	Operation (1993)
2. ESRF	6.0	844.4	3.7	200	32×6.3m	Operation (1993)
3. TLS	1.5	120	25	360	6×6m	Operation (1993)
4. ELETTRA	2.0/2.4	259	7	300	12×6.1m	Operation (1994)
5. PLS/PLS-II	3.0	280.56	5.8	400	12×6.8m	Operation (1995)
6. APS	7.0	1104	3.0	100	40×6.7m	Operation (1996)
7. SPring-8	8.0	1436	2.8	100	44×6.6m, 4×30m	Operation (1997)
8. LNLS	1.37	93.2	70	250	6×3m	Operation (1997)
9. MAX-II	1.5	90	9.0	200	10×3.2m	Operation (1997)
10. BESSY-II	1.7	240	6.1	200	8×5.7m, 8×4.9m	Operation (1999)
11. Siberia-II	2.5	124	65	200	12×3m	Operation (1999)
12. NewSUBARU	1.5	118.7	38	500	2×14m, 4×4m	Operation (2000)
13. SLS	2.4-2.7	288	5	400	3×11.7m, 3×7m, 6 ×4m	Operation (2001)

3rd Generation Light Sources in Operation (2)

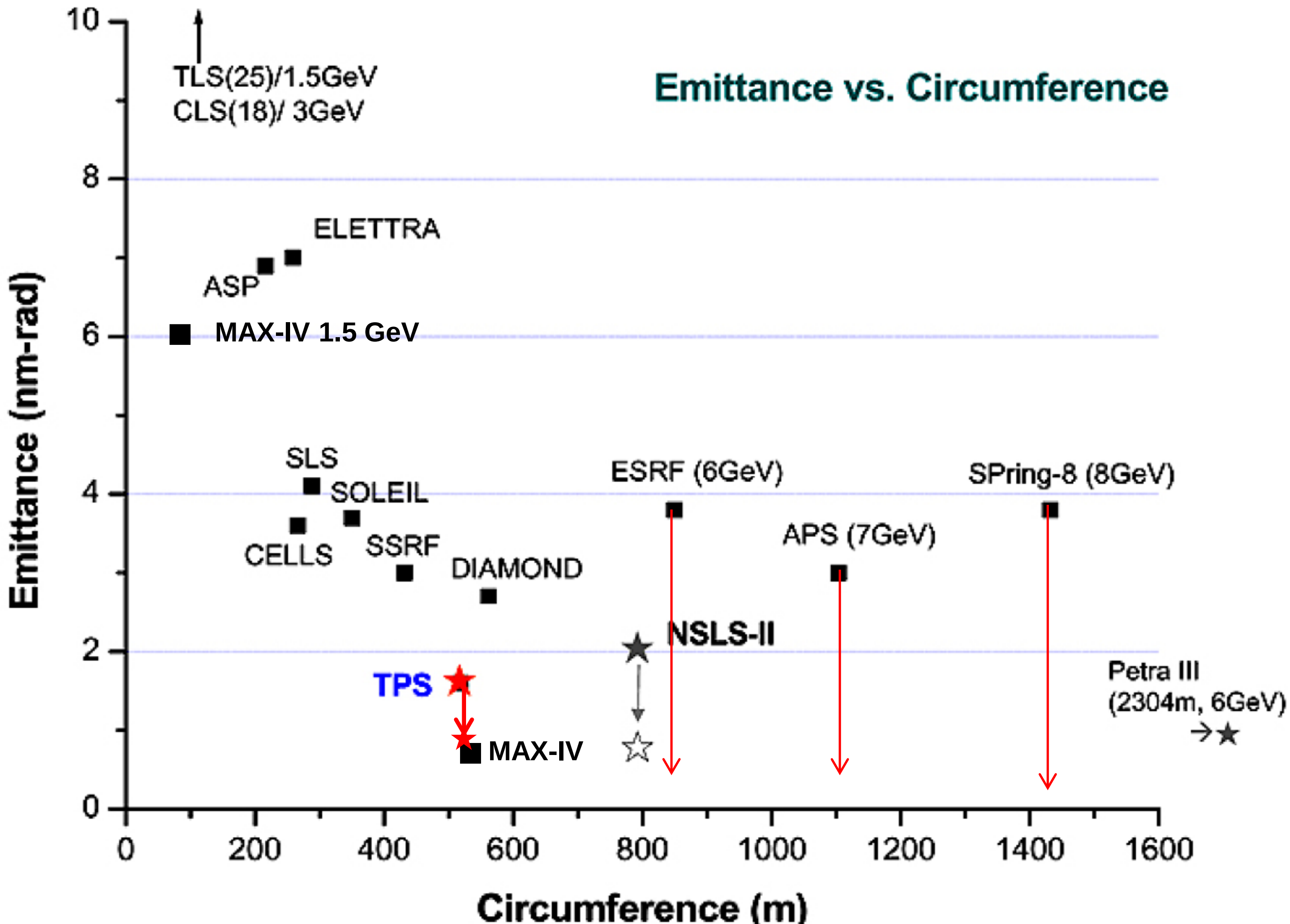
Light Source	Energy (GeV)	Circumference (m)	Emittance (nm.rad)	Current (mA)	Straight Section	Status
14. ANKA	2.5	110.4	50	200	4×5.6m, 4×2.2m	Operation (2002)
15. CLS	2.9	170.88	18.1	500	12×5.2m	Operation (2003)
16. SPEAR-3	3.0	234	12	500	2×7.6m,4×4.8m, 12×3.1m	Operation (2004)
17. SAGA-LS	1.4	75.6	7.5	300	8×2.93m	Operation (2005)
18. ASP	3.0	216	7-16	200	14×5.4m	Operation (2007)
19. DIAMOND	3.0	561.6	2.7	300	6×8m, 18×5m	Operation (2007)
20. SOLEIL	2.75	354.1	3.74	500	4×12m, 12×7m, 8×3.8m	Operation (2007)
21. SSRF	3.5	432	3.9	300	4×12m, 16×6.5 m	Operation (2009)
22. PETRA-III	6.0	2304	1.0	100	1×20m, 8×5m	Operation (2009)
23. ALBA	3.0	268.8	4.5	400	4×8m, 12×4.2m, 8×2.6m	Operation (2010)
24. NSLS-II	3.0	792	2.1	500	15×9.3m, 15×6.6m	Operation (2016)

New 3rd Generation Light Sources
in Commissioning, Construction and Plan

Light Source	Energy (GeV)	Circumference (m)	Emittance (nm.rad)	Current (mA)	Straight Section	Status
25. TPS	3.0	518.4	1.6	500	6×12m, 18×7m	Operation (2016)
26. MAX IV	3.0	528	0.32	500	19×4.6m, 40×1.3m	Operation (2016)
27. Solaris (Poland)	1.5	96	6	500	12*3.5m	Commi.&Oper.
28. Indus-2 (?)	2.5	172.5	58	300	8×4.5m	Commi.&Oper.
29. SESAME	2.5	133.12	26	400	8×4.44m, 8×2.38m	Construction
30. Sirius	3.0	518	0.28	500	10×7m, 10×6m	Construction
31. CANDLE	3.0	216	8.4	350	16×4.8m	Planned
32. ILSF (IPAC14)	3.0	528	0.417	400	20×5.11m	Planned
33. SLiT-J (SRI 2012)	3.0	~300	1.8	300	12×4m	Planned
34. BAPS	6.0	~1295	~0.06	200	48*6m	Planned

SR circumference and beam emittance

TPS is designed to produce electron beams with emphasis on small emittance and great brilliance, stability and reliability.

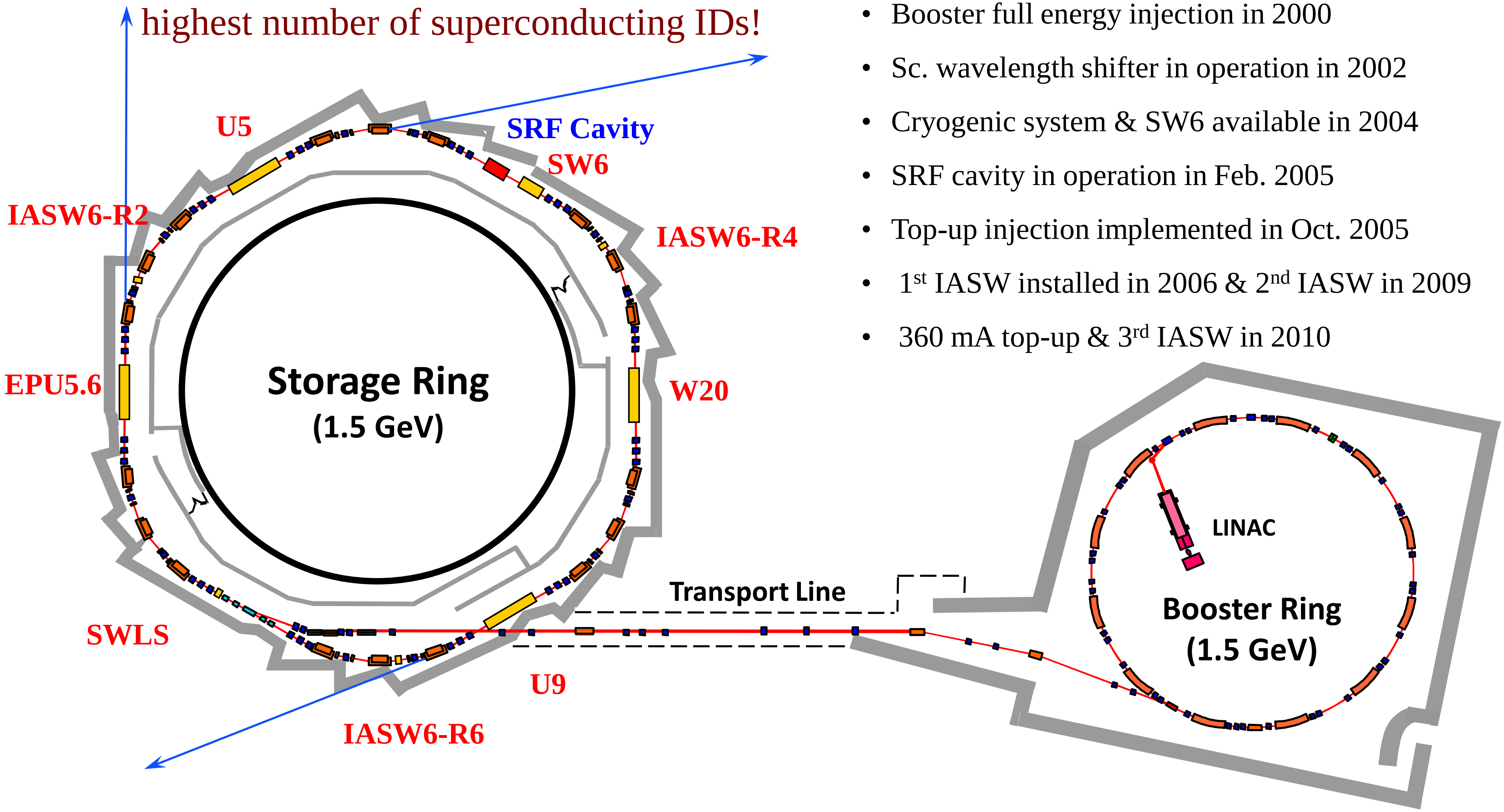


Taiwan Light Source

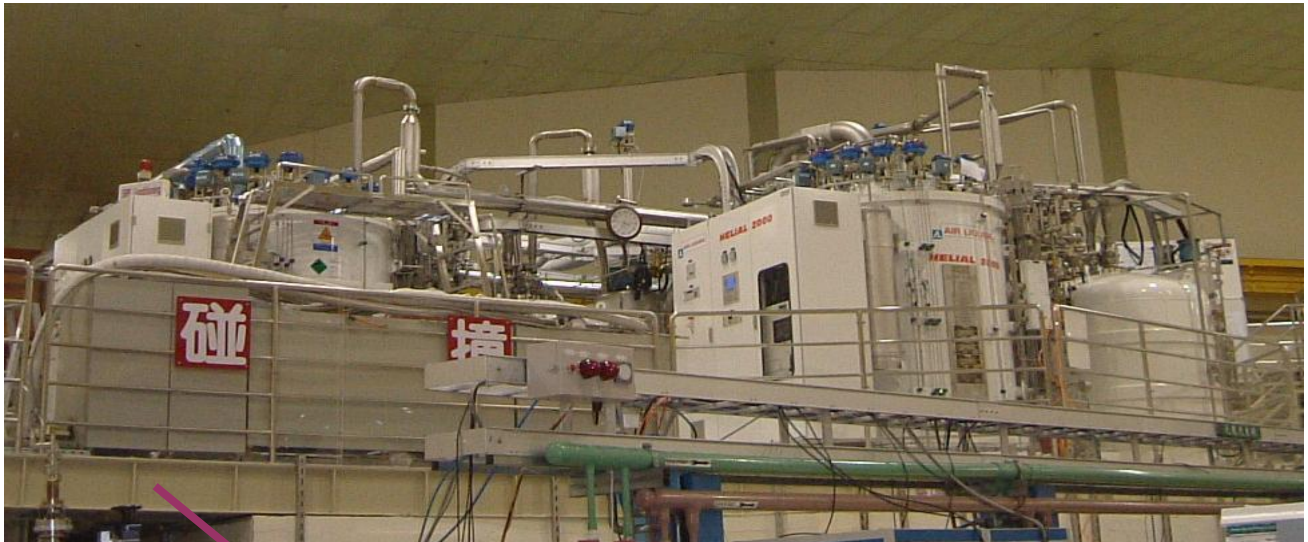
TLS accelerator layout and key milestones

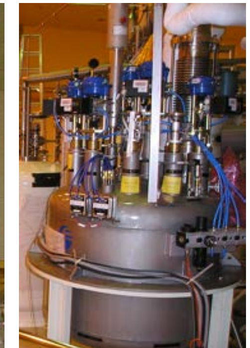
- The 1st 3rd G light source in Asia (1993)
- The 2nd LS using SRF cavity (2005)
- The 3rd LS full time top-up injection (2005)
- The most densely-packed SR ring with the highest number of superconducting IDs!

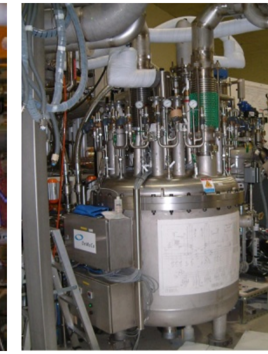
- Commission in Apr. & open to users in Oct. 1993
- 1.3 to 1.5 GeV ramping in operation in 1996
- 240 mA operation beam current in 1996
- Booster full energy injection in 2000
- Sc. wavelength shifter in operation in 2002
- Cryogenic system & SW6 available in 2004
- SRF cavity in operation in Feb. 2005
- Top-up injection implemented in Oct. 2005
- 1st IASW installed in 2006 & 2nd IASW in 2009
- 360 mA top-up & 3rd IASW in 2010

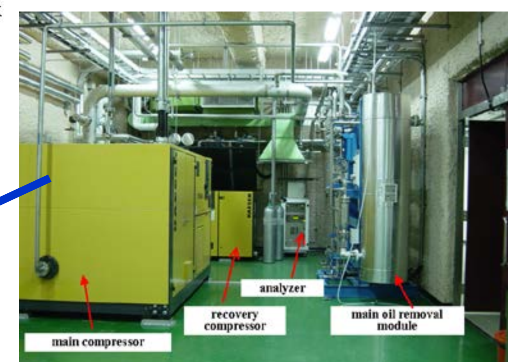


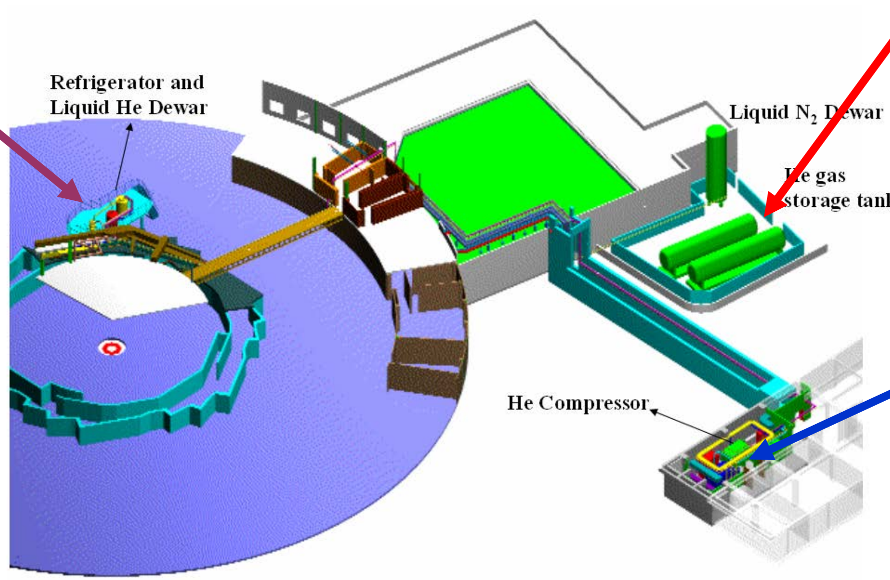
The Largest Cryo-plants (2x460W) in Taiwan











Cryo. Sys. Operation Cost

Maintenance (cryogenic system): 1,357 kNT

Safety/Inspection: 395 kNT

Maintenance (utility):195 kNT

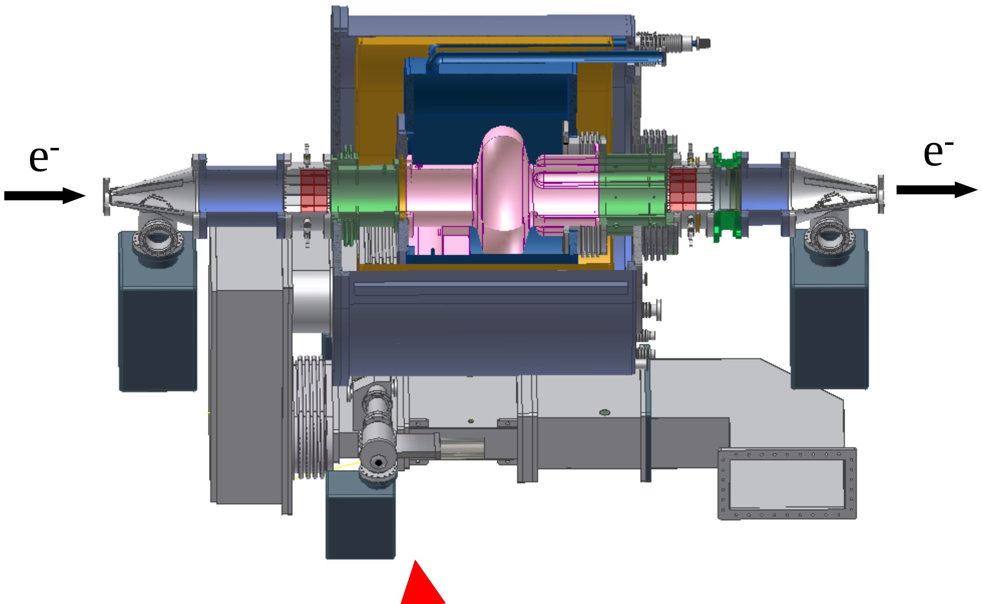
Electricity (335 kW/350days): 7,035 kNT.

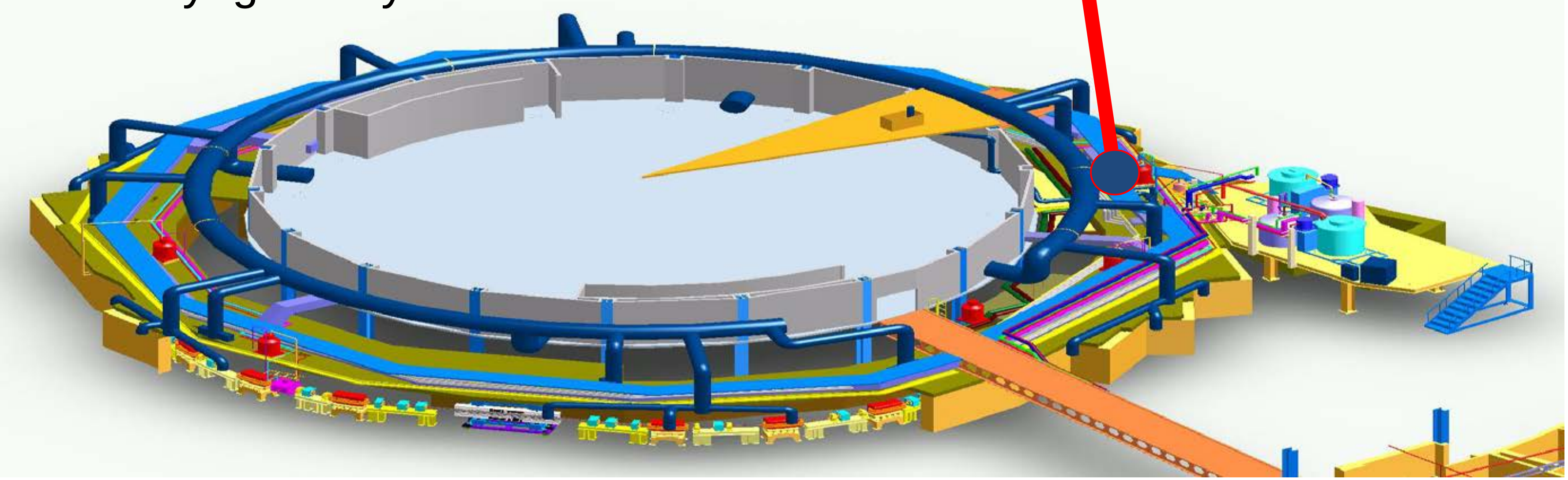
Total: 8,982 kNT

Superconducting RF (SRF) project

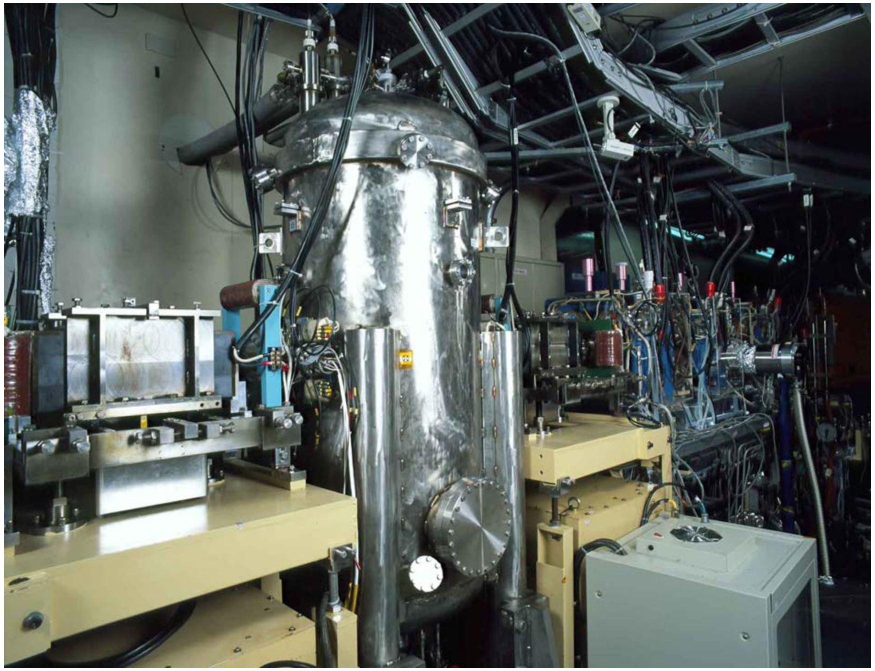
Goals：

- Increase the stored beam current and photon flux
- Eliminate beam instabilities by higher-order-modes (HOMs) free cavities
- Reduce the number of RF transmitters and cavities
- Extra space for ID in straight
- LHe cryogenic system to TLS

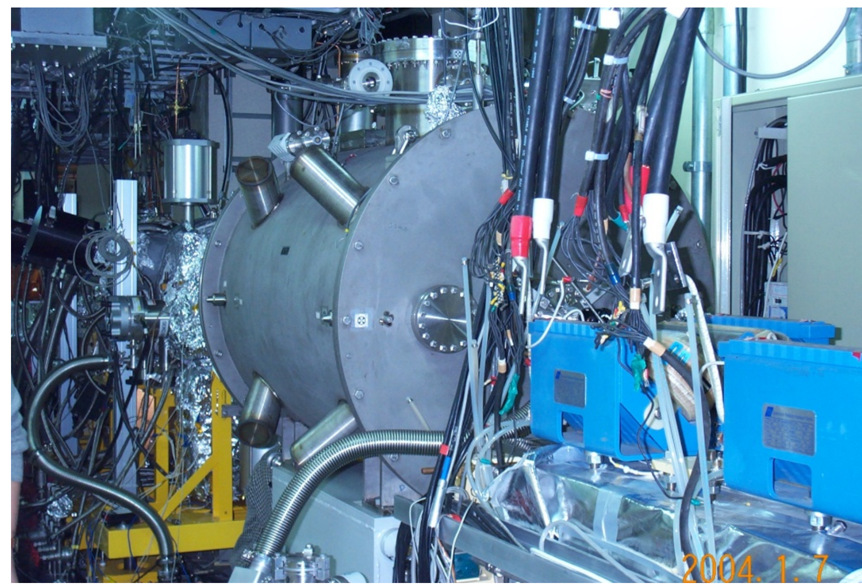




Superconducting Insertion Devices



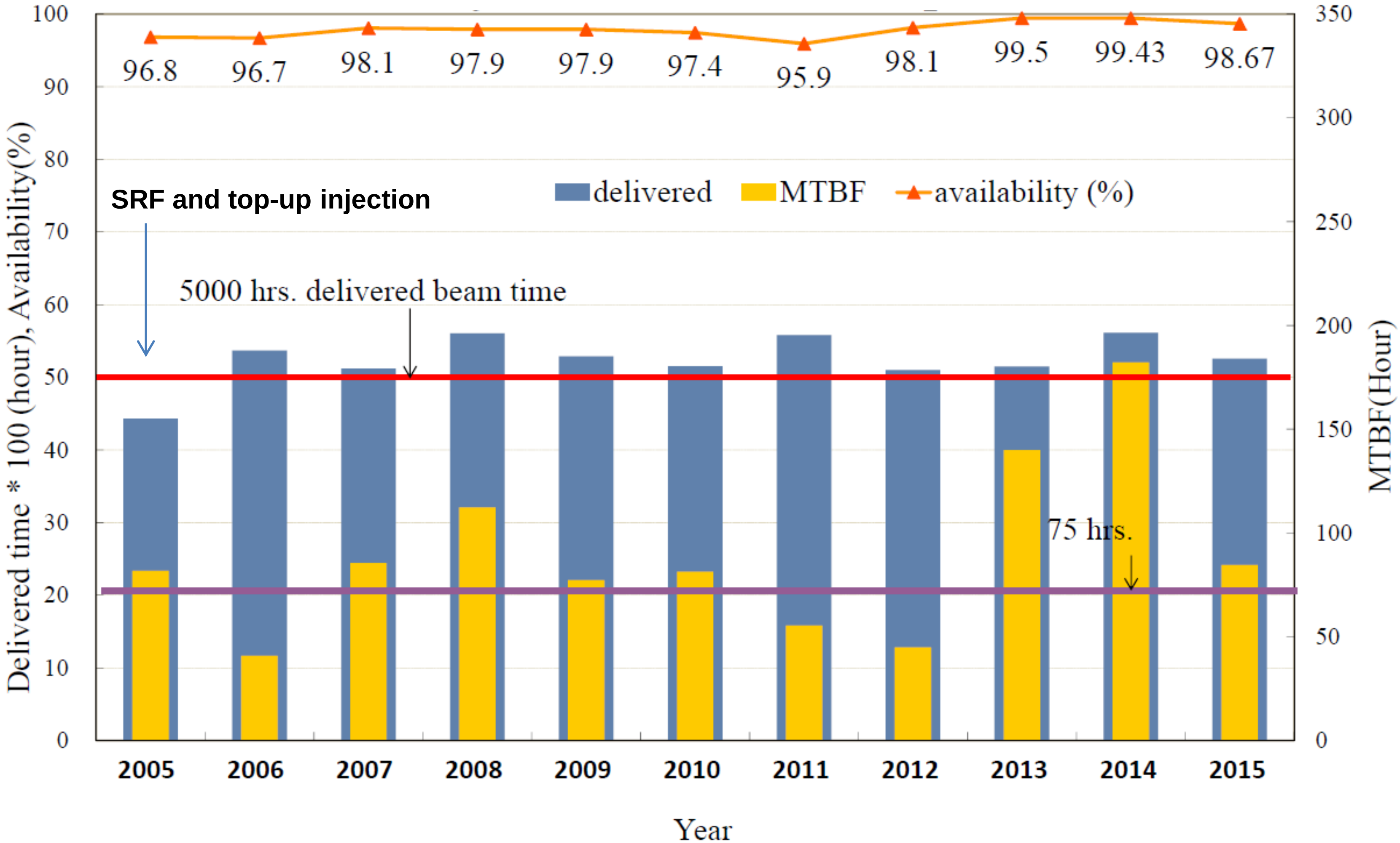
Superconducting Wavelength Shifter (6 T, SWLS) at injection section



Superconducting Wiggler (3.2T, SW6) at downstream of SRF straight section

Statistics of TLS operation

More than 5,000 hrs. users time annually with availability in 96~99%.



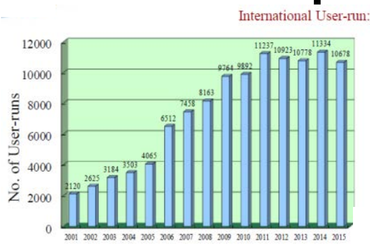
Delivered: 5,256 hrs.; Availability: 98.67%; MTBF*: 84.56 hrs.

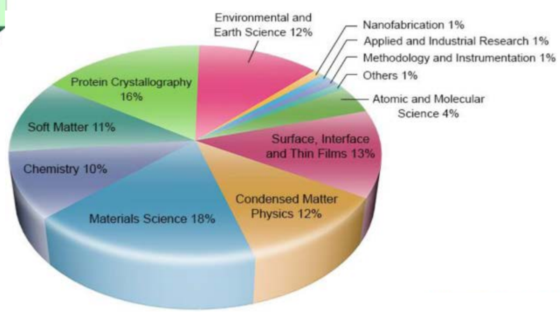
(updated to Jan. 1, 2016)

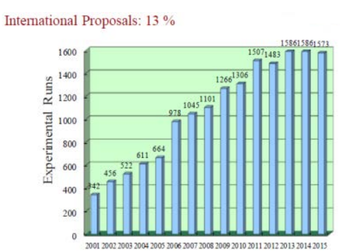
*** MTBF: Mean Time Between Failures**

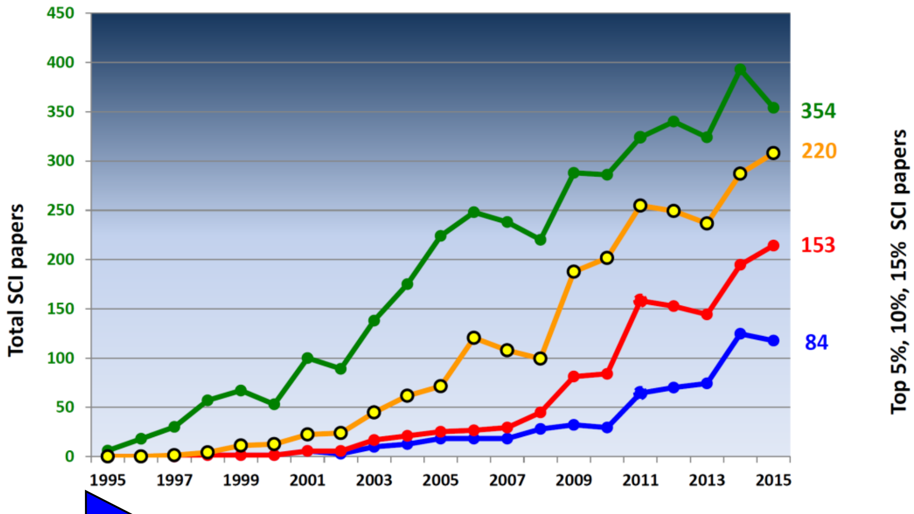
TLS Operation Statistics

Number of experiments and user-runs





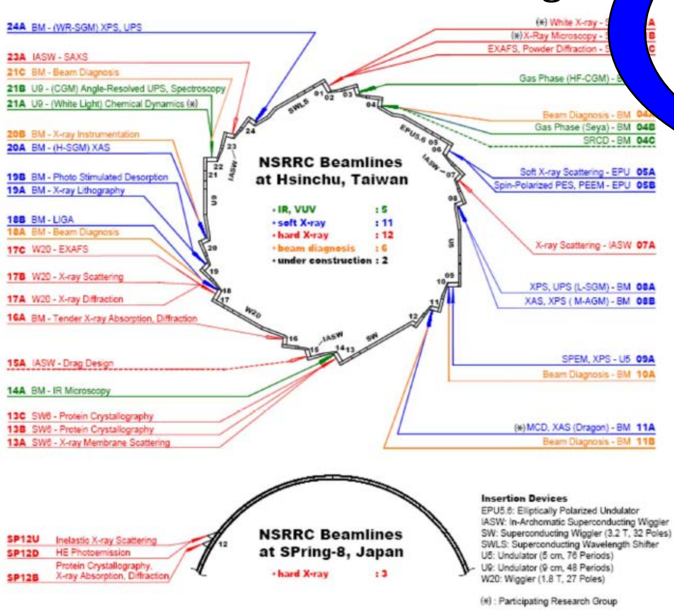




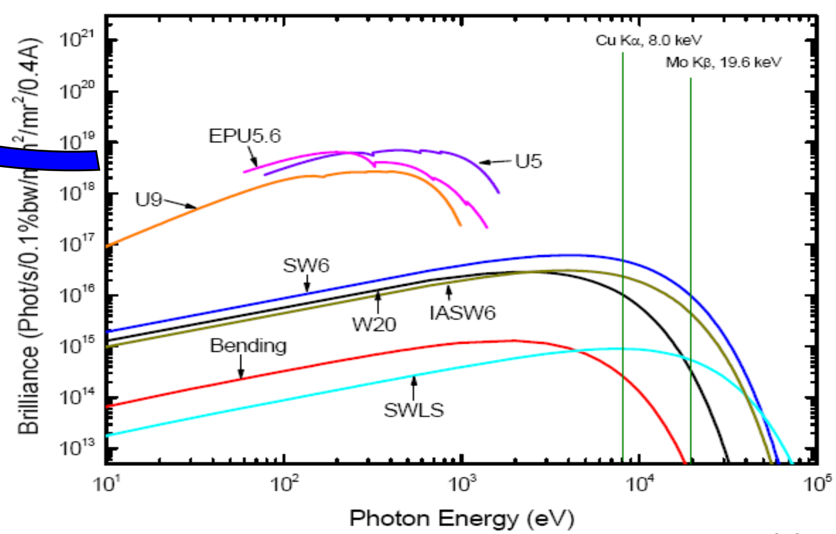
… I.F. ≥ 6.0 for physical science; I.F. ≥ 9.0 for life science.
…p 10%: I.F. ≥ 4.5 for physical science; I.F. ≥ 6.0 for life science.
3. Top 15%: I.F. ≥ 3.5 for physical science; I.F. ≥ 4.8 for life science.

(updated on 105.04.08)

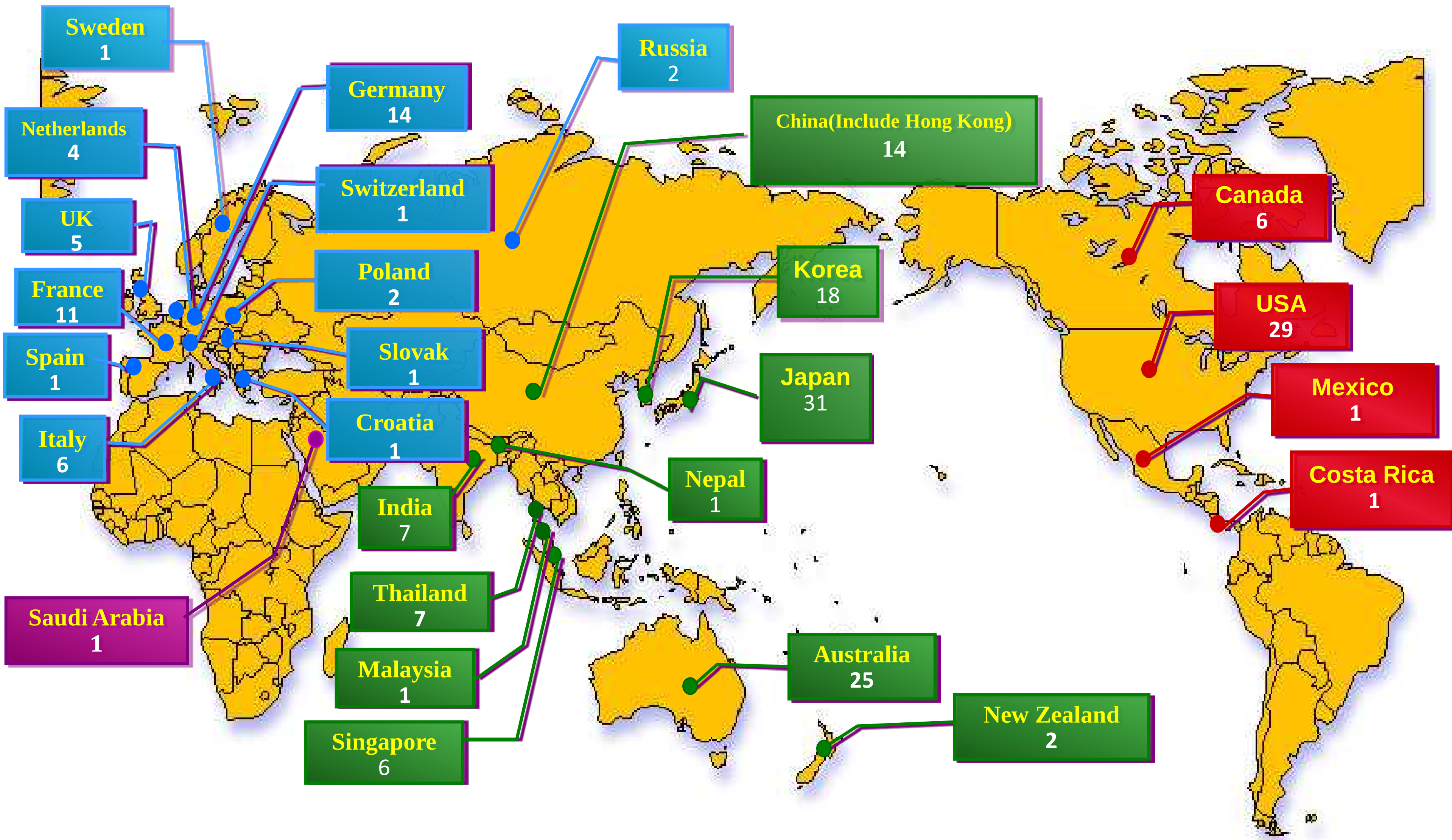
Beamlines in TLS and SPring-8



Brilliance of TLS IDs



Distribution of International Users (199 institutes)

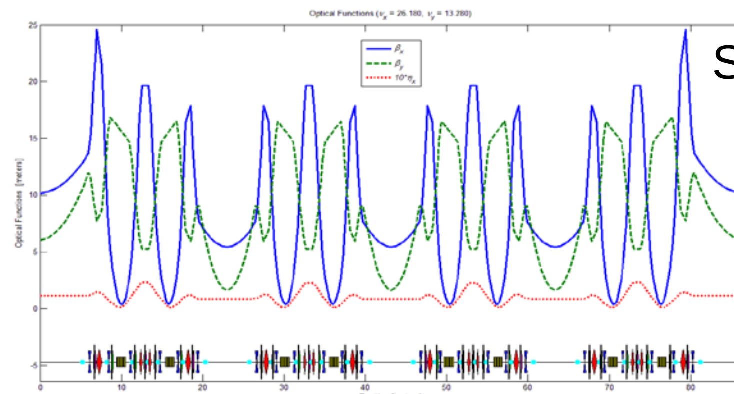


Taiwan Photon Source

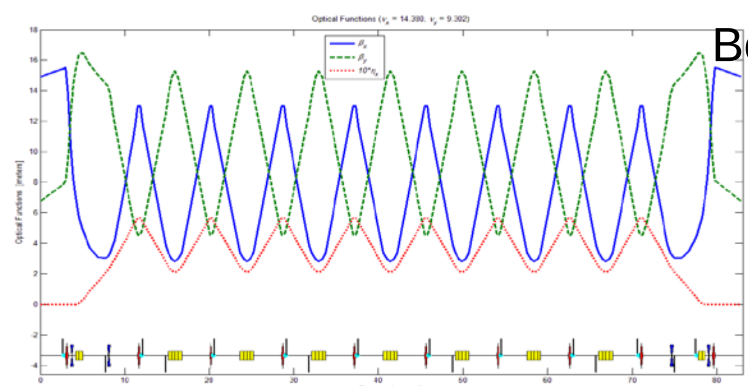
Major parameters of Taiwan Photon Source

Energy	3 GeV (maximum 3.3 GeV)
Current	500 mA at 3 GeV (Top-up injection)
SR circumference	518.4 m (h = 864 = $2^5 \cdot 3^3$, dia.= 165.0 m)
BR circumference	496.8 m (h = 828 = $2^2 \cdot 3^2 \cdot 23$, dia.= 158.1 m)
Lattice	24-cell DBA
Straight sections	12 m x 6 (σ_v = 12 μm, σ_h = 160 μm) 7 m x 18 (σ_v = 5 μm, σ_h = 120 μm)

Storage Ring Circumference (m)	518.4
Energy (GeV)	3.0
Beam current (mA)	500
Natural emittance (nm-rad)	1.6
Straight sections (m)	12 (x6) + 7 (x18)
Radiofrequency (MHz)	499.654
Harmonic number	864
RF voltage (MV)	3.5
Energy loss per turn (dipole) (keV)	852.7
Betatron tune	26.18 /13.28
Momentum compaction (α_1, α_2)	2.4×10^{-4}, 2.1×10^{-3}
Natural energy spread	8.86×10^{-4}
Damping time (ms)	12.20 / 12.17 / 6.08
Natural chromaticity	-75 / -26
Synchrotron tune	0.00609
Bunch length (mm)	2.86



Storage Ring



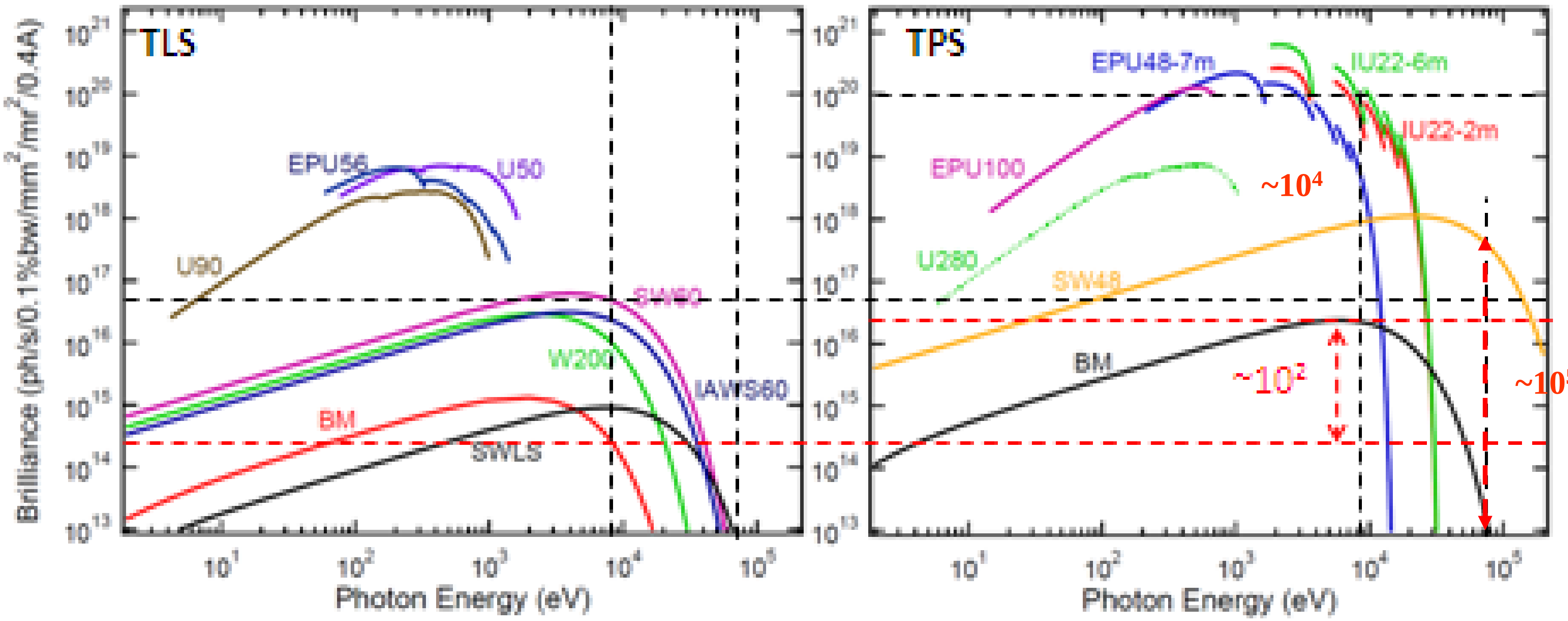
Booster Ring

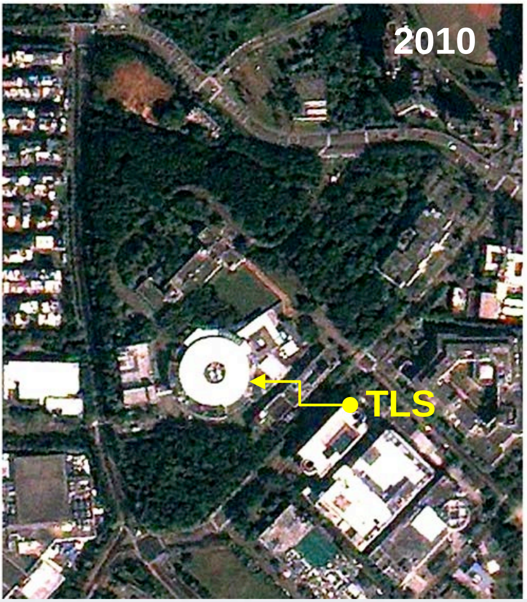
Comparison of brightness between TLS and TPS

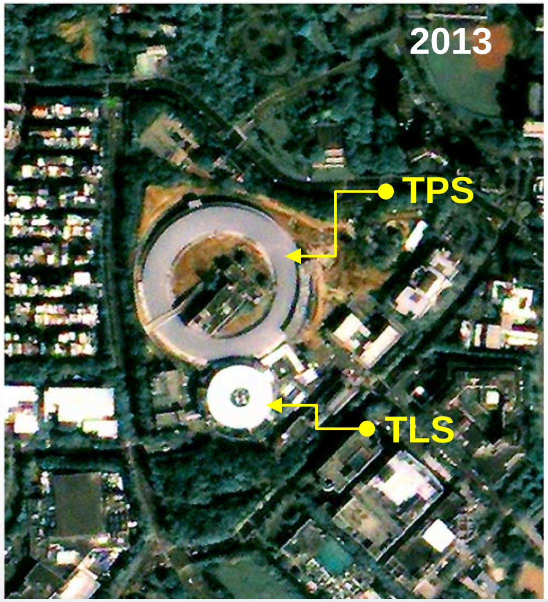
The X-ray spectrum (photon energy 8 keV ~ 70 keV):

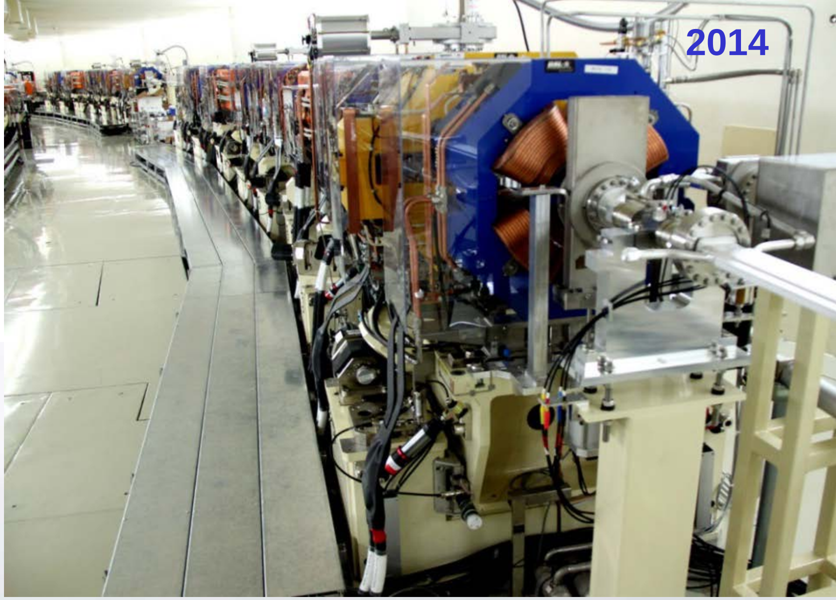
the brightness of bending magnet >10^2.

the brightness of IDs: 4~6 orders of mag.




2010
TLS


2013
TPS
TLS


2014


March, 2015
TLS
TPS

Milestone for Major Acc. Components

- Linac passed the acceptance and under operation since July 2011.
- Two sets of 300 kW transmitters completed acceptance tests in Feb. 2011.
- The 700 W LHe system completed acceptance in Nov. 2012.
- BPM electronics passed acceptance in July 2012.
- The module #1 and #2 of SRF cavity passed 300 kW high-power test in 2013.
- Completed installation of accelerators inside the shielding wall in August, 2014.
- Test of booster hardware integration was completed on Dec. 11, 2014.
- Energy ramping to 3 GeV in booster on Dec. 16, 2014
- Full energy inject to storage ring with stored beam up to 5 mA, on Dec. 31, 2014
- Optimization the performance of booster and storage ring during the Q1 of 2015. (stored current > 100 mA, booster to storage ring efficiency >75%, measured all beam optics parameters with installed Petra cavities.)
- Installation of 10 insertion devices and 2 superconducting SRF cavities in Q2 and Q3 of 2015.
- Re-start the TPS accelerators and commissioning of 6 beamlines, 10 IDs and 2 SRF cavities in September of 2015. (stored current >520 mA with DMB lattice)

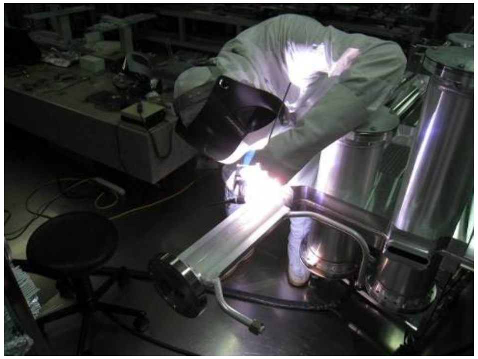
Process welding of BC in Chu-Tung


Upper and lower leaf of BC

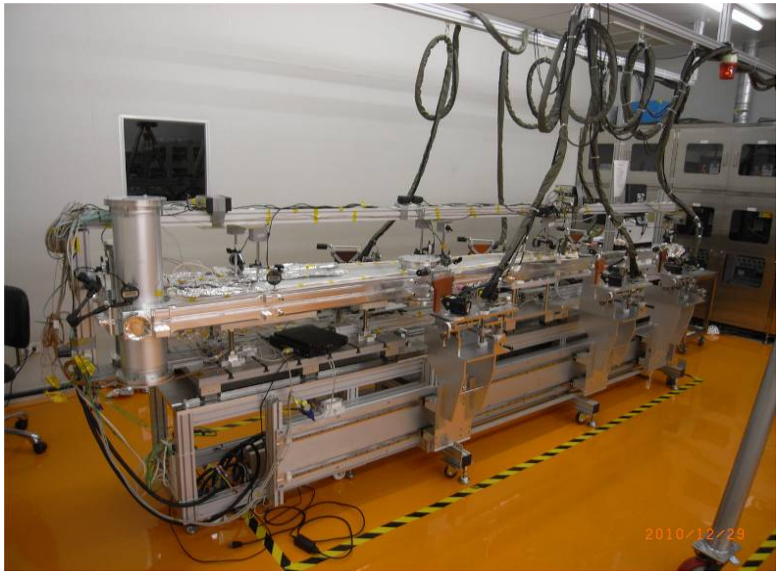

Welding pumping port


Alignment for the bending chamber


Bending chamber in auto-welding stage



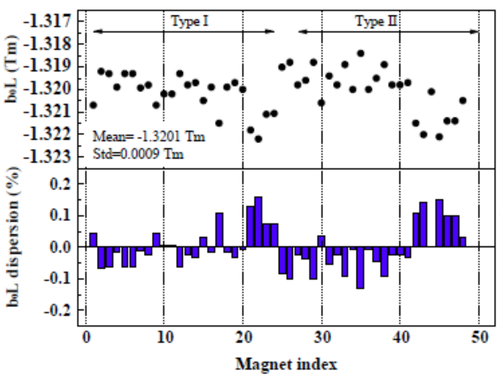
Assembly of vacuum system and storage in Chu-Tung

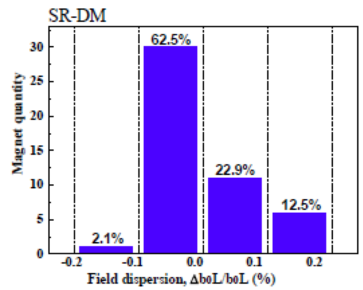


Field qualification of SR and BR magnets

SR dipole magnet

Field dispersion



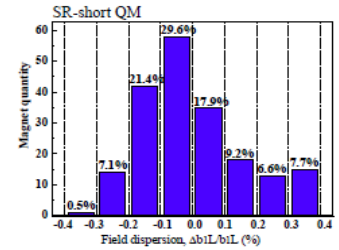


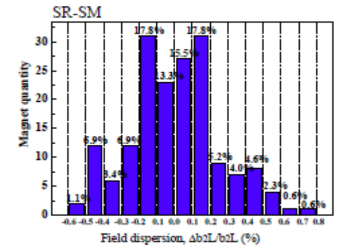
48 SR-DM:

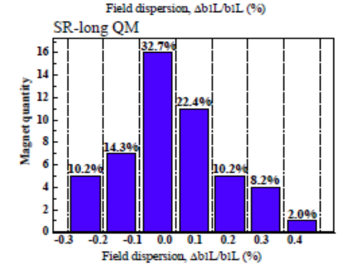
- The mean value of b_0L is -1.3201 Tm.
- The standard deviation of b_0L is 0.0009 Tm (0.07%).
- The b_0L dispersion is better than 0.16%. (85.4% of magnet are better then ±0.1%).

SR quadrupole/sextupole magnet

Field dispersion







SR-QM/SM:

- The b_1L of Short-QM and Long-QM are better than ±0.4%.
- The b_2L dispersion of 95.4% of SM are better than ±0.5%.
- The integral field strength of QM/SM magnet will be fine-tuned with an independent power supply.

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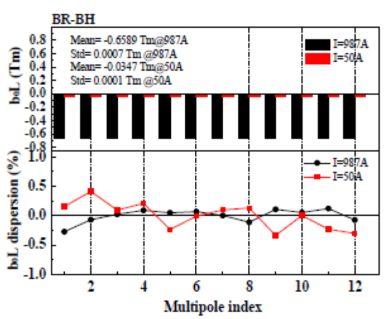
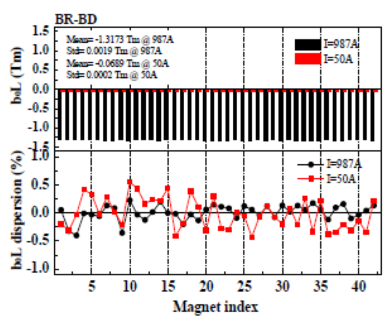
BR-dipole magnet

Field dispersion





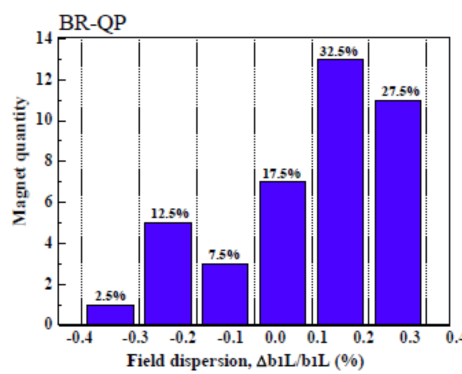
12 BH and 42 BH:

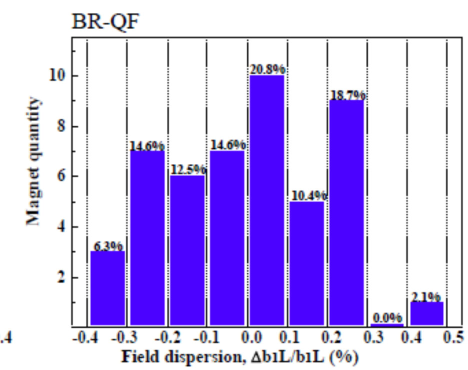
- The mean value of BH and BD is -0.6586 Tm and -1.3173 Tm with 987A charged respectively.
- The standard deviation of BH and BD is 0.0007 Tm (0.11%) and 0.0019 Tm (0.14%) with 987A charged, respectively.

18

BR-quadrupole magnet

Field dispersion





BR-QM:

- The b_1L dispersion of BR-QP is better than ±0.4%.
- The b_1L dispersion of BR-QF is better than ±0.5%.

Integration of magnets, vacuum chambers and girders

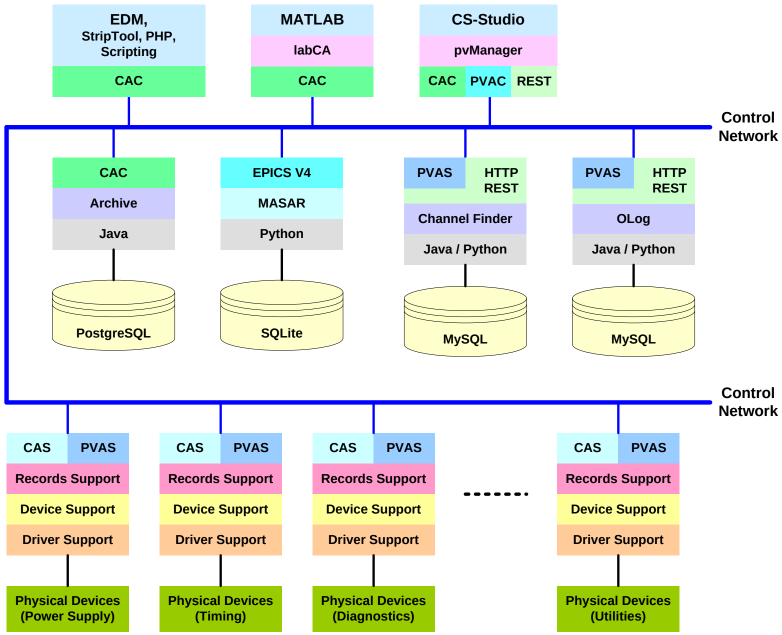
Installation of a 14 m vacuum cell on the girders.

Anchor the 14 m vacuum cell on the girders.

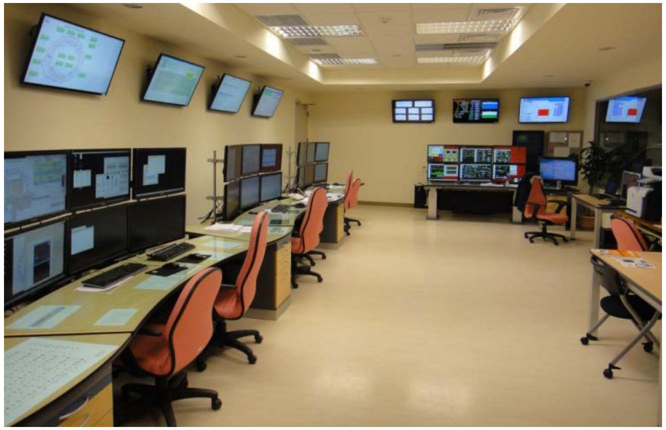
Assembling of a 14 m vacuum cell with magnets in the tunnel

Installation of the vacuum system for the 1/12 section of booster.

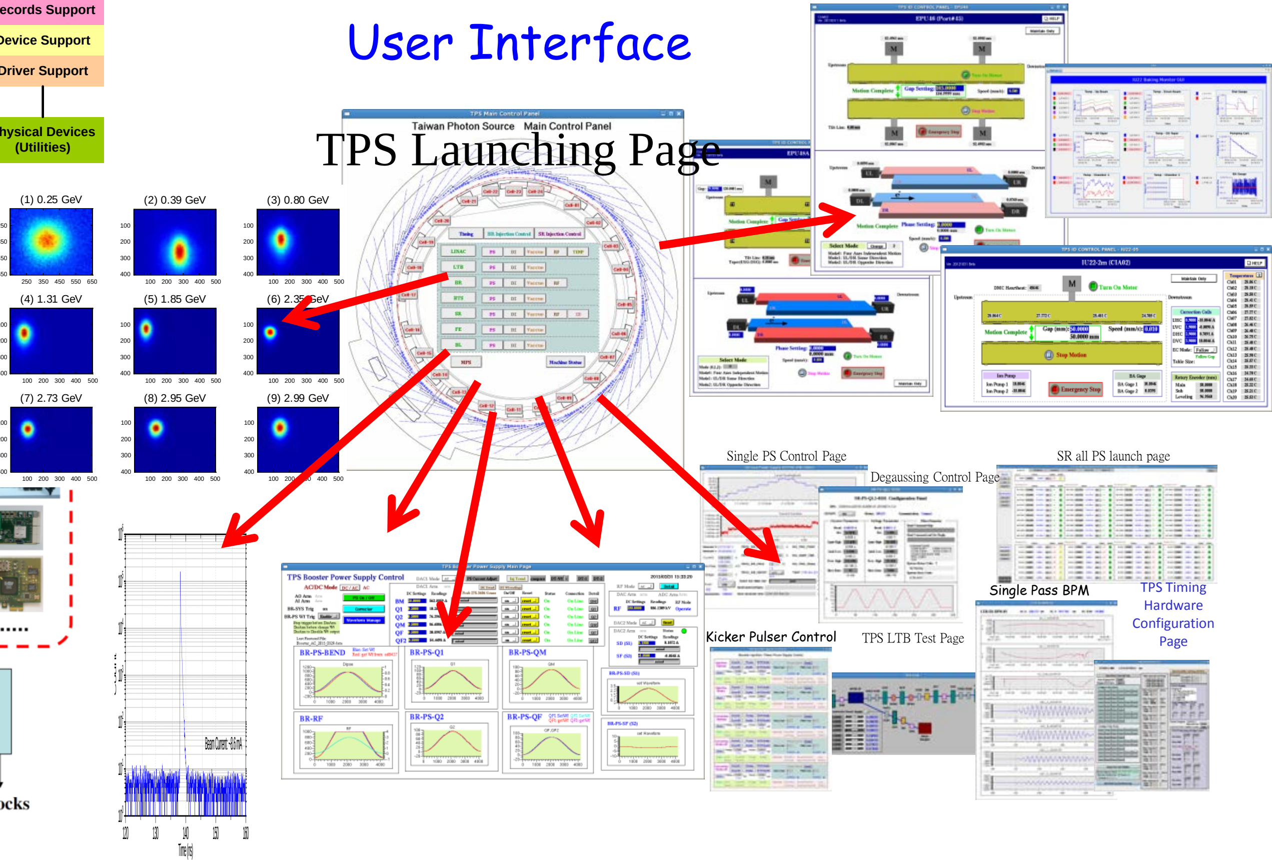
Software Architecture



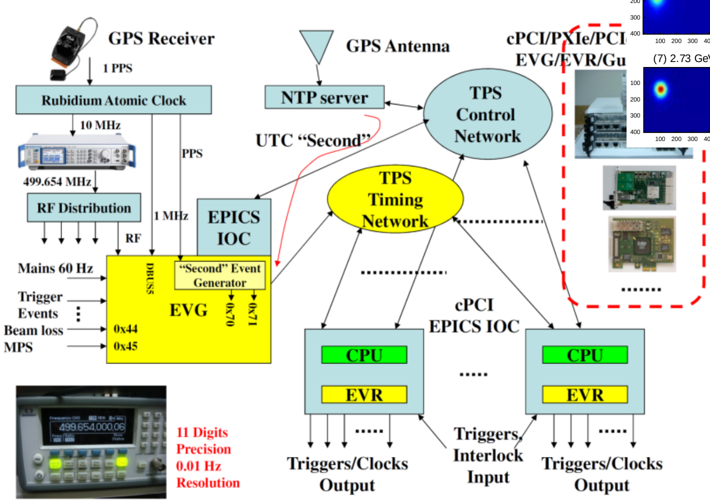
Control Room



User Interface



Timing System

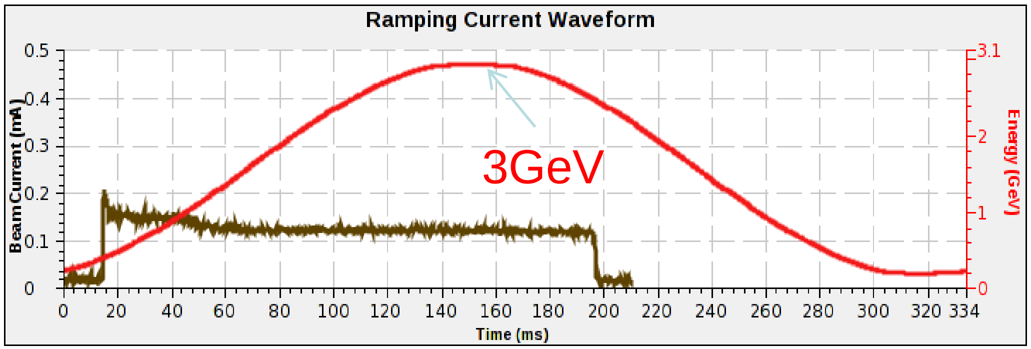


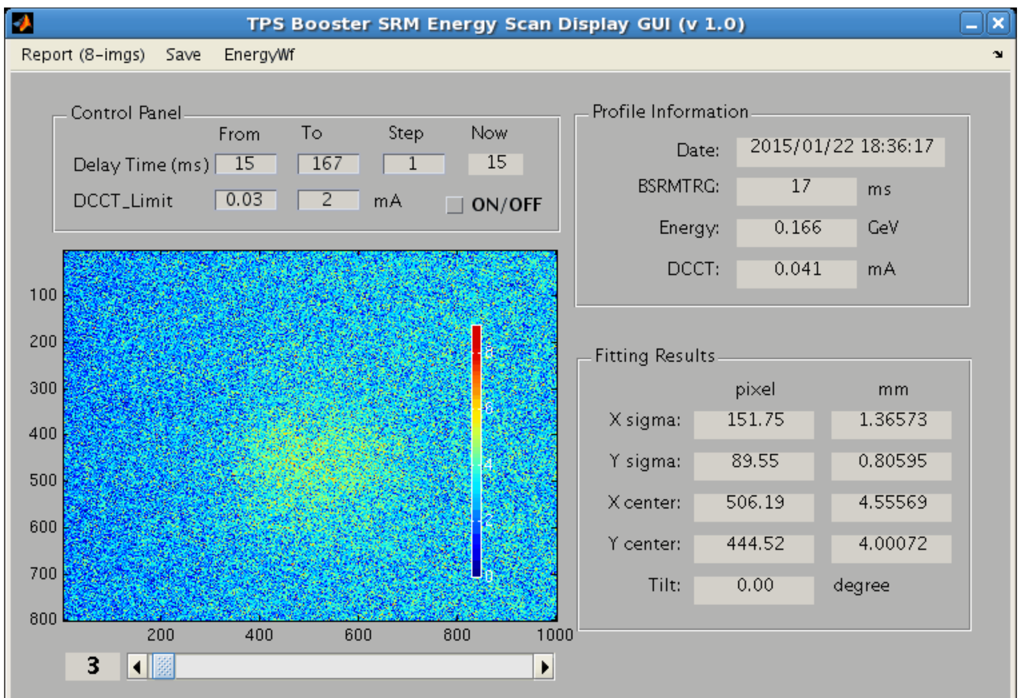
Commissioning of Accelerators

Booster commissioning

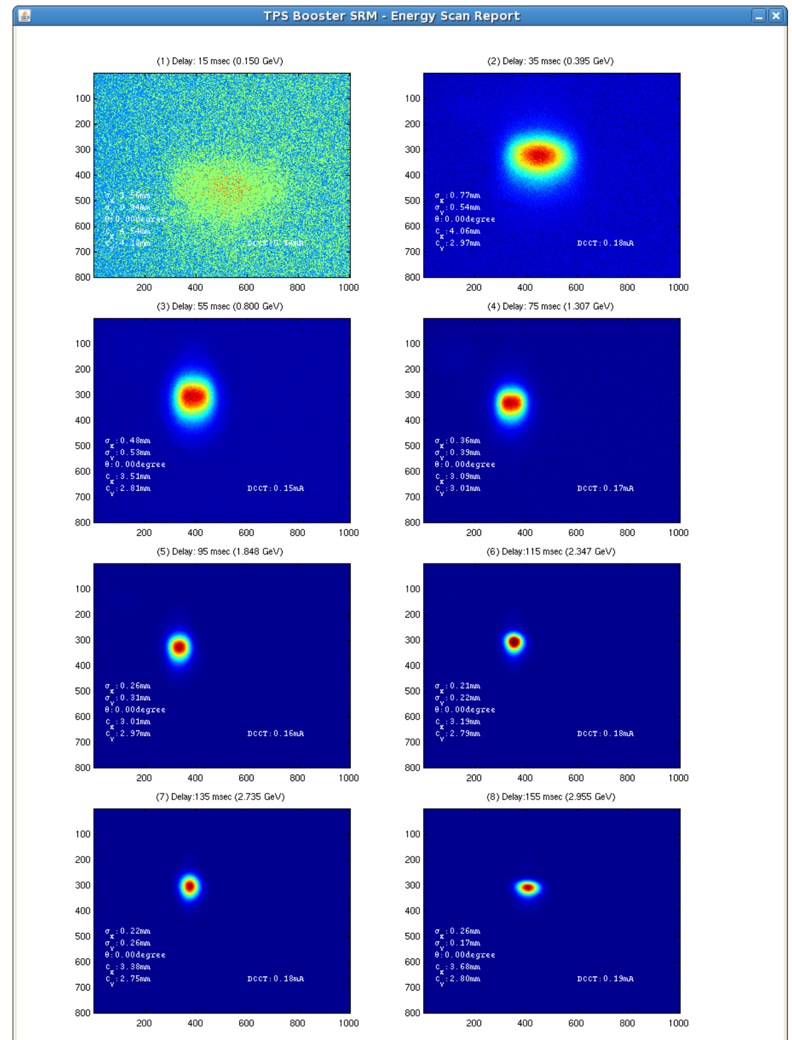
Booster beam commissioning started on 12 Dec. 2014, successfully ramped to 3 GeV on 16 Dec. 2014

Beam Current (peak): 0.16 mA at 3 GeV



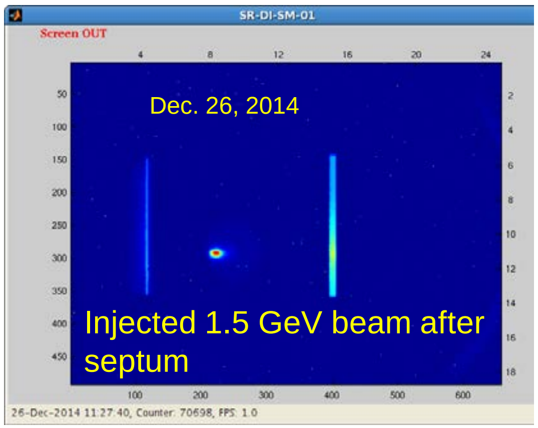


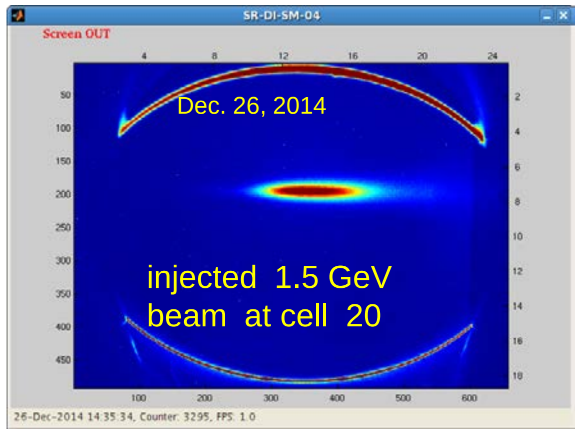
Beam profile measured by synchrotron light monitor

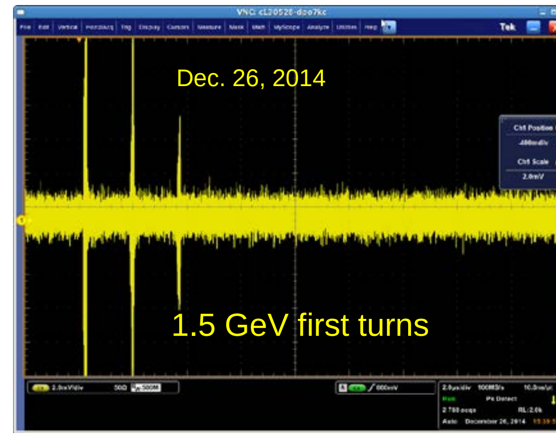


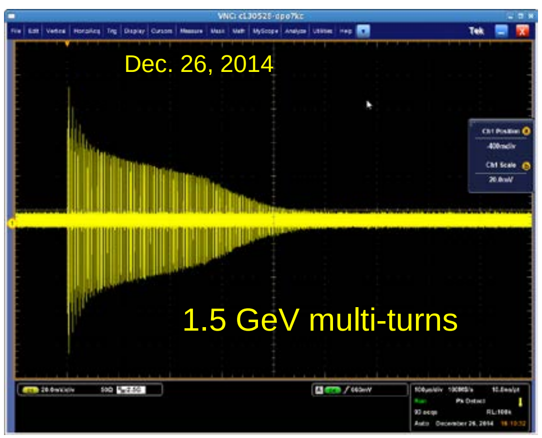
Storage Ring Commissioning at 1.5 GeV

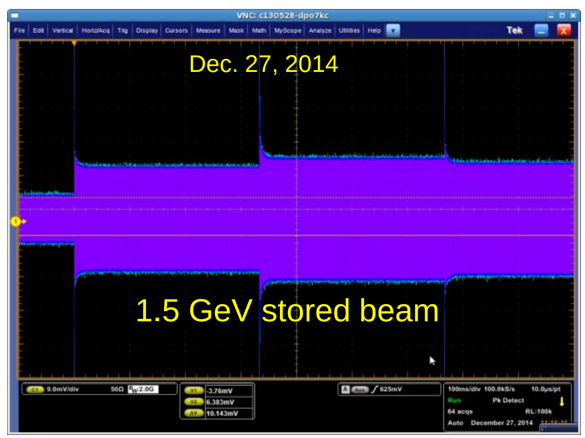
- **Dec. 24, extracted 3 GeV beam but DC septum leakage field affected booster**
- **Dec. 26, 1.5 GeV beam injected, multi-turn with one H corrector**
- **Dec. 27, stored beam with sextupoles and RF on. RF, sextupole, and quad scan**
- **Dec. 29, accumulated beam with kicker scan**

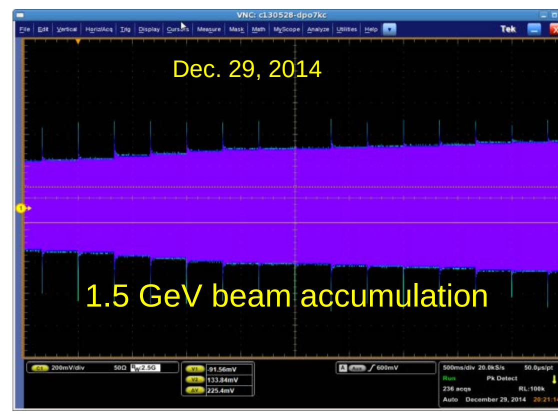










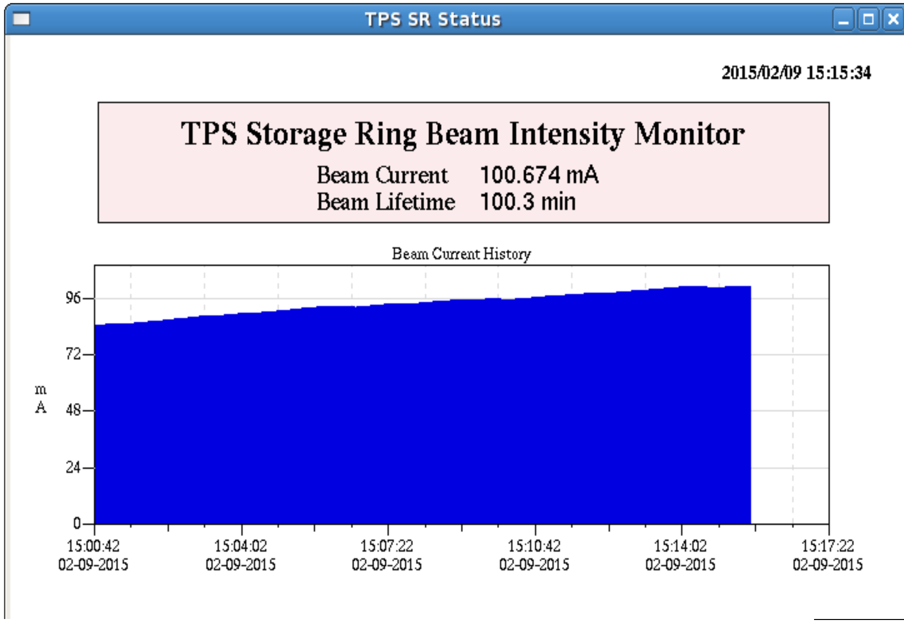


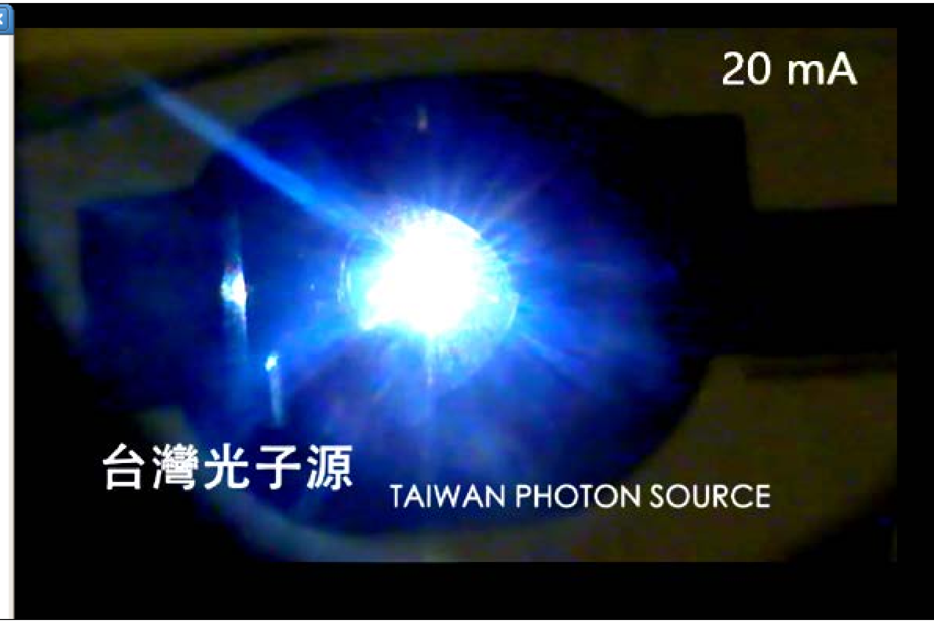
The first synchrotron light from TPS storage ring at 3GeV, 1mA

December 31, 2014

BR and SR commissioning and optimization

On 15 Jan. 2015



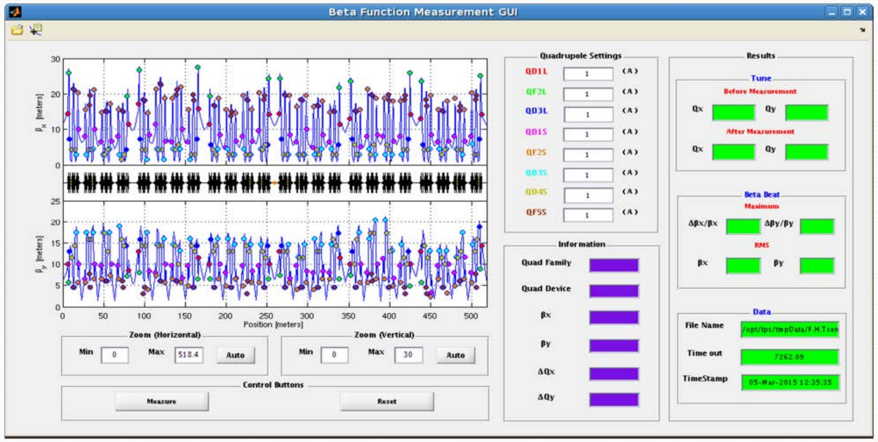


BR inj. with single bunch

注射中電流增加光源亮度增強

Before Optics Correction

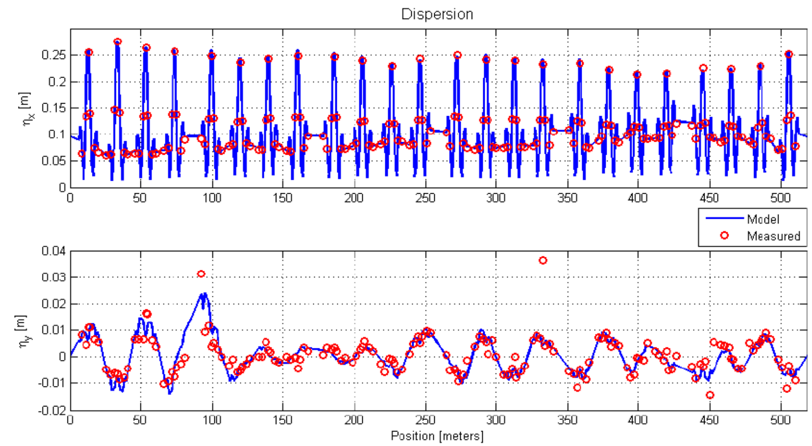
(Beta function)



Blue line is LOCO fitting result

Before Optics Correction

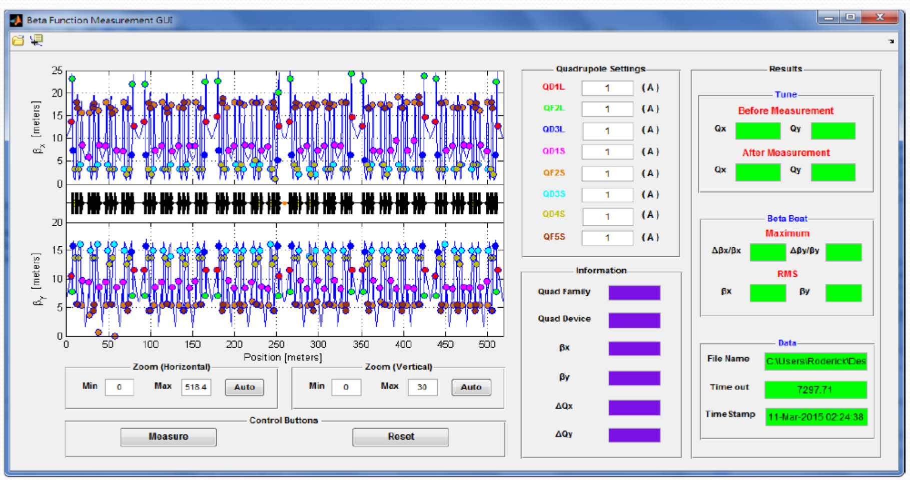
(Dispersion function)



Blue line is LOCO fitting result

After Optics Correction

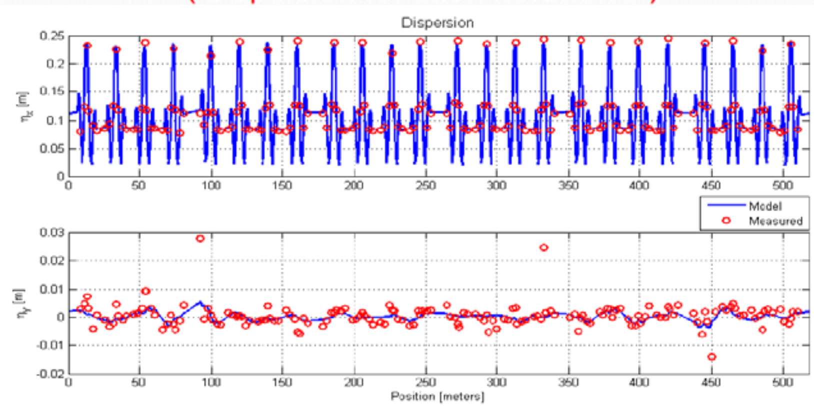
(Beta function iteration 3)



Blue line is LOCO fitting result

After Optics Correction

(Dispersion function iteration 3)

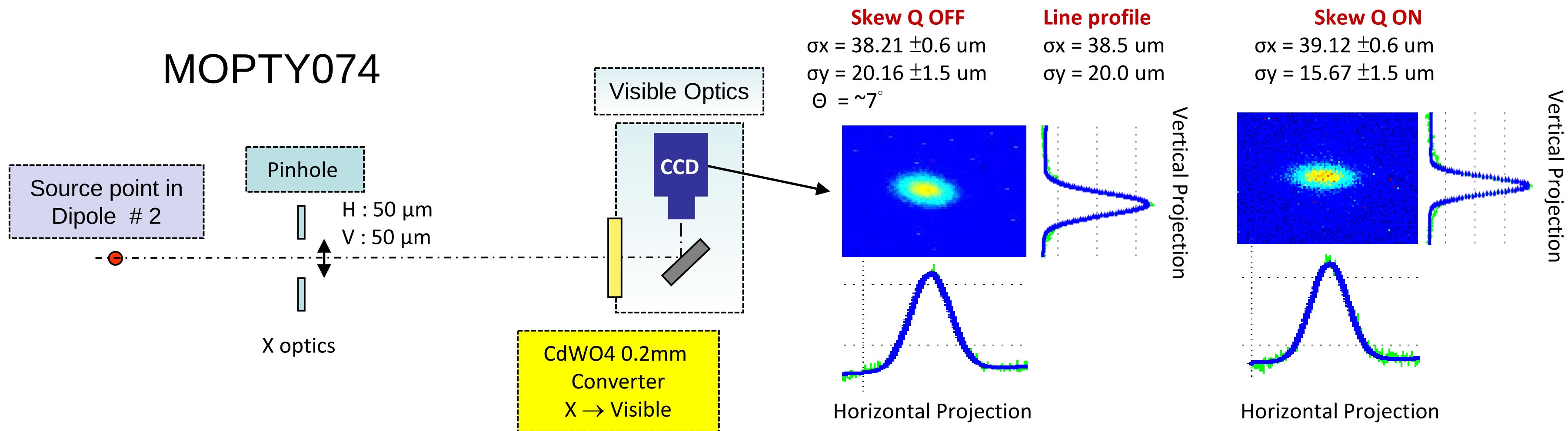


Blue line is LOCO fitting result

TPS commissioning C.C. Kuo, IPAC'15

Coupling Ratio and Emittance

MOPTY074



Pinhole camera	without skew quad	with skew quad
H. Emittance (nm.rad)	1.55	1.64
V. Emittance (pm.rad)	25.6 ±3	15.7 ±3
Emittance ratio (%)	1.65	0.96

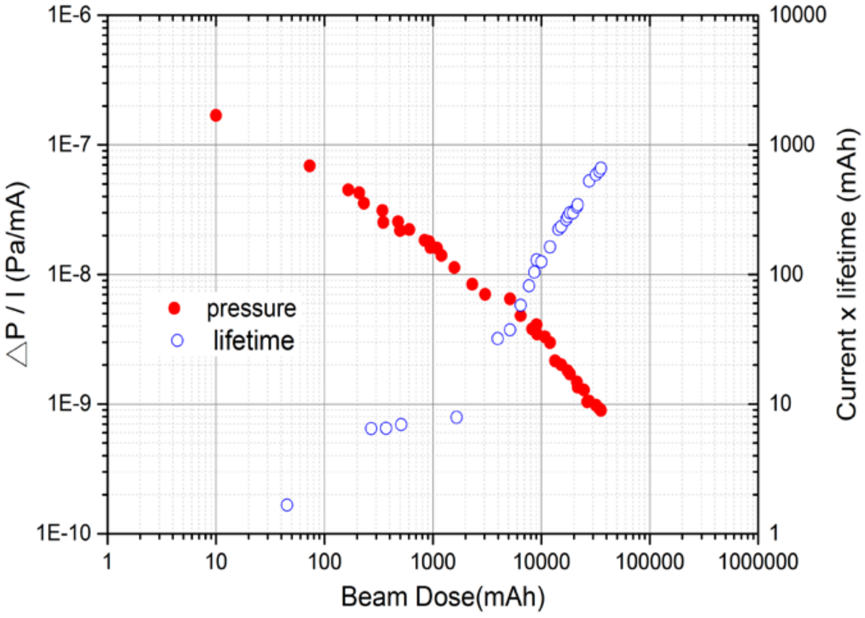
Estimated Emittance ratio (%)	without skew quad	with skew quad
Betatron Coupling	0.170	0.001
Vertical Dispersion	0.156	0.038

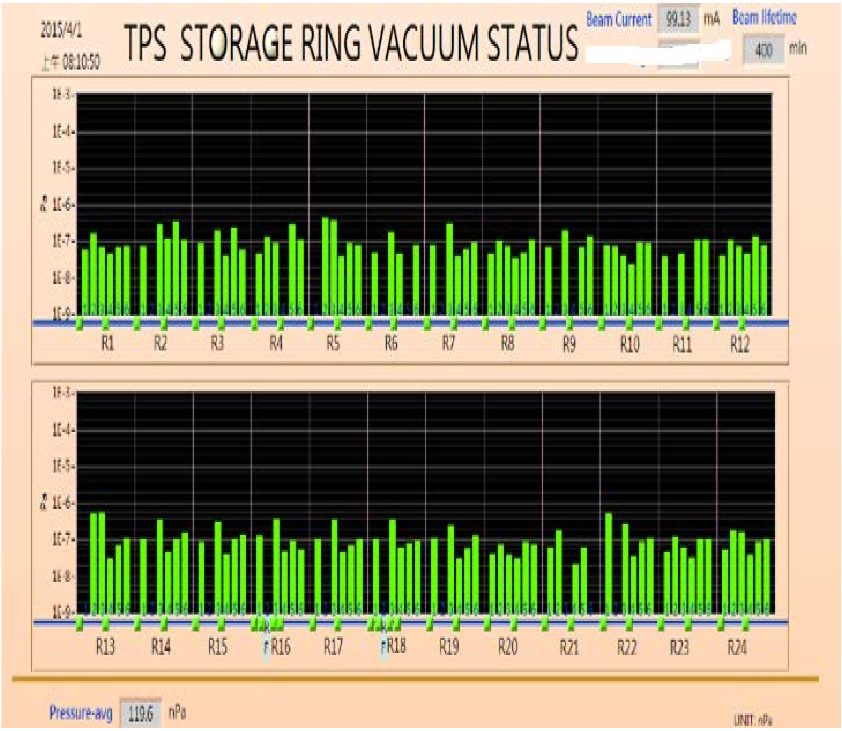
Discrepancy: Orbit noise, instabilities, resolution in instrument

Design Natural Emittance ε_{x0} ***= 1.6 nm.rad***

Vacuum Conditioning

- **At the end of phase-I commissioning, dynamic pressure reached 1.17 10^{-7} Pa at 100 mA after 35 A.h beam dose**
- **Lifetime at 100 mA reached more than 6 hours**

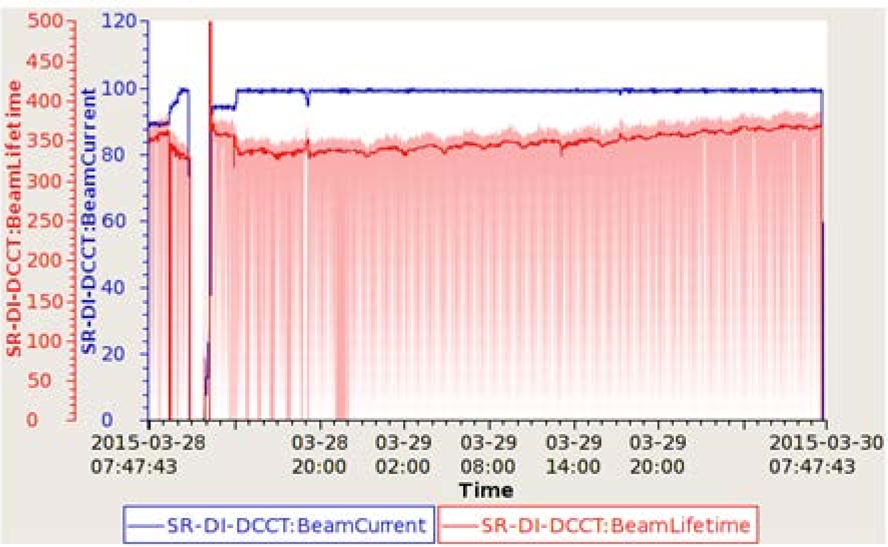




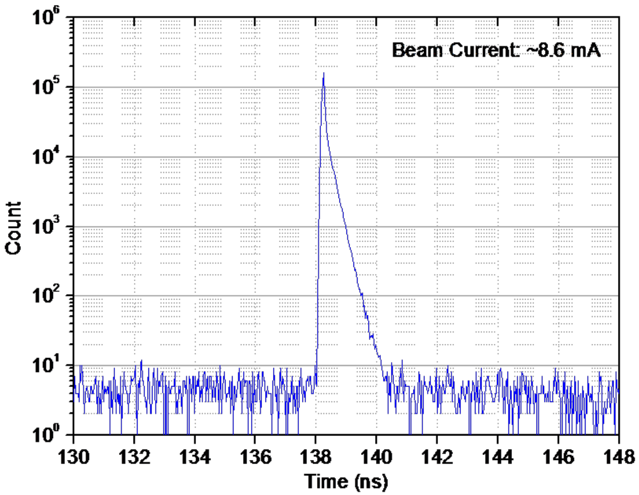
WEPHA048

Beam Current

- **Beam current reached 100 mA in multi-bunch mode**
- **Single-bunch recorded 12 mA**
- **~ 0.4 mA/s accumulation rate in multi-bunch mode**



Beam current and lifetime

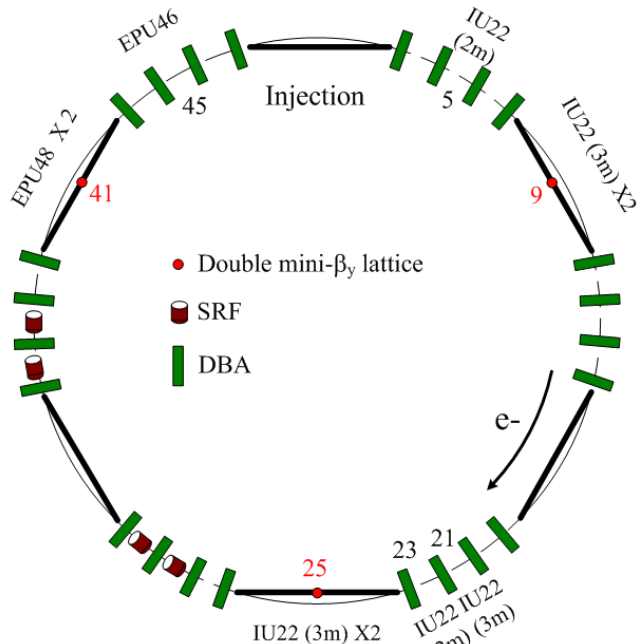


Single bunch impurity (TCSPC) near 10^{-5} with rf knock-out in storage ring

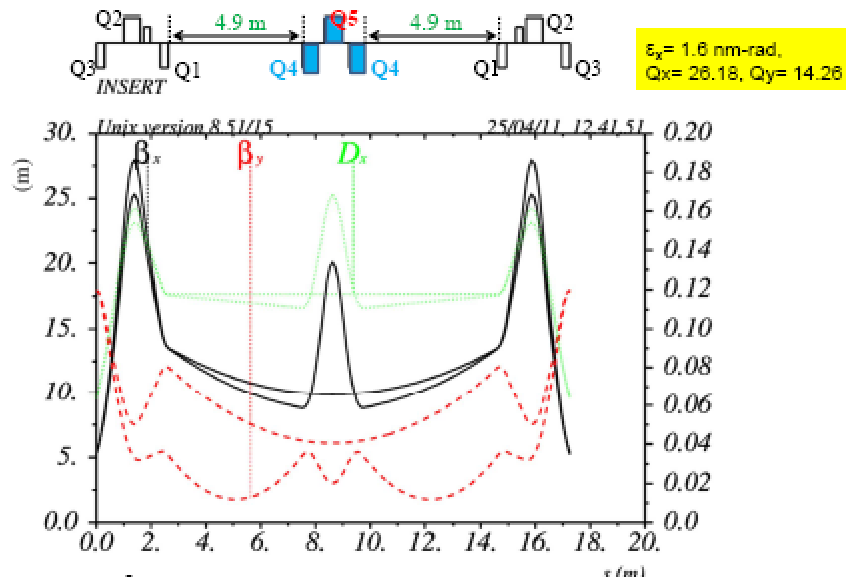
MOPTY074

Installation of IDs, SRF cavities and Other Hardware

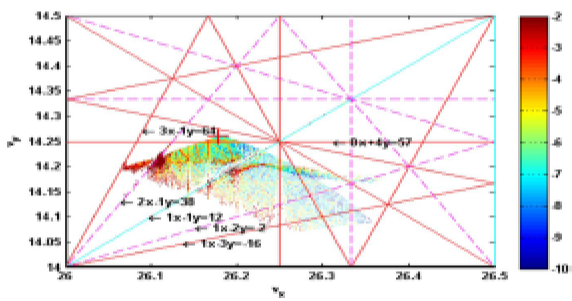
Double minimum-βy lattice

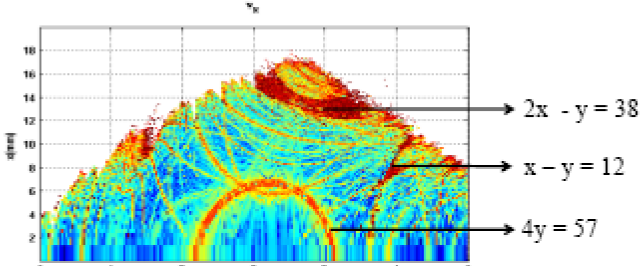


Double mini-βy lattice



Frequency map (TDMB1826_A)



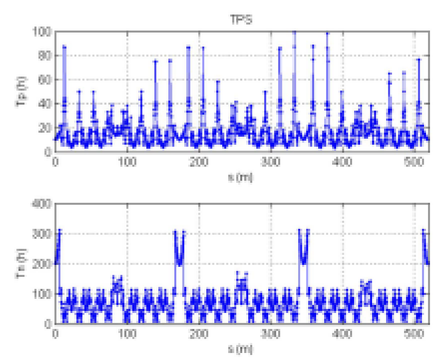


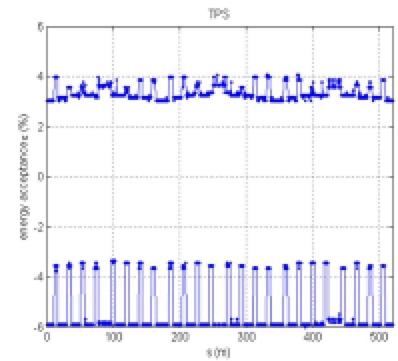
1% Emittance coupling	Multipole errors	Chamber limit	ID kick map
+	+	−	−

+: Included.
−: Not included.

Momentum acceptance & Touschk lifetime

Bruck's formula: TDMB1826_A





Ex: 1.621212E-9
Ey: 1.627102E-11

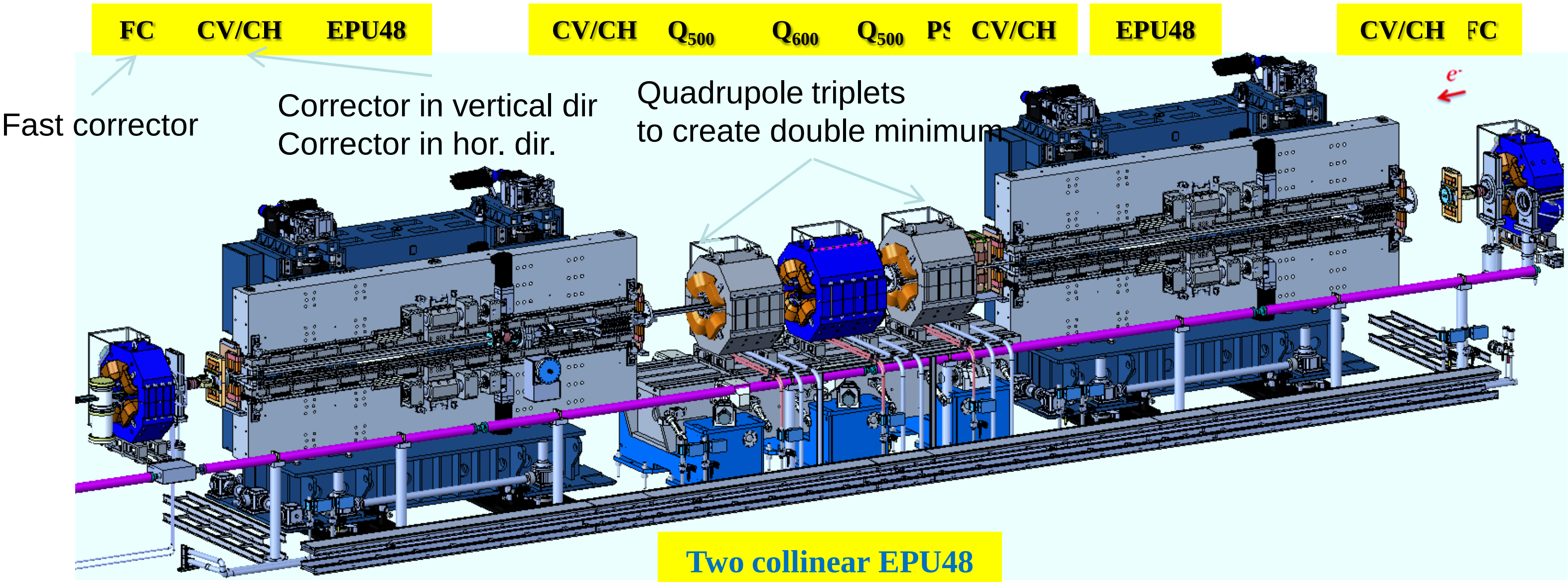
T: 16.94 / Tp:10.87 / Tn: 38.38 (hrs)

Bunch current: 400 mA / 800 bunches
Bunch length: 2.86 mm

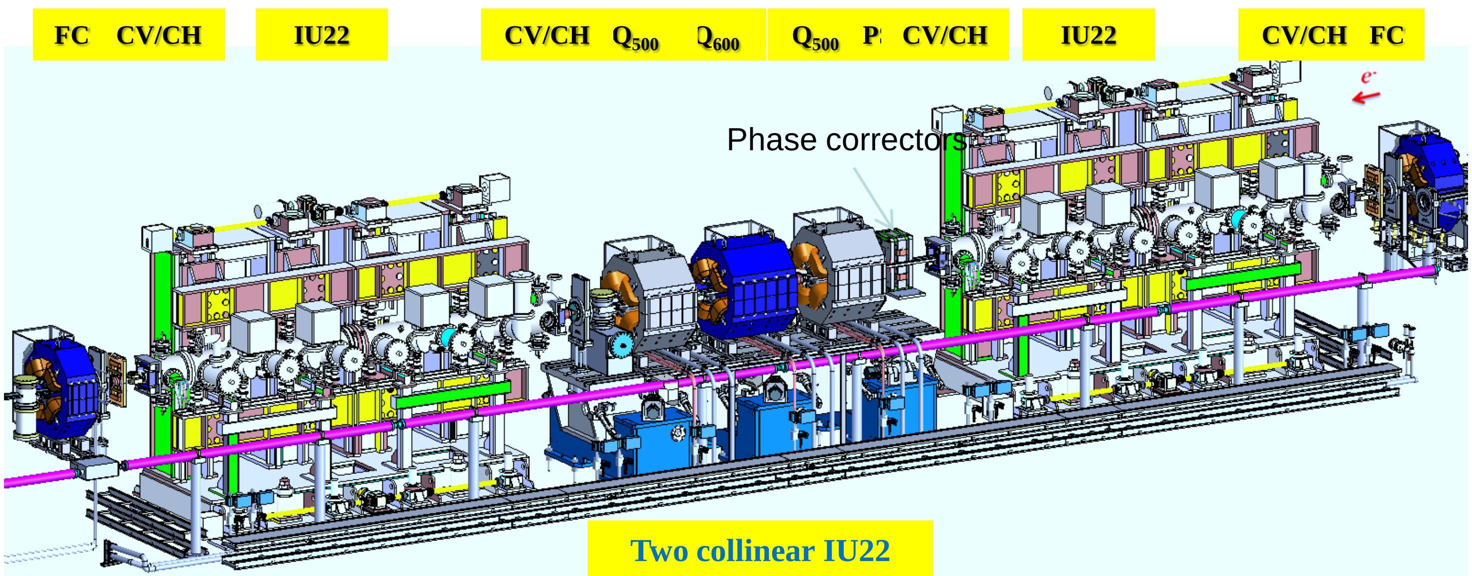
1% Emittance coupling	Multipole errors	Chamber limit	ID kick map
+	+	+	+

+: Included.
−: Not included.

IDs at Straight Section of Double Mini-βy Lattice

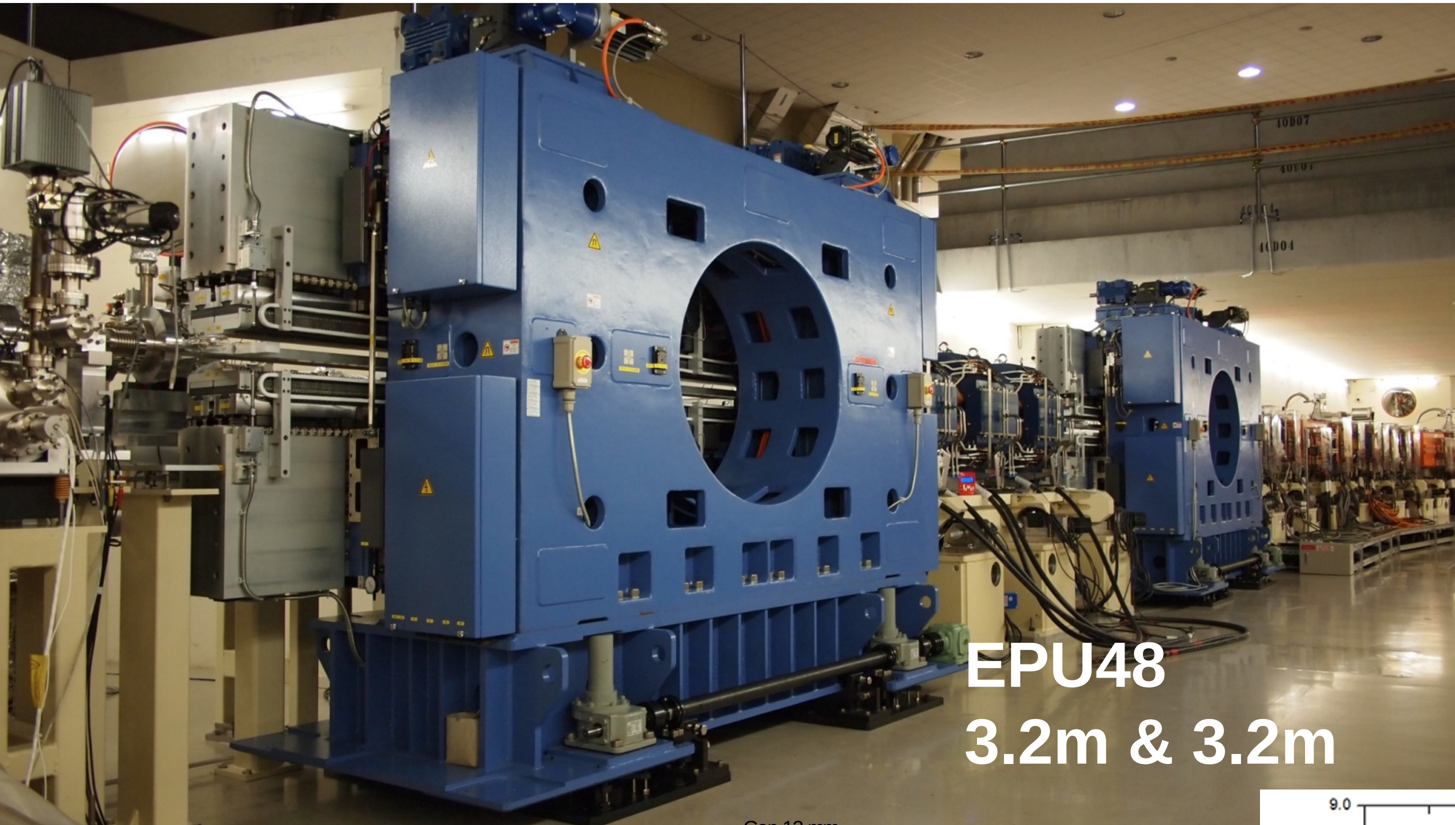


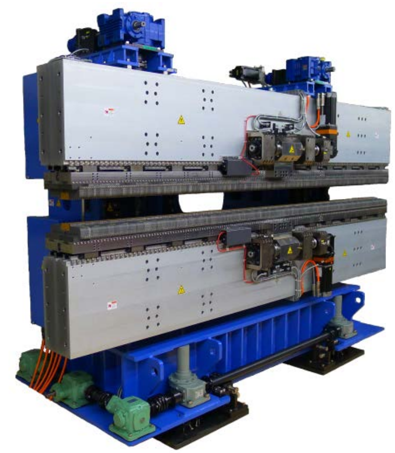
Two collinear EPU48

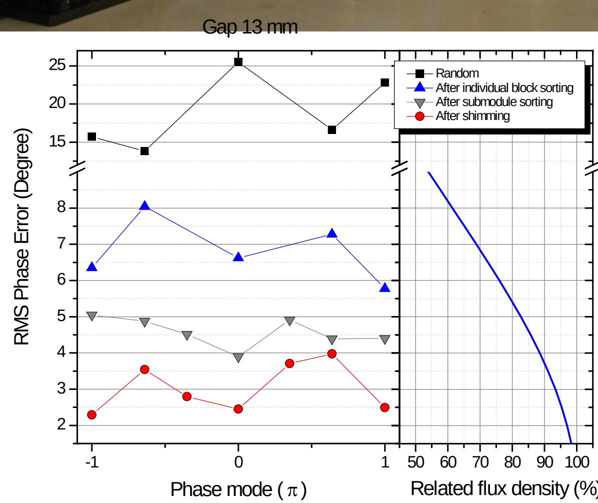


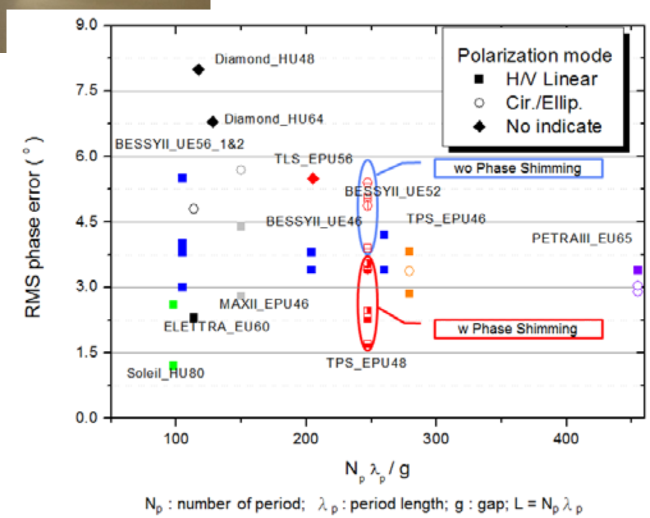
Two collinear IU22

Elliptical Polarized Undulators at long straight

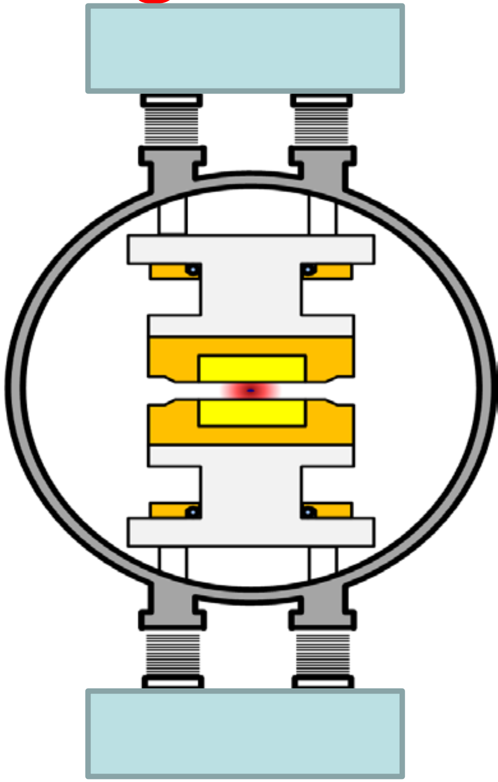


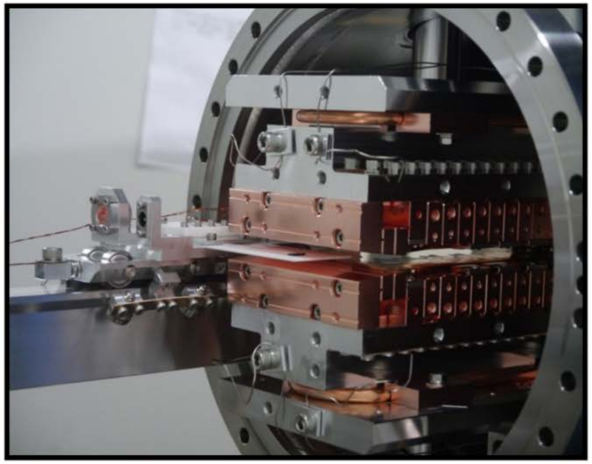


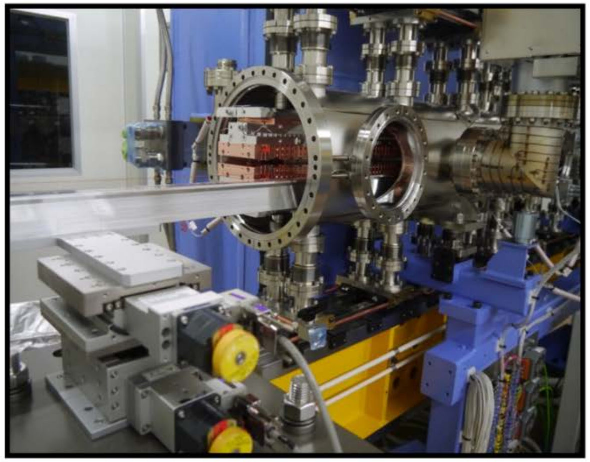


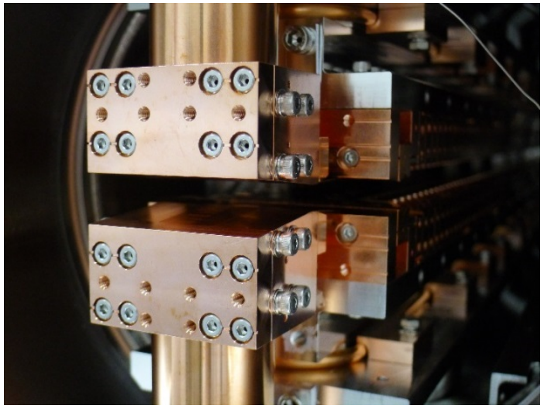


In-vacuum undulators at 12 m straight



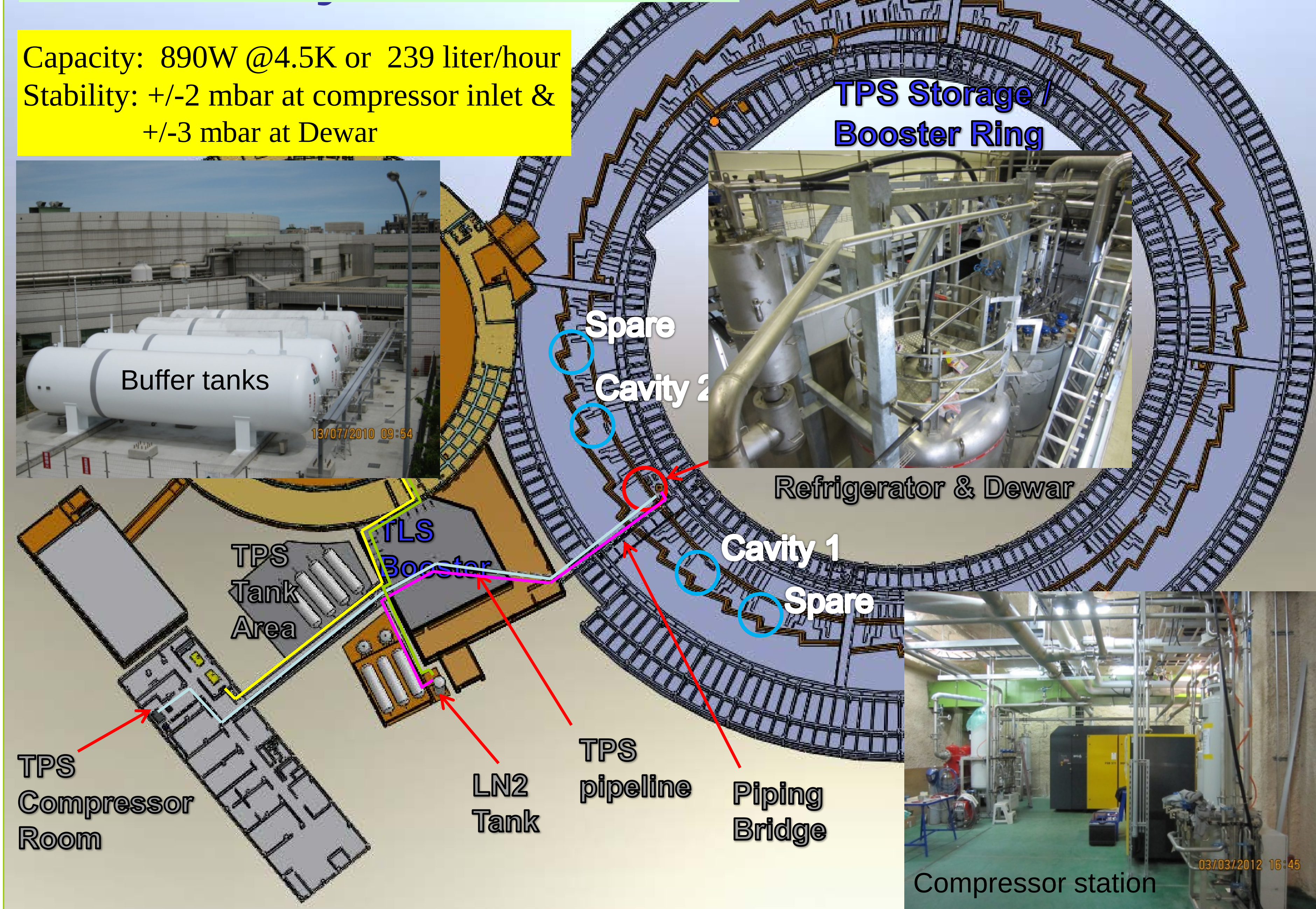






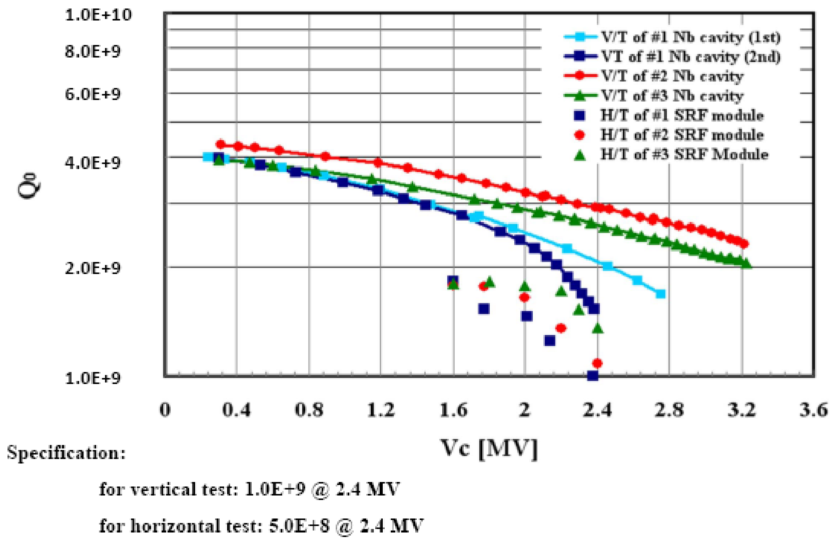
TPS Helium Cryogenic Plant

Capacity: 890W @4.5K or 239 liter/hour
Stability: +/-2 mbar at compressor inlet &
+/-3 mbar at Dewar



Major RF sub-system

Low-level system for RF transmitter



Performance of SRF modules 2.4 MV: $Q_0 > 5*10^8$

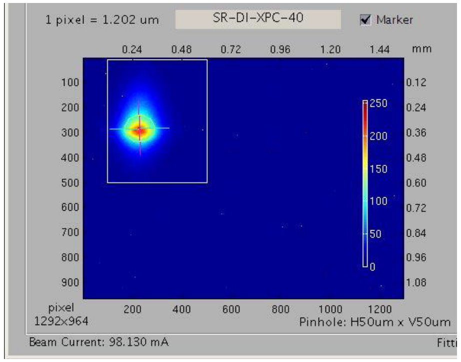
Installed 5-cells Petra cavities for phase-I

SRF cavity installed in tunnel

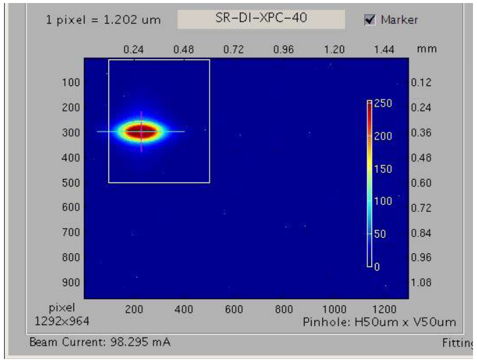
Instabilities in transverse and longitudinal directions

- Transverse instability suppressed by adequate chromaticity setting and by bunch-by-bunch feedbacks (BBF) in vertical planes.
- Stabilized beam up to 500 mA without problem.
- No longitudinal instability observed.

Vertical BBF “OFF”

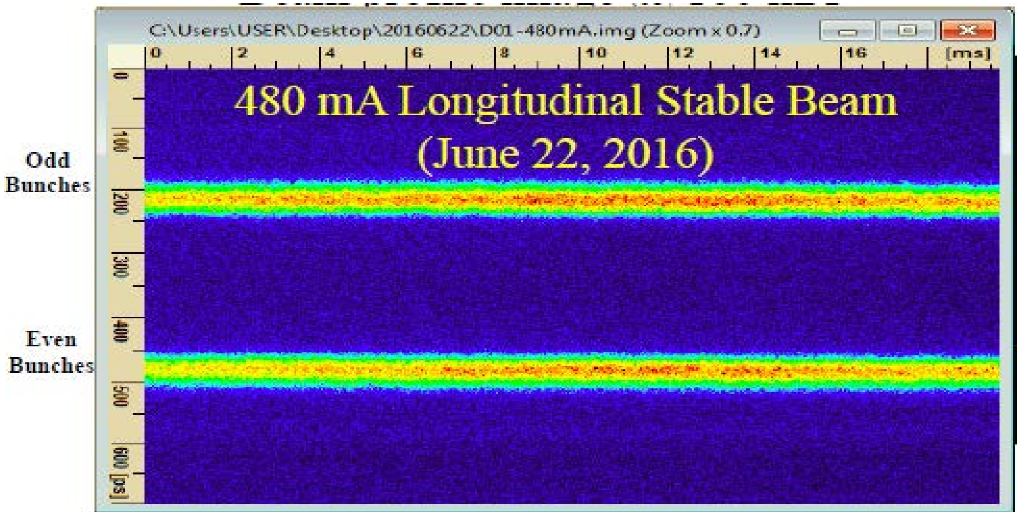


Vertical feedback “ON”

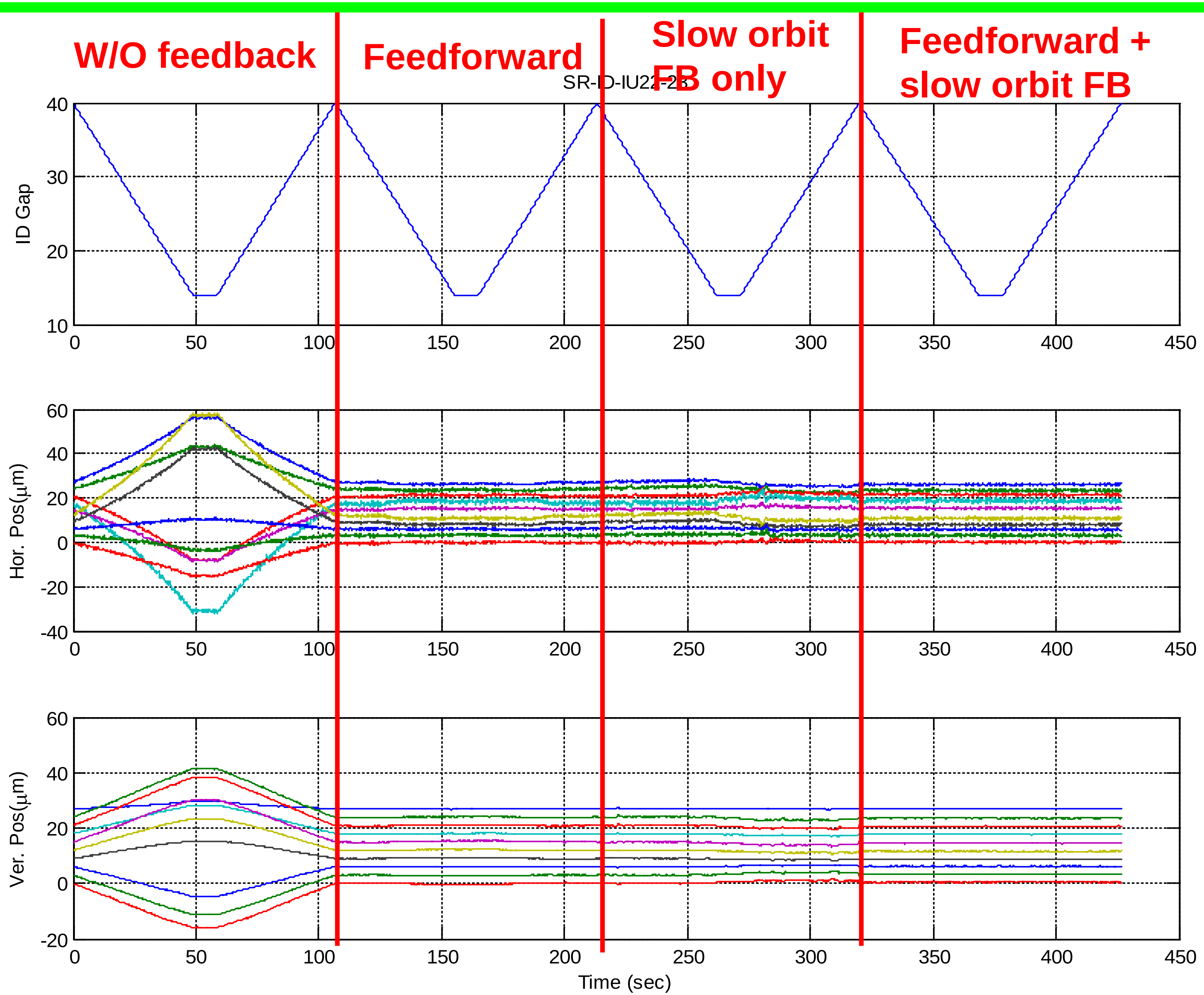


Beam profile image @ 100 mA

Longitudinal Stable Beam @ 480 mA

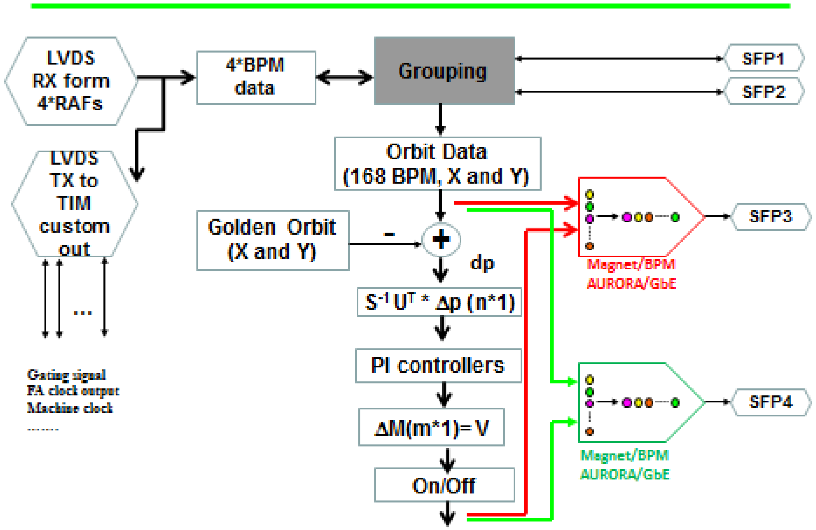


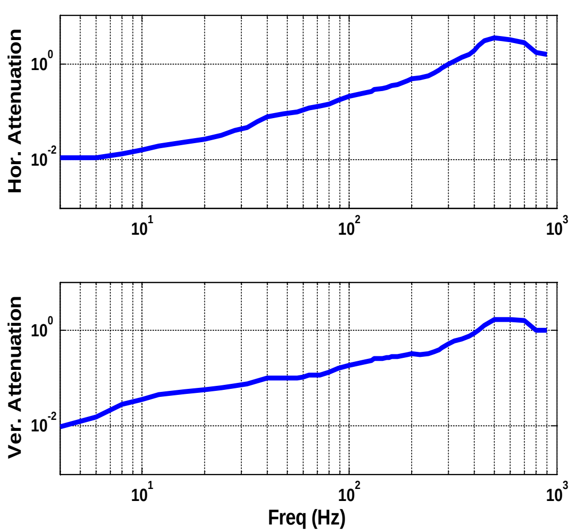
IU22-23 Measured on 2015/11/18



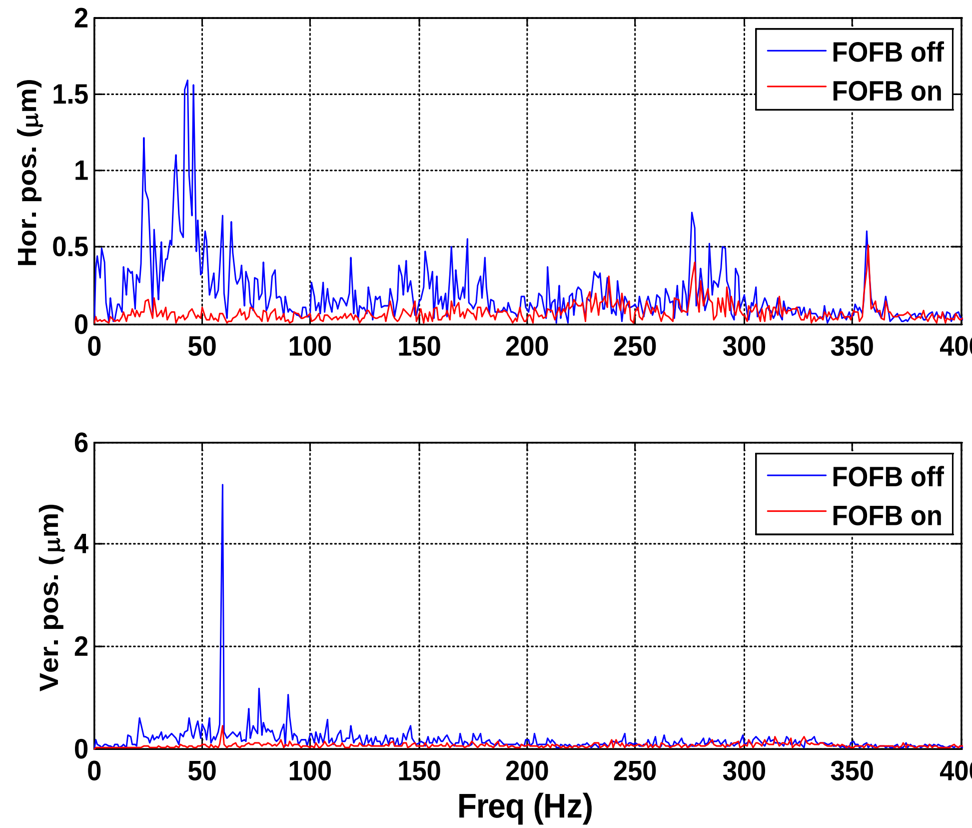
Performance of fast orbit feedback system

Block of FOFB computation modules

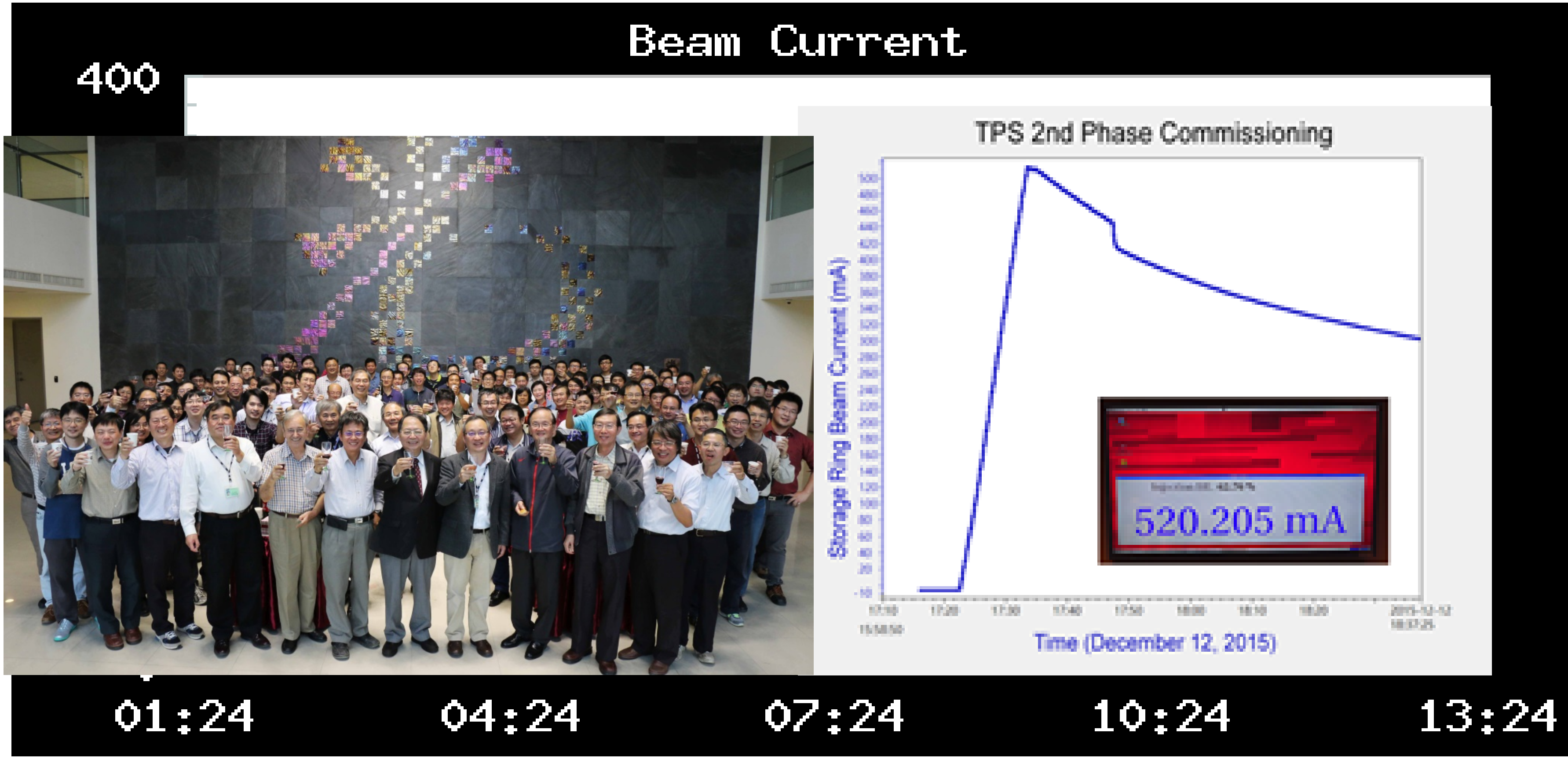




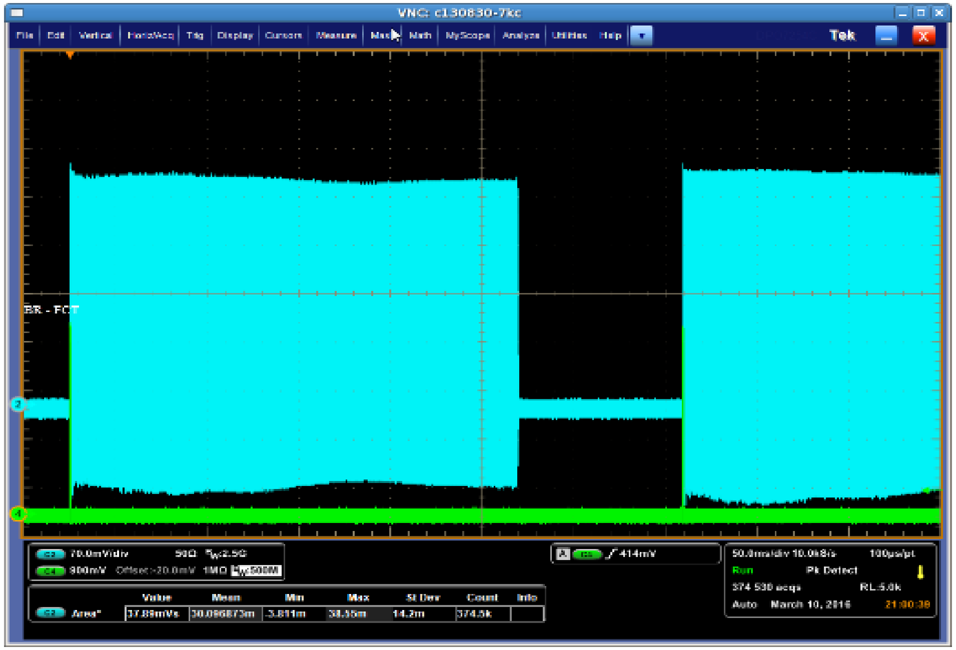
The measured bandwidth of FOFB. Horizontal around 250Hz and vertical around 300 Hz.

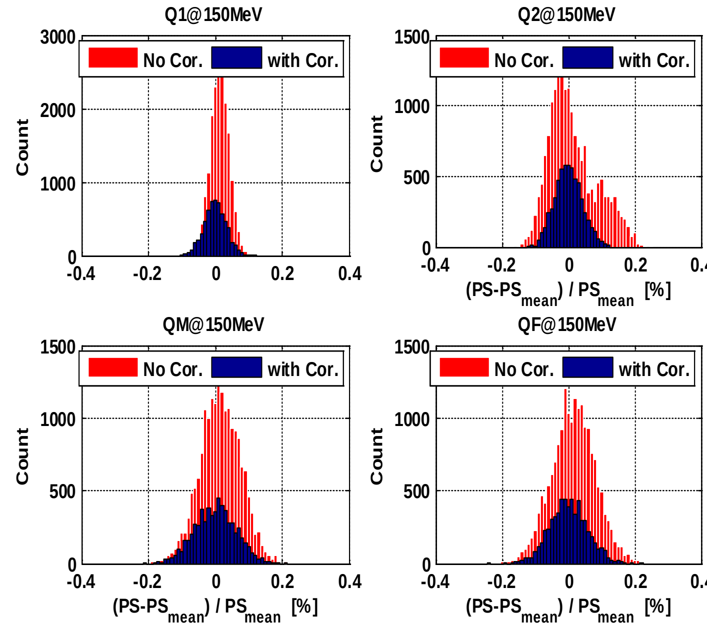


Beam Spectrum (no booster power supply ramping)

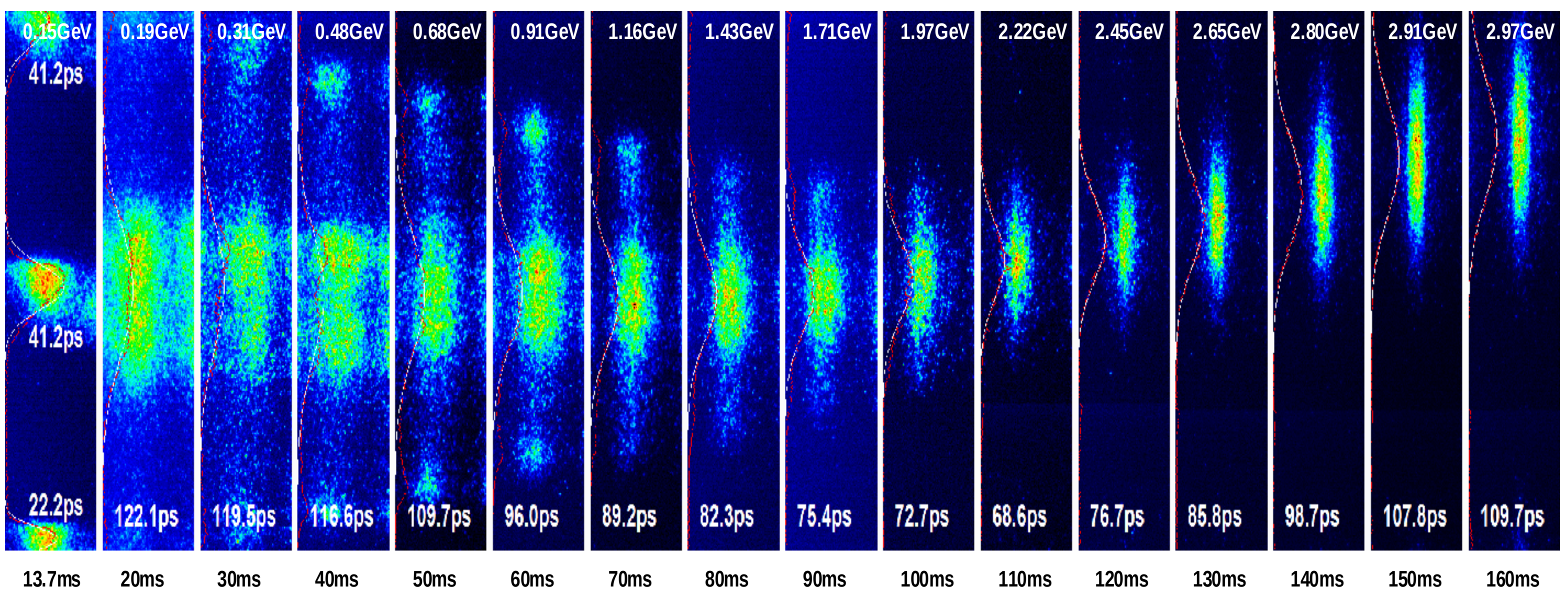


- Replace the B-Chamber of Cell#2, curing abnormal vacuum burst as I >230 mA. Top-up injection with stored current 300 mA on 12/6/2015。
- Stored beam current exceed design goal 500 mA, I > 520 mA, on Dec. 12, 2015.
- Thanks to members of Machine Advisory Committee, consultants and technical supports from various laboratories. With these strong supports around the world, we made the Taiwan Photon Source possible. This shining photon source will serve scientific communities worldwide for the next 30 years.



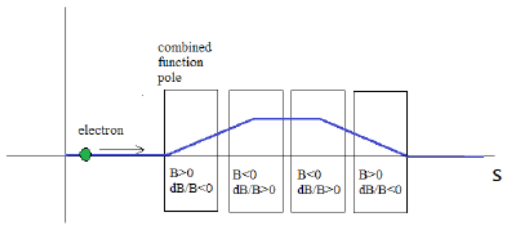


Longitudinal beam profile of TPS booster ring during ramping



Robinson Damping Wiggler (RDW) on TPS

- Robinson wiggler is made of four combined function magnets in one period so that the Product of dipole and quadruple field strength is negative.



Schematic diagram of Robinson wiggler

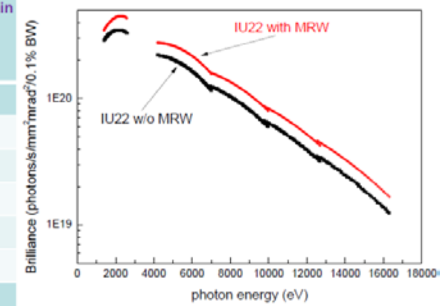
Robinson wiggler in PS

Ref: Emittance control of the PS e± beams using a robinson wiggler, Y. Baconnier et al.

Changing damping partition in horizontal/energy.

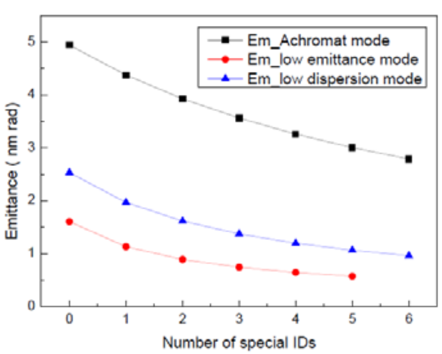
IU22 Spectrum with/without RDW

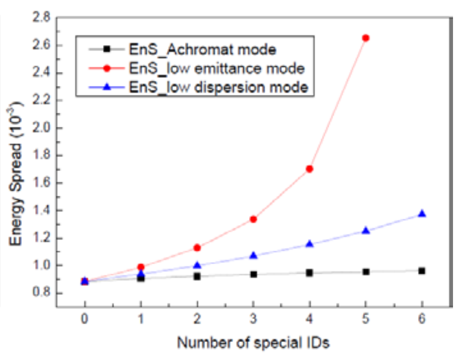
Harmonic number	Brilliance without MRW photon s⁻¹ /(0.1 % BW mm² mrad²)	Brilliance with MRW photon s⁻¹ /(0.1 % BW mm² mrad²)	Increasing gain ratio of IU22
IU22 with 0.74 T			
1	3.38 x10^{20}	4.22x10^{20}	0.25
3	1.82 x10^{20}	2.38 x10^{20}	0.308
5	7.42 x10^{19}	9.88 x10^{19}	0.331
7	2.87 x10^{19}	3.84 x10^{19}	0.336
9	1.08 x10^{19}	1.46 x10^{19}	0.347
IU22 with 0.92 T			
1	2.71 x10^{20}	3.11x10^{20}	0.148
3	2.22 x10^{20}	2.62 x10^{20}	0.177
5	1.33 x10^{20}	1.61 x10^{20}	0.21
7	7.53 x10^{19}	9.30 x10^{19}	0.235
9	4.19 x10^{19}	5.24 x10^{19}	0.25



ID of light source	Dipole field/T	Period length/mm	Period number *N*	Total length/ m
IU22 gap 7mm	0.74	22	140	3.08
IU22 gap 5mm	0.92	22	140	3.08

Impact of RDW on emittance and energy spread

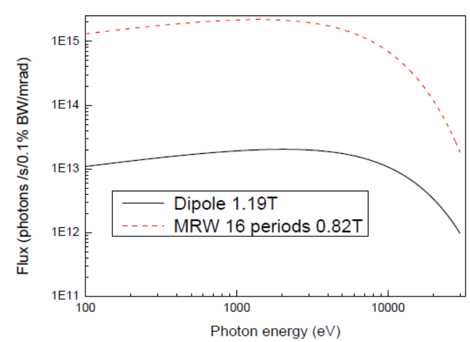


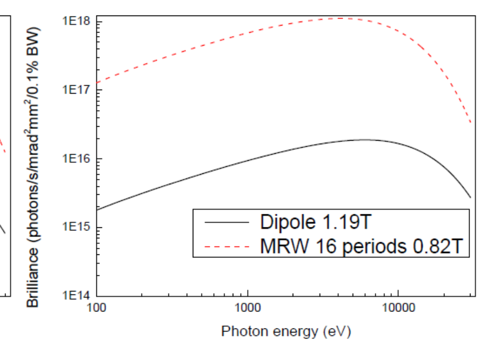


IDs	Dipole field (T)	Quadrupole field (T m⁻¹)	Period number N	Total length (m)	Operating mode
Robinson wiggler	0.82	40	16	4.8	Low-dispersion & Low-emittance
Damping wiggler	2	0	50	5.0	Achromat

Radiation Spectrum from RDW

- MRW radiation power 9.1 KW @ 500mA.
- Instead of the general wiggler.





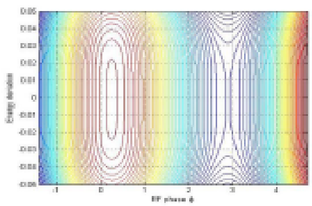
C.W. Huang internal presentation,07/22.

Short bunch by low-alpha lattice

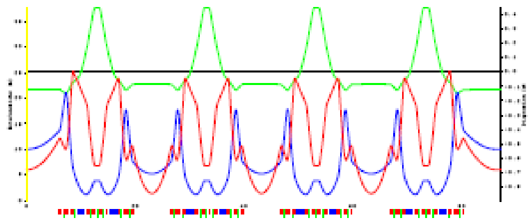
- Emittance = 32.5nm-rad

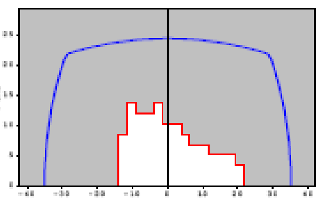
$$\alpha = \alpha_1 + \alpha_2 \delta + \alpha_3 \delta^2$$

- $(\alpha_1, \alpha_2, \alpha_3)$ = (1E-6, -6.74E-5,-2.47E-2)
- Bunch length ~ 0.6ps (3.5 MV rf)
- Integrated sextupole < 6.0 m^{-2}



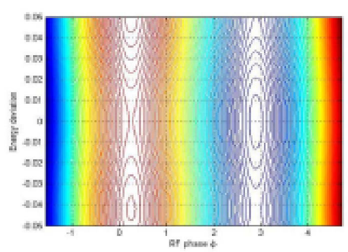
Longitudinal phase space



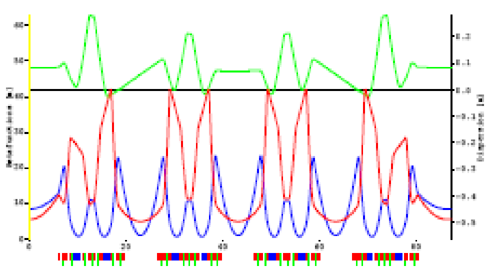


TPS low alpha, low emittance

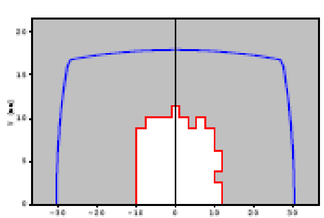
- Emittance = 3.2 nm-rad,
- $(\alpha_1, \alpha_2, \alpha_3)$= (2.62E-5, 1.19E-4, -1.19E-2)
- bunch length ~3.1ps (3.5MV rf)
- SF ~ 9.0 m^{-2}



Longitudinal phase space



Lattice function



Dynamic aperture

C.C. Kuo etc.

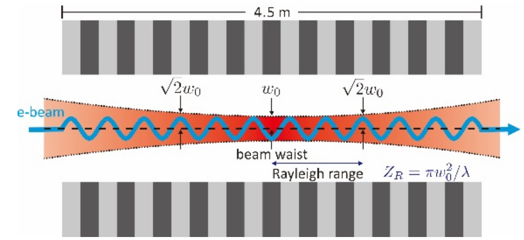
Short bunch by laser slicing

modulator:

W250
0.9T
4.5 m

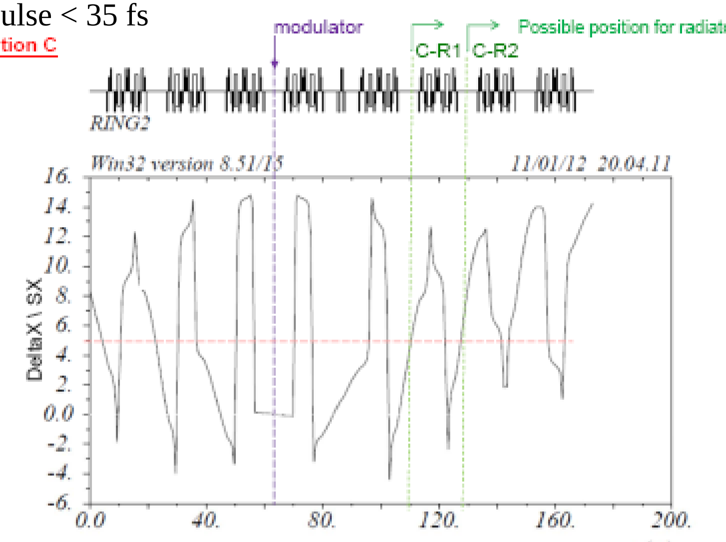
Laser:

800 nm
1-10 kHz
3.5 mJ
Pulse < 35 fs



Beam Separation

Position C

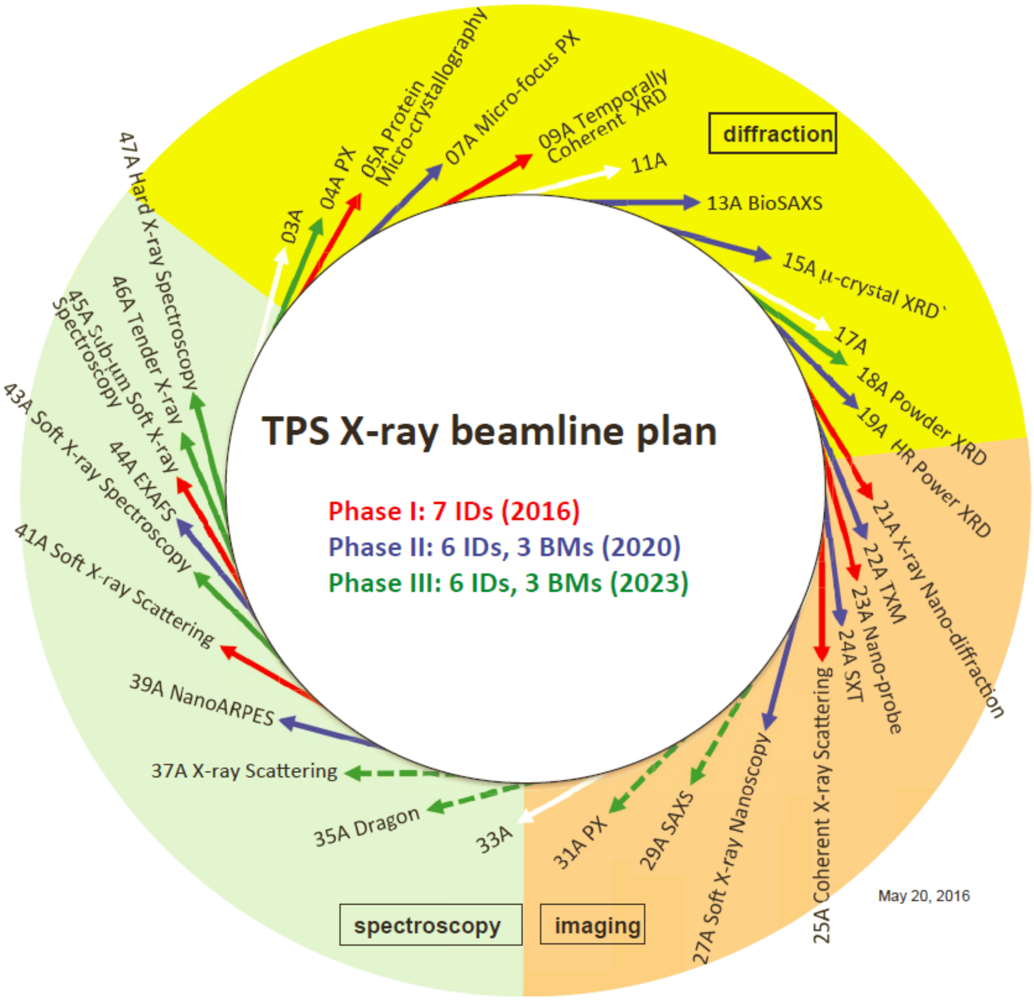


Summary of Estimation on Pulse Length

Modulator position	Radiator position	Laser (fsec)	Laser slippage (fsec)	Betatron dependence (fsec)	Dispersion dependence (fs)	Slice bunch at radiator (fsec)
C	R1	50	48	1.36	30.0	75.54
	R2	50	48	1.88	44.1	82.17
A	R1	50	48	1.35	27.9	74.73
	R2	50	48	1.88	44.1	82.17
B	R1	50	48	1.35	39.9	79.99
	R2	50	48	1.90	46.9	83.71

TPS Beamline construction plan

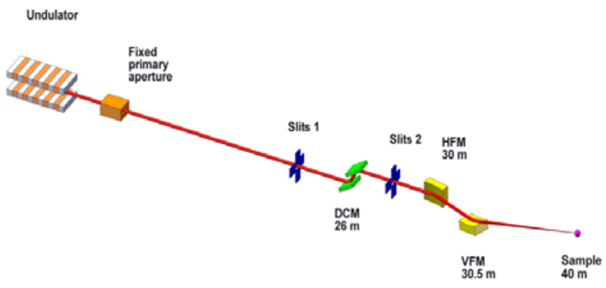
- Based on the allocated budget, there will be three phase of construction plan to install 25 beamlines.



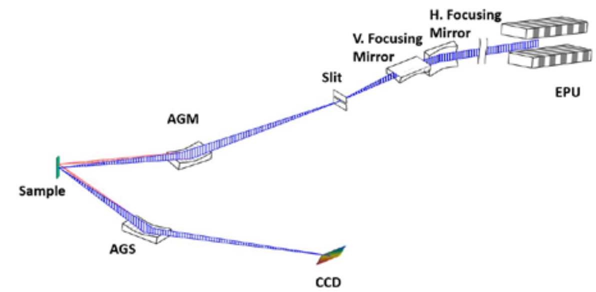
19 beam ports available for industrial and international collaboration.

Design of first-phase beamlines

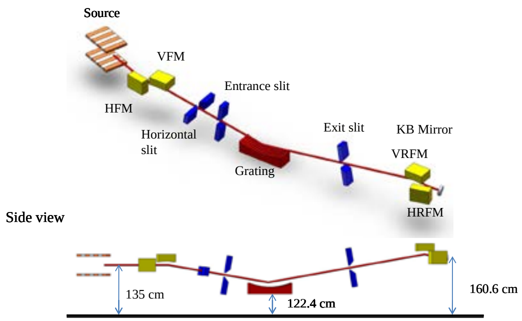
(μ-focus macromolecular crystallography)



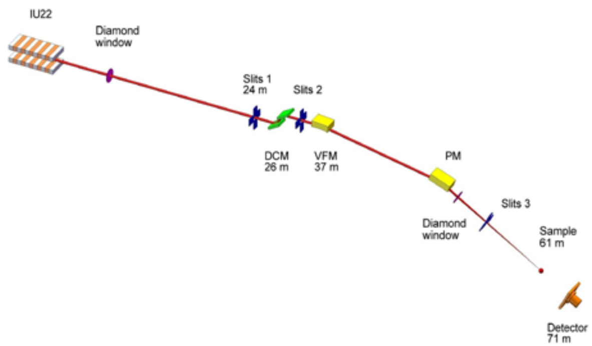
(High resolution Inelastic soft-x-ray scattering)



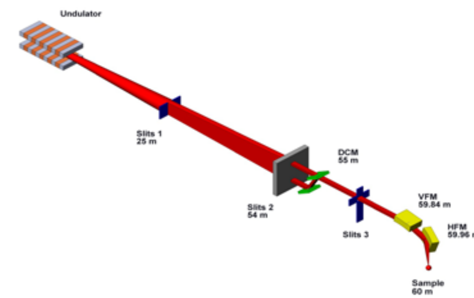
(Sub-μ soft x-ray photoelectron & fluorescence emission)



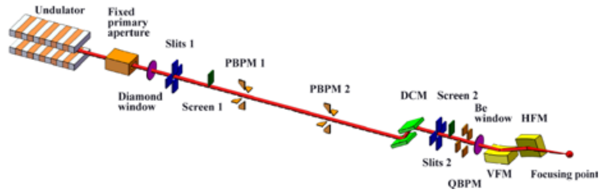
(Soft matter small angle scattering)



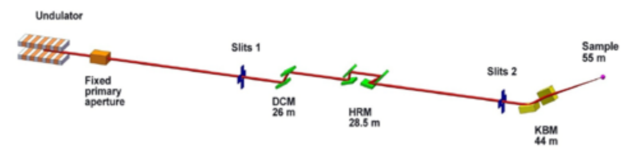
(Sub-μ x-ray diffraction)



(Nano-probe x-ray diffraction)

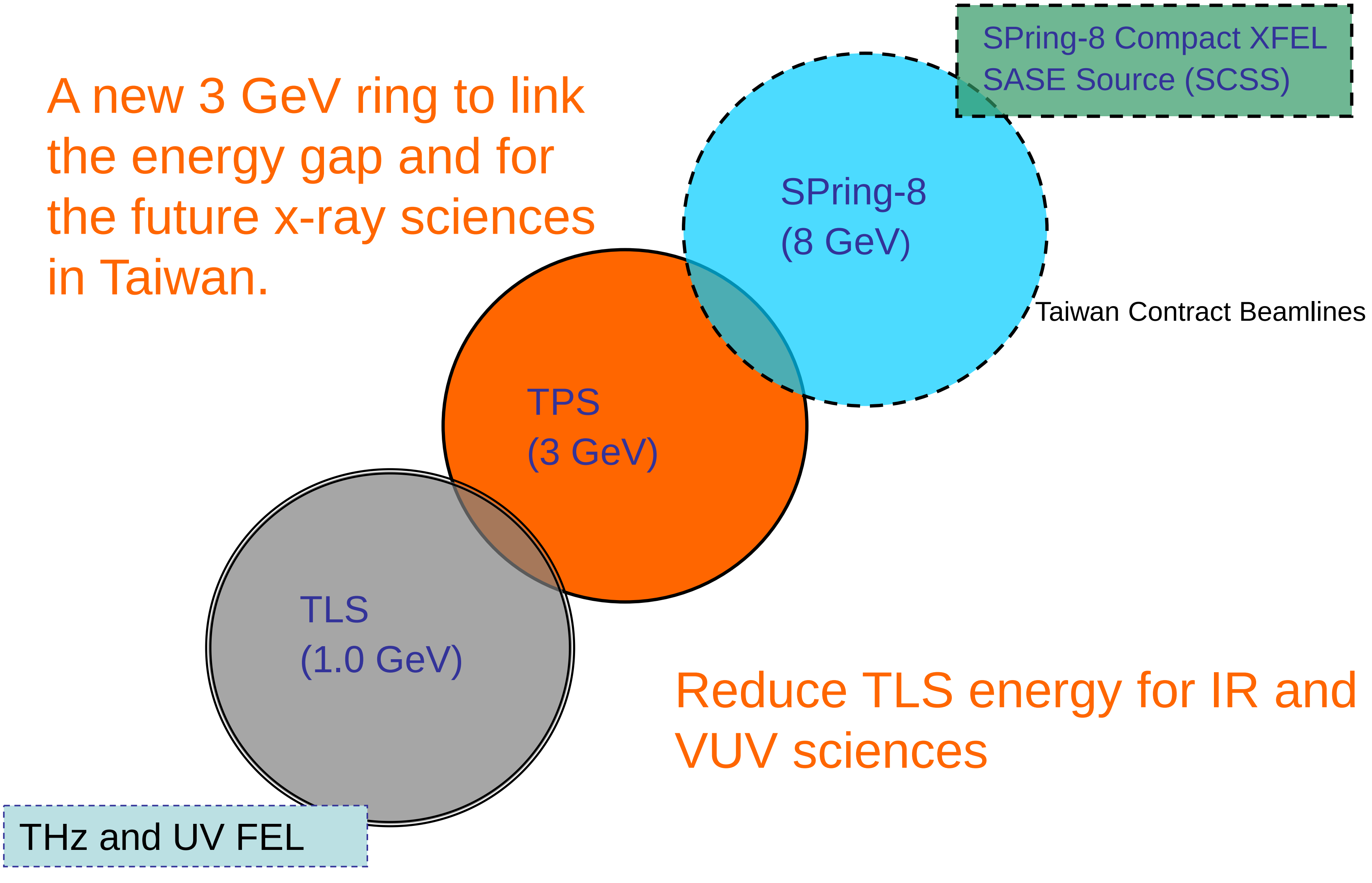


(Multi-purpose coherence x-ray scattering)

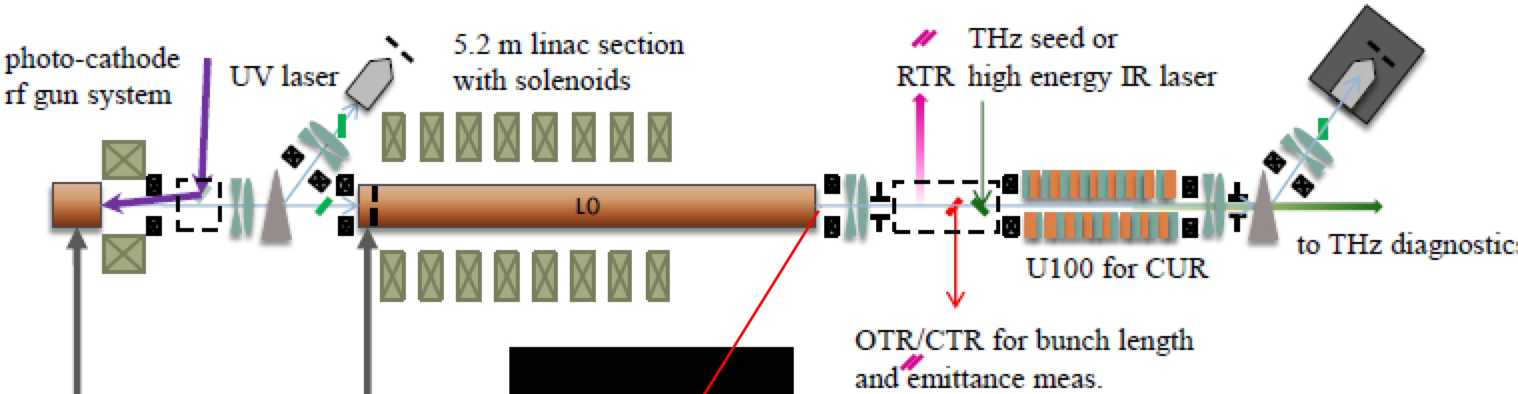


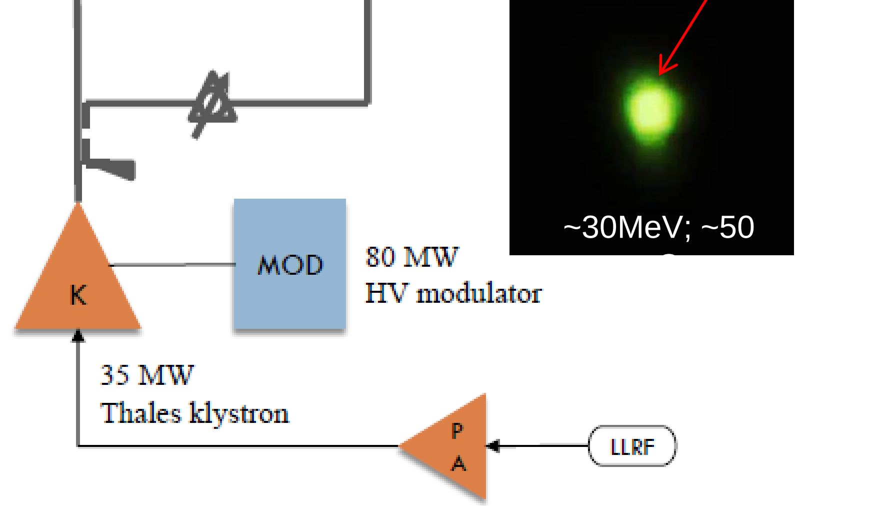
Development of Taiwan Synchrotron Facilities

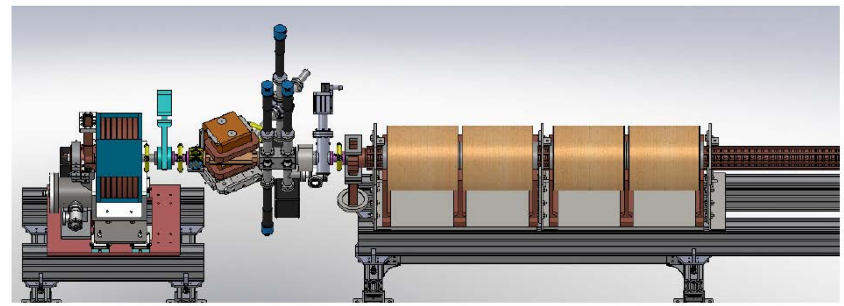
A new 3 GeV ring to link the energy gap and for the future x-ray sciences in Taiwan.



Reduce TLS energy for IR and VUV sciences







High-brightness photocathode gun and THz FEL project

Application-II: FEL Driver Linac

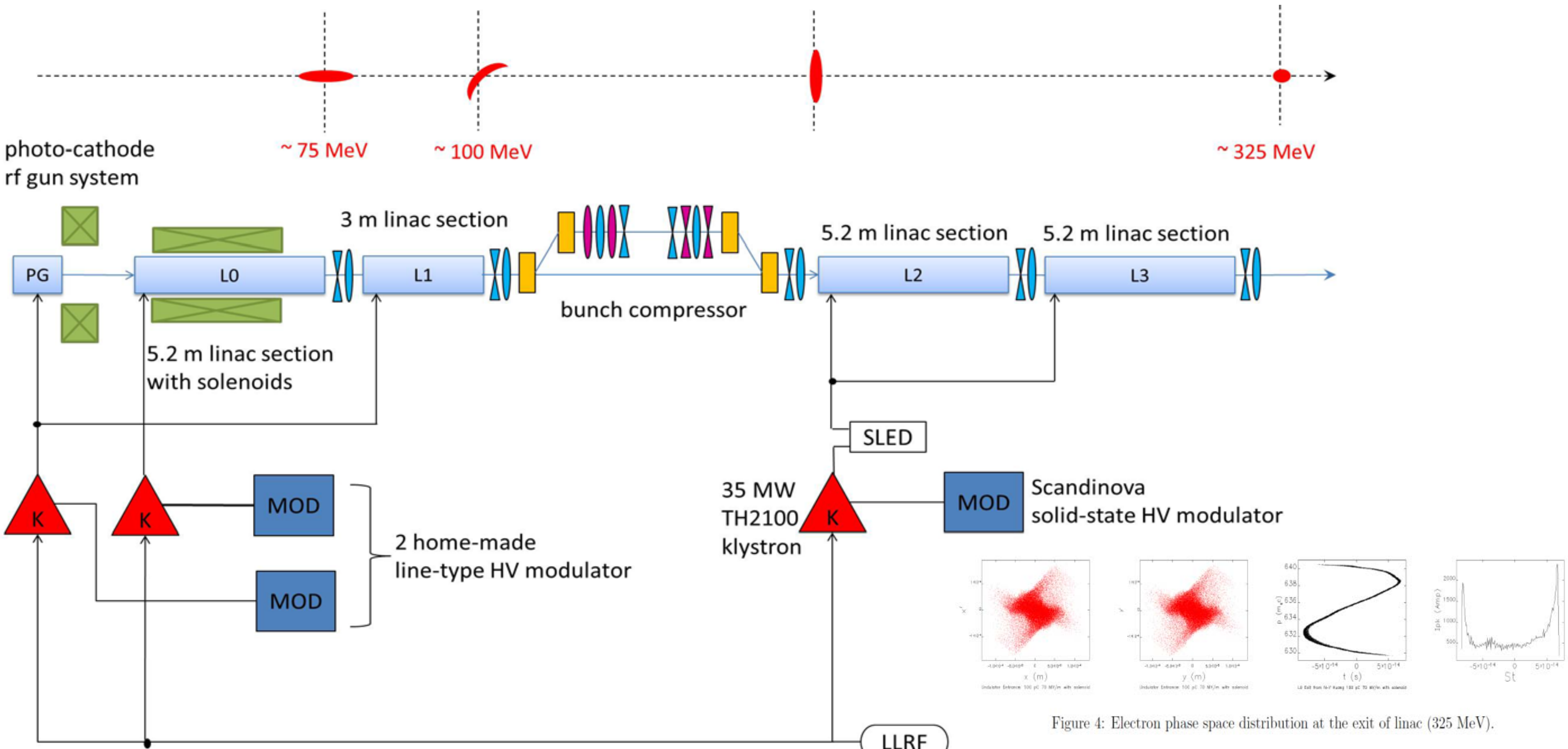


Figure 4: Electron phase space distribution at the exit of linac (325 MeV).

	L_0 entrance	L_0 exit	L_1 exit	L_2 exit	L_3 exit
rms bunch time duration σ_t [fs]	2247	2294	2290	60	60
slice peak current I_p [A]	12.0	11.7	14	500	500
beam energy E_{avg} [MeV]	3.54	93.08	138	231	325
slice beam energy rms spread $\sigma_\gamma/\gamma_{avg}$ [%]	0.016	0.002	0.001	0.003	0.005
slice rms x-emittance ϵ_{nx} [μm]	0.59	0.56	0.56	0.74	0.74
slice rms y-emittance ϵ_{ny} [μm]	0.59	0.56	0.56	0.80	0.80

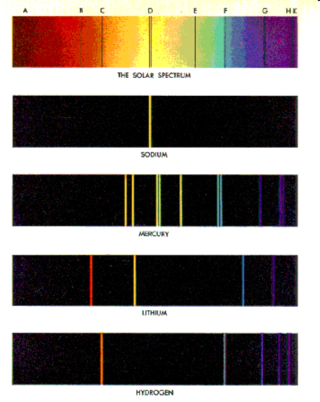
Table 2: Linac simulation result for the VUV Baseline case.

Summary

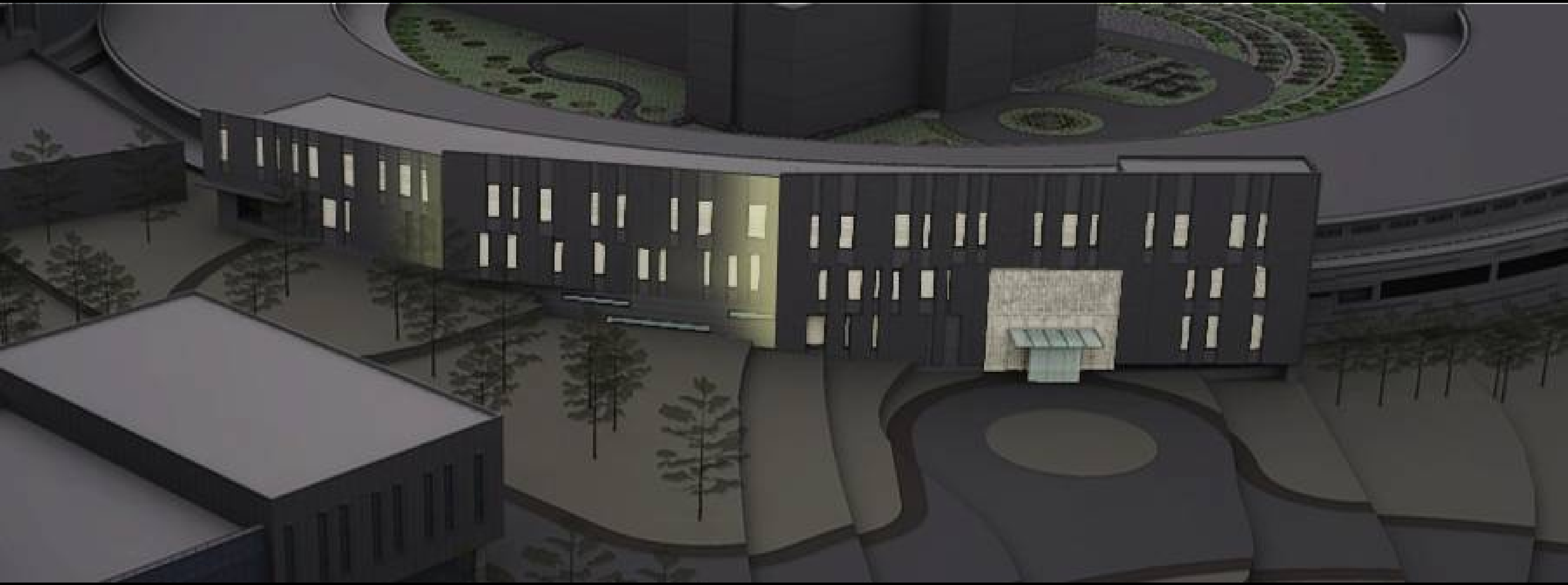
- **Taiwan Light Source**
  - 1.5 GeV beam energy provides 5000~ 5500 hrs with 360 mA top-up to users. Photon energy can be up to ~30 keV by SC wigglers.
  - Beamlines in SPring-8 provide hard x-ray to users.
  - From MOST's point of view, the long term-strategy about TLS fate needs to be planned with the operation of TPS.
  - Coherent Transition Radiation, THz and UV FEL will be tested with photo-cathode gun.
- **Taiwan Photon Source**
  - Ten insertion devices and two SRF cavities installed in Q2 and Q3, 2015.
  - Double mini-βy lattice and phase-I BLs commissioning since Q4, 2015.
  - 3 GeV storage ring top-up injection with 480 mA.
  - Start normal operation in September 2016.
  - Single bunch and hybrid operation modes were tested with beamline.
  - Robinson damping wiggler under investigation, potentially can reduce emittance by ~50% with increase of energy spread.

Acknowledgement

- Thanks to the TPS team for their hardworking and devotion to the project, and efforts made to accomplish the system integration and commissioning successfully in very short period.
- We also very appreciate to the helps from all experts worldwide for the achievement in this community.



Taiwan Photon Source (**TPS**)



Thank you for your attention!