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CONSTRUCTION AND INSTALLATION OF TPS FRONT END

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Abstract

National Synchrotron Radiation Research Center (NSRRC) is nearly completion of Taiwan Photon Source (TPS) project. This 3GeV, 500mA beam current 3rd generation synchrotron accelerator will have total of seven insertion device (ID) beam lines after commissioning is completed. Corresponding front ends have been designed and fabricated. Assembling and installing is underway. Current status of front end installation is reported and presented in this paper.

INTRODUCTIONS

TPS project has been gone very well and smooth during component installation. This 518m circumference 3Gev, 500mA beam current synchrotron accelerator will provide seven ID beam lines for scientists and researchers. The following chart illustrates the type of ID (Table 1):

Table 1: TPS ID Parameters

Type	EPU 48	EPU46	IU22-3m	IU22-2m
Period length (cm)	4.8	4.6	2.2	2.2
Number of period	73	81	137	95
B fields (B_y/B_x)	0.85/ 0.59	0.84/ 0.6	0.79	0.79
Power density (kW/mrad^2)	13.6	15	46.3	32
Total power (kW)	10.7	11.3	5.36	3.72

And seven beam lines are combination of above IDs (Table 2):

Table 2: Phase I TPS IDs

ID port	ID type
5	IU22 (2m)
41	Tandem EPU48 ×2
45	EPU46
25	Tandem IU22 (3m) ×2
21	IU22 (3m) tapered
23	IU22 (2m)
9	Tandem IU22 (3m) ×2

TRANSPORTATION AND ASSEMBLY

Due to lack of assembly space in NSRRC, a temporary factory building, around 6 km away from NSRRC is rented as an assembly place. After front end table is assembled together with chamber and IP, high heat load components. They are delivered by 5-tons truck, and are lift by crane from truck into the tunnel (Fig. 1).

Figure 1: Transporting TPS front end subsystem table into tunnel.

As was described in [1] and illustrated in Fig. 2, TPS ID front end consists of five ion pumps, pre-mask to shadow bending magnet, two fixed masks, one photon absorber (PAB), fast closing valve (FCV), two ion gauges (IG), two photon position monitor (XBPM), two slits, one heavy metal shutter (HMS), two all metal gate valves (AMV), five supporting tables and interlock system.

TPS is designed such a way that crane is used to lift and carry subsystems in the tunnel. Therefore two layers of concrete blocks are on top of the tunnel ceilings that have to be removed by crane either during installation or afterwards maintenance.

To minimize the number of concrete block removing, front end table is designed such that each length is less than 1m, 0.5m wide. Each table supports various subsystems. They can be separated during transportation and each chamber can be easily connected by only bellows after tables are aligned precisely.

Front end chamber are supported on the table top, where there are two precise machined rails parallel to the photon beam direction. In addition, the bottoms of the table surfaces are also precisely machined. The height of the table (measured from top to the bottom) is a controlled number. After table is aligned on the ground, the rail surface will be the datum surface for rest of chamber assemblies. Engineers only have to align the assembly based on the rail surface instead of aligning

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from the table legs again. The benefit of transferring this alignment reference plane from bottom to top is for easy maintenance later on due to crowded space in TPS front end area.

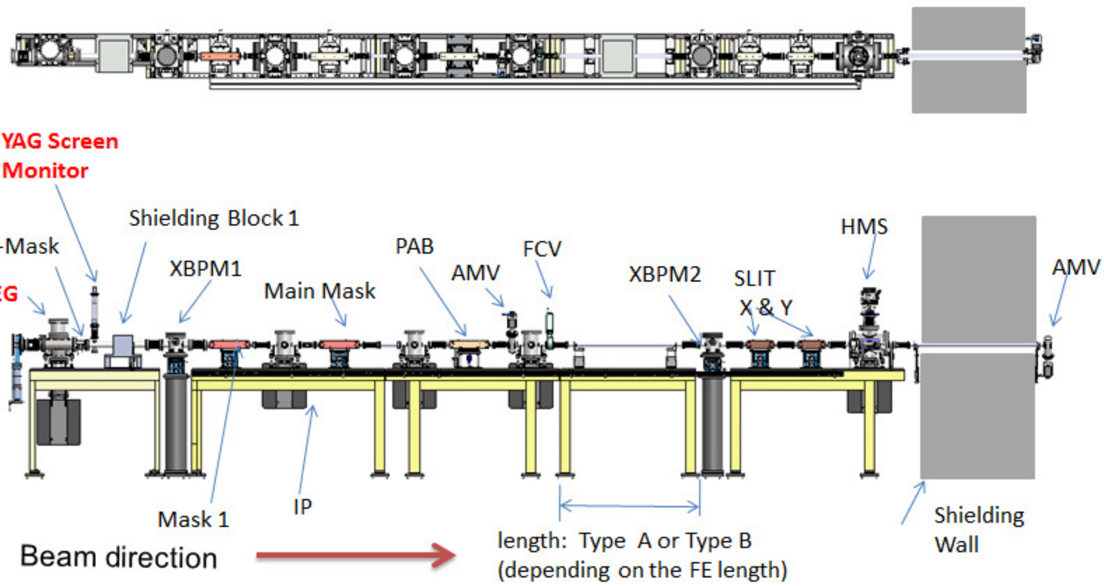

Figure 2: ID front end components.

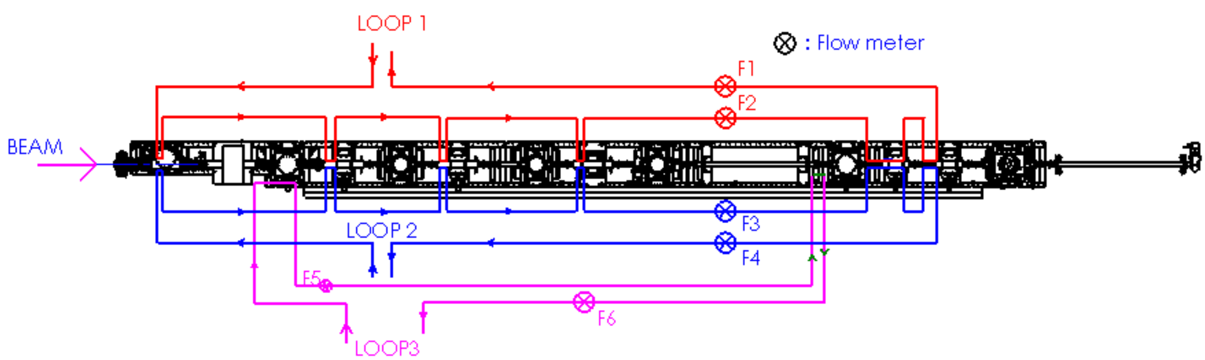

Figure 3: Front end water loops.

Even fixed mask is anticipated to be "fixed" but we also implement XY stages on two masks, the reason is because there might have chance if one only wants to see part of the ID footprint. Since for tandem ID front end it is subjected to double heat power (and power density) than that of single ID's, GlidCop® material is chosen for masks of all tandem ID front ends whereas regular OFHC is used for single ID front ends.

As to power distribution-wise, first two masks are designed to take 50% of power load, PAB takes rest of 50% when it is closed. Finally two slits is able to rest of 50% of power load when PAB is opened and slits are fully closed. Beam line user requests to have less than 700W of power delivered after beam exits from front end. XY stages are installed on both slits. The final confining aperture of beam size is determined by intersecting of two slits' apertures. Four straight Tungsten strips are brazed on the back of each slit to form a pound sign type of aperture. The edge and the perpendicularity of the strip are carefully machined so that no round edge is revealed to introduce imperfect beam footprint for the beam line users.

As shown in Fig. 3, each front end has three water loops. Loop 1 and Loop 2 are for left and right side of all high heat load components, respectively. Loop 3 is for XBPM since low flow rate is required to minimize water induced vibration. They are hooked up in series from upstream to downstream.

Each CIA will control two front ends (one for ID and one for bending magnet), 5 racks for each front end. Racks contain IP, IG, AMV and FCV controllers and interlock systems.

The core logic of front end interlock system is based on that of Taiwan Light Source (TLS). A white box testing platform is made for reliability test, few thousands of different combination scenarios are feed to the interlock logic to ensure the final action is correct and reliability is reproducible. Only few modifications of timing sequence control of HMS and PAB. The reason being is in TPS the radiation power is much higher and intensive than that of TLS. When interlock is activate, according to radiation

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safety rule, both HMS and PAB have to drop down to prevent downstream assembles and human from being damaged. However Tungsten in HMS has no cooling at all, it cannot sustain even few mini-seconds of being heated by synchrotron radiation. Therefore the interlock logic is modified such that PAB has to come down first, then HMS. The time interval is within 2 seconds, this to ensure that HMS will not reveal to excessive heat load.

INSTALLATION

Currently one front end (FE05) has been installed and assembled together as shown in Fig. 5. Welded bellows are connected between vacuum chambers after alignment work is done. Leak check for each subsystem table is performed in the assembly area. After they are connected in the tunnel, overall pumping and leak check are performed. The vacuum pressure is around 10^{-10} Torr. After bake-out.

The last downstream front end component is an all metal gate valve, which is located at the outboard of exit port, a stainless steel tube passing through the 1.2m concrete wall connecting both HMS and gate valve. To easily baking out this long stainless steel tube, a 3mm OD long tubes are spot welded along the long tube. 2mm thick heating wires are therefore inserted into these two small tubes when the tube is installed in the tunnel. The experiment shows that the tube embedded in the exit port concrete wall can reach $200^{o}C$ during bake out. Thus there is no need to remove the lead shielding and rewrap heating pad when baking out is needed during maintenance.

Electrical cables are connected between front end and CIA as well as to control room. Water and gas pressure piping is on the way, and they should be ready in a month.

Due to its low thermal expansion, INVAR material is used as XBPM post. A layer of insulation paint is applied on this 3 mm thick of INVAR shell and sand is filled inside the tube.

A YAG screen monitor is implemented in the upstream of front end during commissioning. The assembly is shown in Fig. 4.

After the FE is baked out alone, it will be connected with storage ring, additional bake out will be performed and XBPM diamond blade will be installed at that time.

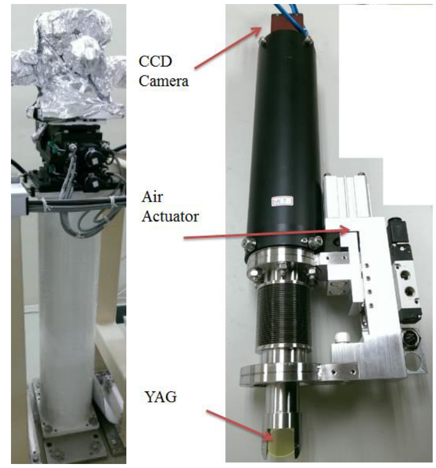

Figure 4: INVAE XBPM post and YAG screen monitor.


Figure 5: ID front end FE05 leak check and pumping in the tunnel.

CONCLUSION

TPS ID front ends has been installed and assembled, both interlock and vacuum chamber subsystems are connected and integrated in the tunnel. Water and pressure tubing will be connected and tested. A YAG screen monitor is installed in day one to detect the beam during commissioning. Successive front ends will be connected and align by the end of this year to meet beam line user requirements.

REFERENCES

[1] I. C. Sheng, C. K. Kuan, G. Y. Hsiung, Y. T. Chung, H. Y. Yan and J. R. Chen, "Status of TPS Front End in NSRRC", to be presented in SRMS MEDSI2010, Diamond Light Source, UK, 11-14 July, 2010.