Preliminary Mechanical Design on TPS Front End in NSRRC

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Abstract

National Synchrotron Radiation Research Centre (NSRRC) will build a 3.3 GeV, 350 mA synchrotron accelerator. Due to some IDs' high power densities, front end design becomes a challenging task to shape the beam size as well as to dissipate the heat load. For instance, undulator CU1.8 will generate 150 kw/mrad^2 peak power. The prototype of TPS front end design is nearly completed. Design of high heat load components, pumps, XBPM, heavy metal shutter (HMS), interlock system are presented in this report.

At 3.3 GeV, 350mA, TPS ID has the following parameters:

Undulator Radiation	Symbol	Unit	EPU10	EPU7	SW4.8	EPU4.6	IU2.8	SU1.5	CU1.8
Period length	λ	cm	10.0	7.0	4.8	4.6	2.8	1.5	1.8
Number of Periods	N		88	64	30	97	160	67	250
Maximum B Field	Bo	T	1.14	1.00	4.20	0.76	0.90	1.50	1.34
Effective total length	L	m	8.80	4.48	1.44	4.46	4.48	1.01	4.50
Deflection Parameters	K		10.65	6.54	18.83	3.27	2.35	2.10	2.25
Total Power	Pt	kW	27.6	10.8	61.3	6.2	8.8	5.5	19.5
Horizontal Span Angle	2θ	mrad	3.30	2.02	5.83	1.01	0.73	0.65	0.70
Vertical Span Angle	2ψ	mrad	0.31	0.31	0.31	0.31	0.31	0.31	0.31
Peak Power (at ψ=0)	Px	kW/mrad	11	7	14	8	16	11	36
Peak Power per Ω	P''(0,0)	kW/mrad^2	45	29	57	33	64	44	148
	G(K)		1.00	1.00	1.00	0.99	0.99	0.98	0.98

Table 1. ID Power Parameters

In general, TPS front end will consist of

- •Pre-mask: Copper absorber to mask unwanted BM fan.
- •XBPM(X-ray Beam Position Monitor): There will be two XBPMs which are 3.2meters apart.
- •Fixed mask: First fixed mask is to confine the ID beam whereas second one to shadow unwanted ID power.
- •PAB (Photon Absorber): To absorber rest of the power when interlock is activate.
- •XY Slit: Two XY slits to shape the final defining aperture for the beam line users.
- •HMS (Heavy Metal Shutter): To block Bremsstrahlung Radiation when PAB blocks the beam.
- •Interlock system.
- •Pumps, bellows, rail, support tables, all metal valves, fast closing valves.

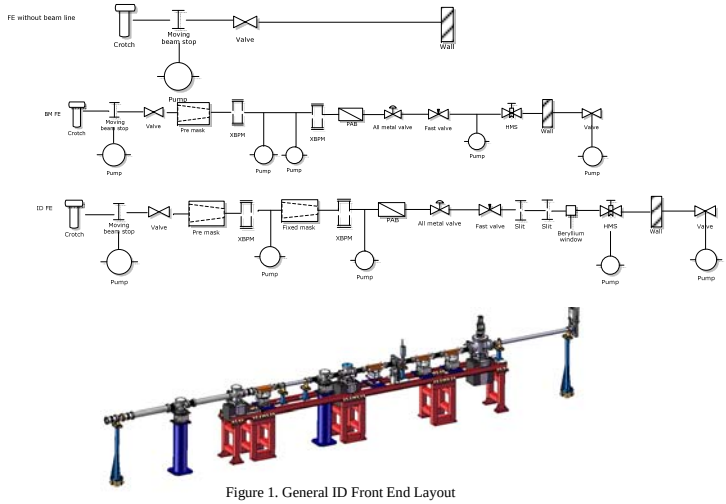

Figure 1. General ID Front End Layout

High Heat Load Components

High heat load components are fixed mask, PAB and XY slits. Due to the high heat power density, all the high heat load components are made of GlidCop@. They will all be fabricated by EDM to form small grazing angles. Water channels will be surrounded to dissipate the heat. Two SST tubes will be vacuum brazed on both side before welded to SST flanges. A typical TPS front end high heat load component design shown below:

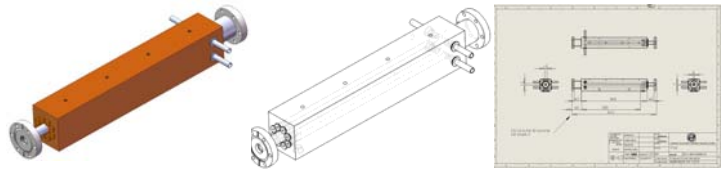

Figure 2. General TPS Front End High Heat Load Component Design

Assuming entire CU1.8 power deposits on side and top of the fixed mask 1 heating surface due to beam miss-steering, the following shows temperature rise and the corresponding thermal stress contours.

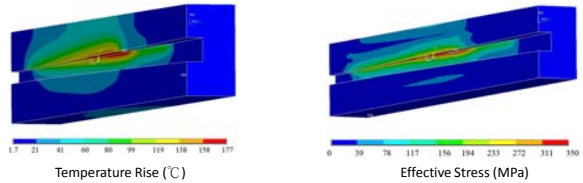

Figure 3. Temperature and Thermal Stress Contours of the Fixed Mask

Table 2 shows the aperture each high heat components, and their power load during normal operation, as well as their maximum design limit for the power load can be sustained. Figure 4 shows the prototype of TPS ID XBPM installed and test in Spring-8. The diamond blades head are designed by Dr. Shu (APS). Currently it has been assembled and implemented at Spring-8 BL12XU front end. Several data measurements have been carried out. Figure 5 shows the spatial distribution of first harmonic flux density, power density vs. fixed masks and possible XY slits opening for the beam line users.

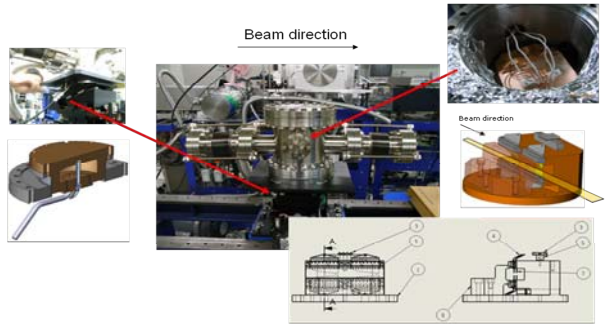

Figure 4. TPS ID XBPM

Component	Distance from ID	Upstream aperture (mm)		Downstream aperture (mm)		Normal Power density	Normal Operation Power deposited	Maximum Designed Power Deposited
	(m)	Horizontal	Vertical	Horizontal	Vertical	(w/mm^2)	(kw)	(kw)
Fixed mask 1	14	23	17	11	8	758	1.1	19
Fixed mask 2	14.6	15	12	5	7	700	10	19
PAB	16.5	12	12	0	0	546	0	10
XY slit1	17.6	22	23	7	6	480	0	10
XY slit2	18.2	22	23	7	6	450	0	10

Table 2. Aperture and Power Distribution of TPS High Heat Load Components

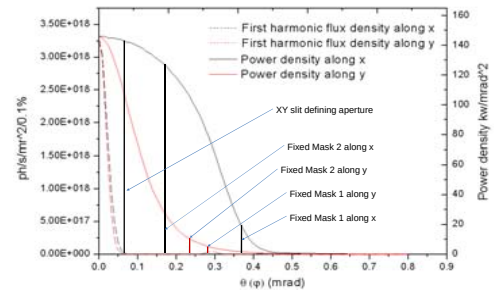

Figure 5. Spatial Distribution of CU1.8 Power/Flux Densities vs. Front End Apertures.