Thermal Simulation of Fluorescent Screen of front ends at SSRF

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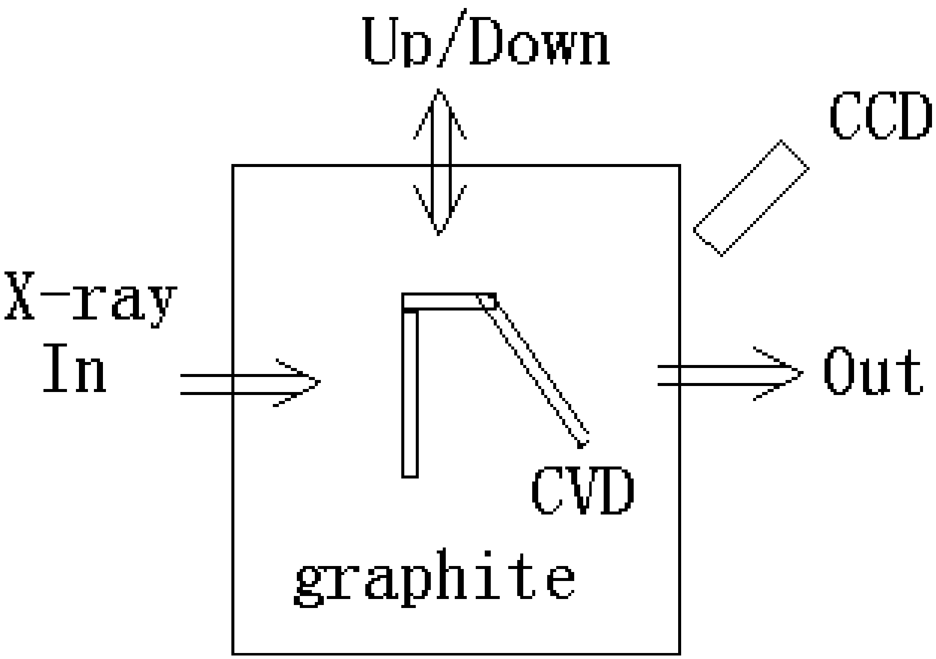
Outline

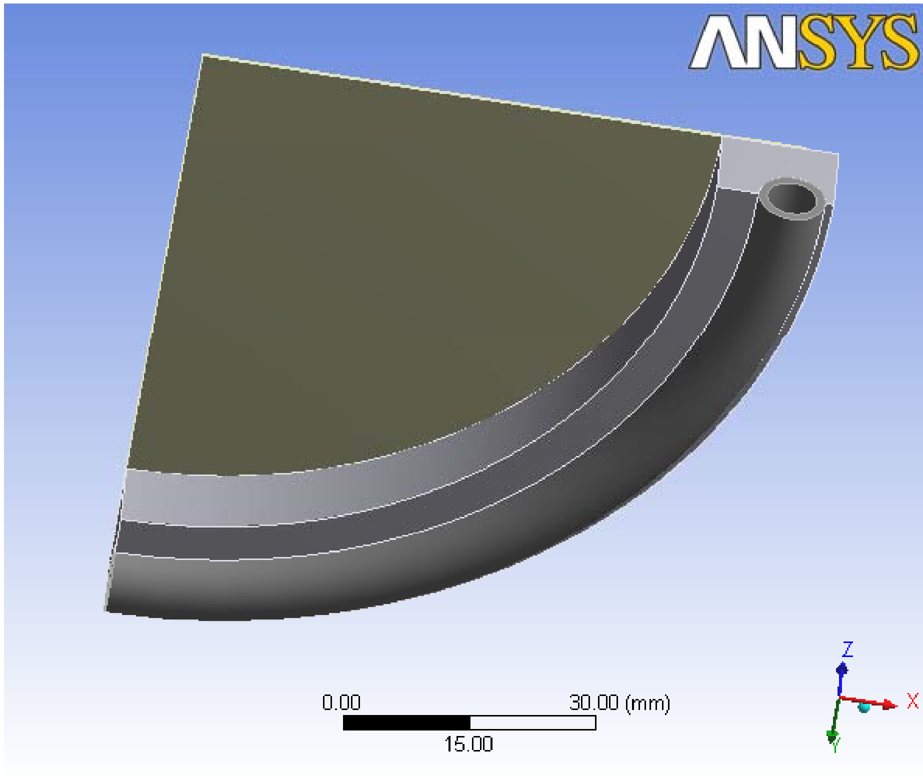
- Introduction
- Simulation
- Experiment (Phase I)
- Conclusion

Introduction-Schematic diagram of FS
(fluorescence screen)

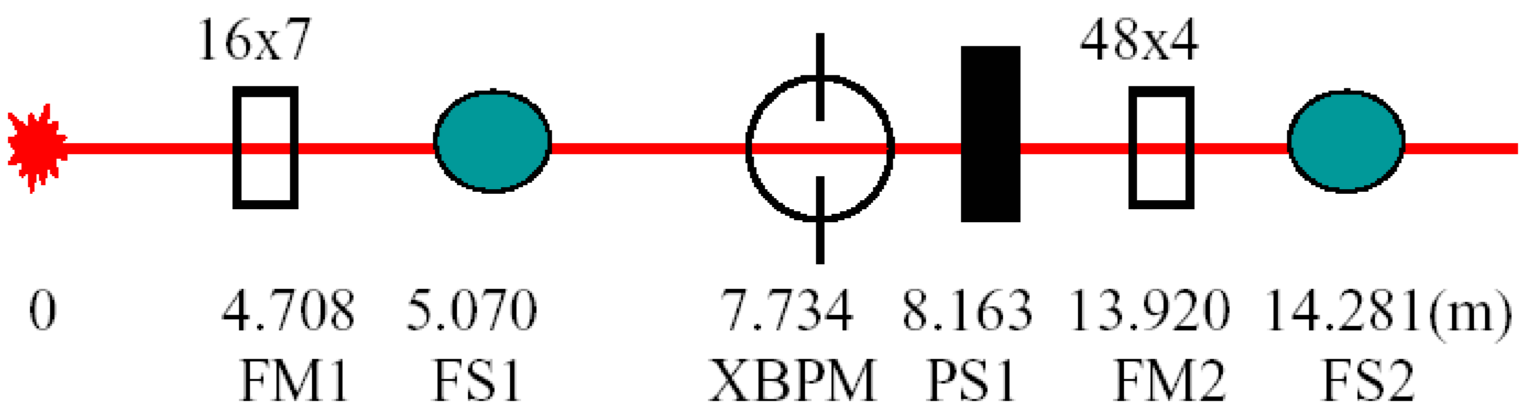


Introduction-structure and dimension

- Graphite and CVD are installed on an OFHC manifold cooled by water. The manifold can be moved vertically on to the beam axis using a pneumatically driven support on which the manifold is mounted. The normal of CVD surface and the beam axis lie at an angle of about 45 degrees.
- The thickness of CVD film is 300um,
- The outer diameter is 65mm.
- The diameter of X-ray traverse is 55mm.
- There is a gold film of 100um thickness between the CVD and OFHC manifold.



Why use the graphite filter?



Schematic diagram of Front End

No beryllium window before FS

Reduce to heat load absorbed by CVD substrate

Reduce the disturbance of visible light from source to CCD camera

Simulation-**Material Properties** of CVD

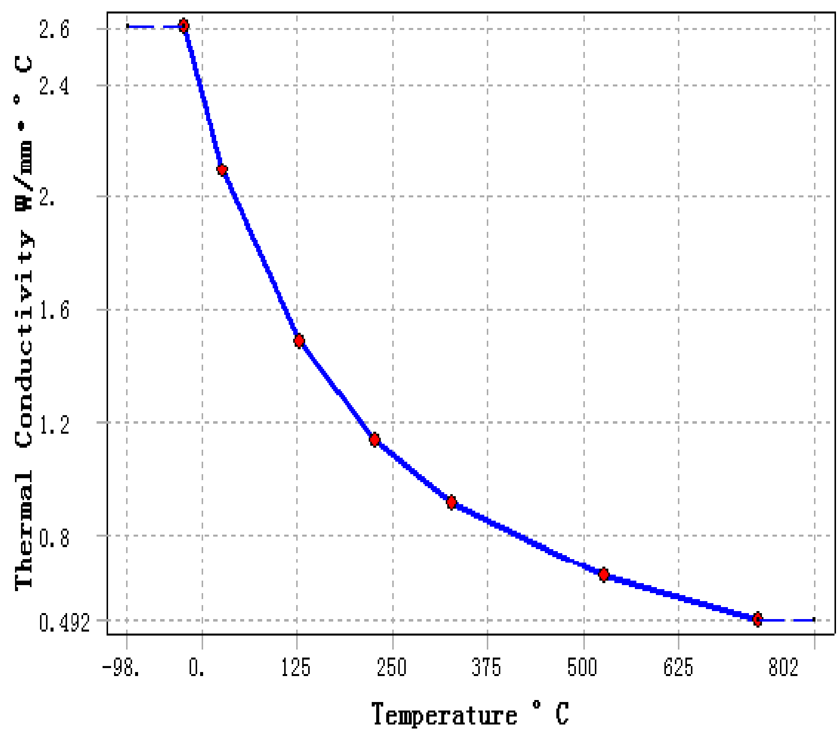
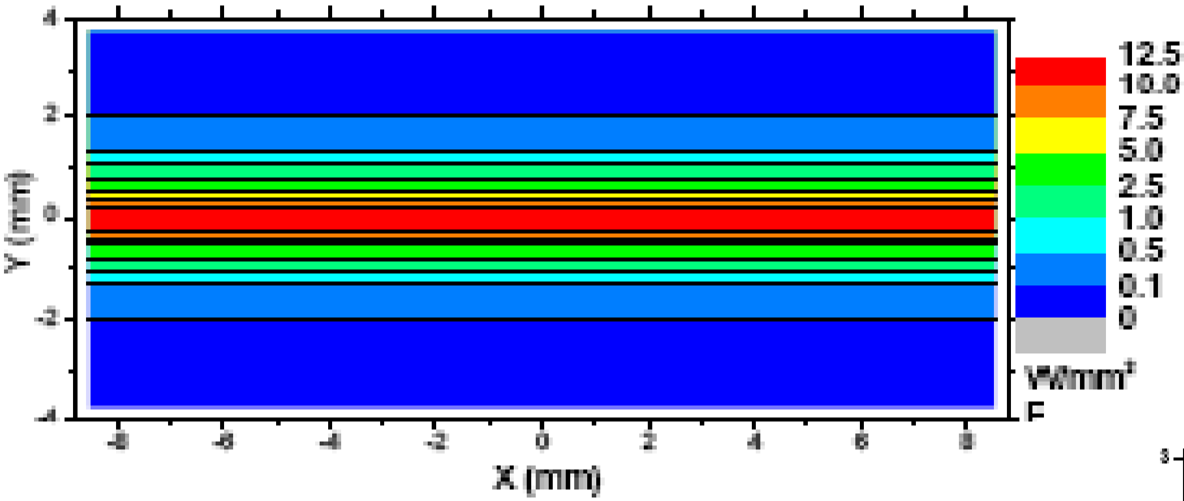


TABLE 21

graphite > Thermal Conductivity > Thermal Conductivity vs. Temperature

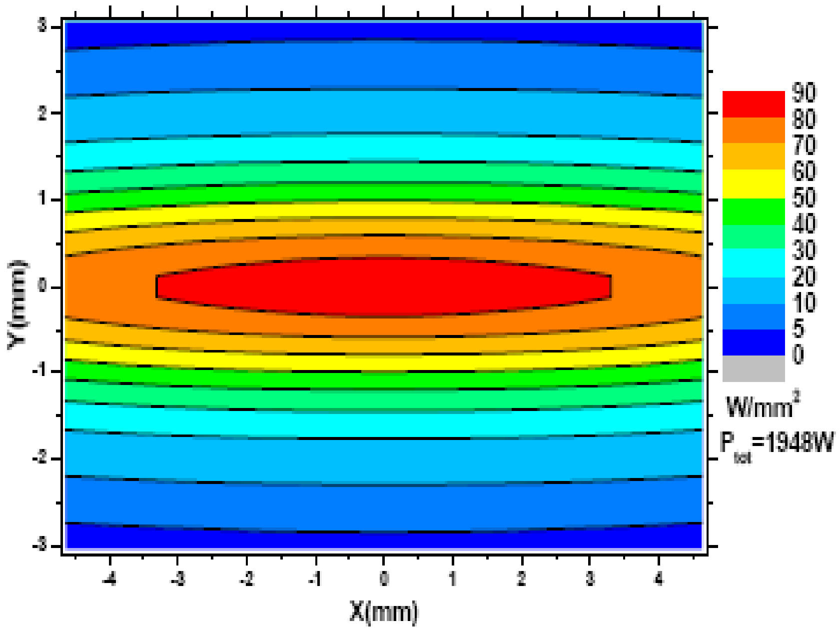
Temperature °C	Thermal Conductivity W/mm·°C
-23.	2.6
27.	2.09
127.	1.48
227.	1.13
327.	0.91
527.	0.644
727.	0.492

Simulation-heat load used in FEA



@5m

@11m



	maximum of power density W/mm2	total power W	spot size mm×mm
EPU	85.2	1948	10.2×6.1
BM	12.1	232	17.3×7.6

Simulation- **Failure Criteria**

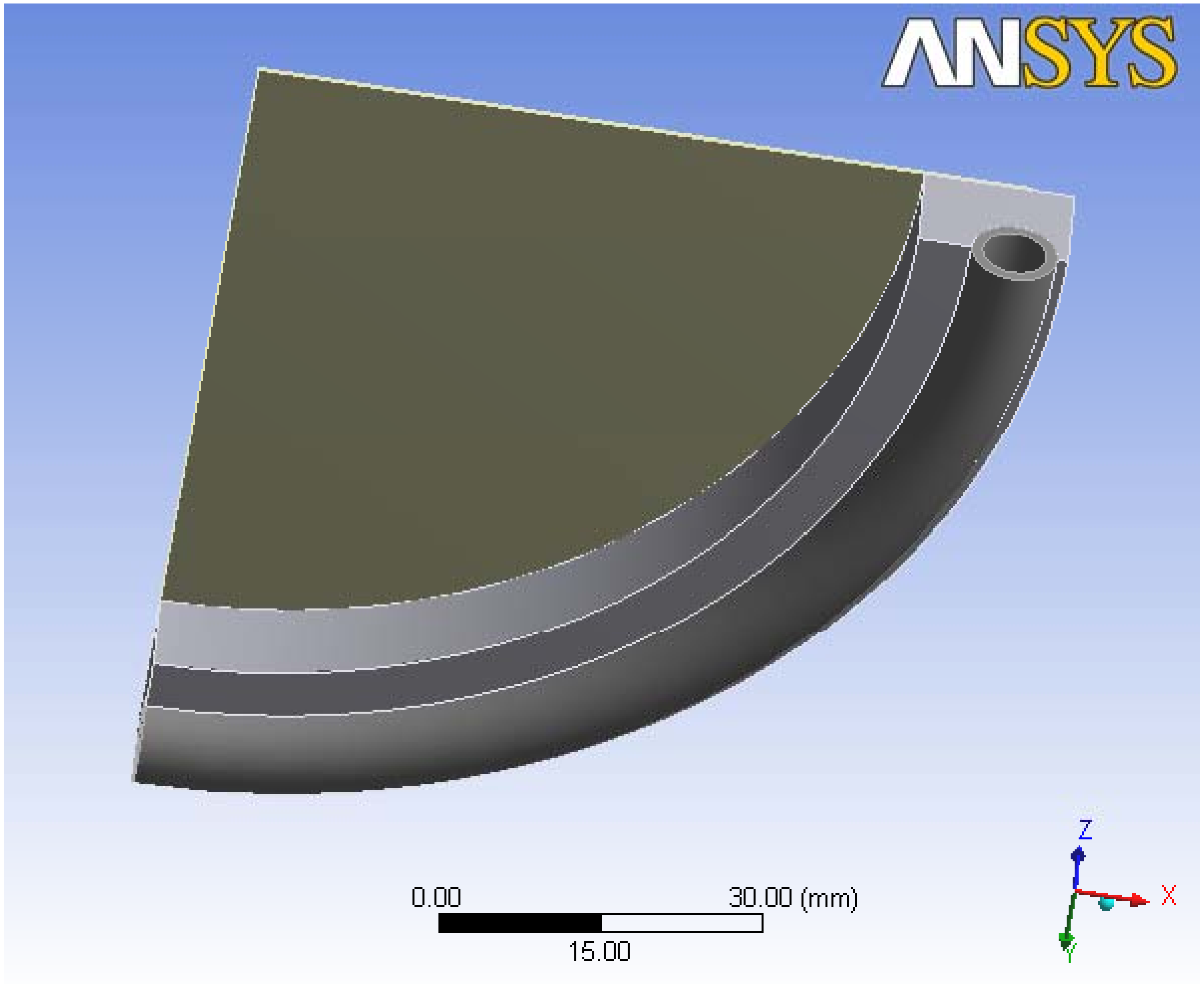
◊Maximum temperature on CVD <1000°C

to prevent material damage (phase transition temperature for conservation).

◊ Maximum temperature on the cooling wall <125°C

water boiling temperature at channel pressure to prevent water from boiling and to maintain single-phase heat transfer.

Simulation-FEA Model (quarter)



Simulation-boundary condition

- just calculate the thermal radiation of CVD surface
- Convection film coefficient of 10000W/m^2°C for the cooling water channel
- The thermal contact conductivity of CVD-Au-OFHC interface is 2000 W/m2.℃.
- The thermal contact conductivity between OFHC body and tube is infinite.

Simulation-Result of bending magnet

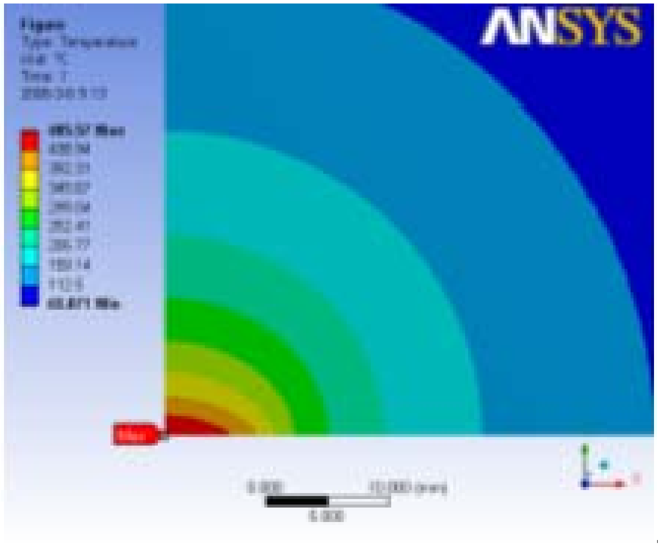


Fig.5a temperature distribution of CVD diamond film.

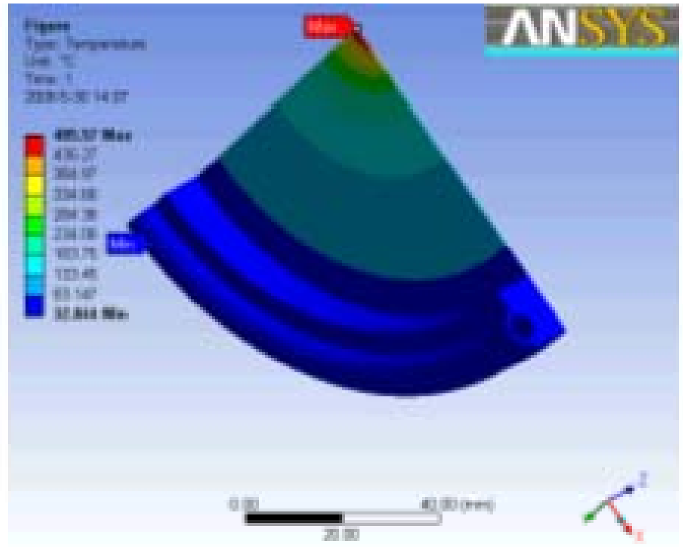


Fig.5b temperature distribution of FS.

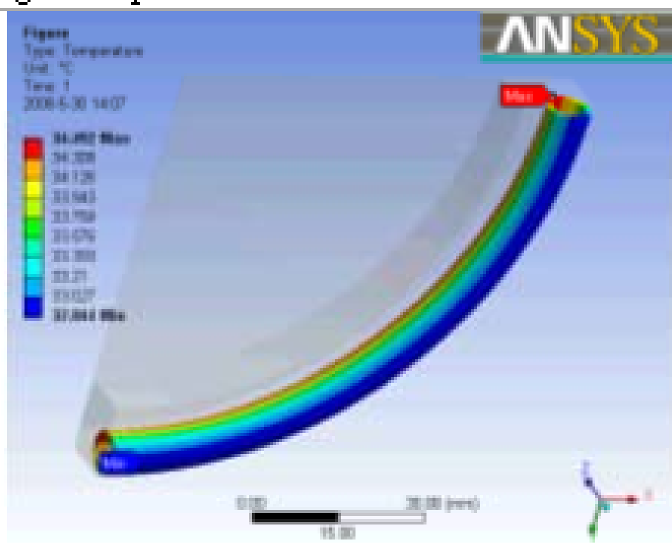


Fig.5c temperature distribution of OFHC water tube.

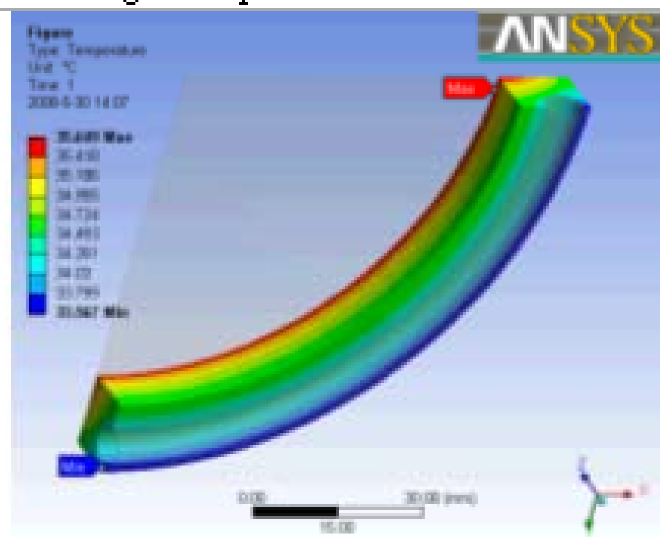


Fig.5d temperature distribution of OFHC manifold.

Fig.5 temperature distribution of Fluorescence Screen.

maximum temperature (℃)

CVD: 485

OFHC tube: 34.5

OFHC manifold:35.6

3.5GeV 300mA

Simulation-Result of EPU FS

maximum of temperature of EPU FS with different electron beam current @3.5GeV

current(mA)	graphite(℃)	CVD(℃)	power(W)
10	318		64
20	477		125
30	900		194
40	1289		258
50	1600	679	264
70		909	473
80		1017	544
100	2573	1226	646
200	3569	2003	1292

Conclusion

In order to keep the FS will be thermal safety, the maximum current of SSRF storage ring is

300mA for bending magnet source

30mA for EPU insertion device source and rise to 70mA by CVD filter

Phase I Experiment-image of FS

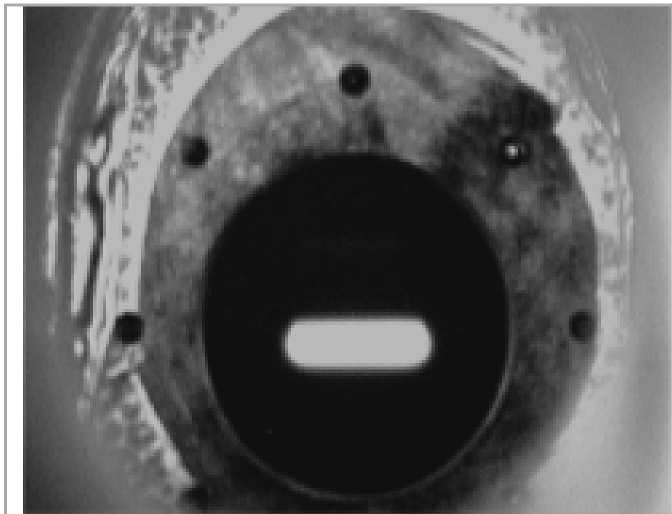


Fig.6a FS1@3GeV 1.6mA (Jan. 2)

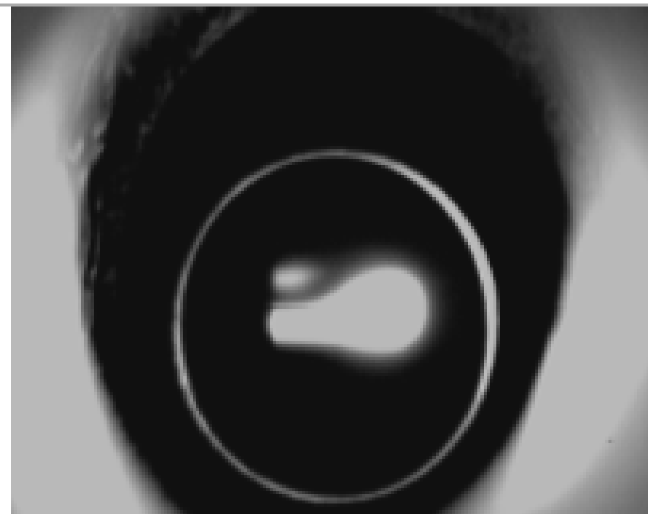


Fig.6b FS1@3GeV 100mA (Jan. 3)

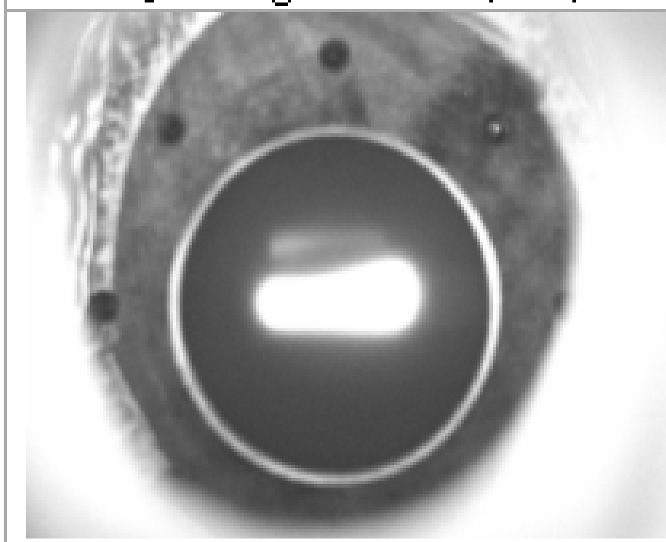


Fig.6c FS1@3GeV 1.6mA (Jan. 21)

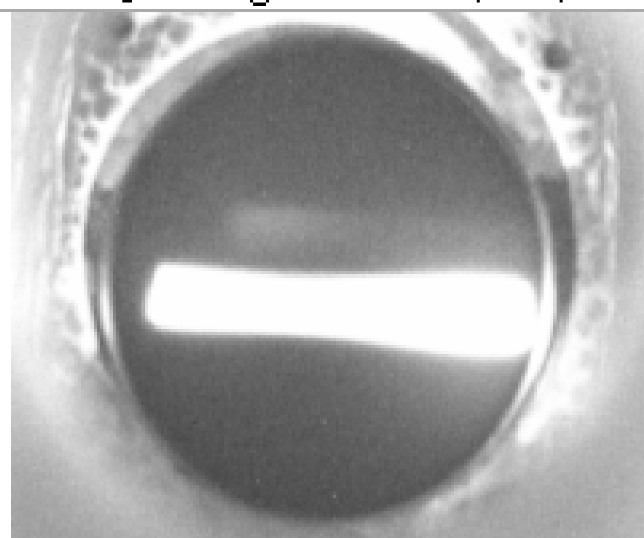


Fig.6d FS2@3GeV 1.6mA (Jan. 21)

Fig.6 X-ray spot image of BL14B FS.
After FS is radiated by X-ray more than 12 hours.

the FS of BL14B was heated by the X-ray emitted by 3GeV 100mA

more than 12 hours.

Phase I Experiment-image of FS

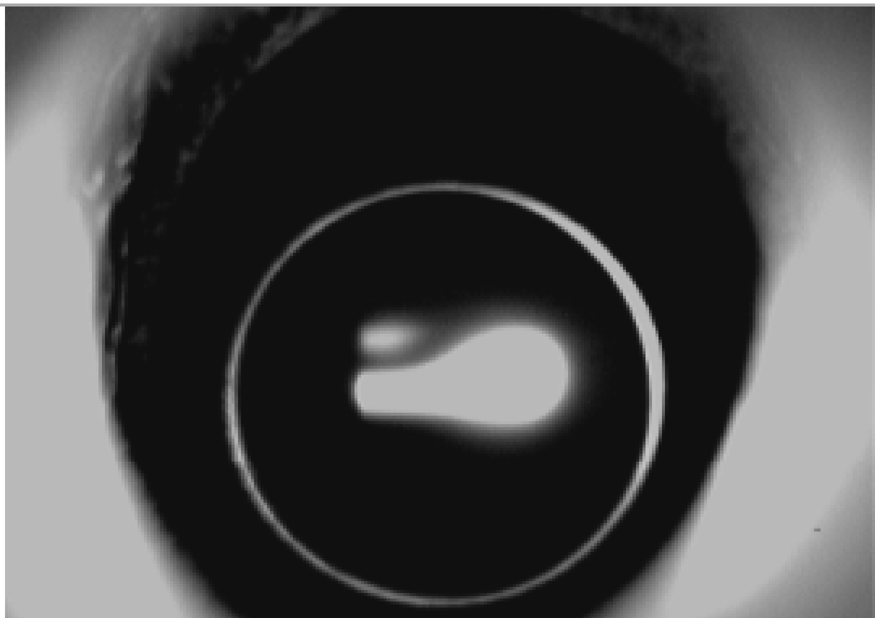


Fig.6b FS1@3GeV 100mA (Jan. 3)

After modification

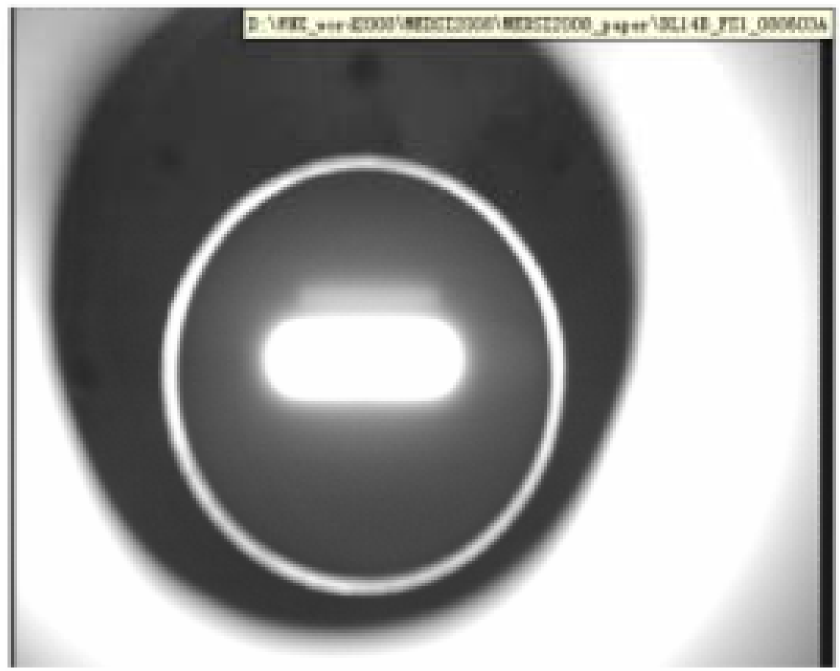
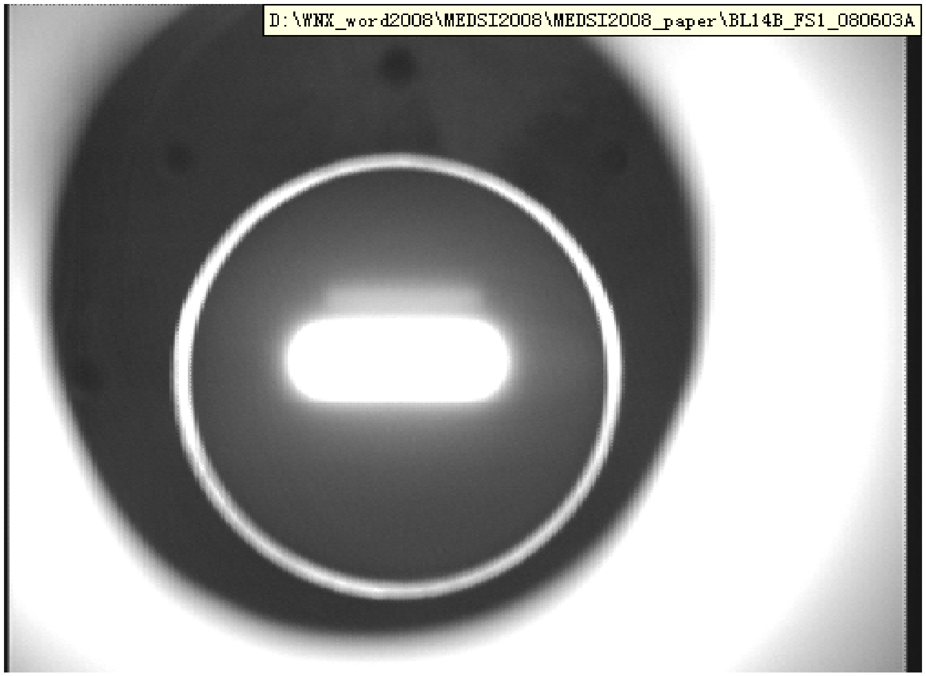
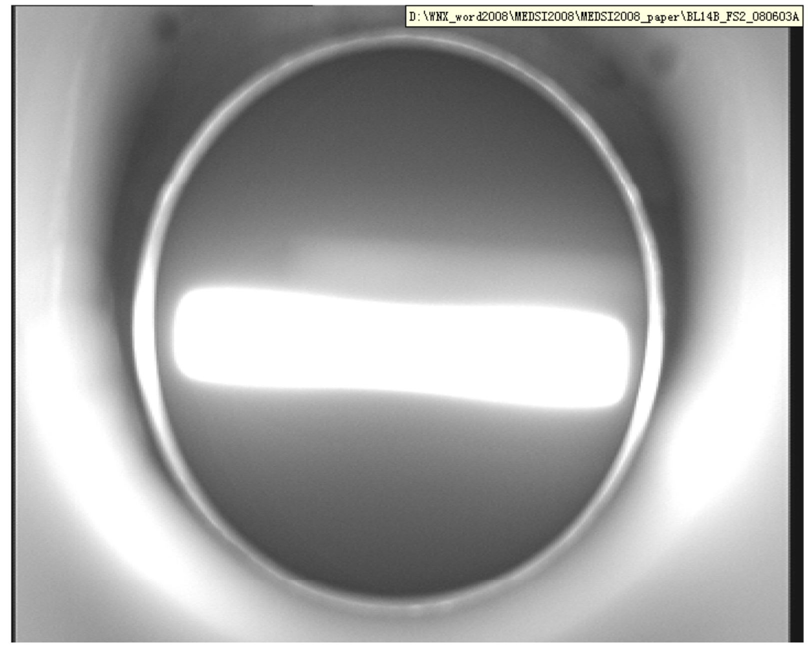


Fig.6d FS1@3GeV 100mA (Jun. 3)

Phase I Experiment-image of FS



FS1



FS2

3GeV 100mA(June 3)

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Thanks for

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