History of solid disk improvement for rotating charge stripper

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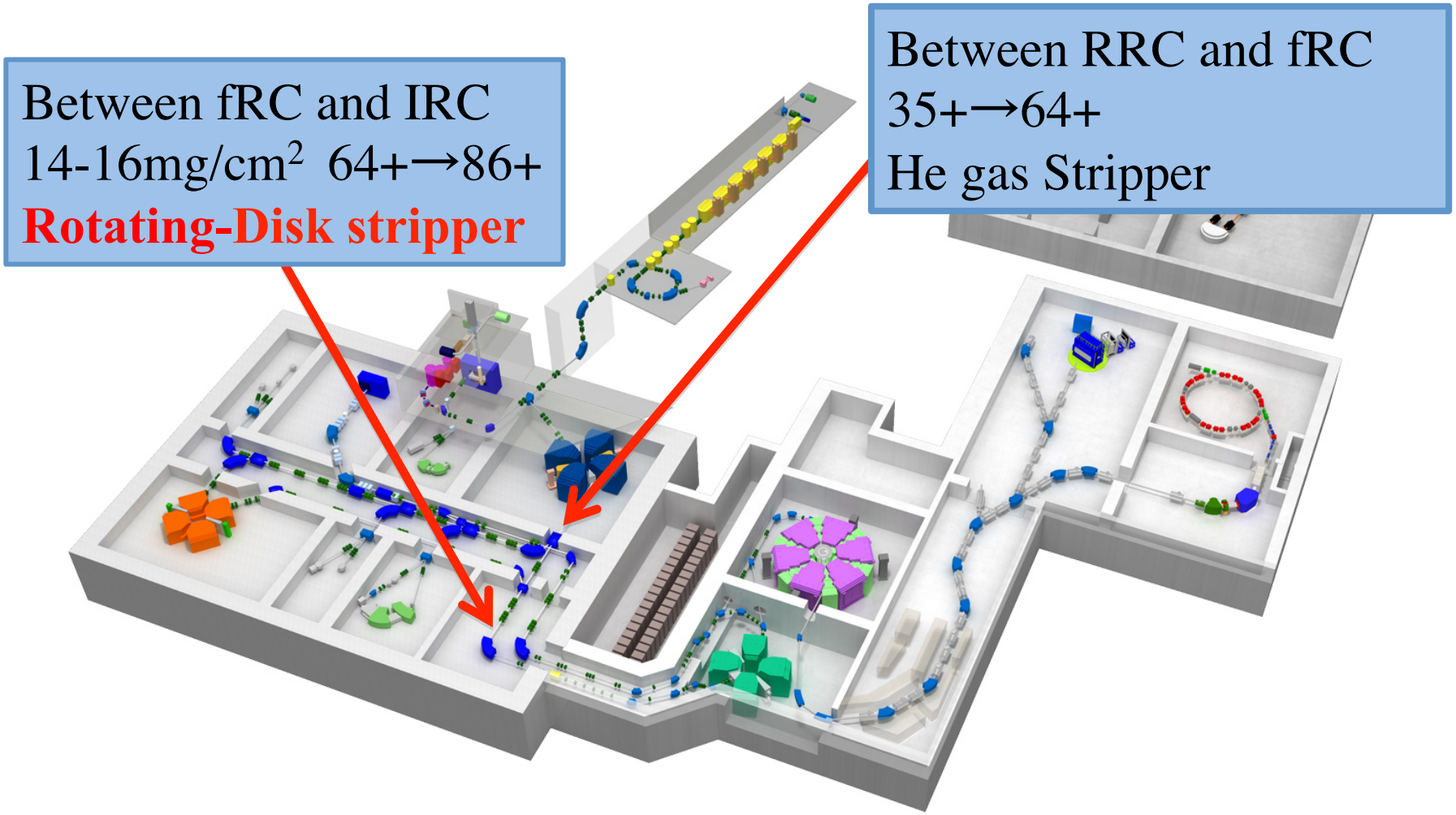
Contents

Charge strippers for U beam acceleration

2 stripping sections



Rotating-Disk stripper

To extend lifetimes by rotation of large C-foil.

Development began in 2005.

C-disk with a diameter of 120 mm was installed and tested in 2007

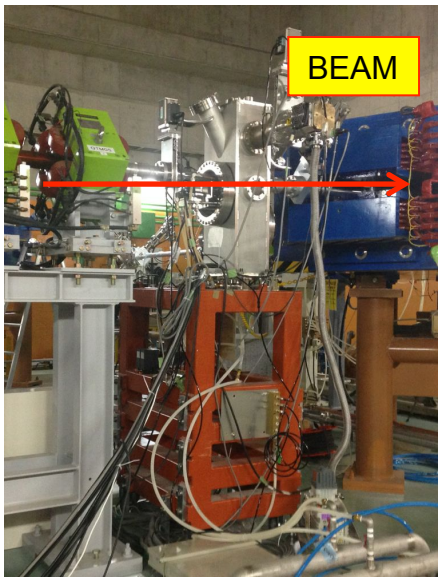
C-disk could not be used as a stripper because of non-uniformity of thickness.

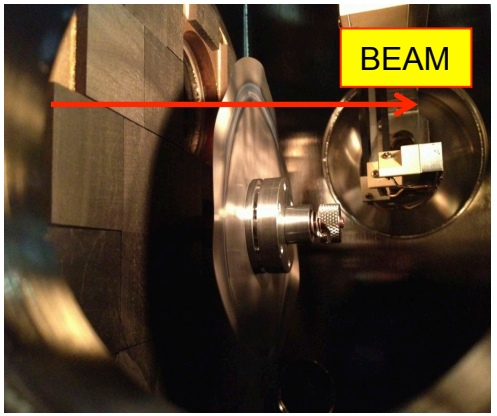
No large C-disk has met our requirements.

→Improvement was necessary as soon as possible.

Small pieces of Arizona Company's Polycrystalline graphite foils were used to manage U beam time until 2011.

Foil was replaced every 9 hours for the increased beam intensity. (U71+ 2-3eμA)

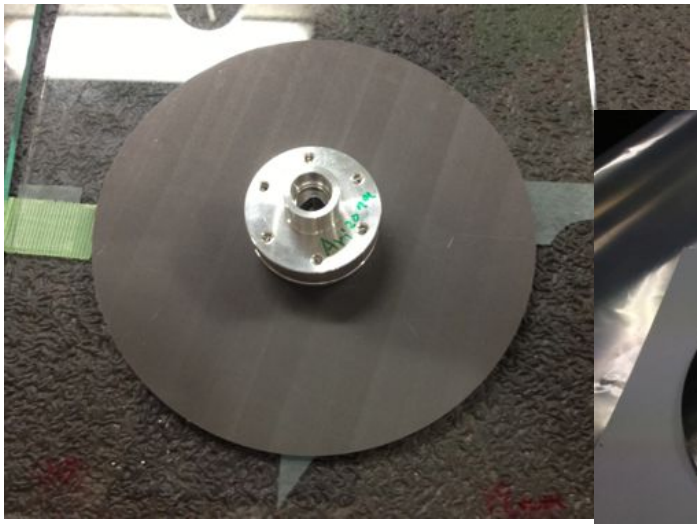




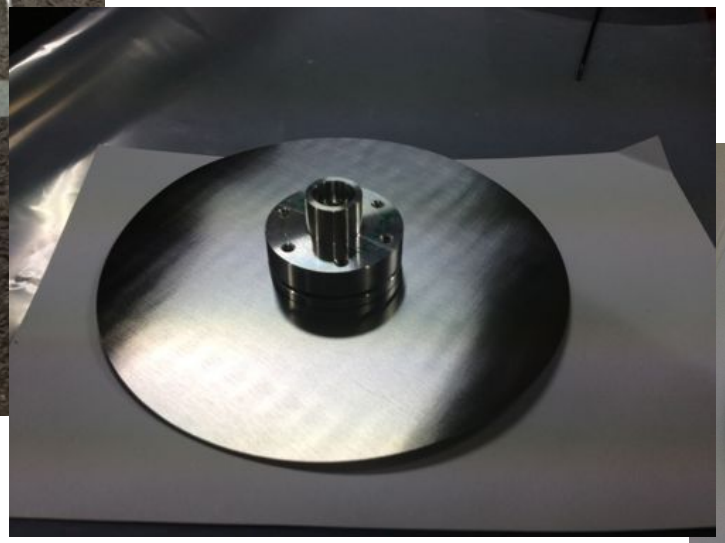
Ref. : H.Ryuto et al., Nucl. Instr. and Meth. A 569 (2008) 697.

Beam study of C, Be and Ti disk

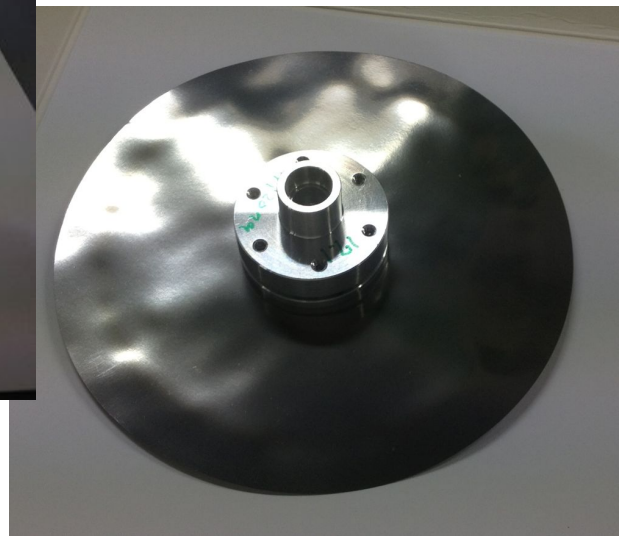
October 2012



C : Arizona
19mg/cm^2 +0 -10%



Be : GoodFellow
0.1mm ±10%
19mg/cm^2



Ti : GoodFellow
0.04mm ±10%
19mg/cm^2

Parameters:

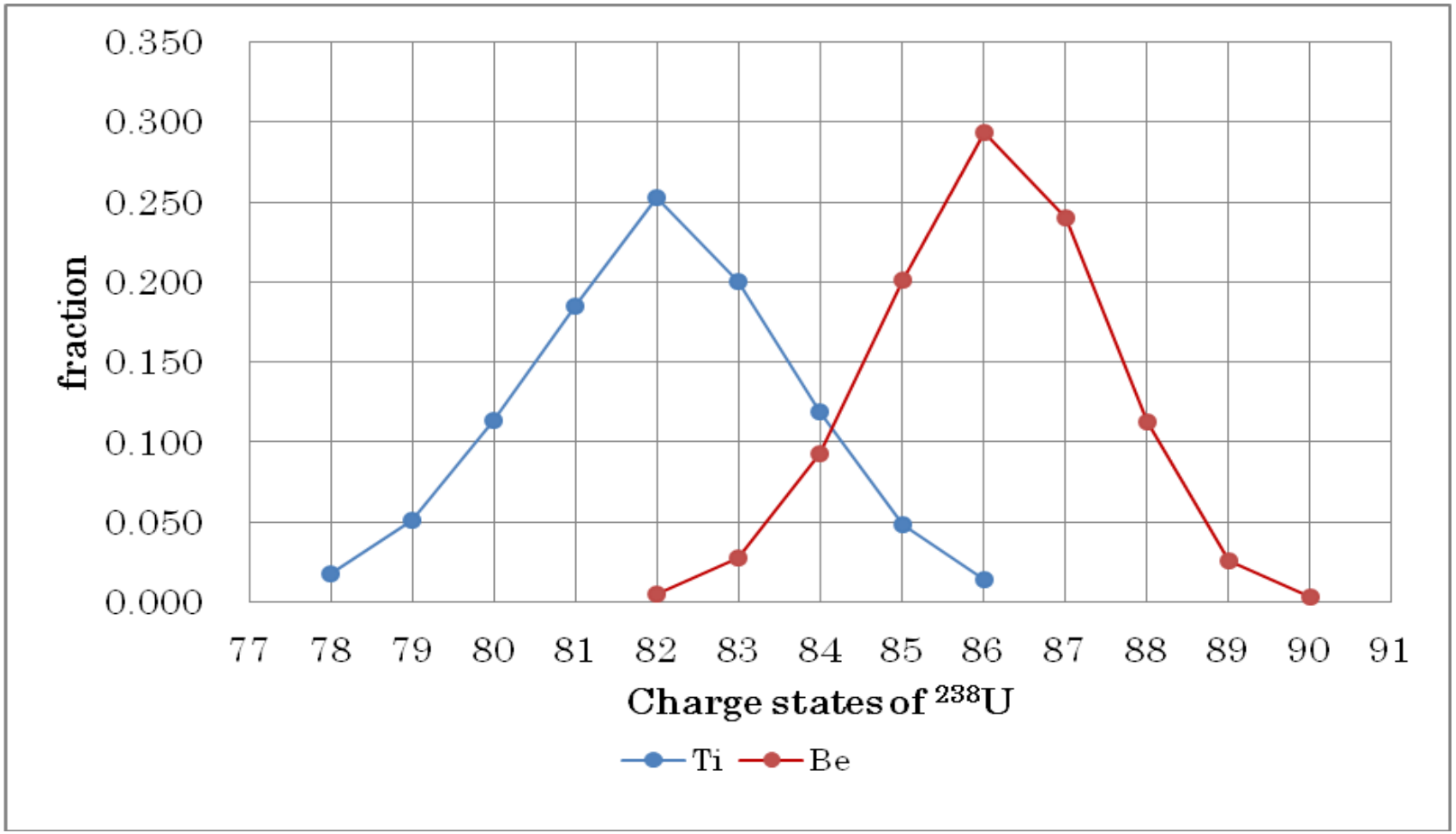
Outside diameter :120mm

U^{64+} (50 MeV / u)

Rotation speed: 300-1000 rpm

Measurement : Charge distribution, Beam quality, Long durability

Charge distributions of Be and Ti disk

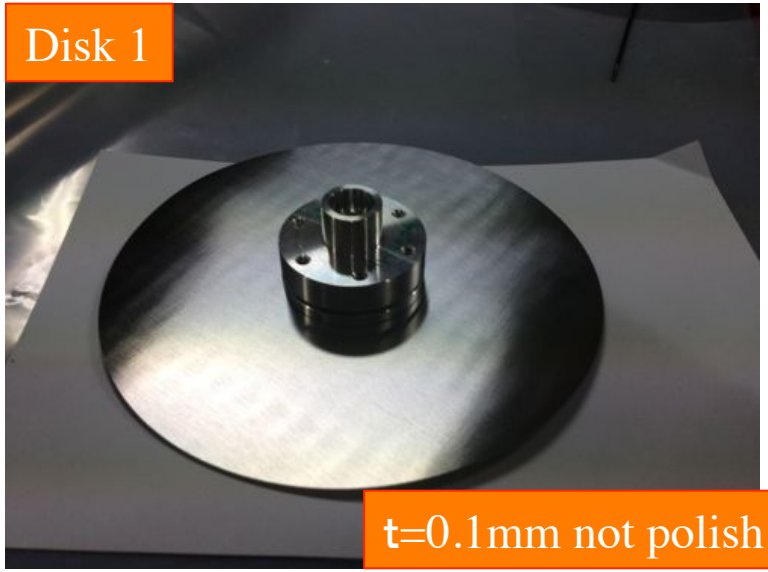


C-disk can not be measured because of non-uniformity of thickness

Ref. : H.Hasebe et al., JRNC. DOI 10.1007/s10967-015-4044-2.

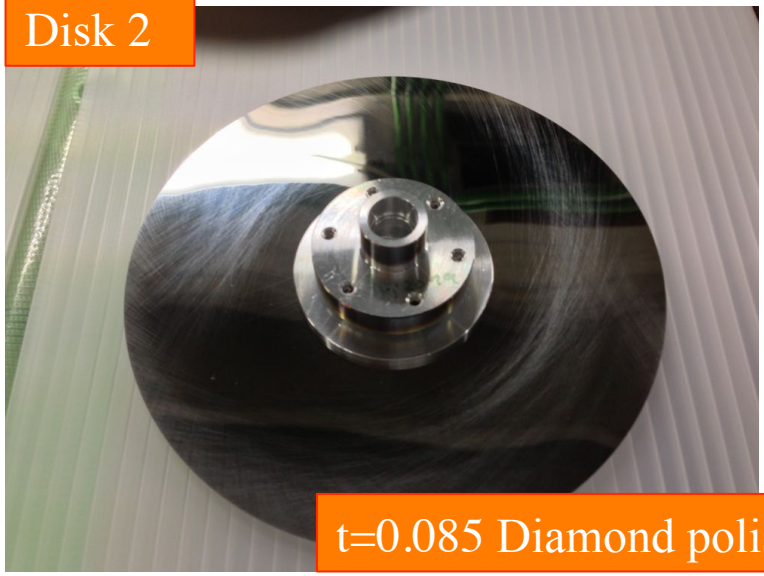
Be disk (before use)

Disk 1



t=0.1mm not polish

Disk 2

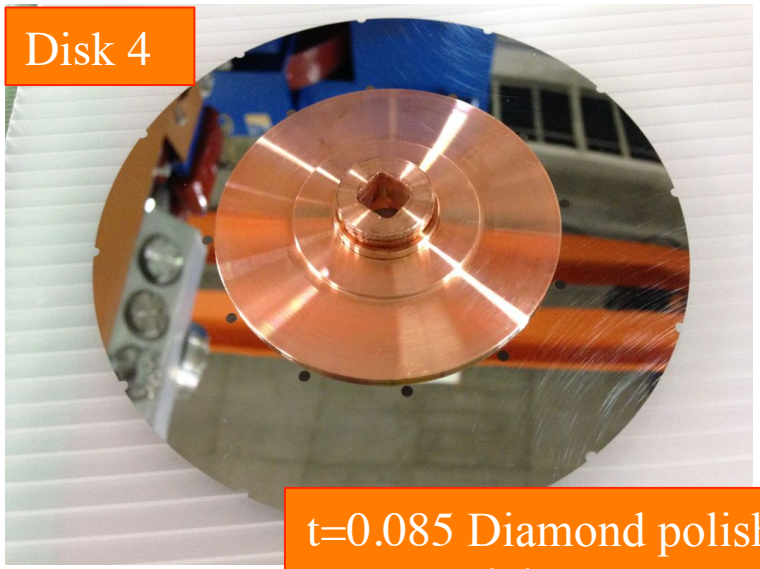


t=0.085 Diamond polish

Disk 3

t=0.085 Diamond polish

Disk 4

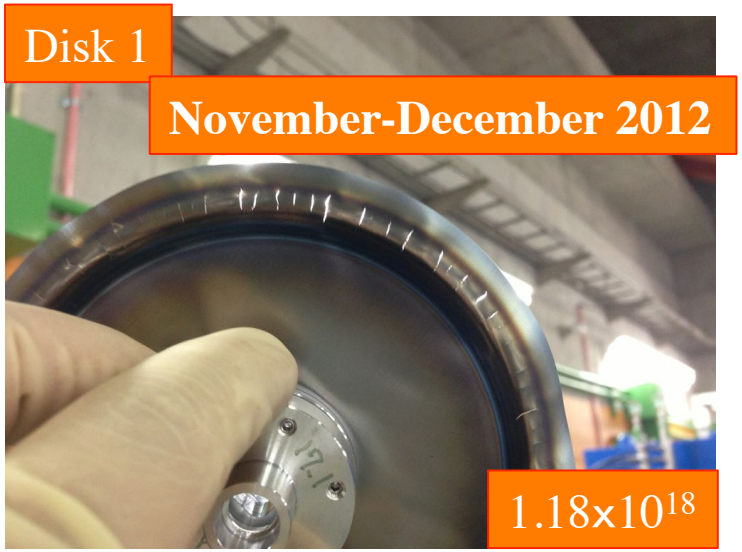


t=0.085 Diamond polish
Special process

Be disk (after use)

Disk 1

November-December 2012



1.18×10^{18}

Disk 2

April-May 2013
March-April 2014

1.68×10^{18}

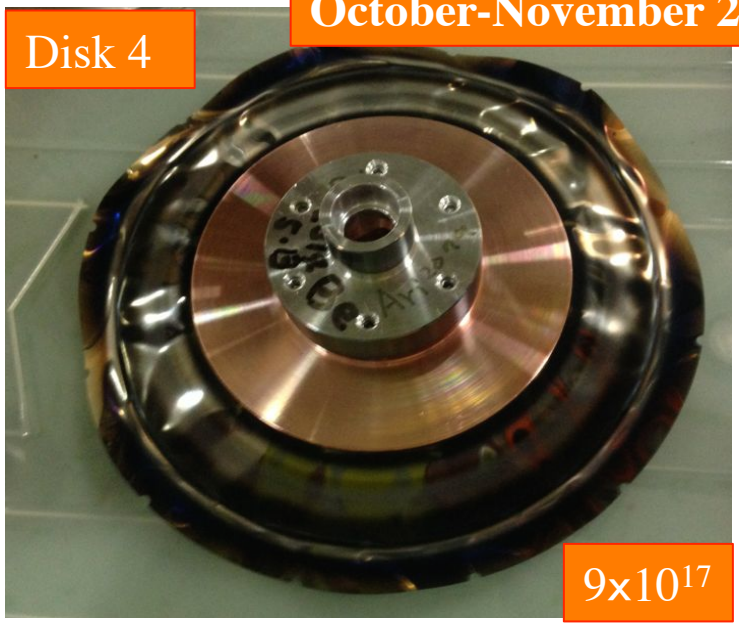
Disk 3

April-May 2014

8.83×10^{17}

October-November 2014

Disk 4



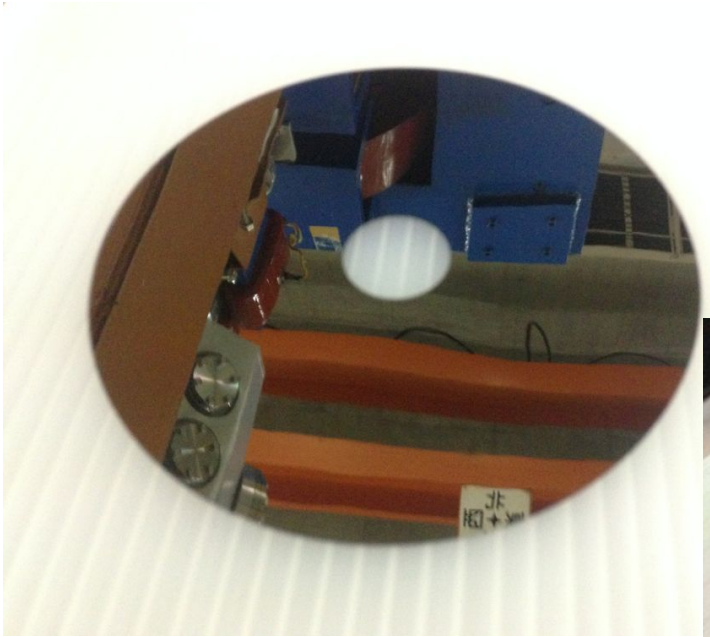
9×10^{17}

Results of Be disk

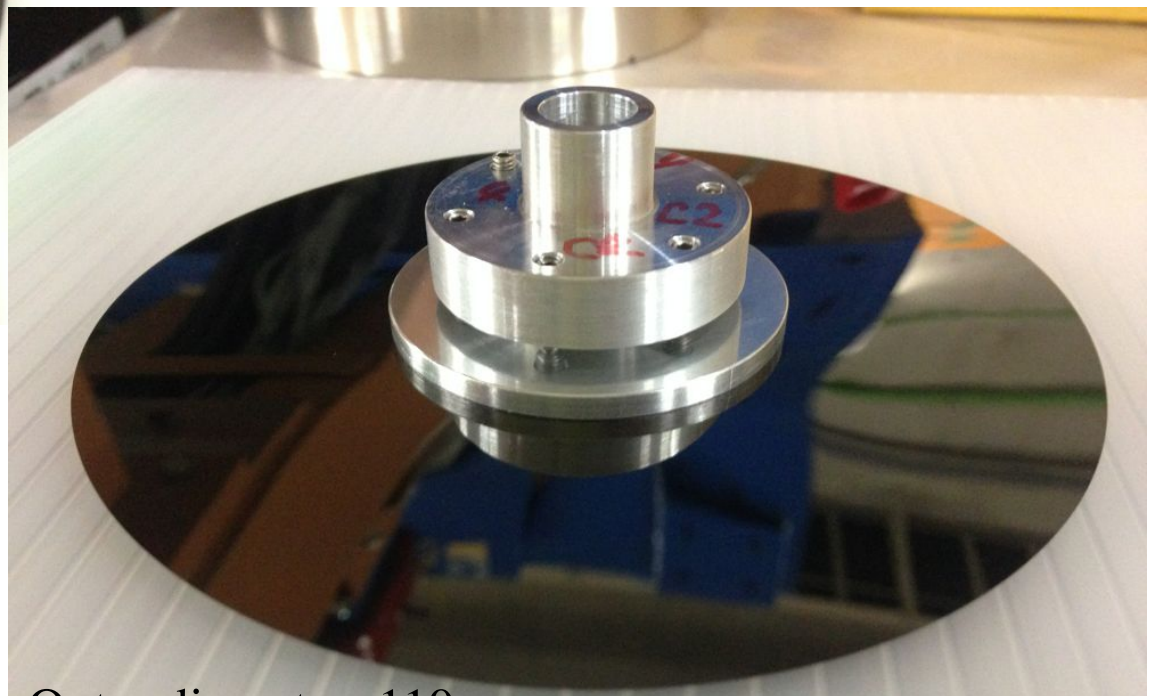
	Irradiation current Total beam particle	**Days**	**State**
Be Disk 1 Not polish 0.1-mm thick	4 - 5 eμA 1.18×10^{18}	37	Many cracks Still usable Slight beam fluctuation
Be Disk 2 Diamond polish 0.085-mm thick	4 - 12 eμA 1.68×10^{18}	51 (30+21)	Distortion and Many cracks Not usable Slight beam fluctuation
Be Disk 3 Diamond polish 0.085-mm thick	12 eμA 8.83×10^{17}	17	Distortion, Slightly cracked Still usable No beam fluctuation
Be Disk 4 Diamond polish 0.085-mm thick ϕ110mm Special processing	8 eμA 9×10^{17}	20	Slightly Distorted No crack Still usable No beam fluctuation

* Static C-foil 7.12×10^{15} (71+)

Polishing the glassy carbon by the technique for Be disk



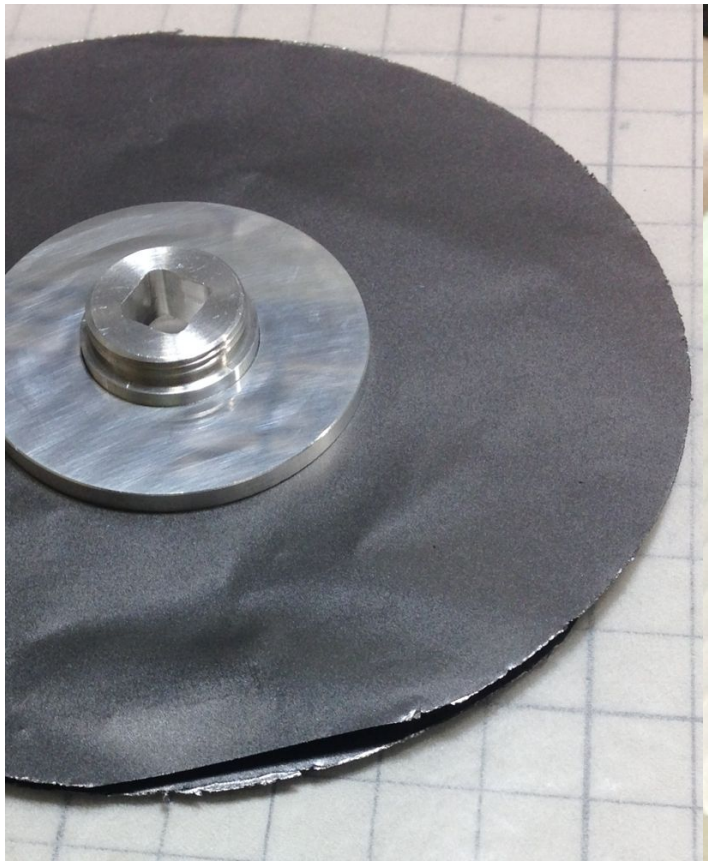
Material: glassy carbon
Manufacturer: TANKEN SEAL SEIKO Co.,LTD.
Model: F22
Thickness: 0.085mm (from 1-mm thick)
Company: Crystal Optics Inc.

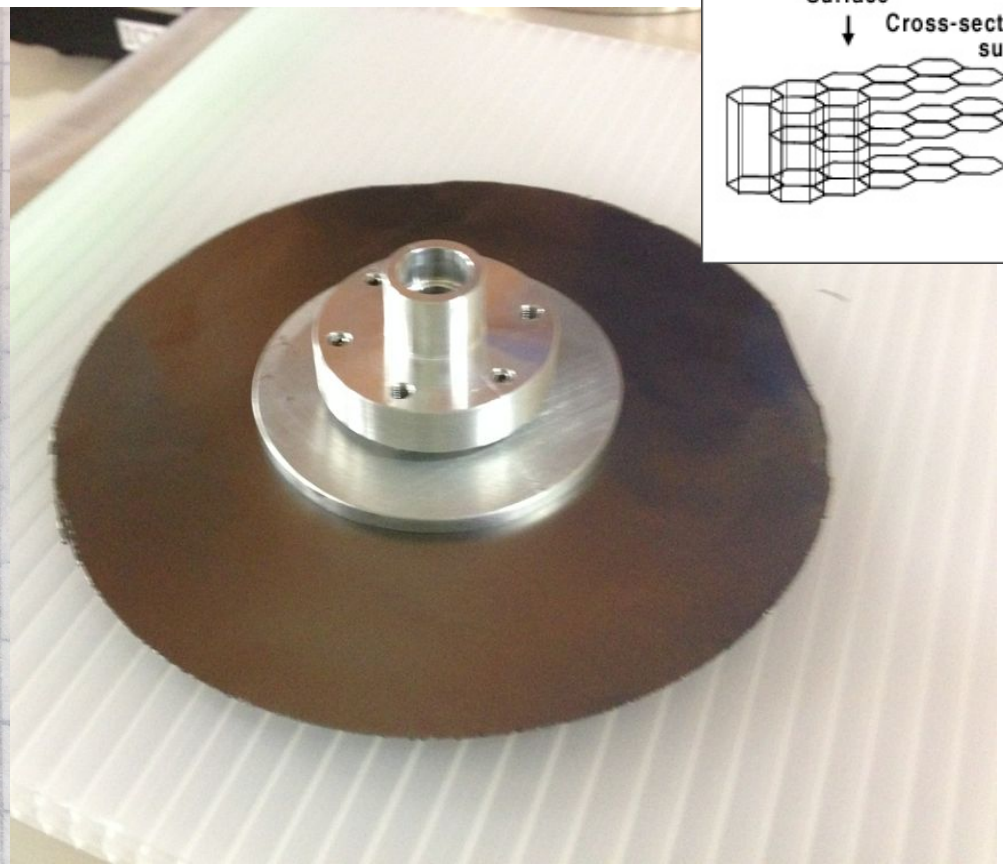


Outer diameter: 110mm
Thickness: 0.085mm ± 0.005
Thickness distribution: within ±2% at 12 positions

High Orientation Graphite sheet

(KANEKA CORPORATION)





$0.035mm \times 2 = 7.1mg/cm^2 x2 = 14.2mg/cm^2$

Typical properties

Properties

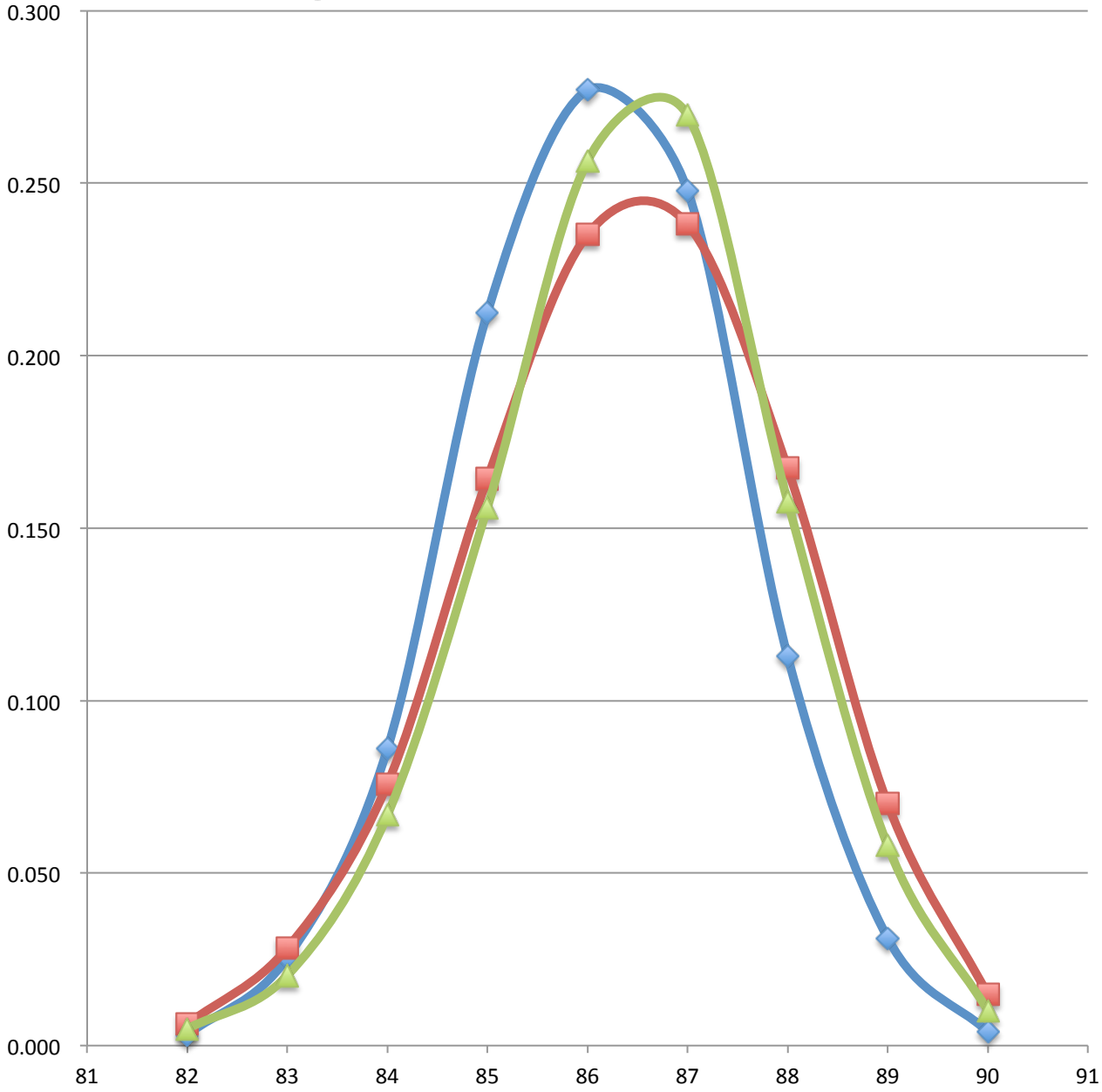
		Units	Test methods	Typical values	
				25μm	40μm
Thickness		μm	Micrometer	25	40
Thermal conductivity	In plane (XY axis)	W/mK	AC calorimeter method	1500	1500
	Thru plane (Z axis)		Laser flash method	5	5
Thermal diffusivity		cm^2/s	AC calorimeter method	9.0	9.0
Density		g/cm^3	Kaneka method	2.0	2.0
Tensile strength		MPa	ASTM-D-882	40	40
Bending		Cycles	JIS-C5016, R=2mm,135°	>10000	>10000
Electrical conductivity		S/cm	JIS K 7194	13000	13000
Heat resistance		°C	TG-DTA	500	500
Water absorption		%	JIS K 7209	<0.1	<0.1

These data are not guaranteed values but the measurement values at our company.

Beam study of C disk and GS

October 2014

Charge distributions Be, C disk and GS



Average charge
Be 86.1
C-Disk 86.4
GS 86.4

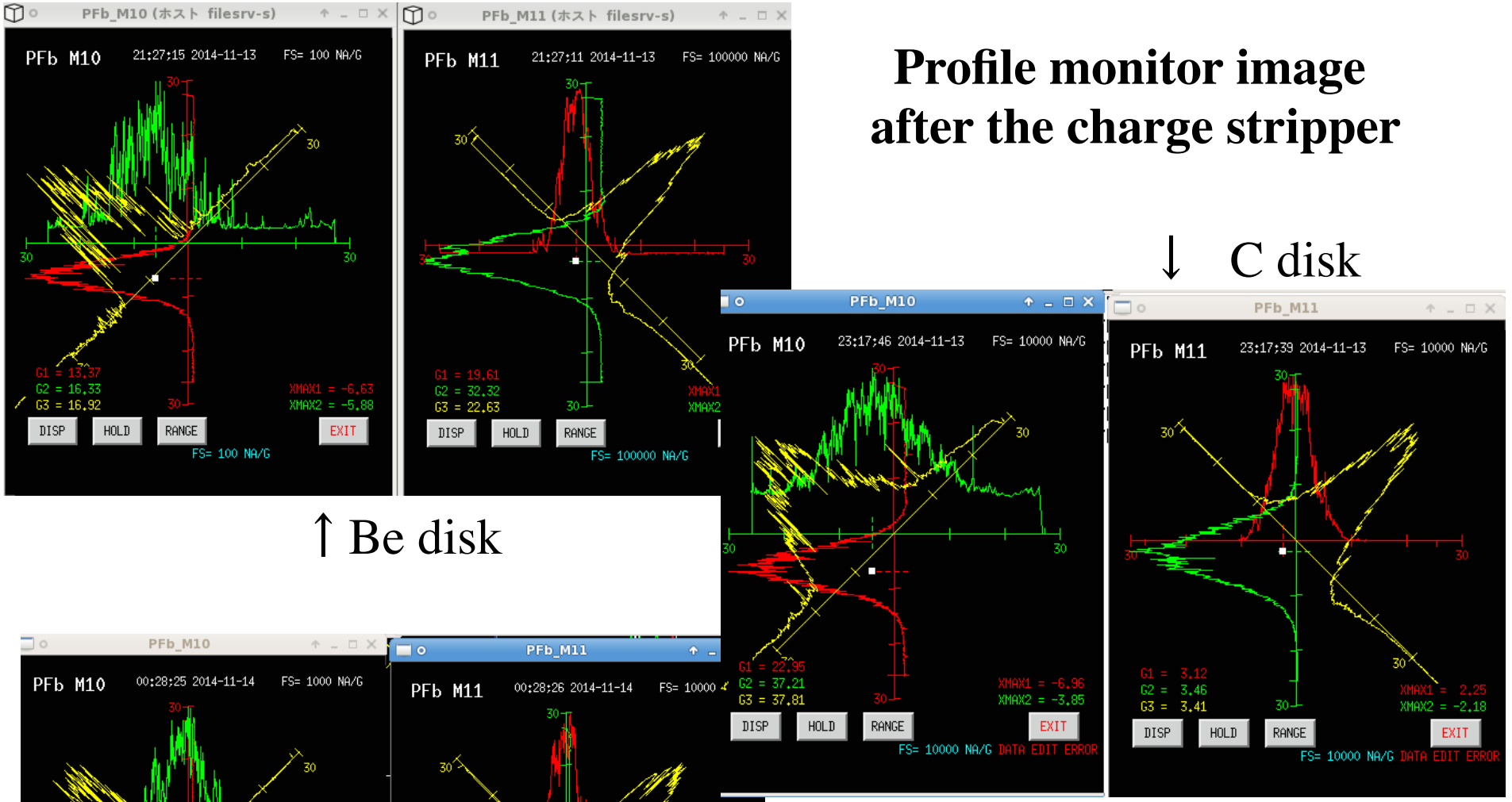
rot. Be
16.1mg/cm2

rot. C2
16.1mg/cm2

カネカシート7.1mg/cm2x2

Profile monitor image after the charge stripper

↓ C disk

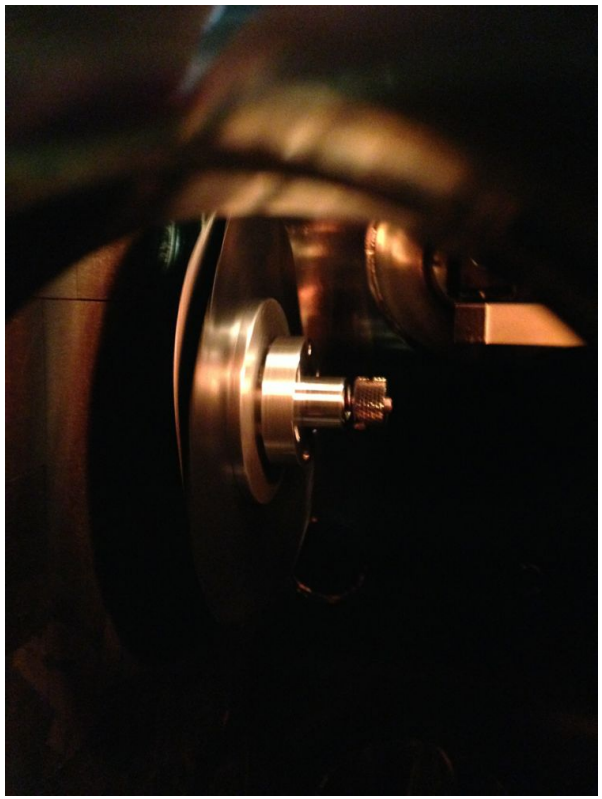


↑ Be disk

← GS

GS in beam time

March-May 2015



Beam intensity :15 eμA
Thermal load :205W
Uranium particles : 1.41×10^{18}
ANSYS Approximately 600K

History

	Arizona	Be disk	C disk	KANEKA GS
Period	2007-2011	2012-2014	2015	2015
Maximum beam intensity	2-3eμA	12eμA	12eμA	15eμA
Lifetime	$7.12x10^{15}$ (71+) 9 hour	$1x10^{18}$ (64+) 20 days	Not measured	$>1.41\times10^{18}$ (64+) Measuring
Cost	$1000（1 Day） $30000 (1 Mon)	$12000 1 piece	$3200 1 piece	$500 1 pair

Summary

KANEKA GS has shown an excellent performance and longest lifetime.
The second stripper problem was solved.
Strippers with thickness variation can be prepared easily.
GS is very strong and flexible (we can treat it with scissors or cutter knife).
GS can be used to provide other ion beams with better quality.

Thank you for your attention!