Update on Detection and Study of Welding Porosity in Niobium EBW

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CavCam Status

- ✓Rotatable Cylinder
- ✓Higher Resolution
- ✓External Camera (from JLAB)
- ✓CERN SPL cavity

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CavCam2

Camera to observe the appearance of wall surface in the cavity

Export agency : REPIC CORPORATION

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Japan Neutron Optics Inc.

Riken-Wako Incubation Plaza 407

Minami 2-3-13, wako, Saitama, 351-0104, Japan

e-mail: info@j-nop.com

URL http://www.j-nop.com

Details of CavCam2 Module Package

1) CavCam2-Cylinder "Upper Module of CavCam2"

Weight < 20 kg

(1) Camera

9M Pixel color CMOS Camera

Better than 4 microns/pixel(about 3.7 micron/pixel)

Focus adjustable by movement of camera position

USB interface to PC with English viewer software, driver software and manual

(2) Mirror

Adjustable tilt angle of the mirror by pulse motor

(3) Illumination

Ten white-LEDs at both sides of camera window

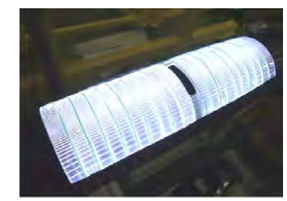
Semi-coaxial illumination by LED through the mirror

The illumination housing slides with the mirror tilting angle synchronously.

(4) Illumination control box

Illumination on/off for 21 LEDs

Illumination intensity for LED are adjustable

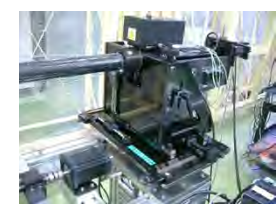


(5) Camera cylinder holder

Cylinder positions are adjustable in horizontal and vertical direction with position indicators.

The cylinder tilt angle and yaw angle are also adjustable.

- The cylinder itself is rotatable by pulse motor from 0 to 360 degree and its angle is displayed to LED indicator and also readable from RS232C.
- The cylinder rotation axis is adjustable by two fine pitch screws to make camera axis in the rotation center.



A built-in damper against the cylinder vibration

(6) Cylinder alignment to cavity

Camera cylinder has rotatable red laser indicator which will guide you the cylinder direction to avoid touch to cavity iris.

(7) motor controller

2 ch pulse motor controller for focus adjustment and mirror angle adjustment.

Another 2 ch pulse motor controller (only 1-ch is used) for cylinder rotation.

These two controllers are linked together so that one handy control terminal can control all three channel.

2) CavCam2-Table "Lower module of CavCAM2"

(1) Table body

Width: 581 mm

Height: 1023 mm

Length: 2950 mm (table at operation), 2950 + 339 mm (including cylinder tail)

2090 mm (retractable for transportation)

Stroke: 1500 mm

Weight: < 230 kg

Cavity rotetes by pulse motor.

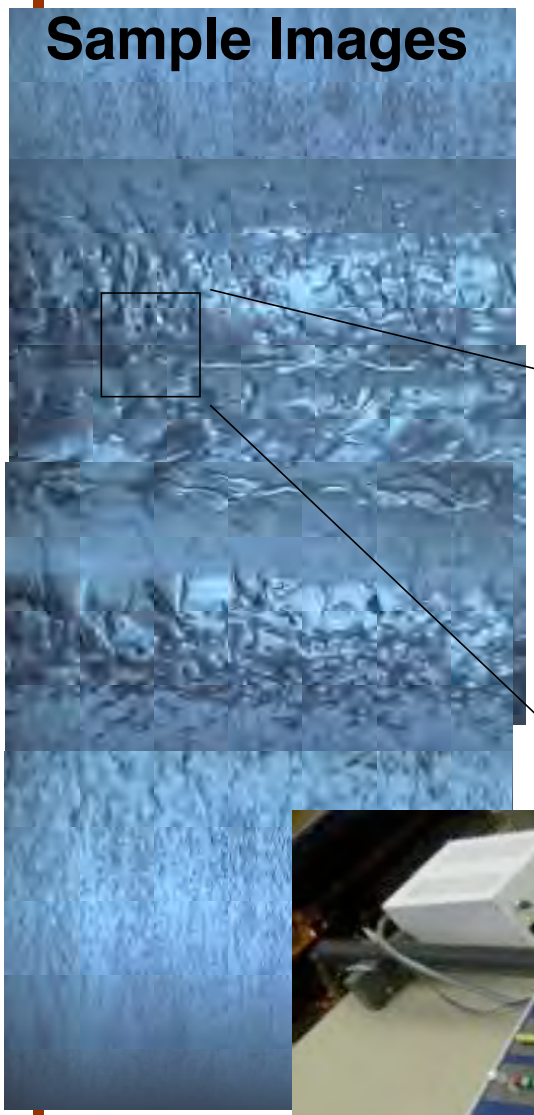
(2) Rotary encoder for cavity rotation angle measurement

(3) Motor controller

2-ch pulse motor controller, handy terminal

(4) The camera cylinder holder sits on the table.

External Camera (for JLAB)

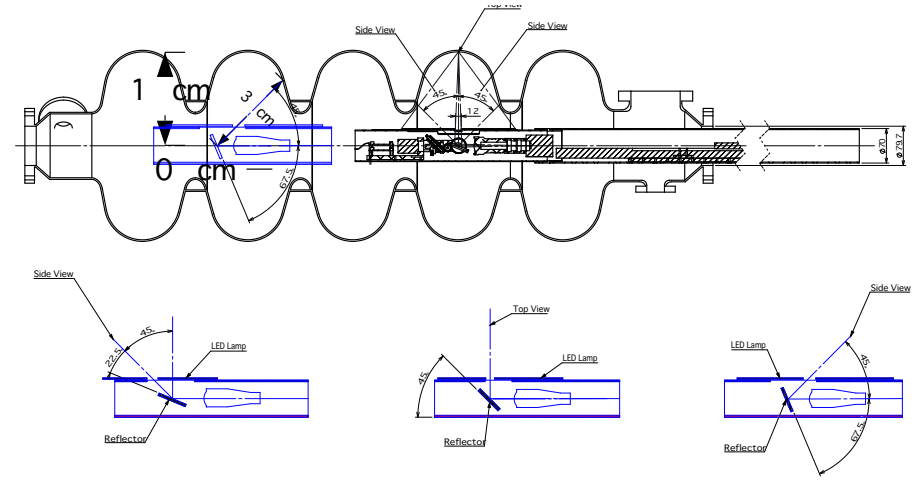


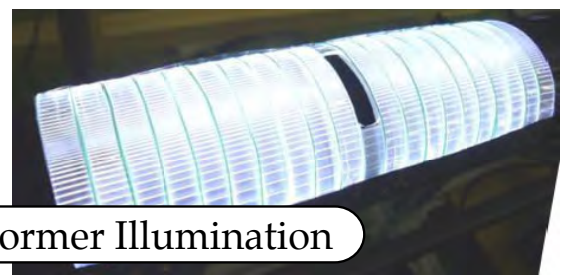
2010.11.22
ARTCAM-900MI
3488 x 2616 mode

Resolution of the left pictures does not reflect the camera resolution.

The resolution depends on that of a camera.

CavCam3 for SPL Cavity





Former Illumination

Enhanced Illumination

New version for large cavity: (Armadillo Illumination)

14 chips/line x 2 lines/strip
x 10 strips/side x 2 sides
= 560 chips!

- Enhanced Illumination for larger surface
- Better lens for longer work distance.

3 LED's/chip!

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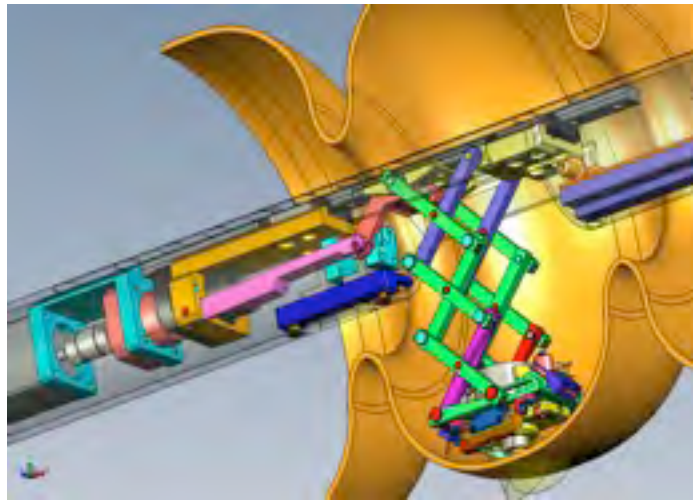
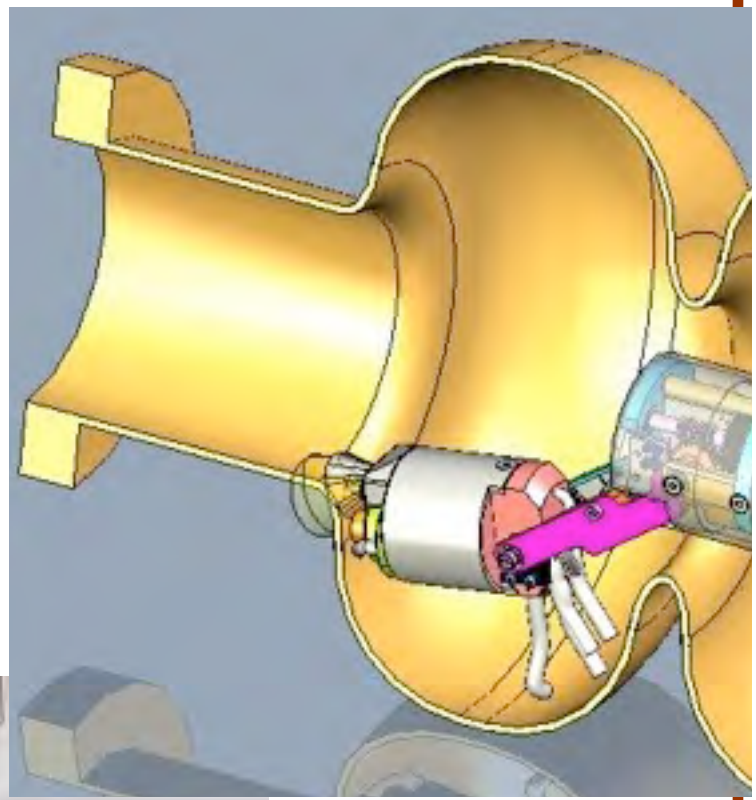
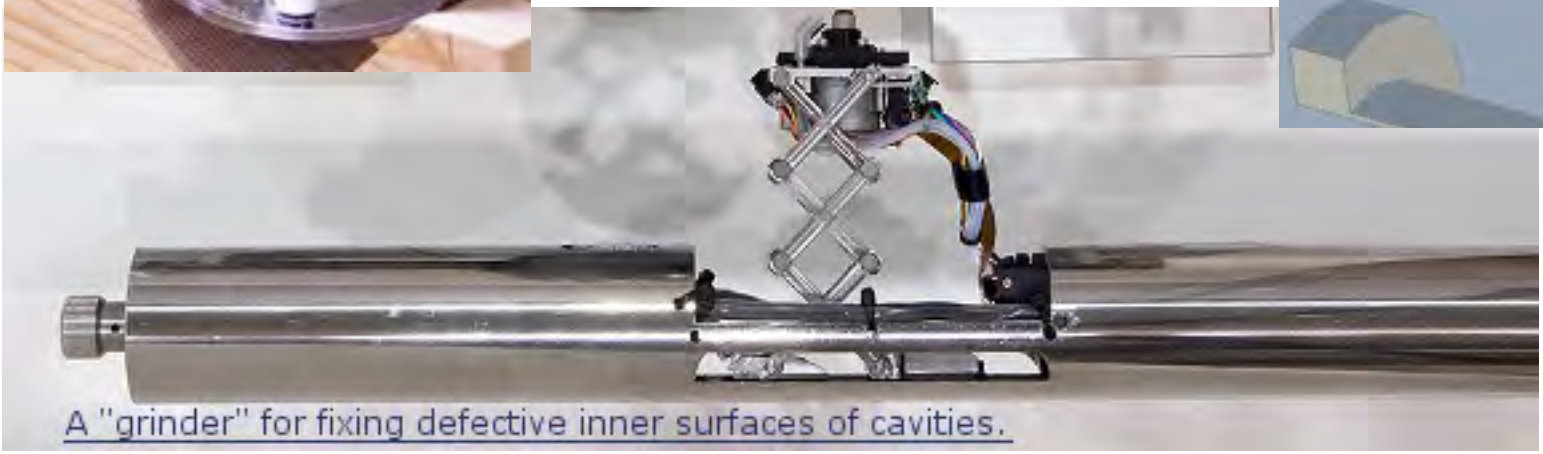
Local Fixing Grinder







A "grinder" for fixing defective inner surfaces of cavities.

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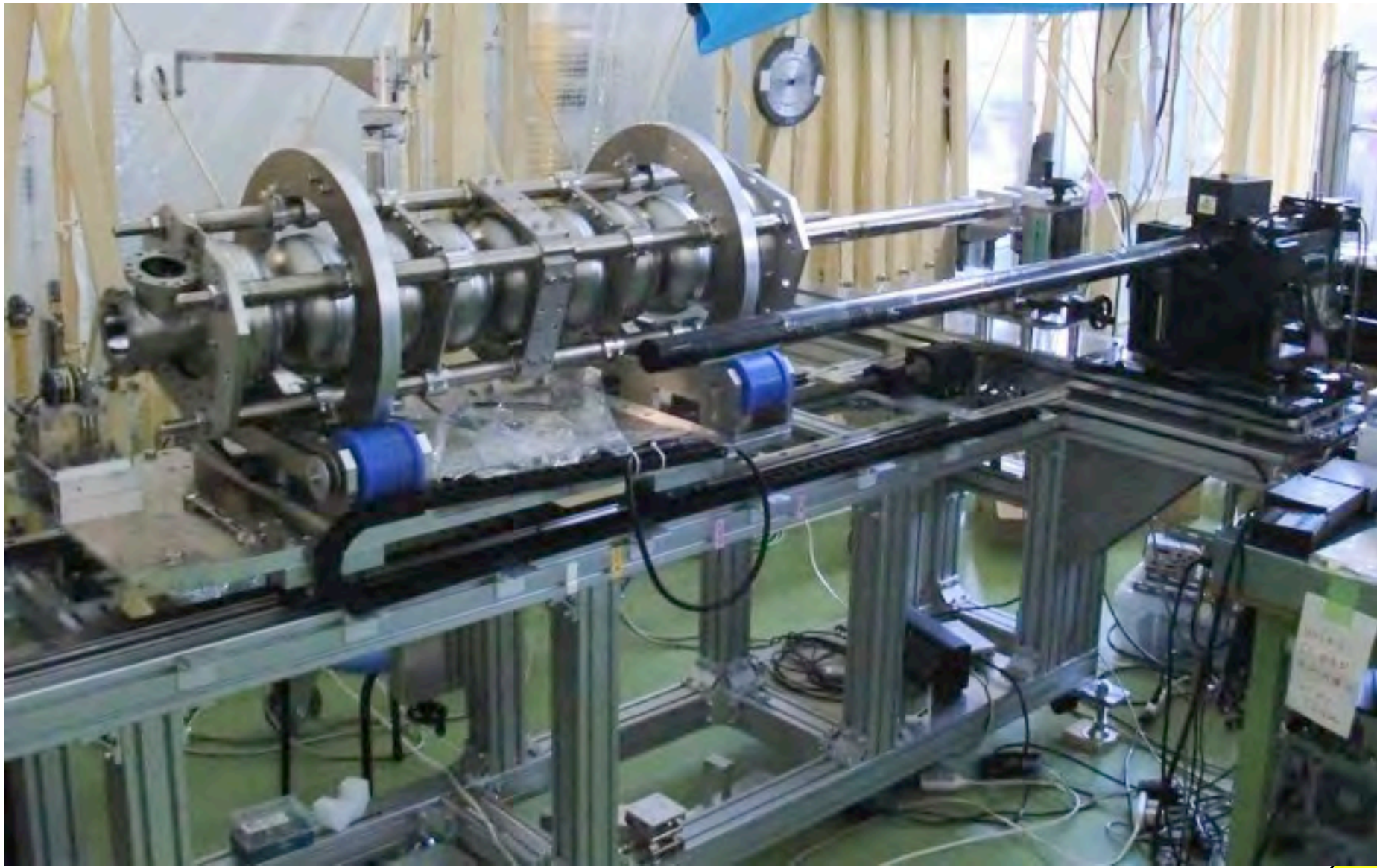
Combination of CavCam and LocalGrinding



Switchable CavCam and LocalGrinder on the same stage.

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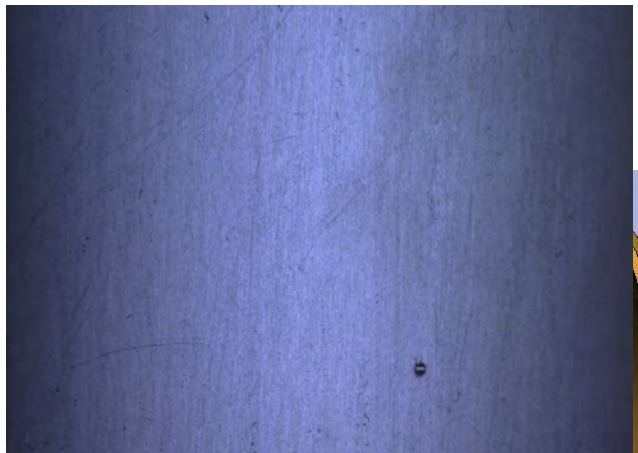
Local Micro-Grinder

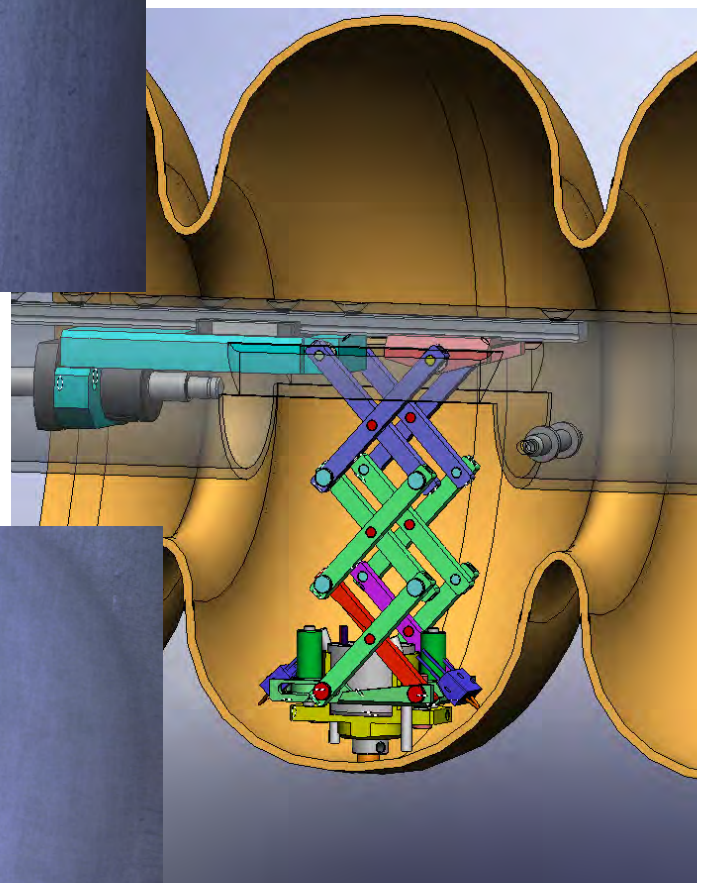
Local grinding example

after 2nd V.T.

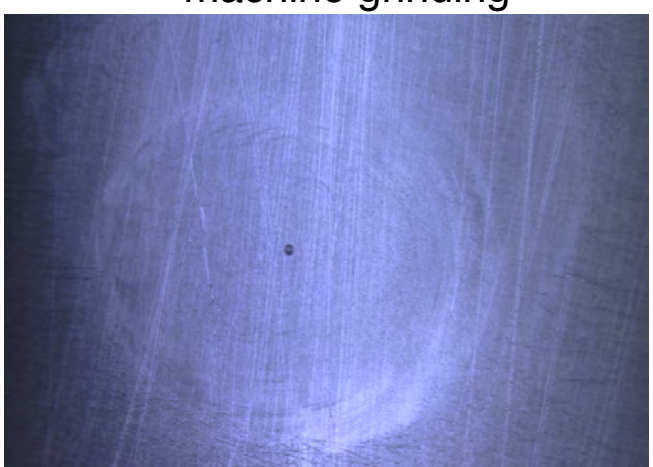
grinding by hand



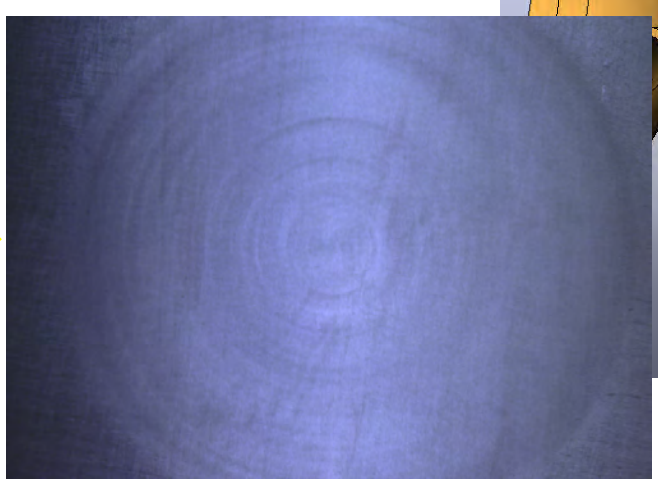
MHI-010



machine grinding



finish



Yasuchika Yamamoto

evolution of grinding @Cell #1

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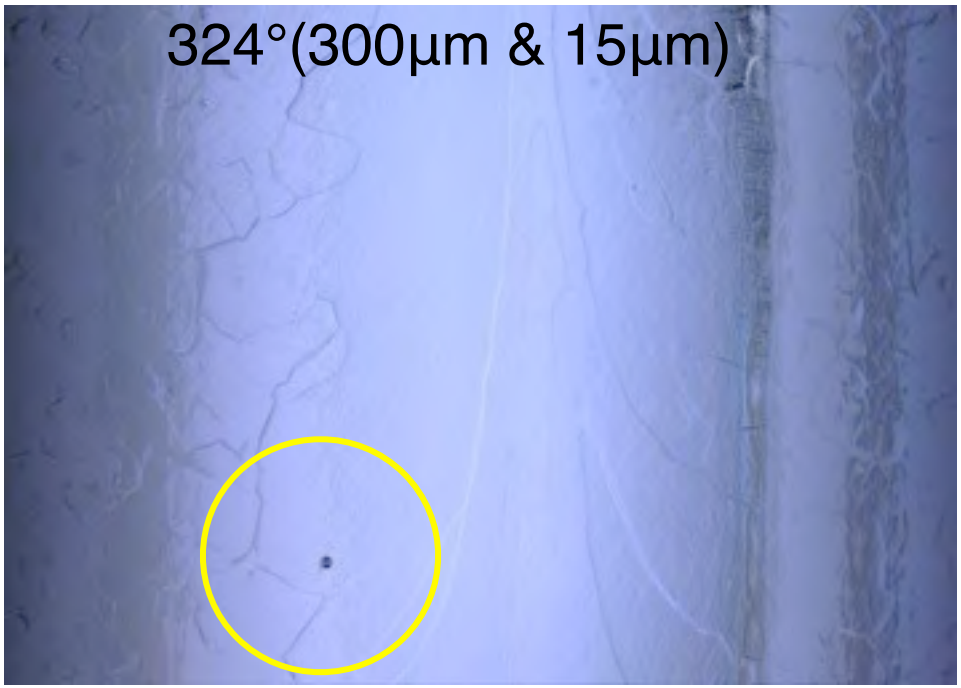
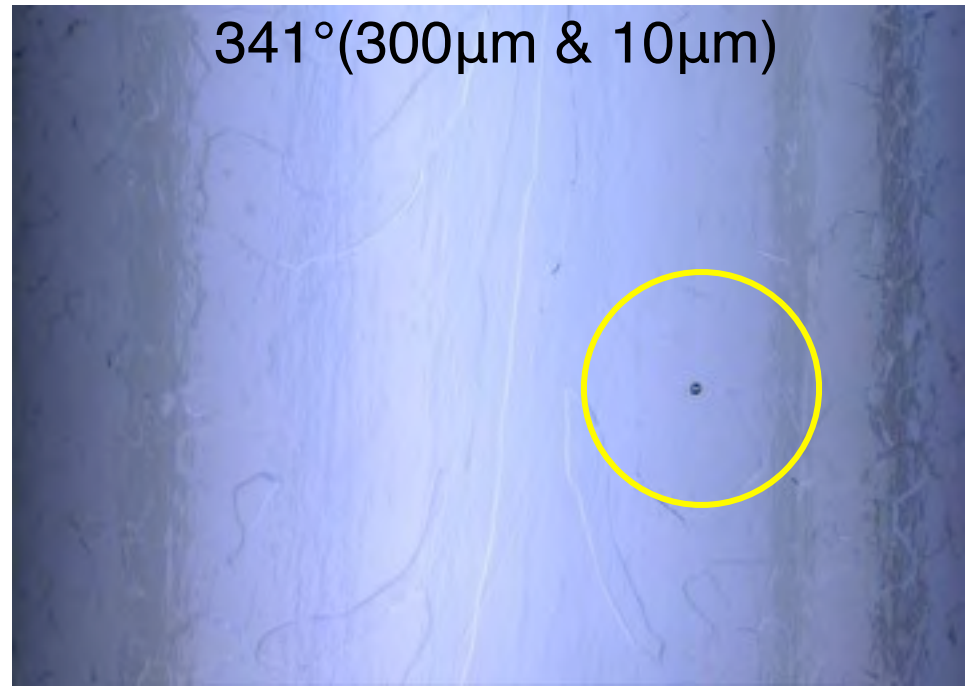
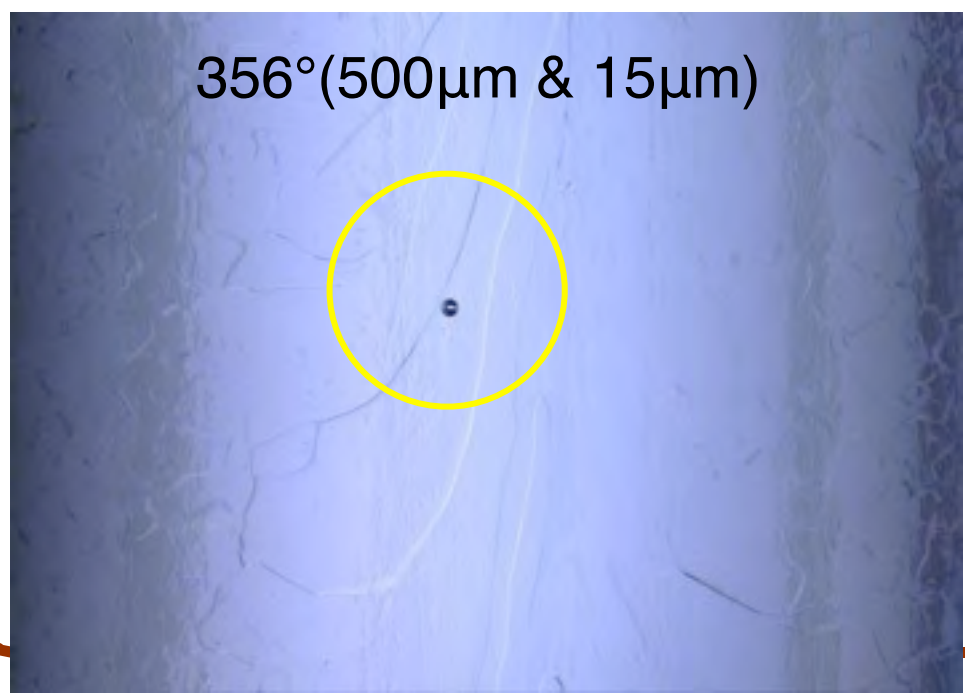
MHI-010

After the LocalGrinding and EP, new defect appeared! Furthermore, it grew with the LocalGrinding!







MHI-010:

1st VT 23.8MV/m @ Q0=1.1E10 May 20,2010

2nd VT 25.7MV/m @Q0=8.1E9 June 17,2010

local grinding and 100mm EP

3rd VT 20MV/m @ Q0=1.1E10 Sep 02,2010

Yasuchika Yamamoto

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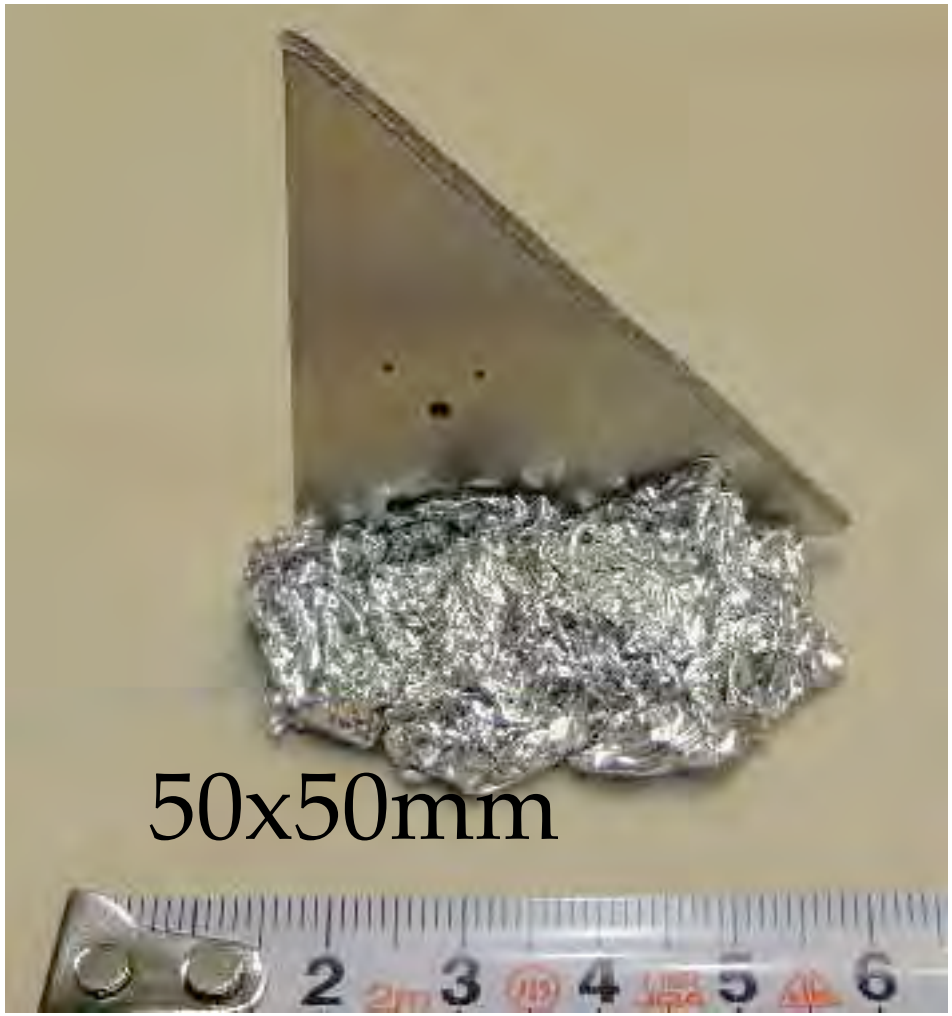
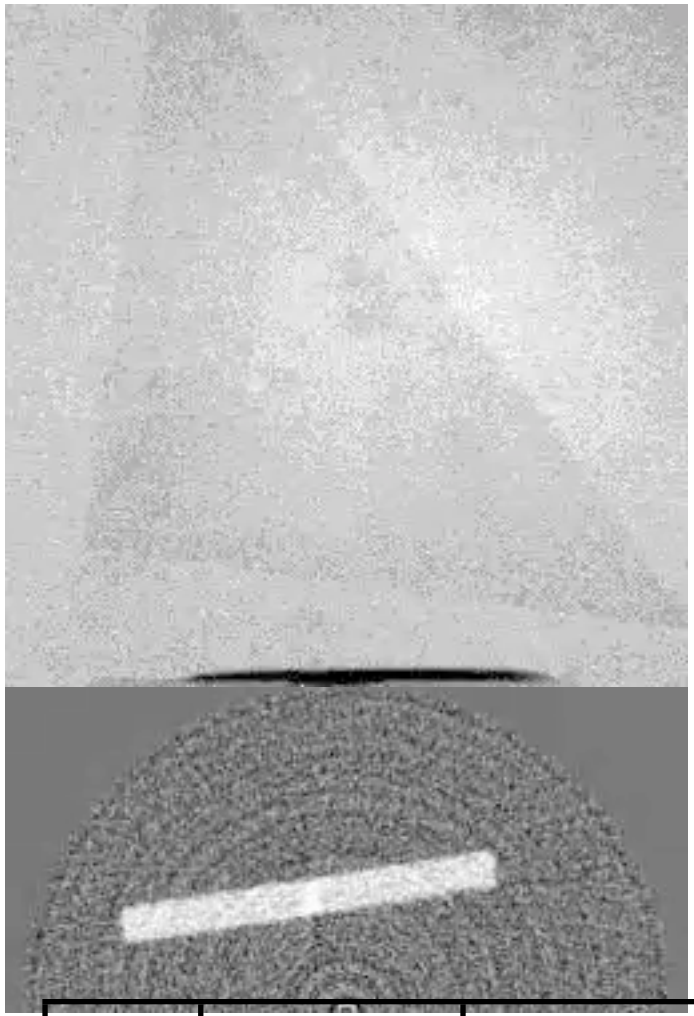
Toward Internal Inspection

Neutron Imaging

Neutron CT





ø1.5 thru hole

ø0.5 x 2.5, ø0.2 WC

Mat'l	Abs. xs	
Nb	1.15	41
Ta	20.6	73
W	18.5	74

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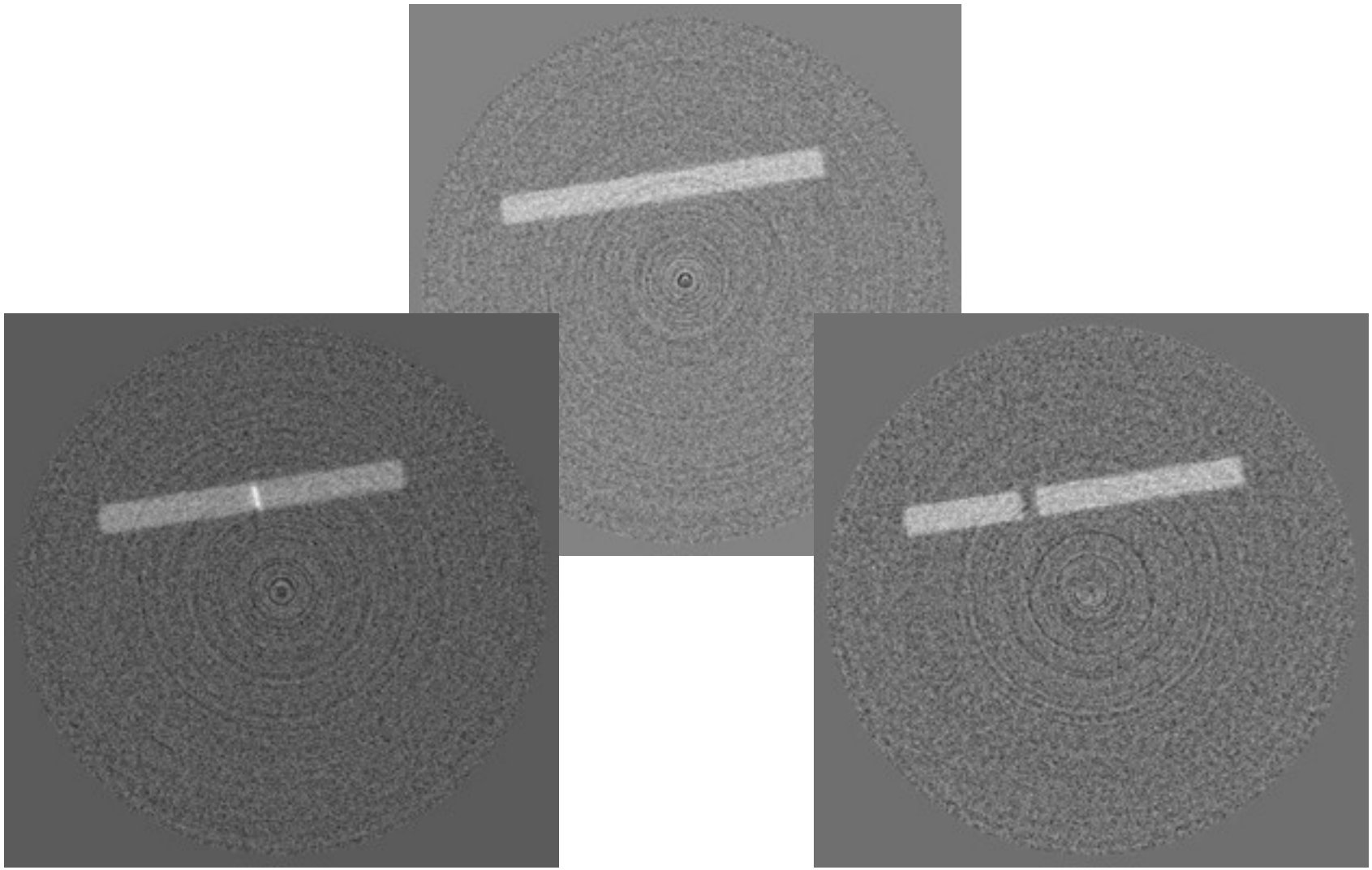
Neutron Imaging



ø0.2 WC

ø1.5 thru hole

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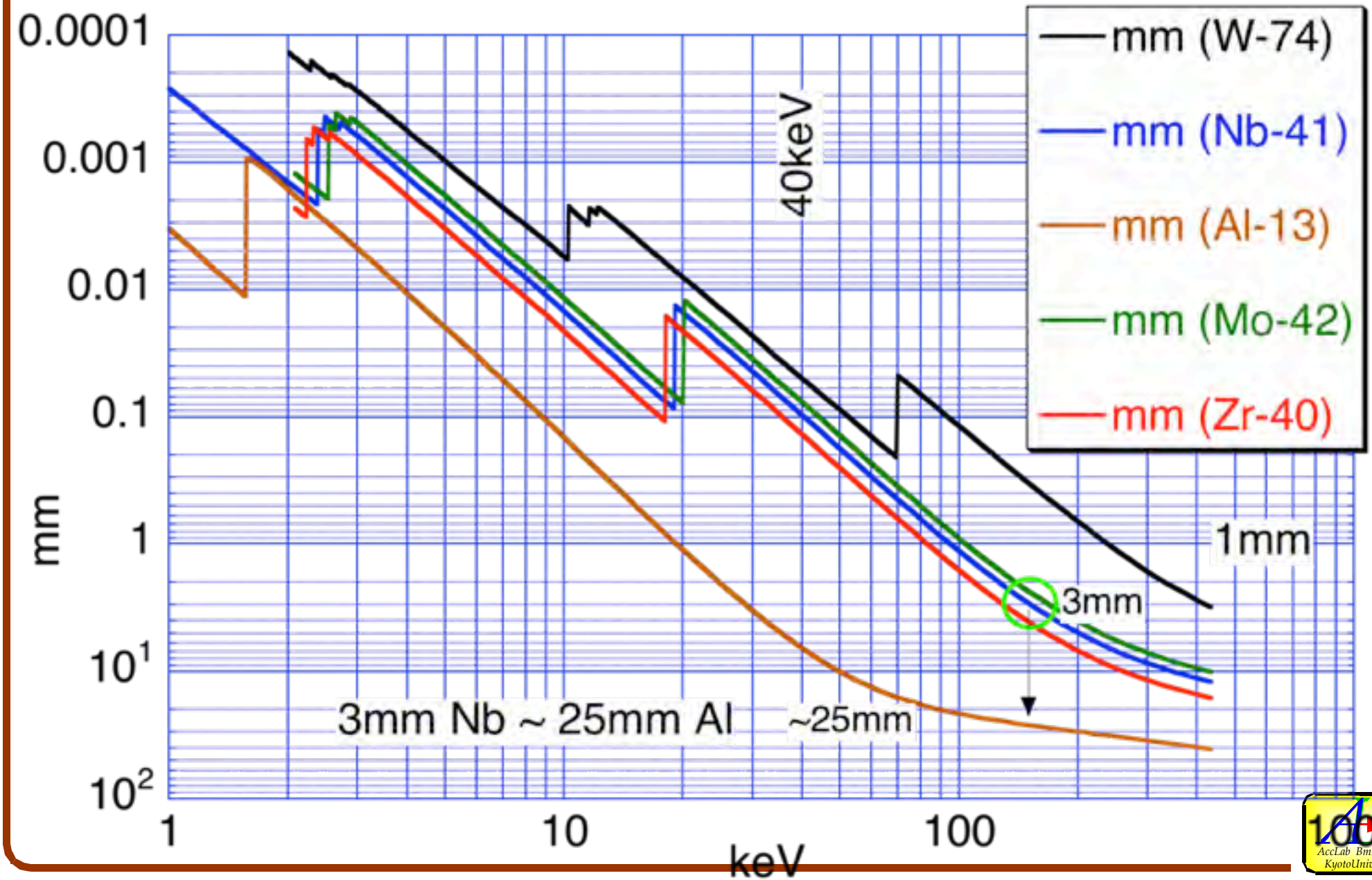
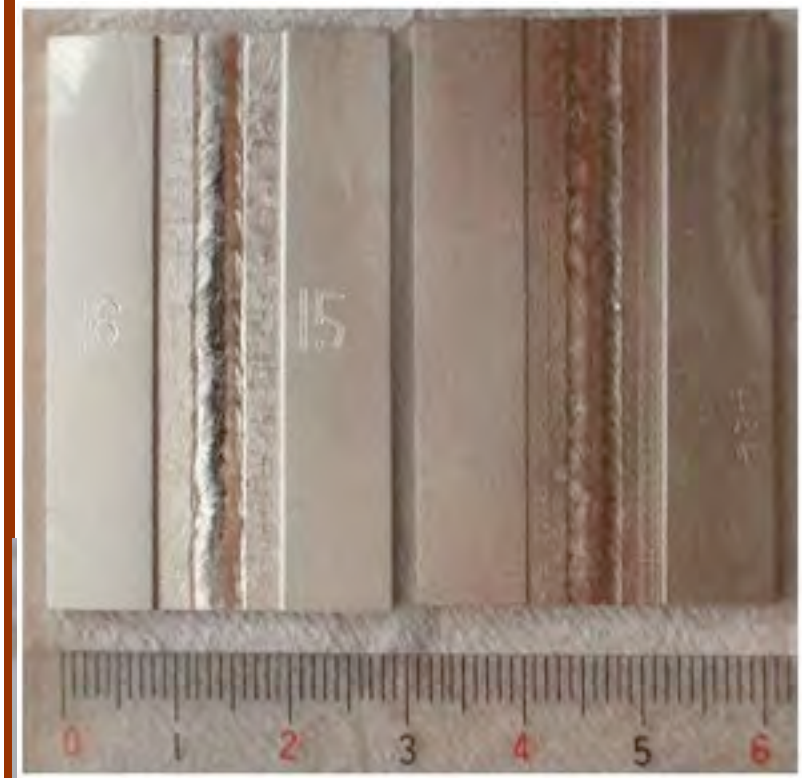
X-Ray Imaging

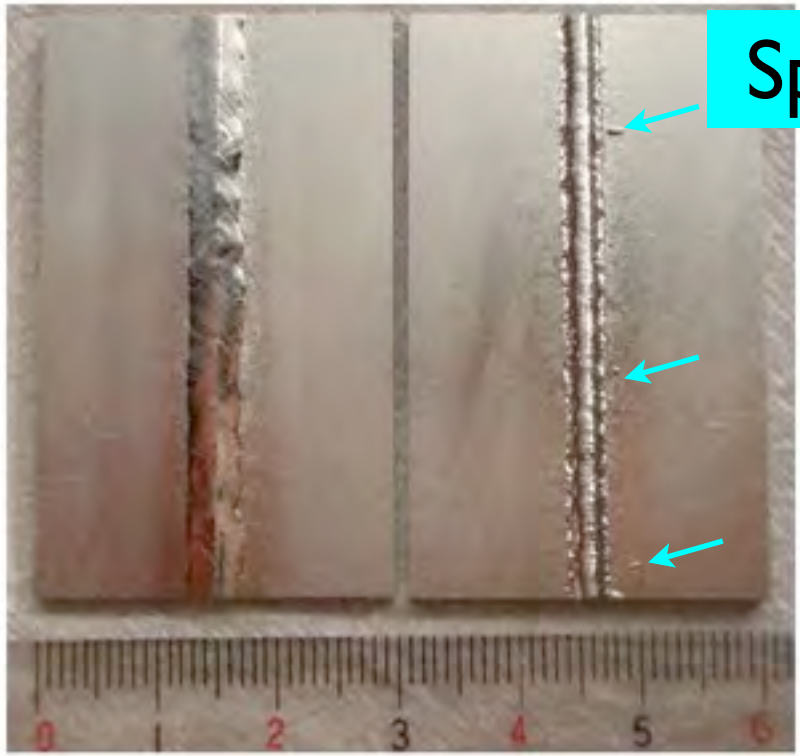
Penetration Depth of X-rays



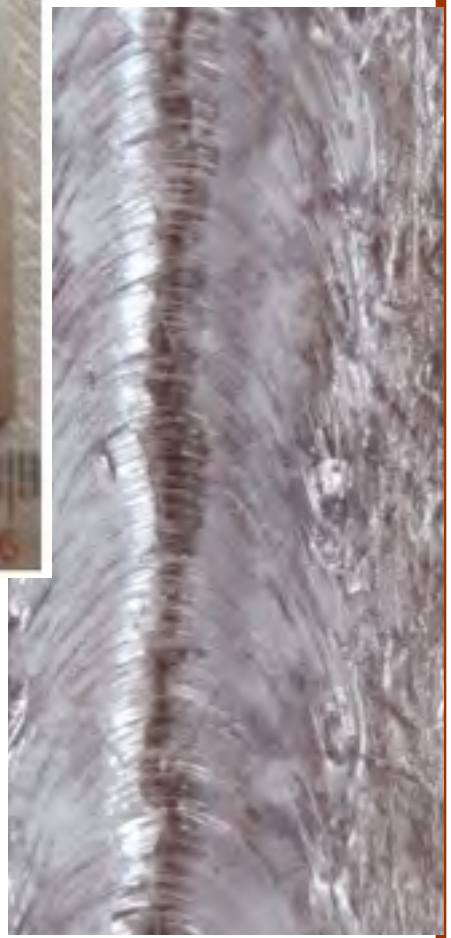
Nb EBW Samples

Prepared at KEK





Sputter balls



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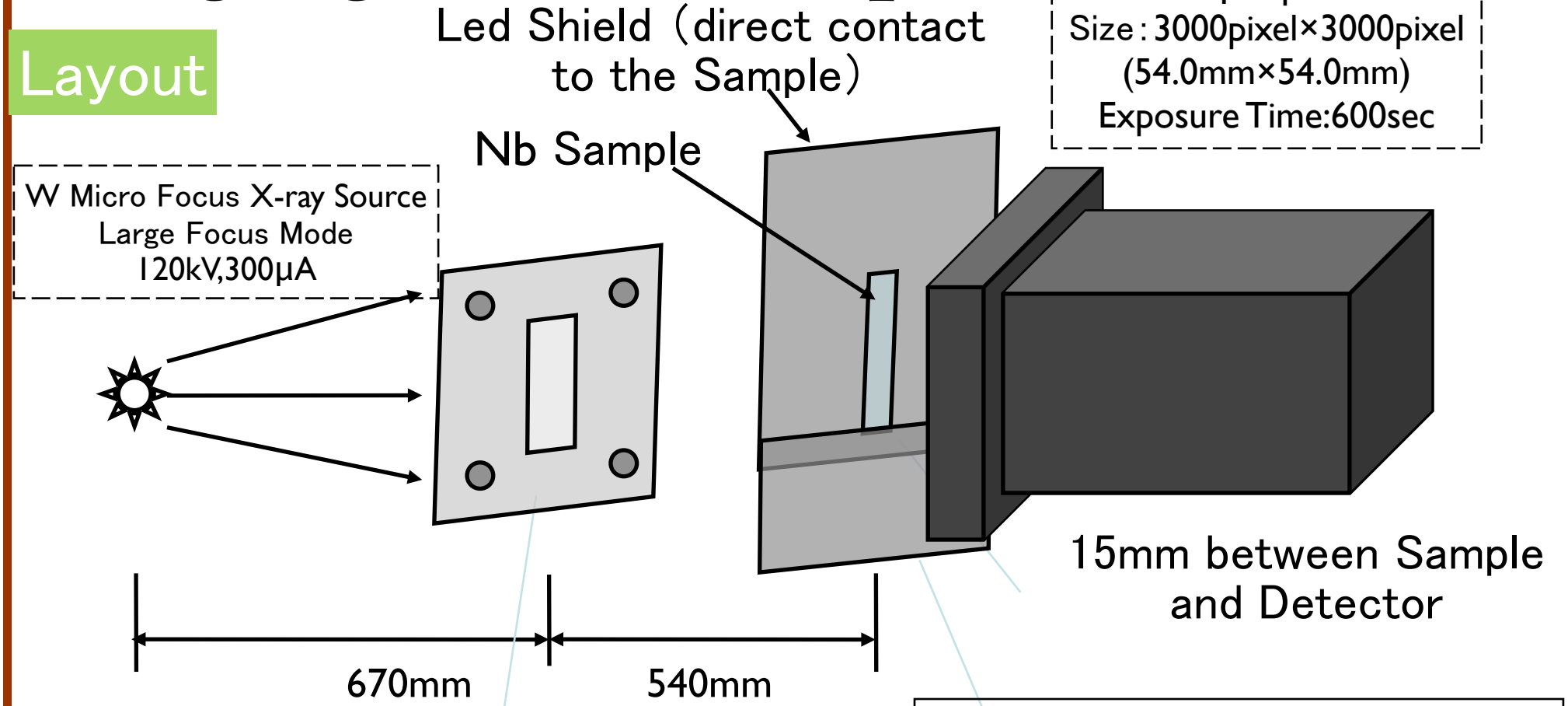
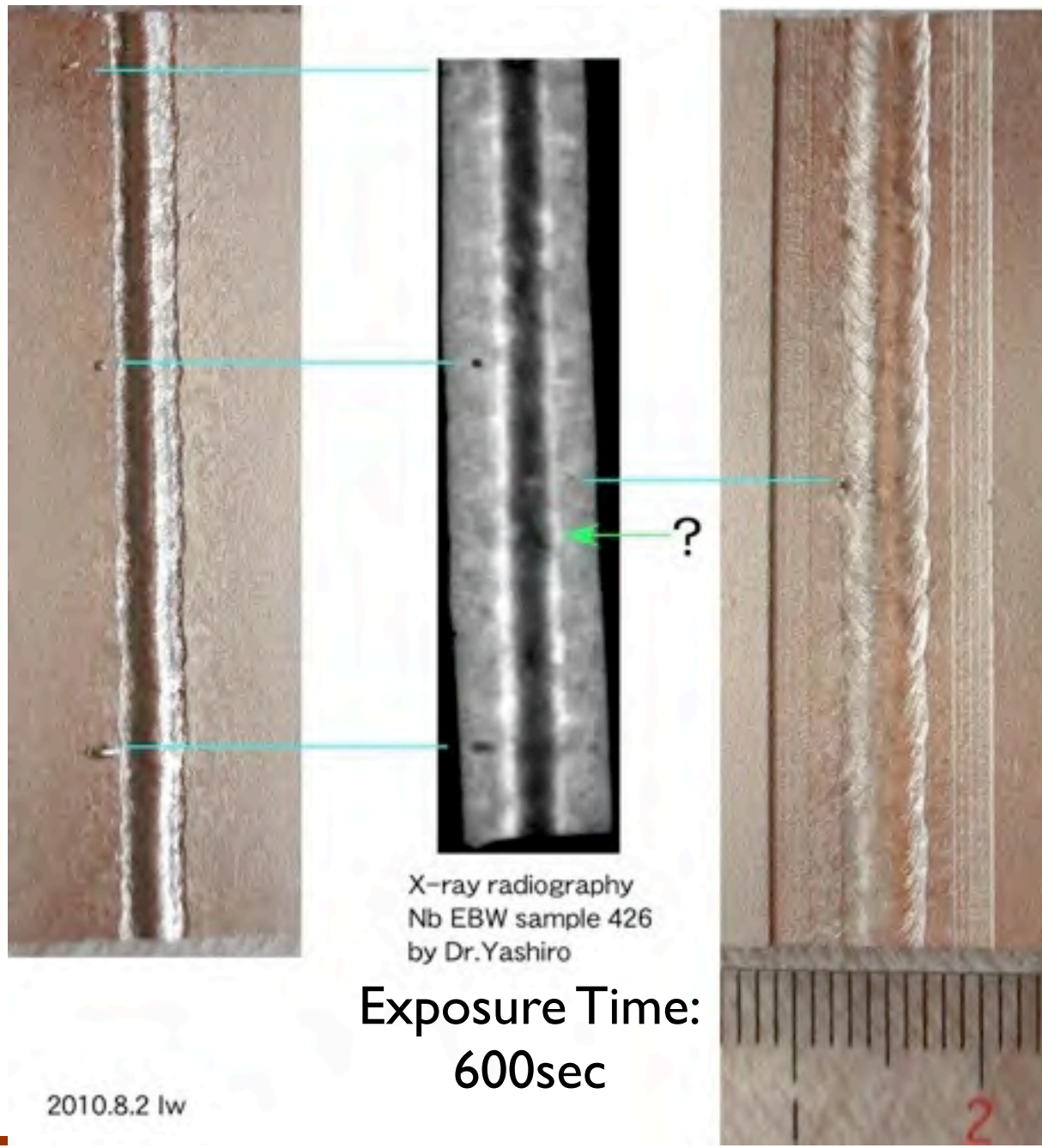
Imaging of Nb sample

Layout

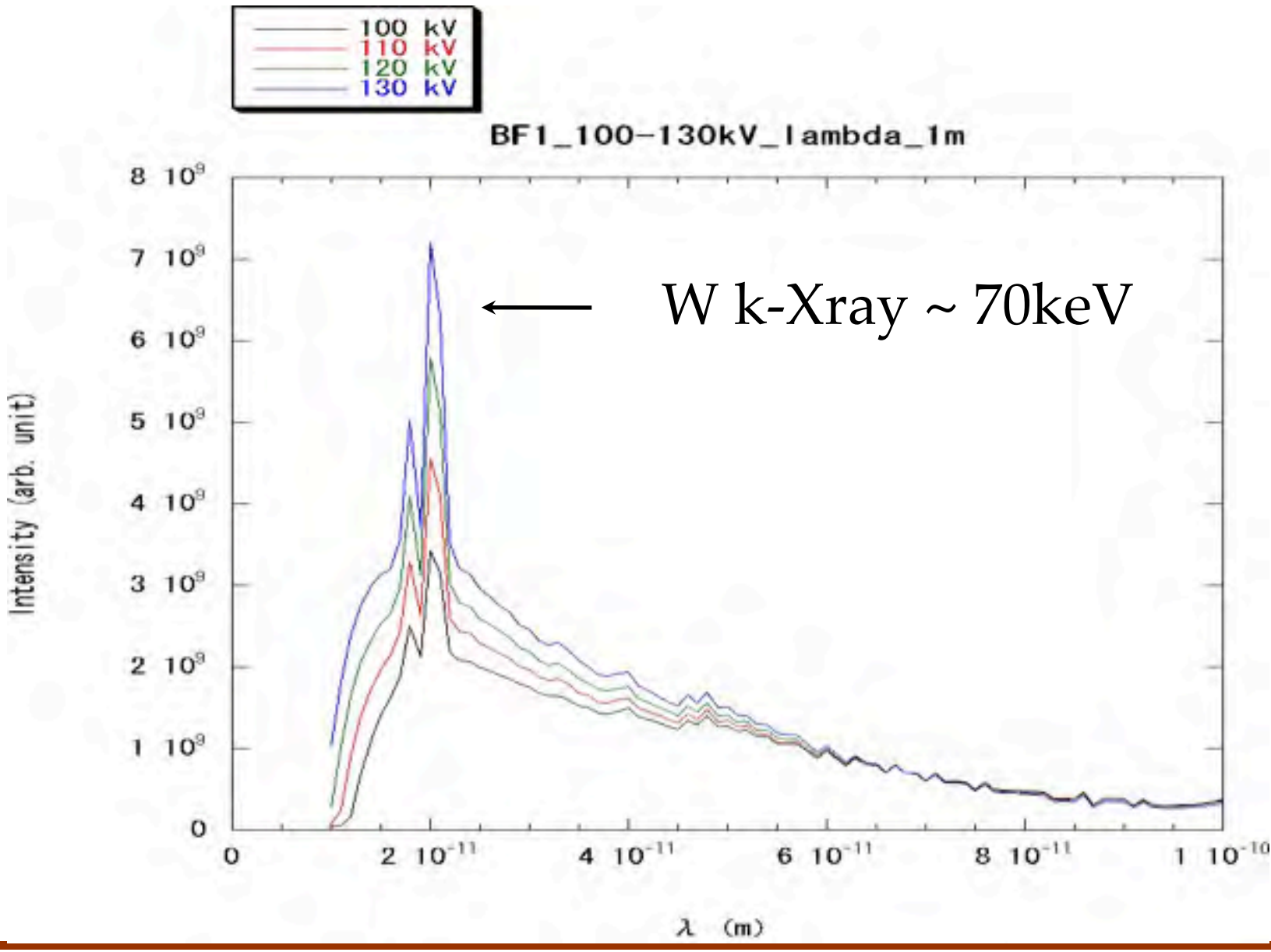


Courtesy of Dr.Yashiro @ Momose Lab., U-Tokyo

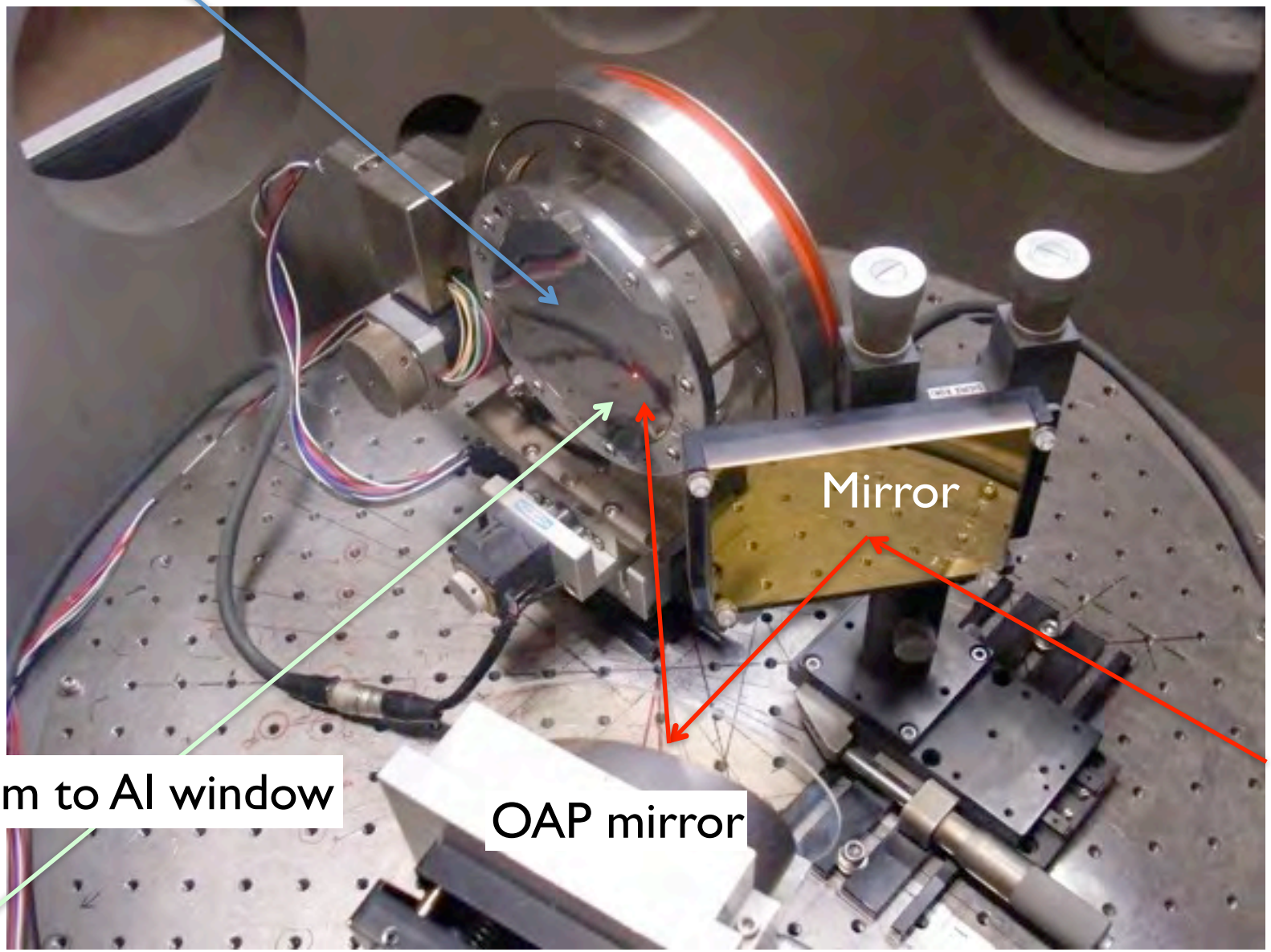
Transmission（Gray Scale：0.3~0.55）



X-ray spectra



Experiment on Laser Plasma X-ray Source

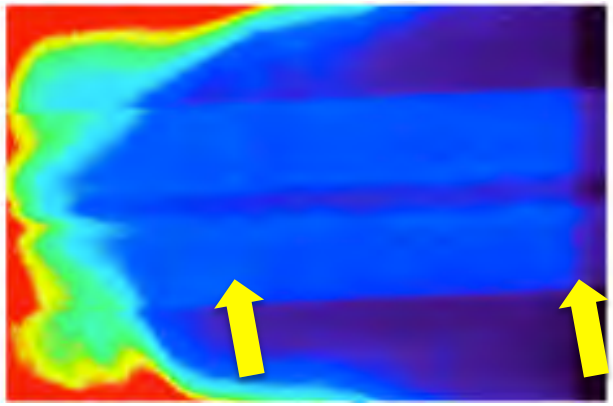


T6レーザー(最大出力 1J、パルス幅 100f、波長 800nm、繰り返し最大 10Hz)

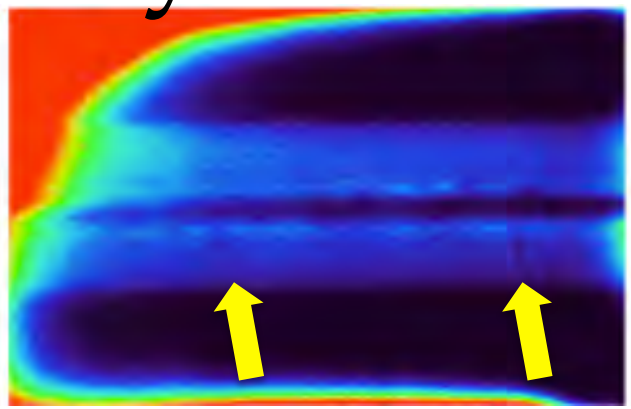
LPX Radiography

Preliminary Result

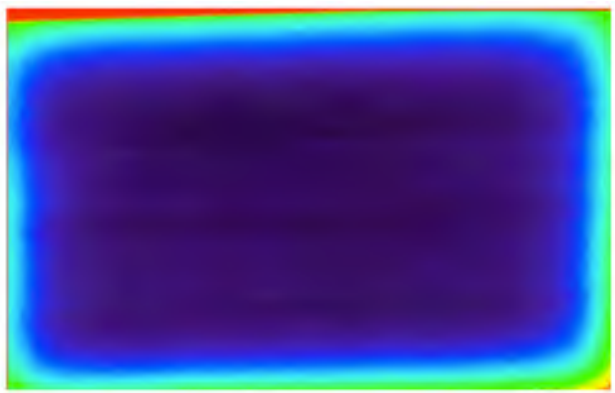
Zr



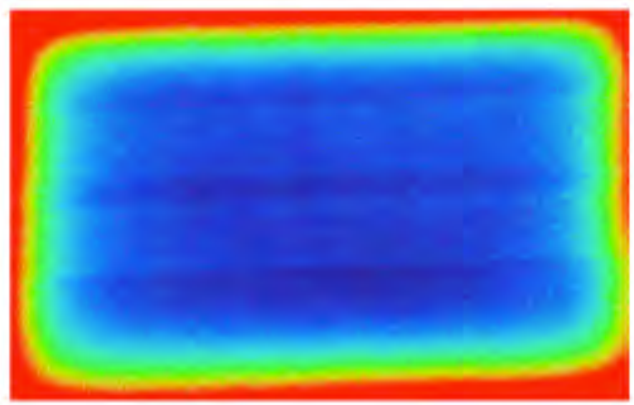
Ag



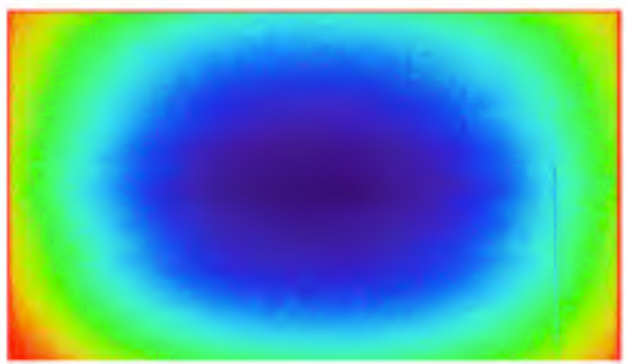
W



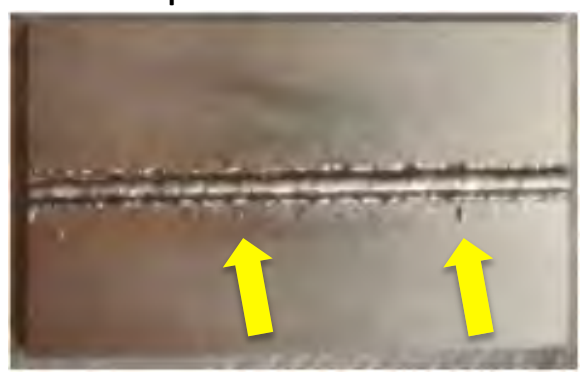
Au



Bi



Nb EBW Sample



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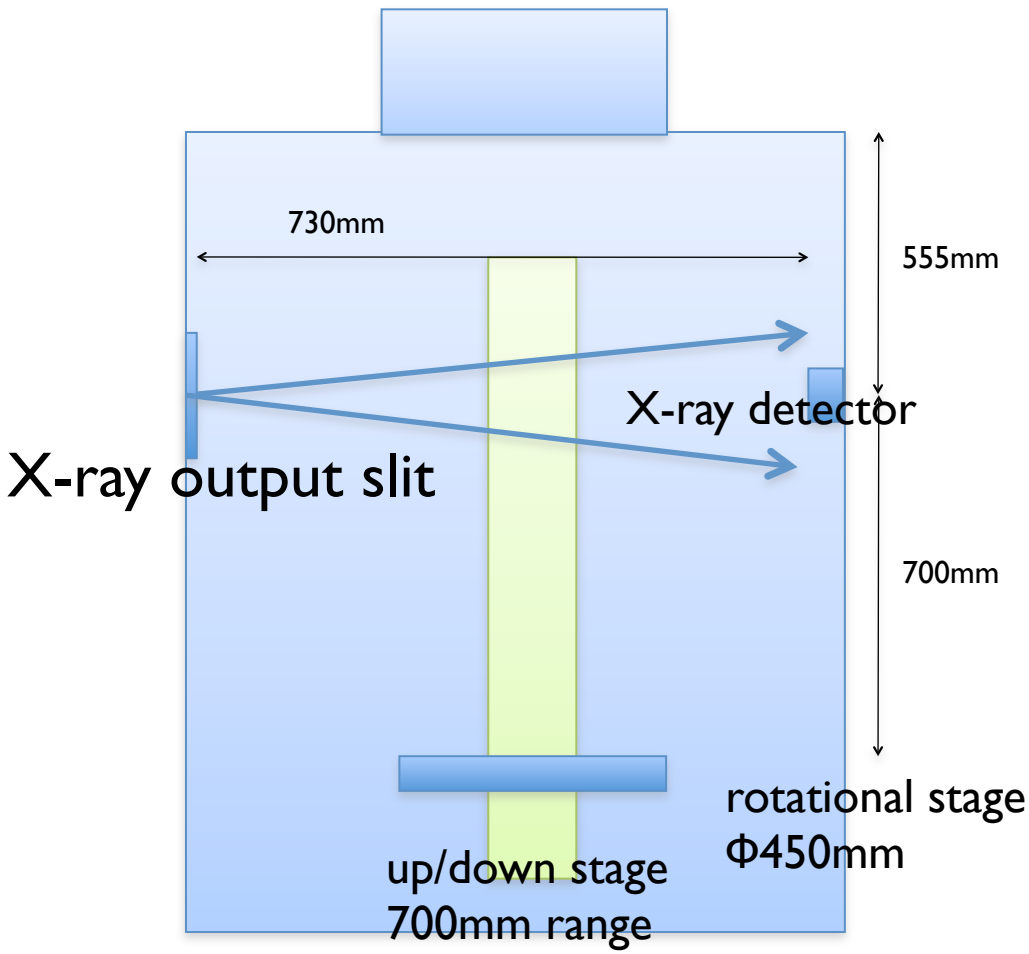
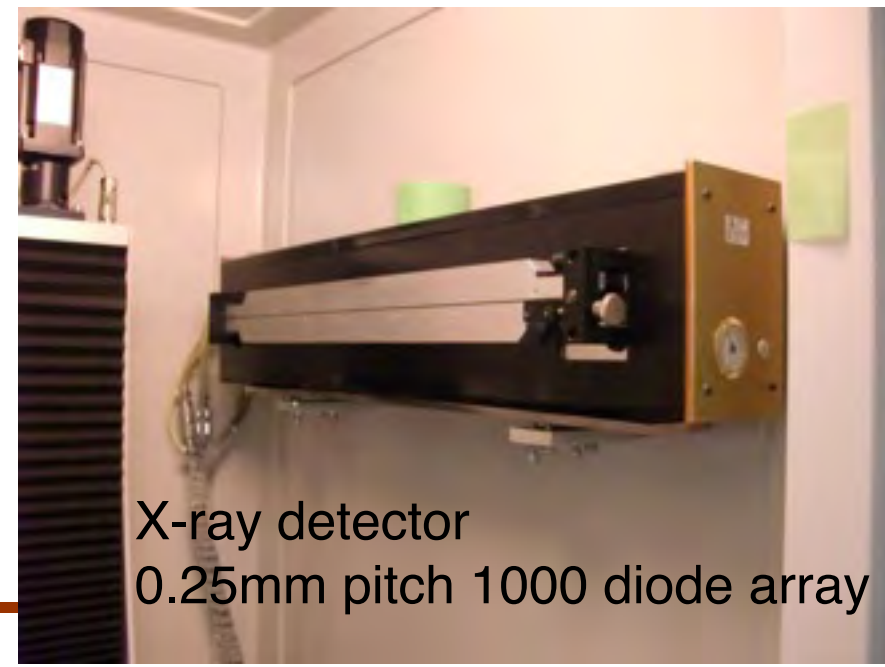
X-ray tomography trial for finding of weld defect

YXLON international Y.CT compact450

X-ray tube voltage: 450kV max

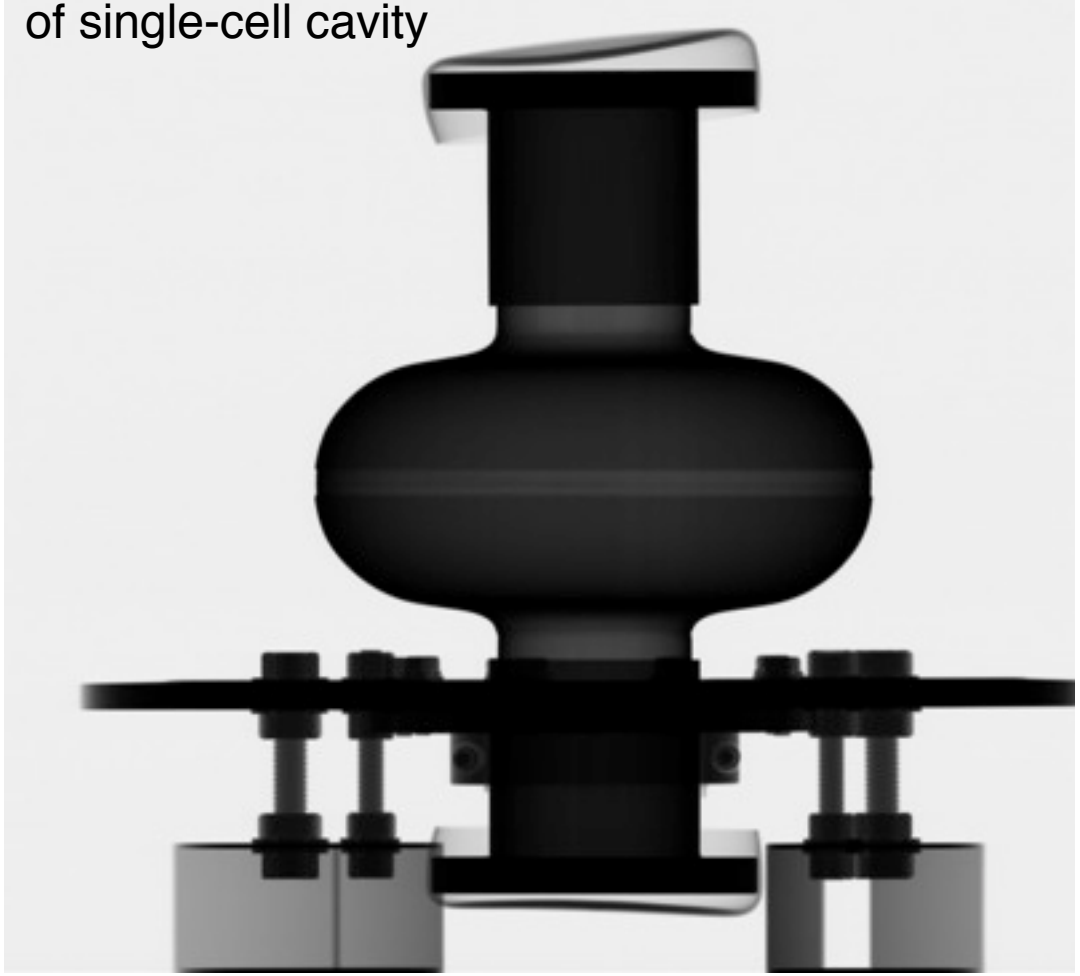


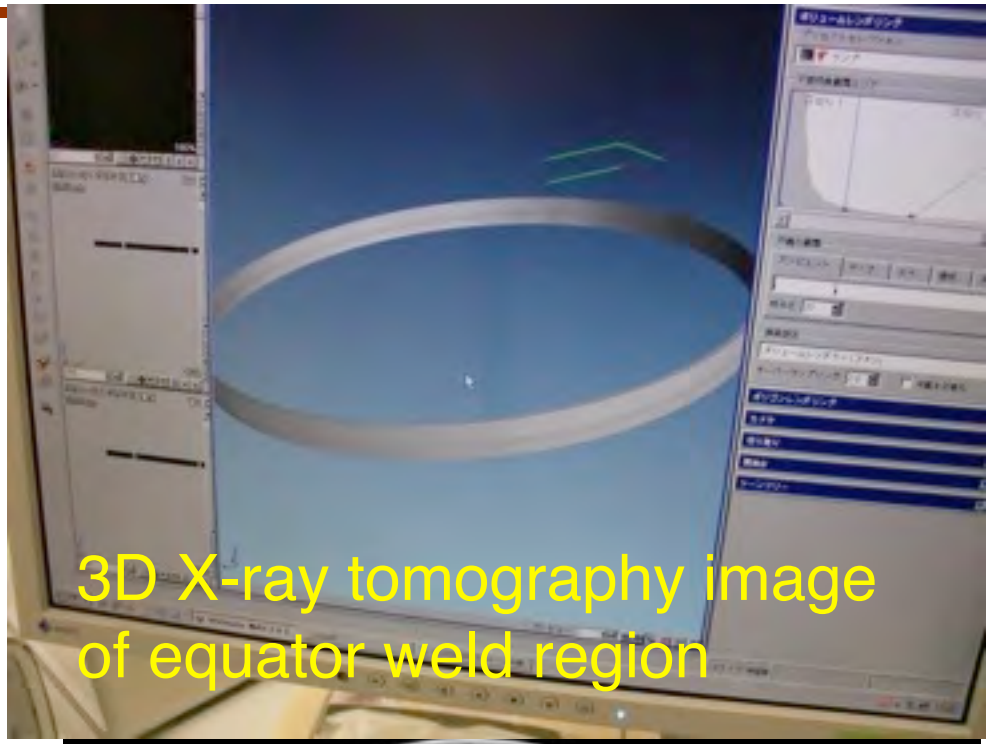


Trial of Xray-CT

➔ Current resolution (~mm) is not enough.

2D X-ray transmission image
of single-cell cavity





3D X-ray tomography image
of equator weld region

Slice cut from 3D X-ray tomography image
for equator weld region

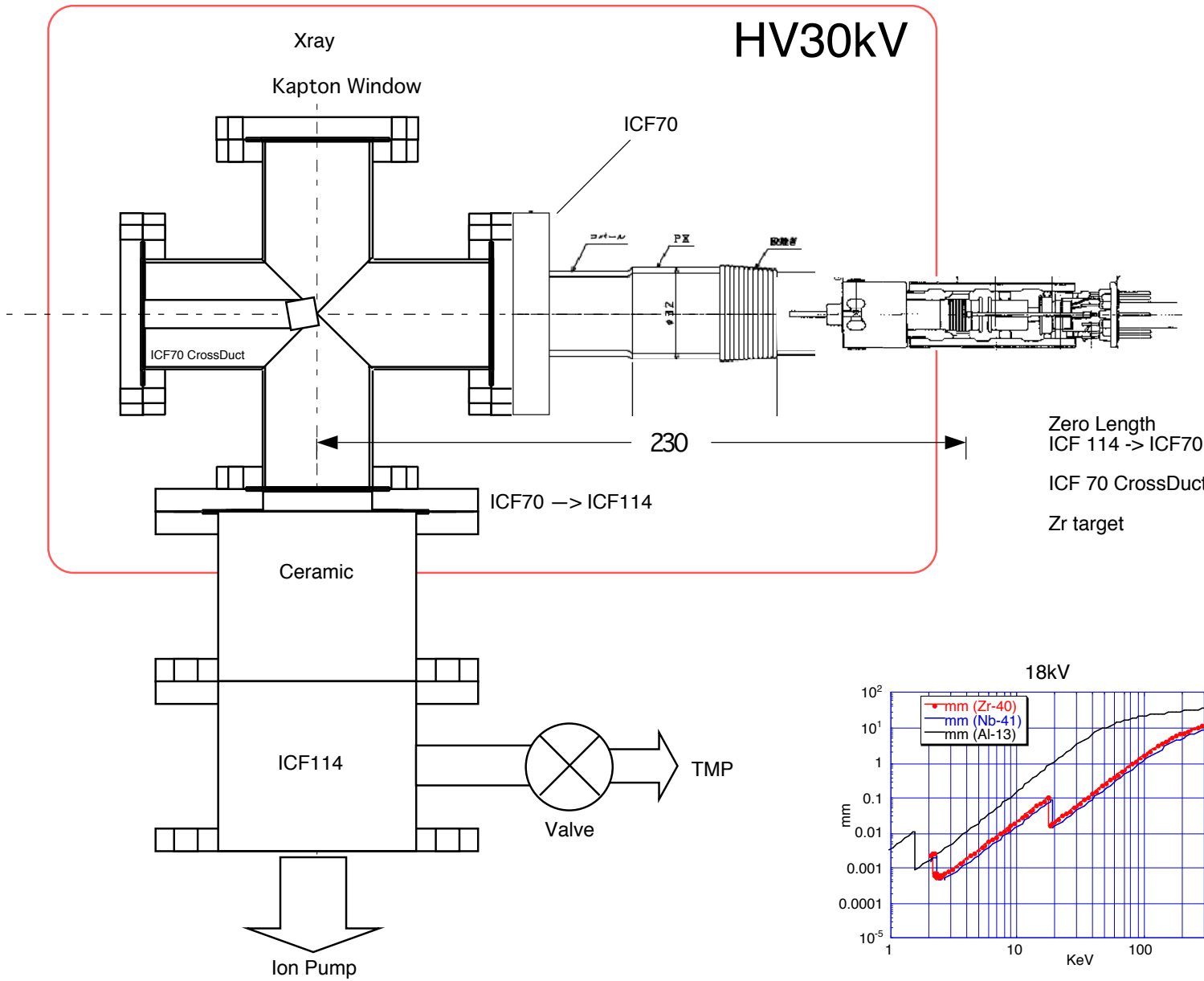
KEK -
Kyoto Univ.

Expanded view of slice cut from 3D X-ray tomography image
for equator weld region

not enough resolution to recognize surface boundary

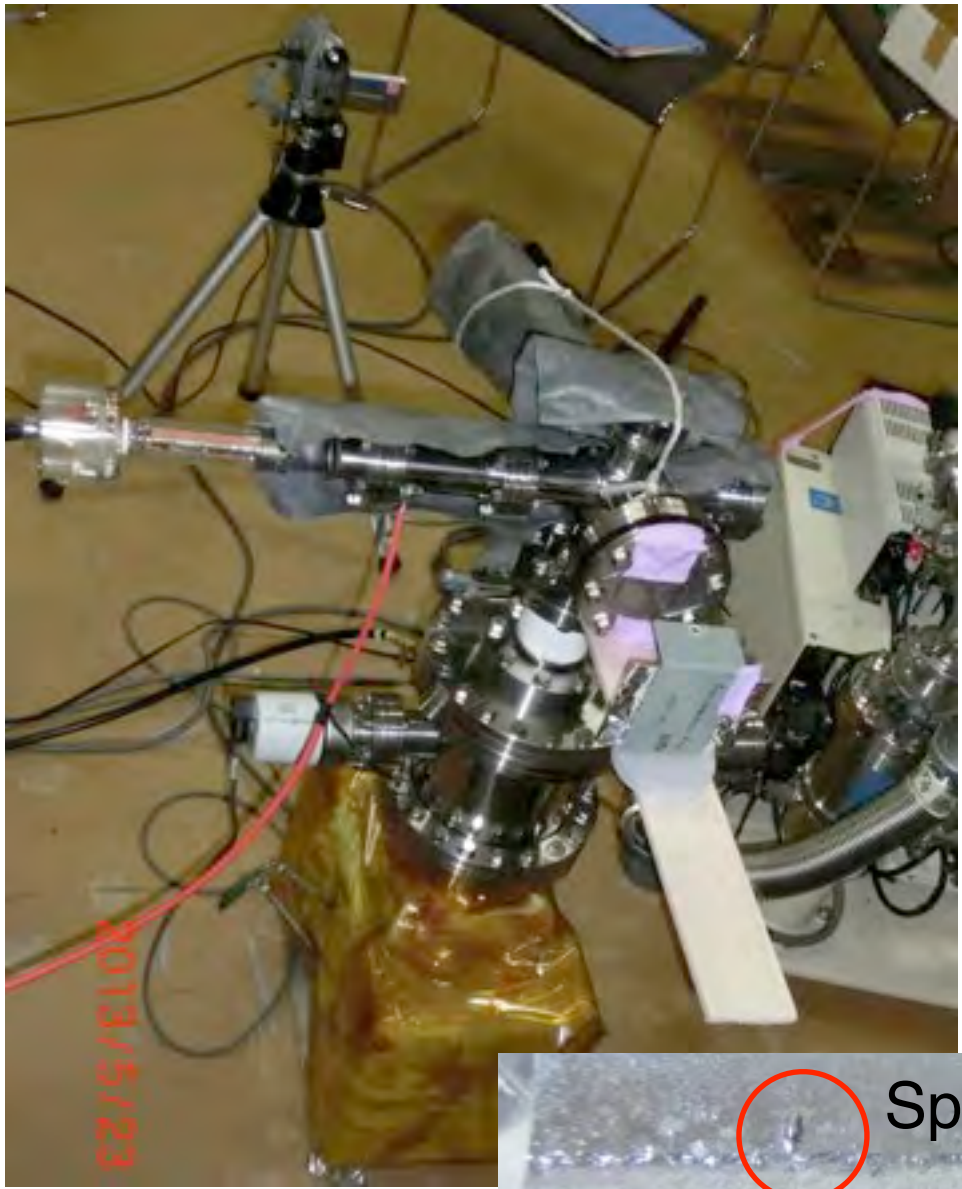
We tried one more X-ray tomography machine (more high energy X-ray)
at TOYOTA automobile co. on July 16, 2011.
However result was similer, not enough resolution.

Simple Test

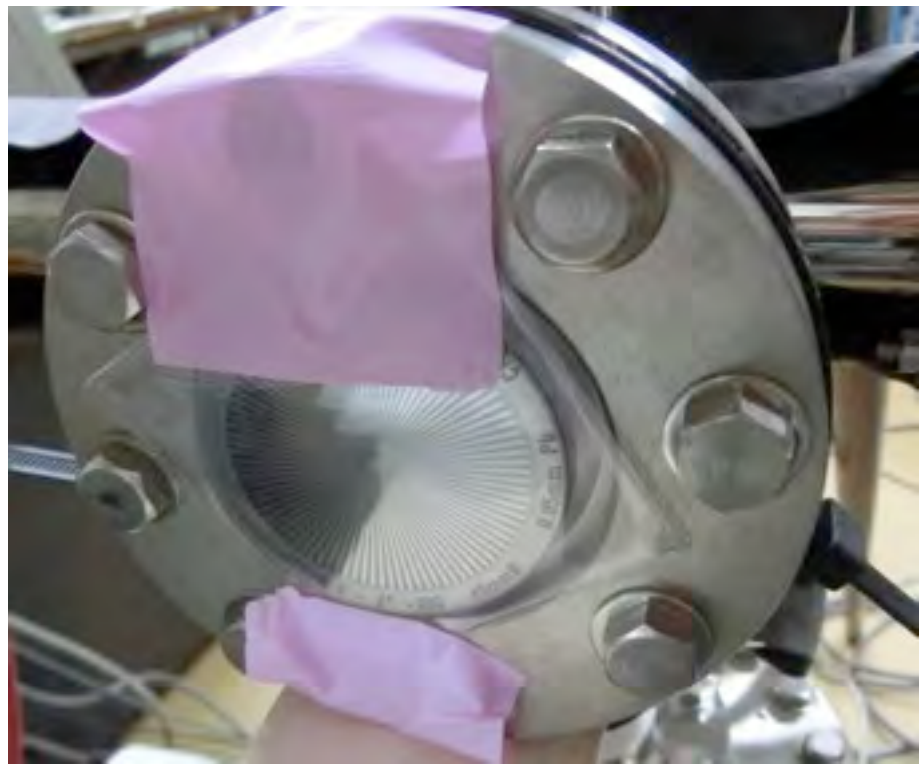

HV30kV
Xray
Kapton Window
ICF70
ICF70 CrossDuct
230
ICF70 —> ICF114
Zero Length
ICF 114 -> ICF70
ICF 70 CrossDuct
Zr target
Ceramic
ICF114
TMP
Valve
Ion Pump

18kV
mm (Zr-40)
mm (Nb-41)
mm (Al-13)
mm
KeV

Trial Exp.



e Gun for CRT
30kV HV



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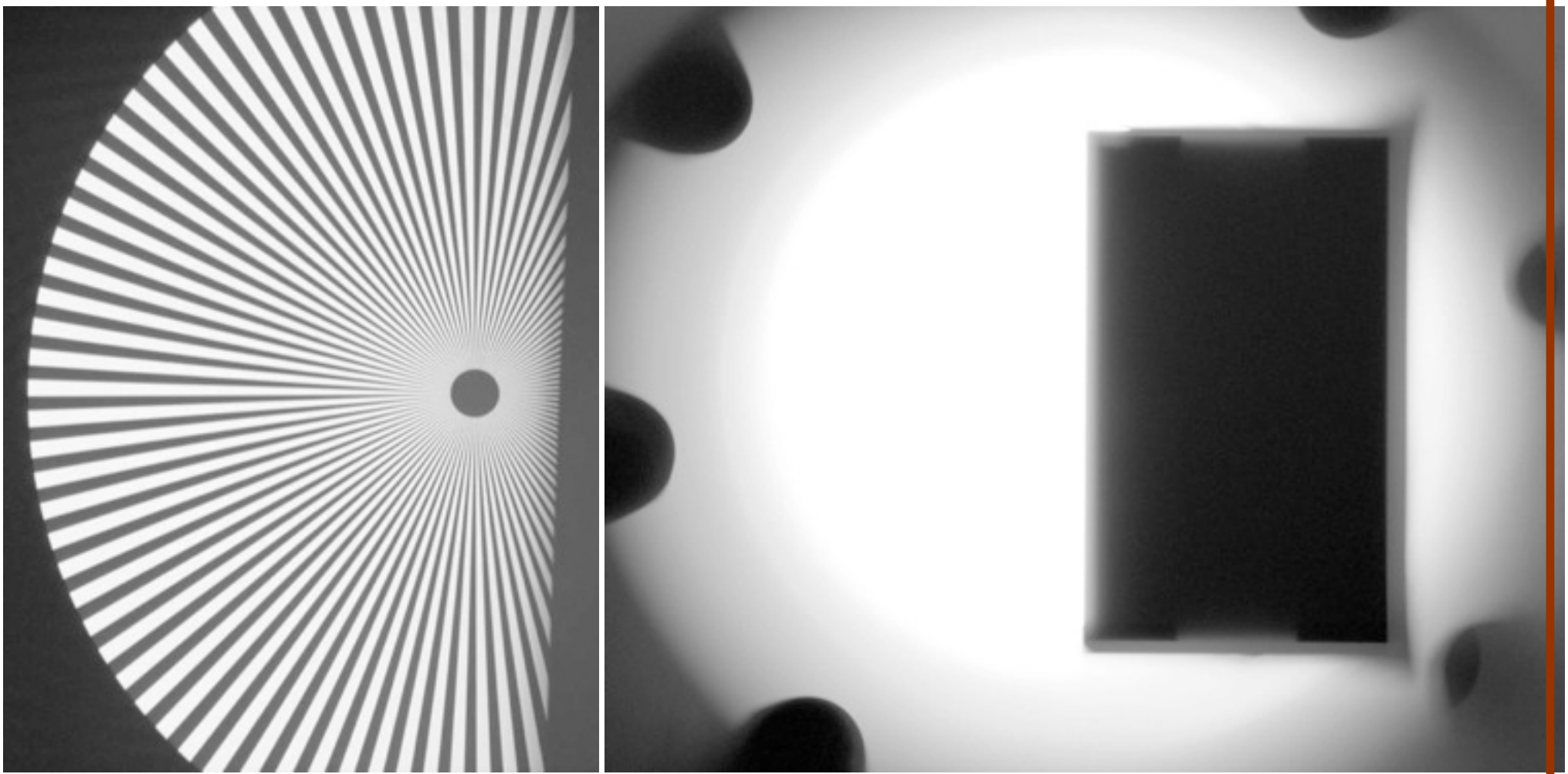
Very Preliminary Result



Zr target, 33kV, 0.1mA

Spot Size: ø0.2~0.3mm

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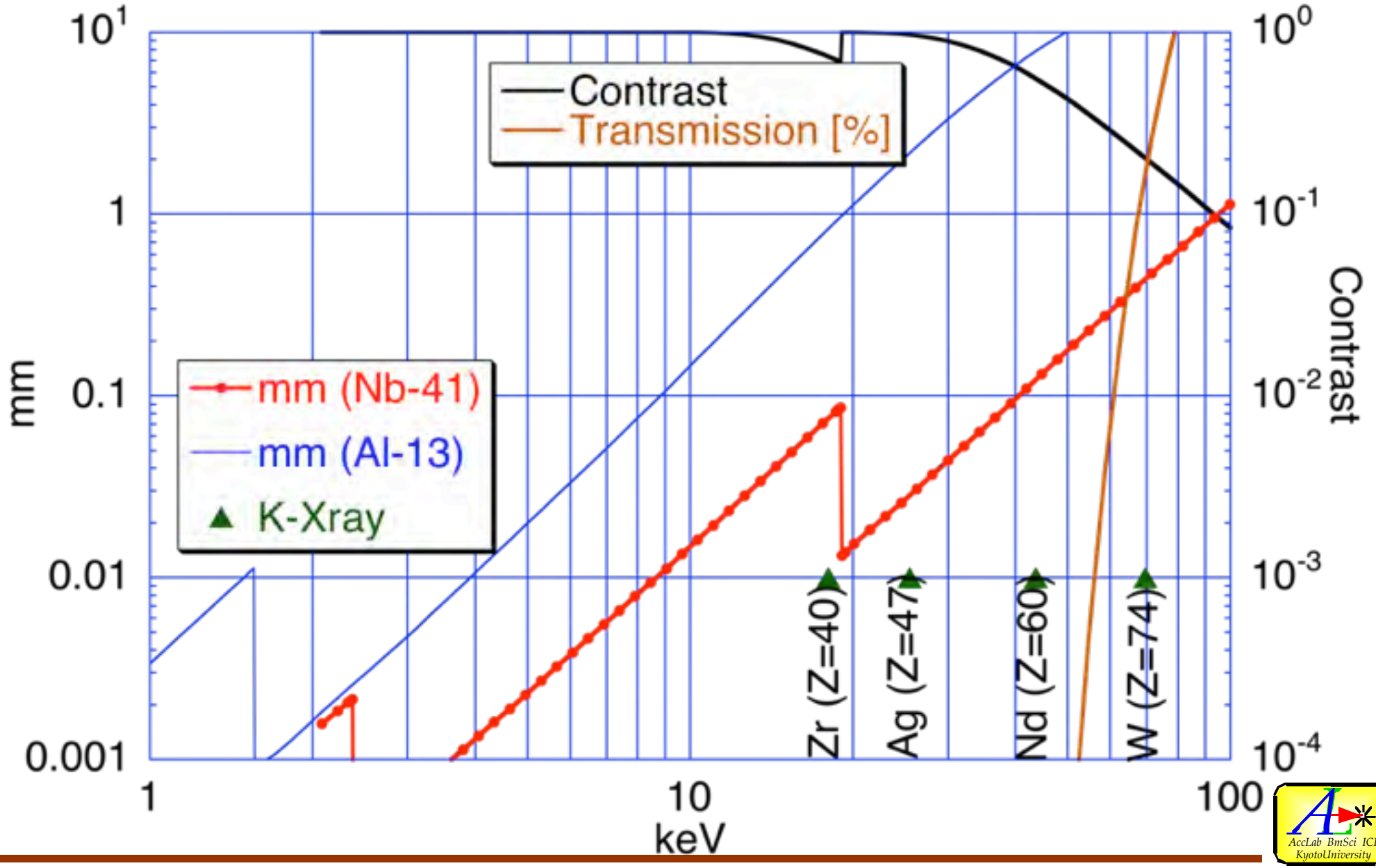
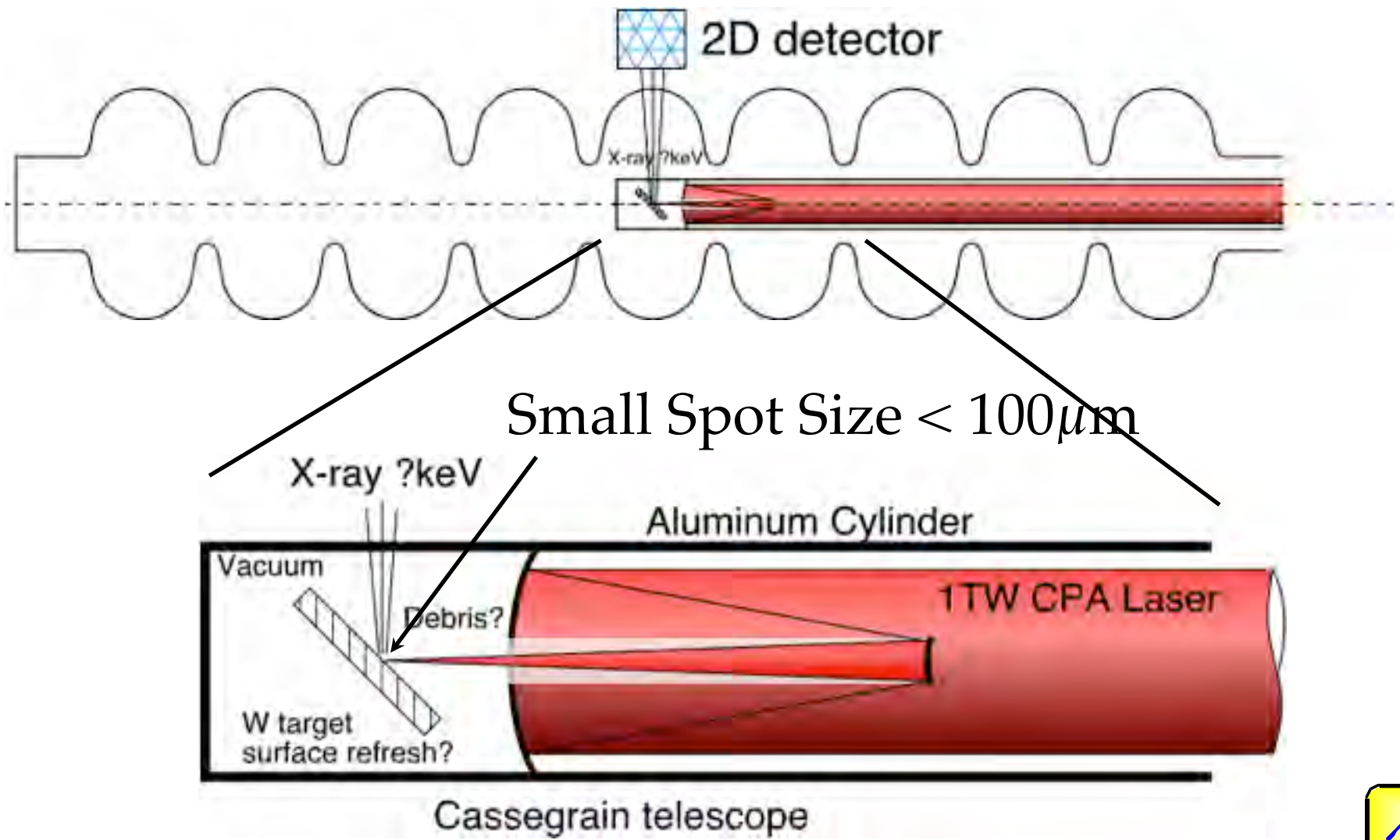
Transmission & Contrast



Possible Configuration



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Concluding Remarks 1/3

HiRes Cavity Endoscope (Kyoto Camera)

Local Grinding → Internal Defect?

Radiography Effort

High Resolution Eddy Current Scan
(only for flat surface...)

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Concluding Remarks 2/3

Neutrons are not handy.
But handy X-rays are difficult to see through 2.8mm Nb (Z=41).

Energy	Penetration	Contrast
High	⇑	⇓
Low	Bad	⇑

W needs high Voltage (>100kV).
Heat removal in narrow space difficult...
Trying Laser Produced X-ray.

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Concluding Remarks 3/3

CPA laser is not small

Fiber laser is acquired (only oscillator kit). Amplifier needs to be added.

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