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石油化学プラントの実機課題解決へのX線・中性子技術の魅力

2016年1月6日
三菱化学株式会社
三浦　到

石油化学業界の環境と非破壊検査技術の推移

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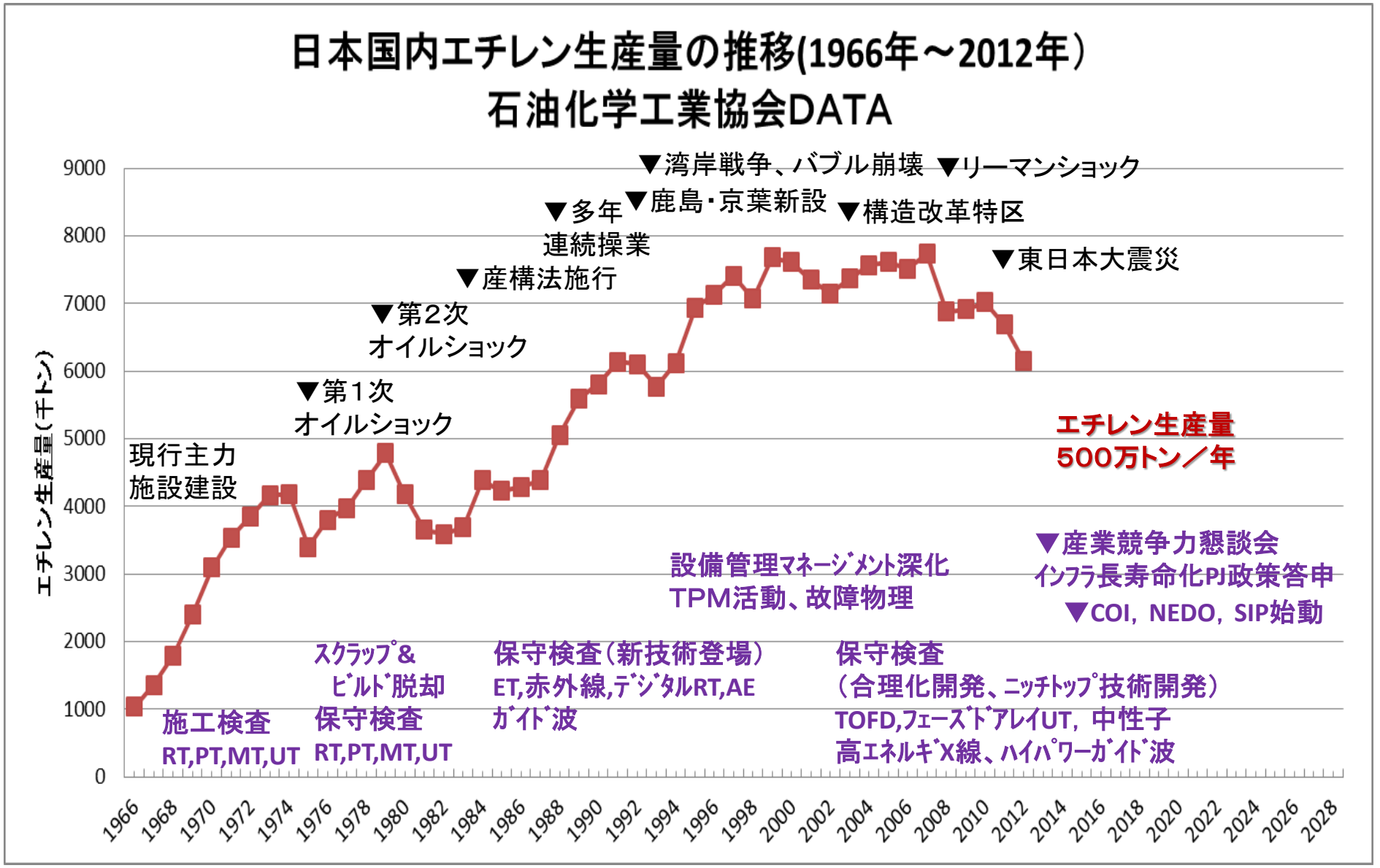

CUI : Corrosion Under Insulation

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Water invades from the gap

Corrosion

CUI:Corrosion Under Insulation

Performance Index

Rank	Moisture Content Vol%
A	＜5
B	≦10
C	≦15
D	≦25
E	＞25

Non-Corrosion

Gray -Zone

Corrosion

【20 years old】

Partial Inspection

【40 years old】

Full length Inspection

Background & Purpose

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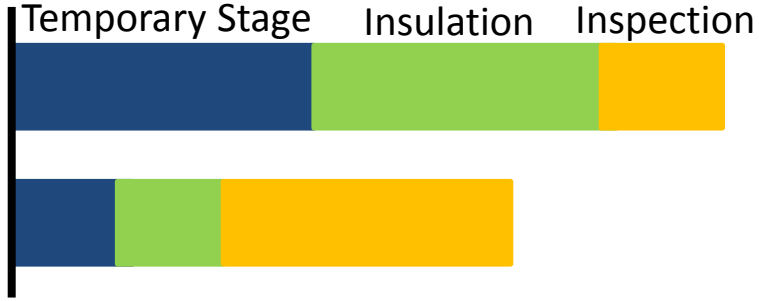
【Appurtenant work】

Full Length

【Inspection】

VT & UT (by Inspecter)

【Comparison of the total cost】



【Appurtenant work】

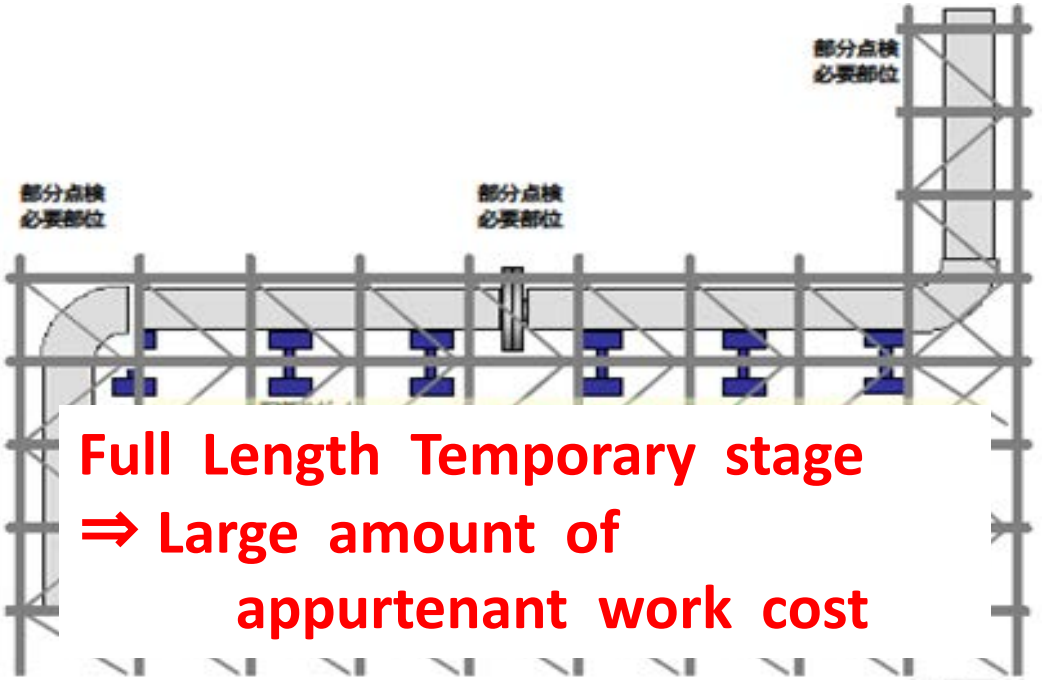
Full Length ⇒ Partial

【Inspection】

Screening: Neutron Moisture Meter(on-Robot)

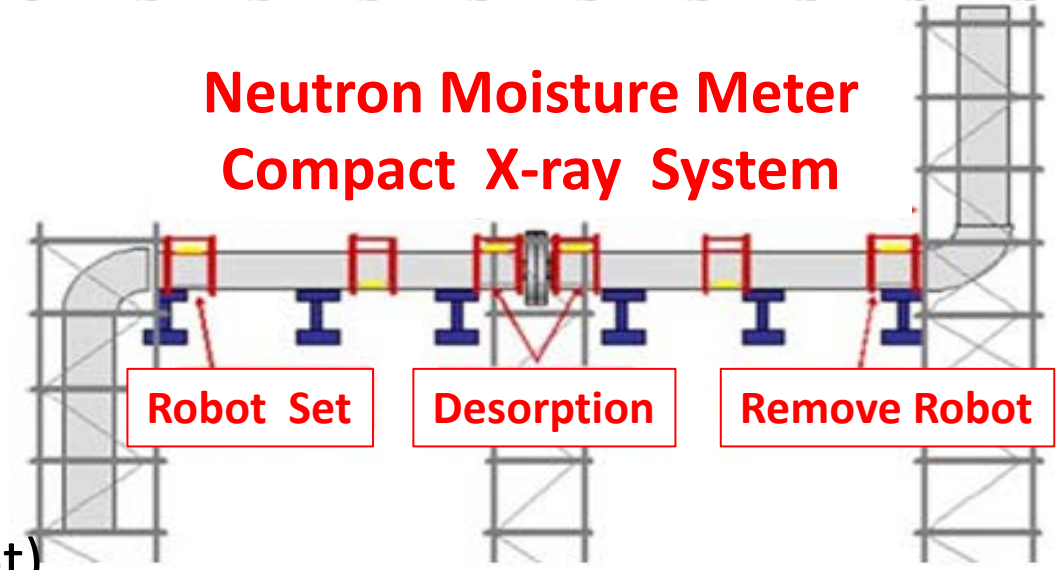
Thickness Measurement

Compact X-ray System(on-Robot)



Full Length Temporary stage
⇒ Large amount of appurtenant work cost

Neutron Moisture Meter
Compact X-ray System



History of Development

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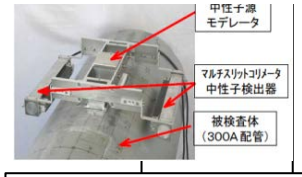
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

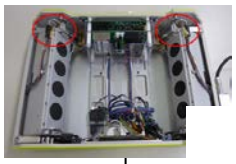
Low Noise Neutron Moisture Meter

Prototype(Portable)
Sponsor:METI-Kanto



January 2011
Commercialization
Portable Model

Type For Robot
Sponsor: JST



HYBRID OPERATION SYSTEM
Neutron Moisture Meter Robot & X-ray System Robot

Sponsor: NEDO

Robot
3rd Model for Neutron

Hybrid
-Operation

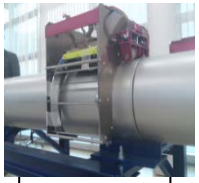
Robot
for X-ray system

X-ray(200keV) CdTe Detector
For Robot

Mobile Robot

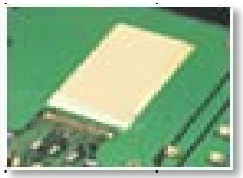
1st Model for Neutron
Sponsor:METI-Kanto

2nd Model for Neutron
Sponsor:METI-SME



Small X-ray System

X-ray(100keV,150keV) CdTe Detector
Sponsor: JST



Concept of Neutron Moisture Meter

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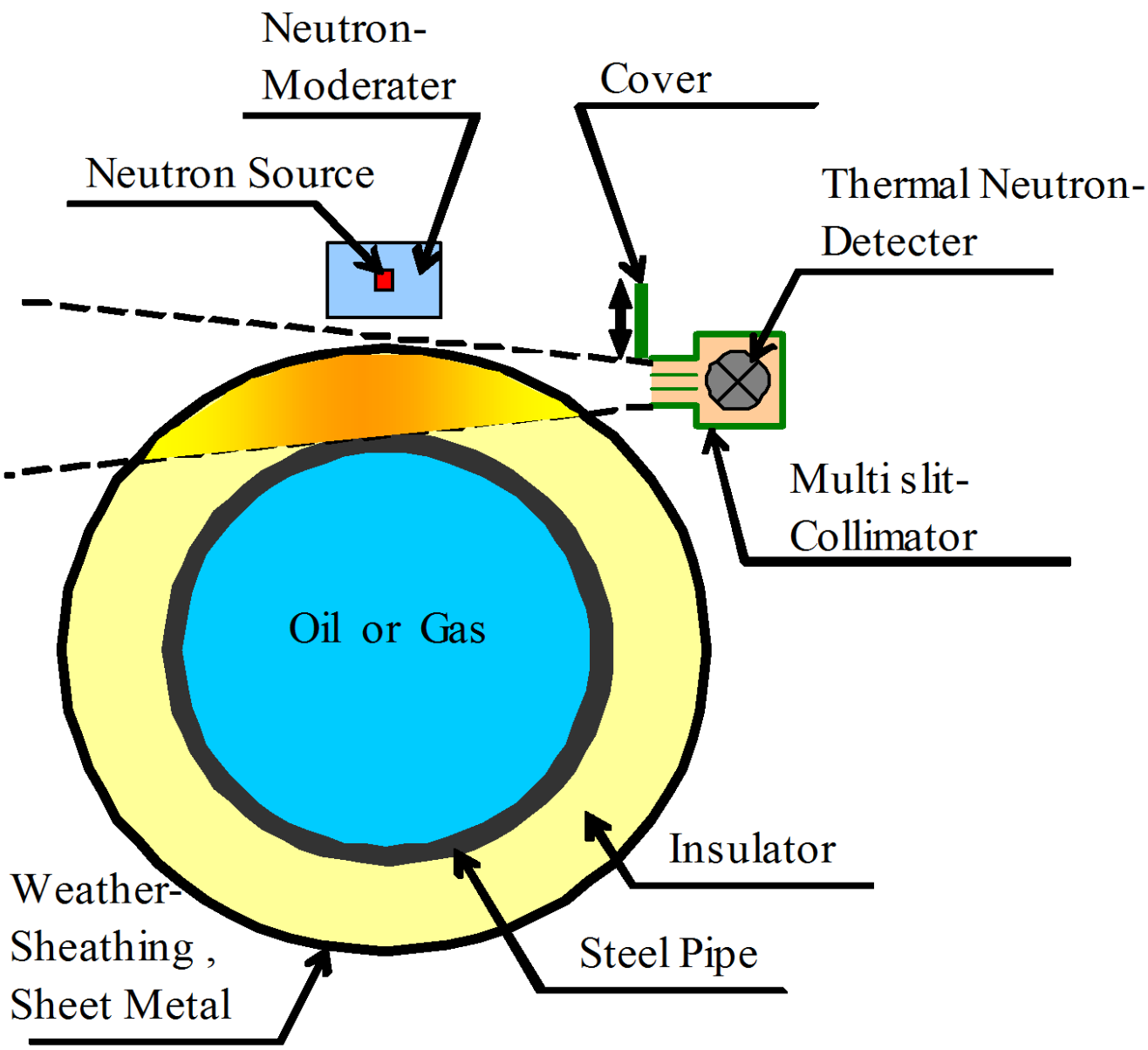

Portable Low Noise Neutron Moisture Meter

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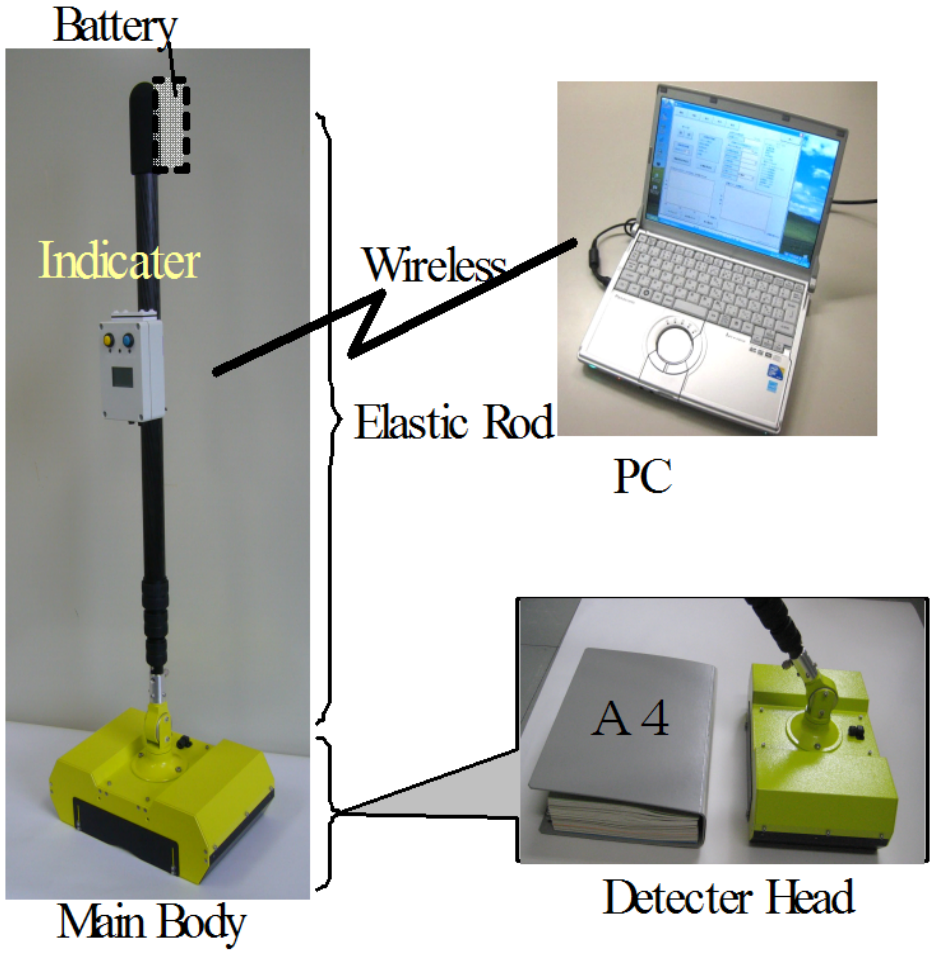
2010.12.16-17　日本機械学会
第9回　評価・診断に関するシンポジウム



Performance Index

Rank	Moisture Content Vol%
A	＜5
B	≦10
C	≦15
D	≦25
E	＞25

Non-Corrosion
Gray -Zone
Corrosion

Result of On-site Inspection

(The length of the pipe: 150m)

Moisture＞5vol%		Moisture＜5vol%	
Corrosion	Non-Corrosion	Corrosion	Non-Corrosion
8%	28%	0%	64%

Made by
Hitachi Power Solutions Co.,Ltd.,

Neutron Moisture Meter Robot System

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Made by Mobile Robot Research Co. LTD

On Site Test Neutron Moisture Meter Robot

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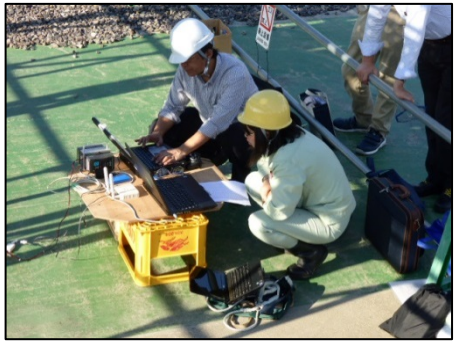
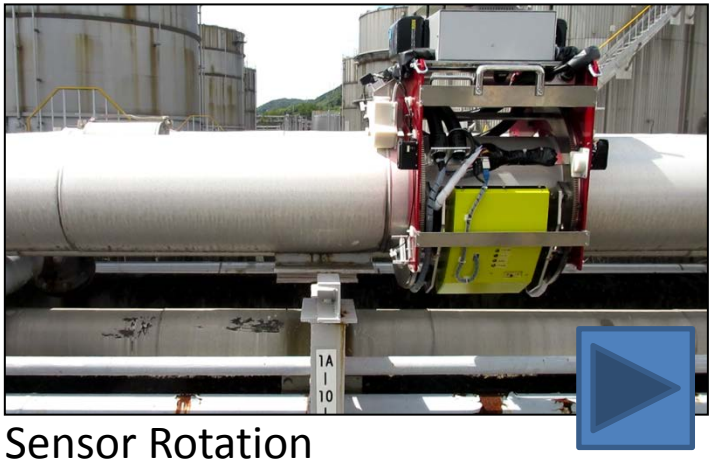
Traveling (15cm/s)

Loading and Unloading

Robot set

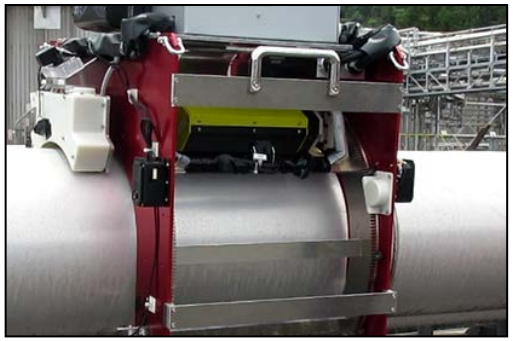


Robot and Sensor Console



Sensor Rotation and Passing Piping Support

Sensor (Down-side)



Sensor (Up-side)

Robot and Portable measurement quality

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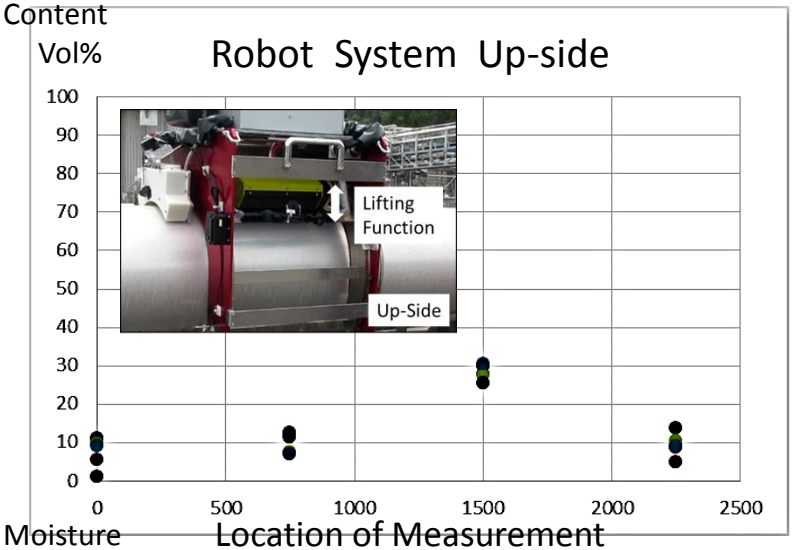
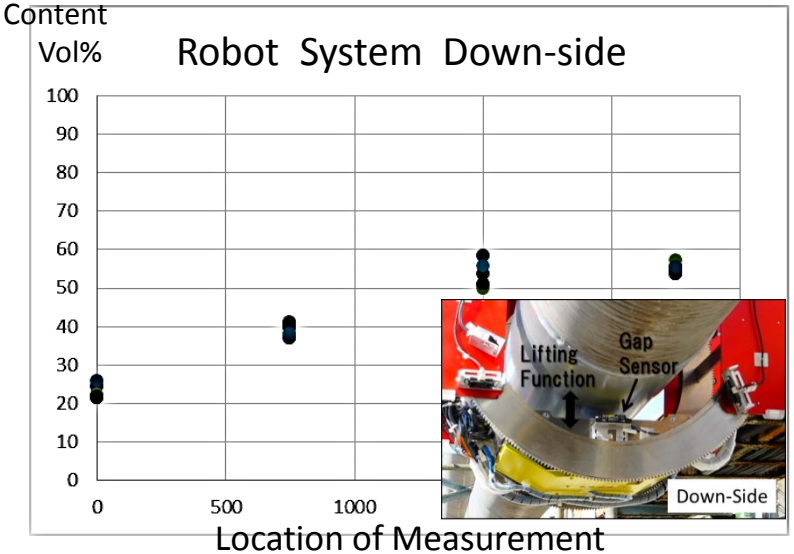
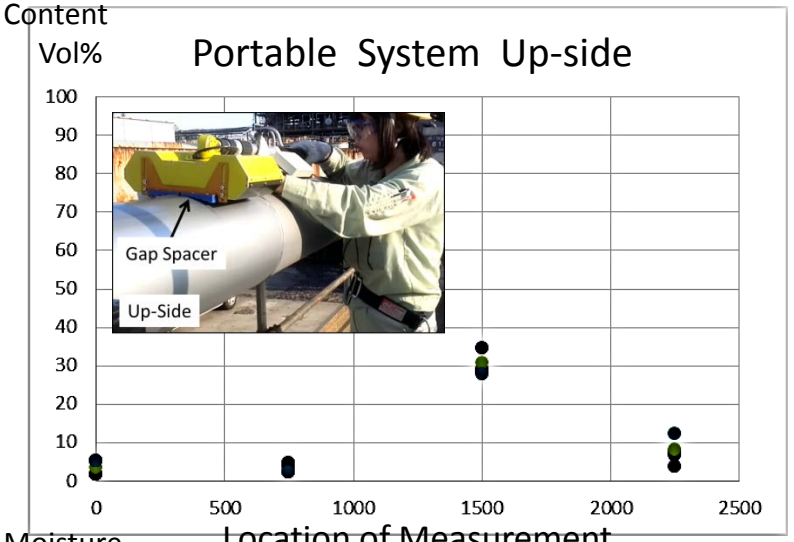
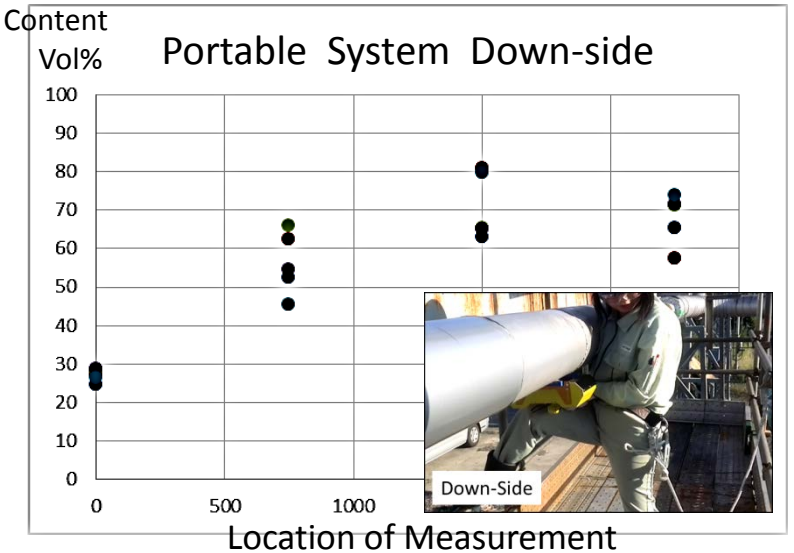
Robot System





Portable System





X-ray Robot System

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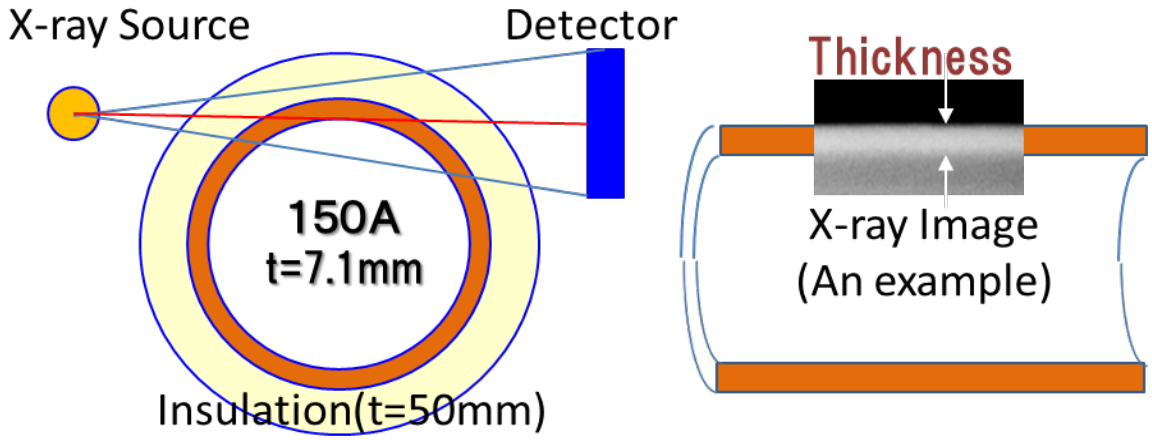
Choice of the technique to measure thickness of piping

Edge Imaging Method

←Choice

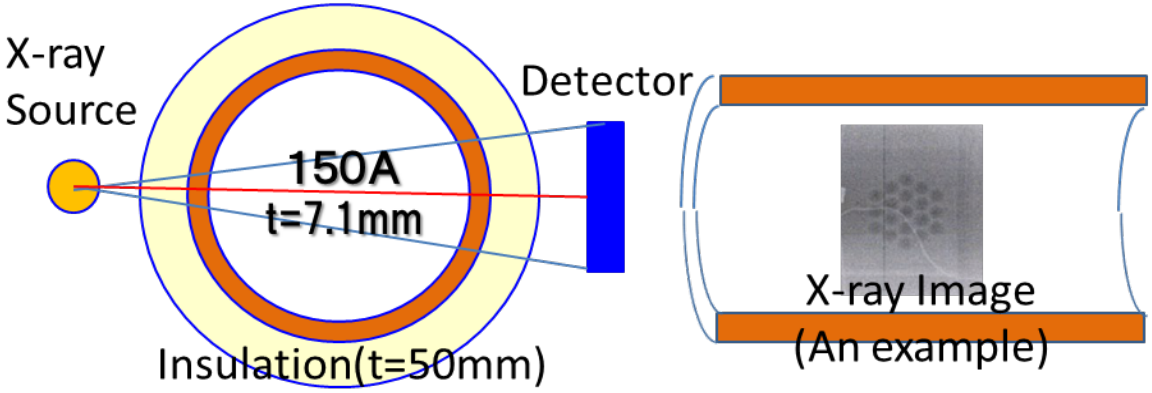
The Thickness measurement is important



【Characteristic】

- I can measure thickness of plumbing
- X-ray transmission thickness is warm
- Inspection speed is slow

Transmission Contrast Imaging Method



【Characteristic】

- I can't measure thickness of plumbing
- X-ray transmission thickness is thin
- Inspection speed is fast

X-ray Robot System

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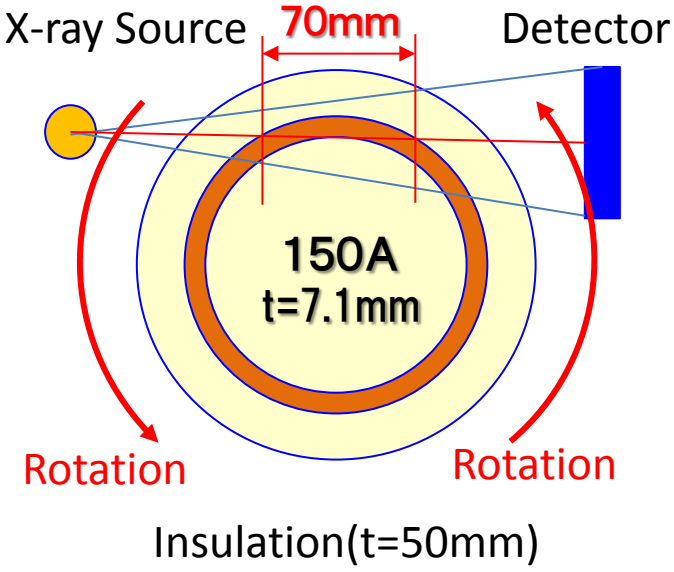
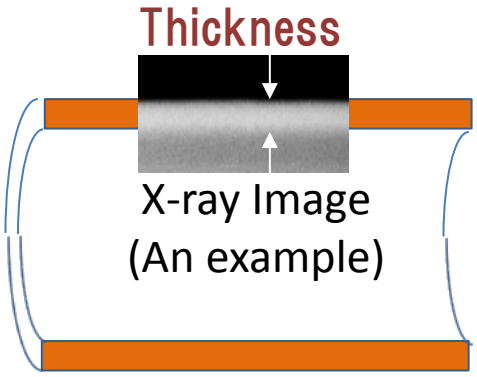
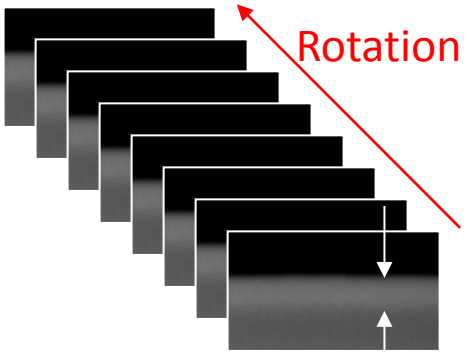
Edge Imaging Method







【Main Technical Problem】

- The compact X-ray source which can penetrate 70mm(Fe)
- High sensitivity, high resolution detector
- Technique to recognize exactly out-side edge and in-side edge
- Technique to turn X-ray system exactly

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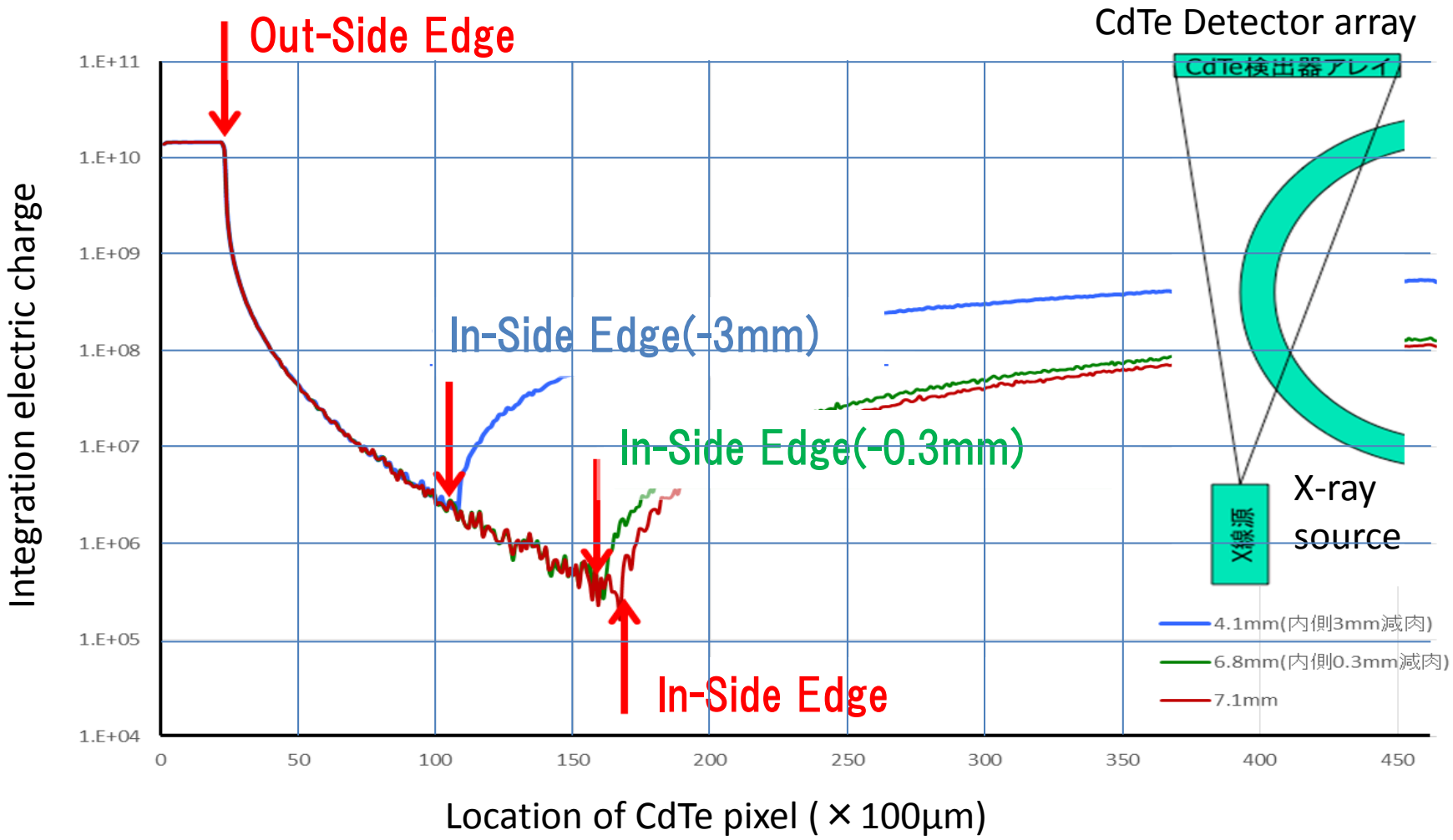
Result of simulation Edge imaging method (Calculation code EGS-5)



X-ray Robot System

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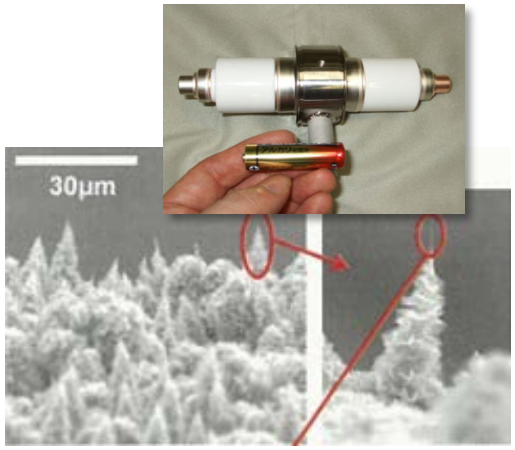


Coniferous carbon
nano-structure (CCNS)

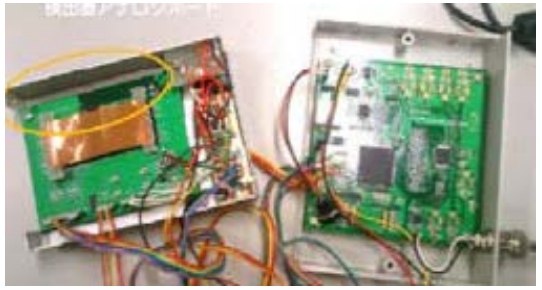
150keV
Compact X-ray source

200keV (for Robot)
Compact X-ray source

Developed by AIST (Advanced Industrial Science and Technology)

CdTe Device

High resolution
X-ray Detector



High resolution
and High sensitivity
X-ray Detector (for Robot)

Developed by Shizuoka University and ANSeeN

現場用X線技術の高度化開発

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2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

950keV for Industrial Infrastructures

Accuthera Inc. Tokyo University Hitachi Power Solutions Co.Ltd
Kantou Giken Co.Ltd Mitsubishi Chemical Co.Ltd

Small Accelerator
Sponsor：METI－Kanto

X-ray System
Sponsor：JTS

X-ray System
2nd-model
Sponsor：JTS

2nd-mode
Upgrad
Sponsor：METI－SME

Future
3rd-mode
（Commercial）
Sponsor：METI－Kanto

3. 95MeV for Social Infrastructures

Public Works Research Ins.
Accuthera Inc.
Tokyo University
National Ins. of Advanced
Industrial Science and Technology

X-ray System
Sponsor：JTS

Partial-angle
CT
Sponsor：MLIT

Partial angle CT and Tomosynthesis
Backscattering
Sponsor：CAO－SIP

950keV高エネルギX線源（開発機）

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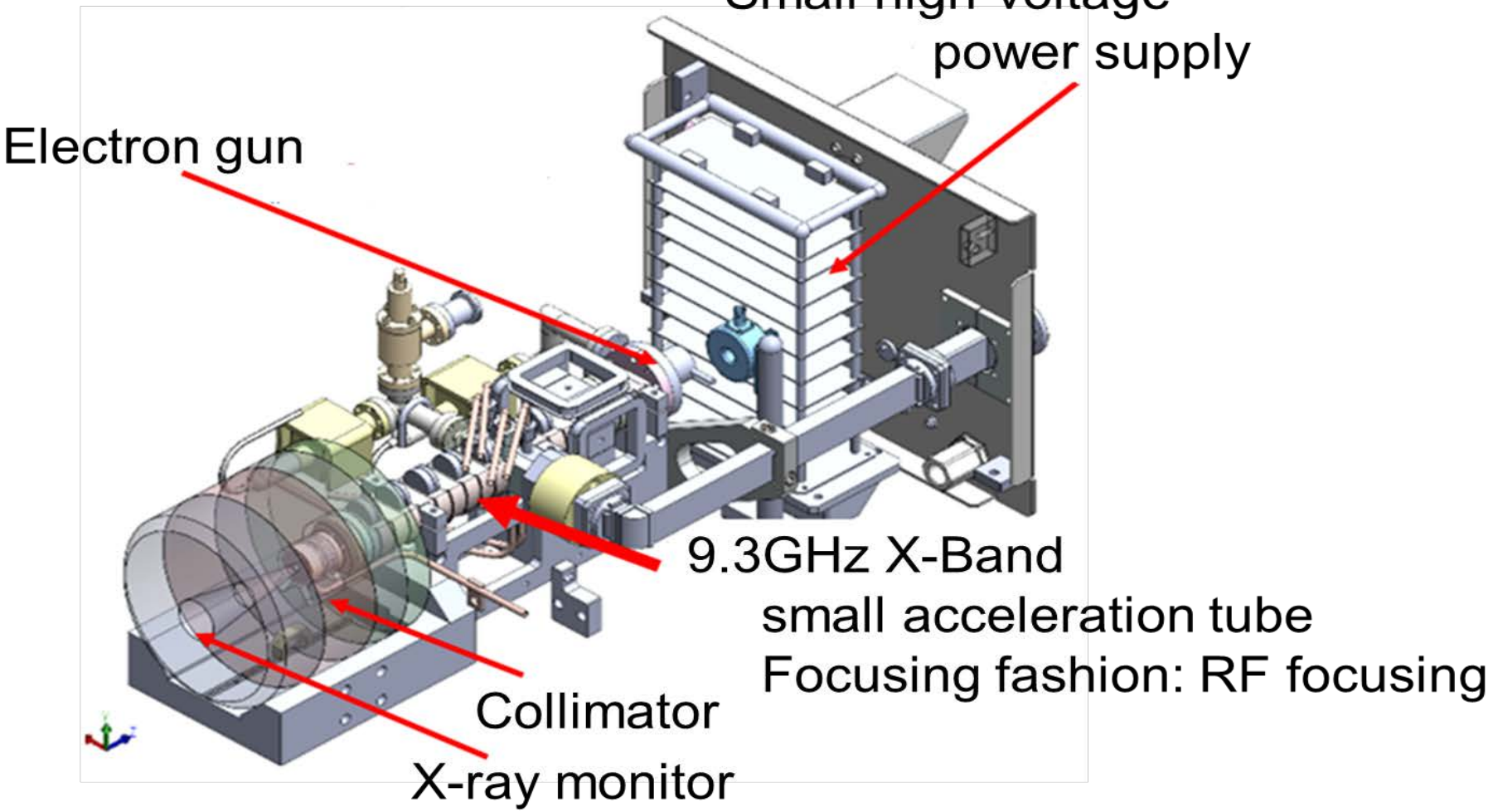

950keV高エネルギX線源（開発機）

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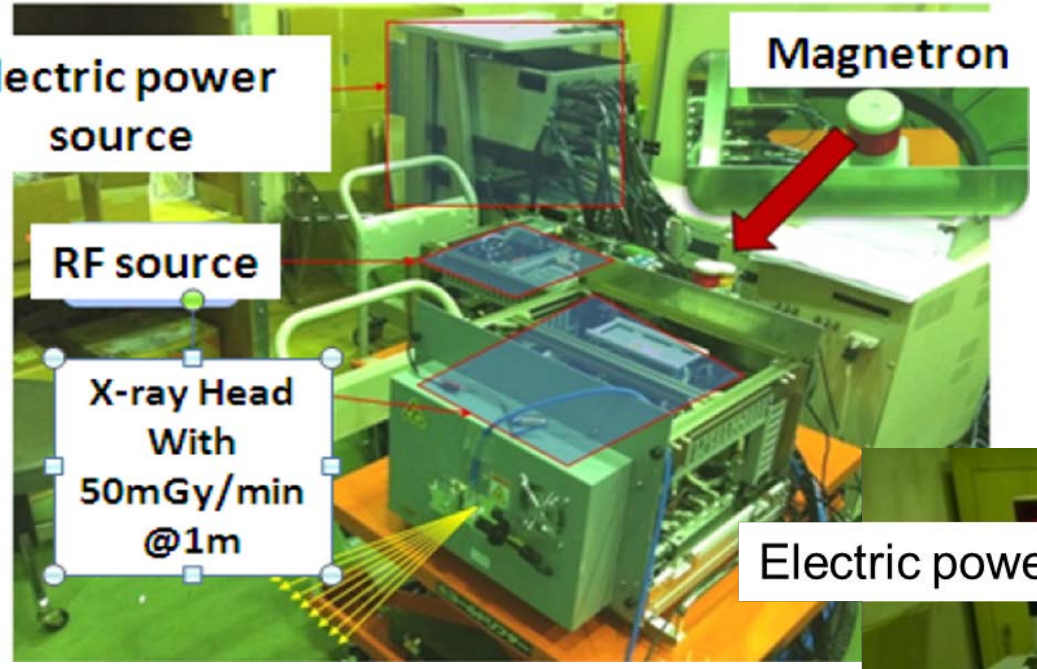
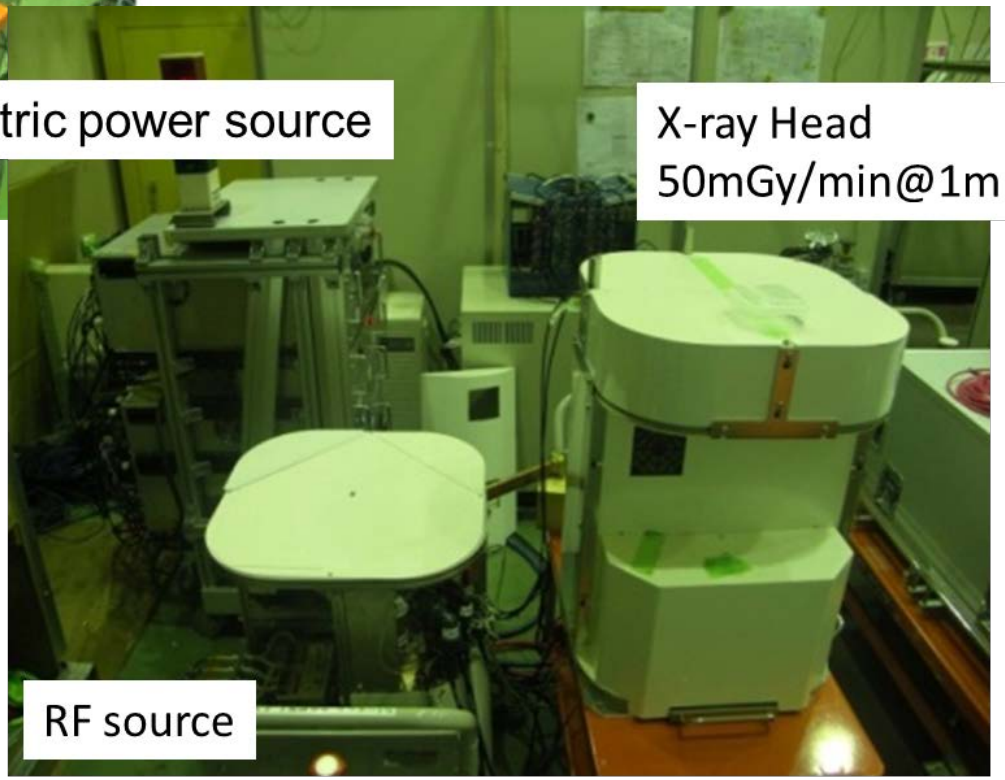


← X-band 950keV linac X-ray source
(The first model)

Upgraded 950keV linac X-ray source →
(The second model)



半導体シンチレーター式X線検出器

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Perkin Elmer 社製
GOSシンチレーター式
フラットパネル検出器

	XRD 0822 AO14 IND	XRD 1622 AO19 IMG
Detector Size	8” × 8” (20cm × 20cm)	16” × 16” (41cm × 41cm)
Energy Range	20keV-15MeV	20keV-15MeV
Scintillator Type	Gd_2O_2S:Tb DRZ Plus (Mitsubishi Chemical)	Gd_2O_2S:Tb & Cu Filter PI-200 (Mitsubishi Chemical)
Resolution	200µm Pixel Size	200µm Pixel Size
Phosphor Layer	208µm, 100mg/cm^2	436µm, 200mg/cm^2
Frame Rate	15 fps	1 fps
Electronics	14bit ADC & 2Gain Settings	14bit ADC & 2Gain Settings
Interface	Gigabit Ether Net (GigE)	Gigabit Ether Net (GigE)
Weight	3.7kg	8.8kg

950keV高エネルギX線現場展開例

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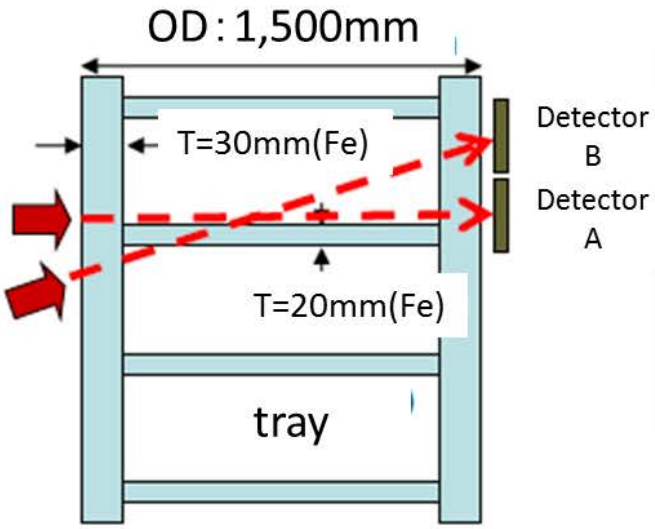
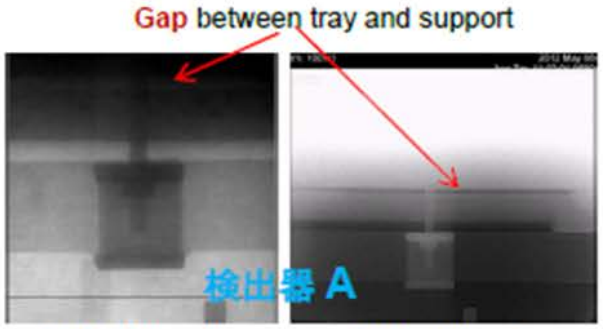
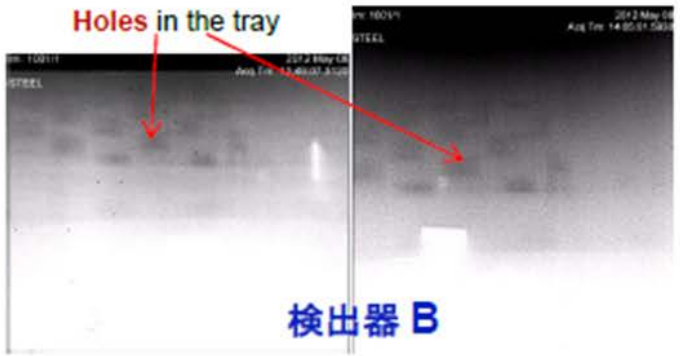


Lifting X-ray Head by crane



20s test time by flat panel detector

90s test time by imaging plate



10min by imaging plate

30min by imaging plate

950keV高エネルギX線現場展開例

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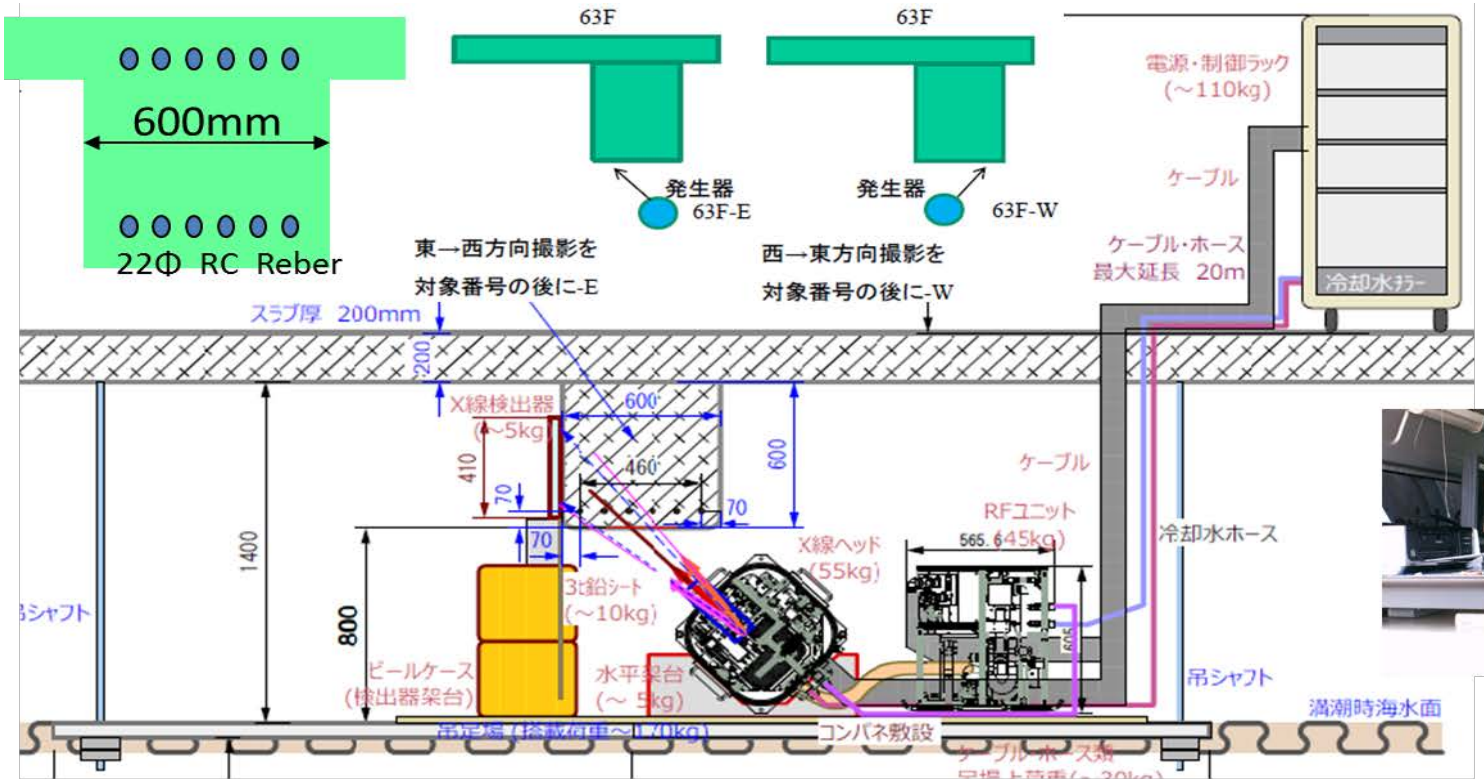
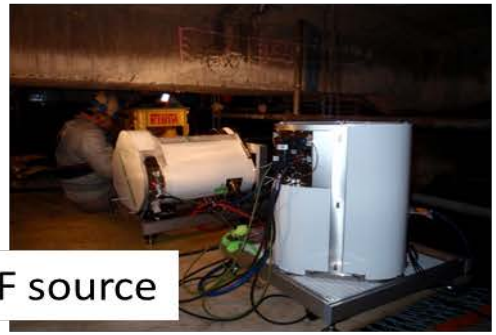


Electric Power Source

Image Processing System

X-ray Head



RF source

Temporary Floor

化学プラント蒸留塔内部流体の可視化

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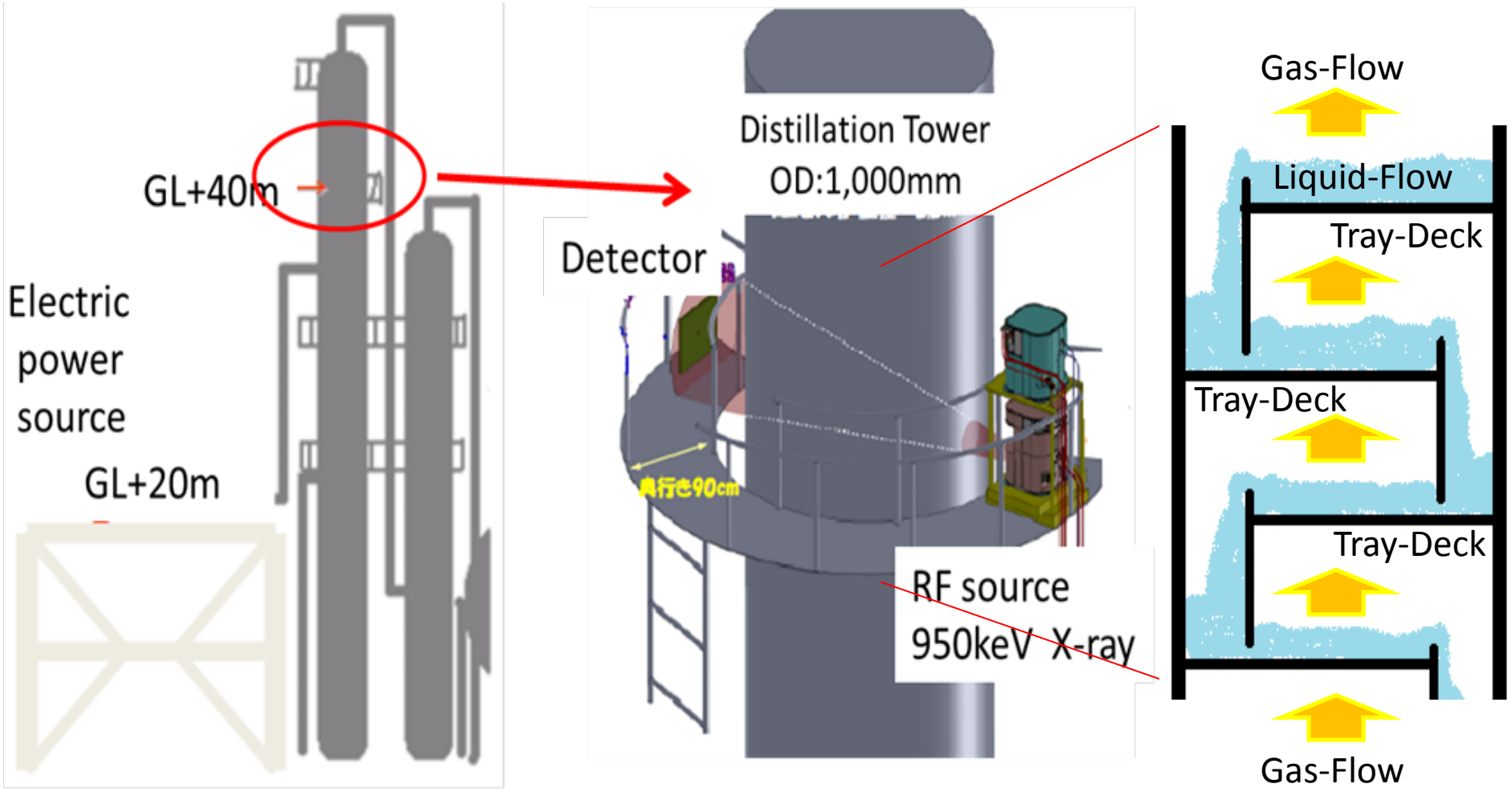

化学プラント蒸留塔内部流体の可視化

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←950keV X-ray source

↓300keV X-ray source

化学プラント蒸留塔内部流体の可視化

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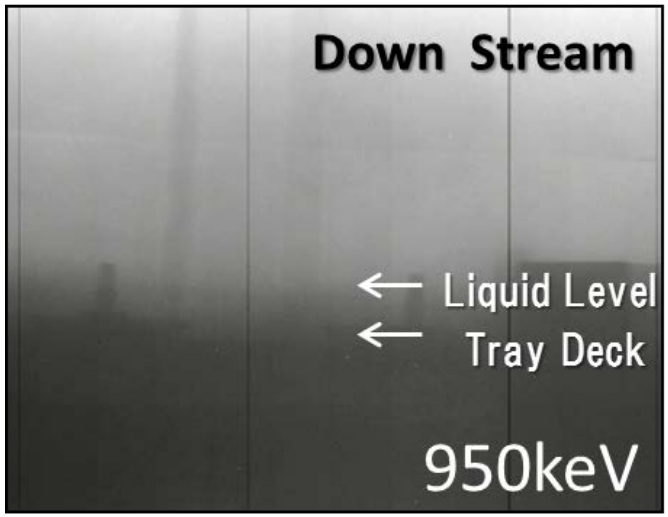
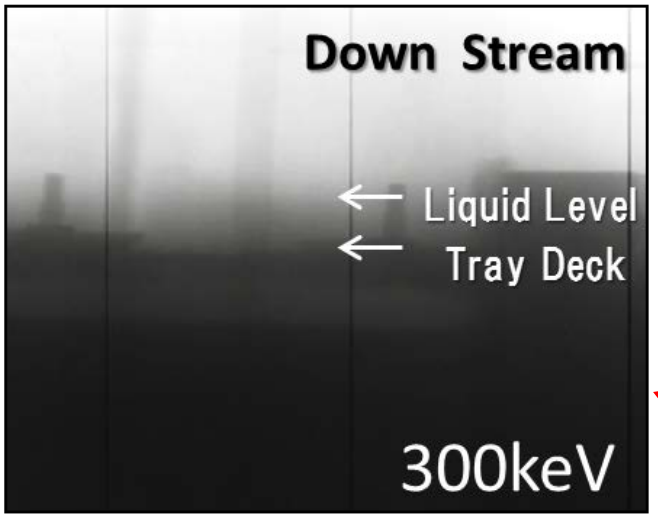
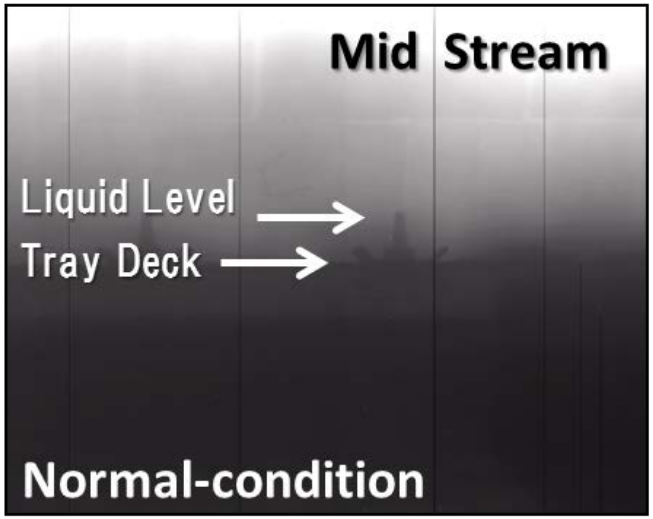
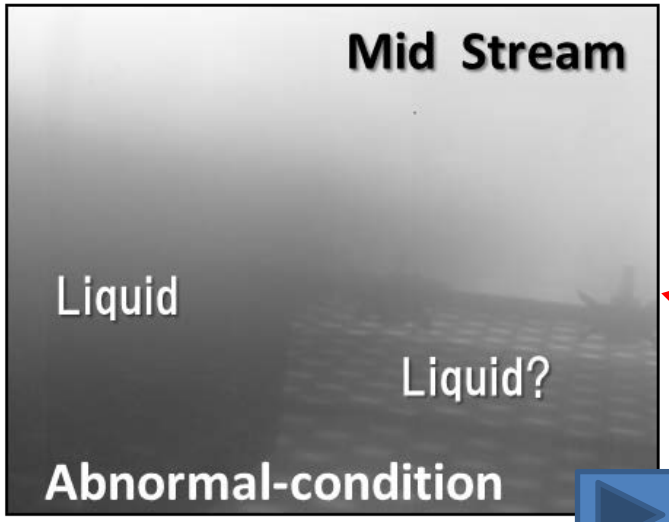


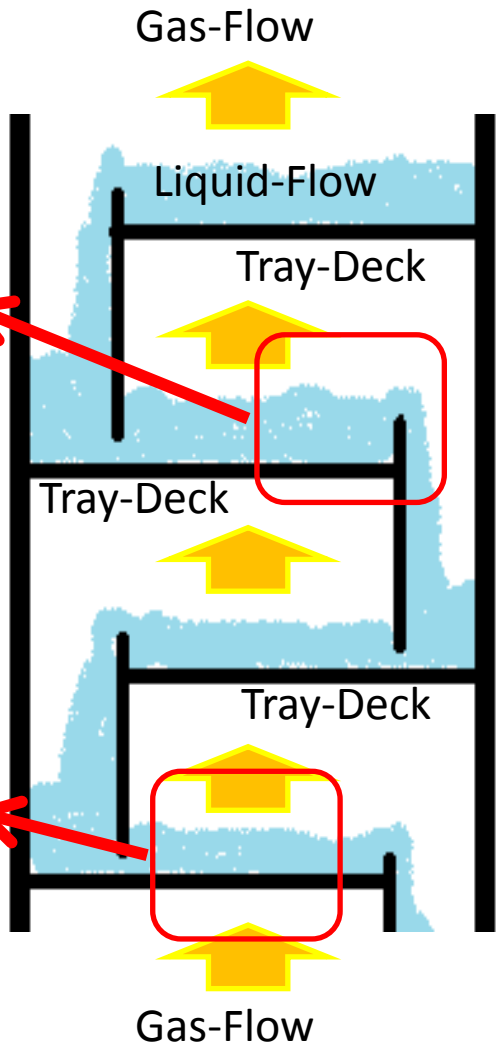


The X-rays image using 950keV,300keV





The X-rays image Normal-condition and Abnormal- condition using 300keV X-ray source



配管内部気液二相流のフローパターン可視化

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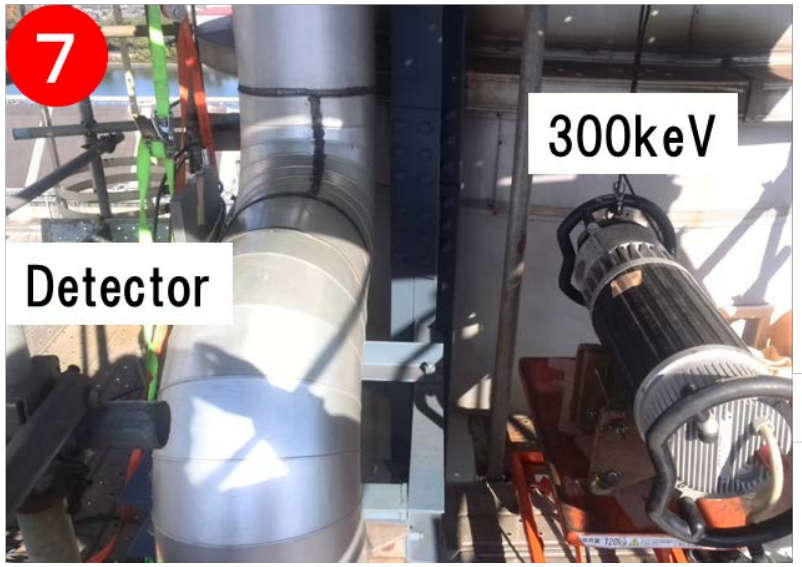

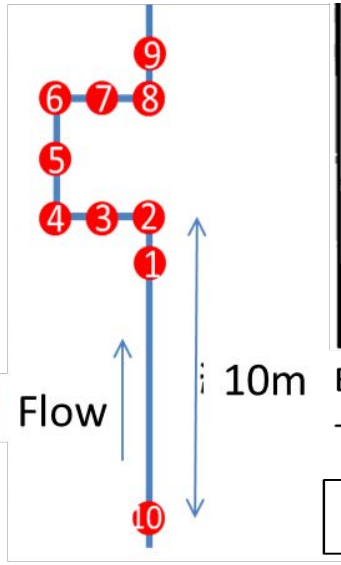

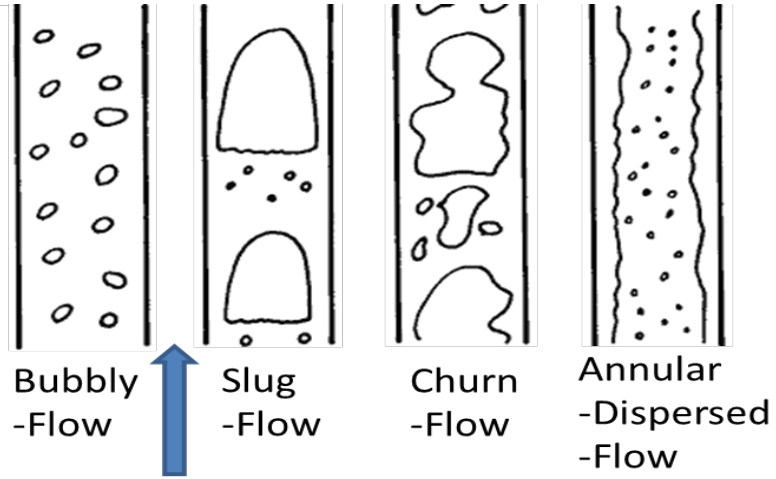

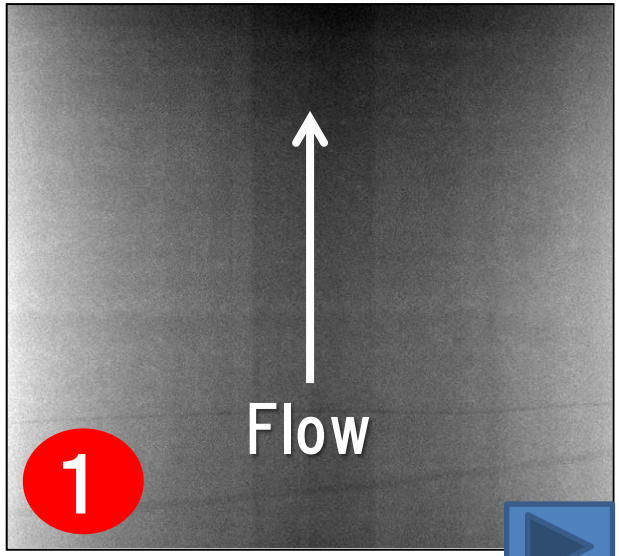

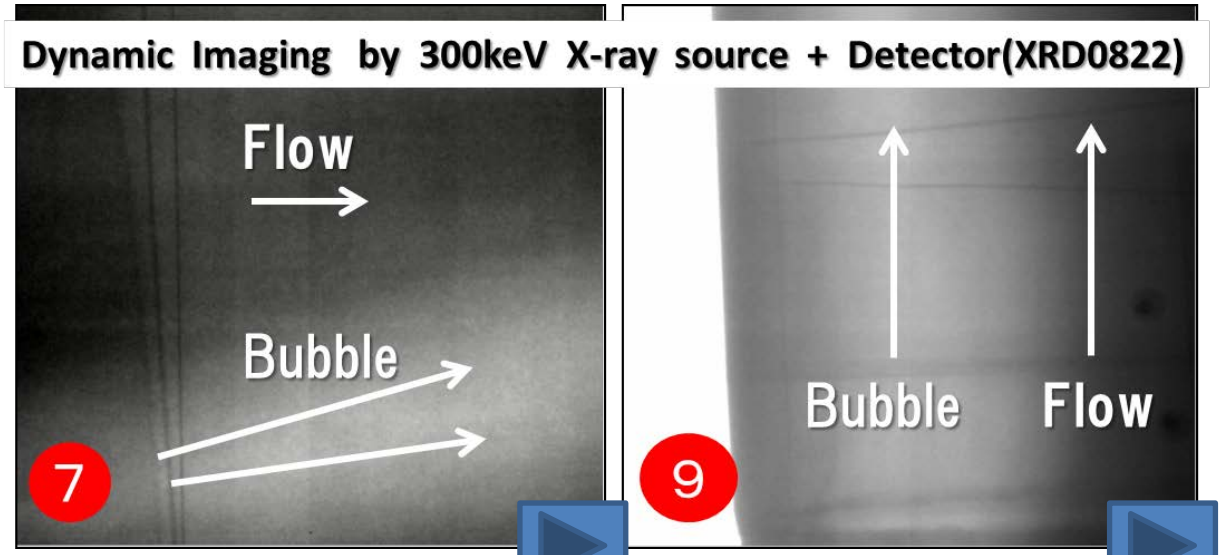

ご清聴ありがとうございます。

以　上