Report on Selected Detectors

SPring-8

A. Baron

1. **SNAP Collaboration (ESRF, DESY, U. Heidelberg, SPring-8, PKI)**

2. **CCD Image Intensifier (Yagi, Sasaki, et al, Talk by Sasaki)**

   Toward 10 microsecond framing

3. **CMOS Detector (Hasegawa, Kumasaka, Yagi)**

   Improvement over CCD, Continuous Data Collection

4. **PILATUS Pixel Array Detector (Toyokawa, et al)**

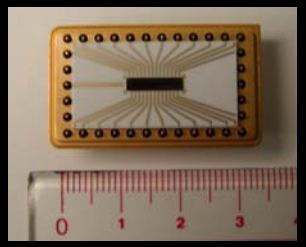
SNAP

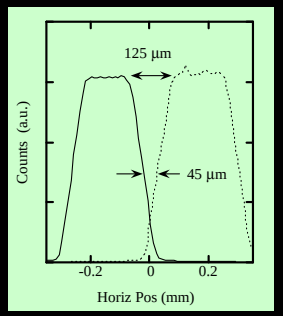
"Sub-ns APD Pixel" Detector

Collaboration: ESRF, DESY, U. Heidelberg, SPring-8
ESRF & PKI (Formerly EG&G)

ESRF: P Fajardo (Leader), R. Rueffer
DESY: H. Graafsma, O. Leupold
Heidelberg: P. Fischer (ASIC Design & Fabrication)
SPring-8: A. Baron

2 to 3 Year Project
Aimed at a FIRST ~ns Photon Timing/Counting Array
- Area: 10x10 mm^2
- Pixel Size: 0.3 x 0.3 mm^2
- ~ns Resolution
- Thickness: 0.1 to 0.2 mm
- Bump Bonded to readout ASIC





Linear Array

Present status: Contact in process.

SNAP: Scientific Targets

Nuclear Resonant Scattering:

Time resolved detection (ns time resolution)
Event based data (x,y,t) - Aim at throughput 10^7 Hz

Nuclear SAXS/WAXS: Spatial Hyperfine Correlations
SR PAC - Hyperfine Spectroscopy
Time Domain Interferometry (quasi-elasticscattering)
Sub-meV inelastic x-ray scattering (?)

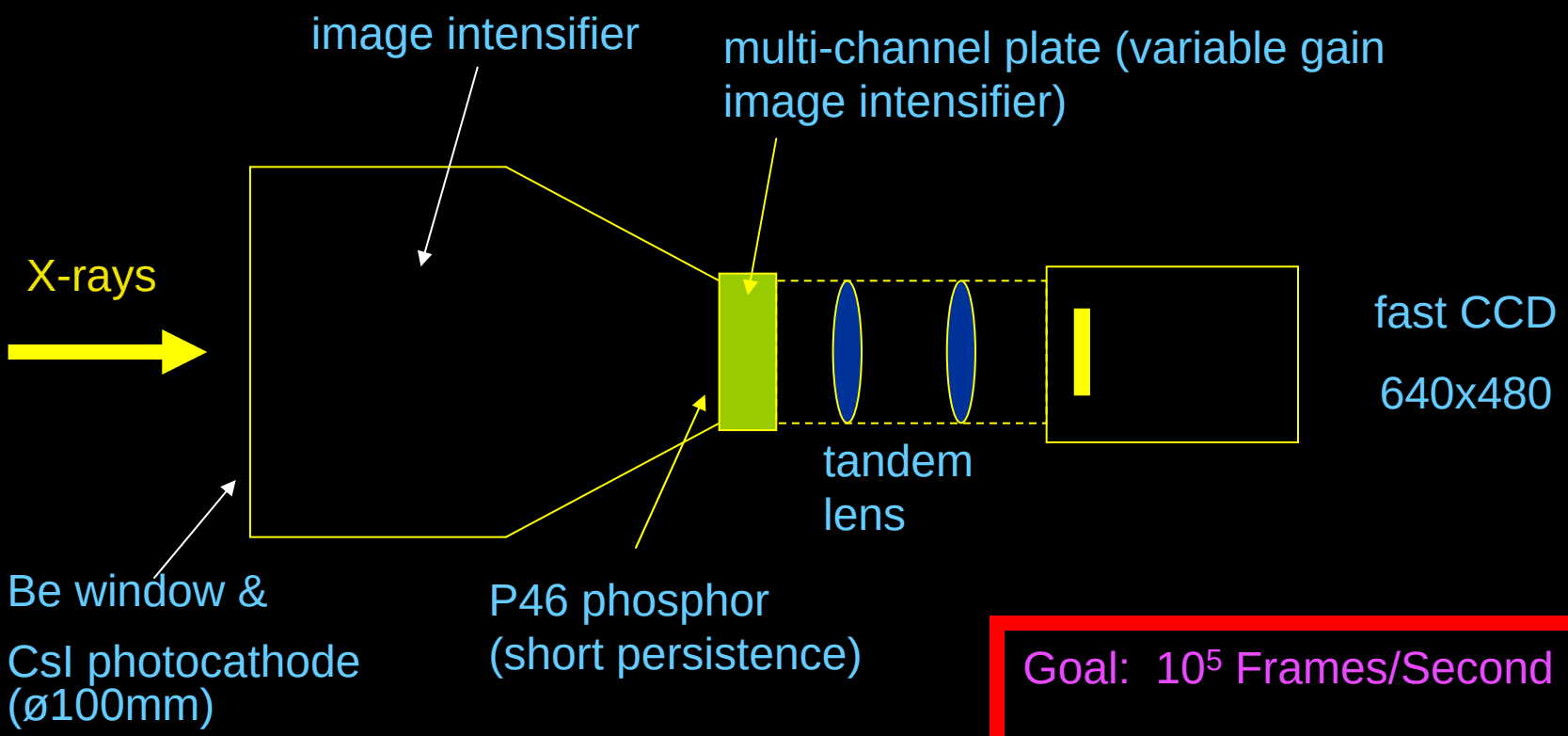
Note: General need for integrated electronics - a first step

Intensity Fluctuation Spectroscopy

Push to sub-microsecond level (count rate limited)

"Fast Framing" - Frames down to 10 ns duration
Updating option to "parallelize" stroboscopic work

Tandem image intensifier *for* single molecule tracking



Goal: 10^5 Frames/Second

With: Prof. Eto (Kinki Univ.)
Hamamatsu

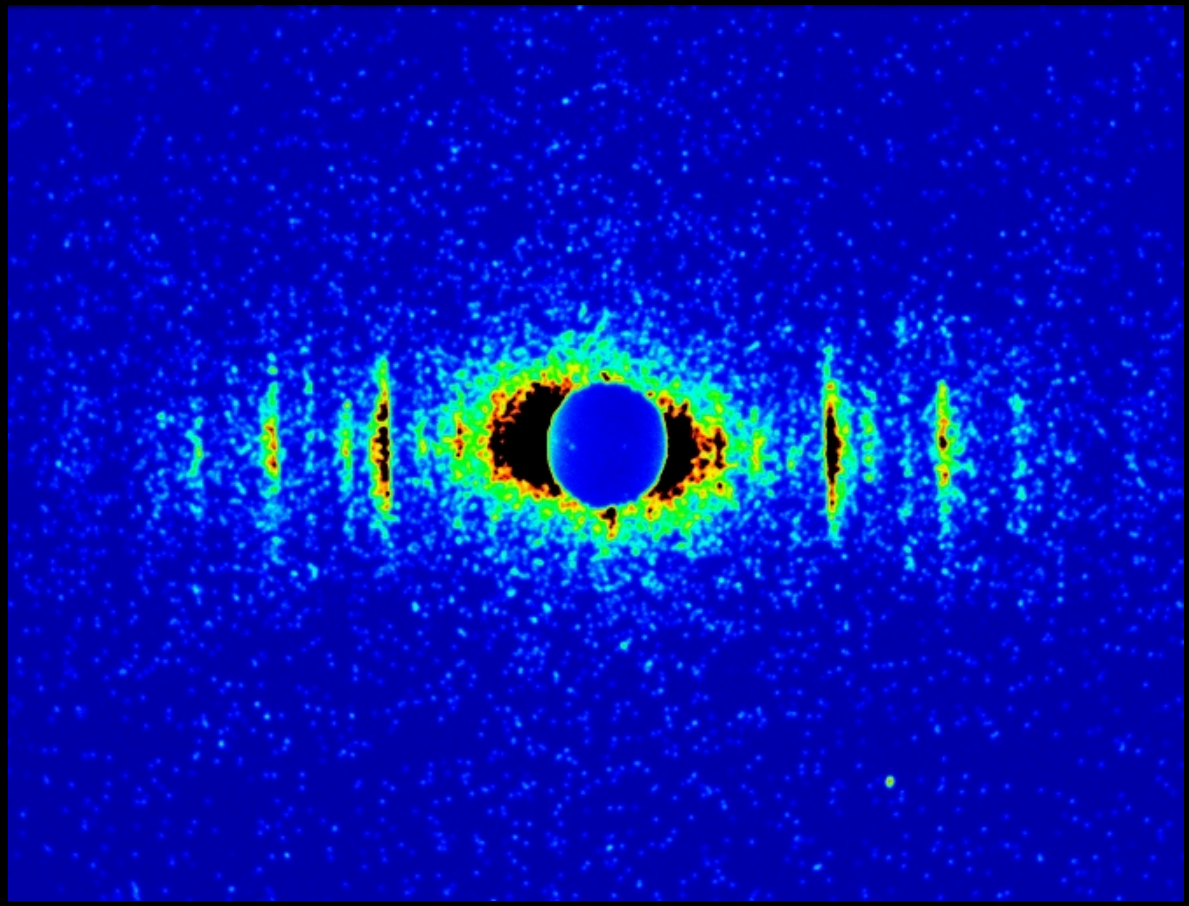
N.Yagi & Y.Sasaki (JASRI)

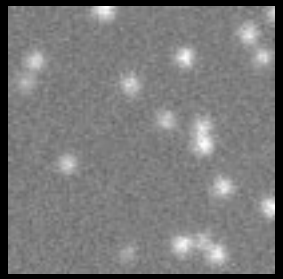
Diffraction from Collagen

Pink Beam

BL40XU@SPring-8

5 μs exposure
(Mechanical Shutter)





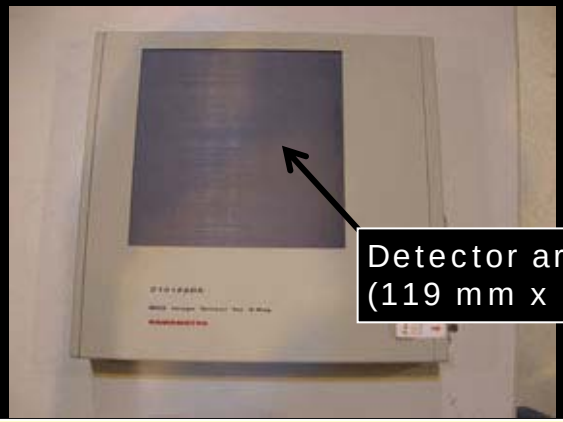
single 15keV photons

Minimum MCP gain (~10)

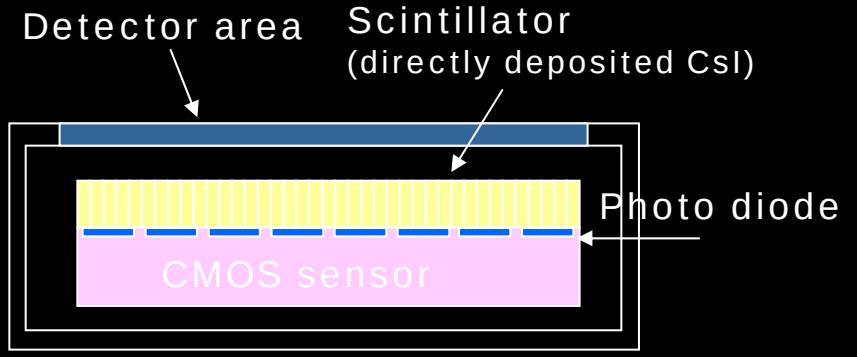
Dynamic Range: ~100

X-ray CMOS Detector

From: K Hasegawa, T. Kumasaka, N. Yagi



Hamamatsu Photonics C10158DK



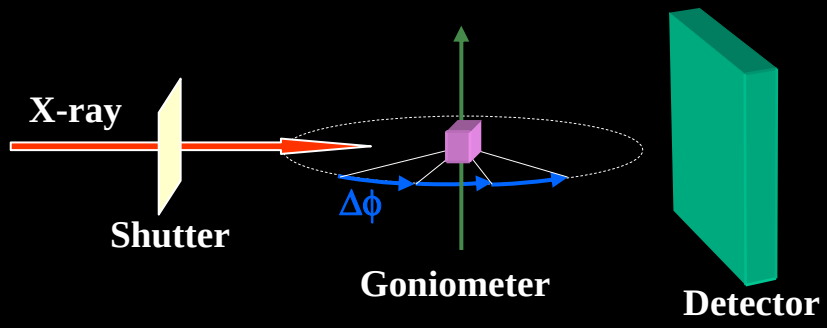
- Compact & Light
  - size: 215mm x 201mm x 35mm
  - weight: 2.3kg
- Max. frame rate 3frame/sec

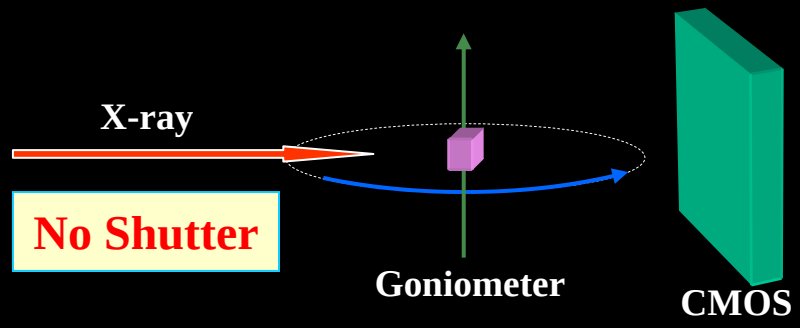
Readout 2D images pixel by pixel sequentially.
Exposure is possible while reading other pixels.
4μsec to readout one pixel.
Dead time due to readout is negligible

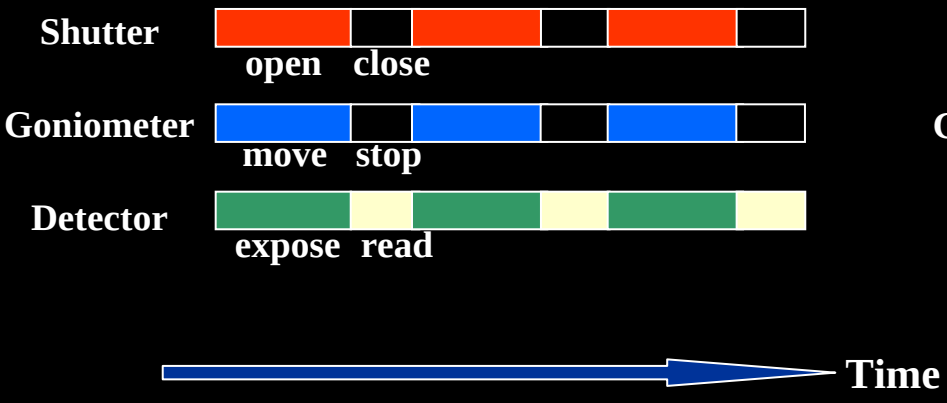
Shutter-less continuous rotation method is possible with CMOS

Continuous Rotation (w/o shutter)

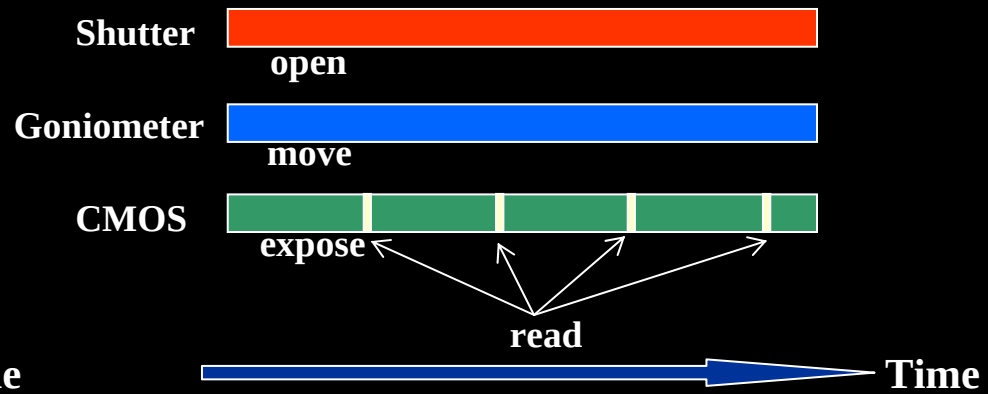
Rotate crystal on spindle axis and record diffraction images with fine ϕ-sliced continuous images







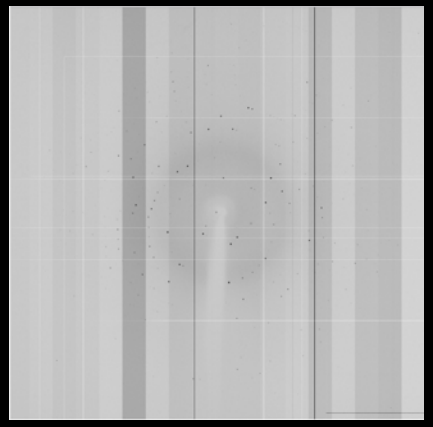
Conventional oscillation method



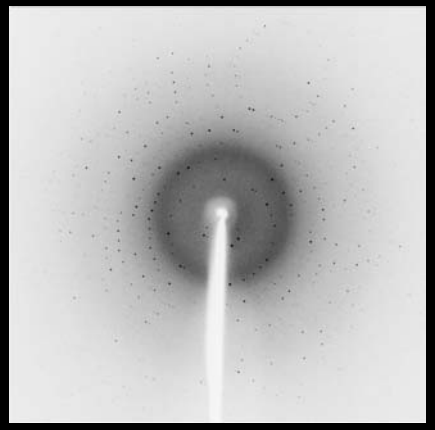
Shutter-less Continuous rotation method

- Rapid data collection with fine rotation step
- Synchronization between shutter & goniometer is not needed

Protein Crystallography Using the CMOS Detector

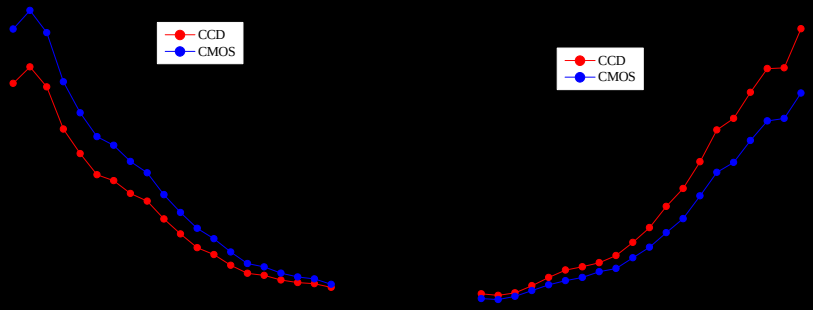


Raw diffraction image
of hen egg lysozyme



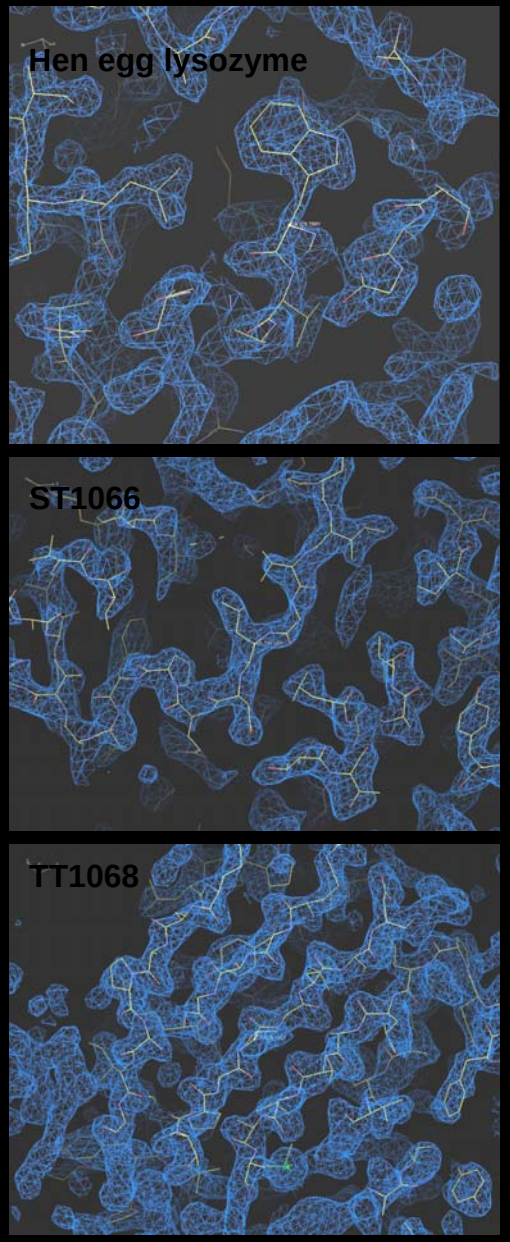
After dark current & defect
pixel correction

Diffraction image recorded with CMOS



Comparison with CCD detector

- Larger S/N (larger I/σ)
- Higher precision (smaller R_{merge})



Pilatus Pixel Detector

From H. Toyokawa

collaboration with SLS since 2001

Single-module (PILATUS-100K)

- Material: Si 320 μm
- Pixel size: 172 x 172 μm^2
- Format: 487 x 195 = 94,965 pixels
- Active area: 83.8 x 33.5 x mm^2
- PILATUS-100K #1
  - User operation since 2006A
- PILATUS-100K #2
  - User operation since 2007A
- PILATUS-100K #3
  - Spectroscopy group I , available from 2008A
  - XAFS and Reflectivity at BL01B1, BL37XU
- PILATUS-100K #4
  - Industrial application division, available from 2008A
  - Ultra- SAXS at BL19B2
  - Fast time resolved XRD at BL46XU

Multi-modules (PILATUS-2M)

- Material: Si 320 μm
- Pixel size: 172 x 172 μm^2
- Phase I (3 x 2 modules)
  - 1475 x 407 = 600,325 pixels
  - 253.7 x 70.0 x mm^2
  - User operation since 2007B
- Phase II (3 x 4 modules)
  - 1475 x 831 = 1,225,725 pixels
  - 253.7 x 142.9 x mm^2
  - Available in 2008A
- Phase III (3 x 8 modules)
  - 1475 x 1679 = 2,476,525 pixels
  - 253.7 x 288.8 x mm^2
  - completion in 2008B

Time-Resolved X-ray Diffraction Study with Pilatus-100K

Two-Dimensional Time-Resolved X-ray Diffraction Study of Directional Solidification in Steels

Materials Transactions, 47 (9), pp. 2292-2298. (2006)

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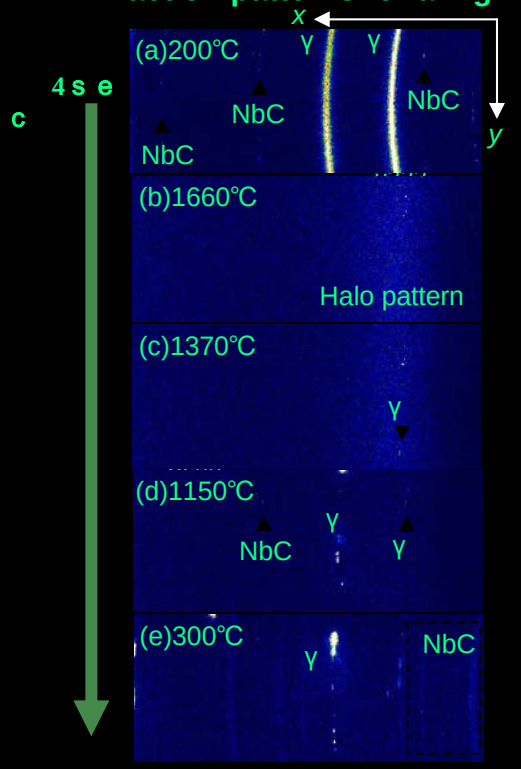
Y. Komizo, H. Terasaki
Joining and Welding Research Institute, Osaka University
M. Sato, H. Toyokawa
Japan Synchrotron Radiation Research Institute

Behaviour of dendrites in steels under welding conditions of a practical manufacturing process were investigated using the TRXRD method for in-situ weld observation with the PILATUS-100K pixel detector. Consequently, the crystal growth during the rapid cooling was caught in detail and employed a systematic peak profile analysis in order to acquire the essential information for controlling the weld microstructure. Our results would suggest the microstructure formation process of low alloy in directional solidification during rapid cooling. Simultaneously, we discuss the possibility of detecting the nucleation.

Diffraction patterns for a high alloy



Readout Time: 2.7 ms, ~100 Hz Frame Rate