CRYTUR – company profile

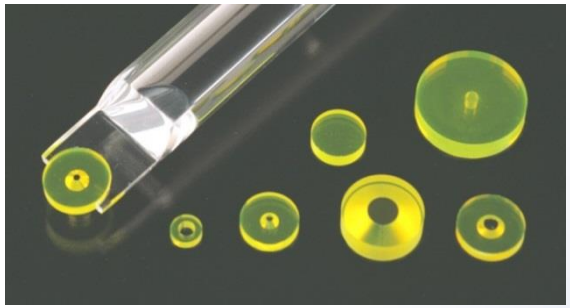
Jan Touš
Head of Scintillation Detectors Dpt.

parizek@crytur.cz




Contents

- CRYTUR company profile
- Materials and technologies
- Scintillating screens for imaging
- Detetion units for EM
- Lasers
- Sapphire
- Imaging systems and single photon counting
- Summary



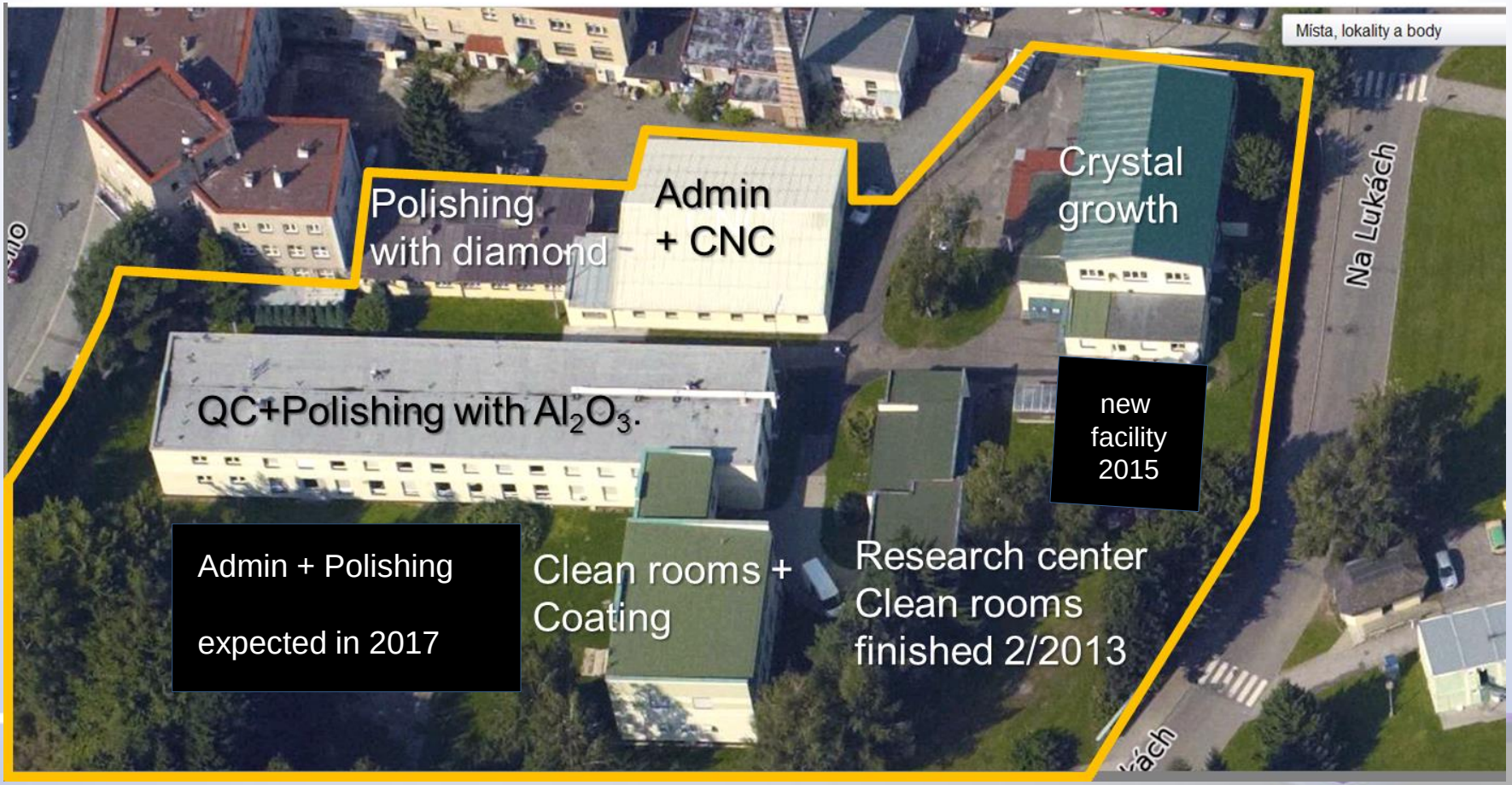
Profile

- Tradition in crystal growth back to 1943
- 142 employees
- ISO 9001:2009 certified

- Scintillators and detectors
- Electron microscopy
- Lasers
- Thin-film coating
- Sapphire profiles

Facility

- **Modern 4500sqm facility**



TECHNOLOGIES – Crystal Growth

CRIG (Crystal Improved Growth)

- based on Czochralski method
- patent EP 2675944
- excellent quality
- Stable and flat growth front
- Optimal choice of growth conditions (according to grown material)

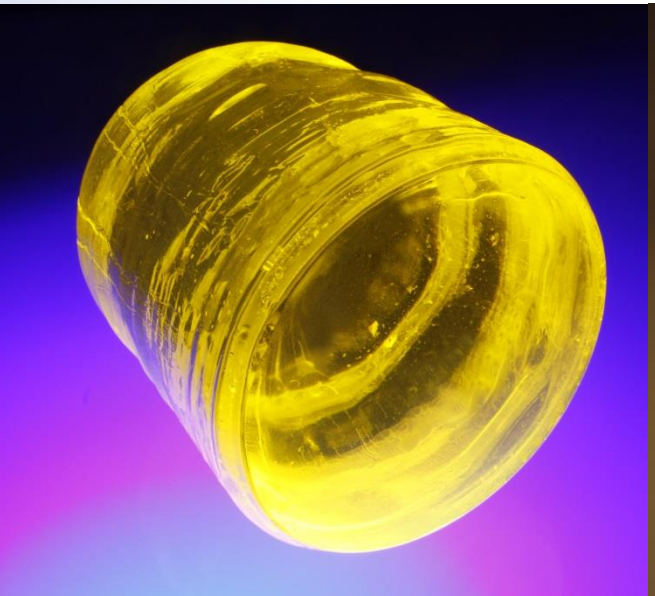
TECHNOLOGIES – Crystal Growth

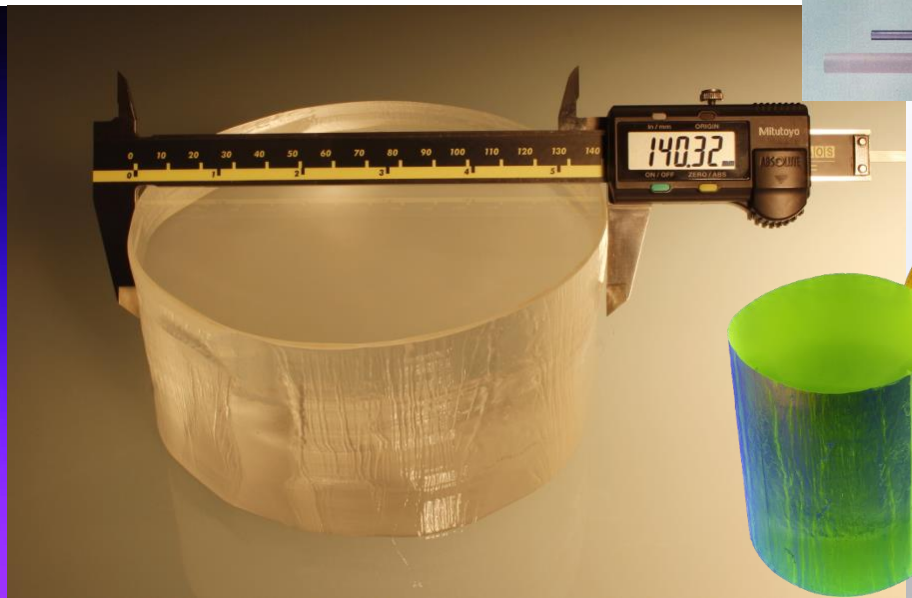
„World largest YAG stress-free crystals“

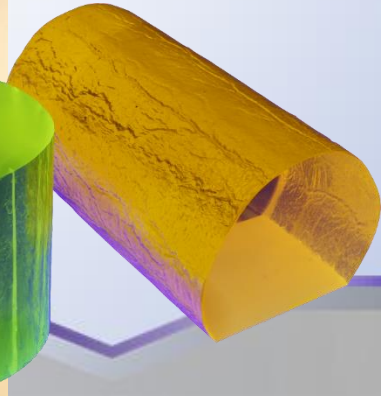
- Diameter up to 6 inch
- Weight up to 14 kg
- Stress-free core

MATERIALS
(grown as single-crystals)

- Garnets YAG and LuAG
- Perovskites YAP
- Silicates, Tungstates (PWO)
- Dopants: Ce, Nd, Tm, V, Yb, Pr, Er, Cr

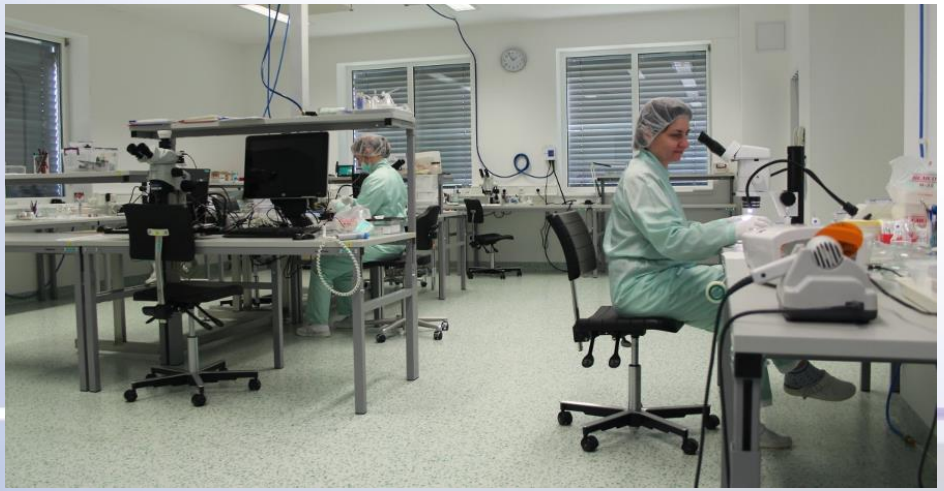


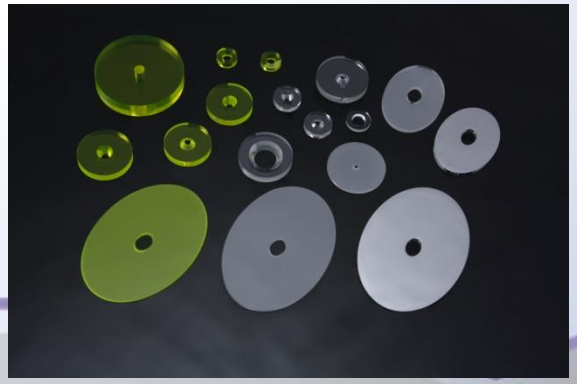




Detection Units for Electron Microscopy

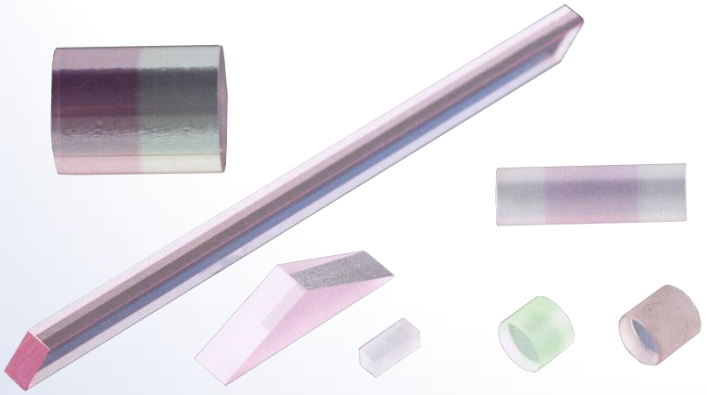
- Single crystals for BSE detection in electron microscopy – Crytur has a market majority globally
- Complete detection systems
- Clean-facilities

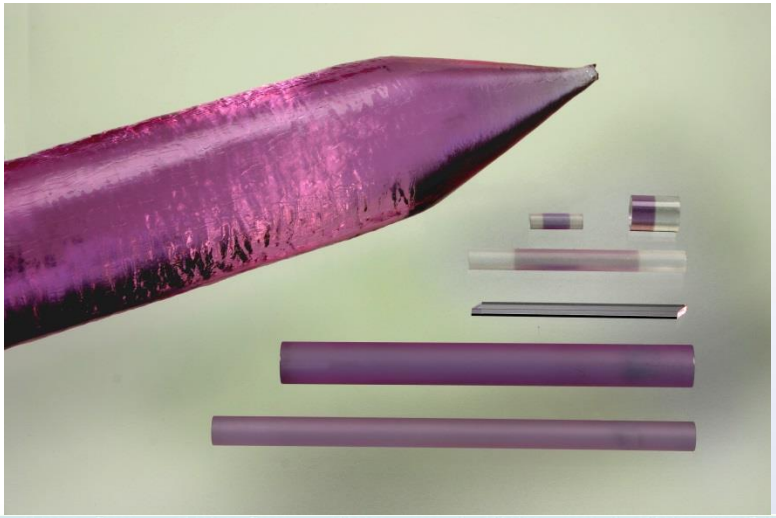


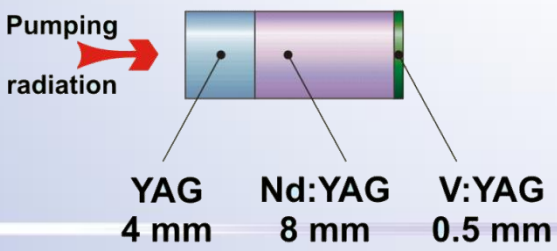


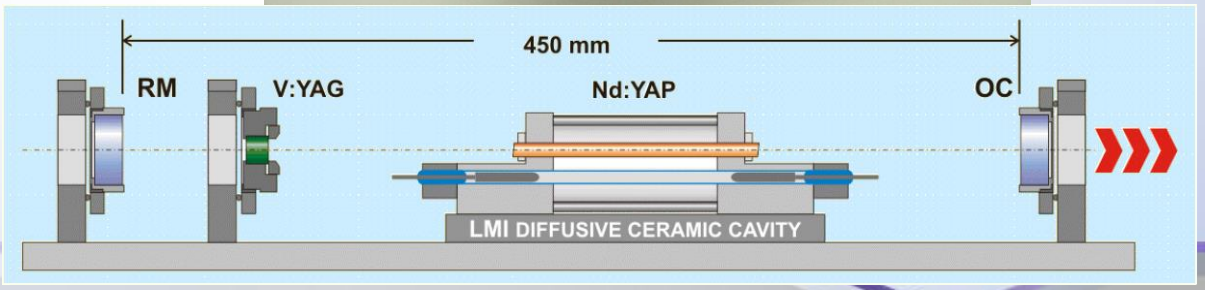
Lasers

- Laser rods primarily for medical and defence industries
- Specialty materials – YAP, YAG, LuAG, $BaWO_4$, etc.
- Bonding, angles, …







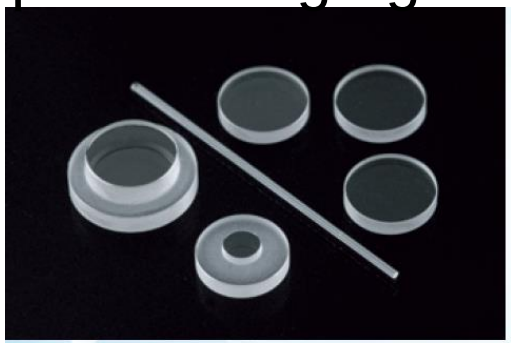


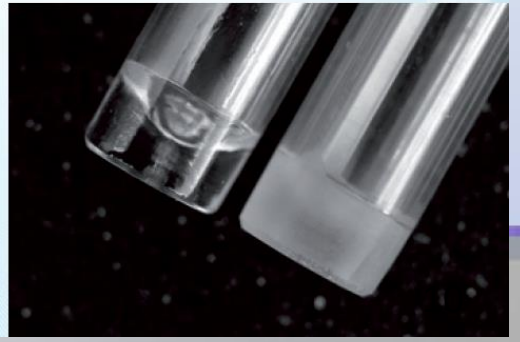
Sapphire profiles

TUBES, RODS

Ø 0,5 mm to 45 mm, length up to 2 m

Applications: Temperature measurement probes, ultra-high pressure probes, high-temperature lightguides, ...

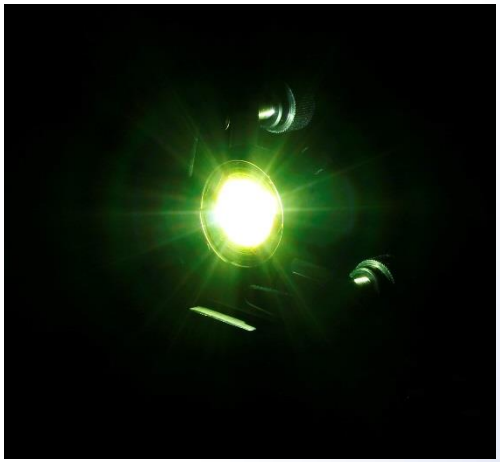


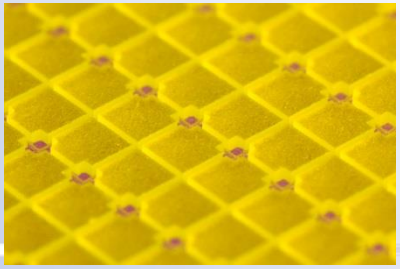


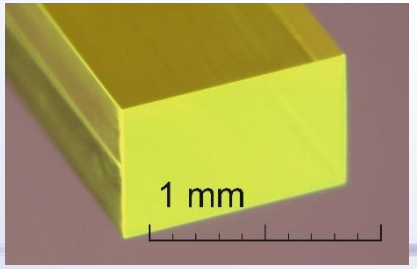
PRODUCTS – LUMINOPHORES

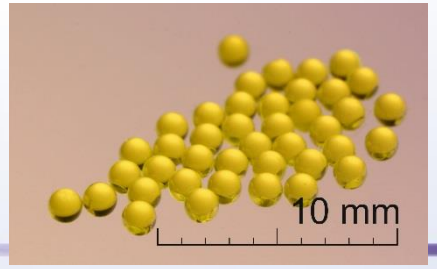
Light conversion elements for LEDs and laser diodes

- White-LED conversion
- Full light conversion elements
- Optical elements
- Remote laser excitaction





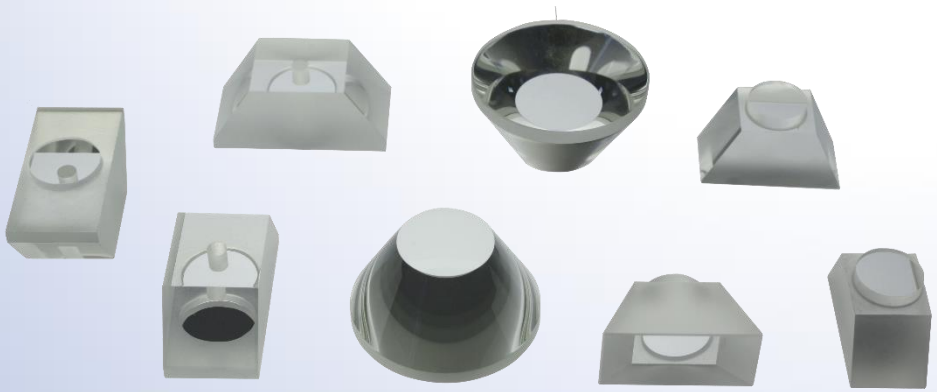


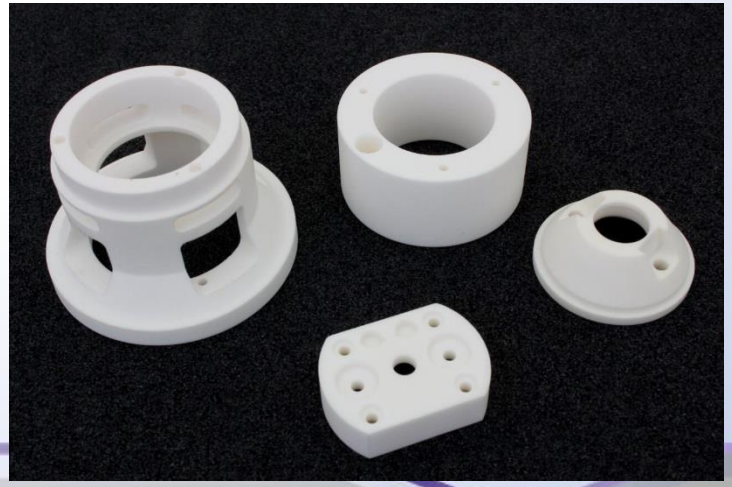


PRODUCTS – PRECISION OPTICS

- High precision crystal optics (sapphire, garnet)
- High precision ceramics
- UV-light gemstone

Complex shapes, high presion,
perfect surfaces





Scintillators & Detectors

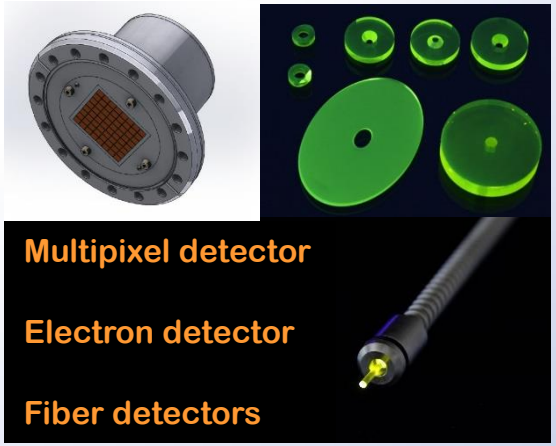
X-ray imaging

X-ray / γ-ray

Single photon counting

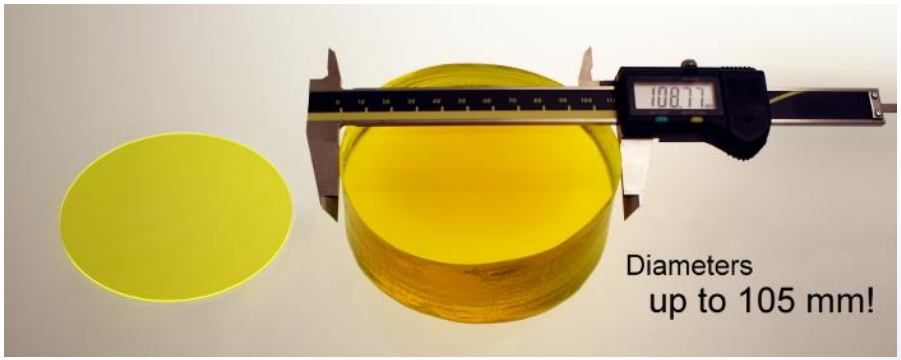
neutron

Integrated solutions



Imaging screens

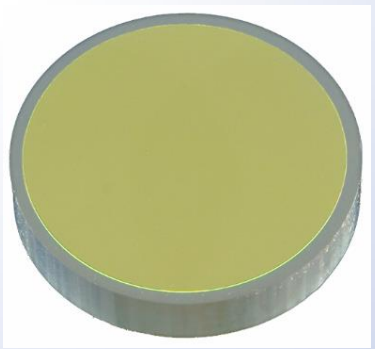
- Optical homogeneity <5 %
- Optical quality (S/D 0/0)
- High light output
- Excellent Radiation Hardness*
- Long life-time
- Chemical & Mechanical stability
- Coatings & lithography



Free-Standing

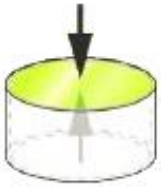
In Frames

On Substrates



*M. T. Lucchini et al. "Radiation Tolerance of LuAG:Ce and YAG:Ce Crystals Under High Levels of Gamma- and Proton-Irradiation," in *IEEE Transactions on Nuclear Science*, vol. 63, no. 2, pp. 586-590, April 2016.

Imaging screens

Available types		Diameter	Thickness
Large imaging screens		**up to 105 mm**	down to 200 µm
Standard screens		typically up to 50 mm	typically 100-1000 µm
Very thin free-standing screens		up to 50 mm up to 10 mm	down to 50 µm down to 20 µm
		up to 50 mm up to 10 mm	down to 100 µm down to 50 µm
Very thin screens with ring support: › aluminium › stainless steel › ceramics (alumina)		up to 10 mm up to 50 mm	down to 20 µm down to 50 µm
Ultra-thin screens on substrate (down to 170µm): › fiber optics › glass, quartz glass › YAG, sapphire		up to 40 mm up to 30 mm	**10 µm** **5 µm**

Imaging screens

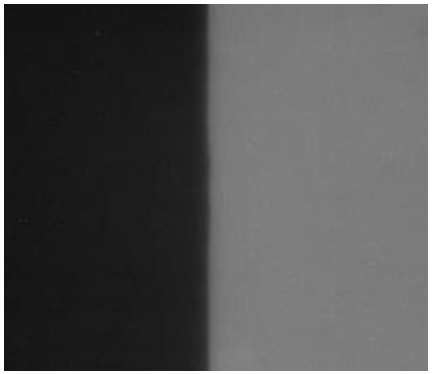
Scintillator	Emission wavelength [nm]	Density [g.cm^{-3}]	Cleavage/ Hygroscopic	Photon Yield [ph/keV]	Decay [ns]
YAG:Ce	550	4.55	**No/No**	35	70
LuAG:Ce	535	6.73	**No/No**	25	70
LuAG:Pr	315	6.73	No/No	19	20
CRY19	420	7.1	Yes/No	32	41
YAP:Ce	370	5.37	No/No	25	25
CRY18	425	4.5	Yes/No	32	45
CsI:Tl	565	4.51	No/Yes	45	900
GOS:Tb	544	7.34	-/No	60	106
CWO	475	7.9	Yes/No	12-15	5000
BGO	480	7.13	No/No	8-10	300

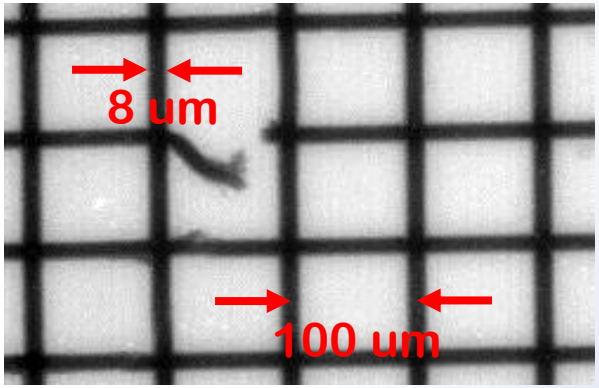
Single crystal vs powder

- Intrinsic resolution limited only by optical system!

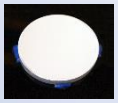
Single crystal

LuAG:Ce screen
20 um

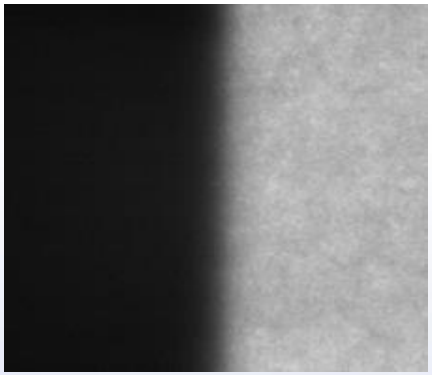


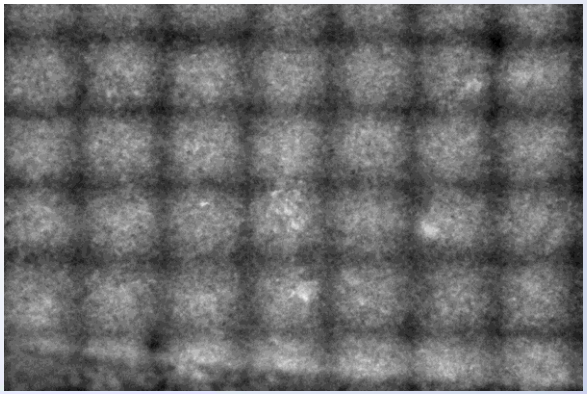


Powder screen



P43 (GOS)
20 um (2um grain)





Imaging systems - CRYCAM

Micro system example

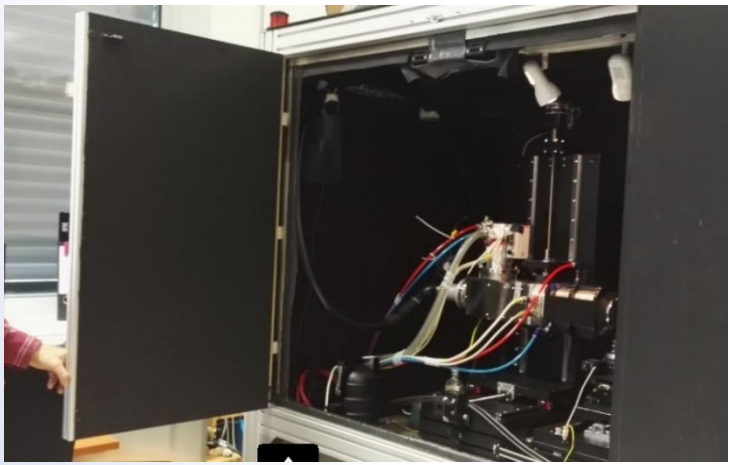
Features

- Macro vs Micro system
- Perfect contrast (single crystal screens)
- Outstanding intrinsic resolution (1 µm)
- Highly customized (FOV up to 35 x 35 mm)
- Multiple imaging options
- OEM or end-user solution

Application

- X-ray radiography
- X-ray tomography
- X-ray topography
- Beam viewer

Our X-ray cabinet



X-ray cabinet

Features

- Custom designed
- Microfocus X-ray source
- 160 Kp, 2W at high power
- Cu, W, Ag targets

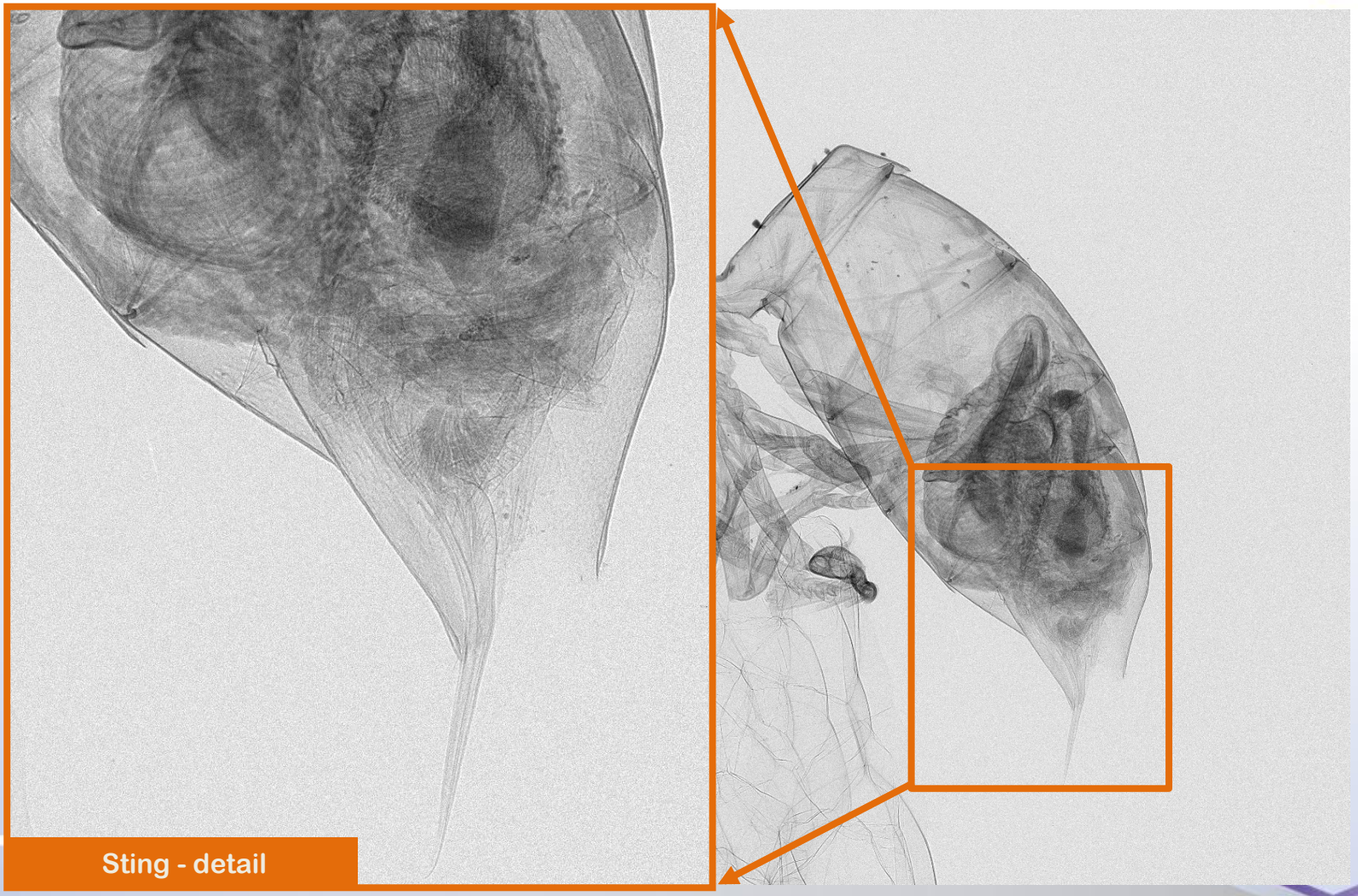
Workload

- X-ray test of our scintillator (optional)
- X-ray radiography measuremets (on demand)
- R&D activities

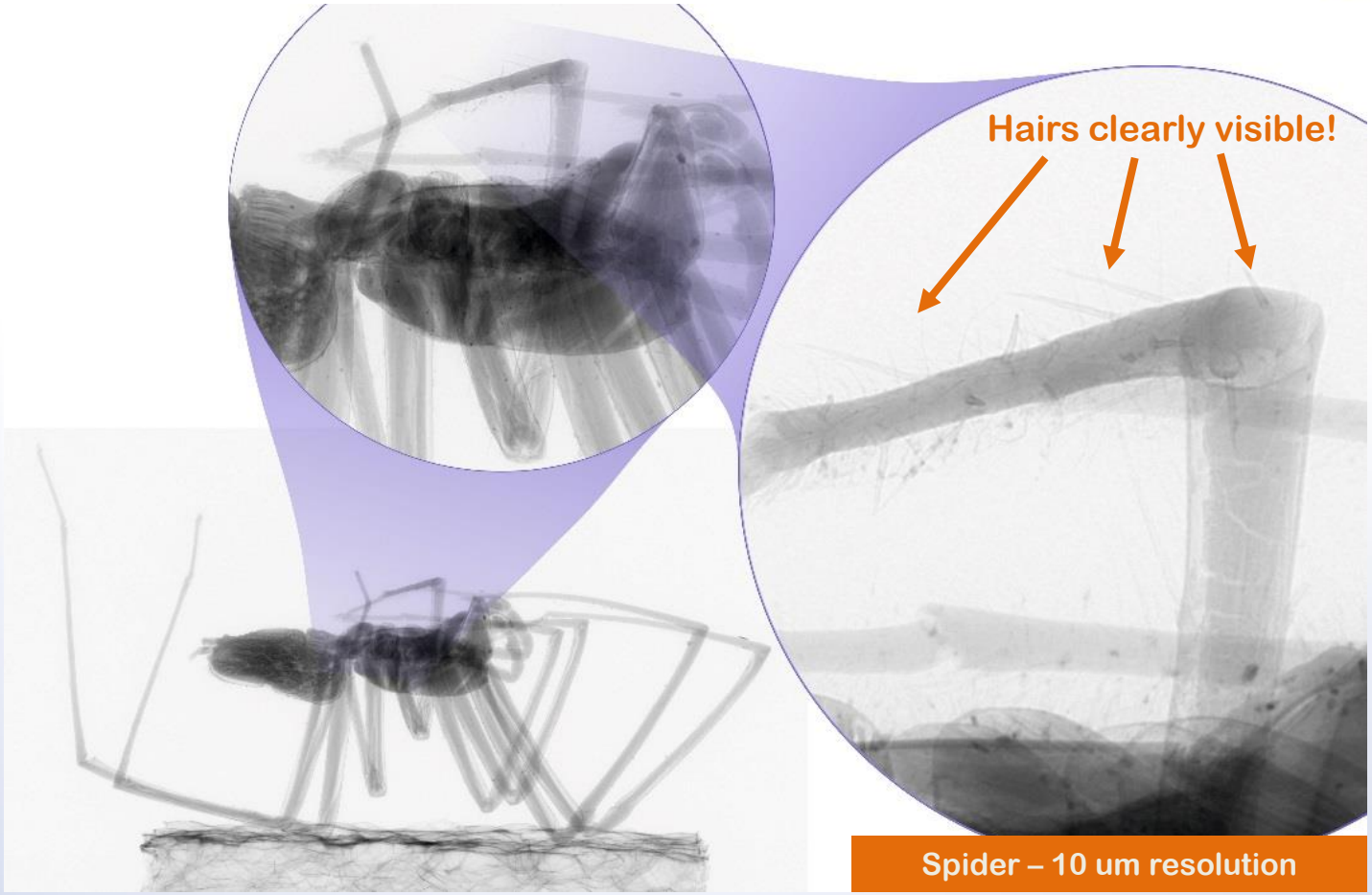
CRYCAM examples

Wasp on foam pedestal

CRYCAM examples

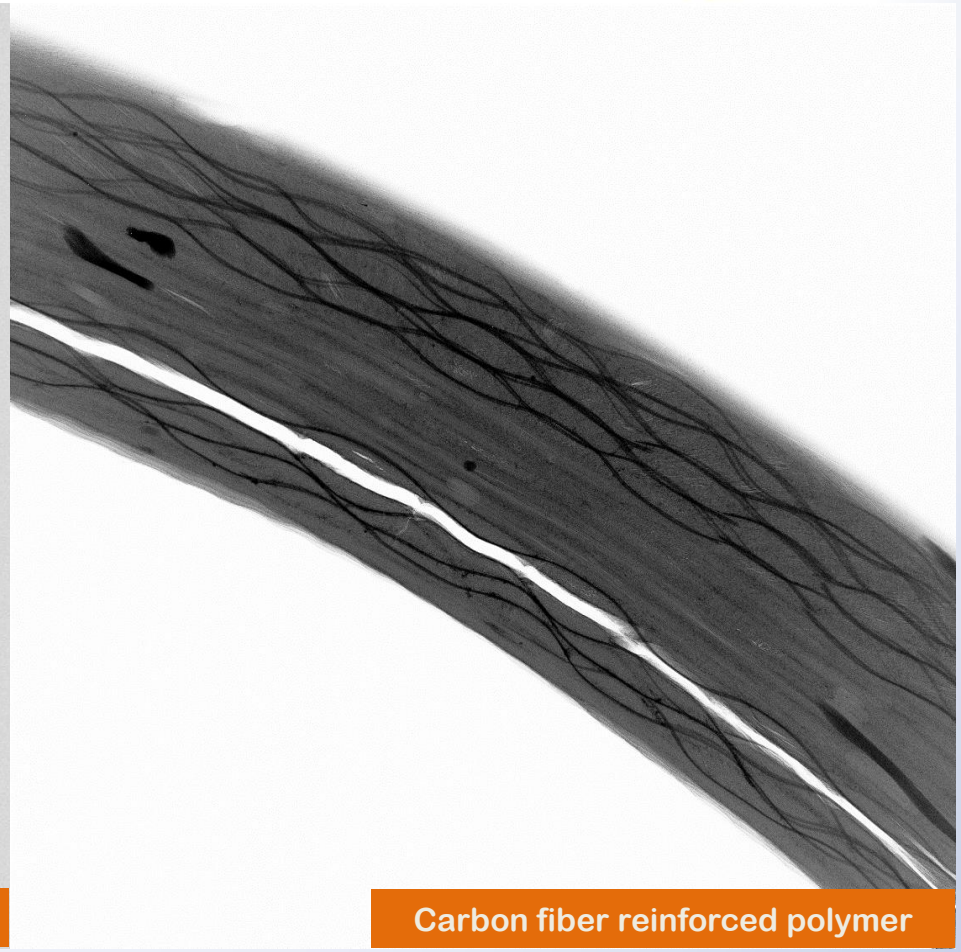


CRYCAM examples



CRYCAM examples

Poppy head



Carbon fiber reinforced polymer

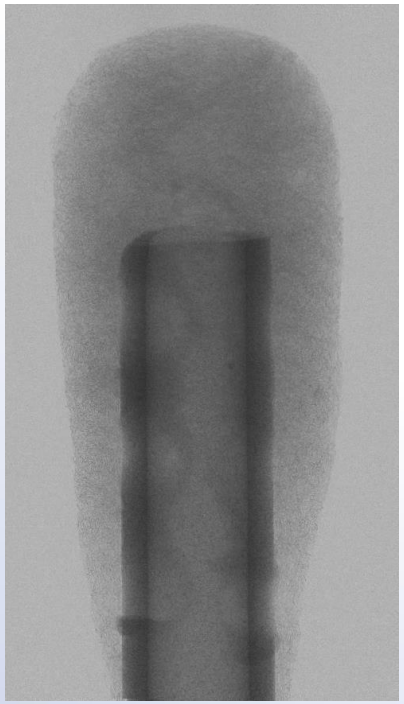
CRYCAM examples

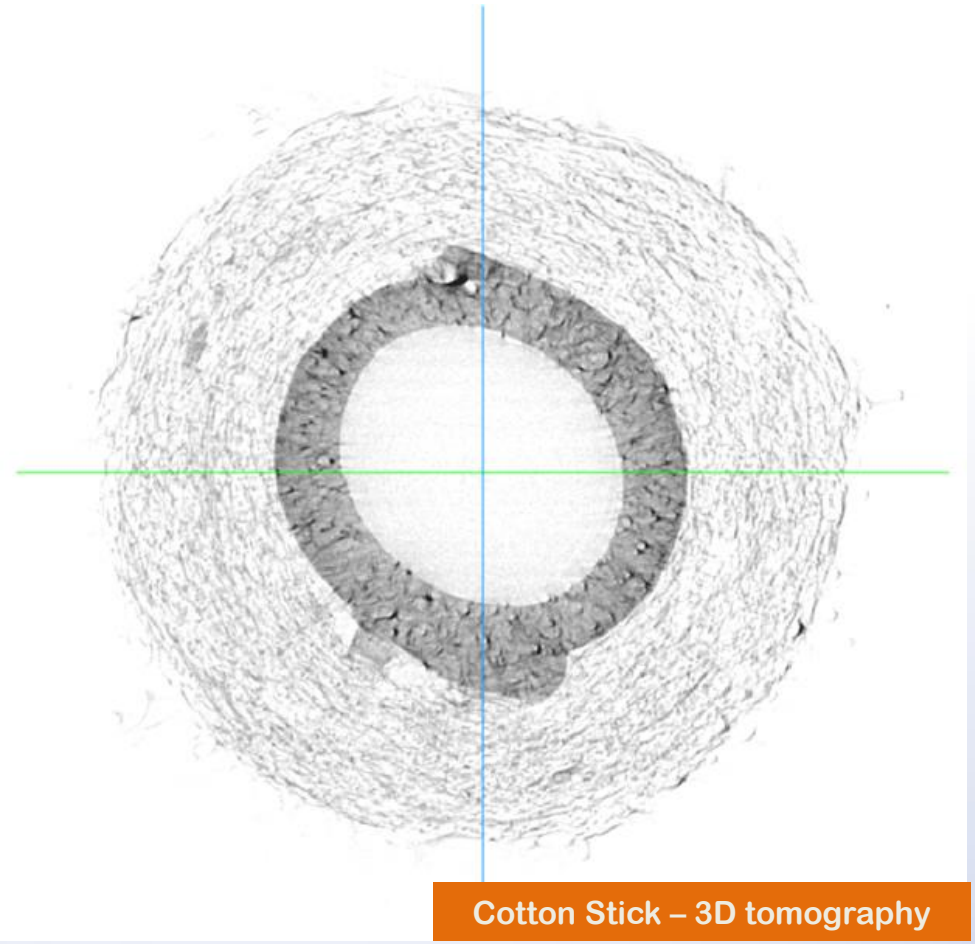
Phase contrast!

Carbon Fibers, 7 µm

- Microfocus X-ray source
- 1 µm spot
- Small focus to object distance

CRYCAM examples





Cotton Stick – 3D tomography

New designs – FOP based cameras

FOP based system example

Features

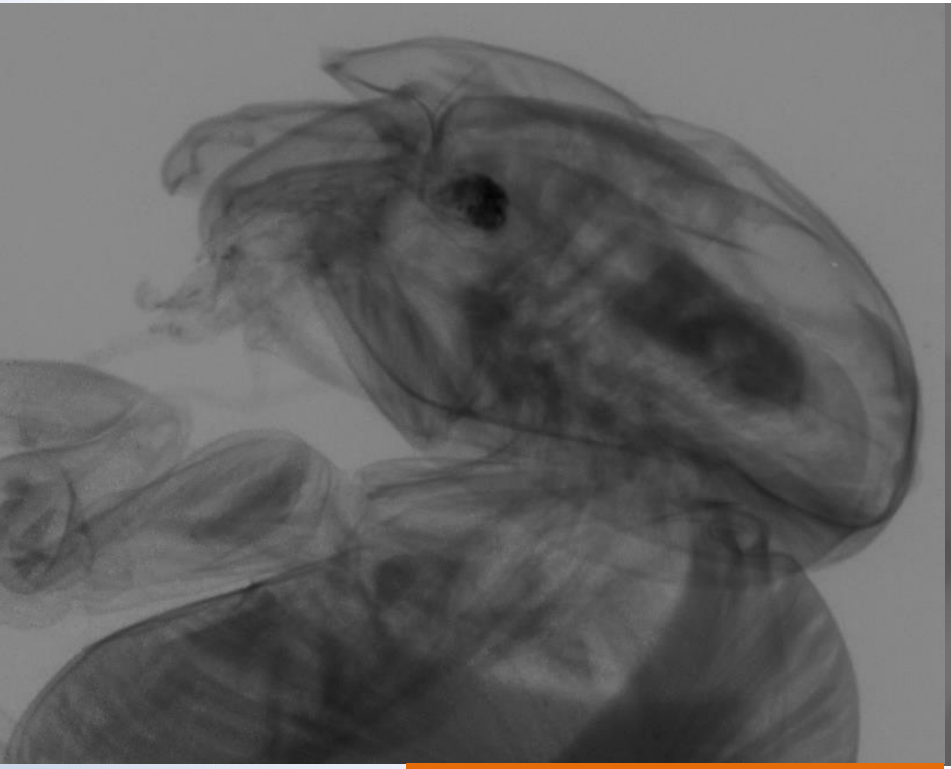
- Medium resolution down to 15-20 µm
- Improved collection efficiency
- High speed acquisition
- Perfect contrast (single crystal screens)
- FOV 32 x 28 mm or 16 x 14 mm
- Multiple scintillator accessories
- OEM or end-user solution

Related services

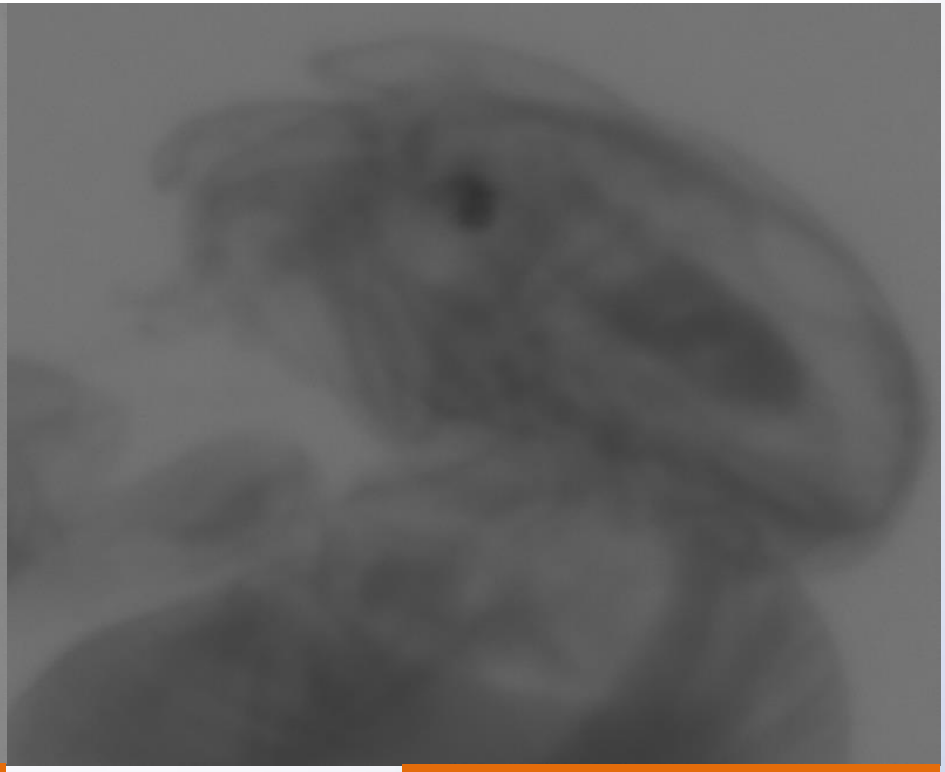
- Bonding to CCD
- Custom design

FOP based camera example

- Cu target, 40kV, 2 W



LuAG screen

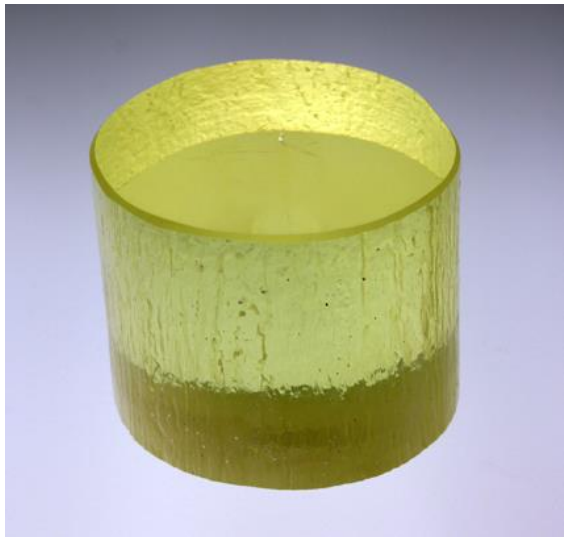


CsI:Tl columnar –HR version

New materials for screens

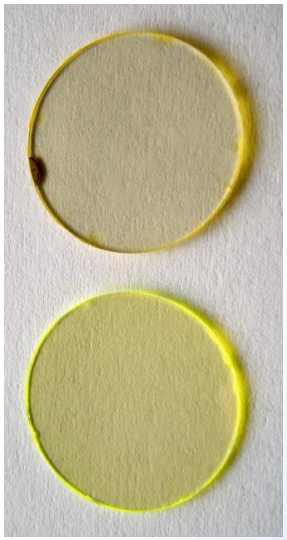
Ruby & undoped YAG screens

- Alternative to OTR
- Low sensitivity



LuAG:Pr

- Fast (20 ns)
- Heavy (6.7 g.cm^{-3})
- Emission 315 nm
- Photon yield 19 ph/keV



LPE screens

- New development
- Update in Q3/2017

X-ray / γ-ray detector family

X-RAY DETECTION

X-ray detector
(counting / spectroscopy)

γ DETECTION

LGD – γ-ray detector

γ DETECTION

175°C
347°F
RESISTANT

HT – X-ray detector for
high temperature environment

X-ray detector

Features

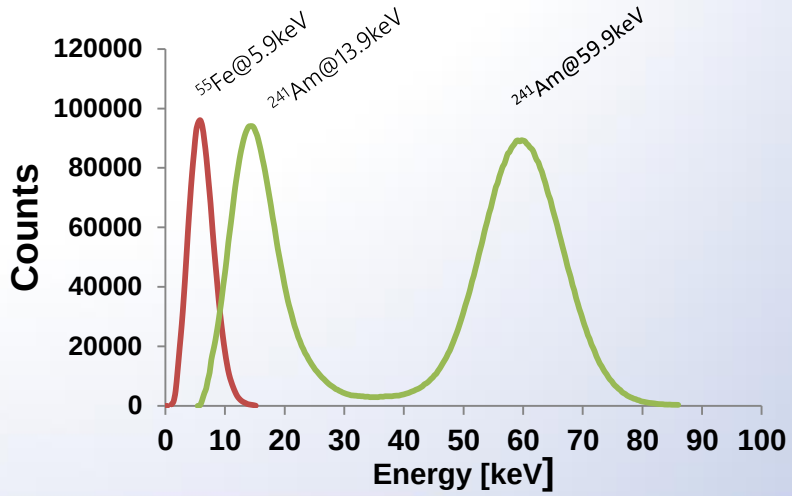
- Innovative YAP:Ce technology => **Non-toxic substances (e.g. Be)**
- Counting and spectroscopy

Properties

- Energy range of **5 keV to 150 keV (50 % absorption)**
- High count rate up to **10^6 pulses/s**
- Detection area: Ø 37 mm (Ø 1.45 inch)
- Magnetic shielding: Mu-metal

Application

- X-ray diffraction
- X-ray fluorescence
- DXA (double-energy X-ray analysis)



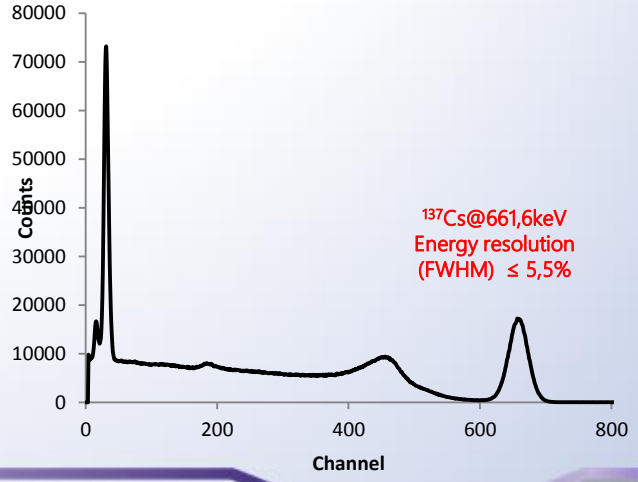
LGD – γ-ray detector

Features

- Scintillation detector based on YAP:Ce scintillation crystal
- Energy resolution **(FWHM) ≤ 5.5 % … ^{137}Cs@662 keV**
- Energy resolution (FWHM) ≤ 18% … ^{241}Am@59.9 keV
- **No intrinsic background**
- Fast detector for **high count rate** applications
- Minimal energy non-proportionality (max. 3 %)

Properties

- Energy range of **20 keV to 800 keV (@ 50 % absorption)**
- Detection area: Ø 44 mm (Ø 1.45 inch)
- Typical voltage 700 V
- Magnetic shielding: Mu-metal



Application

- **Spectroscopy with high resolution**

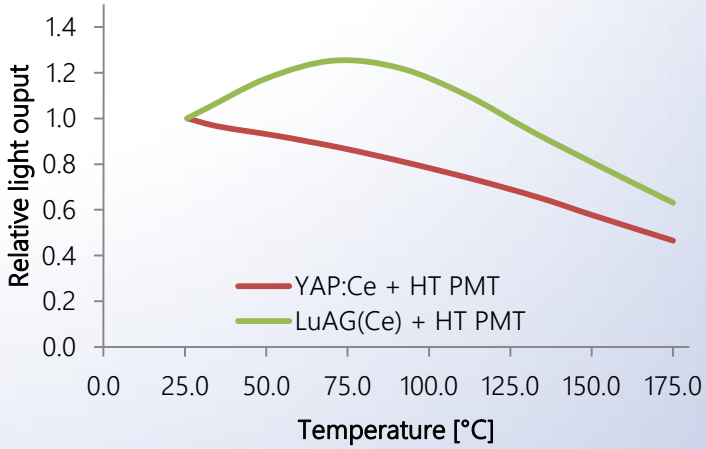
X-ray detector for HT

Features

- High temperature resistivity **up to 175 ° C**
- Ruggedized detector for **harsh operating conditions**
- **Fast** response
- All parts of the unit adapted for HT

Application

- Densitometry at high temperatures
- Geology
- Level gauges



Single photon counting

"Ionizing radiation and neutron imaging has never been easier"

CRYPIX

Art, Archeology
Biological research
Forensic science, Geology
Particle physics
NDT

RASPIX

First alarm radiation monitor

RasPIX

Key features

- Precise radiation monitoring (2D)
- Stand-alone data acquisition
- Real-time data analysis
- Easy-to-use
- LAN or Wi-Fi connectivity
- Online web interface
- Implemented battery

Typical application

- First alarm radiation monitor

RasPIX	
Sensor	Silicon
Pixel size	55 x 55 µm
Image resolution	256 x 256 pixels
Sensitive detection area	14.1 x 14.1 mm
Frame rate	15 / 2 fps
PC Interface	LAN/Ethernet
Software	Included

Note: RasPIX is not a certified dosimetric device. Radiation protection of people cannot be based on its measurements

RasPIX

Motivation

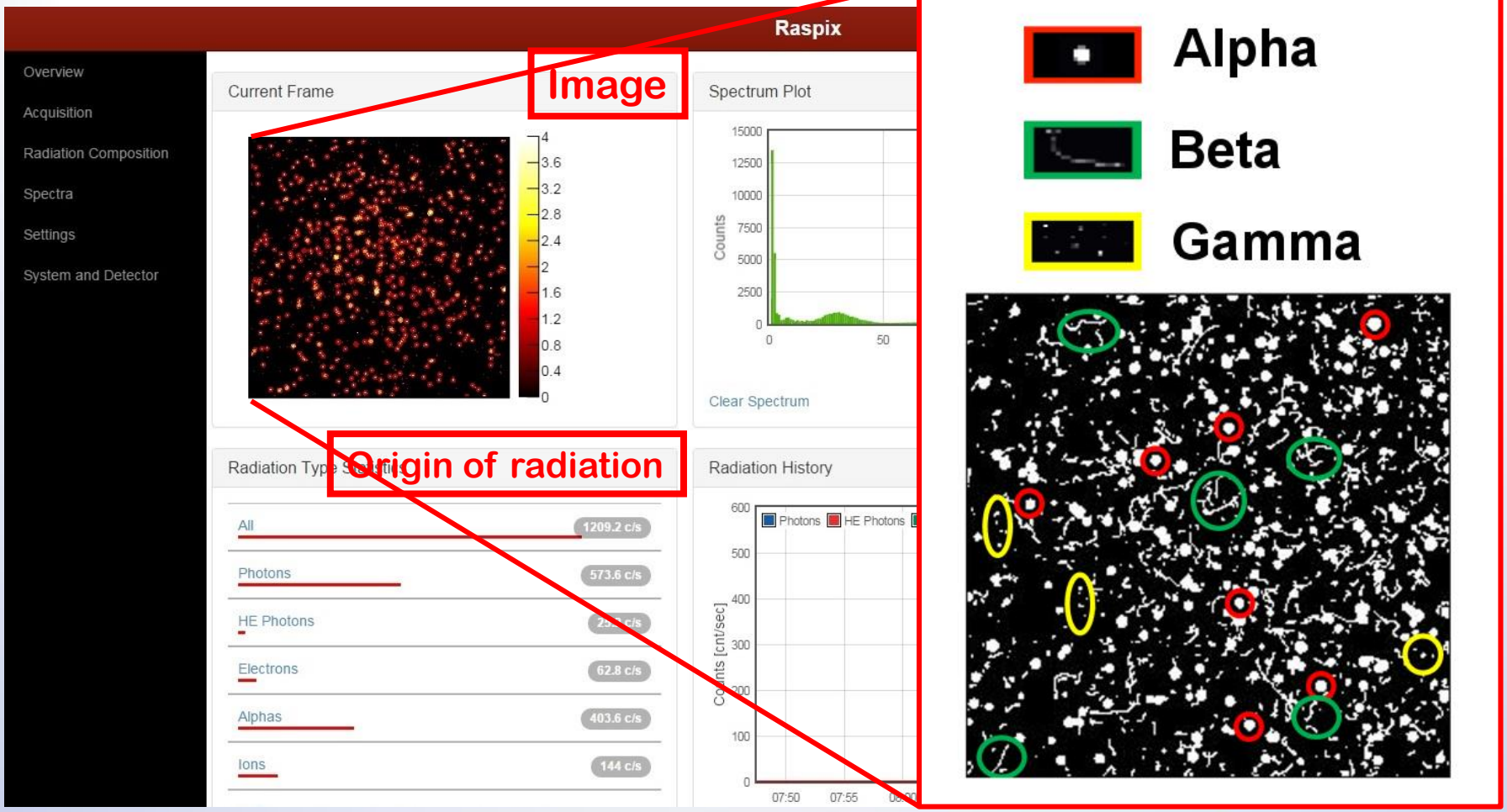
- Radiation monitoring is crucial in different industries
- Can we also see and distinguish between particles (2D detection)?

Main Requirements:

- Real-time monitoring
- Radiation recognition
- Count/Dose information
- Reliable operation 24/7
- Fast data access
- Compact Stand-alone version
- User friendly

Warning notice

RasPIX – application



CRYPIX system

Key features

- **Single particle counting in large area**
  - **14 x 14 mm (256 x 256 pixels)**
  - **14 x 70 mm (1280 x 256 pixels)**
- High contrast (unlimited dynamic range)
- **Silicon** or **CdTe** sensors
- Modular system (optional)
- X-ray, Alpha, Beta, Gamma detection, neutron (optional)

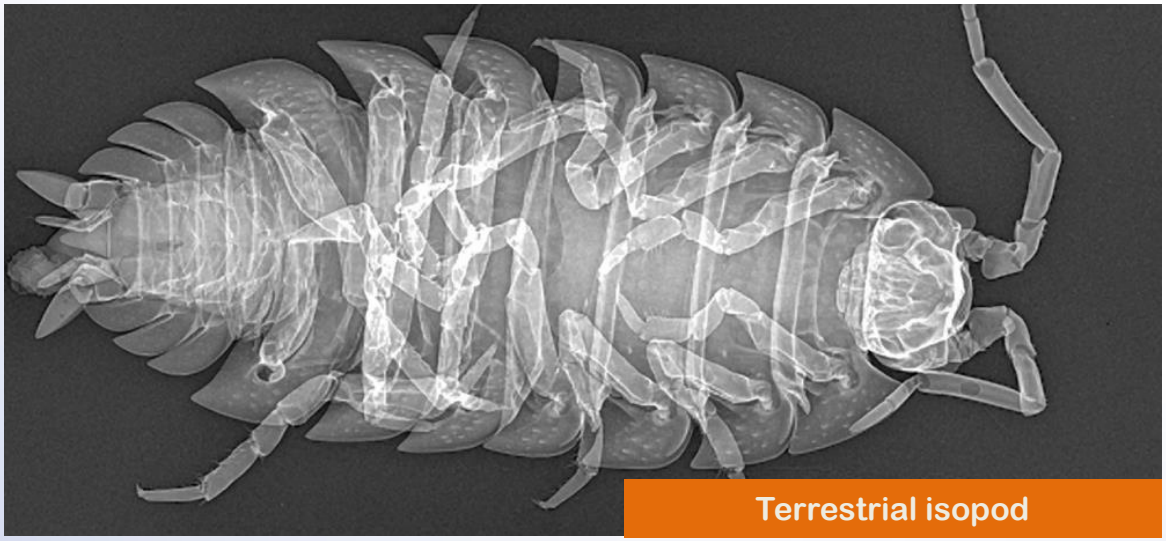
Typical applications

- Art, Archeology
- Biological research
- Forensic science, Geology
- Particle physics
- Non-destructive testing

Biological research

X-ray radiography

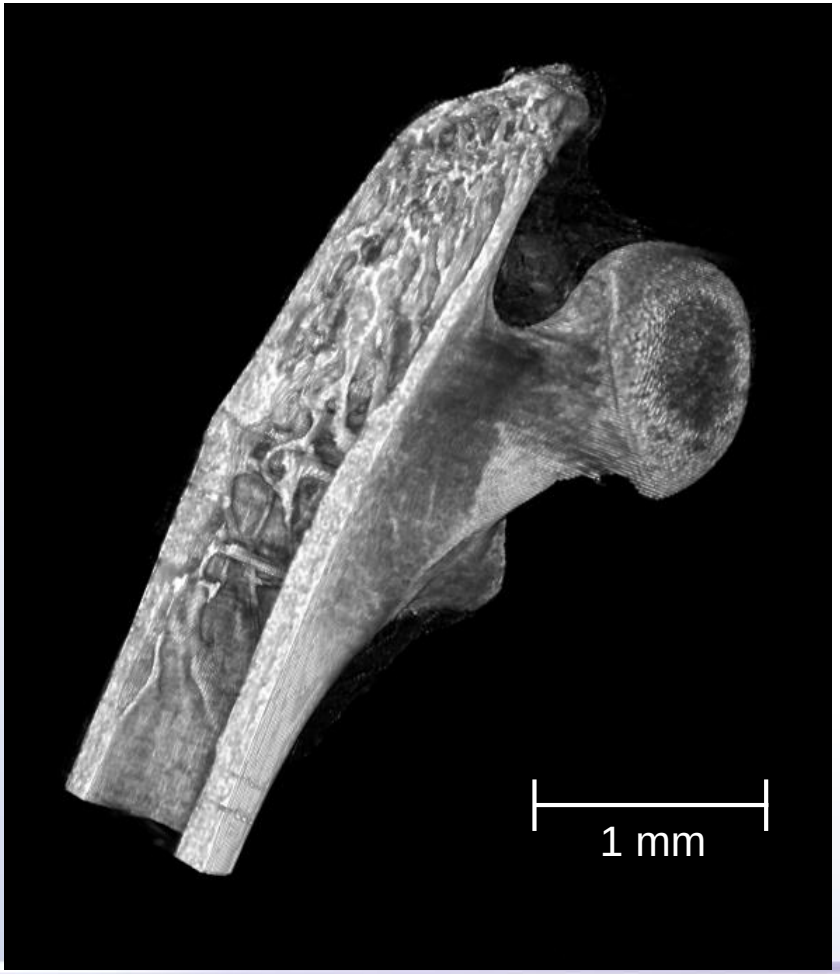
- **Live video: 1000 frames (20 ms each)**
- **Real-time video, 50 fps**

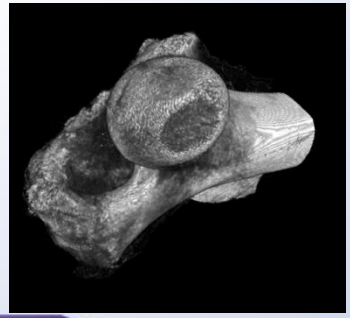


Terrestrial isopod

Biological research

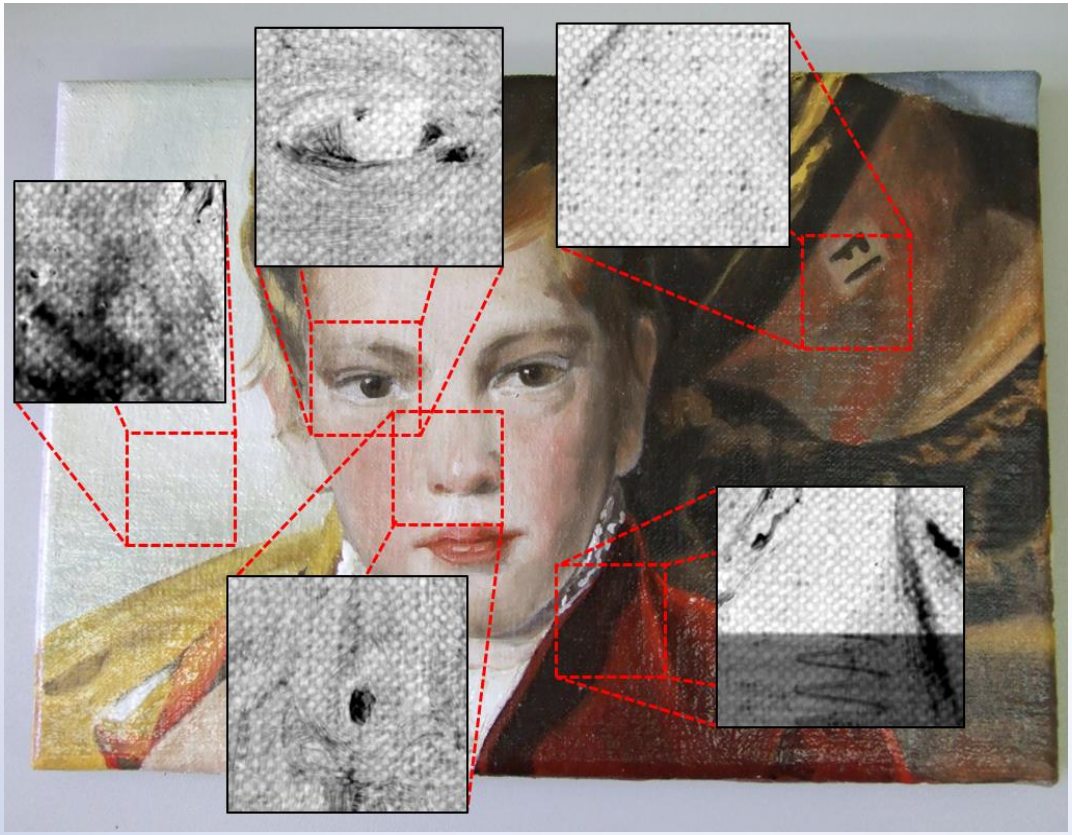
High resolution X-ray tomography



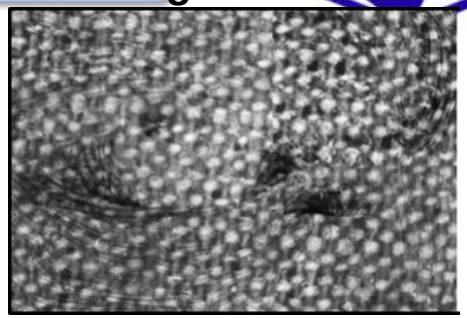


Art, Archeology

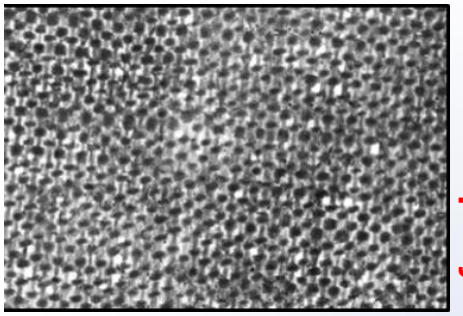
Multi energy X-ray radiography



Full image

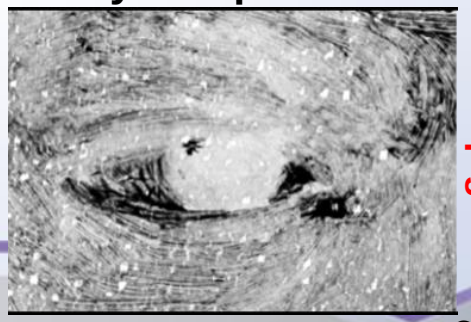


Light component



Canvas + putty

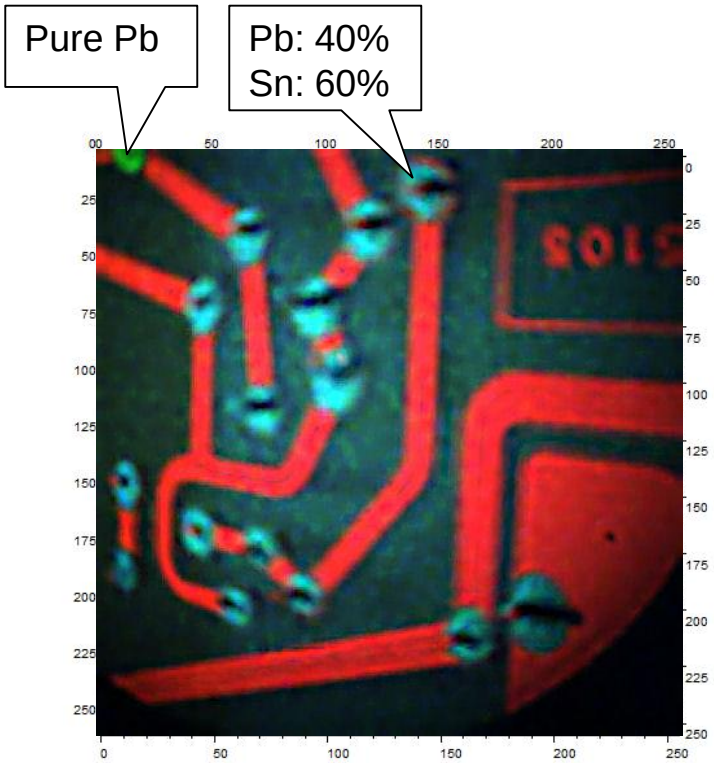
Heavy component



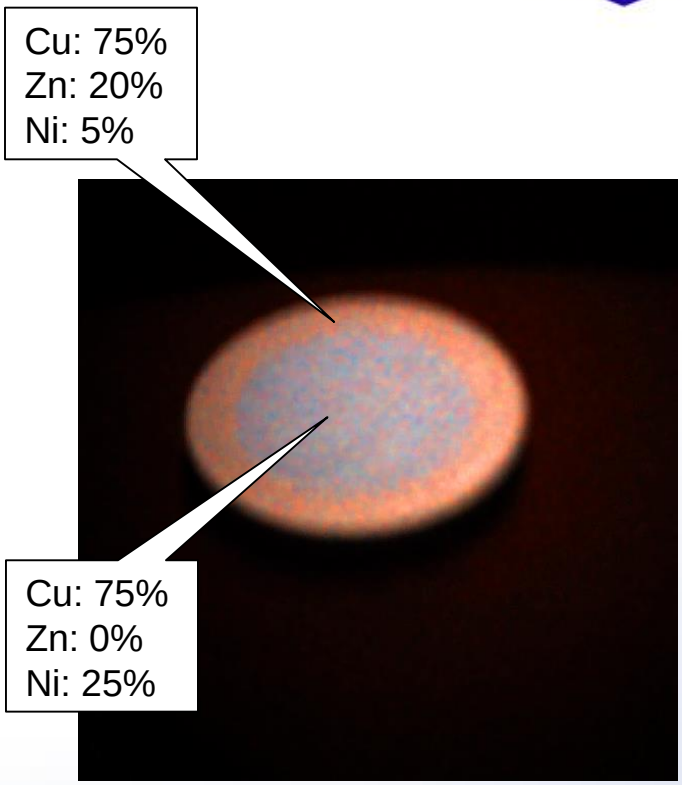
Mineral pigments

Non-destructive composition investigation

X-ray fluorescence



Color coding:
Cu = Red, **Pb** = Green, **Sn** = Blue



Color coding:
Zn content in pink

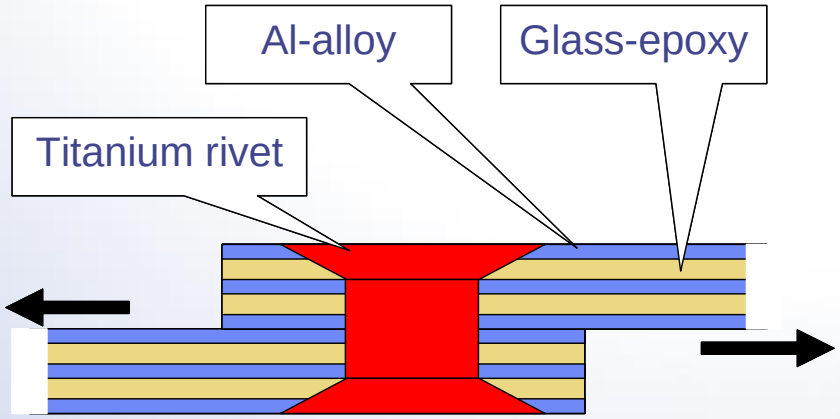
Non-destructive testing

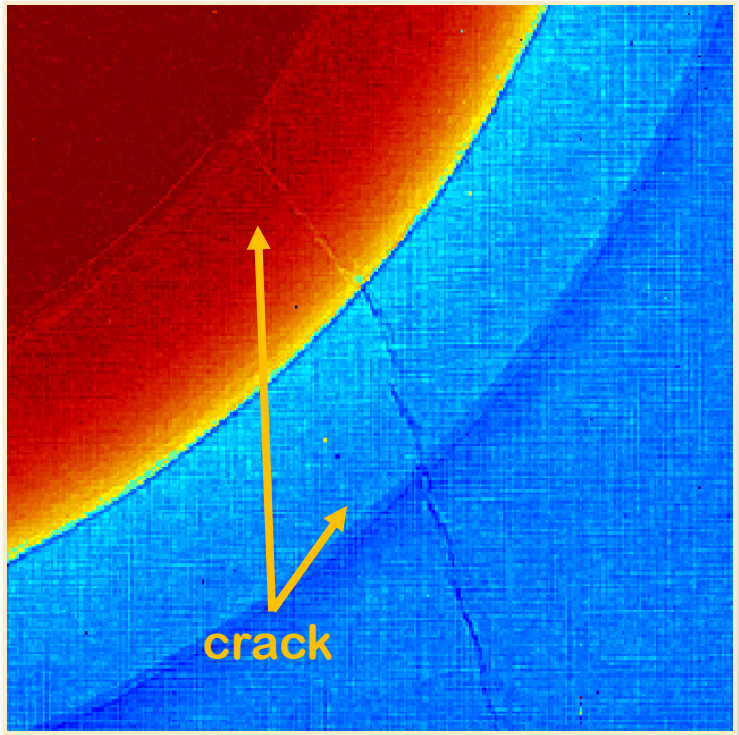
X-ray defectoscopy

crytur

Inspection of fatigue internal crack in multilayer composites

- Crack shielded by rivet head
- Optical observation is impossible
- **High dynamic range => crack visible (virtually unlimited)**

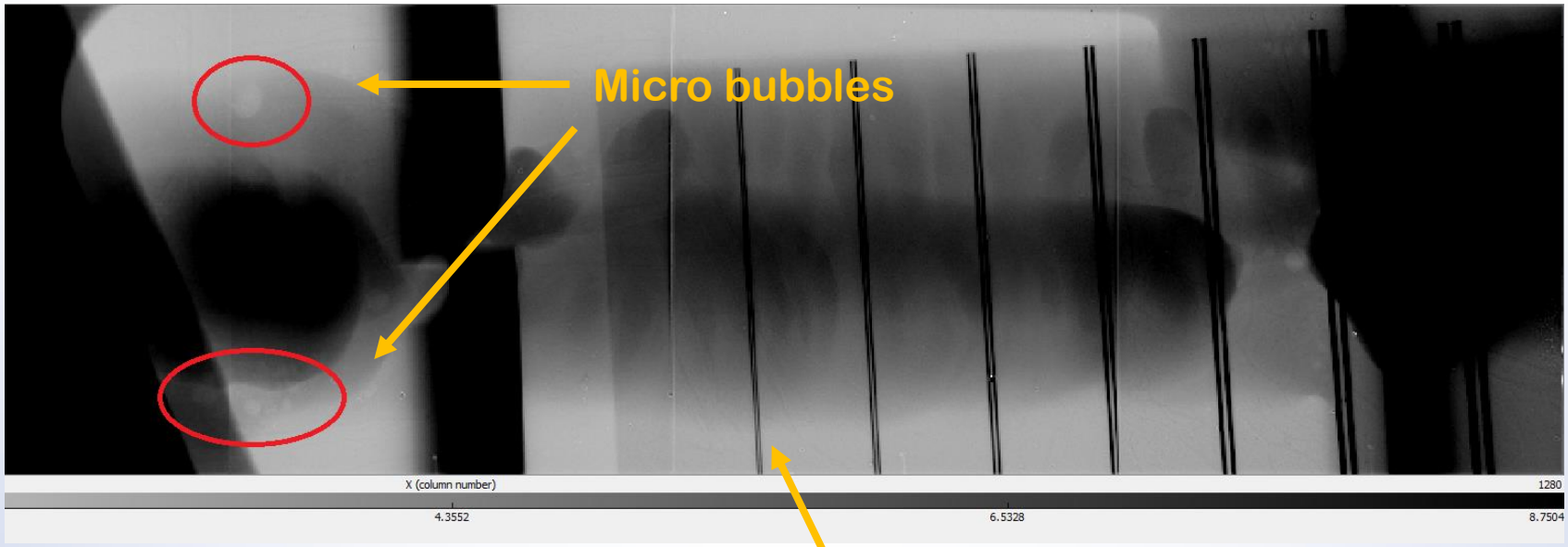




Non-destructive testing

X-ray defectoscopy

- **Aluminium profile welding quality check**



Resolution

- Duplex IQI, 13D clearly resolved

Summary

- Reliable partner in **scintillation crystals** and **integrated solution**
- **Niche application with single crystals, crystal growth and precise technologies**
- **Long-term collaboration** with international institutes
- **New opportunities welcome**

Staff

Absolventi MFF UK v CRYTUR

- **11** absolventů
- **5** ve vedoucích funkcích hlavních vývojových oddělení
- **1** specialista obchodu
- **5** vývojáři

- Hledáme další schopné členy týmu

Thank you for your attention!

Contacts:

CRYTUR, spol. s r.o.
Palackeho 175
511 01 Turnov
Czech Republic

crytur@crytur.cz

Jan Touš
Head of Scintillation Detectors Dpt.

tous@crytur.cz