Detector developments at ESRF

M. Ruat on behalf on the Detector Unit and the Instrumentation Services and Development Division

APS 3-Way Meeting, Detector Workshop, July 31st 2013

A light for science ESRF

Outline

The Detector Unit at ESRF

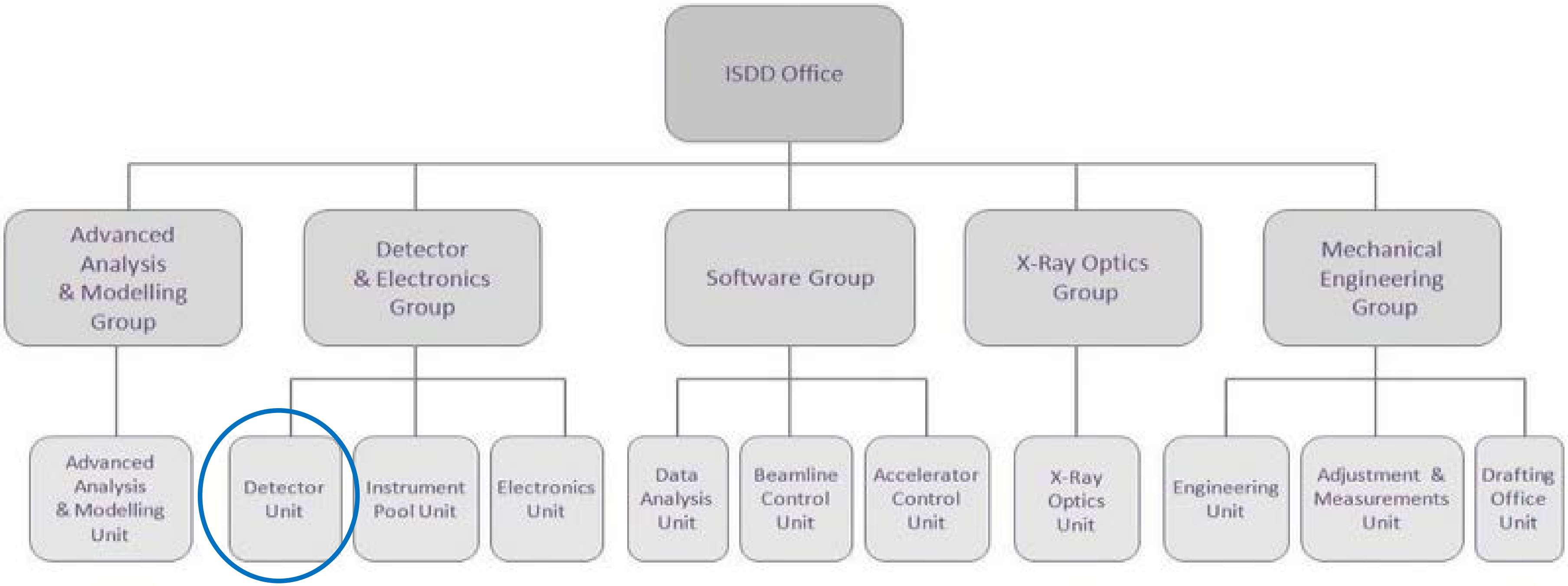
Overview of current developments

Beamlines Upgrade program (UPBL)

Warning : this is a non exhaustive and subjective presentation….

The Detector Unit at ESRF

The Detector Unit is part of **the Instrument Services and Developments Division (ISDD)**



The Detector Unit at ESRF

The Detector Unit is composed of :
- 9 Engineers
- 7 Technicians (Detector Technical Support Team (DTST))
- 1 visiting engineer from ALBA
- 1 PhD student
- 1 Administrative assistant

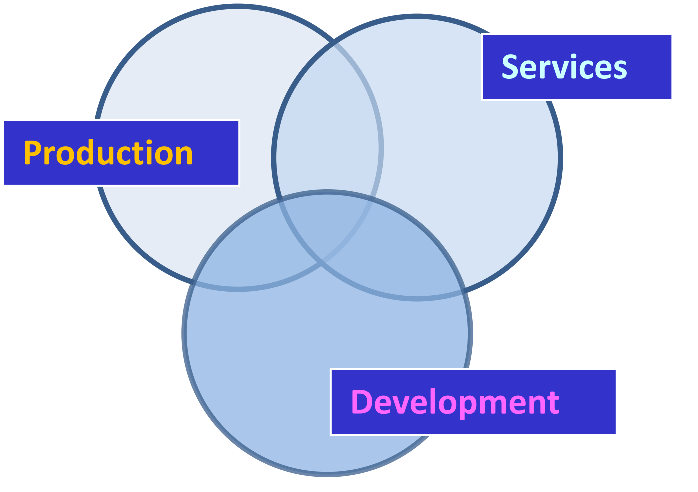
Spread into 5 laboratories

A balanced combination of:

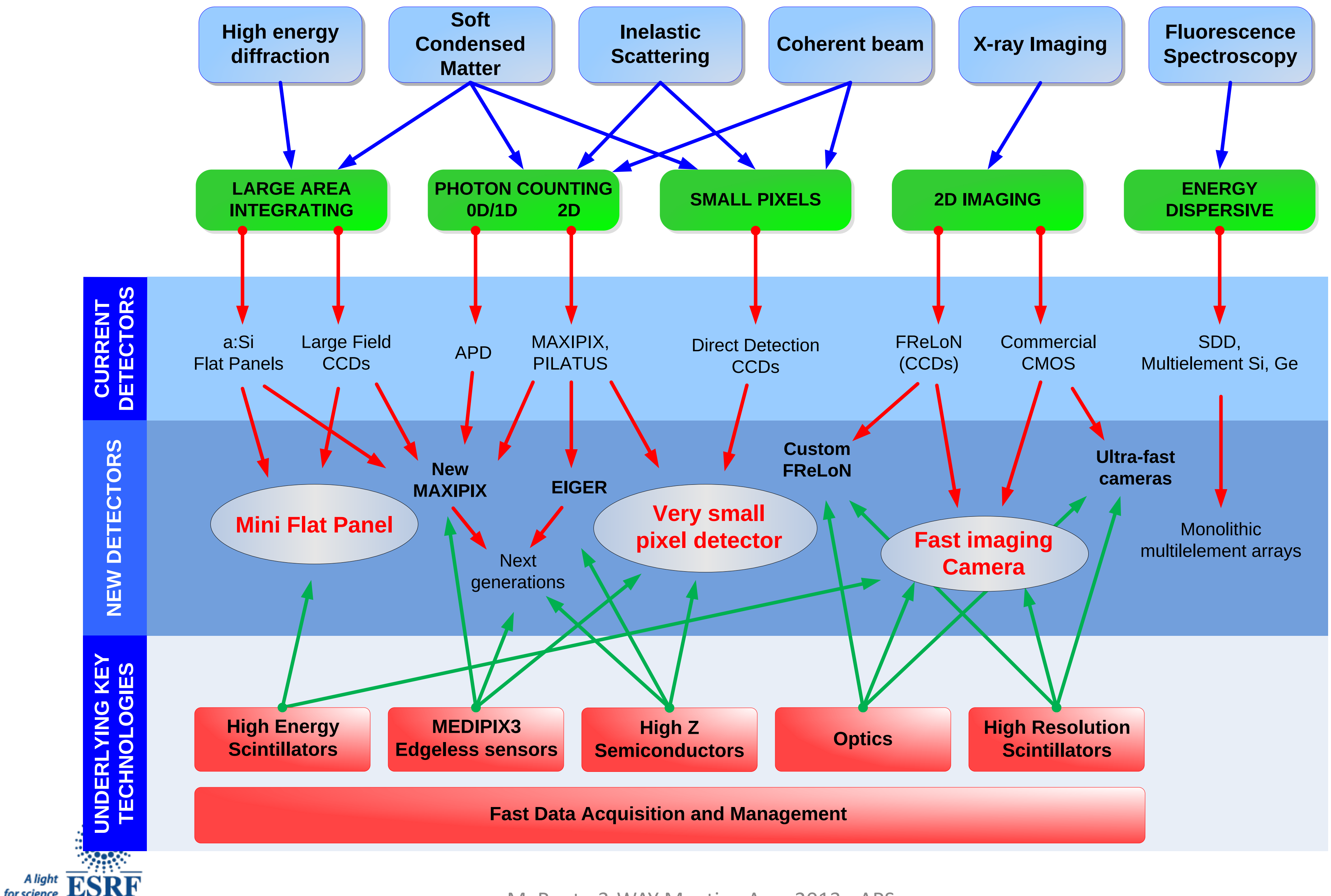
- Services:
Advice, test, commissioning, loan, BL operation, administrative support (CFT, RFQ, EU project, …)

- Instrument development:
Detectors and control electronics

-**Production**
Mainly of in-house developments

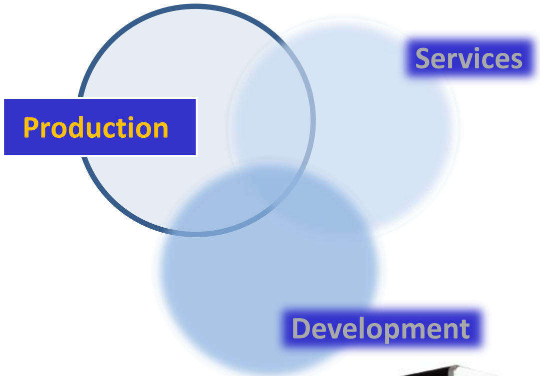


Detectors @ ESRF: overall picture and foreseen evolution



The Detector Unit at ESRF

PRODUCTION



Regular **production of devices** (figures for 2012):

- Maxipix (4 systems delivered)
- FReLoN (3 cameras delivered)
- High resolution scintillators / SCF (~60 crystals produced)
- Electronic modules (MoCo, BCDU8, …)
- A large number of customized I/O Boxes (WAGO)
- Beamviewers (focus on micro & nano beams, white beam)

Contract for the **manufacturing of 2560 IcePAP axes** (over 3 years)

Sales of equipment to external labs:

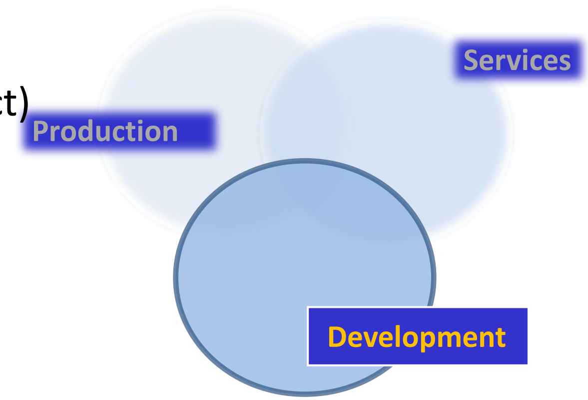
- ✓ 2×2 Maxipix system (Soleil)
- ✓ 3 Monochromator controllers, MoCo (ALBA)
- ✓ 22 SCF scintillator crystals (Diamond, BNL, Australian Synchrotron, LBNL, Cornell, Max Plank, Carnegie Mellon, Korea, Bruker)

→ Production and R&D scintillator programme affected by an **accident in the LPE lab**

The Detector Unit at ESRF

DEVELOPMENTS : Examples of Know-How and associated projects

- **Beam diagnostics**
    - New Beamviewers (Diamond) & UPBLs
- **OD photon counting (APD, scintillator + PMT + fast electronic)**
    - ✓ XNAP Project
- **Hybrid pixel detector (MAXIPIX)**
    - ✓ Medipix 3 & SMARTPIX
    - ✓ Edgeless Si sensors
    - ✓ High-Z semiconductor sensors (HIZPAD^2 project)
    - ✓ PEEC (PSI-ESRF Eiger collaboration)
    - ✓ UPBLs
- **X-ray Imaging (scintillator/phosphor, optical coupling)**
    - ✓ Large field optical coupling
    - ✓ UPBLs
- **CCD camera (FRELON)**
    - ✓ UPBLs
- **Spectroscopy**
- **Flat panel**



Outline

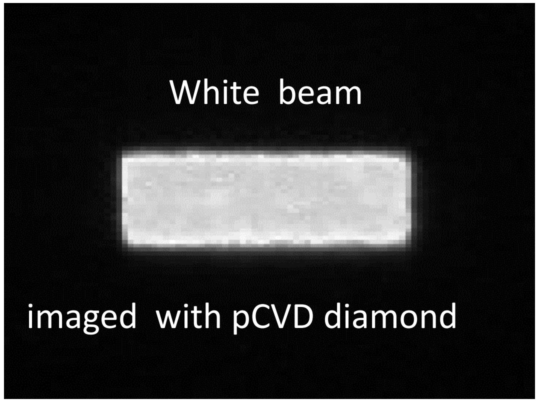
The Detector Unit at ESRF

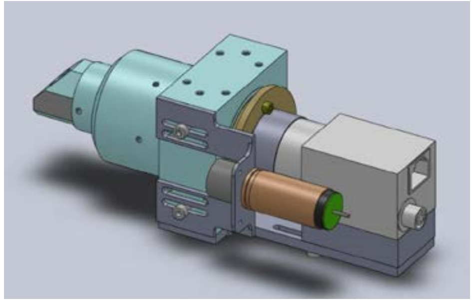
Overview of current developments

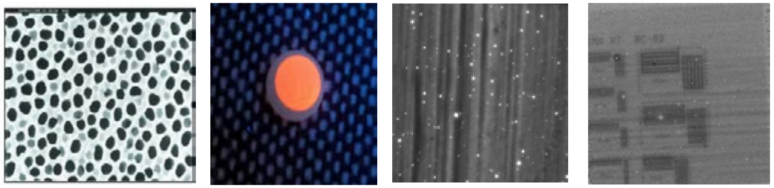
Beamlines Upgrade program (UPBLs)

Current developments: Beam diagnostic

- **White/pink beam Viewer**
  - pneumatic actuator
  - Cooled
  - pCVD diamond sensor or YAG:Ce
  - Intensity monitor
  - 20 µm pixel size
- **Monochromatic beam viewer**
  - pneumatic or stepper actuator
  - YAG:Ce screen
  - Intensity monitor
  - Accessory : diode for calibration
- **Focus beam viewer**
  - Compact, low cost
  - Standard Model: 0.8x , 1x, 2x magnification
  - under development : 4x mag., 0.9 µm pixel, 3 µm resolution
- **Semi-transparent screen**
  - 450nm thick Lu_2O_3:Eu on Al_2O_3
  - 8% absorption @15keV
  - 1s expo @ 10^{11}ph/s/mm^2
  - σ=80nm on position



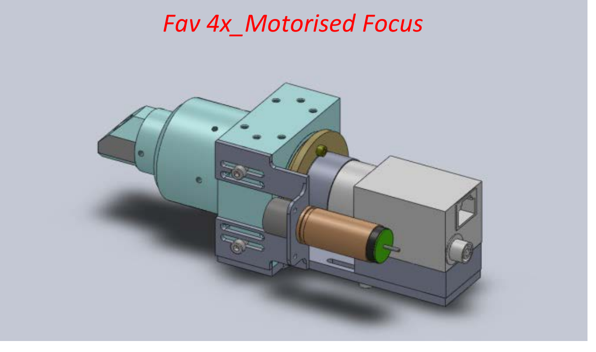


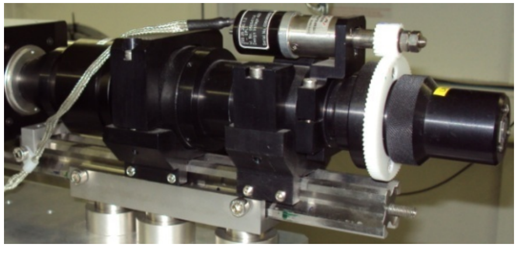


90 cameras are currently running for X-ray diagnostic

Current developments: Beam diagnostic

Focused Beam Viewer





1x version: 3.75 µm pixel size, 10 µm resolution
1280 x 960 pixels, 30 fps, 10bit DR
In 2x2 binning → VGA 50fps

2x version: 1.9 µm pixel size, 6 µm resolution
1280 x 960 pixels, 30fps, 10bit DR
In 2x2 binning → VGA 50fps

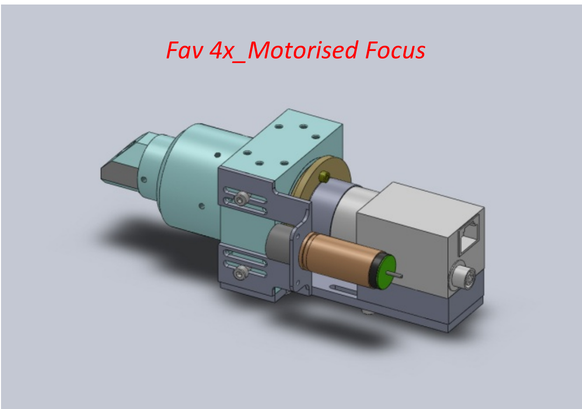
Recently characterized:
4x version: 0.9 µm pixel size, 3 µm resolution
1280 x 960 pixels, 30 fps, 10bit DR
In 2x2 binning → VGA 50 fps

10x – 80x: sub-micrometer resolution
Scientific grade camera, 5-20µm thick scintillator

Current developments: Beam diagnostic

4x magnification focused Beam Viewer: first characterization results

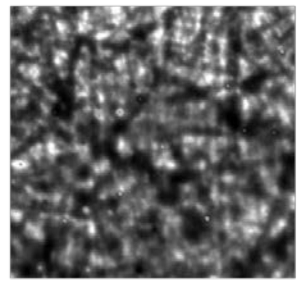
A new design



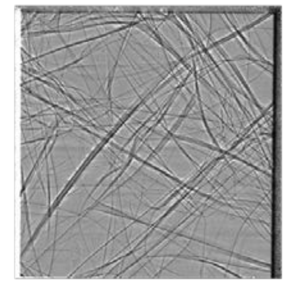
- A 90 degrees folded head with mirror
- Integration into a small, light body
- Need of motorized focus
- Radiation-hard design
- 3µm spatial resolution and 0.93µm pixel size
- Robustness and reliability under evaluation

Imaging capabilities

(1): Unfocused Image

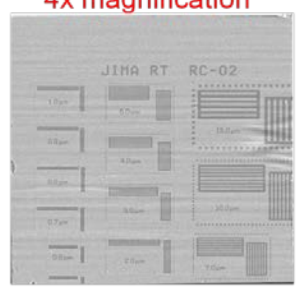


(2): Focus Image of foam



(3):YAG 250µm

4x magnification



(4): YAG 50µm

4x magnification

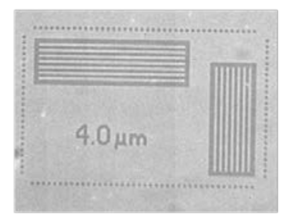
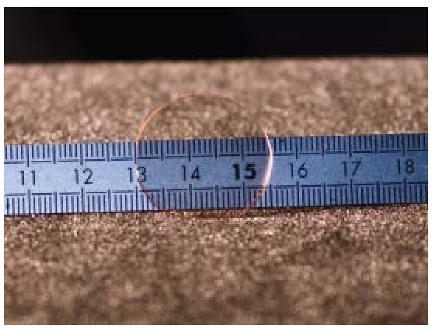


Figure 7: X-ray transmission images of a foam (1) and (2) at 15KeV X-ray energy and recorded with the basler camera coupled to different scintillators. The need of motorized focus was evaluated with real images and x-ray patterns

C. Cruz de la Torre, T. Martin, D. Pothin, IWORID 2013

Current developments: Converter screens



Scintillators

- **LPE status**
  - PbO contamination (August 2012)
  - Decontamination/ neutralization of acid (Sept 2012-Dec2012)
  - Test of all equipment (Jan-Feb. 2013)
  - Design of a new PbO extraction system with Safety and TID (Feb-March 2013)
  - Refurbishment of lab, mainly furnace room (April-May 2013)
  - Restart lab (June - July 2013)
  - Production: GGG:Tb , GGG:Eu, large LSO:Tb for UPBL4

- Developments:
  - **Fast garnet scintillator**: LuAG:Ce ,GGG:Ce,Cr (P.A. Douissard)
  - **High-stopping power material**: LuAP:Tb (F. Riva)
  - **Large format phosphor and structured screen**
  - **Ceramics scintillator:** GLO:Eu (40µm thick)
  - **Structured scintillator:** scintillating fiberoptic plate

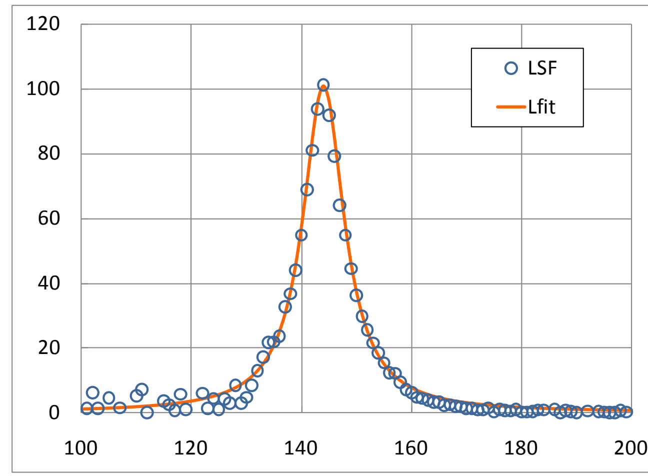
Current developments: Converter screens

New Phosphor screens

- **Application** : any optically coupled (lens or fibre) 2D detector with ≥ 40 mm entrance field.

- **Custom development on ESRF specs :**

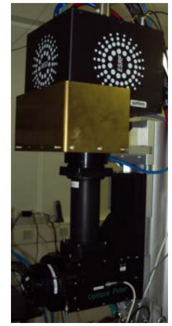
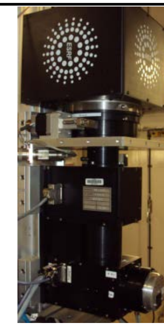
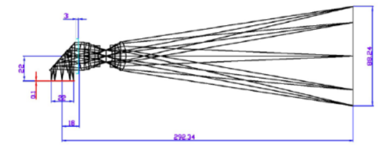
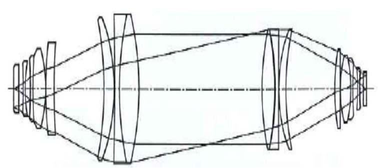
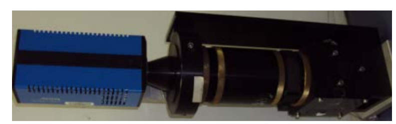
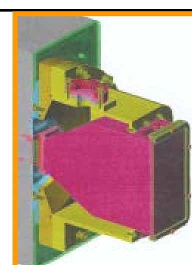
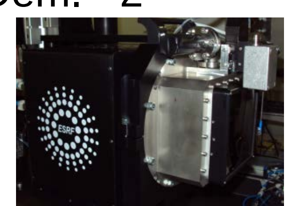
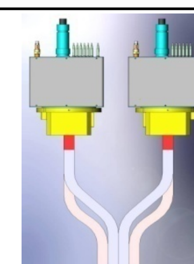
P43 phosphor ($Gd_2O_2S:Tb$), mean grain size 2.5 µm
Active thickness from 10 µm to 50 µm
Any area up to 200 x 270 mm^2



30 µm thick screen
measured LSF FWHM = 30.8 µm

:-) Cost-effective, high light yield, quick implementation
:-(Burnishing under high flux

Current developments: Front-End Optics

Pixel size	2003	2011	Future
100-500nm Very high resolution Refractive microscope	1 mag. 1 scint. 	 	High Definition 16Mpixels 
1-3μm High resolution Reflective microscope	Com. Ealing 	Custom optic 	Custom optic for enhancement of imaging contrast and speed in UV-blue band
5-30μm Medium resolution Tandem lens			Custom optic for large field of view. Dispersive EXAFS UPBL11(TEXAS)
20-50μm Low resolution Fiber optic input	Dem. = 3.6 	Dem.= 2 	FAN 

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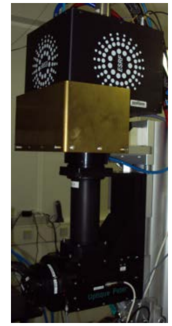
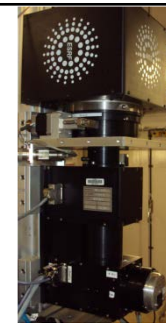
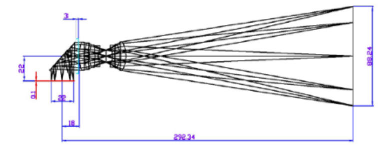
100-500nm Very high resolution Refractive microscope	1 mag. 1 scint. 	 	High Definition 16Mpixels 
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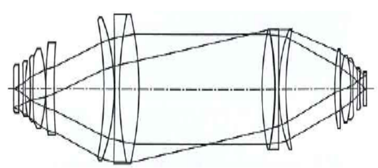
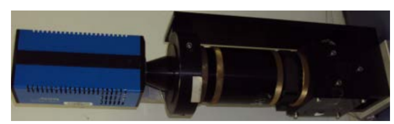
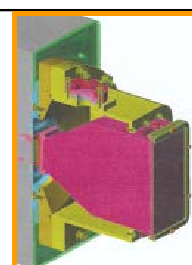
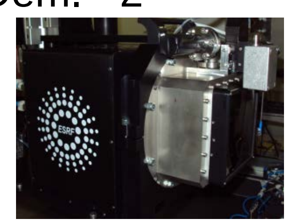
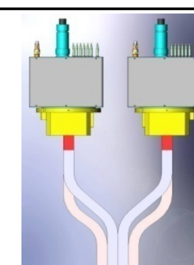
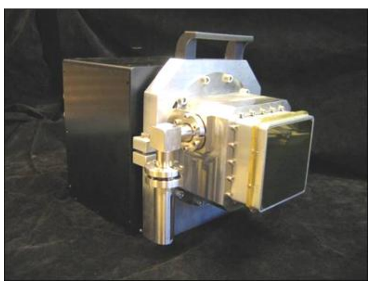
5-30μm Medium resolution Tandem lens			**Custom optic for large field of view.** Dispersive EXAFS UPBL11(TEXAS)
20-50μm Low resolution Fiber optic input	Dem. = 3.6 	Dem.= 2 	**FAN** 

100 mm Large-field detector for ID17/ID19

Request :

- High energy tomography for medical and paleontology applications
- 100 x 20 mm^2 field
- 30 - **150+** keV energy range

→ Possible reuse of custom F300 mm lens
New mechanical design



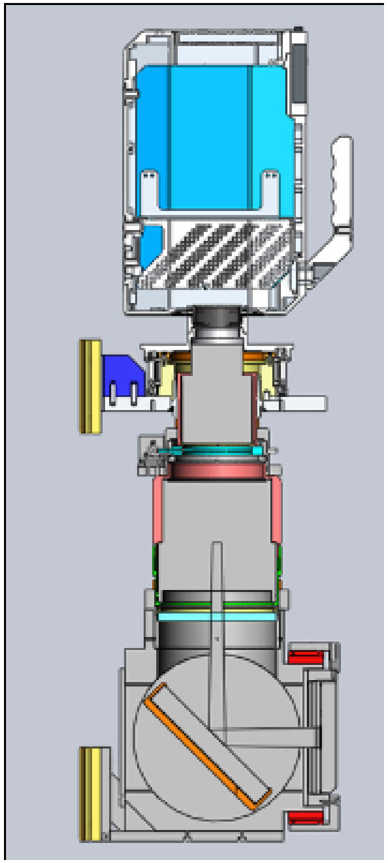
Current system : FReLoN CCD/fiberoptic taper

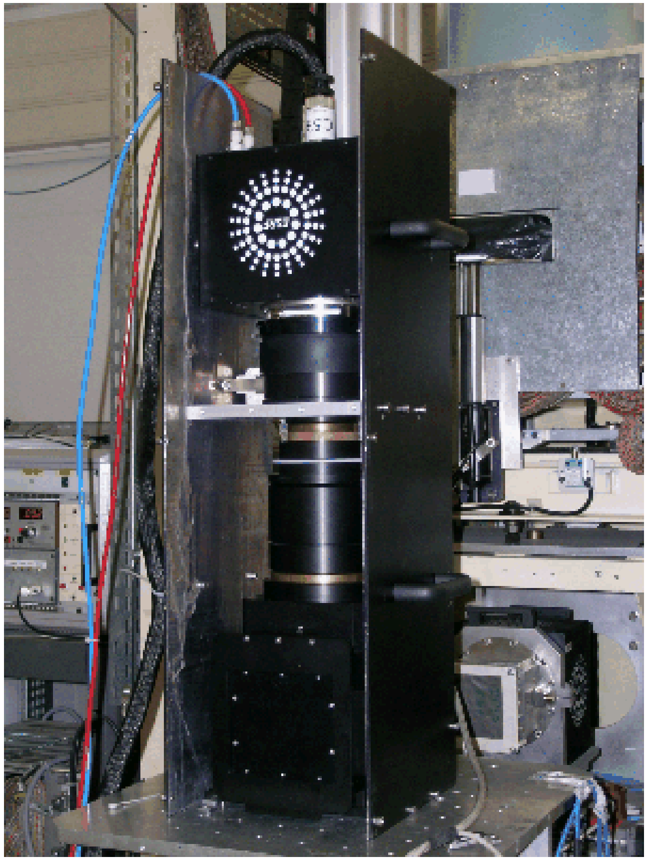
Rapid taper burnish in pink beam
Low absorption efficiency at high energy
Geometrical distortions

→ **Proposal : lens-based optical front-end**

Current developments: Front-End Optics

Layout





Pixel row alignment (FReLoN rotation)

Motorized iris

Motorized focusing

Lead glass protecting window

Lead shield housing

High absorption fiberoptic scintillator

Pixel size	49 µm
FOV	100x20 mm^2 up to **100x100** possible
QE @ 100 keV	**> 99%**
Frame rate	40 fps

Mechanical design : Christophe Jarnias (Det.Unit)

Applications : X-ray imaging, X-ray diffraction (> 30 keV)

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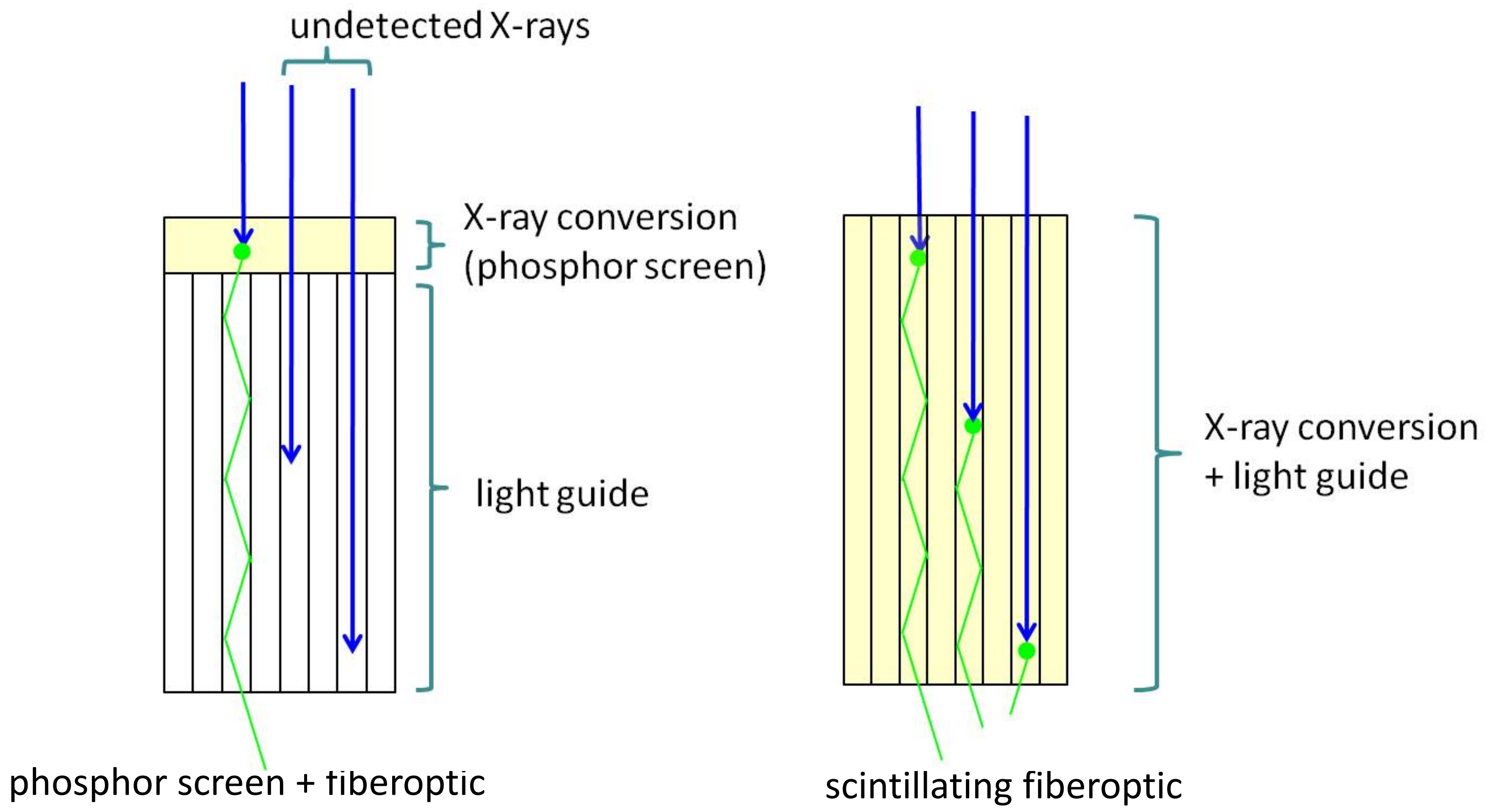
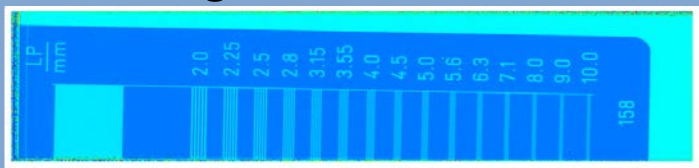
Scintillating fiberoptic plate

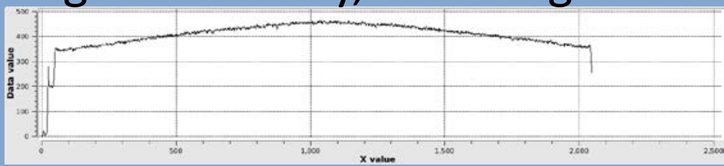


100 mm Large-field detector : First results (1)

High resolution



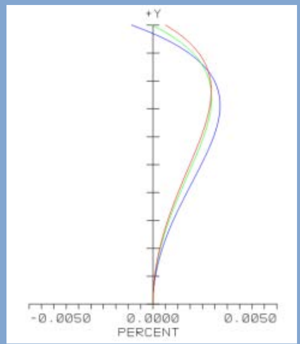
High uniformity, low image noise



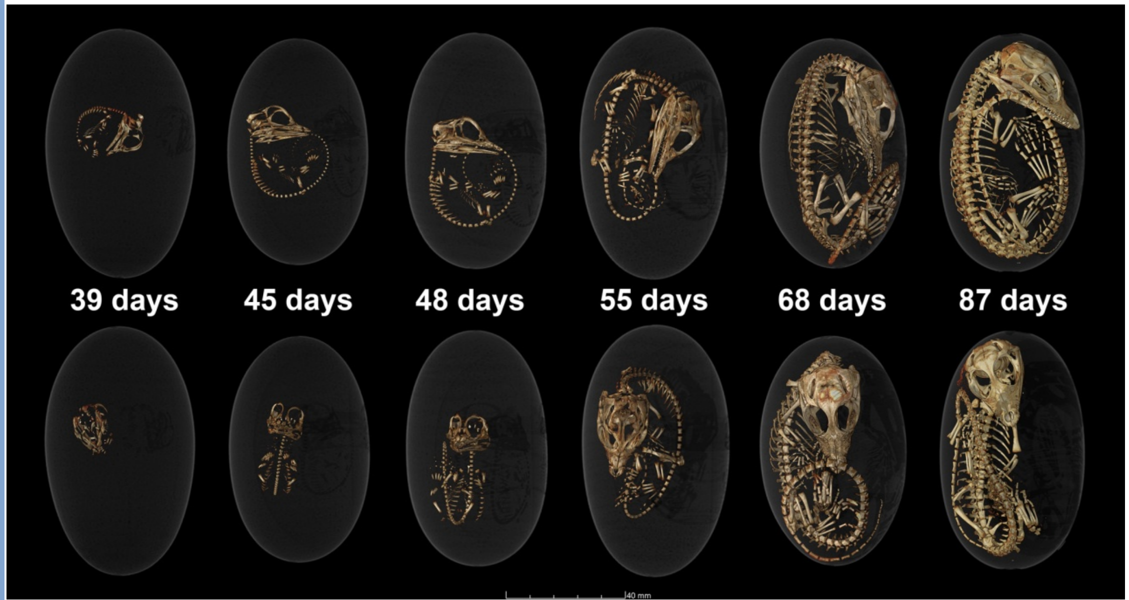
High efficiency at high energy

12.5 mm high-Z scintillator thickness

Low distortion



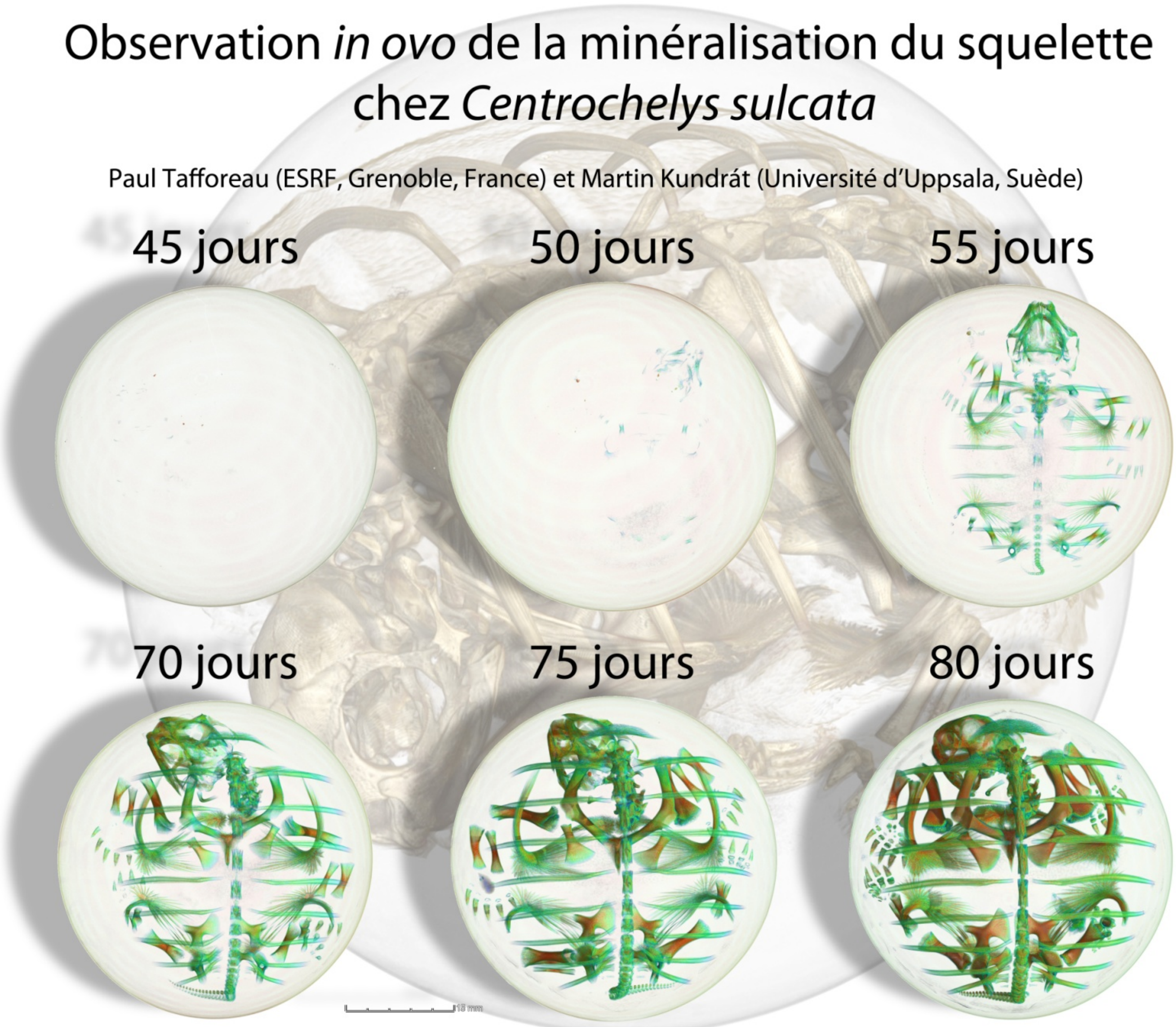
High image quality...



In-vivo crocodile embryo development
Courtesy of P. Tafforeau, ID19

Current developments: Front-End Optics

100 mm Large-field detector : First results (2)



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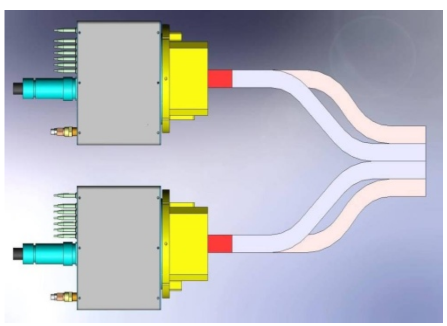
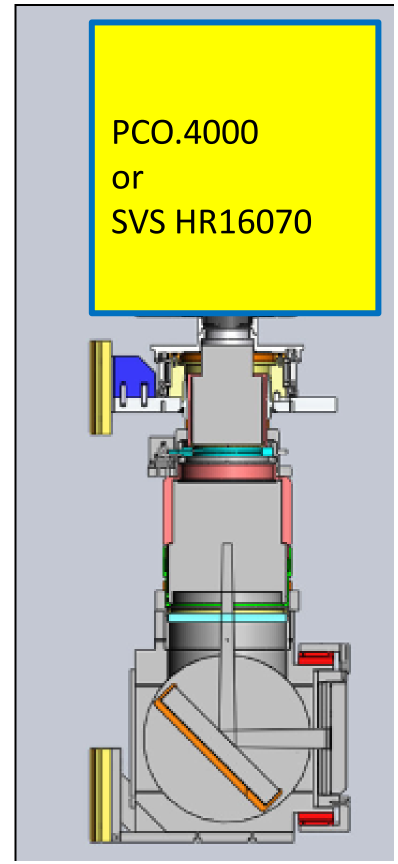
Future: 150mm Large field, LAFIP (PALEONTOLOGY)

- **Large field fan taper optic** to replace the FReLoN-2k taper optics
- Radiation hardness, better resolution, no mechanical shutter
- First proposal: 2-3 Frelon cameras with FAN (1:1)
- Second proposal: RayoniX camera with FAN (1:1)
- Third proposal: 2 Frelon cameras with FAN (1:1)
- Fourth proposal: High resolution camera with lens optical
  - Custom lens f=400mm
  - 24x36mm^2 chip size
  - Input size: 150mm width





Status:
Specifications for CFT (lens) on-going

C. Ponchut, O. Hignette, T. Martin, H. Requardt, P. Tafforeau, A. Bravin

The MAXIPIX Detector and its evolution

TECHNOLOGY	CURRENT	FUTURE
SOFT X-RAYS LARGE FIELD OF VIEW NEEDED	Si sensors TIMEPIX chip	- Edgeless Si sensors - Medipix 3 & SMARTPIX
HARD X-rays		High-Z semiconductor sensors (HIZPAD^2 project)

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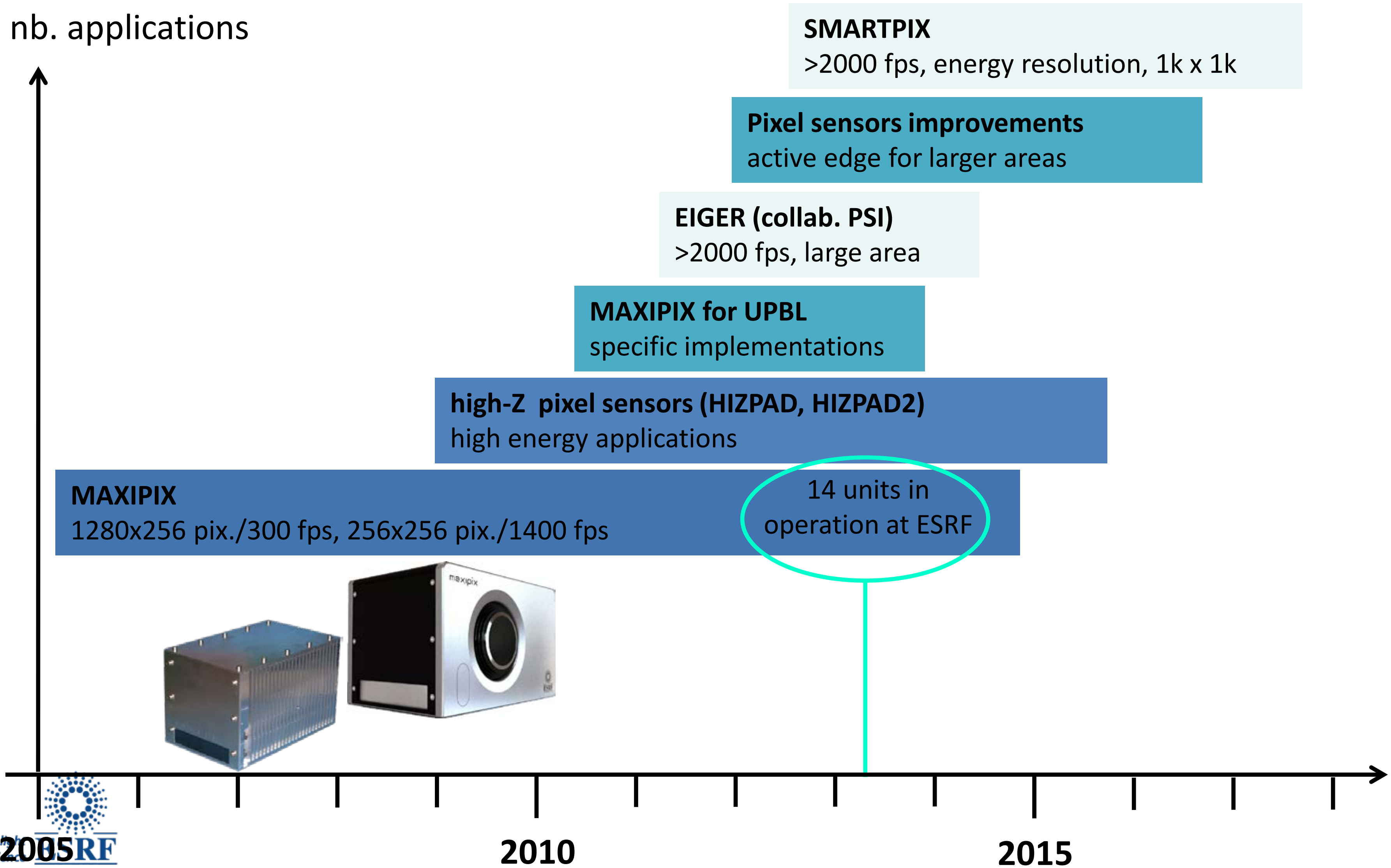
Current developments: Hybrid Pixel Detectors

Development "roadmap"

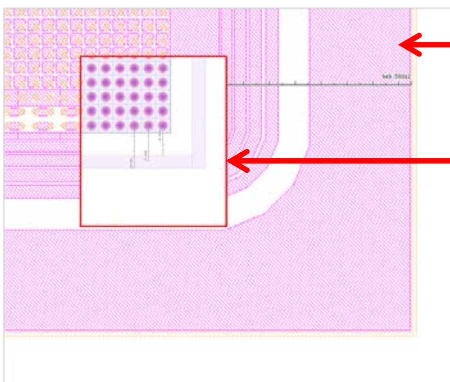


ESRF

Si Edgeless detectors (1)

ESRF participation in multipartner project managed by VTT research centre of Finland (2012)

- Goal : side buttable sensors on 4 sides.
- => **nearly seamless large areas can be built.**



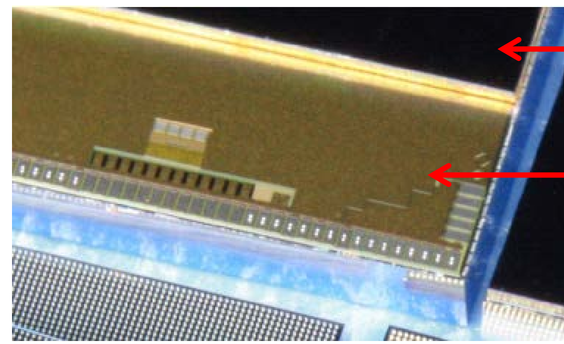


image courtesy of VTT

- Edge leakage current is controlled by sensor edge processing.
- Enables reduction or elimination of guard rings.

Ongoing : characterizations of active edge sensor samples at ESRF

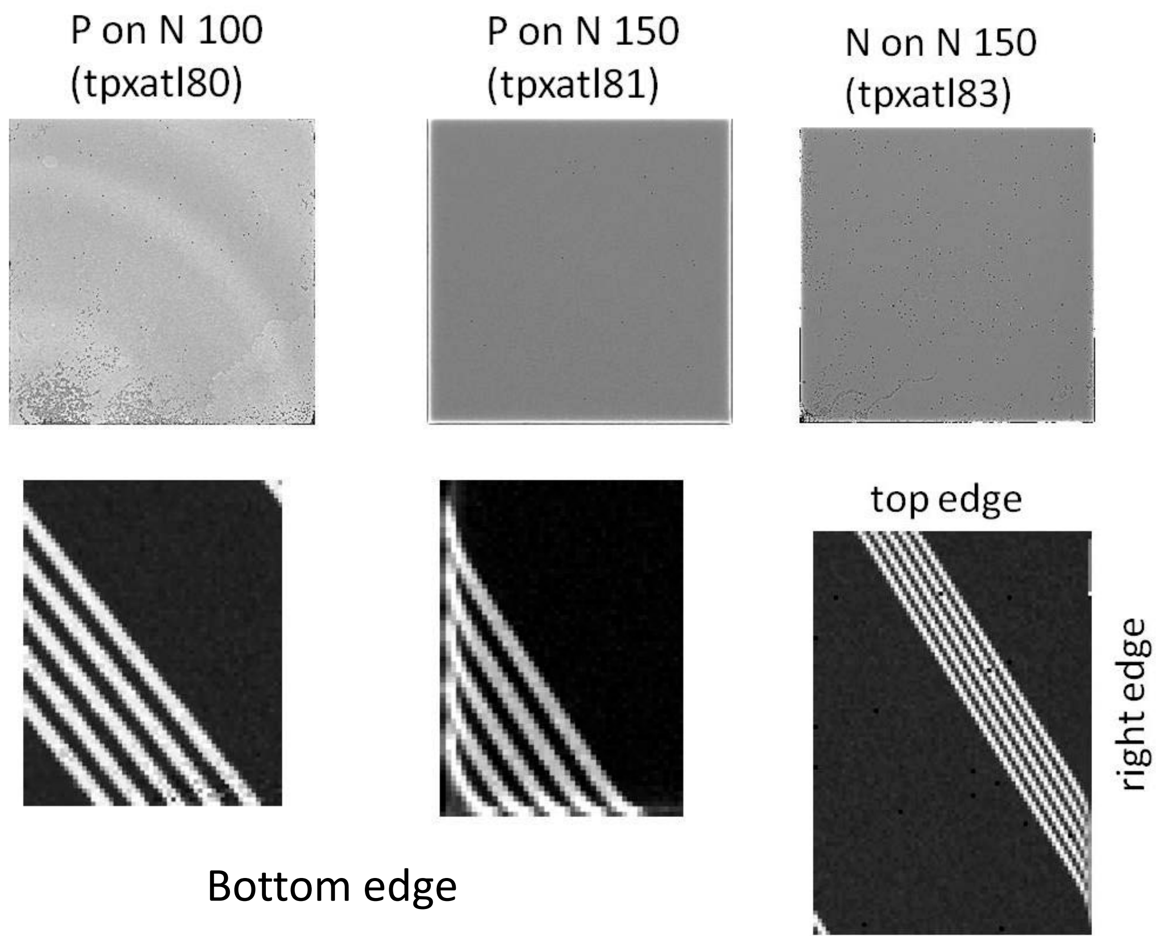
Si Edgeless detectors (1)

Various doping schemes & gaps to physical edge

Assemblies mounted on 2-side edgeless ESRF chipboards with Maxipix RO

Flat-fields and edge distortions:

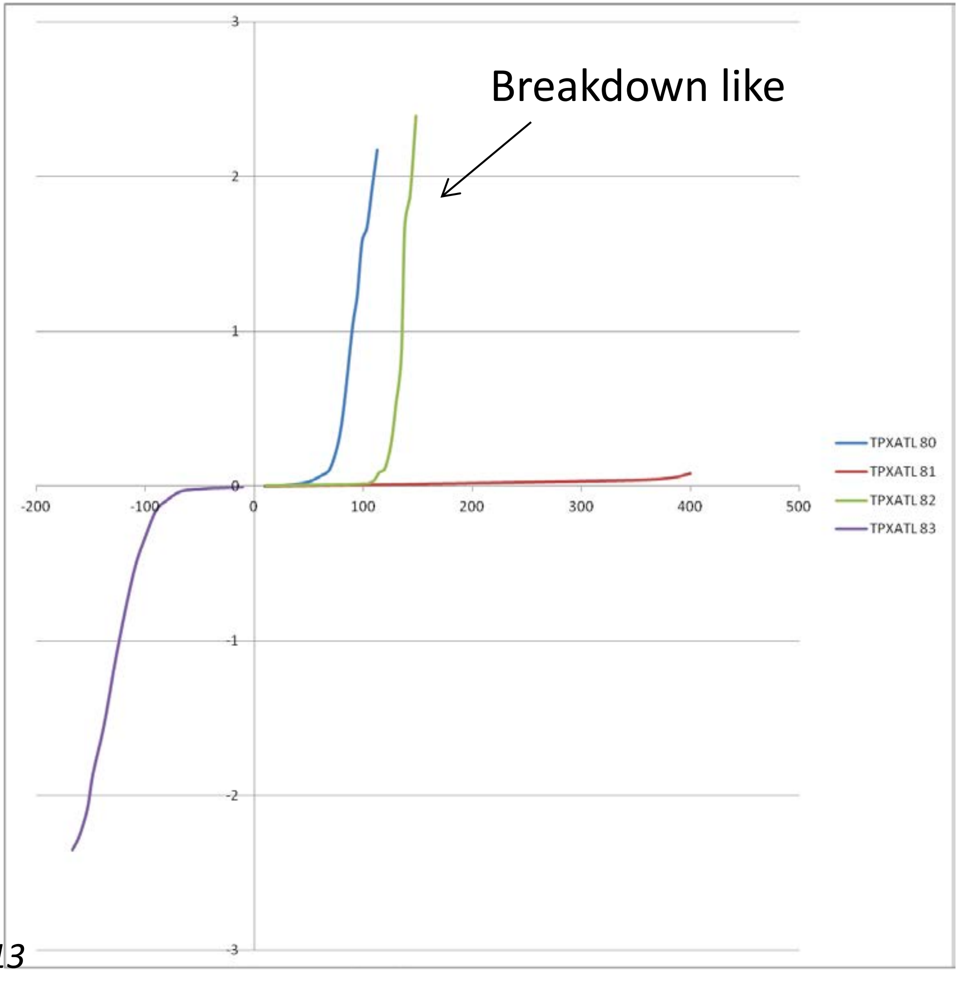
17.4 keV (Mo X-ray tube + Zr filter)



C. Ponchut, IWORID 2013

Si Edgeless detectors (2)

I(V)



(P on N 500 um thick)
(P on N 500 um thick)
(P on N 500 um thick)
(N on N 300 um thick)

C. Ponchut, IWORID 2013

Large variations in leakage currents + breakdown like behavior

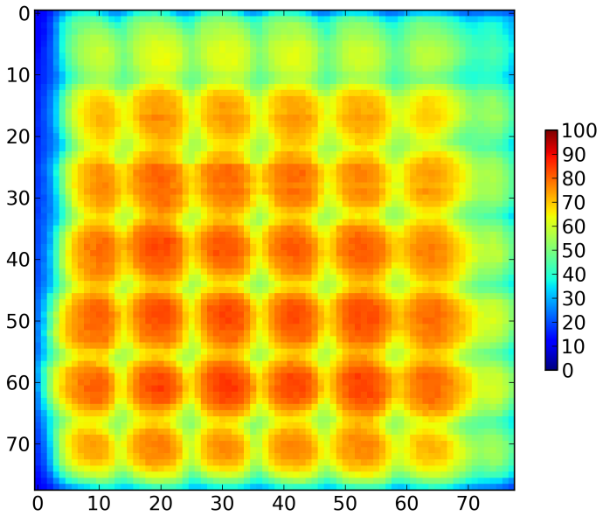
Si Edgeless detectors (3)

MESH SCANS

BM05, 10 keV, threshold = 7 keV, 5 µm steps

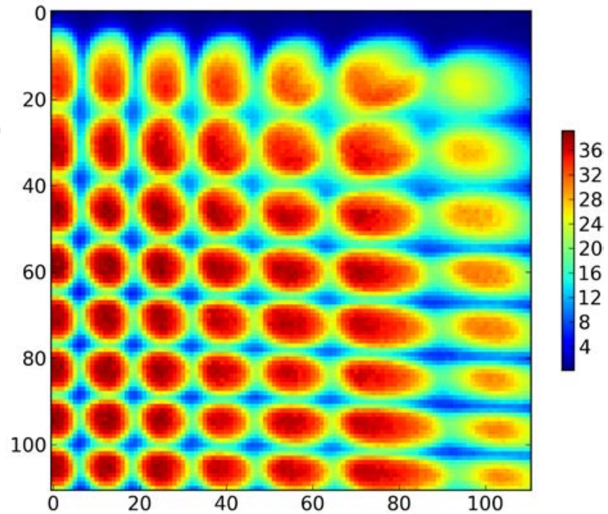
5x5 µm theoretical beam spot size with refractive lenses; < 5 µm with Kb mirrors.

Refractive lenses , normalized to ring current



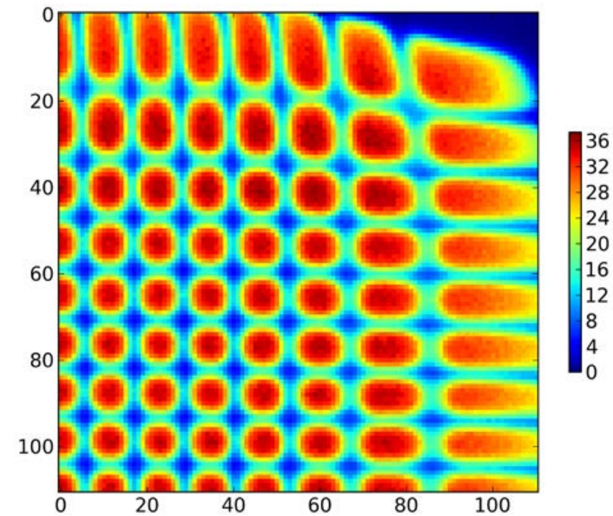
P on N 100 (tpxatl80),
top left corner
No distorsion

Kb mirrors, normalized to ring current



P on N 150 (tpxatl81),
Top right corner
Stretched edge pixels

Kb mirrors, normalized to ring current



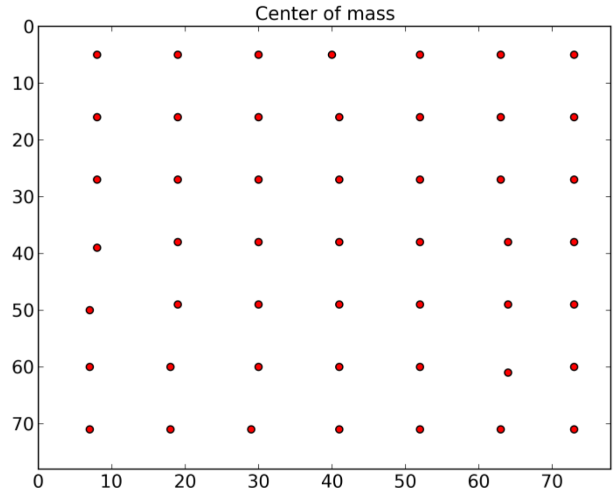
N on N 150 (tpxatl83),
Top right corner
Stretched edge pixels

C. Ponchut, IWORID 2013

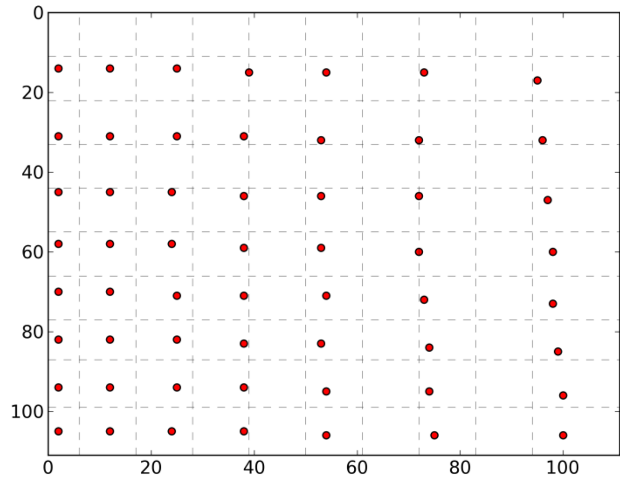
Si Edgeless detectors (4)

MESH SCANS

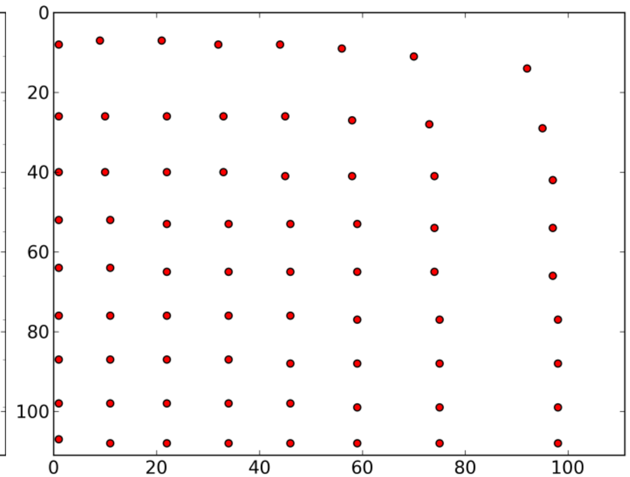
Corner pixels - measured centers of mass



P on N 100 (tpxatl80),
top left corner
No distorsion



P on N 150 (tpxatl81),
Top right corner
Stretched edge pixels



N on N 150 (tpxatl83),
Top right corner
Stretched edge pixels

C. Ponchut, IWORID 2013

Si Edgeless detectors (5)

First conclusions

- Compared polarities P on N (500 µm), N on N (300 µm)
- Compared edge structures 100, 150, G2-100
- Best edge behaviour : P on N type 100, but incomplete CCE
- Edge 100 seems better than edge 150 (less distortion)
- Correlation between low leakage current and higher edge distortions ?
- Variability of image quality, leakage currents => process stability issue ?
- **Active edge sensors with virtually no edge distortion can be produced.**

Medipix 3 and SMARTPIX Project

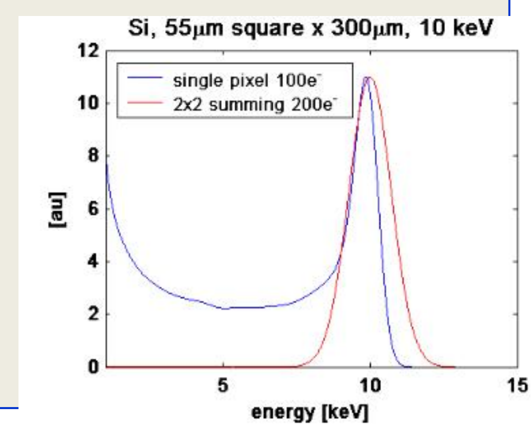
Integration of Medipix3:

Medipix3 chip = Medipix2 +

- Analog charge summing mode (charge sharing correction)
- Continuous read-write (no dead time)
- Configurable pixel counters 1,6,12,or 24 bits
- 1 to 8 thresholds/pixel
- Frame rates up to 6 kHz with 6 bit counters
- Compatible with 4-side stitching
- Same geometry as Medipix2 : 256x256, 55x55 μm^2 pixels

- Readout electronics (NIMAD) are under test
- Small modules to be characterized
- Long-term development for large area detectors

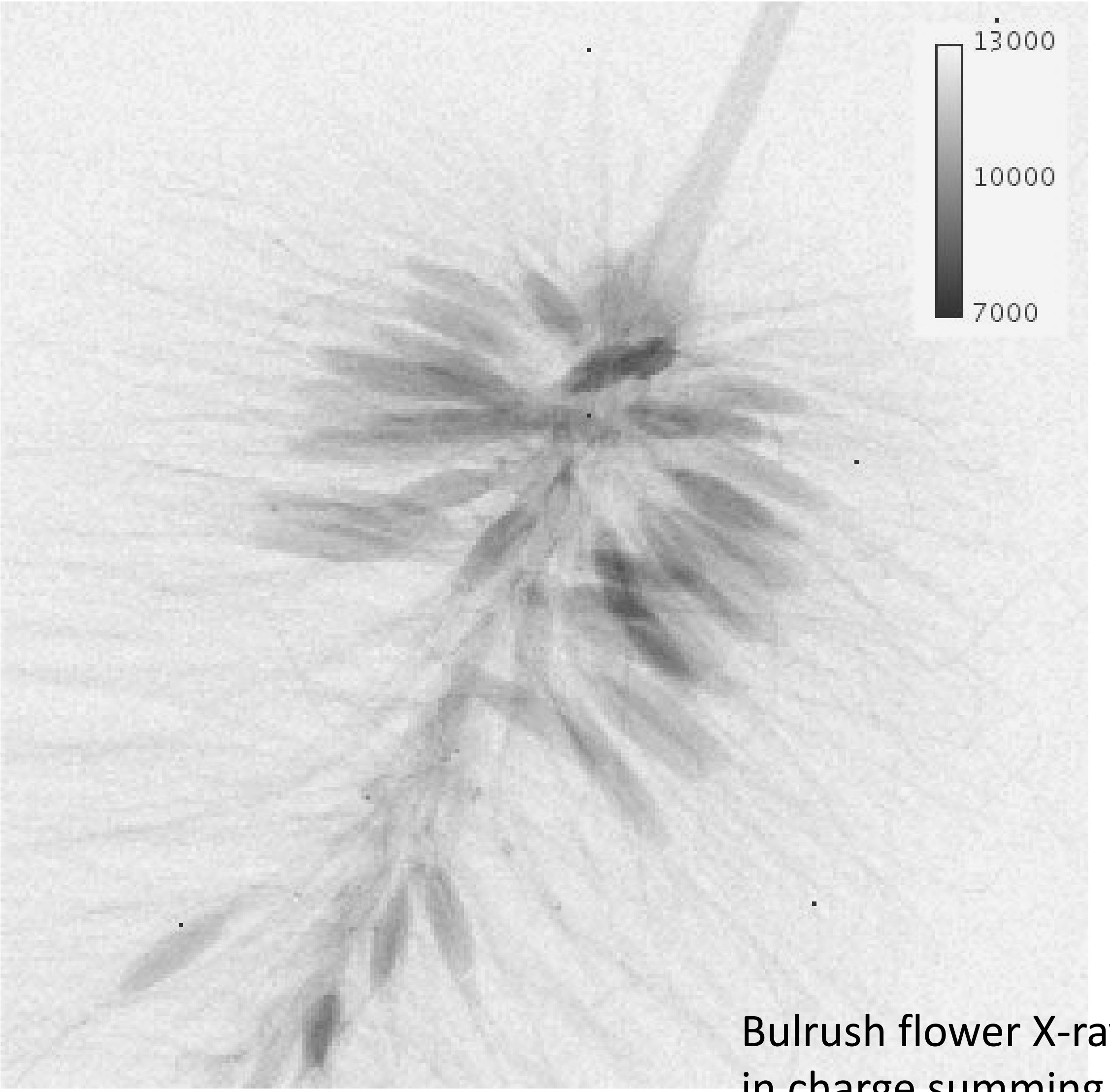
  → SMARTPIX



Courtesy L.Tlustos, CERN

Current developments: Hybrid Pixel Detectors

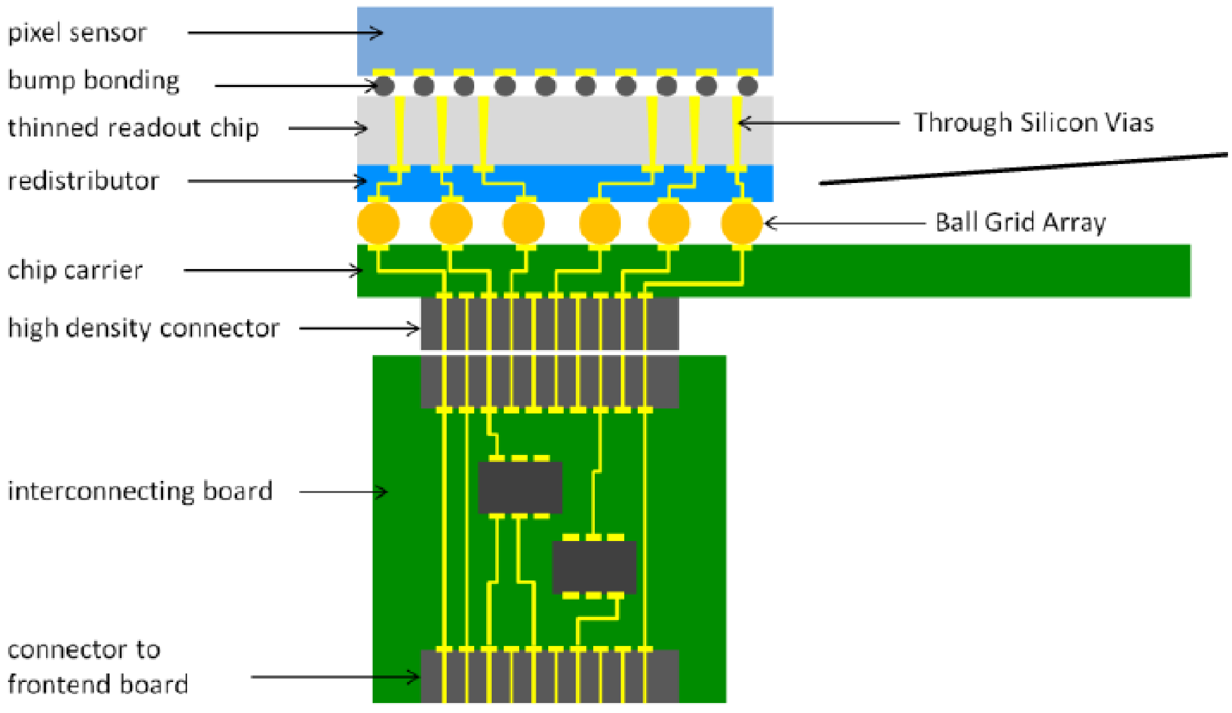
Medipix 3 and SMARTPIX Project



Bulrush flower X-ray image collected in charge summing mode

Medipix 3 and SMARTPIX Project

SMARTPIX is based on the use of Through silicon Vias (TSVs) for the Medipix 3 chip output

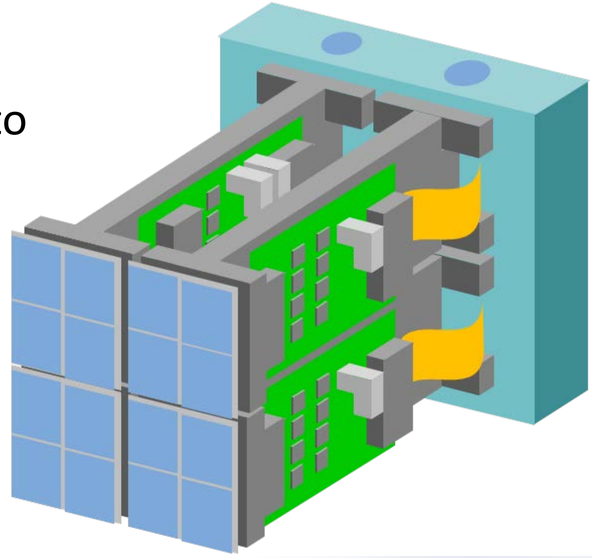


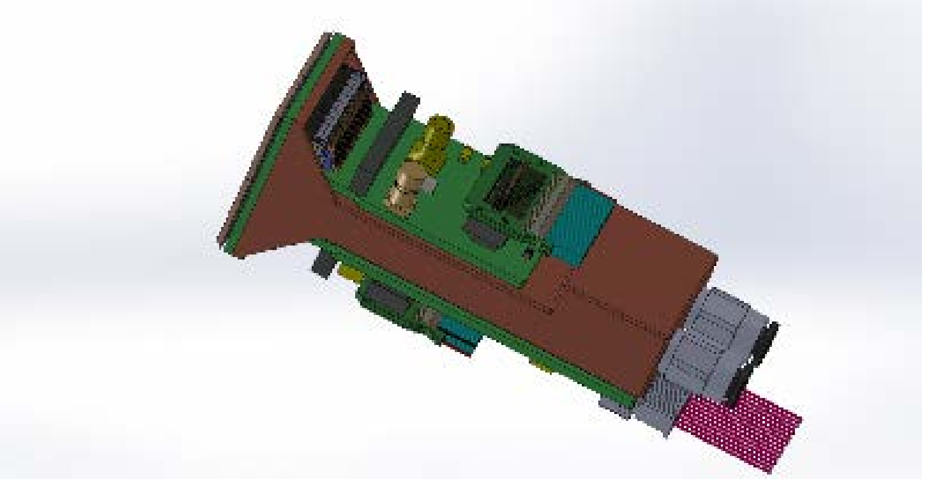
3D integration scheme and terminology

Current developments: Hybrid Pixel Detectors

SMARTPIX **an implementation of Medipix3RX photon-counting chip for ESRF beamlines.**

- **Target specification :**
- 60 x 60 mm^2 detection field (**1k x 1k pixels**) , scalable to
- larger (or smaller) areas
- 30 x 30 mm^2 unit modules, dead gaps < 0.5 mm
- **55x55 μm^2** pixel size
- **6000 fps** frame rate
- No dead time (continuous read/write)
- **3 keV** energy threshold
- Vacuum compatibility





Development challenges :

- Active edge sensors
- Vertical connections (TSV)
- Fast readouts

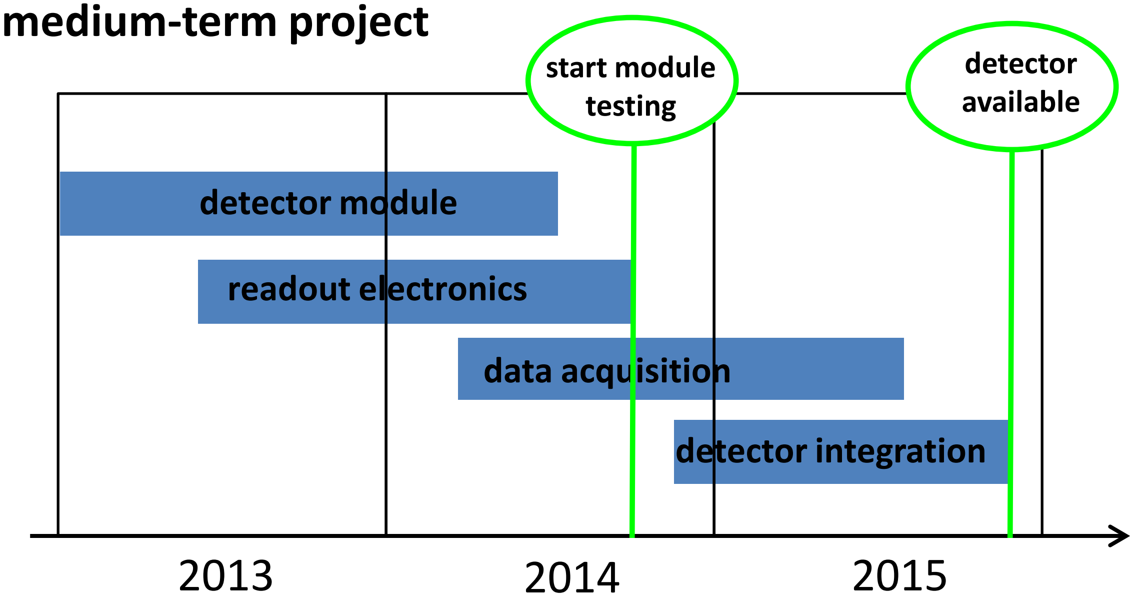
A light for science ESRF

SMARTPIX benefits

SMARTPIX = evolution of maxipix with :

- higher frame rate
- larger areas possible
- enhanced energy resolution
- lower energy threshold

A medium-term project



Similar to LAMDBA (DESY) and EXCALIBUR (DIAMOND) developments

High Z sensor material : CdTe (1)

Developement in the framework of HIZPAD and now HIZPAD2 European projects (started in 2009)

CdTe sensor grown by Acrorad (Japan)

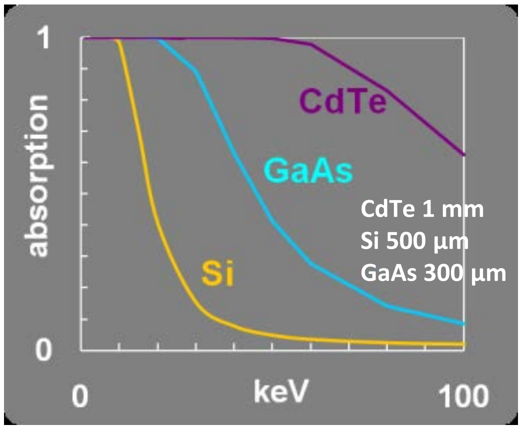
FMF (Germany) bump-bonding on 2x2 Timepix chips maximum size

MAXIPIX ESRF readout system

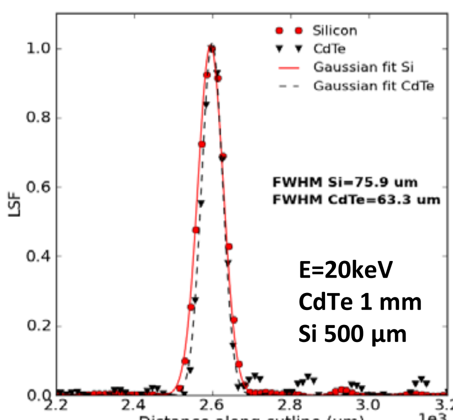
Very simple design without cooling

High Z sensor material : CdTe (2)

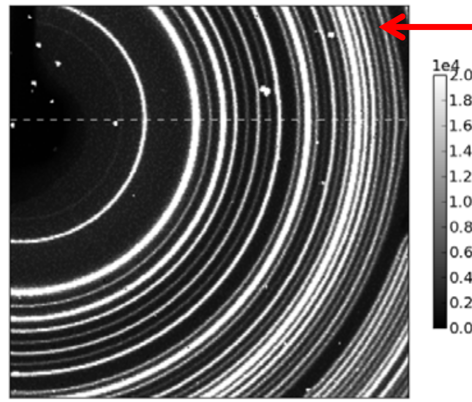
Quantum efficiency



Spatial resolution 63 µm

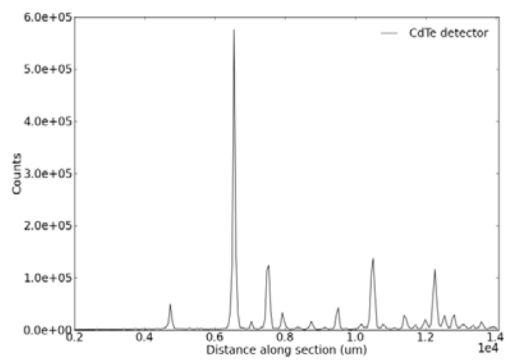


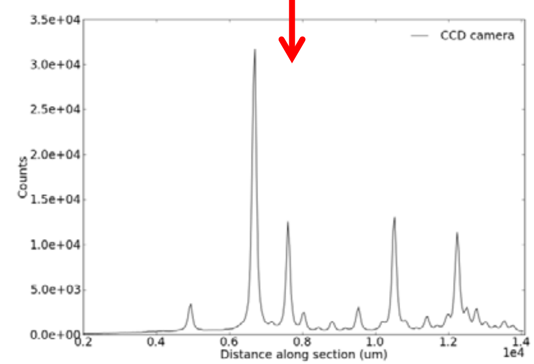
Linear count rate up to **10^5 photons/pixel/s (Timepix limited)**



Yb_2O_3 nano-powder diffraction rings at 50 keV.

Comparison with FRELON CCD Camera (50 µm pixel pitch) : No significant background, sharper peaks, more low intensity rings

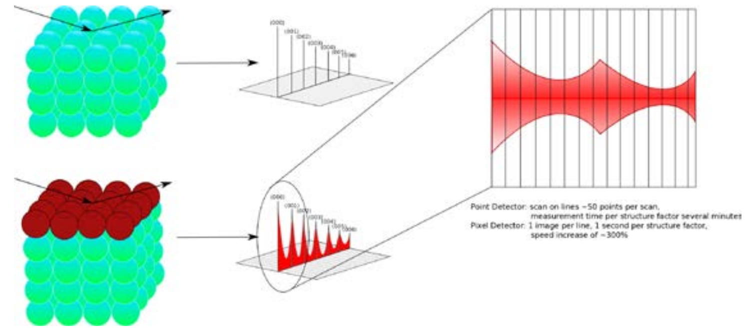




GOOD PERFORMANCES!!

M. Ruat and C. Ponchut, *IEEE Trans. Nucl. Sci.*, Vol. 59, n° 5, pp. 2392-2401, August 2012
C. Ponchut and M. Ruat, *Proceedings of IWORID 2012*
M. Ruat, E. Gros d'Aillon and C. Ponchut, *Proceedings of the 2012 IEEE NSS/MIC/RTSD conference*

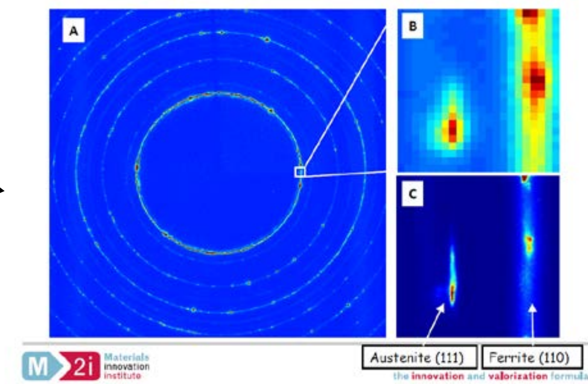
Beamline evaluations at ESRF



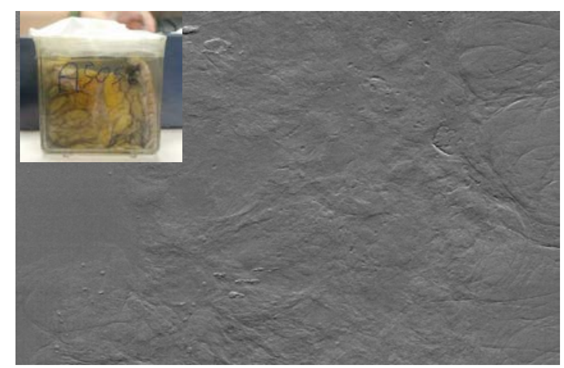
ID15 – Surface diffraction: Reflectivity liquid Ga on solid Sapphire at 70 keV (Oct. 2012)

ID15 – Surface diffraction: In-situ following of GaN growth at 70 keV (Oct. 2012)

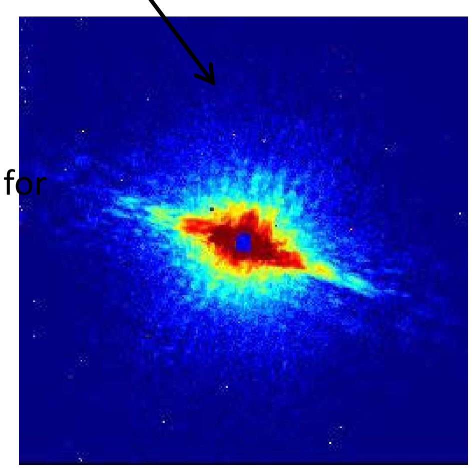
ID11 – High resolution diffraction imaging at 80keV. Mechanical stability of retained austenite grains in TRIP steels studied by synchrotron X-ray diffraction during deformation (Nov. 2011)



ID17 - Edge-Illumination phase contrast imaging for mammography at 60 and 85 keV (Sept. 2012)



ID22 - Coherent SAXS or Ptychography experiment at 20 keV (Sept. 2012)



FUTURE:

ID15 – Fast SAXS-WAXS experiment with Perkin Elmer detector for WAXS and Maxipix-CdTe for SAXS measurements

ID17 – Detector evaluation for new tomography setup for paleontology

ID17 – Dosimetry reconstruction for MRT

A light for science ESRF

High Z sensor material : CdTe (3)

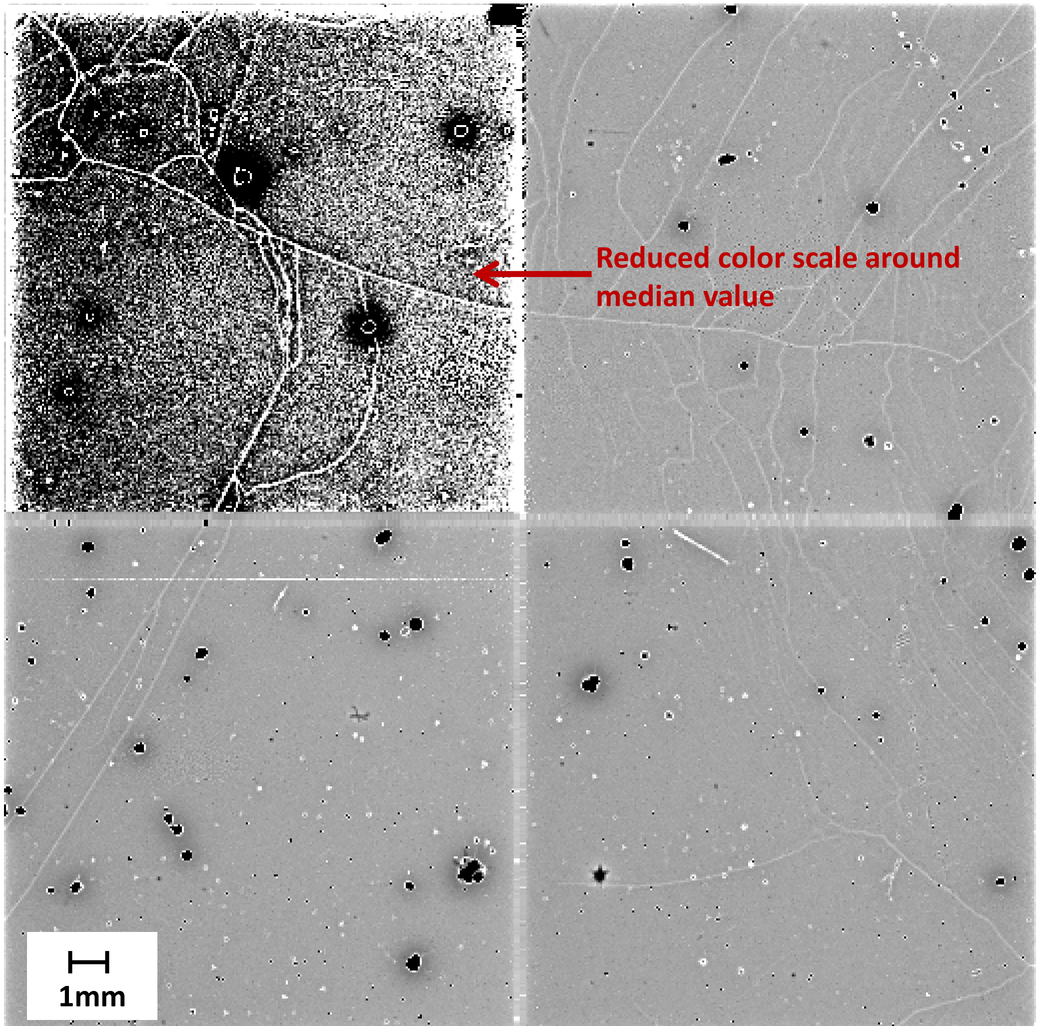
GOOD PERFORMANCES….

BUT…

CdTe detectors suffer from native defects, defects induced by processing, and instabilities under irradiation

Examples to follow

CdTe sensor : detector defects



<u>Network of Lines</u> (Native):
-Increased counts by ~10%,
- Can be FF corrected
- Sub-grain boundaries
- Next to a line of reduced counts (drift of the charges to the neighbor pixels)

<u>Extended clusters of saturated pixels (from processing)</u>:
- current overflow of the analog input stage of the readout chip.
- Strain in the material (From E. Hamman *et al,* IEEE RTSD 2012)
- Surrounded by large areas of reduced counts (*gettering effect*)

M. Ruat and C. Ponchut, *IEEE Trans. Nucl. Sci.*, Vol. 59, n° 5, pp. 2392-2401, August 2012
C. Ponchut and M. Ruat, *Proceedings of IWORID 2012*
M. Ruat, E. Gros d'Aillon and C. Ponchut, *Proceedings of the 2012 IEEE NSS/MIC/RTSD conference*

CdTe sensors

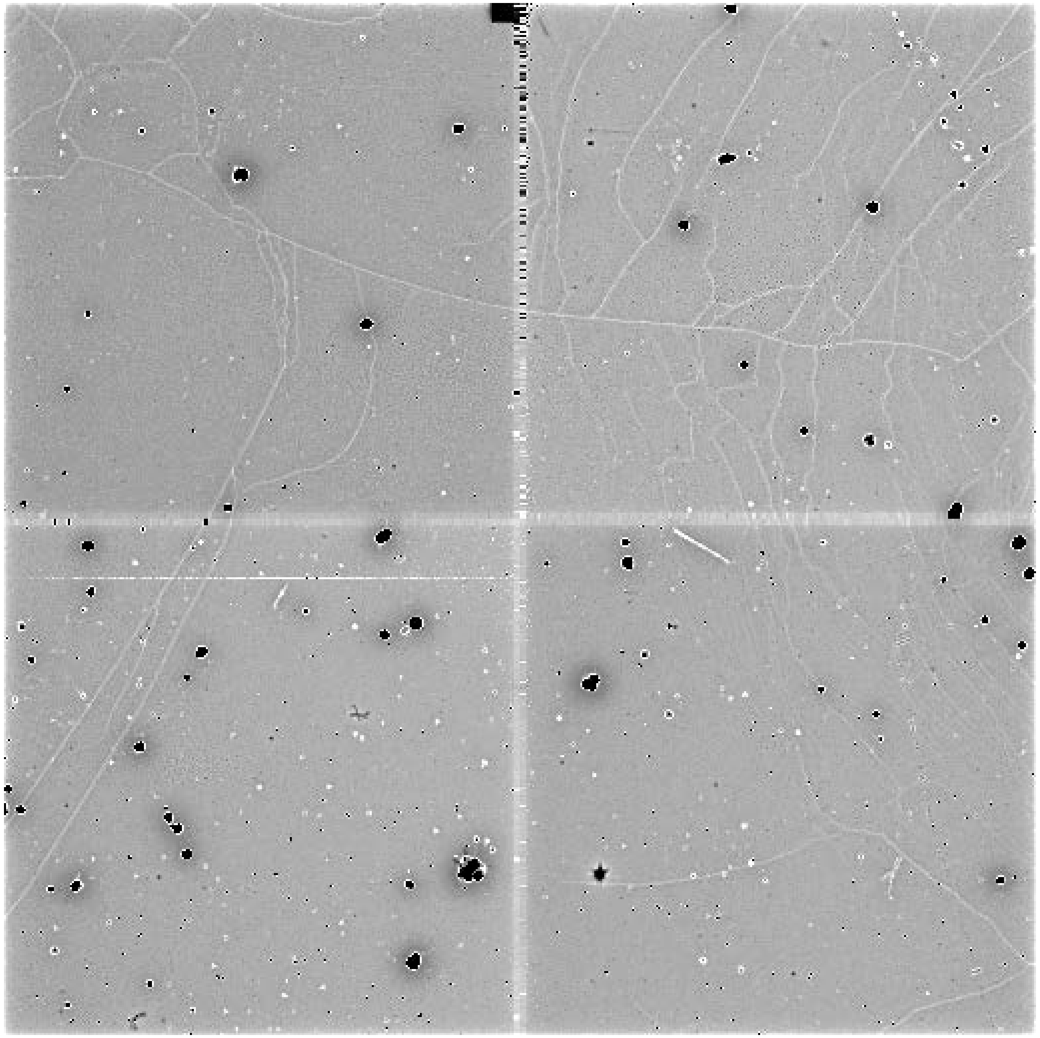
Detector ‘aging’

Flat-Field when received (2012-02)

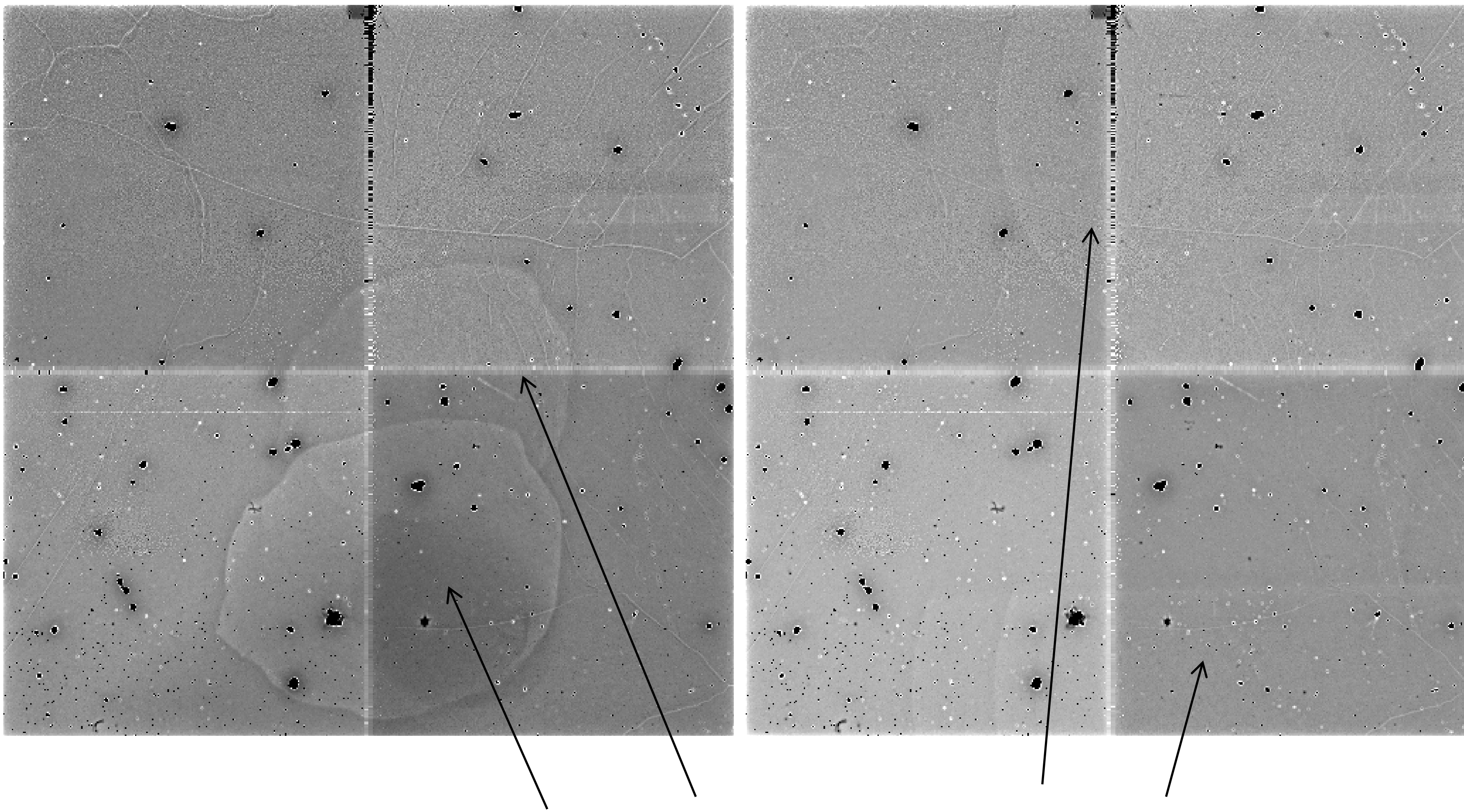
Soleil synchrotron 20 keV +
air scatterer

Thld 5

12 x 60 s



Temporary radiation damage (2013-03)



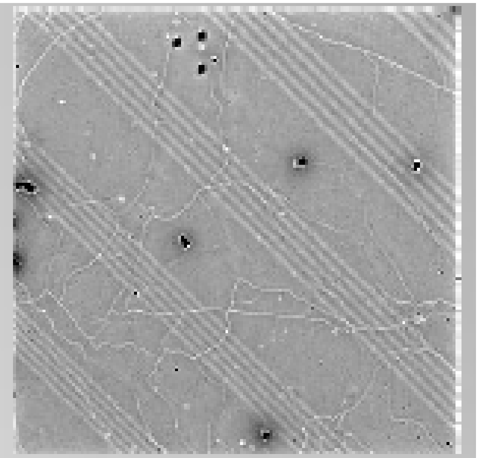
Phantom images of previous irradiation field

Temporary radiation damage (2013-05)

Irradiation with X-ray tube (Ag anode) at 7.10^5 photons/mm^2/s with a lead pattern in front of the detector

Flat-field image after irradiation with **pattern removed**

Temporary polarization = increased counts (similar to round shapes on central image)



Reset bias voltage at regular intervals in time

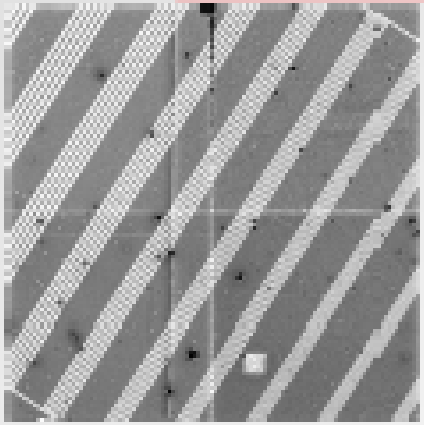
Images of a lead pattern after continuous irradiation of one half of the detector surface with X-ray tube (Ag anode) at 10^7 photons/mm^2/s for 3h

(a) without bias reset.

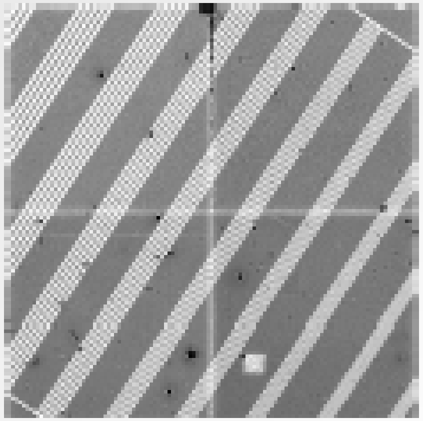
(b) With bias reset every 10 min

Irradiated part

(a)



(b)

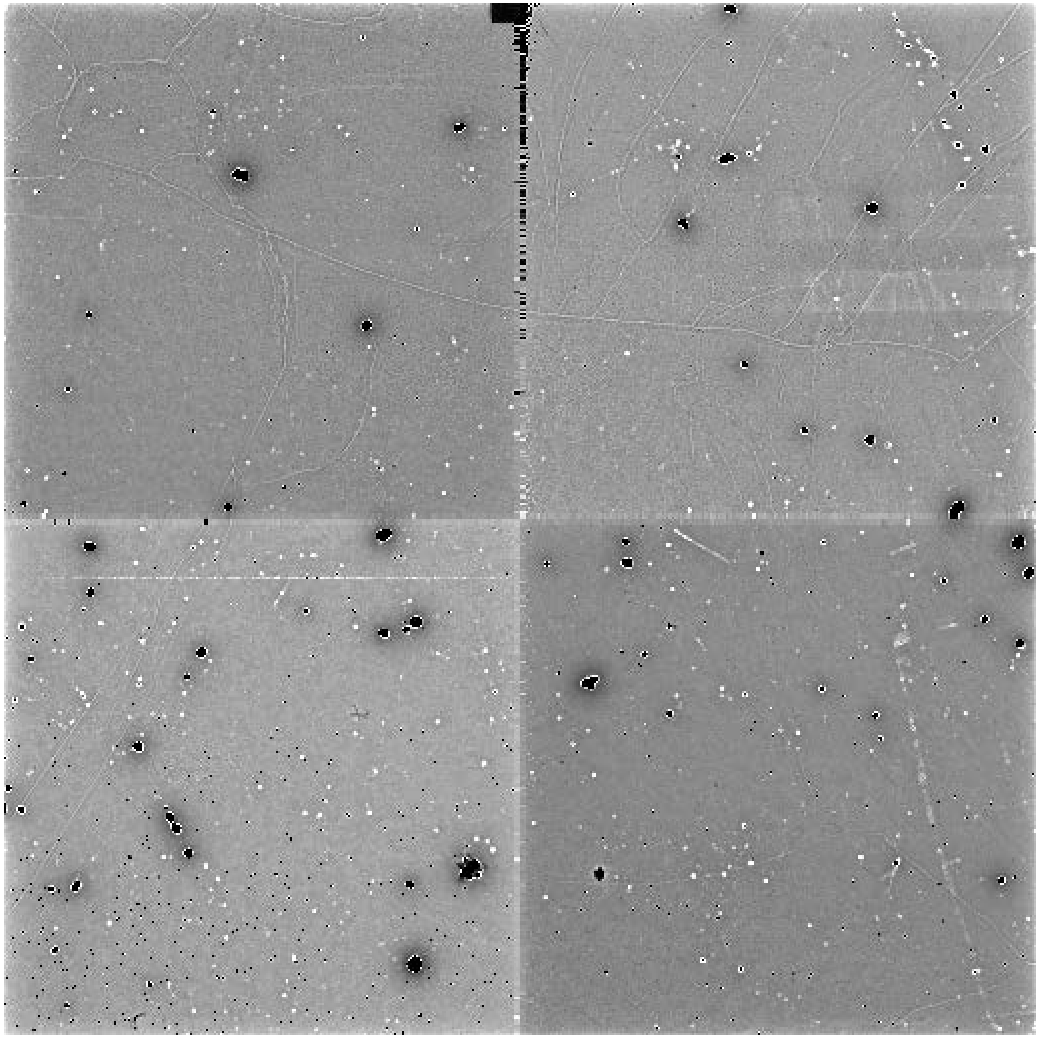


As is, after 18 months of experiments…

Ag Tube 35kVp – 25 mA
+ 100 um Ag filter

Thld 11

100 x 1 s



Chips 00, 01, 11 exhibit more extended defects + history effect.
Chip 10 is noisy and some pixels look disconnected

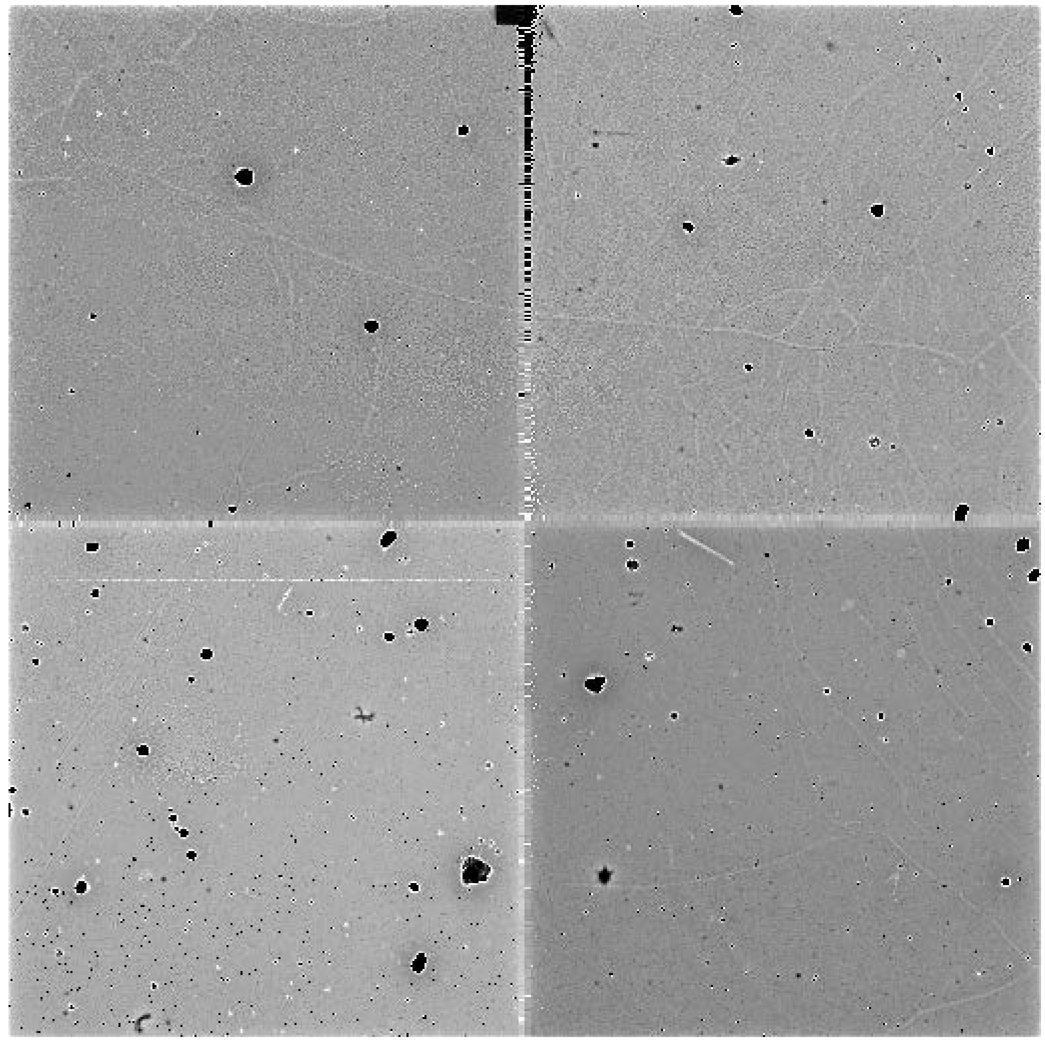
A light for science ESRF

After 2 hours at 50°C…

Ag Tube 35kVp – 25 mA
+ 100 um Ag filter

Thld 11

60 x 1 s



History effects have disappeared, as well as some defects on chips 00, 01, 11. Chip 10 idem → temporary :-(

A light for science ESRF

CdTe sensor : detector instabilities

- Extensive use → quicker polarization, enhanced radiation damage, extra noise
- Low temperature baking (50°C) induces defects relaxation in CdTe

NEED TO CHARACTERIZE TEMPORARY vs PERMANENT or RECURRING EFFECTS
And the way to avoid or 'anneal them', if possible.

→ Need to improve the design by cooling and / or resetting the bias on the detector at regular interval times

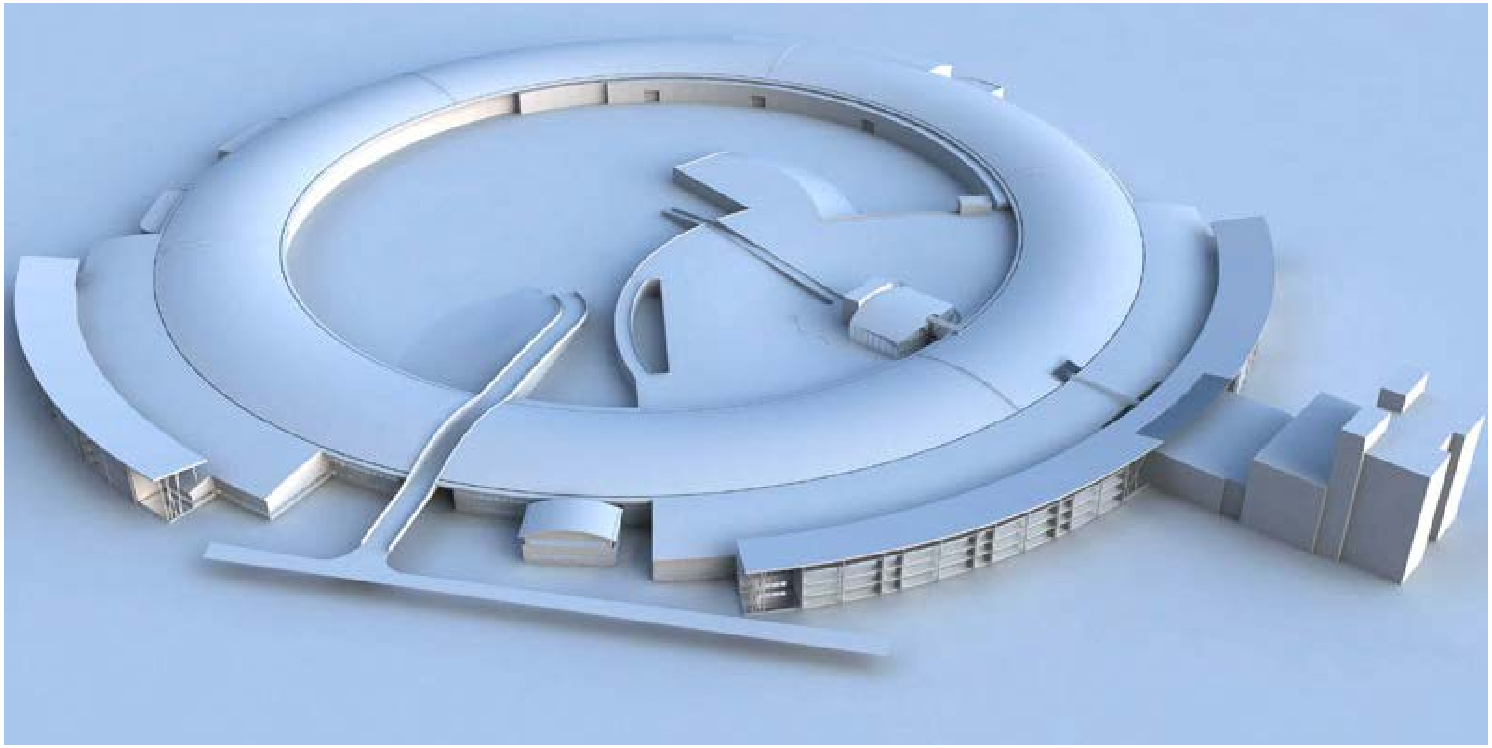
Outline

The Detector Unit at ESRF

Overview of current developments

Beamlines Upgrade program (UPBLs)

ESRF Upgrade

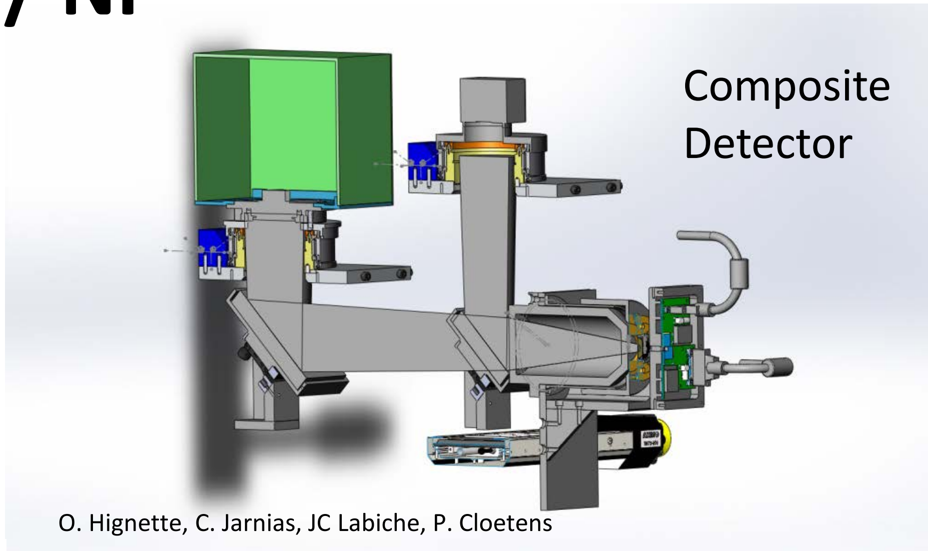


Longer beamlines, increased flux, new techniques → New detector solutions

Phase I examples

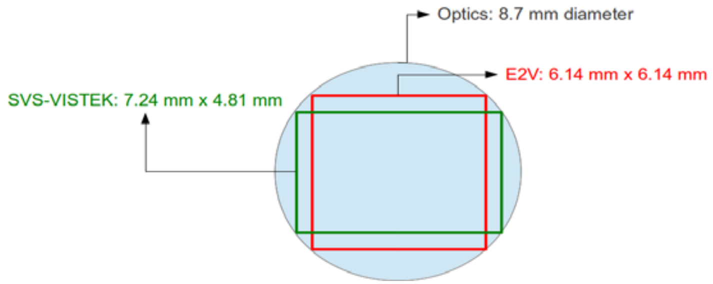
A light for science ESRF

NINA / NI

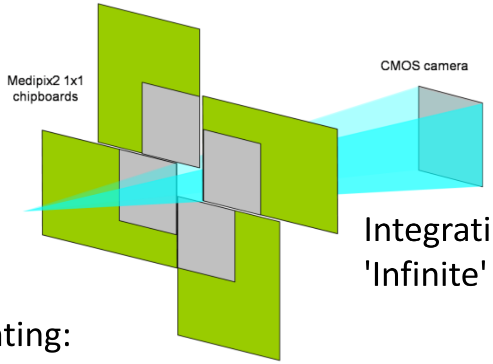


High resolution imaging and ptychography

- High resolution detector 16Mpixels
  - 10x custom optics (CFT)
  - 1.5um pixel size
  - Rot-C, 45°motorized mirror for 5x mag.
  - Frelon e2V 16Mp, 6.14 x 6.14 mm^2
  - SVS HR16070, 7.24 x 4.81mm^2



- Composite detector for cSAXS
  - Remote head Maxipix detector, 4 chips, 256x256
  - Central hole ~5x5mm



Status:
detector delivery planned end 2013 (! optics)

C. Ponchut, J.M. Rigal, C. Jarnias, D. Pothin, P. Cloetens

NINA / NI

Energy dispersive detectors

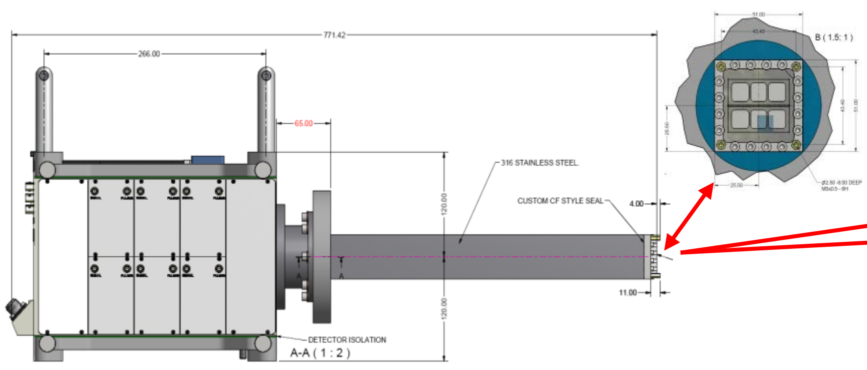
Two identical detectors:

2 x PNdetector SDD 6 element arrays = 2 x 540mm^2 energy range ~2…25keV, global *throughput* count rate to ~6Mcps

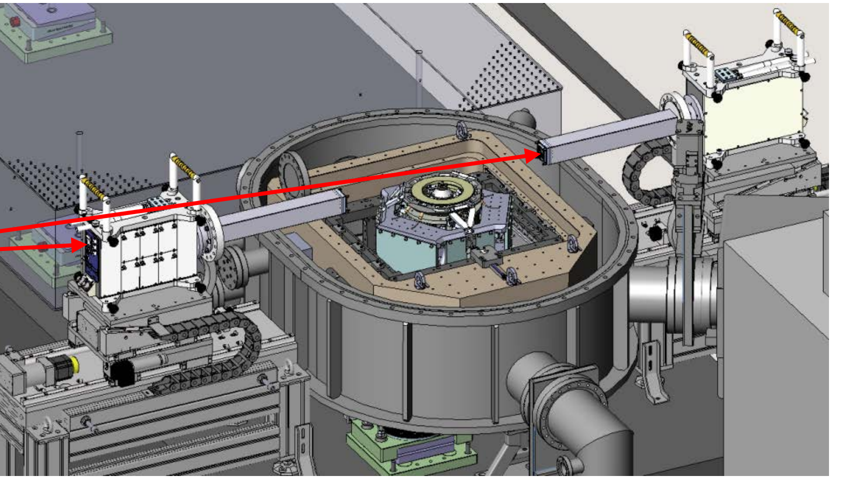
Fast MCA spectra readout to 1kHz, based on existing (ID22) XIA-XMAP pulse processors

Operation in vacuum ~10^{-7}mbar, confined space need for ~30mm approach to sample for large detection solid angle.

Detector Peltier coolers and electronics are water cooled.



detectors assembled by SGX Sensortech



detectors show in retracted position F Villar 20130319

J. Morse, P. Cloetens, R. Tucoulou, G. Martinez Criado, E. Gagliardini, F. Villar, C. Cohen

Status:

- detectors delivery planned for *June 2013*
- upgrade of obsolescent ID22 DAQ (PXI-->PXIe), testing by BCU and C Cohen completed.

ESRF Upgrade phase I

NINA / NA

Energy dispersive detectors

Operation in air

'Low energy'

Two identical detectors:

~2…25keV, total throughput count rate to ~3Mcps

2 x PNdetector silicon drift-diode 3 element arrays = 2 x 270mm^2, detectors assembled by SGX Sensortech

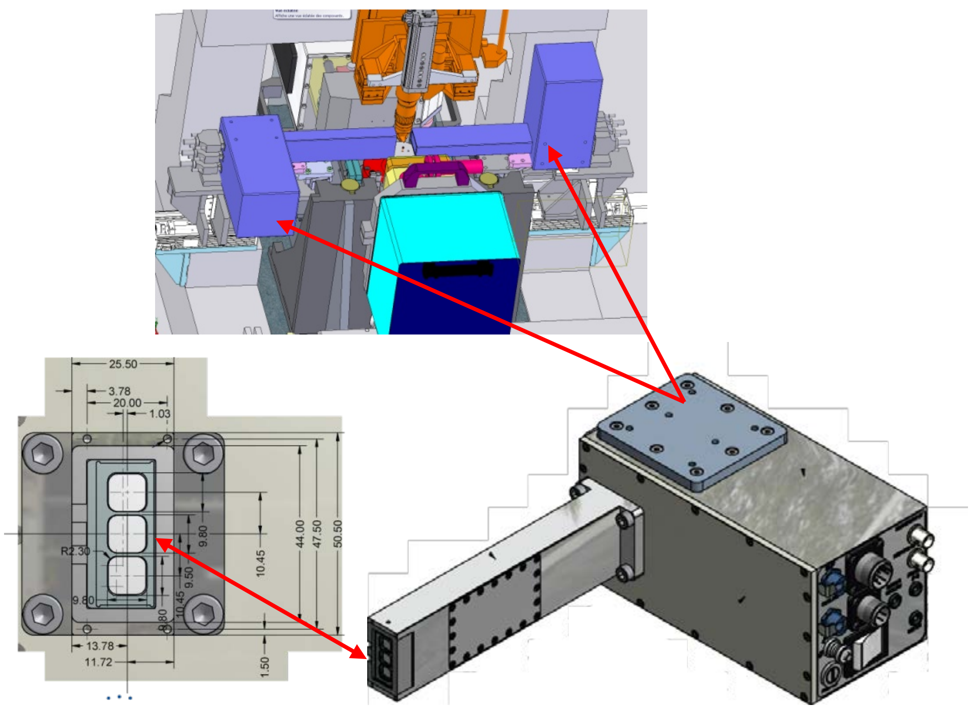
'High energy'

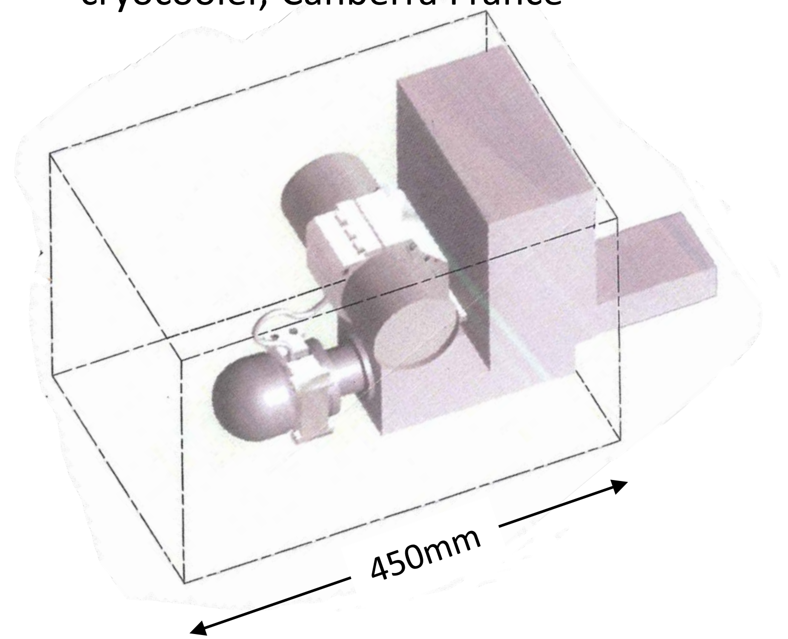
single detector :

~2…70keV, throughput count rate to ~4Mcps

8 element germanium diode array = 400mm^2

low vibration, water cooled Pulse Tube cryocooler, Canberra France





Status: CFT completed, finalizing contract, delivery ~April 2014

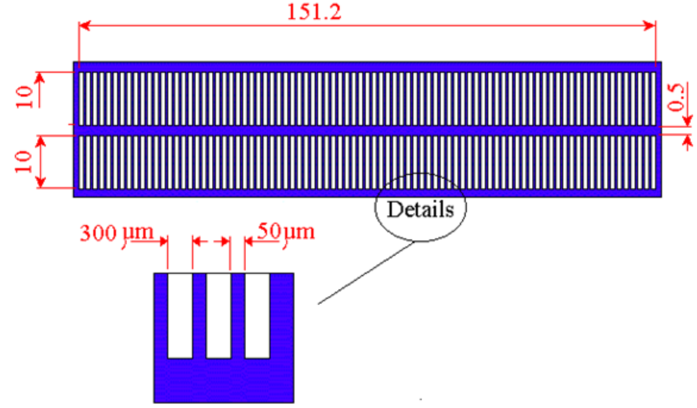
Status:

detector delivery planned for Sept 2013

J. Morse, P. Cloetens, R. Tucoulou, G. Martinez Criado, E. Gagliardini, F. Villar, C. Cohen

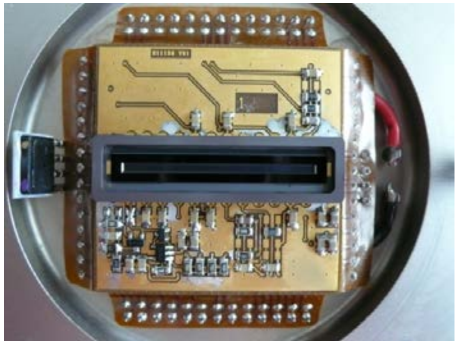
ID17

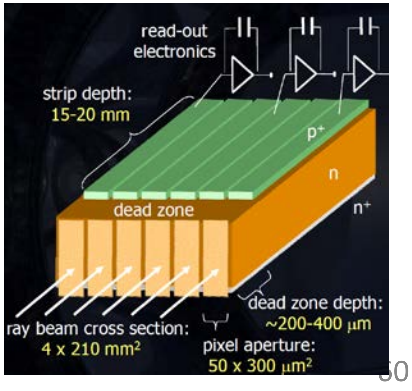
In-line Germanium detector, 350µm pitch



- Spare and obsolescence issues of electronics
- Request also
  - better resolution (50µm)
  - why not 2D (151mm x10mm)
  - 10µs readout time

  - Investigations are on-going
    - Ge upgrade
    - Microstrip sensors i.e. Elettra Picasso (Si microstrip sensors illuminated in the edge)
    - Flat panel
    - Pixel detectors
    - Frelon Hama + Front-end optics

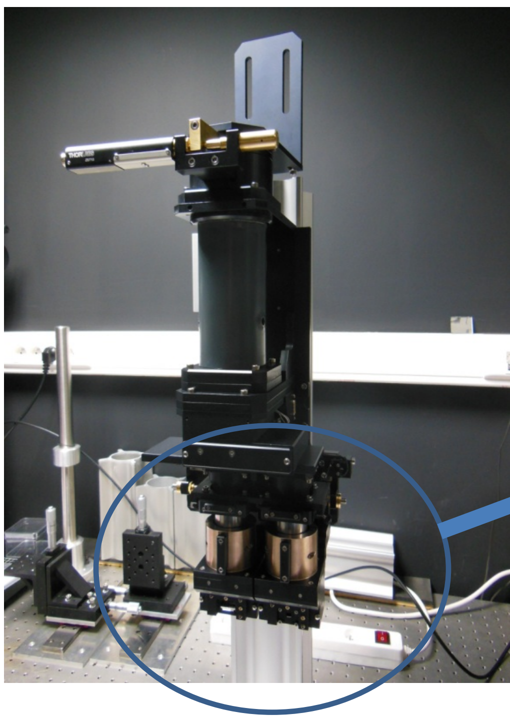


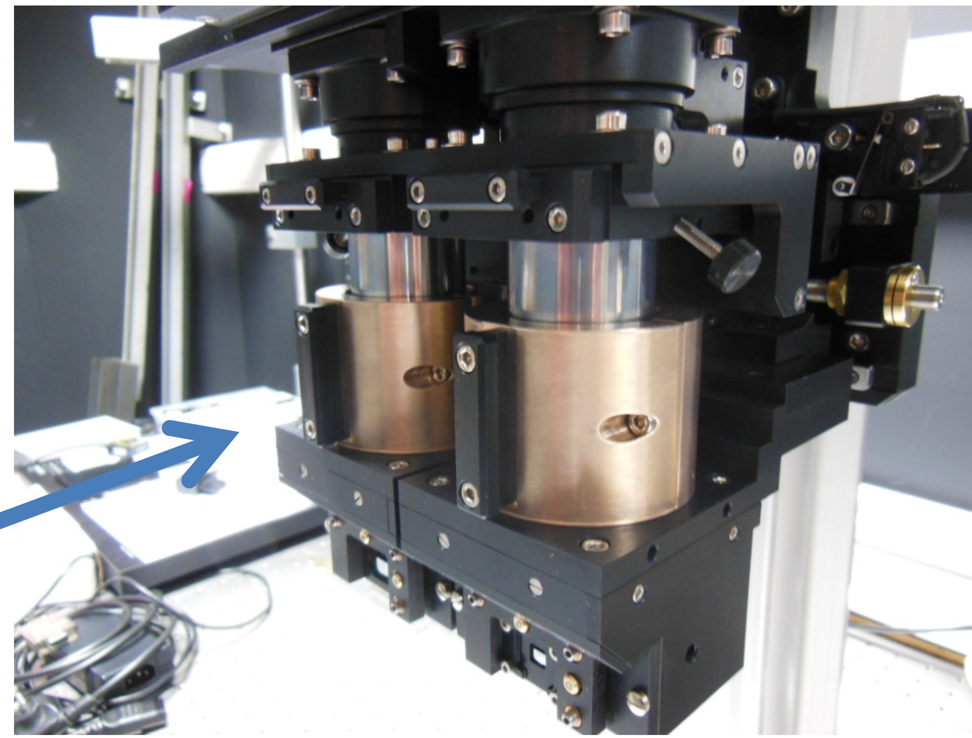


T. Brochard, C. Nemoz, A. Bravin, P. Fajardo, T. Martin

ID19: High resolution detector for white beam application

- Folded head (mirror between scintillator and objective)
- Rot-C (F-mount and Frelon)
- Two motorized optics
- 5x, 10x magnification, Mitutoyo objectives
- Eyepiece for large format sensor



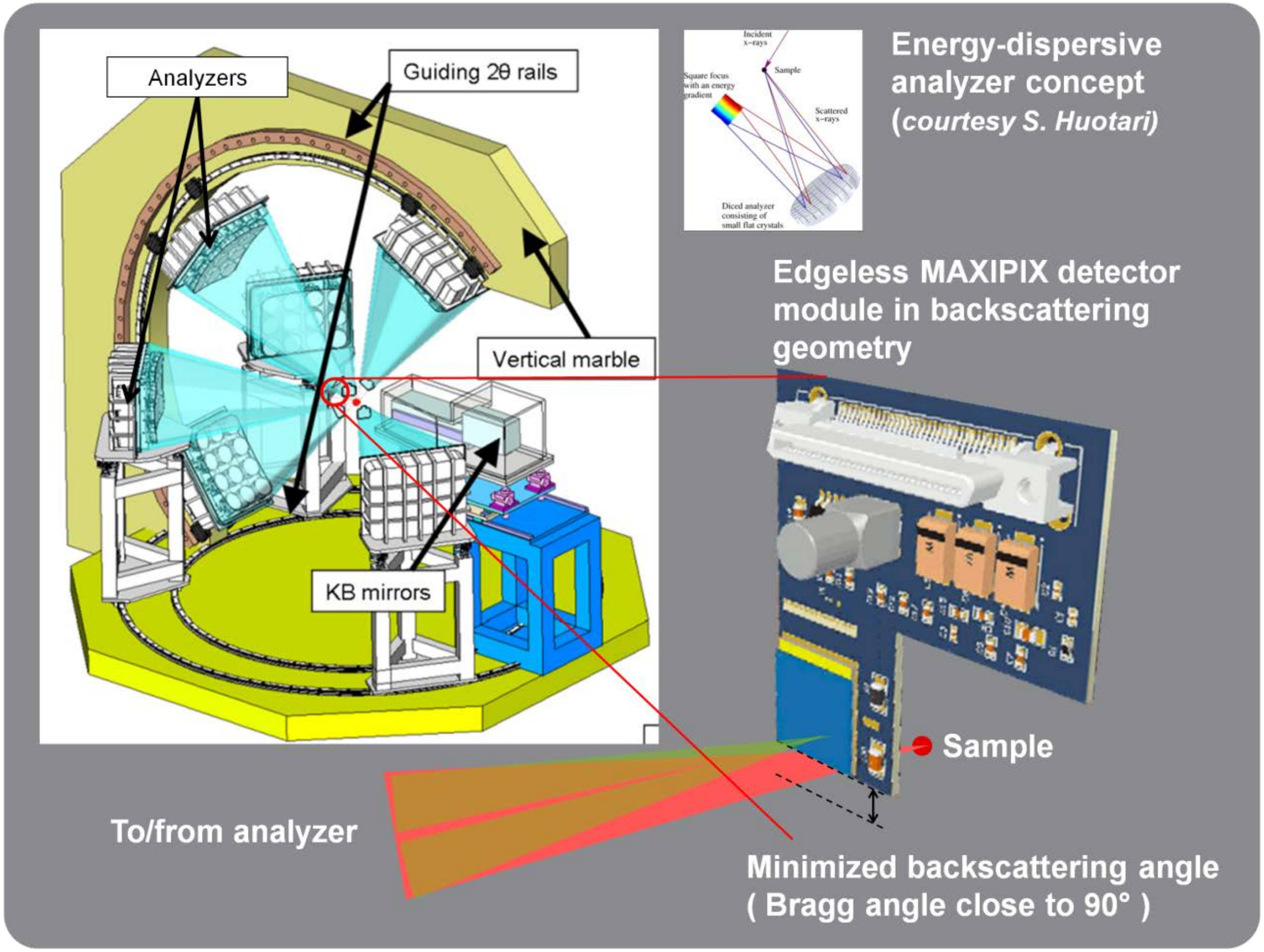


Optique Peter, A. Rack, P. Tafforeau, E. Boller

Status:
detector expected last year but now ready to be delivered

A light for science ESRF

UPBL6 –ID20 Raman spectrometer



1 single chip **MAXIPIX** detector per analyzer (end May 2013)

Specific chipboard with no edges along one corner enables :

- minimum back scattering angle
- tilted geometries

C. Ponchut, J.M. Rigal, C. Jarnias, D. Pothin, G. Monaco, M. Krish

Status:
detector commissioned July 2013

A light for science ESRF

Many thanks to the following people who contributed to this presentation:

The ESRF Detector Unit

Collaborators of Beamline Control Unit
see presentation by A. Homs @ 16:10

Collaborators of Electronics Unit and Engineering group

Collaborators of the ESRF Science Division

Our partners from collaborative projects

Thank you for your attention!