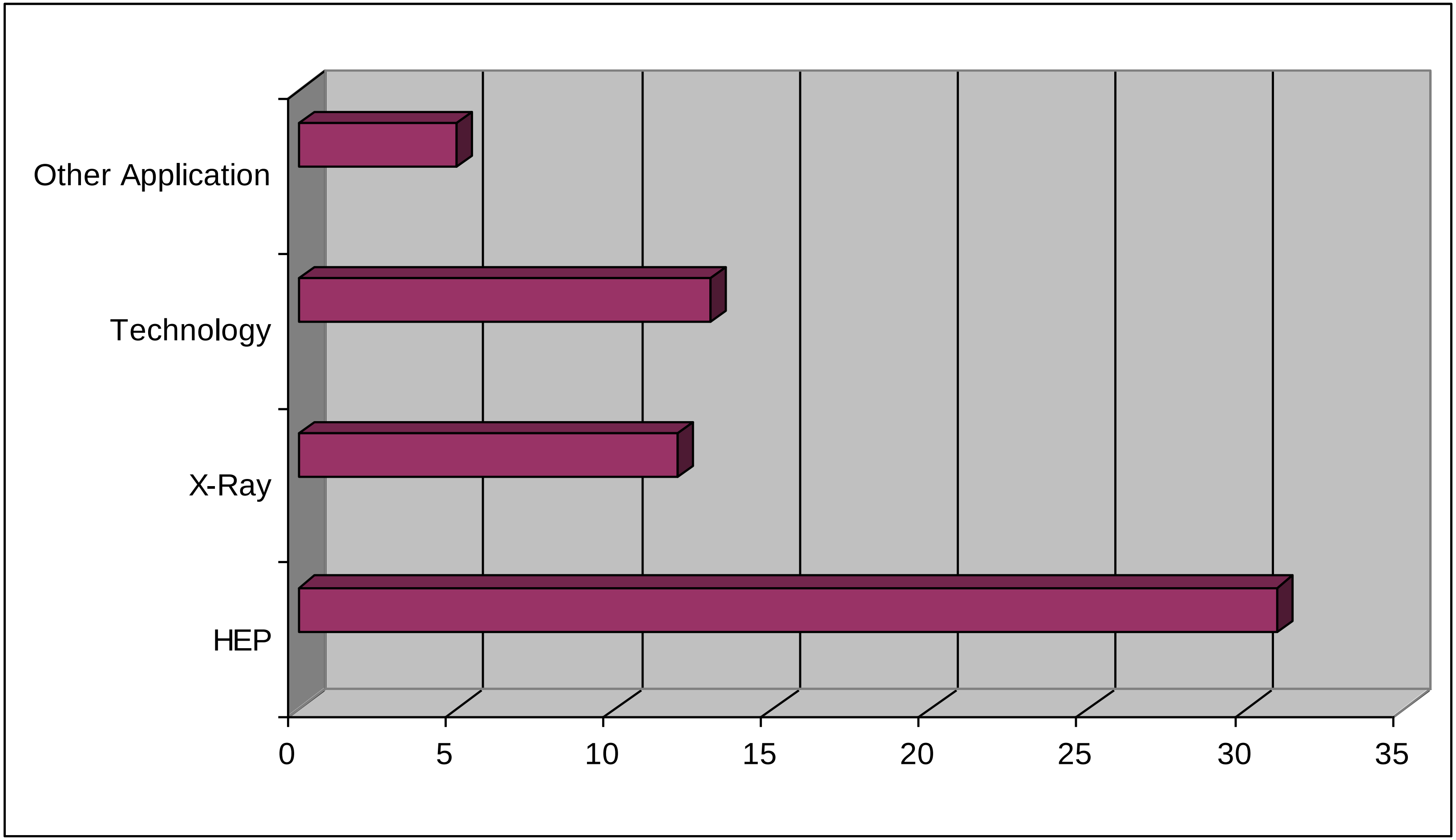
Summary talk

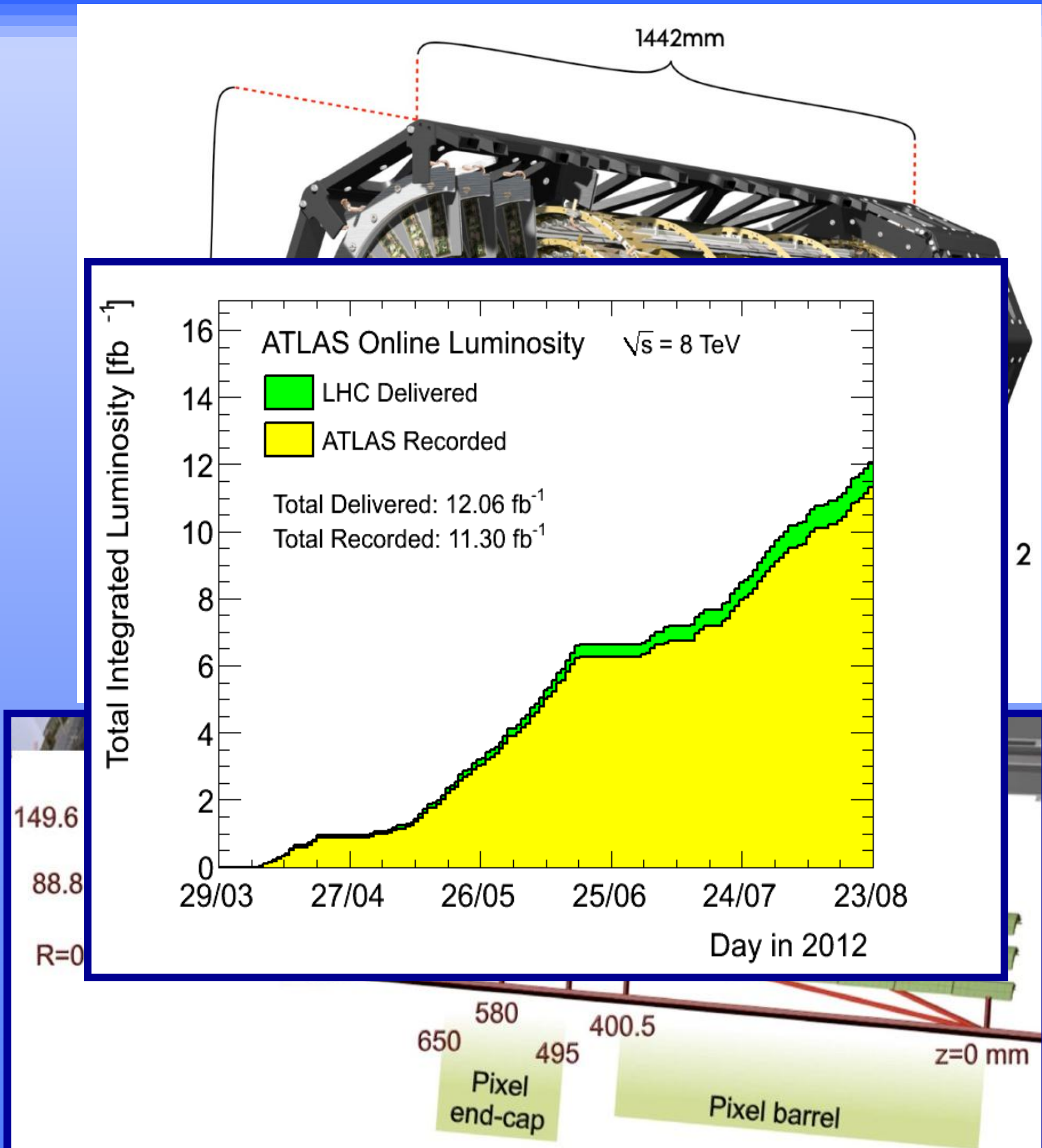
From a synchrotron detector developer's point of view

Bernd Schmitt / PSI


Other Application
Technology
X-Ray
HEP
0
5
10
15
20
25
30
35

- lot of work is currently done in R&D for LHC upgrades
- lot of technology development MAPS, Monolithic Pixel Detectors
- too much to show this all
- made personal selection, not based on importance

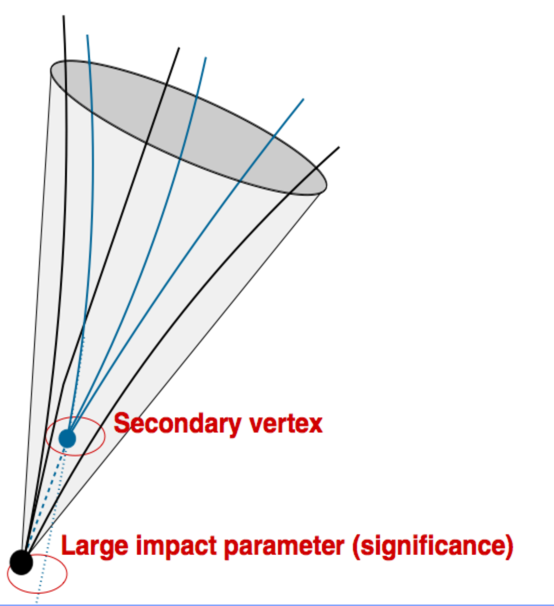
The ATLAS Pixel Detector

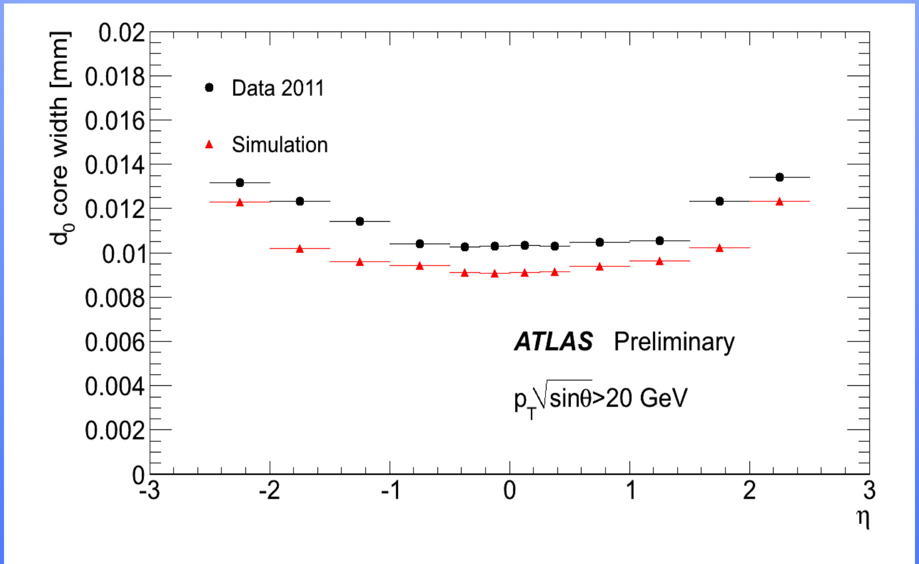


- **Three barrel layers:**
  - R= 5 cm (B-Layer), 9 cm (Layer-1), 12 cm (Layer-2)
  - modules tilted by 20º in the Rϕ plane to overcompensate the Lorentz angle.
- **Two endcaps:**
  - three disks each
  - 48 modules/disk
- **Three precise measurement points up to |η|<2.5:**
  - RΦ resolution:10 μm
  - η (R or z) resolution: 115 μm
- 1456 barrel modules and 288 forward modules, for a total of 80 million channels and a sensitive area of 1.7 m^2.
  - Environmental temperature about -13 ºC

Impact parameter resolution

- Impact parameter is used to discriminate primary from secondary particles.
- Key ingredient in the reconstruction of heavy flavours (*b*, *c*, τ)
- Resolution is dominated by the first measurement on track.
  - At high *p*, **intrinsic detector resolution** and **alignment**. **10 µm resolution** in barrel region

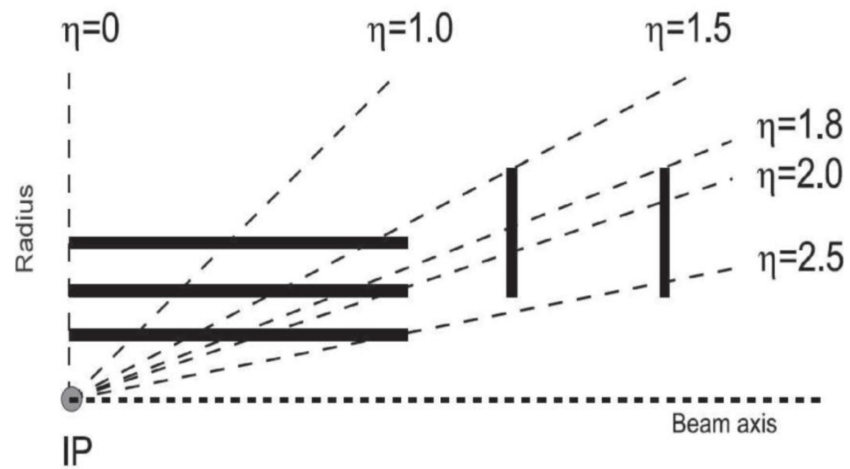




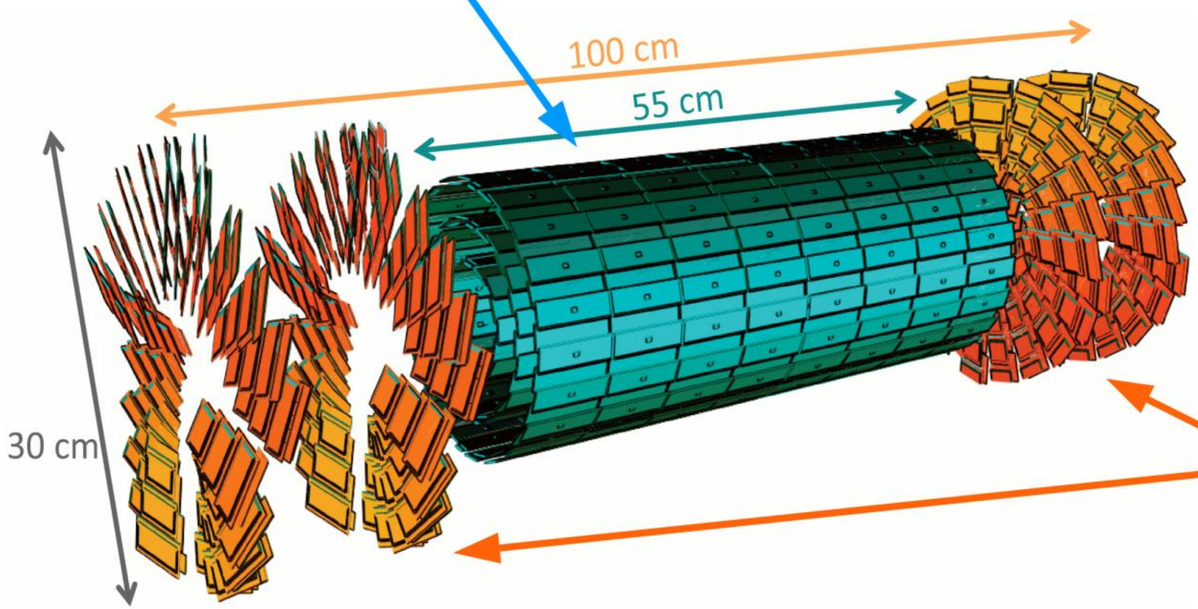
The CMS Pixel Detector

Pixel Barrel (BPix):

3 layers (56 cm long) placed at
r = 4.3, 7.2, 11.0 cm
48M pixels, 11520 ROCs
1120 readout links



Excellent (good) tracking efficiency up to η = 2.0 (2.5)

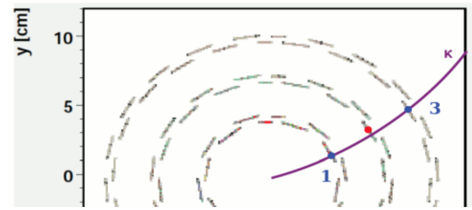


Pixel Endcap (FPix):

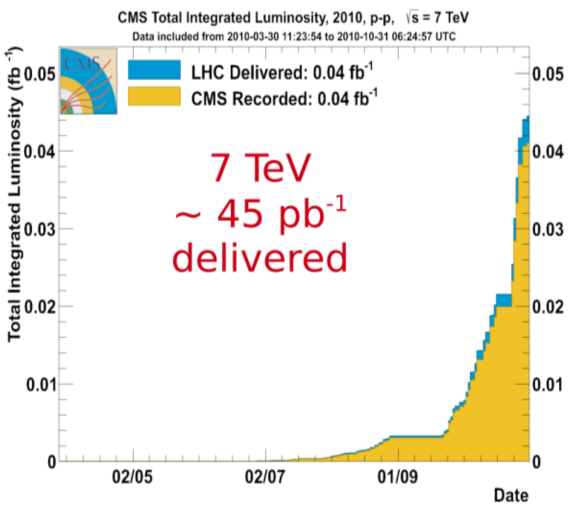
4 disks placed at
z = ±34.5, ±46.5 cm
inner (outer) radius = 6 (15) cm
18M pixels, 4320 ROCs,
192 readout links

Pixel Hit Resolution

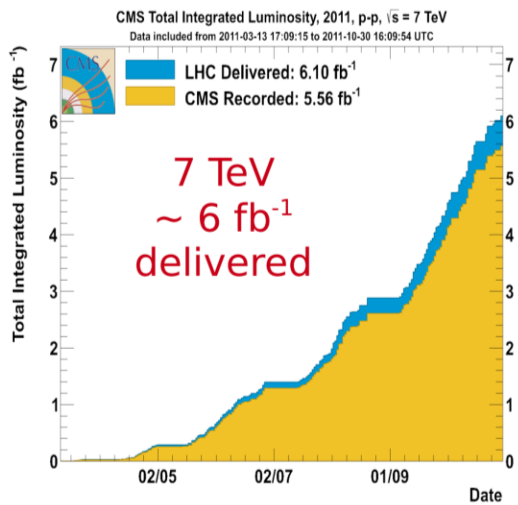
- The Pixel Hit Resolution is measured using the “triplet method”;
- Tracks with three hits in the barrel are



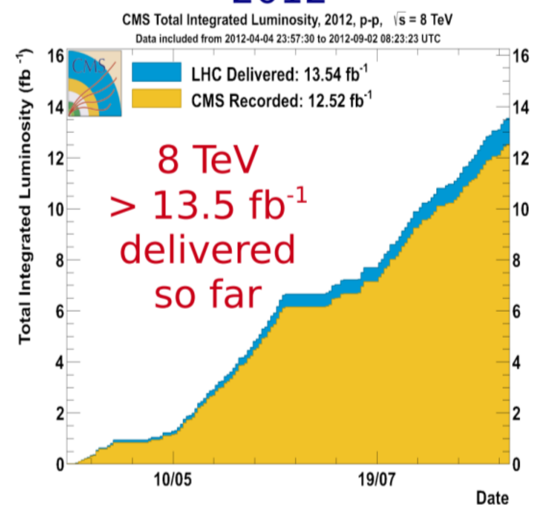
2010



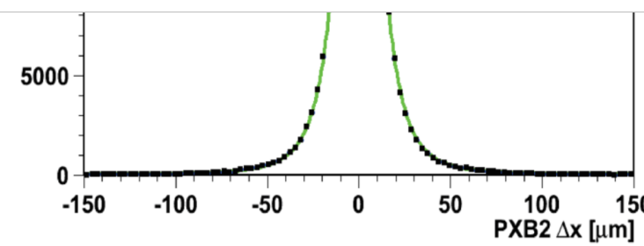
2011



2012



the “overlap method” give consistent results.

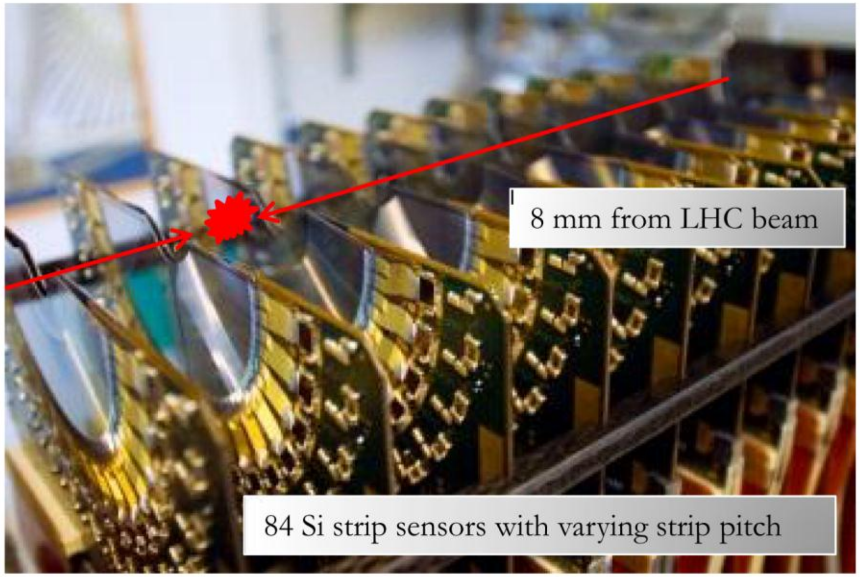


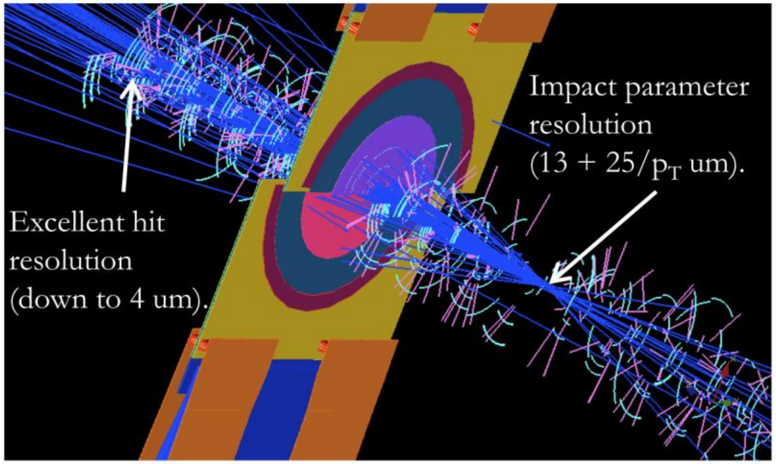
LHC detector upgrades

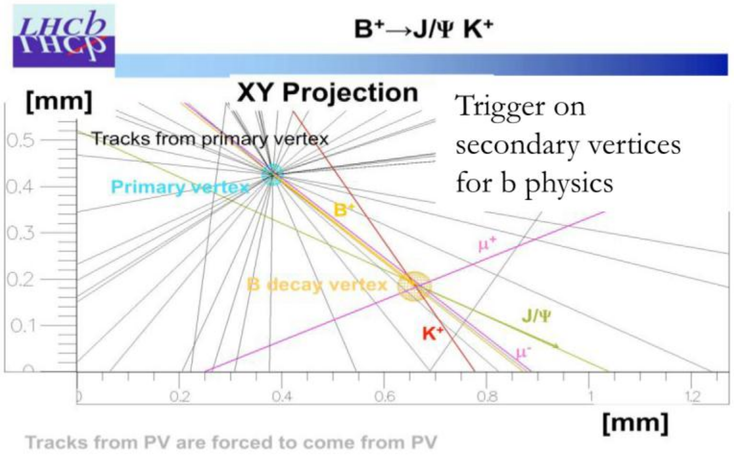
The VELO detector.

Vertex locator of the LHCb detector : select beauty and charm decays.

See talk of K. Akiba, Session 2



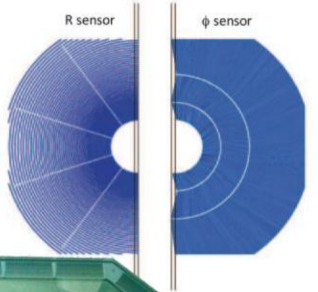




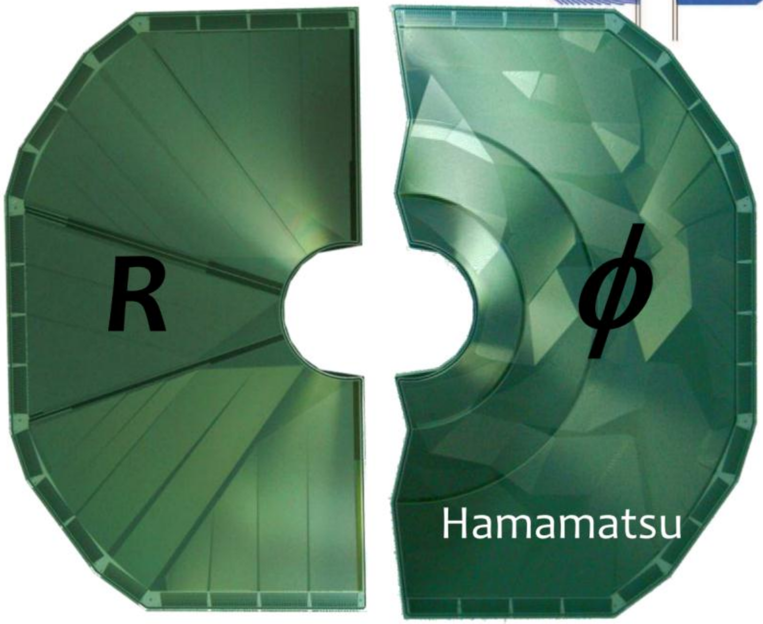
Trigger on secondary vertices for b physics

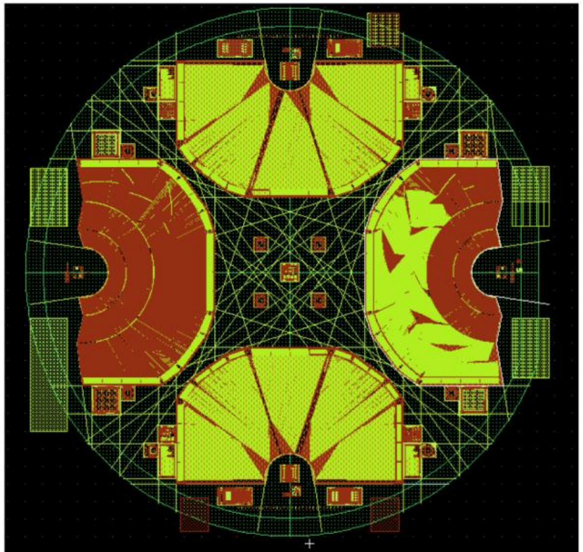
- Cooling:
  - Module power dissipation ~16W
  - Operates in vacuum.
  - Pioneering use of evaporative CO_2 cooling.

Strip Design



- similar to current detector (Rϕ geometry)
  - 30 μm minimum pitch, 20 x 128 strips per sensor
  - keep occupancies < 0.6 % at $10^{33} cm^{-2} s^{-1}$
  - Keep capacitances low ➔ higher lifetime
  - No pitch adapter (compared to now)
  - Sensitive area close to the edge
  - Active @ 7 mm from the beam
- Sensor prototypes (Hamamatsu) being tested
- Sensor hybrid to be developed
  - Cooling options shared with Pixel alternative.
- New ASIC chip under development:
  - on-chip common mode subtraction, clustering and zero suppression

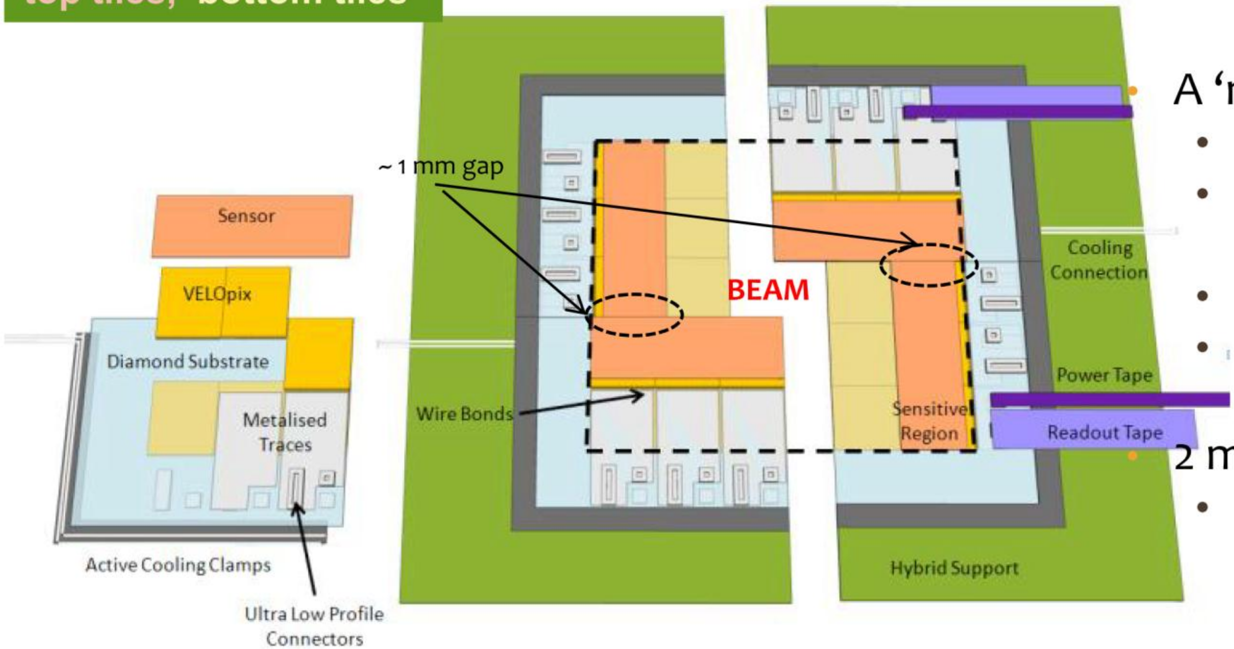




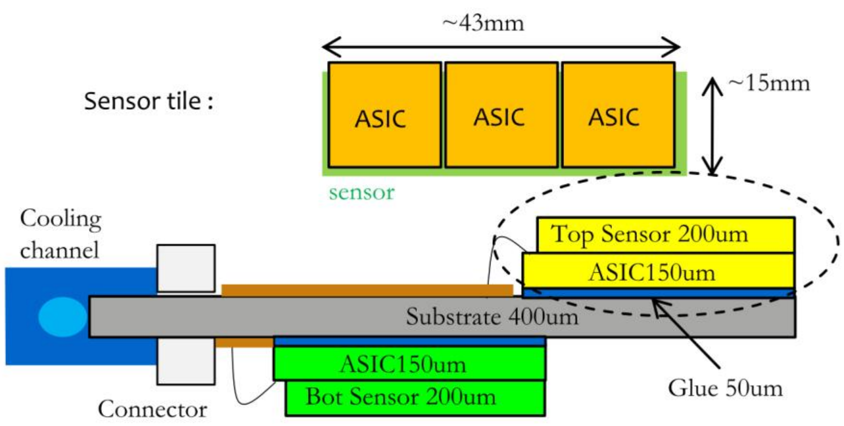
Kazu Akiba

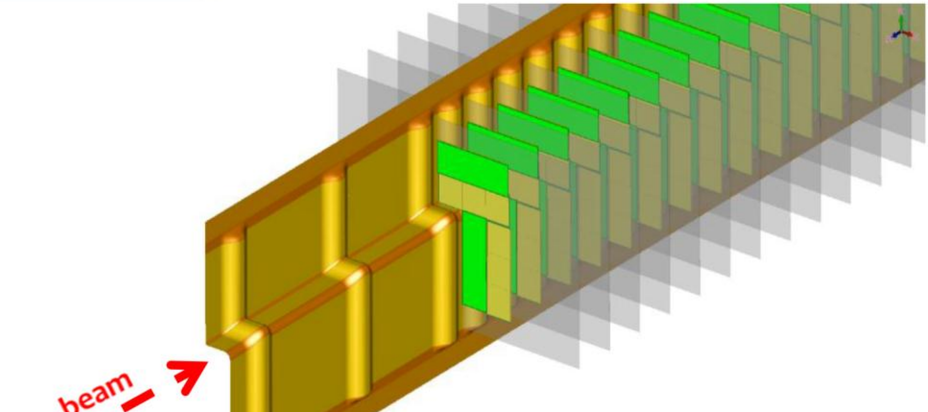
Pixel Module

top tiles, bottom tiles



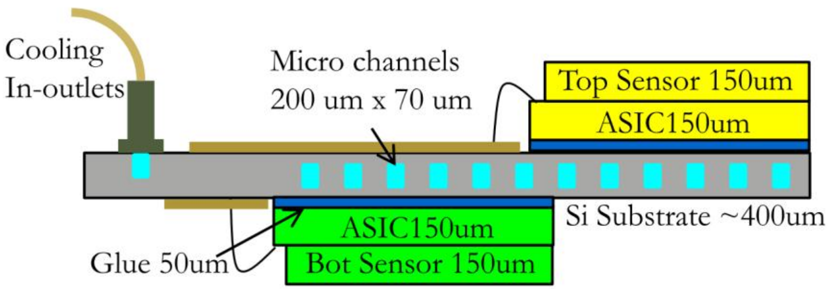
- A 'module' is made of 4 sensor tiles.
  - active area ~100% (except small gaps)
  - Closest pixel is at 7.5 mm from the beam center
  - Each tile has 3 ASICs
  - 2 tiles on each side of the substrate
- 2 modules make 1 station
  - 26 stations in total

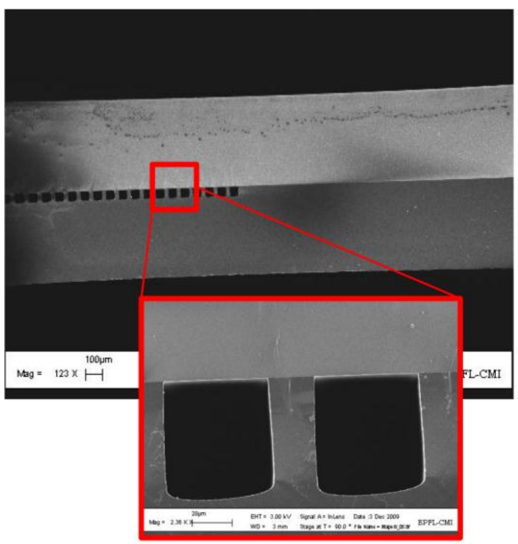




Varying spacing along the beam axis. Minimal pitch 24 mm

Micro-channels in Si.



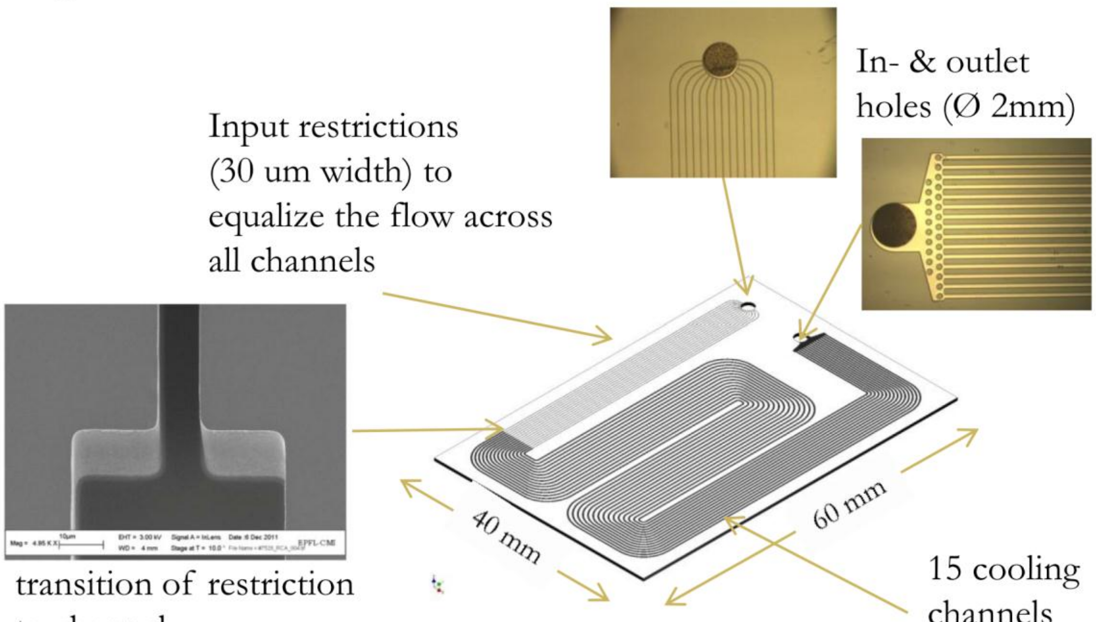


Advantages:

- Cooling tube is integrated in the substrate:
  - Can customize the routing of channels to run exactly under the heat sources.
- Many parallel channels:
  - large liquid-to-substrate heat exchange surface.
- Low mass :
  - No extra 'bulky' thermal interface required between cooling channel and substrate.
- No heat flows in the substrate plane:
  - Small thermal gradients across the module.
- All material is silicon :
  - No mechanical stress due to CTE mismatch.

First prototypes

- The aim is to:
  - Demonstrate CO_2 circulation in micro channels.
  - Measure
    - the cooling performance
    - the pressure resistance.



transition of restriction to channel

“Snake” layout

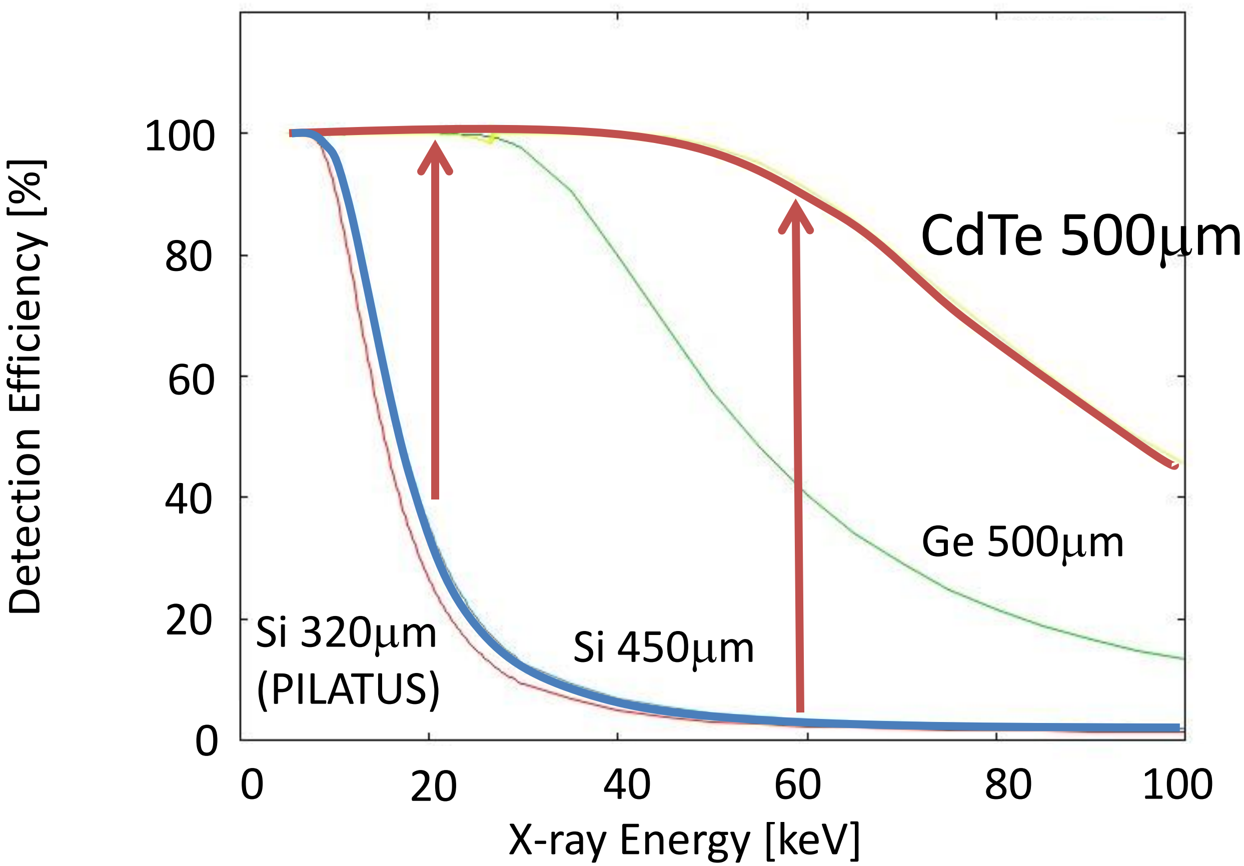
X-ray detectors

CdTe Pixel Detector Development for Synchrotron Radiation Experiments

T. Hirono[1], H. Toyokawa[1], M. Kawase[1], S. Wu[1],
Y. Furukawa[1], T. Ohata[1],
H. Ikeda[2], G. Sato[2], S. Watanabe[2], T. Takahashi[2]
([1]JASRI/Spring-8, [2]ISAS/JAXA)

Introduction

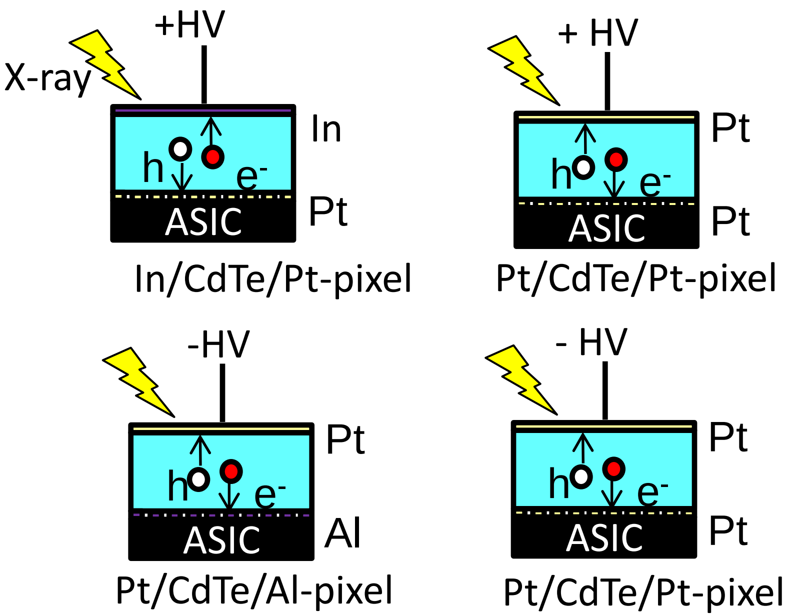
- Detection Efficiency of Sensors
  - CdTe has almost 100% detection efficiency up to 40keV, more than 50% at 60-100 keV where Si has only 1.5%



Design of SP8-02B (Sensor)

- Basic Properties of CdTe sensors

	CdTe	Si	Ge
density (g/cm^3)	5.85	2.33	5.33
atomic number	48, 52	14	32
band Egap energy (eV)	1.44	1.12	0.67
ε (eV)	4.43	3.62	2.96
resistivity (Ωcm)	10^9	1400	3900
$(\mu\tau)_e$ (cm^2/V)	~2×10^{-3}	0.22	0.42
$(\mu\tau)_h$ (cm^2/V)	~1×10^{-4}	0.84	0.72



- CdTe has a large density and atomic number but a short lifetime compared to Si.
- Ideally, electrons, which have a larger mobility and a longer lifetime than holes in CdTe, have to be collected for high energy resolution. In particular the Schottky type detector functions as a diode device, which reduces the leakage current.

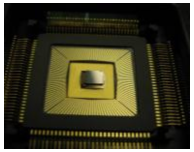
Design specification for CdTe detector in SPring-8

- Pixel size : 200 μm x 200 μm
- Size of module: 40 mm x 40 mm
- Energy range: 15- 40 keV, 30 – 100 keV with a gain switch
- Maximum counting rate : 10^7 count/sec
- Window-type discriminator
- Noise count : < 1 count/hr/mm^2
- High stability

SP8-01

16 x 16 pix

3.2 x 3.2mm^2

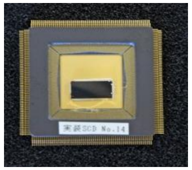


Small Single chip

SP8-02

20 x 50 pix x 1 chip

4 x 10mm^2



Medium size

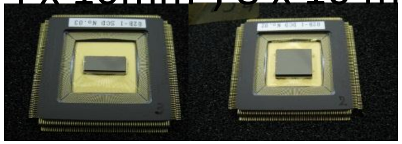
3-side buttable chip

ASIC as SP8-01

SP8-02B

20 x 50 pix x 1,2 chips

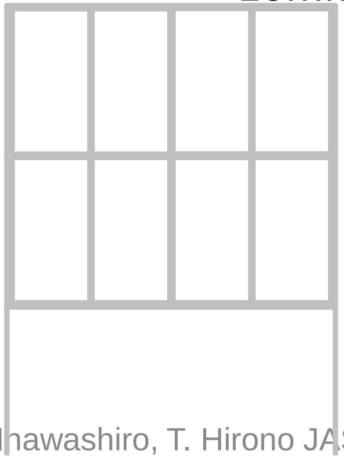
4 x 10mm^2, 8 x 10 mm^2



Multi-chip module

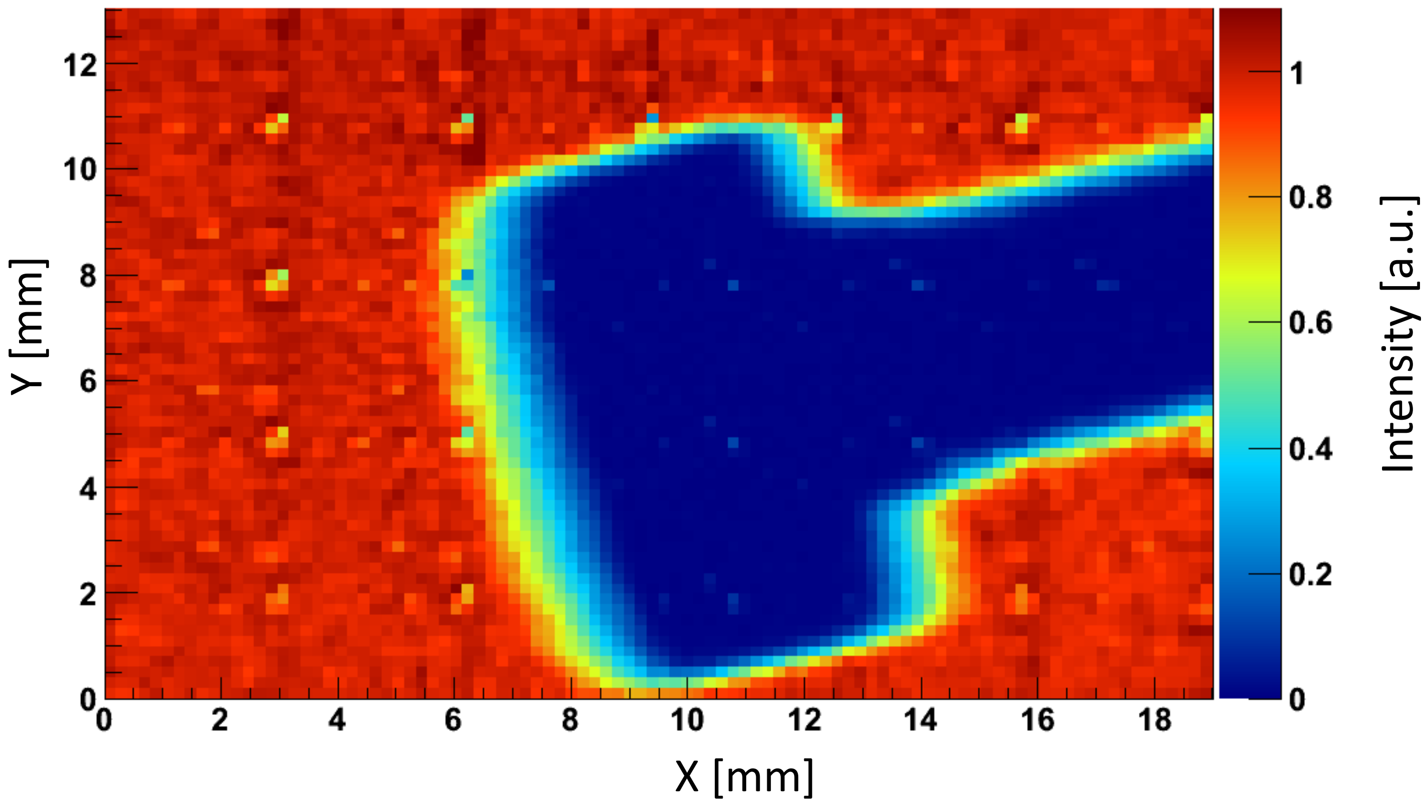
Optimized ASIC

SP8-03 (final design)



Pixel Size

- X-ray shadow image with SP8-01 detector



Pt/CdTe/Al-pixel
Gain : High Gain
HV: -300V
Exposure time : 10s
Energy: 32KeV
Combined image with 4 x 6 positions

SP8-01(pixel size of 200 x 200 um^2) worked as an imaging detector

Development and Deployment Status of X-ray 2D Detector for SACLA

SPring-8 Angstrom Compact free-electron LAser

Takaki Hatsui

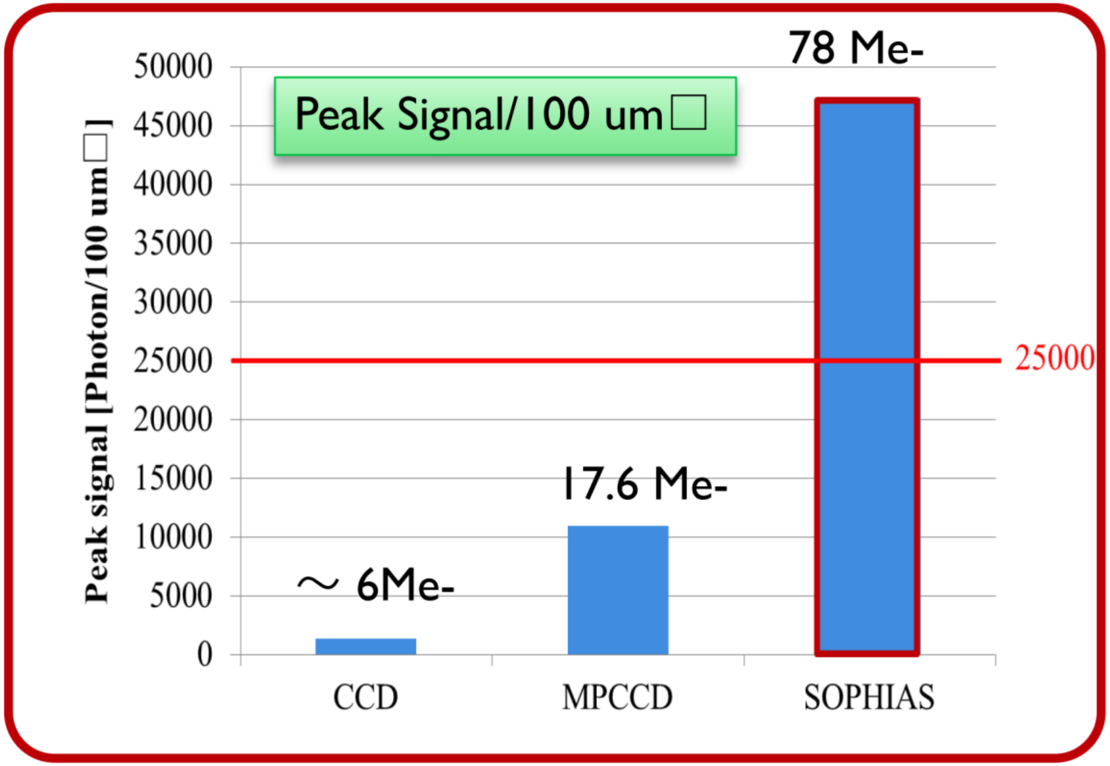
on Behalf of SACLA Team & SOPHIAS collaboration

RIKEN SPring-8 Center

SOPHIAS

Silicon-On-Insulator Photon-Imaging Array Sensor *by using SOI Sensor Technology*

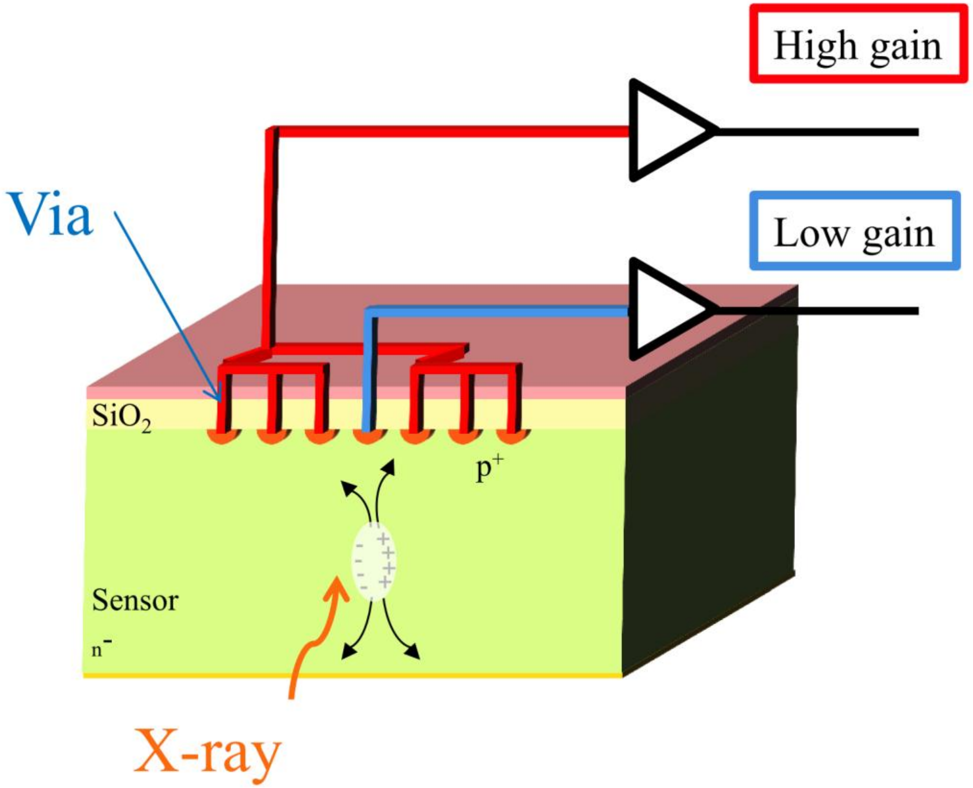
- *with A-R-Tec, ARKUS, and Tokyo Electron Devices, Kyocera*

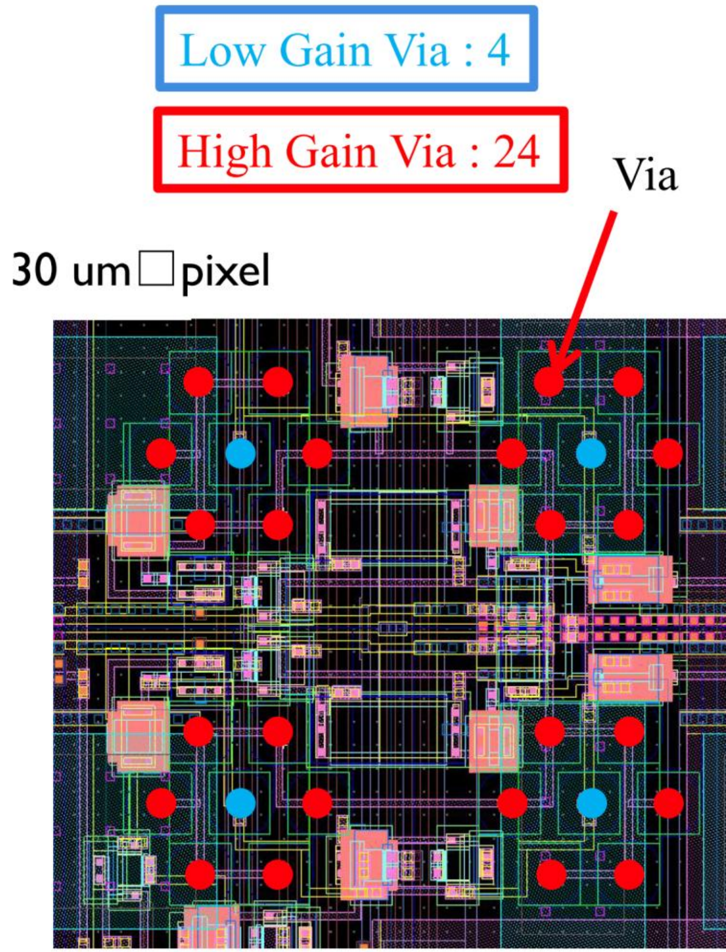


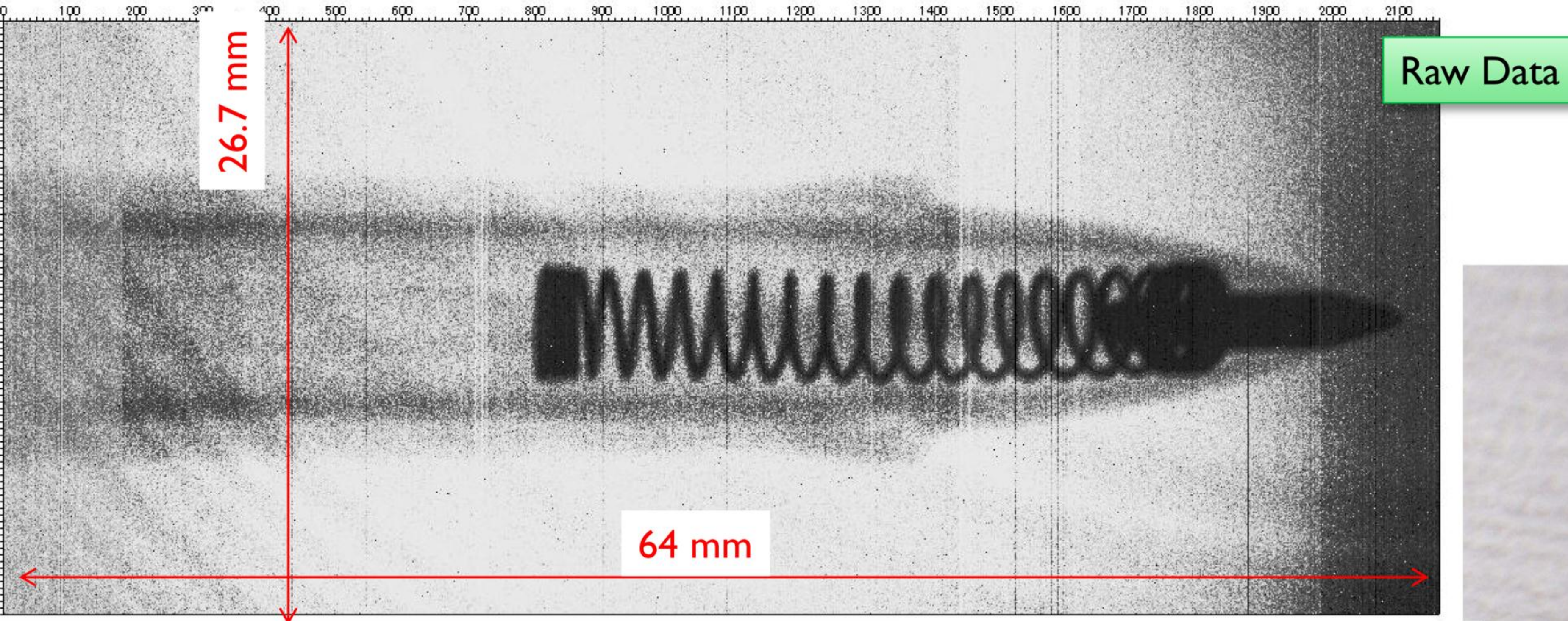
- Peak Signal 7 Me-
- Noise 100 e- (Effective 16.1 bit)
- Dual gain pixel
- 30 um□ pixel
- 1.9 M pixel/chip
- 60 frame/sec

See Poster #25 for details: Omodani et.al.

SOPHIAS Pixel Layout by Multi-Via Concept







25 msec Exposure Ag 20 kV 0.2 mA

Front end electronics for European XFEL sensor: the AGIPD project

Julian Becker, Laura Bianco, Peter Göttlicher, Heinz Graafsma, Helmut Hirsemann, Stefanie Jack, Alexander Klyuev, Michael Lohmann, **Alessandro Marras**, Björn Nilsson, Sabine Sengelmann, Ulrich Trunk,

Dominic Greiffenberg, Beat Henrich, Aldo Mozzanica, Bernd Schmitt, Xintian Shi,

Michael Karagounis, Hans Krueger,

Robert Klanner, Joern Schwandt, Jiaguo Zhang

HELMHOLTZ GEMEINSCHAFT DESY
PAUL SCHERRER INSTITUT PSI
universitätbonn
Universität Hamburg

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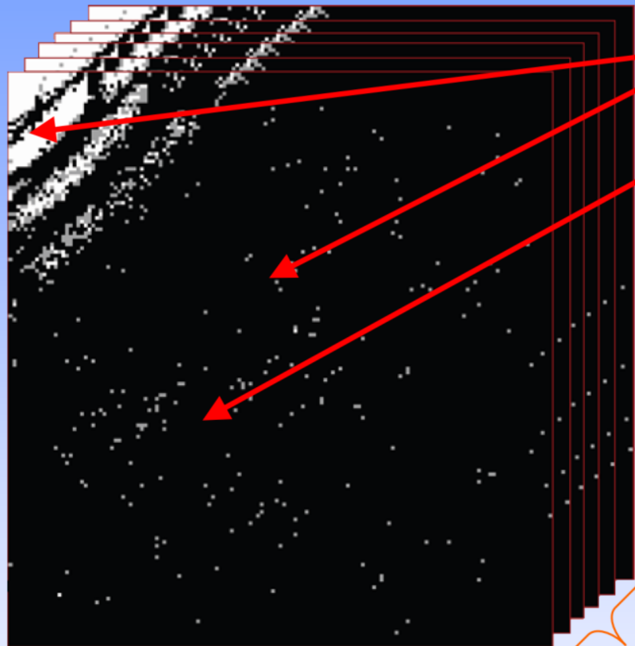
PAUL SCHERRER INSTITUT PSI
universitätbonn
Universität Hamburg

Constraint Summary

AGIPD

in the same image:
- up to ~ 10^4 photons
- down to 0~1



4.5MHz x
2700 images

radiation tolerant!

1-photon resolution!
(or better than poissonian)

single-image experiments!
as many as possible!

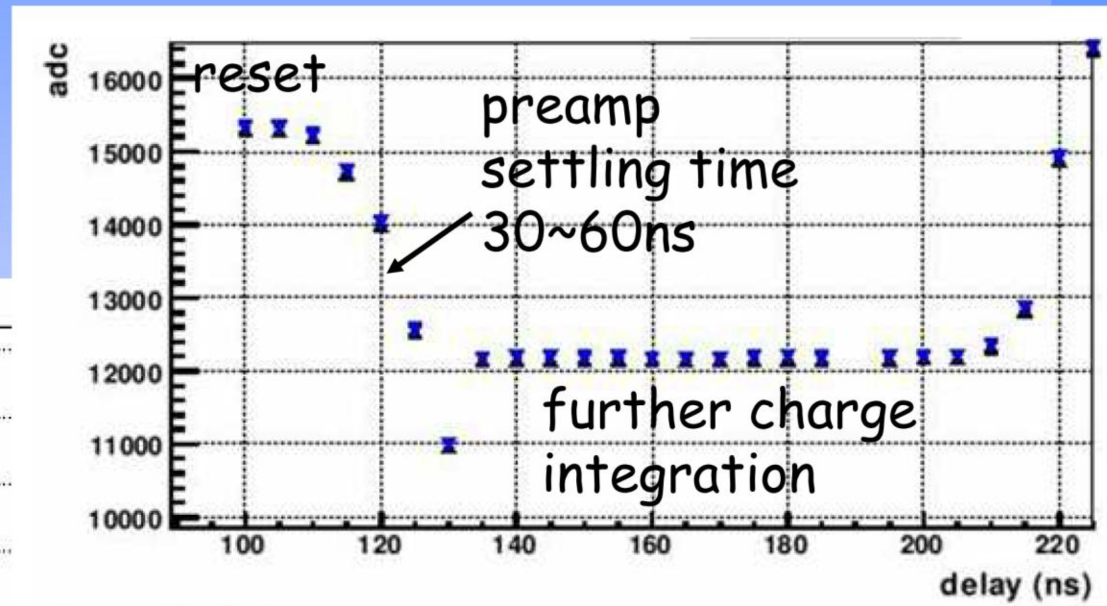
many pixels!
small pixels!

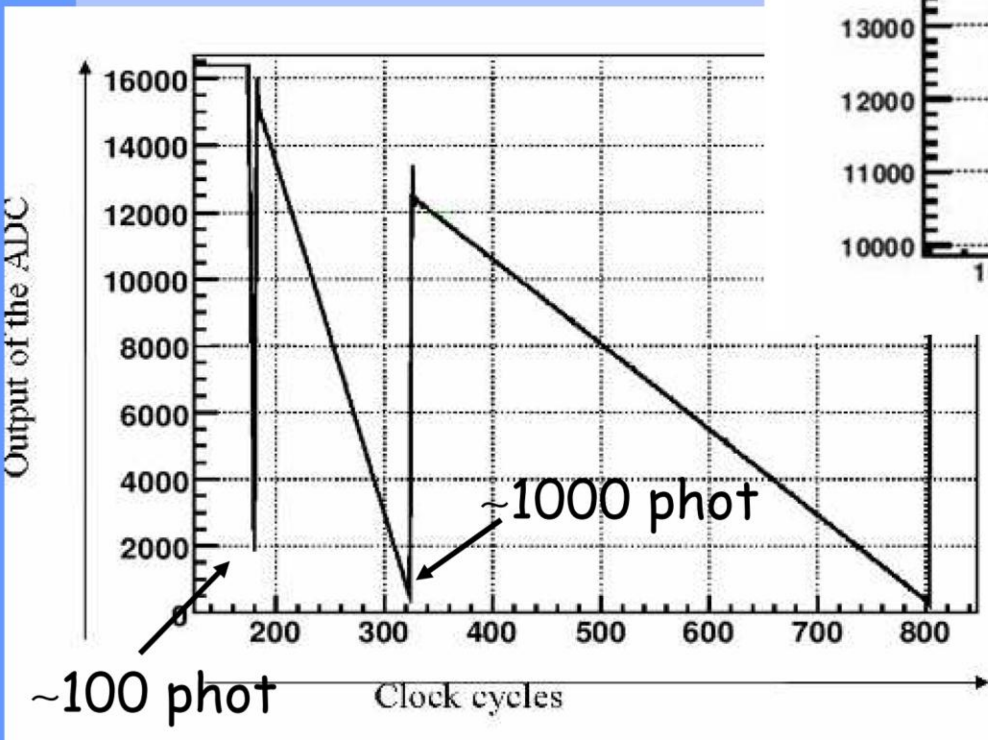
- Charge integration
- Adaptable Gain O(2)
- noise ~ 0.1 photon
- 1Mpixel, 200 µm pitch
- in-pixel Memory ~ 350 frames
- veto schema
- leakage minimization
- rad hard design

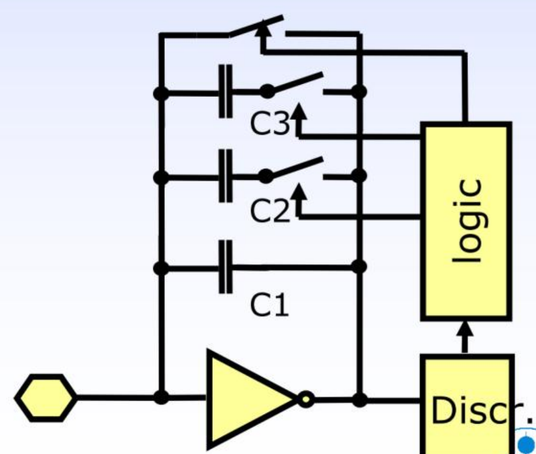
DESY HELMHOLTZ GEMEINSCHAFT

Adaptive Gain

- multiple (3) scaled feedback cap (60fF/3pF/10pF)
- 1:35:4 gain reduction(s)







At Berkley they make nice CCDs for low energies, however I could not extract pages from the presentation so I can not show anything….

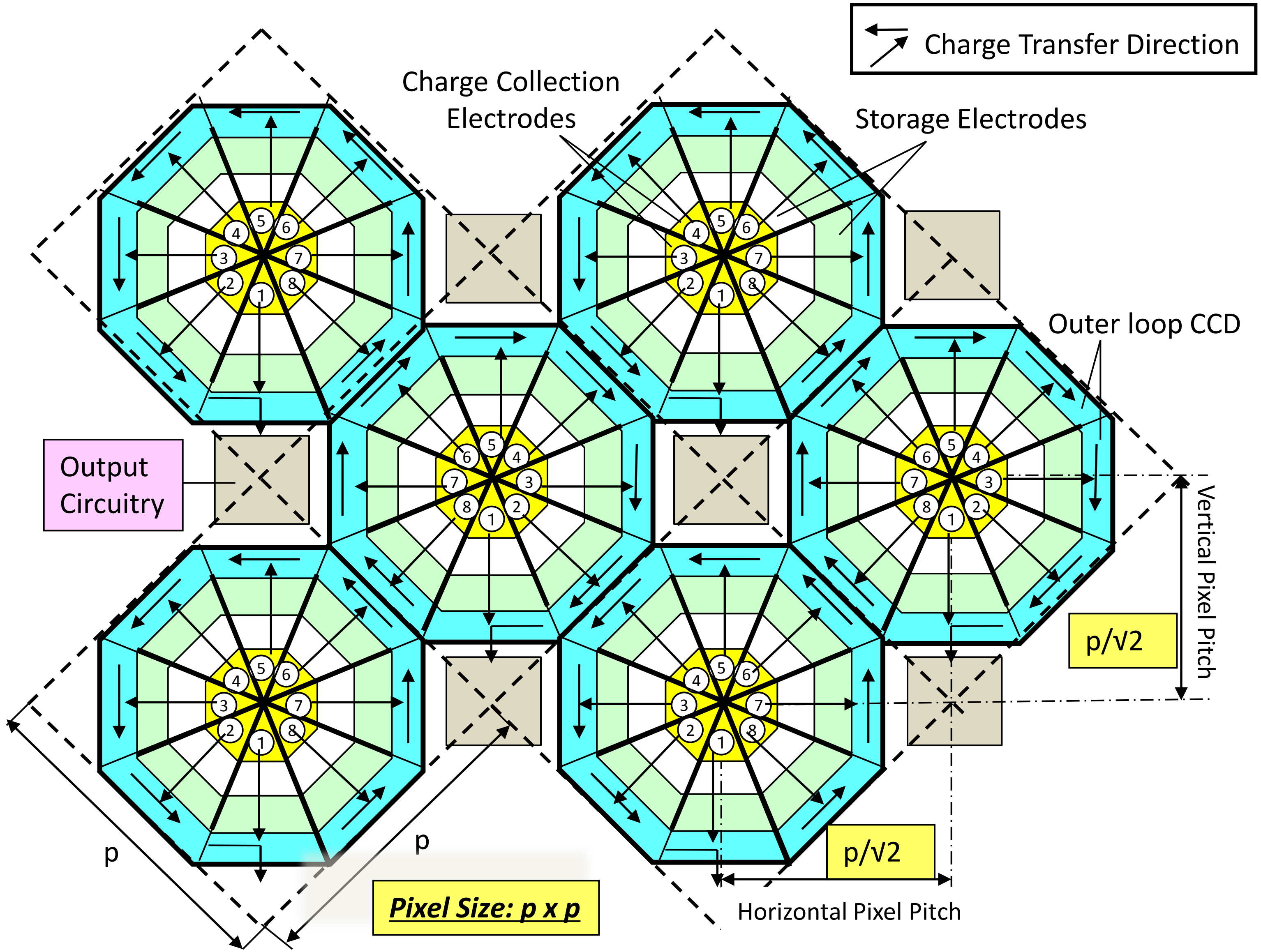
Toward one Giga frames per second
- Evolution of In-Situ Storage Image Sensors -

PIXEL2012

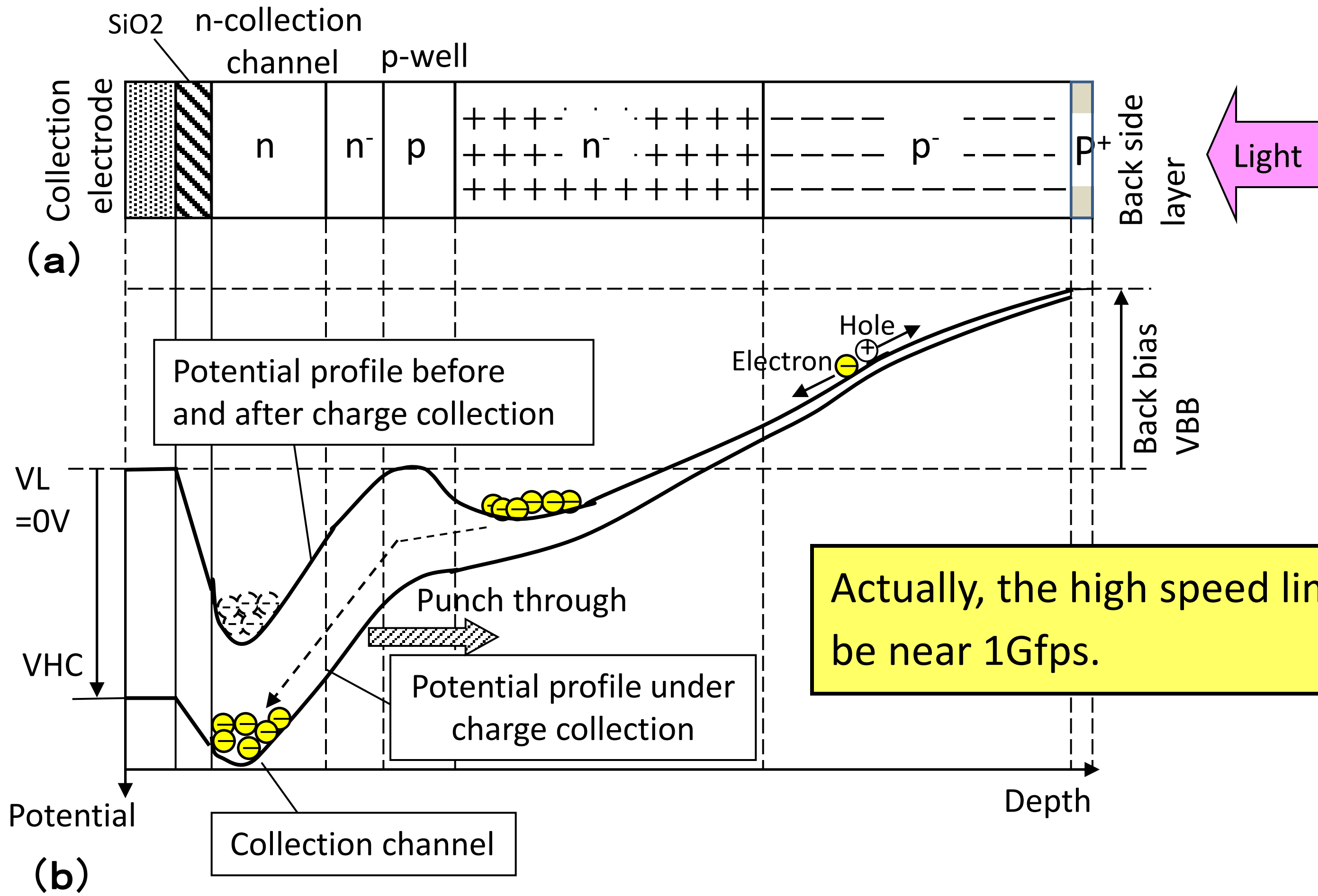
“6th International Workshop on Semiconductor Pixel Detectors for Particles and Imaging”

September 3 – 7, 2012; Inawashiro, Japan

ETOH, T. Goji & DAO, V. T. Son (Ritsumeikan University)
YAMADA, Tetsuo* (Tokyo Polytechnic University)
(*Speaker)



An Example of Pixel Arrangement (Pixel Interleaved Array)



Actually, the high speed limitation will be near 1Gfps.

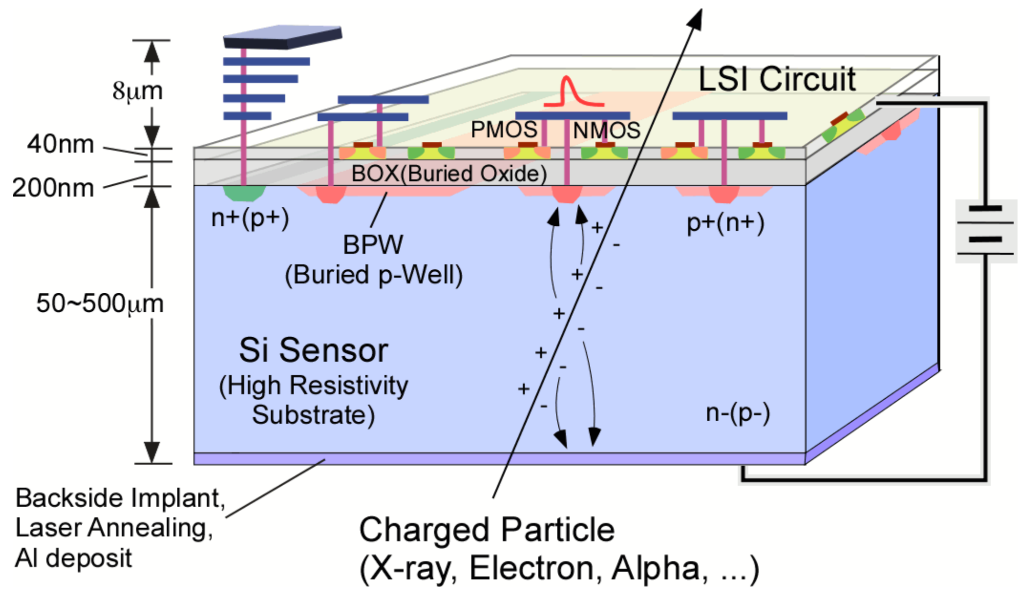
Charge Collection Mechanism

（a）One Dimensional Si-Bulk Structure, （b）Potential Profile

Technology

Lapis SOI Pixel summary

8 Oral Talks &
4 Poster presentations



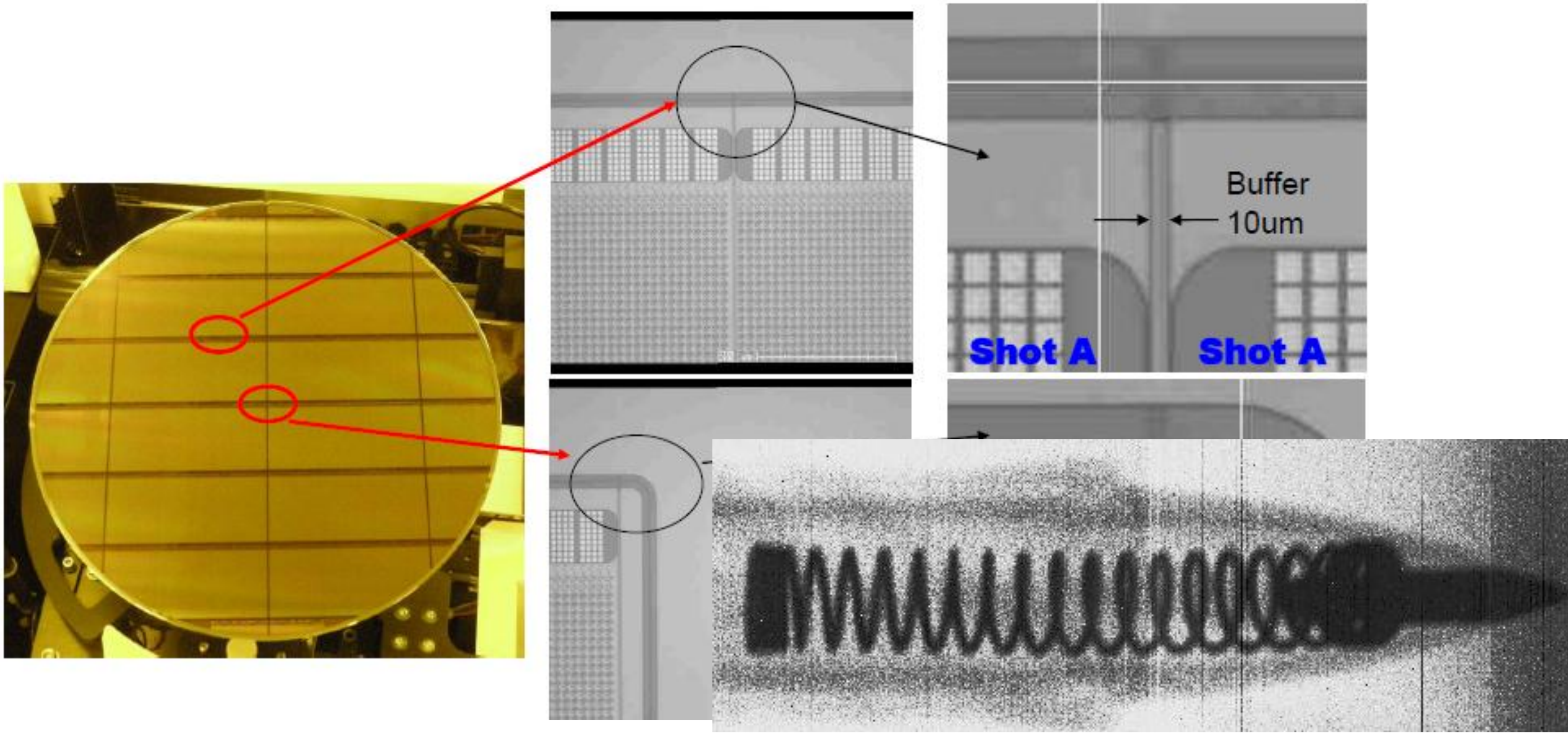
Yasuo Arai SOI Pixel Process

- SOIPIX Collaboration is increasing with regular MPW runs.
- Steady progress on the Process : Buried p-well, High Resistivity Wafer, Larger Mask, Stitching, Nested well, 3D integration ...
- Remaining issues are TID and Cross-talk.
  To solve these issues, Double-SOI wafer is introduced and successfully processed.

SOPHIAS Detector

T. Hatsui

◆Stitching Process: Intermediate Observation

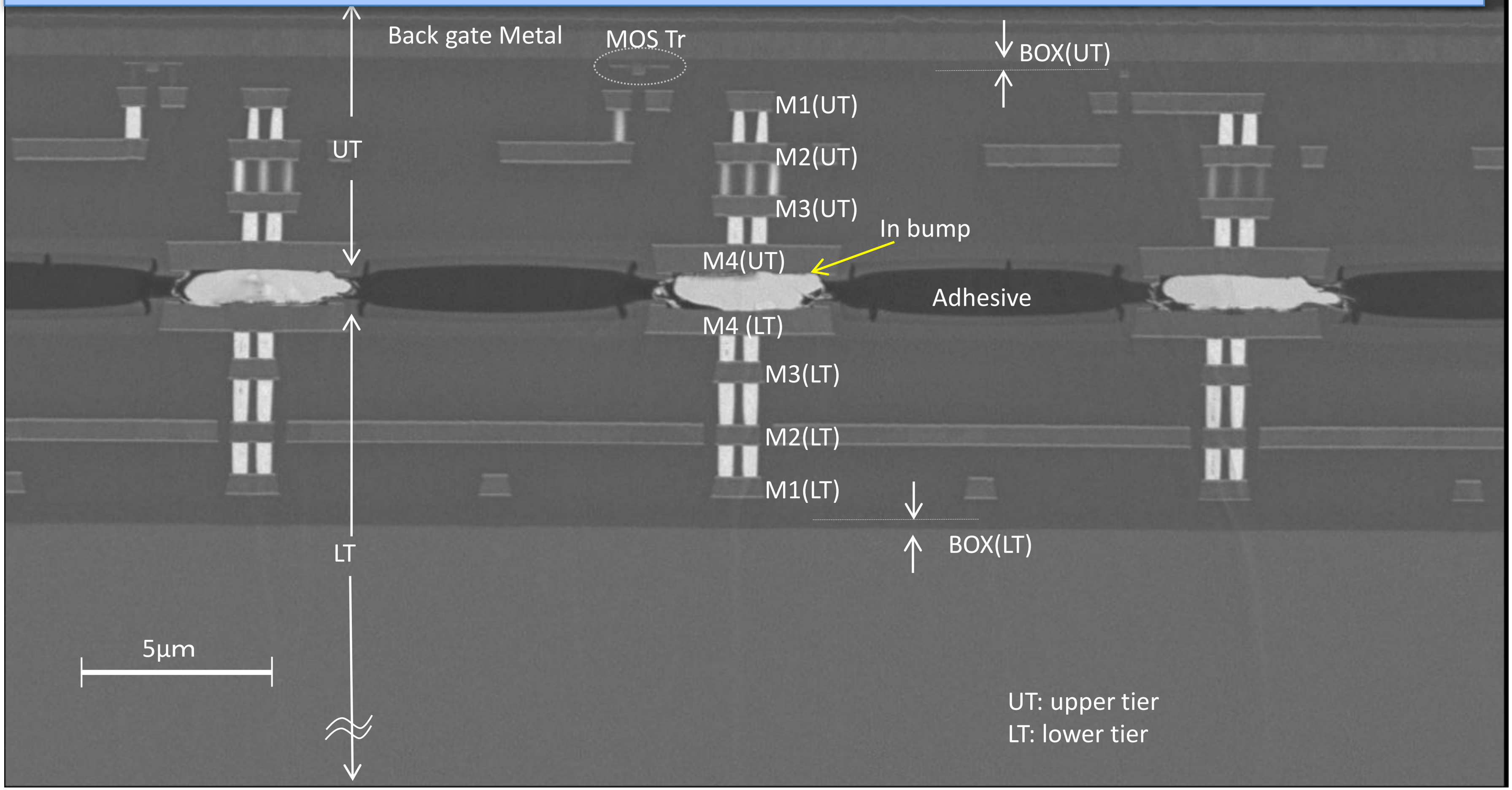


Large dynamic range X-ray detector (SOPHIAS) is successfully operated. The Detector of 3cm x 6cm is made with stitching for the first time.

3D Integration of SOI Wafer

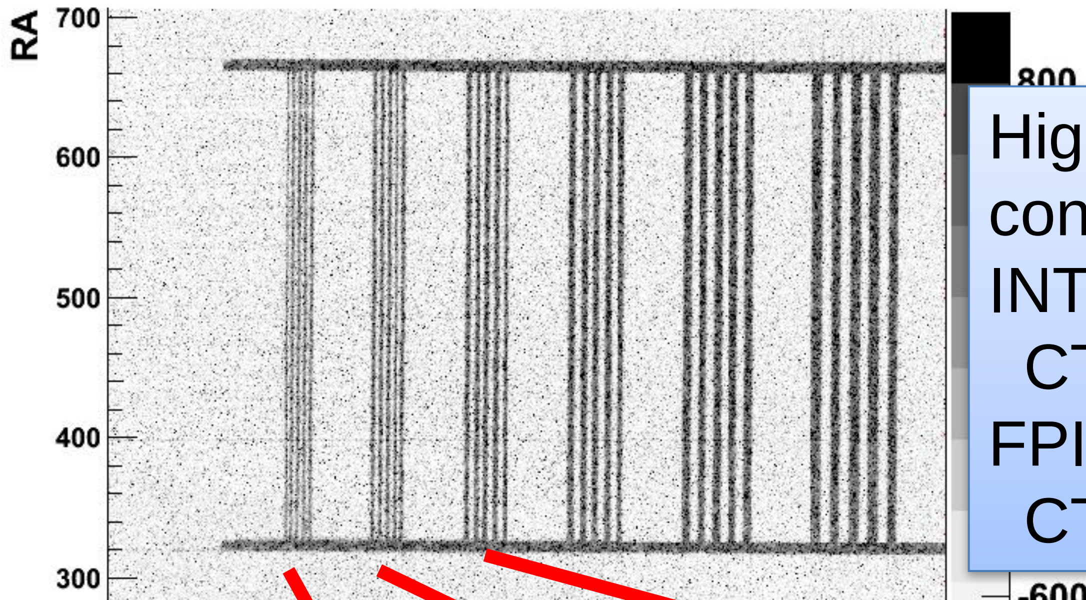
M. Motoyoshi

3D LSI Integration technology using minimum 5μm pitch bump is verified using SOI stacked pixel detector as circuit level test device.



High-Resolution Monolithic Pixel Detectors

T. Miyoshi



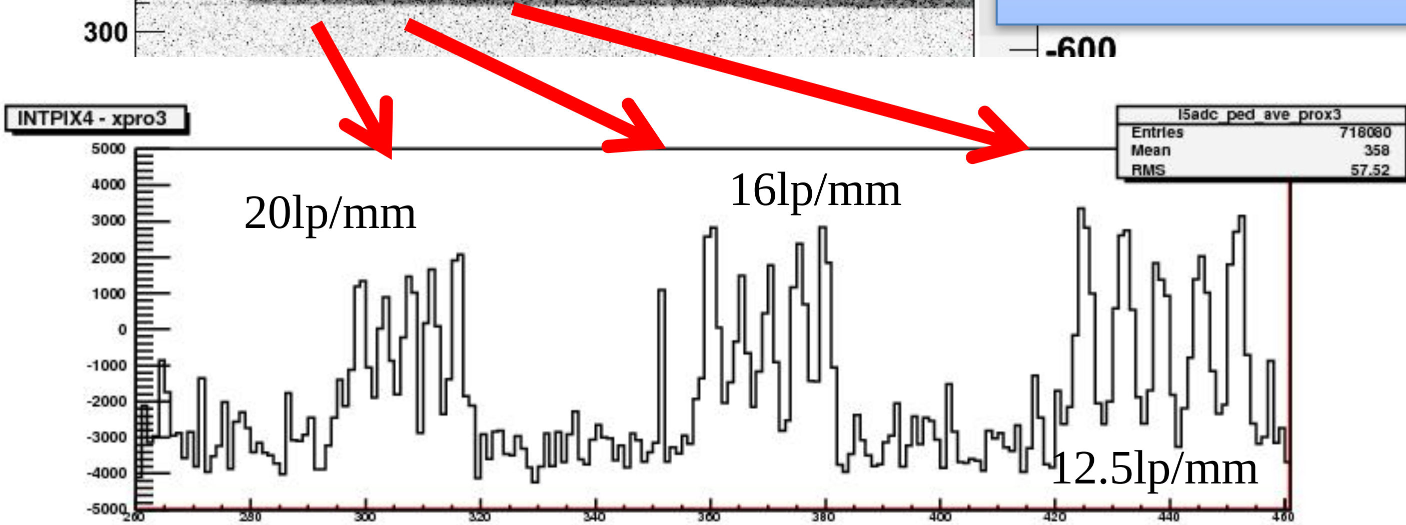
High spatial resolution is confirmed.

INTPIX5 :

CTF ~ 80% in 20 LP/mm

FPIX1 :

CTF > 20% in 8 μm slits



20lp/mm slits are cleary seen CTF > 50%

Very sucessful, nice and enjoyable conference

Well organized with many interesting
Talks

Lots of good food

Secretariat:
Yuko Honda, Yukiko Ikemoto
Session secretaries
Ryuma Hori, Akiya Takeda, Ryo Ichimiya
Photographer
Sebastian Glab

Thanks to the organizer !!!!