Technology transfer: Another contribution from High Energy Physics

Efforts in KEK

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KEK
KEK: Center for High Energy Accelerator/Science Research
KEK: Versatile Research Institute for Particle, Nucleus, Materials and Life-Science, utilizing diverse beams of SuperKEKB and ILC.
From Science to Society

**Fundamental Science (Big Science)**
- Advanced Accelerator
- Innovative detector
- HP Computing/Network/
- ASIC development

Only one

**Variety of Sciences (medium/small scale)**
- Material, Life Science
- Photon and neutron
- Compact accelerator
- Compact detector system

~100

**Industrial, medical, commercial applications**
- Reliable, High Yield
- Cost effective
- Mass productive

~100,00 to million

**Ultra high performance**

Competitive performance/
Reasonable cost

Standard performance/
Lower cost
High reliability
KEK Detector Technology Project
Detector Technology Development

Super Cond. device
Pixel technology
MPGD
Liquid TPC
Single photon sensor

Generic detector technologies

Nano technology
Cryogenics
Laser

Interactive Researches and Developments

Network
μ-electronics
μ-lithography

Generic Tools

Pure and Applied Sciences and more …
SR/FEL Xray
LHC
Neutron Science
Belle II
Liq TPC DM / ν
ILC
CMB FIR astronomy
J-PARC
Gamma camera
SOI pixel R&D started at KEK in 2006

Monolithic detector:
Sensor and electronics fabricated on a single wafer
Monolithic Detector having fine resolution of silicon and data processing power of CMOS LSI by using Silicon-On-Insulator (SOI) Technology.
SOI monolithic chip, SOFIST proposed for ILC with rad. hard

**SOFIST**

(SOI sensor for Fine measurement)

**Final design**

Active area 3125(H)×500(V) pixels

Pixel size = 20 x 20 μm²
Thickness = 50 μm
Invoke innovations in wide range field of Basic Science

High Energy Physics

Ultra Fast Imaging mass spectrometry

FIR observatory

Evolution of stars and Galaxy

X-ray imaging for Photon Science

Nano particle $10^5$ atom

$\Delta x \approx 10$ nm

Explore ultra large Balckhole at Early universe

XFEL with femto sec and 1nm resolutions

128x128 (目標)

3D structure of Biocell

2mm

SOIPIX (目標)

X-ray Astronomy
SOI can hold more complicated circuit without separating wells.

In the SOI process, it is possible to merge NMOS & PMOS Active region and share contacts.
Looking Fine Pattern with X-ray

INTPIX4 FZn, 17μm pixel

FPIX2 FZn, 8μm pixel

25μm Pitch 20μm 16μm

Gray scale

Number of pixel

Contrast of 16μm Pitch Slit

INTPIX4(17 μm pix) : 0.57

FPIX(8 μm pix) : 0.83

16 μm pitch
X-ray Image with the INTPIX

- Needle
- Acrylic Resin
- Stent Wire

PF-AR NE7A 33.3keV
Acrylic resin 40mm
200us x 250 frames

8.704mm
14.144mm

Arb. unit

(INTPIX4)
Tornado research in KEK?

Quick and early detection of presage phenomenon should help a lot.
Presage detection of tornado/heavy rain storm may be possible with a slight sign...

Rapid increase of water vapor in atmosphere

Twister, Rain storm

Sudden and localized
Twister: ~10 m
Heavy rain: 10km area

Rapid development
In a few tens minutes

Wet and warm air
Cold air
Boost
Upper cold air

Wind

To be detected before cloud develops
Water vapor is a serious foreground against CMB observation

**PWV**: Index of water vapor in upper atmosphere

CMB observation
Frequency less affected by Water vapor

**Frequency to monitor PWV**
High sensitive RF detector for CMB observation developed at KEK

Cryogenic system in high speed rotating cryostat

Noise (K) vs System Temp. (K)

- Noise: 50, 300
- System Temp: 10, 300
Successful detection of presage of the coming rain

Data taken at Tsukuba

Observed water vapor

Concentration in atmosphere

PWV (mm)

Date

5月1日 2 4 6 8 10 12 14 16 18

Rainy period
Summary

- Advanced technologies developed for huge detector system in High energy physics is essential tool for the research as well as state-of-the-art accelerators.
- Those technologies have been transferred first to smaller science in wider fields and then to the applications in industrial and medical fields.
- Ultra sensitive detector for particle physics can, for example, make a standard medical diagnose much quicker with extremely lower radiation exposure on a patient.
- Advanced accelerator technologies which were not mentioned this report are also treasure for innovations in industrial and medical applications.