

Korean Group's Activities for PHENIC Nose Cone Calorimeter

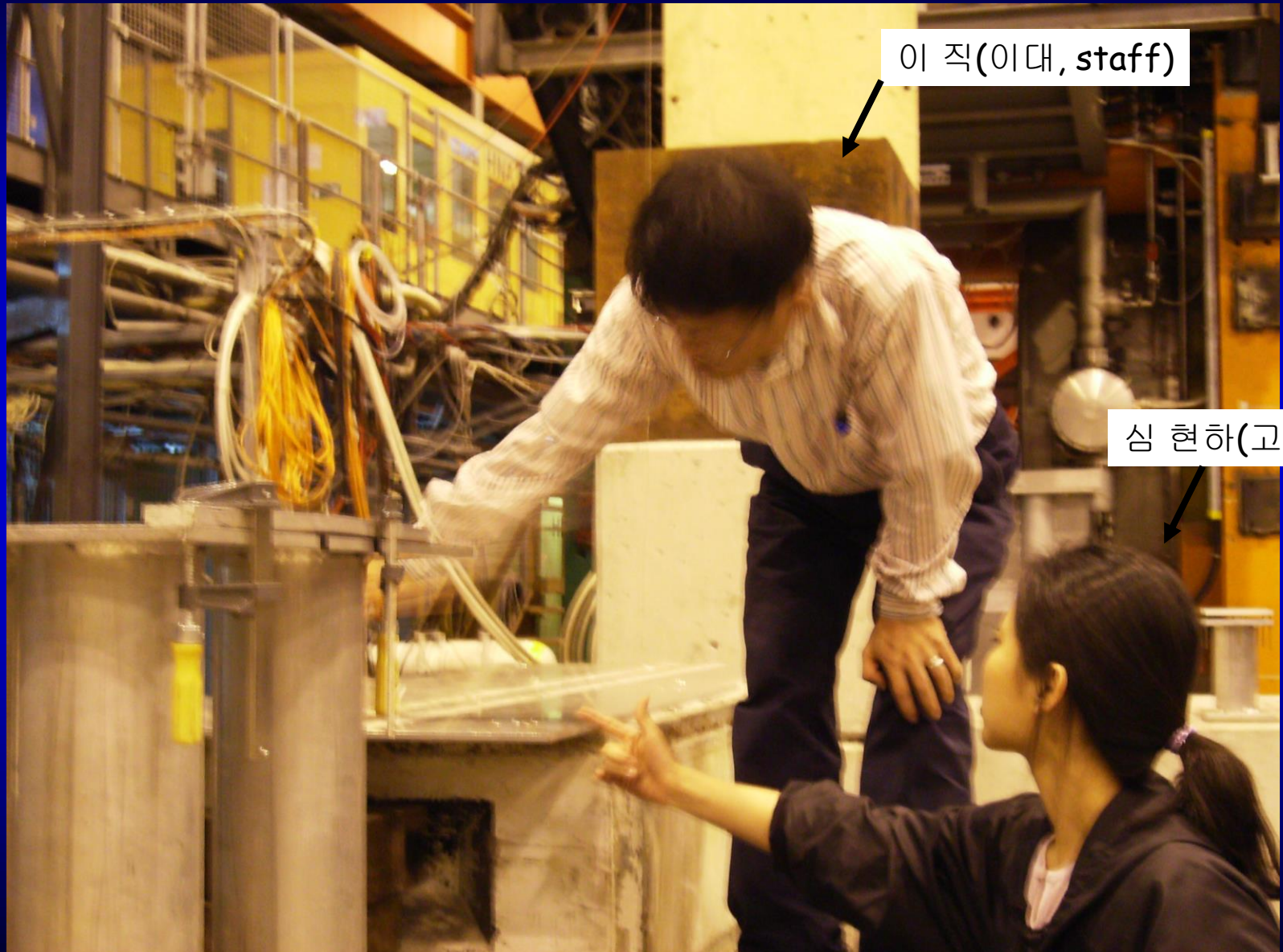
**Youngil Kwon
for Korean NCC group**

**HIM at JeJu
October 20, 2007**

Outline

- **Status report!**
- **We cover behind story... (informal, free style)**
- **Nosecone Calorimeter (NCC)**
 - **Beam Test**
 - **Sensor Production**

CERN Beam test & Pictures





이 혜영(이대)





이 남희(이대)

문 혜진(명지대)



복 정수(연세대)

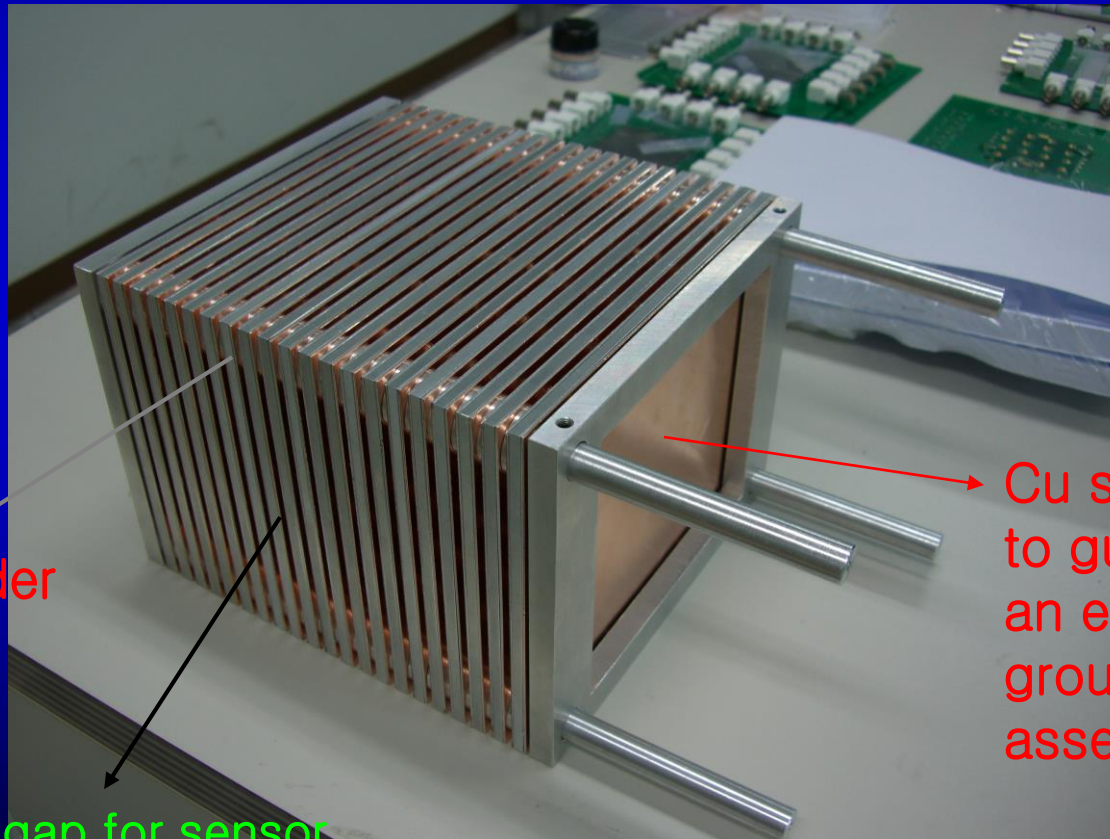
Russian connection?



Interests in Si sensors, students, physics (muon)

CERN Beam Test

- Support 20 layers of W-Si pad sensor sandwich (2 W-Si, but readout only 1 W-Si having 16 channels*3 due to limited pre-amp's)
- Silicon sensor : 62mm*62mm * 380 um
- Tungsten : ~ 65.5mm* 57.4mm * 3.5 mm

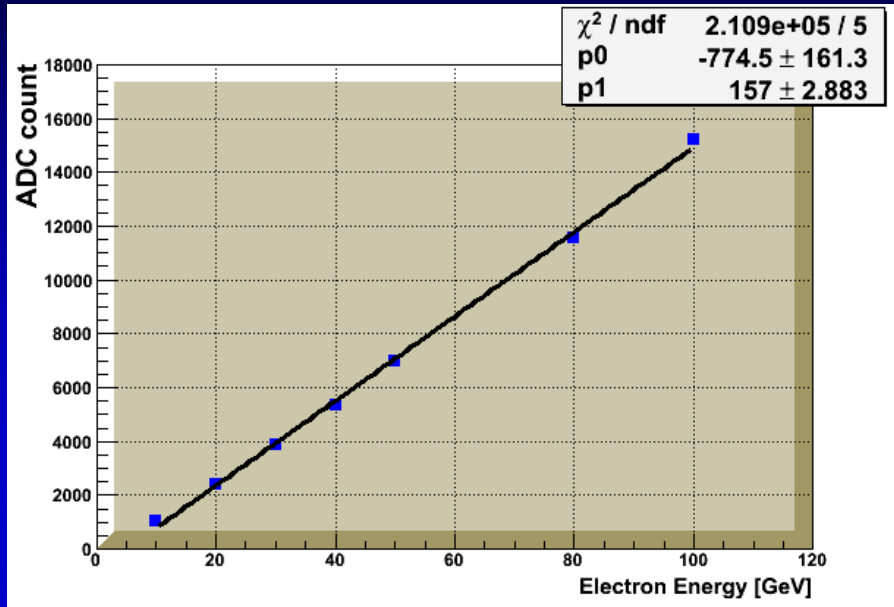


Tungsten holder w/ Cu skins

Cu skin of W holder to guarantee an excellent ground for the whole assembly

2.5mm gap for sensor and mount components

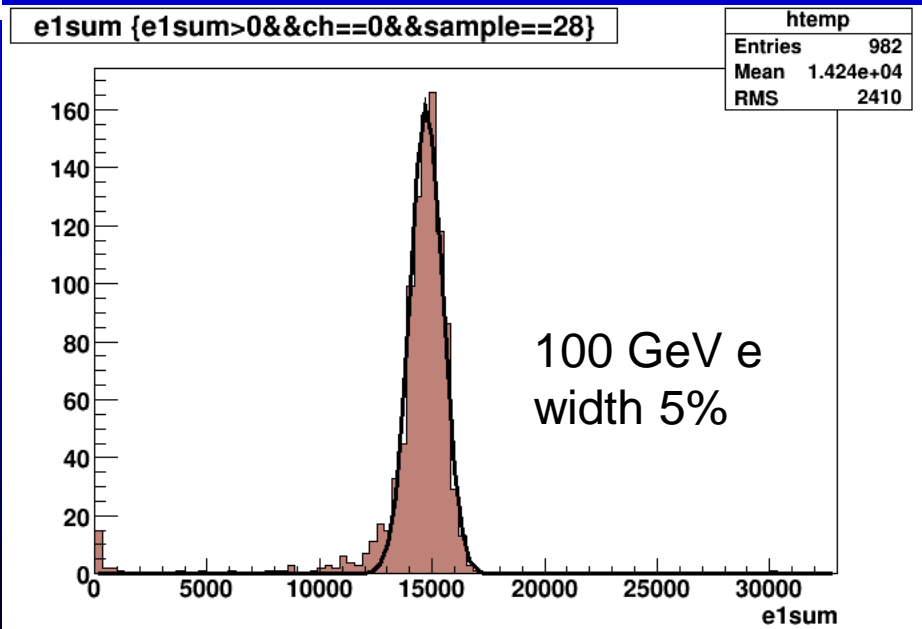
Beam test results



✓ ADC mean value shows linear dependence on incident electron energy

Close to simulation result

$$\frac{\Delta E}{E} = \frac{23\%}{\sqrt{E}} + 1\%$$



Issues

The PHENIX Detector

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Charged Particle Tracking:

Drift Chamber
Pad Chamber
Time Expansion Chamber/TRD
Cathode Strip Chambers (Mu Tracking)

Particle ID:

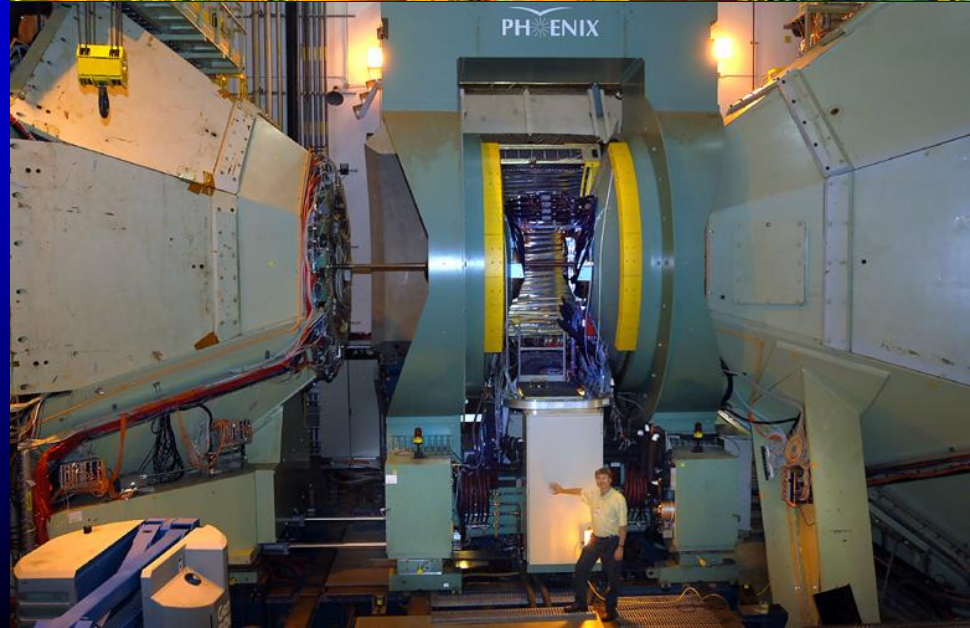
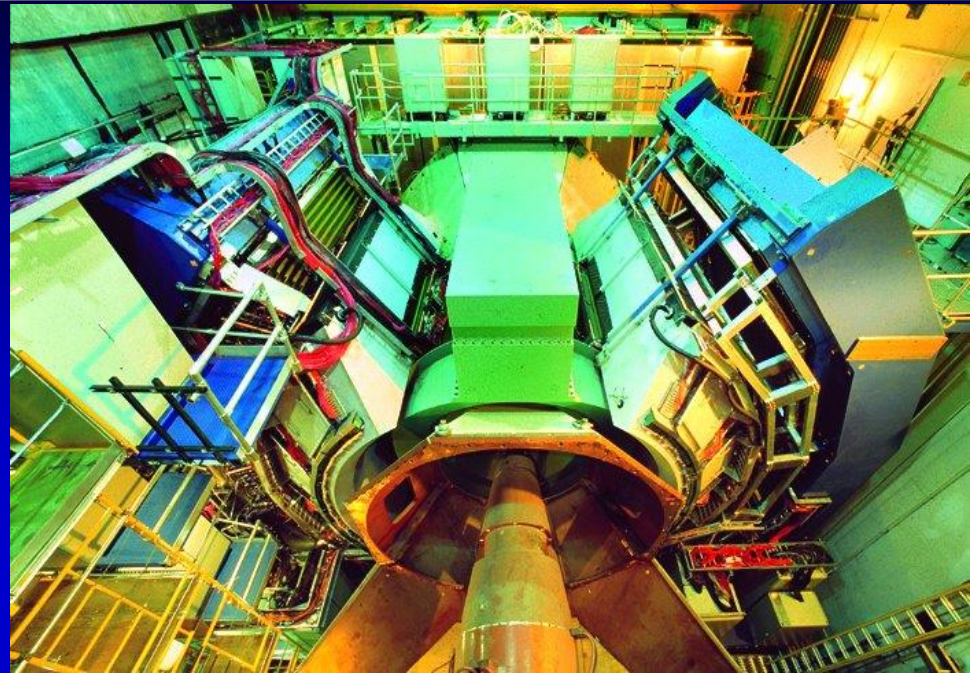
Time of Flight
Ring Imaging Cerenkov Counter
TEC/TRD
Muon ID (PDT's)
Aerogel Cerenkov Counter

Calorimetry:

Pb Scintillator
Pb Glass

Event Characterization:

Beam-Beam Counter
Zero Degree Calorimeter
Forward Calorimeter



Collaboration

Universidade de São Paulo, Instituto de Física, Caixa Postal 66318, São Paulo CEP05315-970, Brazil

Institute of Physics, Academia Sinica, Taipei 11529, Taiwan

China Institute of Atomic Energy (CIAE), Beijing, People's Republic of China

Peking University, Beijing, People's Republic of China

Charles University, Ovocnýtrh 5, Praha 1, 116 36, Prague, Czech Republic

Czech Technical University, Zikova 4, 166 36 Prague 6, Czech Republic

Institute of Physics, Academy of Sciences of the Czech Republic, Na Slovance 2,

182 21 Prague 8, Czech Republic

Helsinki Institute of Physics and University of Jyväskylä, P.O.Box 35, FI-40014 Jyväskylä, Finland

Dapnia, CEA Saclay, F-91191, Gif-sur-Yvette, France

Laboratoire Leprince-Ringuet, Ecole Polytechnique, CNRS-IN2P3, Route de Saclay,

F-91128, Palaiseau, France

Laboratoire de Physique Corpusculaire (LPC), Université Blaise Pascal, CNRS-IN2P3,

Clermont-Fd, 63177 Aubiere Cedex, France

IPN-Orsay, Université Paris Sud, CNRS-IN2P3, BP1, F-91406, Orsay, France

SUBATECH (Ecole des Mines de Nantes, CNRS-IN2P3, Université de Nantes)

BP 20722 - 44307, Nantes, France

Institut für Kernphysik, University of Münster, D-48149 Münster, Germany

Debrecen University, H-4010 Debrecen, Egyetem tér 1, Hungary

ELTE, Eötvös Loránd University, H - 1117 Budapest, Pázmány P. s. 1/A, Hungary

KFKI Research Institute for Particle and Nuclear Physics of the Hungarian Academy of Sciences (MTA KFKI RMKI),

H-1525 Budapest 114, POBox 49, Budapest, Hungary

Department of Physics, Banaras Hindu University, Varanasi 221005, India

Bhabha Atomic Research Centre, Bombay 400 085, India

Weizmann Institute, Rehovot 76100, Israel

Center for Nuclear Study, Graduate School of Science, University of Tokyo, 7-3-1 Hongo, Bunkyo,

Tokyo 113-0033, Japan

Hiroshima University, Kagamiyama, Higashi-Hiroshima 739-8526, Japan

KEK, High Energy Accelerator Research Organization, Tsukuba, Ibaraki 305-0801, Japan

Kyoto University, Kyoto 606-8502, Japan

Nagasaki Institute of Applied Science, Nagasaki-shi, Nagasaki 851-0193, Japan

RIKEN, The Institute of Physical and Chemical Research, Wako, Saitama 351-0198, Japan

Physics Department, Rikkyo University, 3-34-1 Nishi-Ikebukuro, Toshima, Tokyo 171-8501, Japan

Department of Physics, Tokyo Institute of Technology, Oh-okayama, Meguro, Tokyo 152-8551, Japan

Institute of Physics, University of Tsukuba, Tsukuba, Ibaraki 305, Japan

Waseda University, Advanced Research Institute for Science and Engineering, 17 Kikui-cho,

Shinjuku-ku, Tokyo 162-0044, Japan

Chonbuk National University, Jeonju, Korea

Ewha Womans University, Seoul 120-750, Korea

KAERI, Cyclotron Application Laboratory, Seoul, South Korea

Kangnung National University, Kangnung 210-702, South Korea

Korea University, Seoul, 136-701, Korea

Myongji University, Yongin, Kyonggido 449-728, Korea

System Electronics Laboratory, Seoul National University, Seoul, South Korea

Yonsei University, IPAP, Seoul 120-749, Korea

IHEP Protvino, State Research Center of Russian Federation, Institute for High Energy Physics,

Protvino, 142281, Russia

Joint Institute for Nuclear Research, 141980 Dubna, Moscow Region, Russia

Russian Research Center "Kurchatov Institute", Moscow, Russia

PNPI, Petersburg Nuclear Physics Institute, Gatchina, Leningrad region, 188300, Russia

Saint Petersburg State Polytechnic University, St. Petersburg, Russia

Skobel'syn Institute of Nuclear Physics, Lomonosov Moscow State University, Vorob'evy Gory,

Moscow 119992, Russia

Department of Physics, Lund University, Box 118, SE-221 00 Lund, Sweden



14 Countries; 69 Institutions

July 2007

Abilene Christian University, Abilene, TX 79699, U.S.

Collider-Accelerator Department, Brookhaven National Laboratory, Upton, NY 11973-5000, U.S.

Physics Department, Brookhaven National Laboratory, Upton, NY 11973-5000, U.S.

University of California - Riverside, Riverside, CA 92521, U.S.

University of Colorado, Boulder, CO 80309, U.S.

Columbia University, New York, NY 10027 and Nevis Laboratories, Irvington, NY 10533, U.S.

Florida Institute of Technology, Melbourne, FL 32901, U.S.

Florida State University, Tallahassee, FL 32306, U.S.

Georgia State University, Atlanta, GA 30303, U.S.

University of Illinois at Urbana-Champaign, Urbana, IL 61801, U.S.

Iowa State University, Ames, IA 50011, U.S.

Lawrence Livermore National Laboratory, Livermore, CA 94550, U.S.

Los Alamos National Laboratory, Los Alamos, NM 87545, U.S.

University of Maryland, College Park, MD 20742, U.S.

Department of Physics, University of Massachusetts, Amherst, MA 01003-9337, U.S.

Muhlenberg College, Allentown, PA 18104-5586, U.S.

University of New Mexico, Albuquerque, NM 87131, U.S.

New Mexico State University, Las Cruces, NM 88003, U.S.

Oak Ridge National Laboratory, Oak Ridge, TN 37831, U.S.

RIKEN BNL Research Center, Brookhaven National Laboratory, Upton, NY 11973-5000, U.S.

Chemistry Department, Stony Brook University, Stony Brook, SUNY, NY 11794-3400, U.S.

Department of Physics and Astronomy, Stony Brook University, SUNY, Stony Brook, NY 11794, U.S.

University of Tennessee, Knoxville, TN 37996, U.S.

Vanderbilt University, Nashville, TN 37235, U.S.

NCC Groups and Activities

Members

- **BNL**
- **CZECH GROUP**
- **Jyvaskyla, Finland**
- **KOREA GROUP**
- **RIKEN**
- **RUSSIA GROUP**

□ **Korea Group**

- **Chonbuk Univ.**
- **Ewha Univ.**
- **Korea Univ.**
- **Myunggi Univ.**
- **Yonsei Univ.**

□ **Activities of Korean Group**

- **Fabrication and test --- prototype stripixel sensors**
- **Fabrication and test --- NCC pad sensors**
- **Design and production of prototype calorimeter (Al support structure and W plates) for CERN beam test**

What's special with NCC?

□ Silicon

□ Under exploration

→ Good fabrication facility in Korea (NTs!, NTs!, ...)

→ Marriage with “high energy”/”nuclear” physics?

→ Silicon in calorimeter? Linear Collider R&D

→ Bright future for Koreans?

□ Academic geometry

□ Participation from universiti**es**... Chonbuk, Ewha,
Korea, Myongy, Yonsei, and **Students!**

NoseCone Calorimeter (NCC) Overview

□ Physics Goals

□ Heavy ions (and pA)

- jet energy loss in sQGP
- medium properties of QGP
- initial state and gluon saturation

□ Spin

- $\Delta G(x)$ to $x \sim 10^{-3}$

Muons?

□ High density Si-W calorimeter to measure over large rapidity

- π^0 's, direct γ
- χ_c
- Jets

□ \$4.3 M (FY07 \$) for 1 NCC

- request is for funding of 1 NCC by DOE
- 2nd NCC to be funded by foreign sources

□ Installed in 2011

The PHENIX Detector

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Charged Particle Tracking:

Drift Chamber
Pad Chamber
Time Expansion Chamber/TRD
Cathode Strip Chambers (Mu Tracking)

Particle ID:

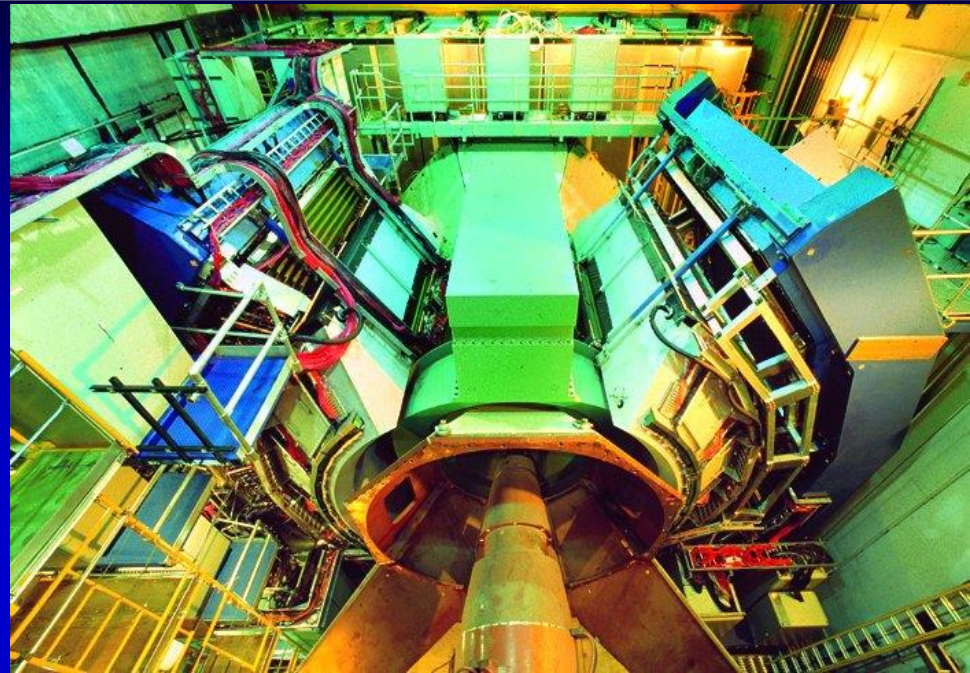
Time of Flight
Ring Imaging Cerenkov Counter
TEC/TRD
Muon ID (PDT's)
Aerogel Cerenkov Counter

Calorimetry:

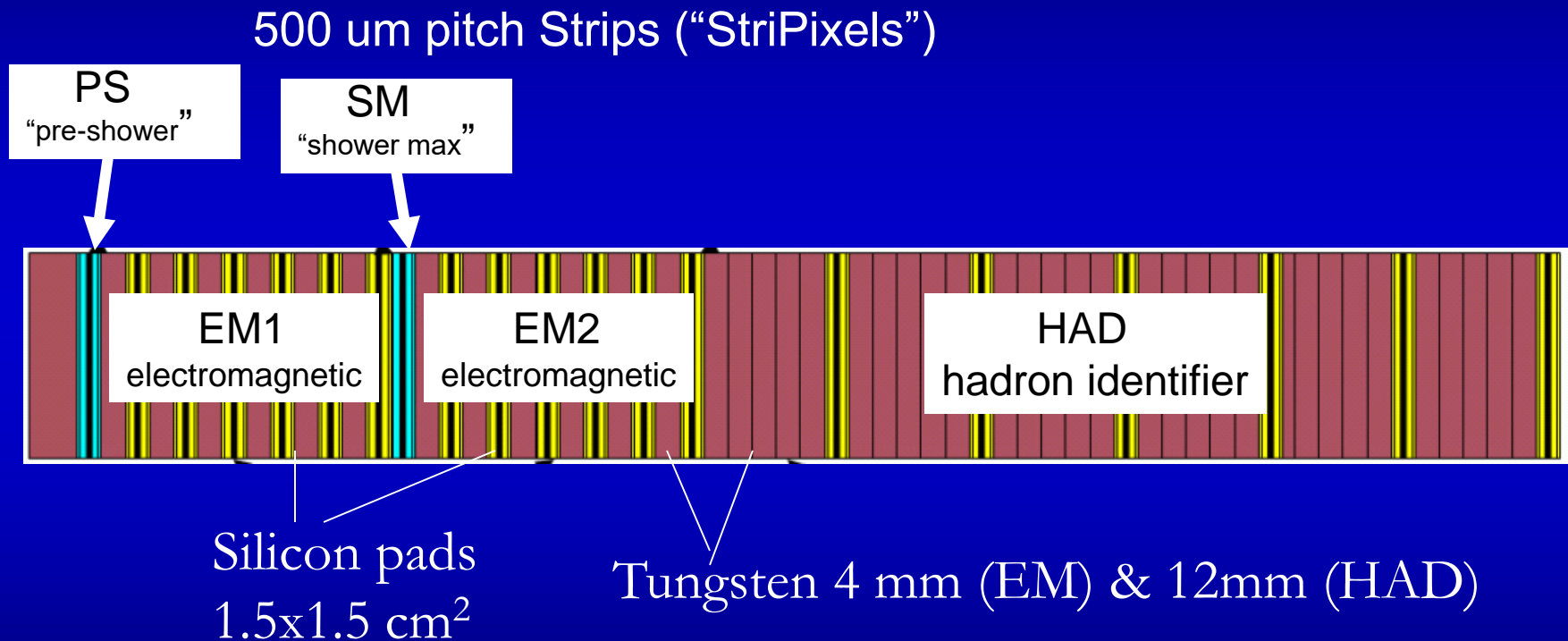
Pb Scintillator
Pb Glass

Event Characterization:

Beam-Beam Counter
Zero Degree Calorimeter
Forward Calorimeter



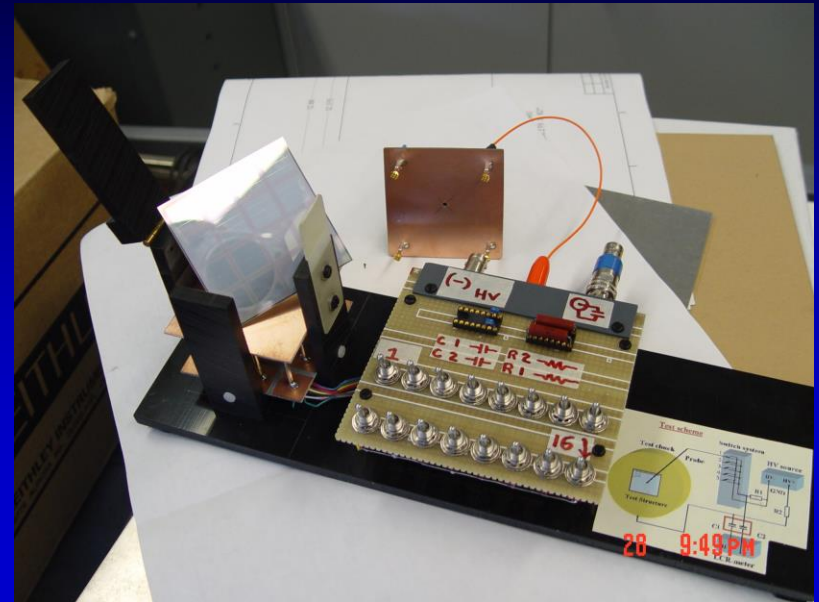
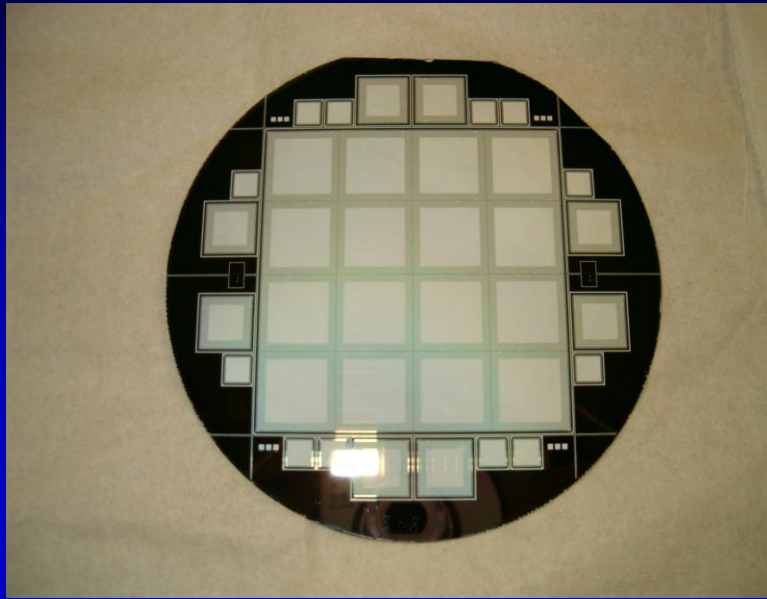
The parts of the NCC



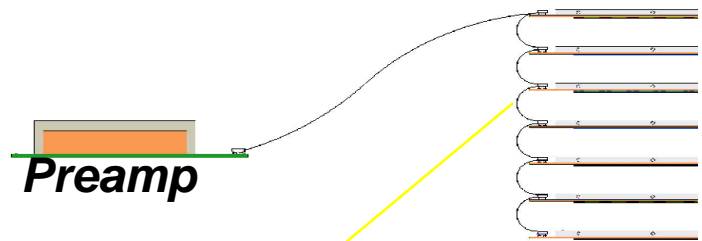
Depth: $42X_0$ ($1.6 \lambda_{\text{ABS}}$)

$$\frac{\Delta E}{E} = \frac{23\%}{\sqrt{E}} + 1\%$$

NCC Pad Readout



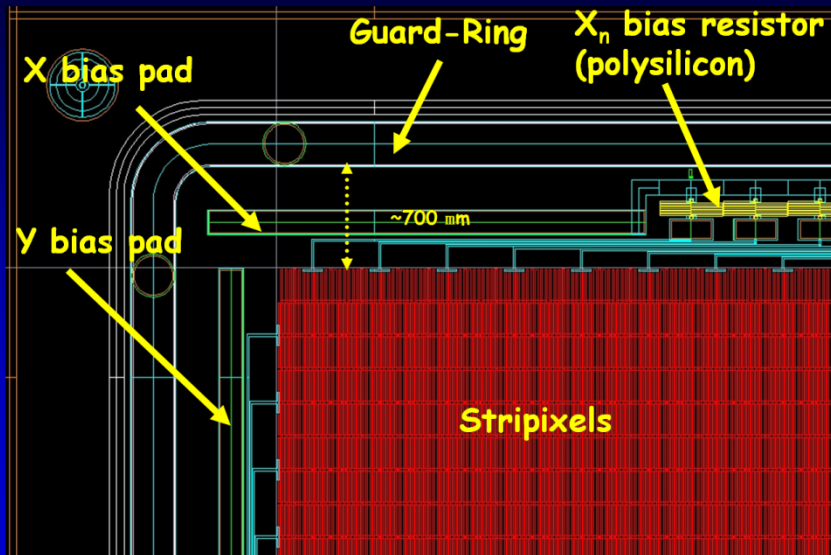
Sampling cell's ganging



FPC cable

- ❑ 62x62 mm² subdivided into 15x15 mm² pads
- ❑ 525 μm , 3-10 k Ω , 111
- ❑ Leakage current 5-15 nA
- ❑ Full depletion at 120V
- ❑ Nominal operating bias 150V
- ❑ PreAmp + ADC board for HBD

Stripixel Sensor



Stripixel (pixelated strips) Sensor

- Single sided sensor with 2D position sensitivity to measure PreShower and ShowerMax position.
- Two independent electrodes interleaved in one pixel ($500 \times 500 \mu^2$) for charge sharing.
- Comb pitch in the 15-60 μ range.

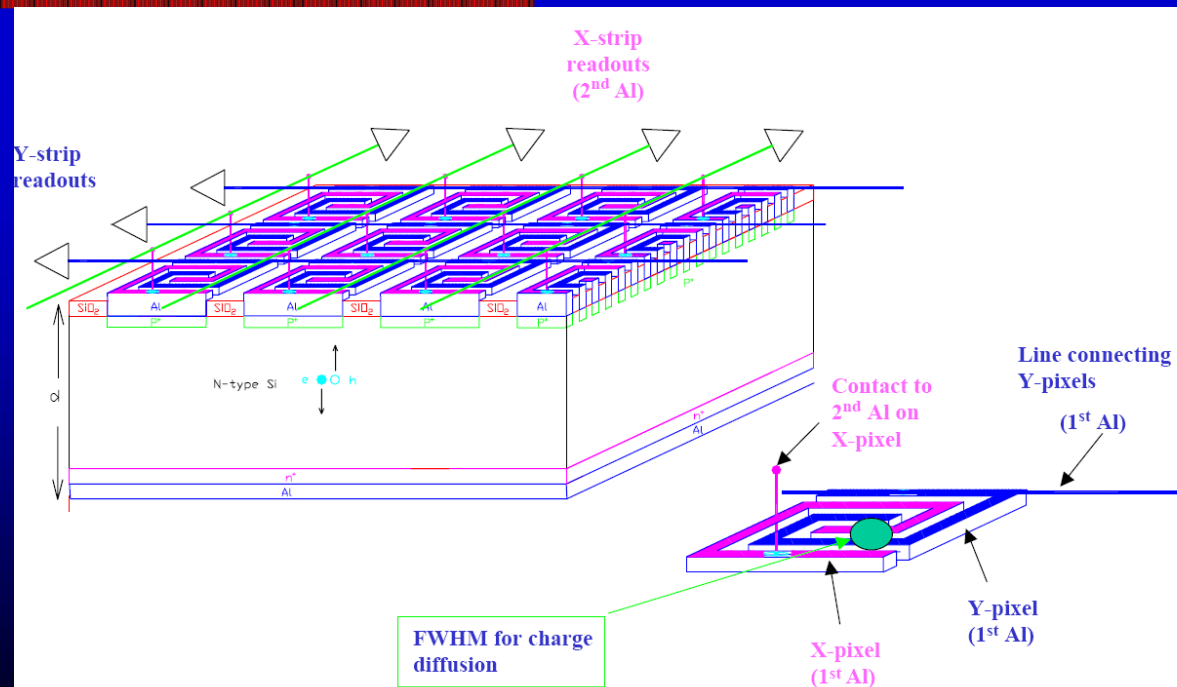
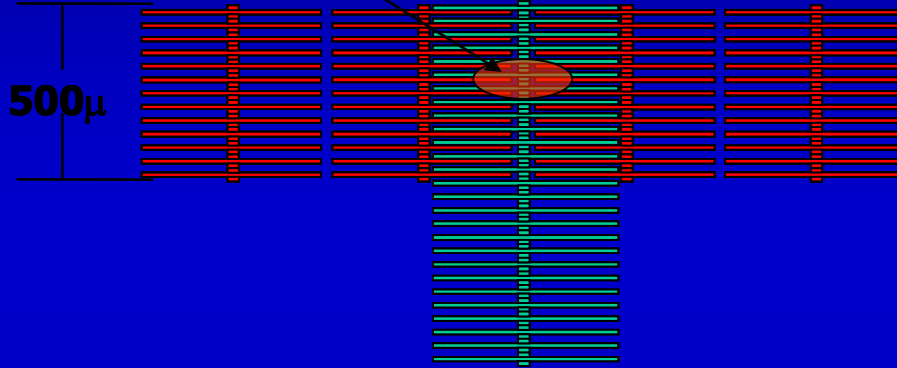


Fig. 1. Schematic of a square spiral interleaving Stripixel scheme for PHENIX upgrade.

PreShower and ShowerMax

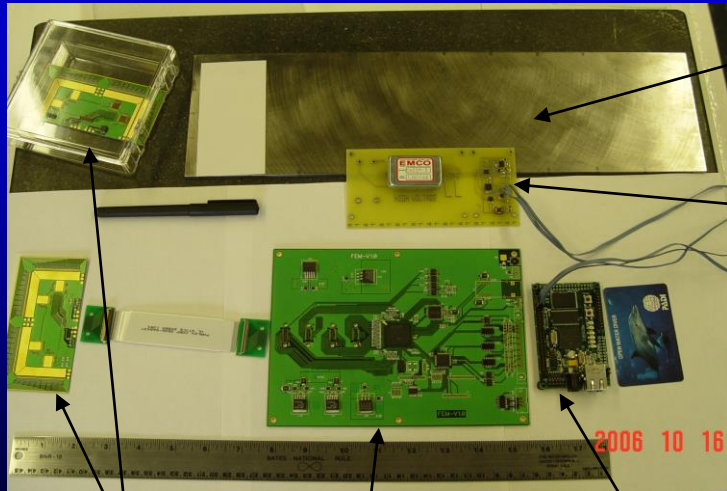
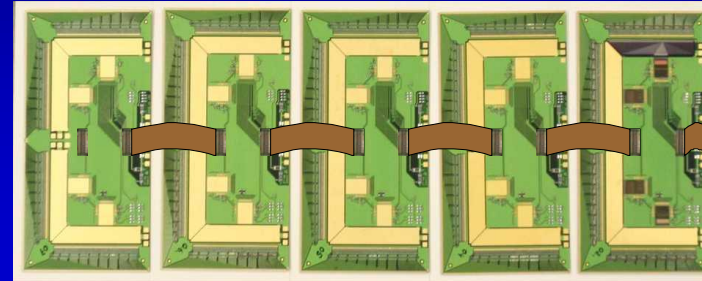
Bridges:

metal
implant



SVX4 based readout

Stripixel readout unit



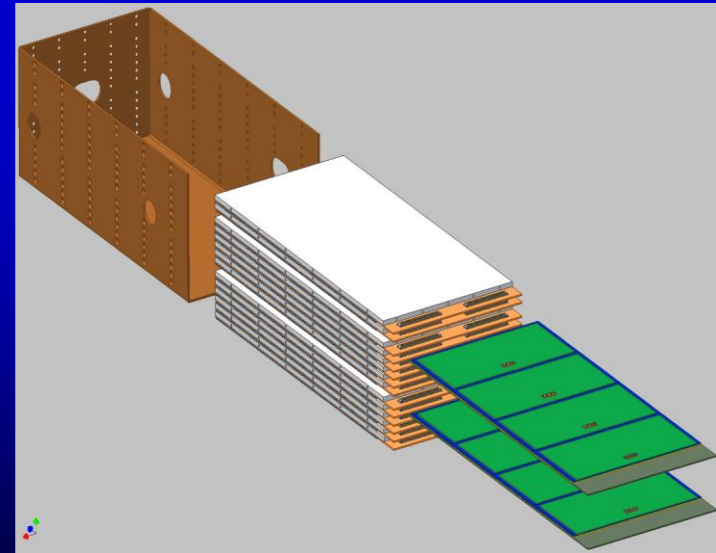
W Plate

Bias

SRC

FEM

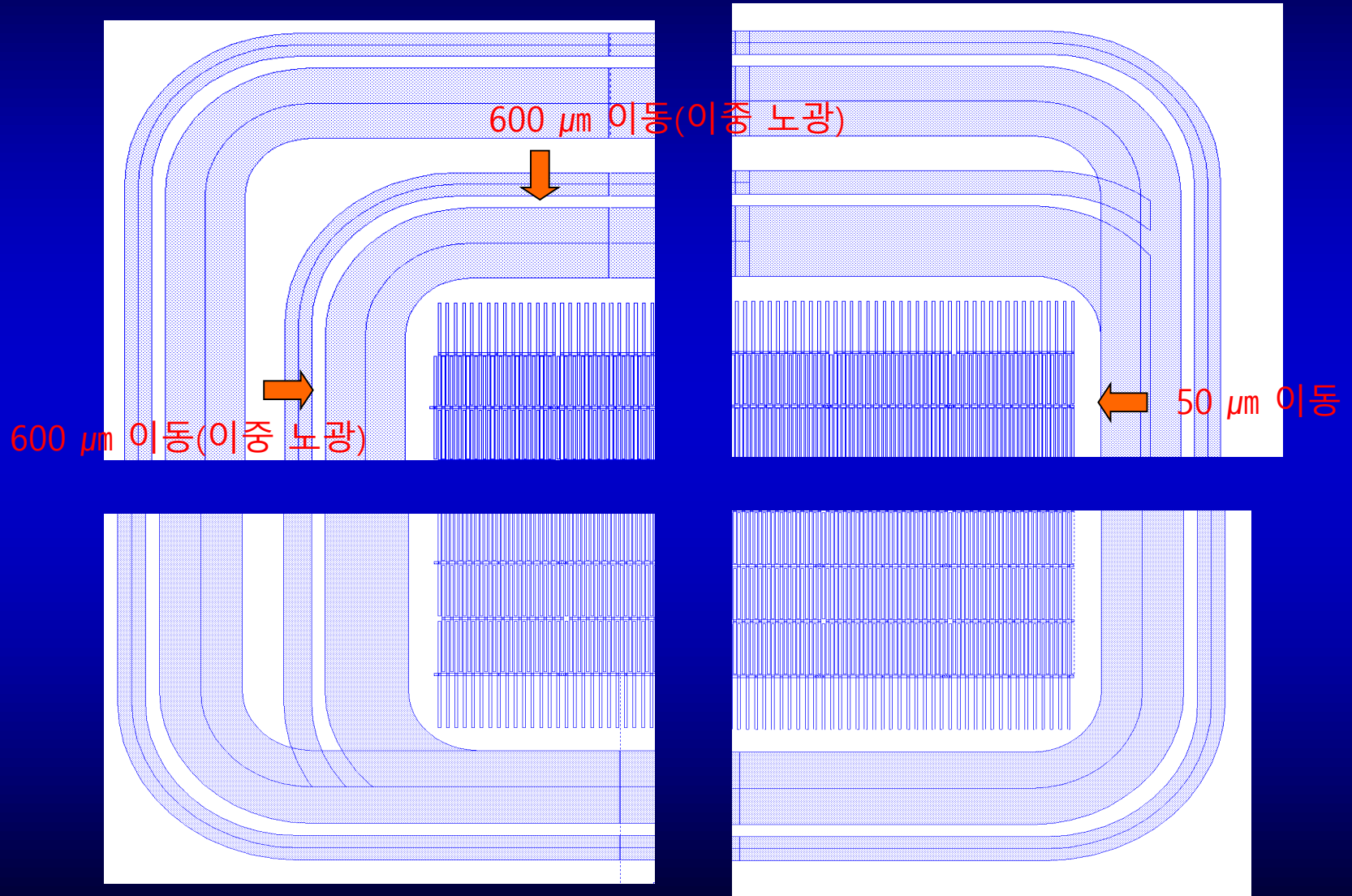
PCM



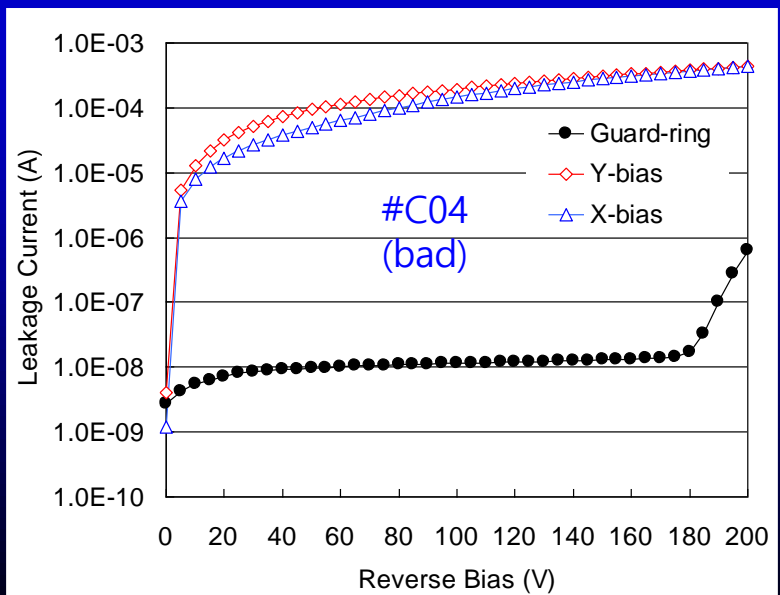
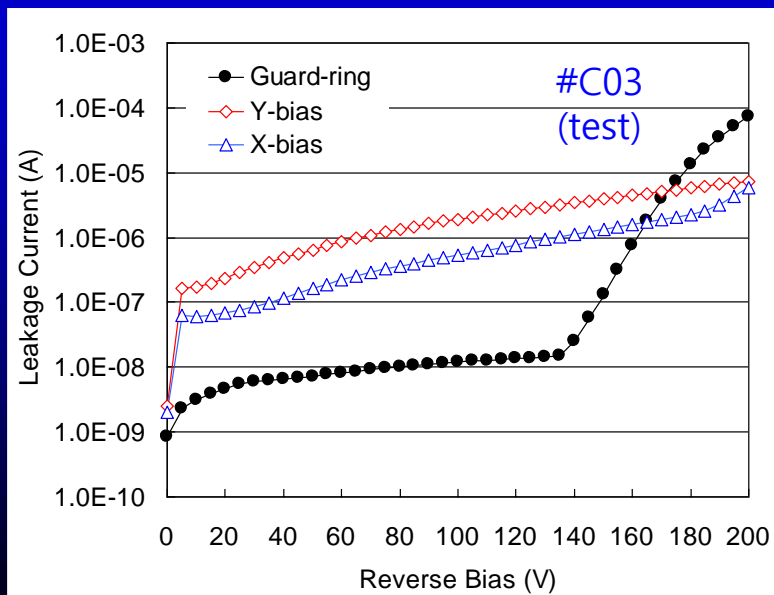
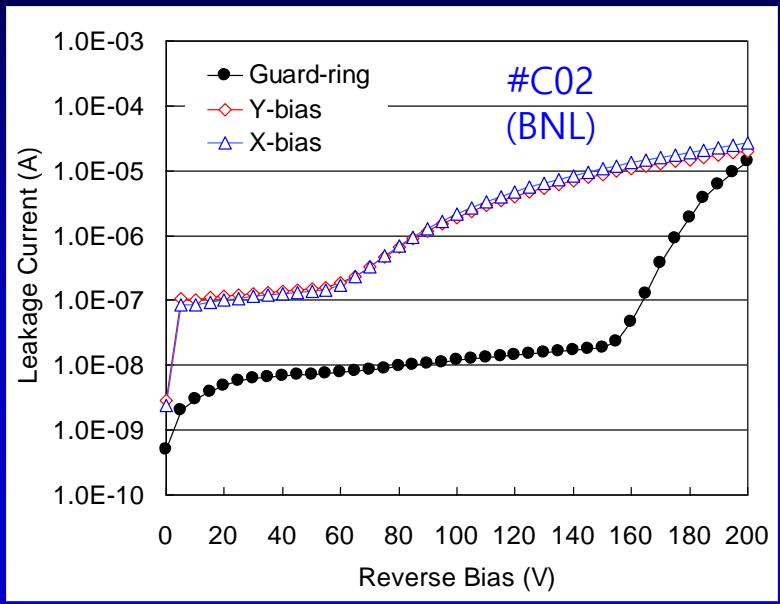
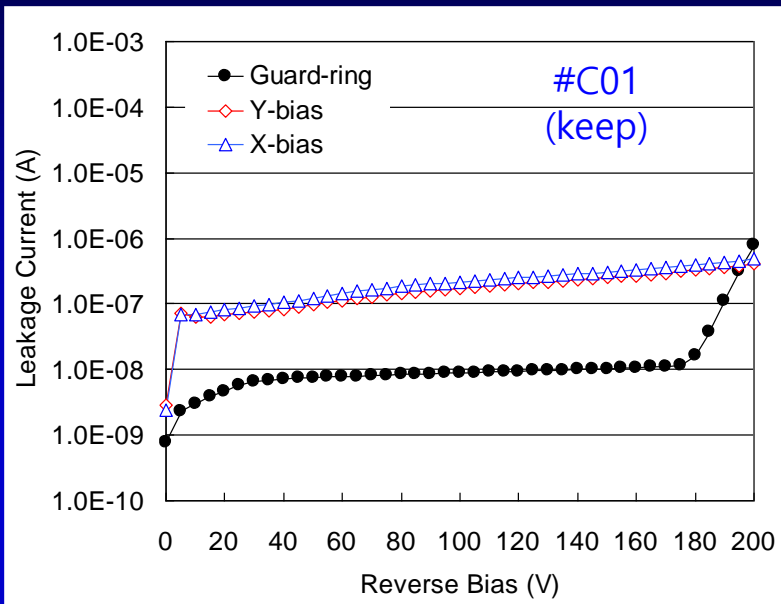
Stripixel sensor R&D

- Funding from BNL and Korean group
- 1st Fab-out in Sep. 2006
 - Breakdown problem
 - Suspicious of shorts between channels
- 2nd Fab-out in Jan. 2007
 - n+ doping on surface to avoid shorts
 - Characteristics worse
- 3rd Fab-out in May 2007 (inserting p implant as a closer guarding w/o mask modification)
 - Breakdown problem disappeared
 - Sr90 source test looks ok
 - CERN beam test : cross talk
- 4th Fab-out in Aug 24, 2007 (same as 3rd, just more sensors)
 - CERN beam test : cross talk

Closer Guarding



Performance of 3rd Fab

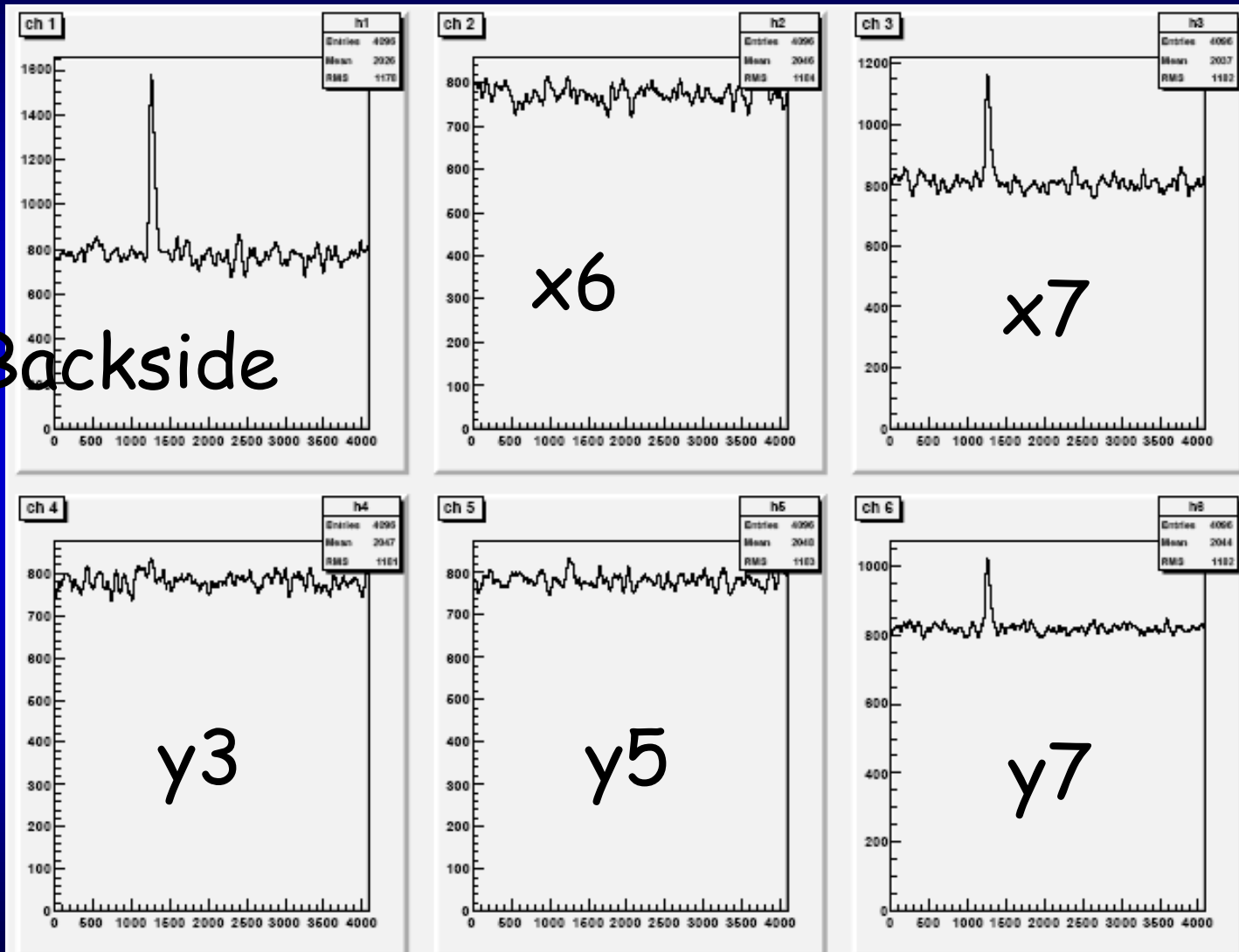


$(x+y)/256$
~ nA

An example of Sr90 event

Sensor C3

Backside



Total : 64usec

Toward Final Design

- **With funding from ETRI, SENS, Korean NCC group**

- **Second Design**
 - **Four different combinations of implant tooth width and distance between teeth**
 - **Fab started in Mid August using 4 wafers**
 - **Fab out last week, now testing**

- **Third Design**
 - **The same design, but with different wafers with different resistance to remove cross talk**

- **Final Design**
 - **After digesting the test results from previous designs**

Additional Presentations

There are 4 more NCC related talks and 1 poster

- **C-21[13]** “Beam Test Results of the Prototype Nosecone Calorimeter for the PHENIX Upgrade”, 심 현하
- **C-26[13]** “Performance of stripixel sensors from radiation source and beam tests for PHENIX forward detector upgrade”, 이 남희
- **C-28[14]** “Nosecone Calorimeter Readout”, 복 정수
- **Cp-045** “Design, Fabrication And Electrical Characteristics Of Stripixel Sensors”, 문 혜진
- **E-42[13]** “Design, Fabrication and Performance of Silicon Stripixel Sensors and Pad Sensors”, 이 혜영

Summary

- **Rough ride ahead, but we will continue our endeavor!**