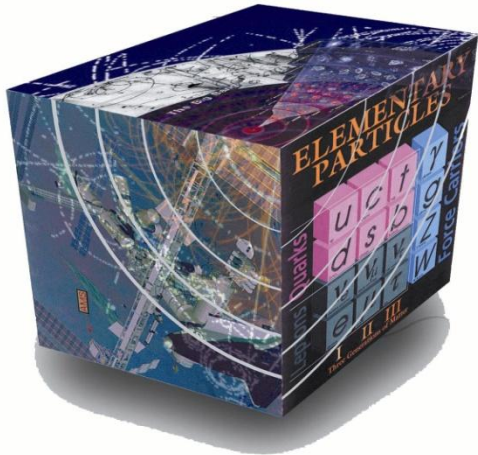


HEP Community in KOREA



Dongchul Son

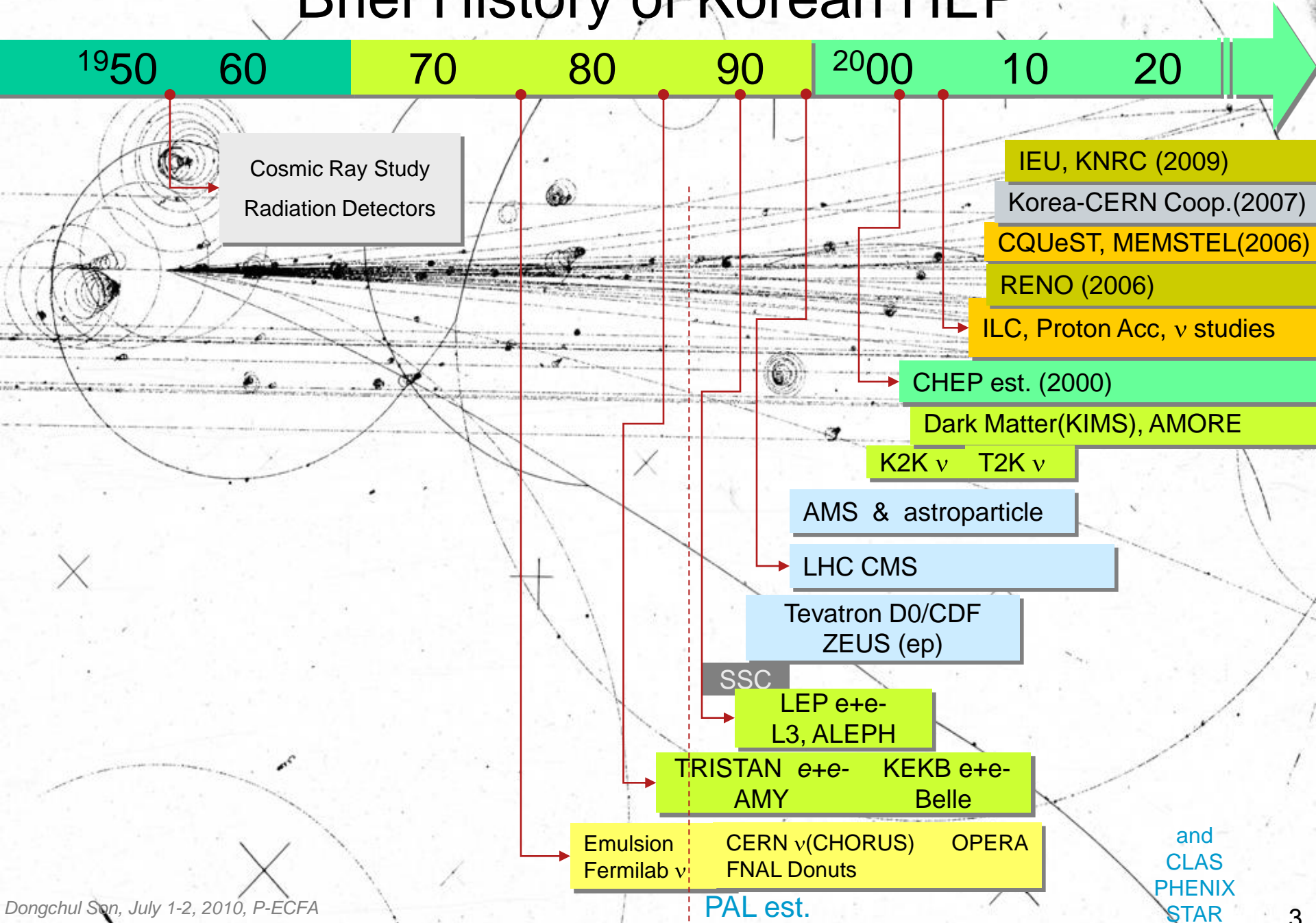
Kyungpook National University
Center for High Energy Physics
Association of Korean HEP

Plenary ECFA, Frascati, Italy, July 1-2, 2010

Outline

- Brief History
 - HEP Organizations
 - HEP Institutions
 - Major Experimental Groups
 - Korean HEP Roadmap
 - Some Highlights from Exp. Groups
 - RENO, Dark Matter Search,
 - CMS, Tier2
 - ILC and other efforts
 - Korean Accelerators
 - Accelerator-based HEP Roadmap
 - Future Considerations
- More Information with Backup Slides
 - Institute of Early Universe (IEU), MEMSTEL Project
 - Center for Quantum and Space Time (CQUeST)
 - Korean ALICE, PHENIX, OPERA
 - HEP at Kyungpook
 - More on ILC Efforts

Brief History of Korean HEP



Major HEP Organizations

(Institutes, Centers, WCU Teams)

Center of Excellence

CHEP

(2000)

Kyungpook NU
(host)

Center of Excellence

CQeST

(2005)

Sogang U
(host)

WCU

(2009)

WCU-IEU

(2009)

Ewha W U (host)

KPS

Particles and Fields
Nuclear Physics
Astrophysics
Plasma Physics

KHEP: Association of Korean HEP
(2005)

MEMSTEL

(2006)

**Korea-CERN
Coop.** (2007)

RENO

(2006)

Center of Excellence

KNRC

(2009)

Seoul NU (host)

KODEL

(1997)

Korea U

Emulsion
Group

GSNU

PAL

(1988)

POSTECH
(host)

APCTP

(1997)

POSTECH
(host)

CTP

(1990)

Seoul NU
(host)

KIAS

(1996)

KAIST
(host)

WCU

(2009)

DMRC

(2000)

And others (KAERI, etc.)

HEP Institutions in Korea

Seoul, Korea, Yonsei, KIAS, Sogang Hanyang, SKKU, Kyunghee, Konkuk Sejong, U of Seoul, Ewha, etc.

Kangnung, Kangwon

KAIST, KAERI, KISTI
Chungnam, Chungbuk

Kyungpook CHEP
Andong, Keimyung,
Daegu Catholic,
PAL, APCTP

Chonbuk

Chonnam, Dongshin

Kwangju

Daegu

(Pusan)

Busan

Pusan, Inje, Kyungsung

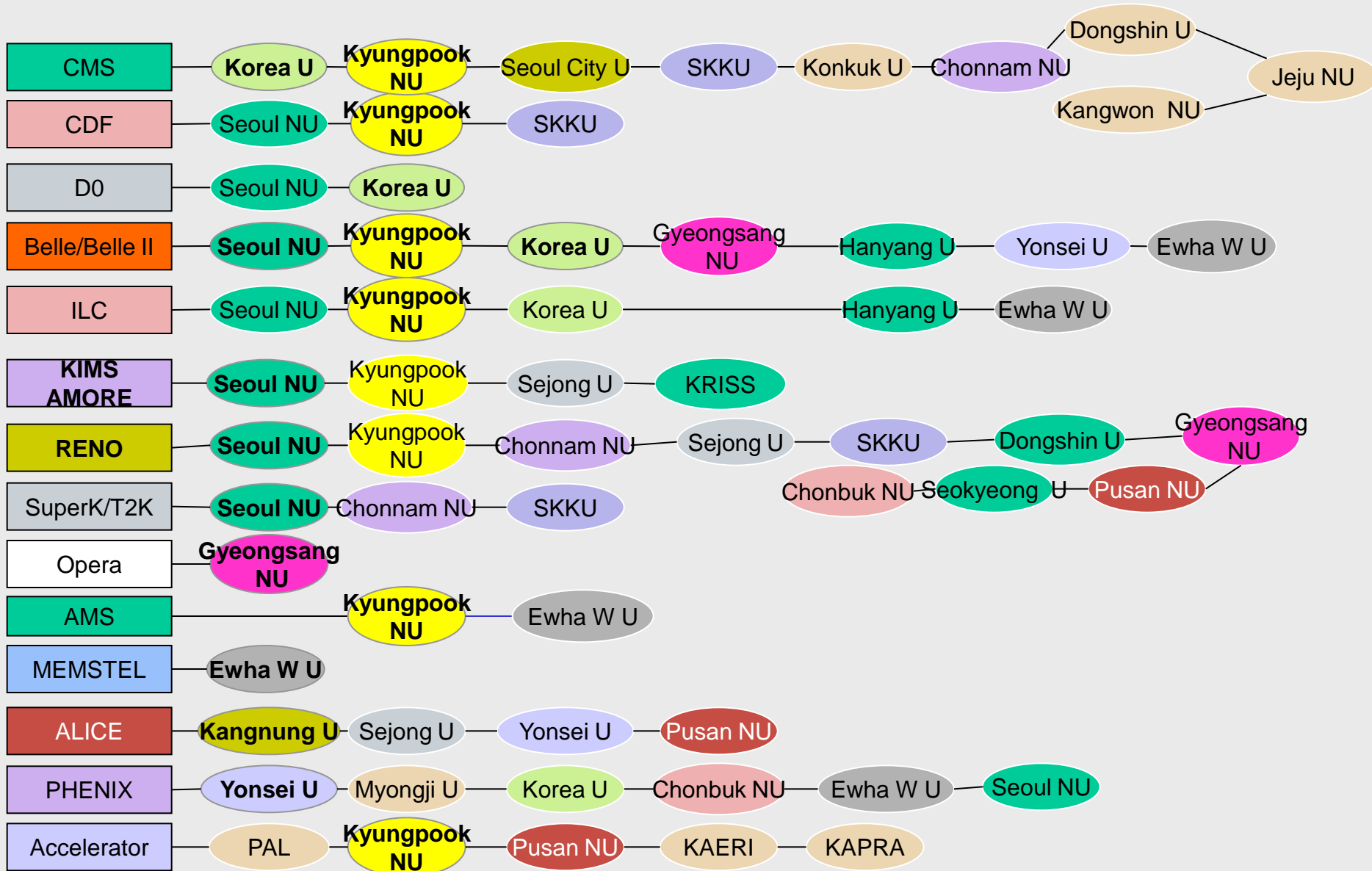
Gyeongsang

Jeju

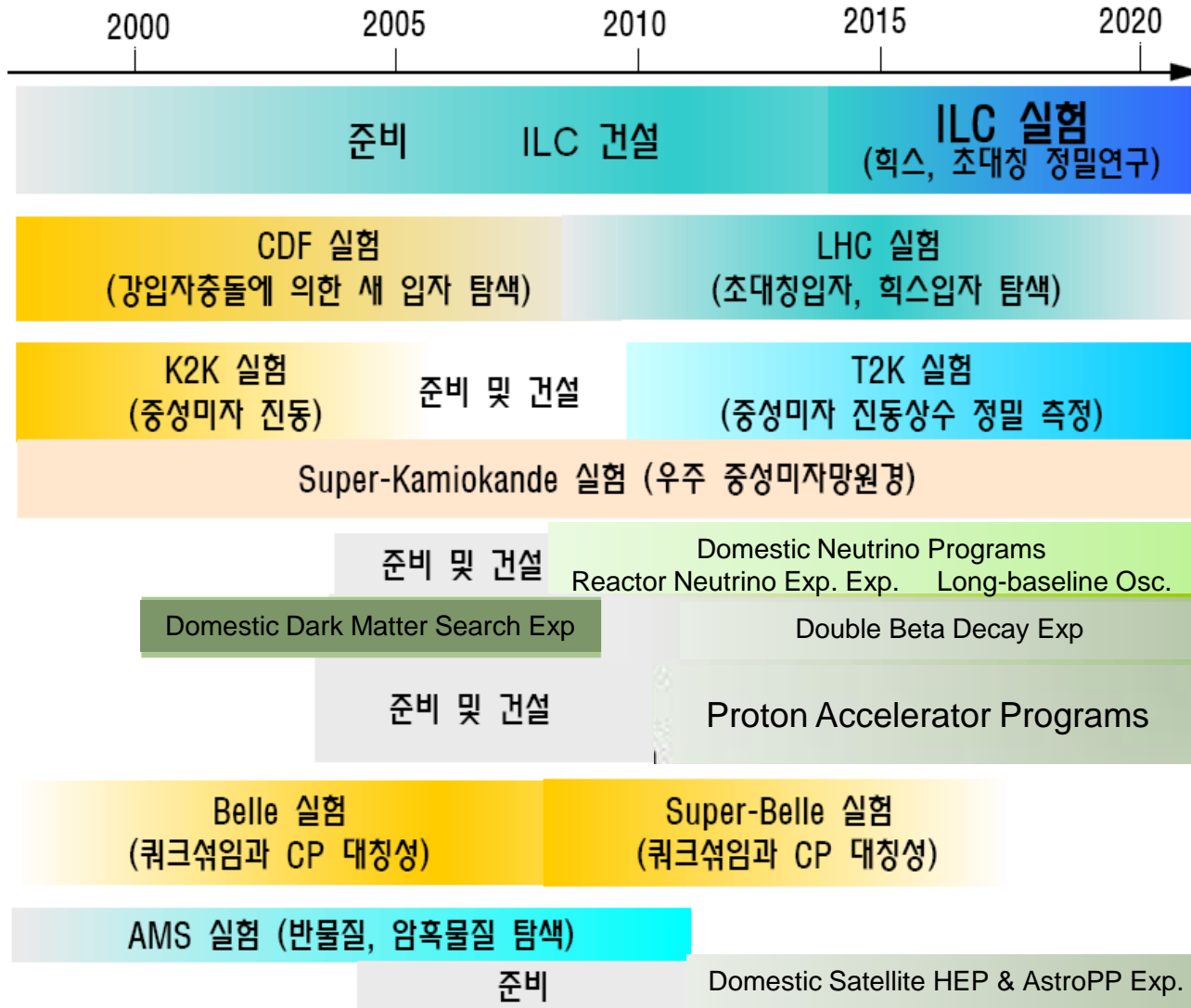
● HEP Programs
● others

~ 57 Institutions
~ 150 Experimental HE & N Physicists
~ 200 Theoretical HE Physicists
~ 100 Accelerator Experts

Major Experimental Groups in Korea



Korean HEP Roadmap (2005)



Strategy for Roadmap



- Many current activities will be phased out
- Will encourage new ideas and activities
- Will train manpower and establish facilities for future

RENO (Reactor Experiment for Neutrino Oscillation)

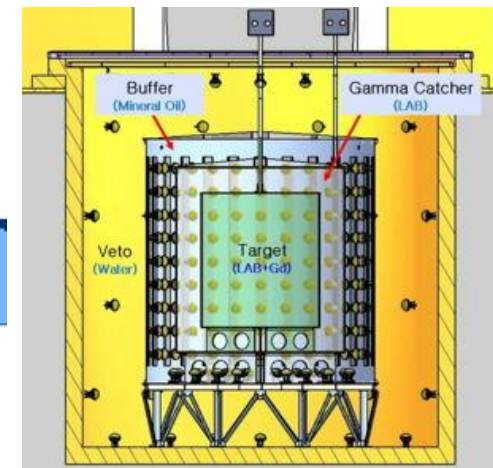
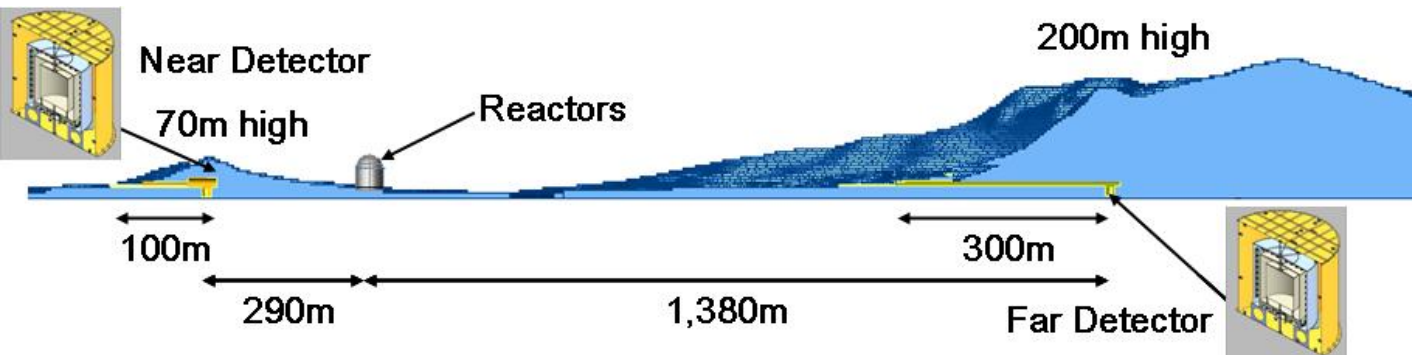


RENO Construction

- Near Yonggwang Nuclear Power Plant (2006 – 2010, 10M US\$)
- Parameters:

Thermal Power (GW)	Distances Near/Far (m)	Depth Near/Far (mwe)	Target Mass (tons)
17.3	290/1380	120/450	16/16

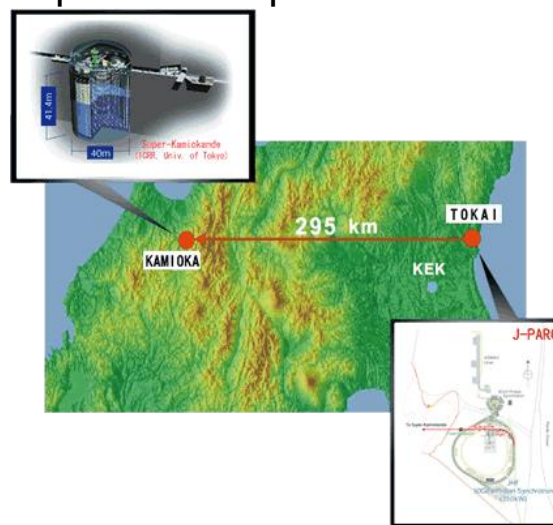
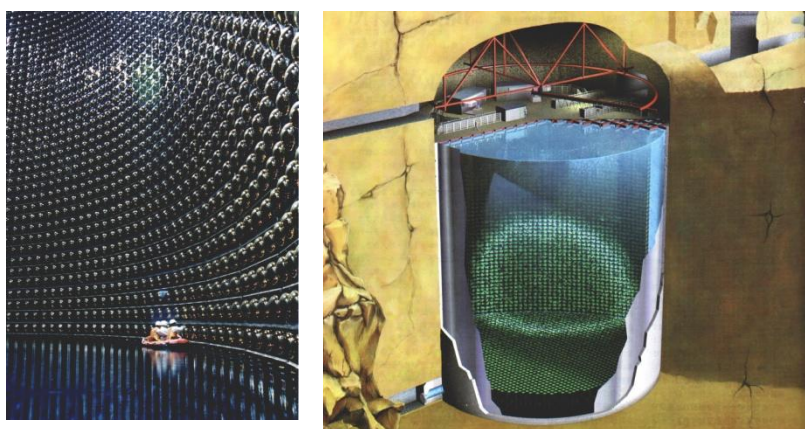
- RENO operation: data-taking for 2010 – 2016, KNRC, 1M US\$/year
- Goal: Measurement of θ_{13} ($\sin^2(2\theta_{13}) > 0.02$) using reactor antineutrinos
- Geological survey & tunnel design completed (Oct. 2007)
- Near and far tunnels and detector halls completed (Mar. 2009).
- Detector structure including stainless steel tanks completed (Nov. 2009)
- Acrylic containers completed (Jun. 2010)
- PMT & DAQ installation will begin in July 2010
- Detectors will be filled with liquid scintillator from Sep. 2010
- Data-taking is expected to start in late 2010



□ Pictures from RENO Construction



□ KNRC (Korea Neutrino Research Center) also participates in Super-Kamiokande & T2K



RENO Collaboration

- Chonnam National University
- Chonbuk National University
- Dongshin University
- Gyeongsang National University
- Kyungpook National University
- Pusan National University
- Sejong University
- Seokyeong University
- Seoul National University
- Sungkyunkwan University
- Institute of Nuclear Research RAS (Russia)
- Institute of Physical Chemistry and Electrochemistry RAS (Russia)

+++ <http://neutrino.snu.ac.kr/RENO>

YangYang Underground Laboratory(Y2L)

(Upper Dam)

Y2L

- Located in a tunnel of Yangyang Pumped Storage Power Plant Korea Middleland Power Co.
- Minimum depth : 700 m
- Access to the lab by car (~2km)

Experiments:

- KIMS: DM search exp. in operation
- AMORE: DBD Search exp. in preparation

(Power Plant)

(Lower Dam)

양양양수발전소

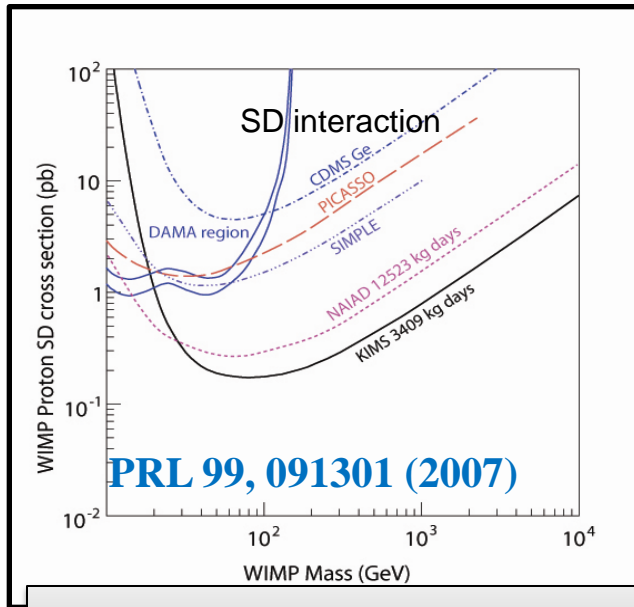
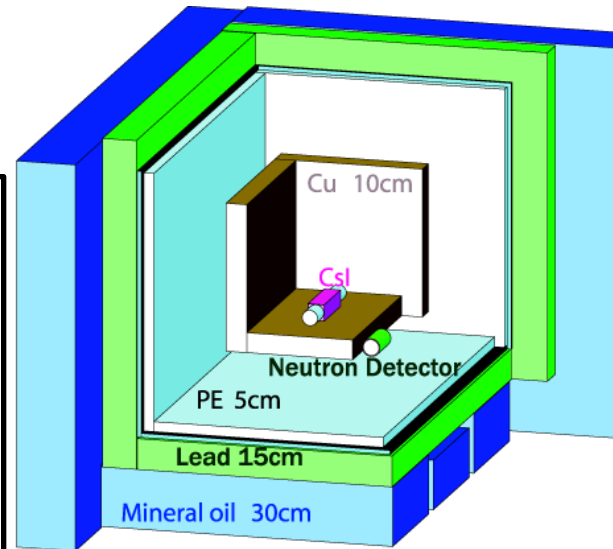
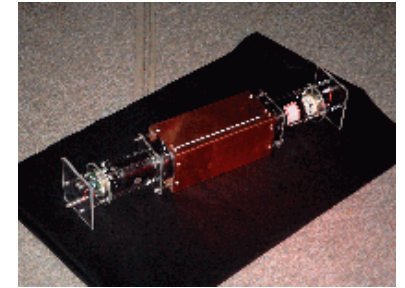
KIMS(Korea Invisible Mass Search)

DM search experiment with CsI crystal

CsI(Tl) Crystal $8 \times 8 \times 30 \text{ cm}^3$ (8.7 kg)

3" PMT (9269QA) : Quartz window, RbCs photo cathode

~5 Photo-electron/keV



**Best limit on SD interactions
in case of pure proton coupling**

12 crystals(104.4kg) running

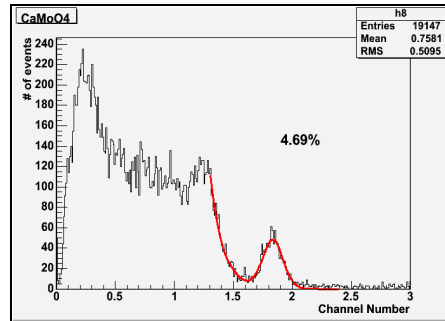
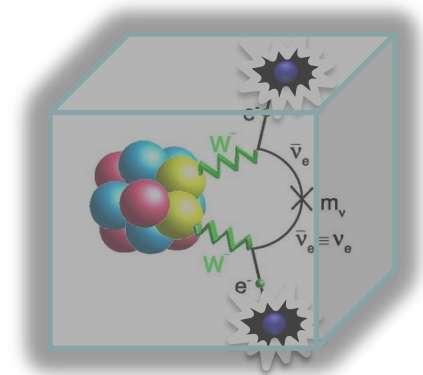
- Stable data taking for more than a year
- Unique experiment to test DAMA annual modulation

AMORE Experiment at Y2L

Double beta decay search with $^{40}\text{Ca}^{100}\text{MoO}_4$ crystal
 Int. Collaboration : Korea, Russia, Ukraine, China
 in preparation

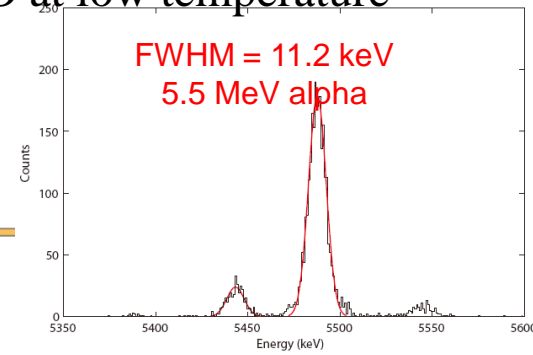
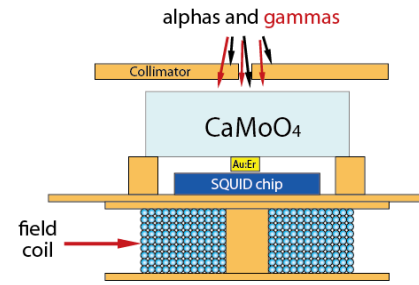
$^{40}\text{Ca}^{100}\text{MoO}_4$ crystal

- Unique in the world (depleted Ca + enriched Mo)
- Scintillation crystal + Cryogenic detector

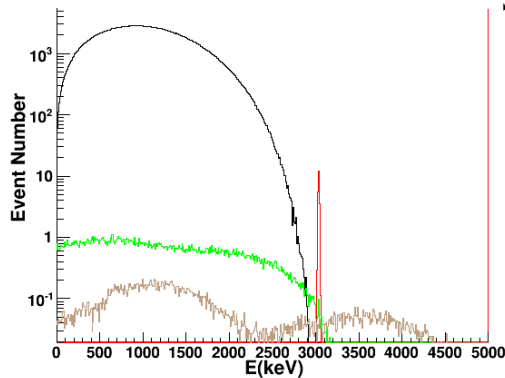
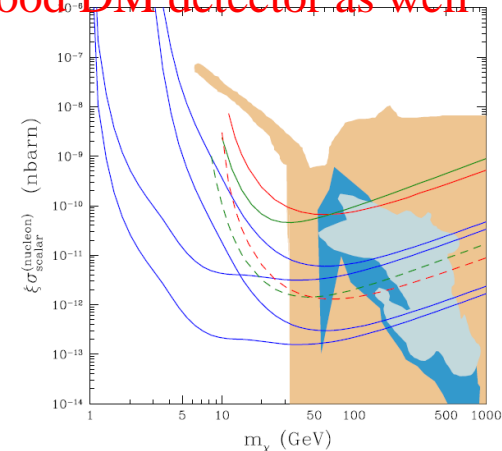


Energy spectrum for 600 keV gamma
 Scintillation readout

MMC+CMO at low temperature



good DM detector as well



Cryogenic CaMoO₄ Sensitivity

0.5% FWHM \rightarrow 15 keV FWHM for low temp.
 5 years, 100 kg $^{40}\text{Ca}^{100}\text{MoO}_4$:
 $T_{1/2} = 7.0 \times 10^{26}$ years \rightarrow $\langle m \rangle = 20 - 70$ meV
 Fully covers inverted hierarchy

AMORE Collaboration

- Korea (35)
 - Seoul National University* : H.Bhang, S.Choi, M.J.Kim, S.K.Kim, M.J.Lee, S.S.Myung, S.Olsen, Y. Sato, K.Tanida, S.C.Kim, J.Choi, S.J.Lee, J.H.Lee, J.K.Lee, H.Kang, H.K.Kang, Y.Oh, S.J.Kim, E.H.Kim, K.Tshoo, D.K.Kim (21)
 - Sejong University* : Y.D.Kim, E.-J.Jeon, K. Ma, J.I.Lee, W.Kang, J.Hwa (5)
 - Kyungpook national University* : H.J.Kim, J.So, Gul Rooh, Y.S.Hwang(4)
 - KRISS* : Y.H.Kim, M.K.Lee, H.S.Park, J.H.Kim, J.M.Lee (5)
- Russia (16)
 - ITEP(Institute for Theoretical and Experimental Physics)* : V.Kornoukhov, P. Ploz, N.Khanbekov (3)
 - Baksan National Observatory* : A.Ganggapshev, A.Gezhaev, V.Gurentsov, V.Kuzminov, V.Kazalov, O.Mineev, S.Panasenko, S.Ratkevich, A.Verensnikova, S.Yakimenko, N.Yershov, K.Efendiev, Y.Gabriljuk (13)
- Ukraine(11)
 - INR(Institute for Nuclear Research)* : F.Danevich, V.Tretyak, V.Kobychev, A.Nikolaiko, D.Poda, R.Boiko, R.Podviianiuk, S.Nagorny, O.Polischuk, V.Kudovbenko, D.Chernyak(11)
- China(2)
 - Tsinghua University* : Y.Li, Q.Yue(2)

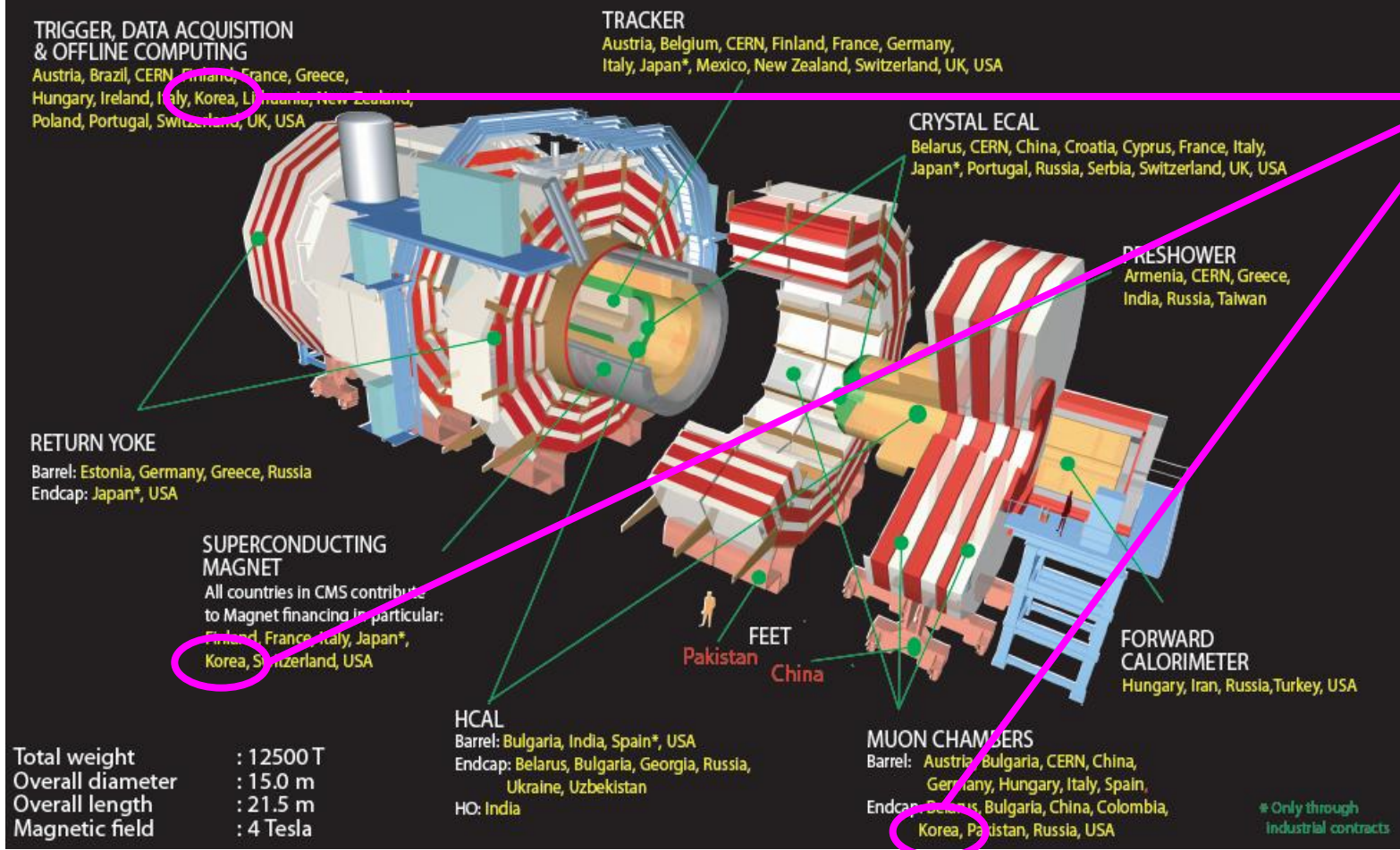
4 countries
8 institutions
64 collaborators



CMS and KCMS contributions

38 Countries, 183 Institutes, 3000 scientists and engineers (including 400 students)

June 2008



Korea's Major Contributions

- Funding status: supported by a NRF program to promote the International Collaborations
 - 1st 3 years (2007.05-2010.04) : 0.75BW/Y → 1.5 BW/Y , 0.2 BW/Y for a Tier2, M&O (0.1BW→0.2BW)
 - 2nd 3 years (2010.05-2013.04) : 1.5BW/Y, 0.2 BW/Y for a Tier2, M&O (0.2BW)

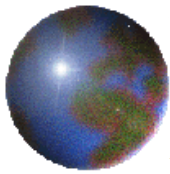
KCMS Participating institutions and members

Institutions	Faculties	Post-docs	Graduate students
Korea Univ.	K.S. Sim		D. Moon
	S.K. Park	K.S. Lee	S. Shin, E. Seo, M.S. Chung
	B.S. Hong		J. Kim, H. C. Kim, M. Jo
	S.Y. Choi	T.J. Kim	B.H. Lee, Y.K. Jo, J.T. Kwon, D.Y. Kyun
Kyungpook National Univ.	D.C. Son	S.Y. Ro, H.K. Park, J. S. Suh	Researchers: D.H. Han, D.H. Son, J.H. Kang
	D.H. Kim	D.J. Kong, J.E. Kim, Y.D. Oh	S.H. Chang, T.J. Son
	G.N. Kim	J.H. Chung	
	S. Uozumi		
	T. Kamon		
Sungkyunkwan Univ.	Y.I. Choi	H.K. Seo	S.E. Lee, J.S. Lee, Y.K. Choi, Y.J. Cho
	I.T. Yu		J.H. Goh, E.H. Kwon, J.Y. Seo
University of Seoul	I.C. Park	C.W. Park	S.K. Kang, M.K. Choi, G.M. Ryu, H.Y. Kim, S.N.Park
Chonnam National Univ.	J.Y. Kim		Z. Kim, S.H.Song
Kangwon National Univ.	S.K. Nam	T.Y. Kim	S.G. Heo
6	14	14	28 Students + 3 Researchers

- Konkuk Univ., Cheju Nat'l Univ, Chonbuk Nat'l Univ will join in 2010
- more informations are available at <http://www.cms-kr.org>

6 physics subgroups, Detector and Tier2

Subgroup	Convenors	Members	Korea CMS's major interests
Higgs search	Young-Il Choi Intae Yu Suyong Choi*	H.K. Seo, S.E. Lee, J.S. Lee, Y.K. Choi, Y.J. Cho, J.H. Goh, E.H. Kwon, T.J. Kim, B.H. Lee, Y.K. Jo, J.T. Kwon, D.Y. Kyun	SM Higgs : $H \rightarrow WW \rightarrow 2l2\nu$ by MAOS approach Doublu Charged Higgs search Top mass measurement
Heavy Ion	K.S. Sim Byungsik Hong* Inkyu Park	D. Moon, J. Kim, H. C. Kim, M. Jo, S.K. Kang, M.K. Choi	Quarkonium production J/Psi, Upsilon production Elliptic flow measurement
QCD	S.K. Nam Inkyu Park*	T.Y. Kim, S.G. Heo, C.W. Park, S.N.Park, H.Y. Kim, G.M. Ryu	QCD Jet shape measurement
Beyond SM	D.H. Kim*	D.J. Kong, J.E. Kim, Y.D. Oh, S.H. Chang, T.J. Son	W' (prime) search New particle search by tau trigger
SUSY	J.Y. Kim*	S.Y. Ro, Z. Kim, S.H.Song	SUSY particle search with 3 lepton final state
Extra-D	G.N. Kim*	J.H. Chung	Gravition $\rightarrow ZZ \rightarrow 4$ muons
Detector (RPC)	Sungkeun Park*	K.S. Lee, S. Shin, E. Seo, M.S. Chung	High Lumi RPC R&D and CMS RPC upgrade
Tier2	D.C. Son*	H.K. Park, S.J. Suh, D.H. Han, D.H. Son, J.H. Kang	CMS Tier2 Operation



CMS Tier-2 at Kyungpook

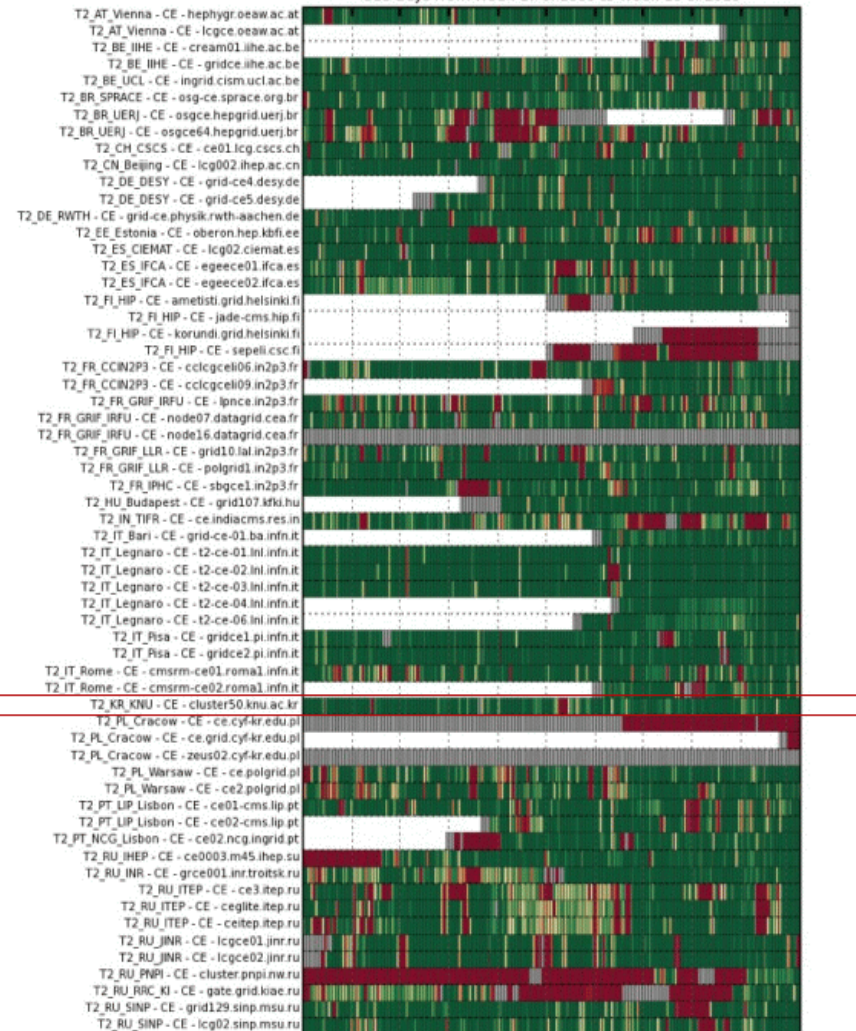
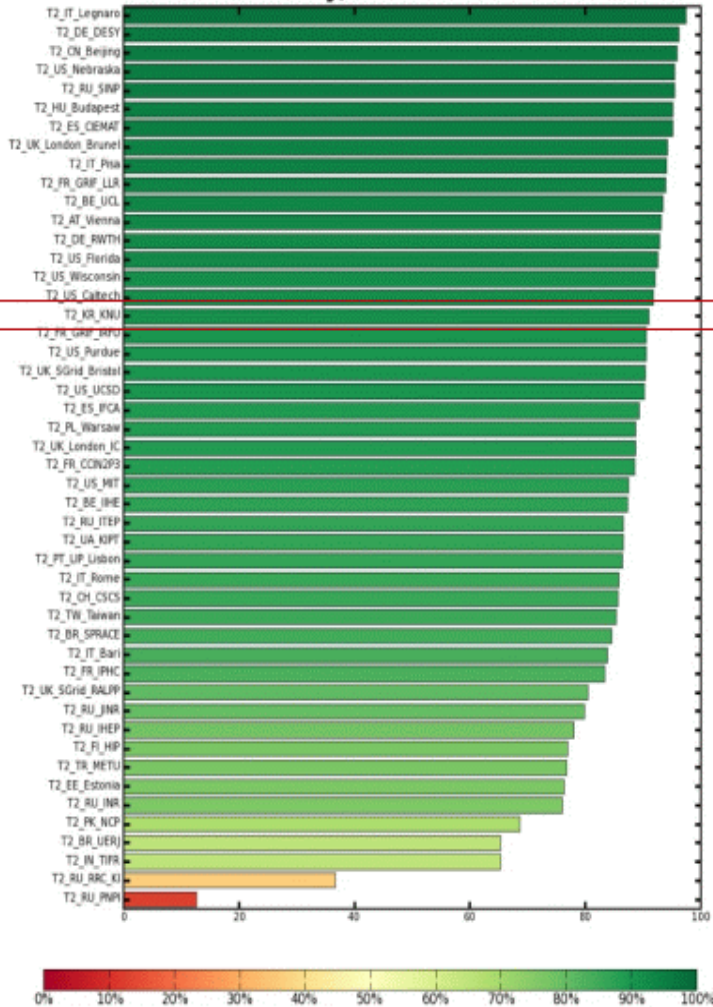
✪ Tier-2 Site Availability > 90%

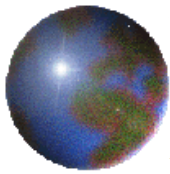
Service Availability

Service Availability

313 Days from Week 17 of 2009 to Week 10 of 2010

Site Availability, 2009-05-01 - 2010-03-10





Usage of KNU Tier-2

- Home
- T2_KR_KNU
- + How to use T2_KR_KNU?
- + DOE Certificate
- + LCG User Registration
- + KNU Account Registration
- + KNU Network
- + CMS Tier Site DB
- + CMS Tier-2 Activities
- + CCRC08
- + CSA07
- + LoadTest 07
- + CSA06
- + DBS Discovery
- Monitoring Tools
- + Ganglia
- + dCache Pool Usage
- + GStat
- Documents
- + LCG User Guide
- + Grid Acceptable Use Policy
- Related Projects
- + LHC Computing Grid

KNU Tier2 Center for CMS



Welcome to the CMS Tier2 Center at Kyungpook National University in Korea.



This web portal is your gateway to the CMS Tier2 center at Kyungpook National University (KNU) in Korea. This CMS Tier-2 center is being supported by the Ministry of Education, Science and Technology and is being maintained by the Center for High Energy Physics of the KNU.

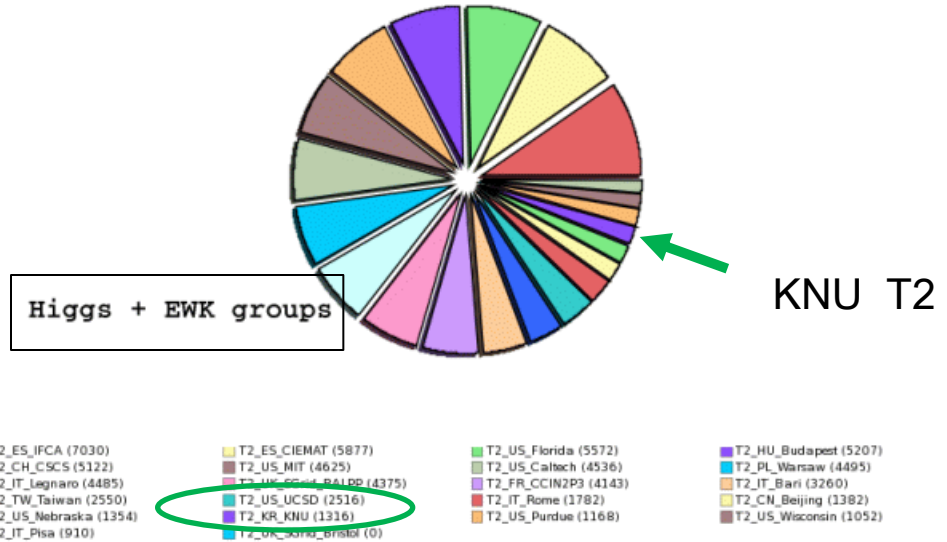
We will support the CMS computing needs for Korean and overseas collaborators. For your general comments, questions, or reports of any problems regarding to this Center, please email to lcg_knu@knu.ac.kr.

✉ Contact:
Email: lcg_knu@knu.ac.kr
Phone: +82-53-950-5326
Fax: +82-53-955-5356

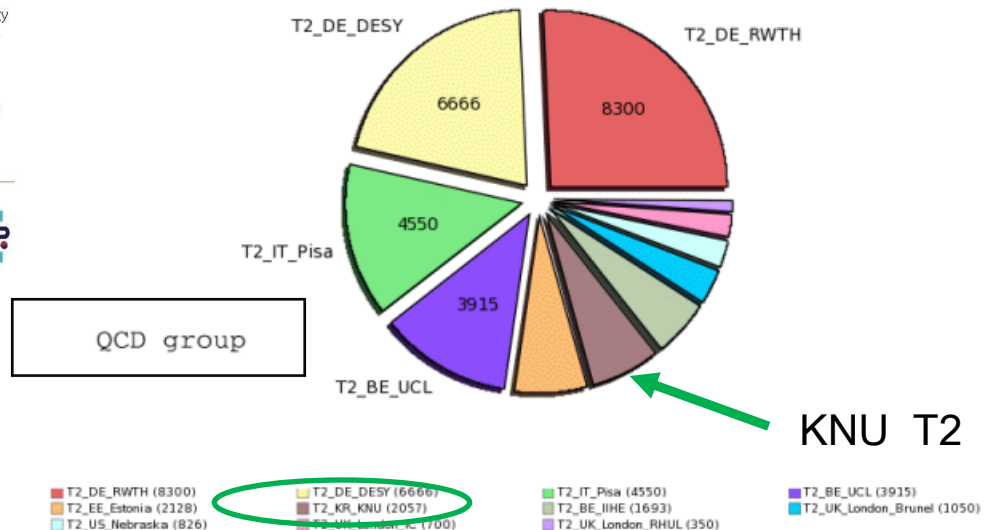
THE CENTER FOR HIGH ENERGY PHYSICS
KYUNGPPOOK NATIONAL UNIVERSITY
1370 Sangyeok-dong, Buk-gu, Daegu, 702-701, Korea

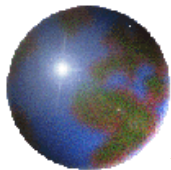


Destination Sites Distribution (Sum: 72757)



Destination Sites Distribution (Sum: 32235)





Computing Resources and Facilities



4th Floor



Supercomputing Center
at CHEP



Linux Cluster System

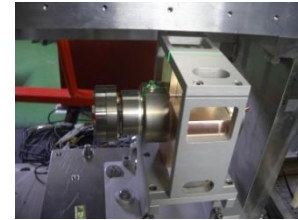


Tape Library System

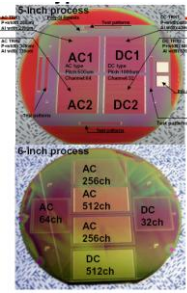
ILC Activities



9-cell ICHIRO cavity made at PAL (PALIC #1)



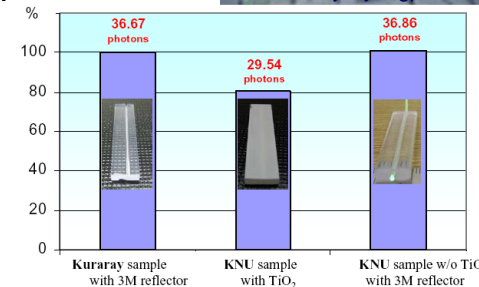
Low Q-IP BPM made by Kyungpook



DSSD made by Kyungpook



Extruded Plastic Scintillator made by Kyungpook



Accelerator R&D's

- RTML: Design of **Bunch Compression** and **Damping Ring** – part of GDE, working on **Electron Cloud Effects** in the ED phase (Kyungpook)
- **Cavity type Q-BPM** (6.5 GHz): 39 BPM's fabricated by PAL and delivered to KEK-ATF2
- BDS(ATF2): **Low IP Q-BPM** (design, fabrication by Kyungpook in Korea and tested at ATF2), **Cold BPM** (Pusan Nat'l U. with KEK)
- **SC RF cavity**: fabricated a 9-cell one in Korea and surface treatment and e-beam welding done in Japan (by PAL), A prototype of 9-cell SC cavity to be fabricated at KEK (multipacting simulation done at Kyungpook)
- Designing a prototype of High Power (5MW) **IOT** (Kyungpook)
- **Beam test of IP-BPM with nanometer position resolution for ILC (June 2010, Kyungpook)**
- **Beam test of L band-BPM for ILC Main Linac (June 2010, Kyungpook)**

Detector R&D's

- **Silicon (double sided strip)** detectors of AC and DC types for vertex and trackers (Kyungpook/Yonsei/Hangyang/SKKU etc.) – sensor fabrication and beam test done
- **Silicon Tungsten** detectors (PIN diode, pixellated silicon sensor) for **EM calorimeters** (with CALICE) (Ewha/YU/SKKU etc.) – sensor fabrication and beam test done
- **Extruded Plastic scintillator** detectors for Calorimeters (Kyungpook)
 - Good light yields and uniformity achieved, beam test done (~30 photons/fiber)

GDE Common Fund contribution 2006-2008 (CHEP/Kyungpook)

Other Efforts

- **Belle** @KEK (SNU/Korea /Yonsei/Gyeongsang/Kyungpook/SKKU/Hanyang/Ewha)
- **CDF** (Kyungpook/Seoul/SKKU) & **D0** (Korea) @ FNAL
- **CMS** and **ALICE** @ CERN
 - Providing **Resistive Plate Chambers** for **CMS** Muon Detector (Korea) and **DAQ computing resources** (Kyungpook)
 - **Tier-2's** for CMS (Kyungpook) and ALICE (KISTI)
 - **TOF** for ALICE (Kangnung)
- **T2K** (Seoul/Kyungpook/Chonnam/SKKU/Dongshin) @ J-Parc
 - Contributing to Proton Beam Monitoring (**Beam Profile Monitor**) **Electronics**
 - Construction of **On-axis Beam Near Detector**, etc.
- **AMS** (Kyungpook/Ewha)
 - **Slow Control and Power Distribution System** of the Cryocooler for SC Magnet , TRD
- **OPERA** (Gyeongsang)
 - Contributing **Emulsion** Targets
- **CREAM** with NASA (Ewha)
 - **Silicon Charge Detectors** (SCD) for Particle ID
- Feasibility studies of **Long Baseline neutrino exp. with detector in Korea** (T2KK)

Korean Accelerators



Pohang Accelerator Laboratory

- ✓ 2.5 GeV
- ✓ Costs: 150 Bwons
- ✓ Since 1995 ~

양성자가속기시설



Proton Accelerator (Linac)

- ✓ 100 MeV
- ✓ Costs: 128.6 Bwons
- ✓ 2006 ~ 2012



국제과학비즈니스벨트 기획연구단

Heavy Ion Accelerator (under design)

- ✓ 200 MeV/n
- ✓ Expected Costs: 460 Bwons
- ✓ 2010 ~ 2015

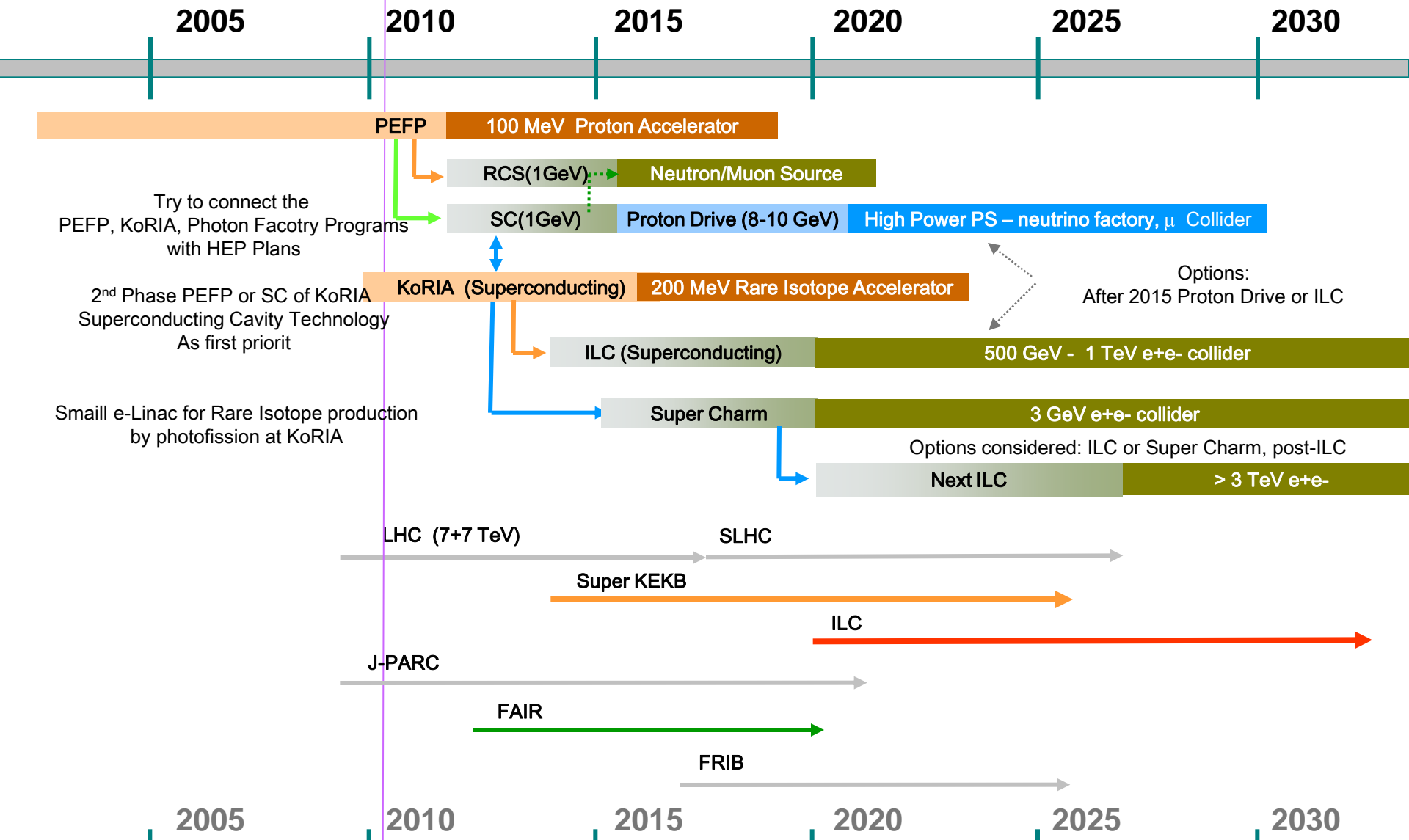


4th Gen. XFEL

4th Gen. XFEL – Under consideration

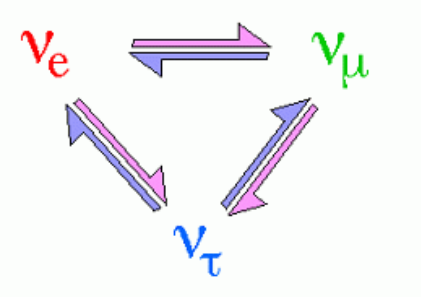
- ✓ 10 GeV
- ✓ Expected Costs: 400 Bwons
- ✓ 2010 ~ 2013

Accelerator Based HEP Roadmap (2009.4, KHEP Association)



Future Considerations

- Preparing a National High Energy Physics Laboratory “Benjamin W. Lee Laboratory”
 - Considering accelerators in the lab
- Proposing a Korean CMS Tier 1
- Proposing an underground Laboratory for the Long-baseline Neutrino Oscillations Experiment (T2KK) also as a Proton Decay Experiment Facility



A Vision of Future Korean HEP Facilities

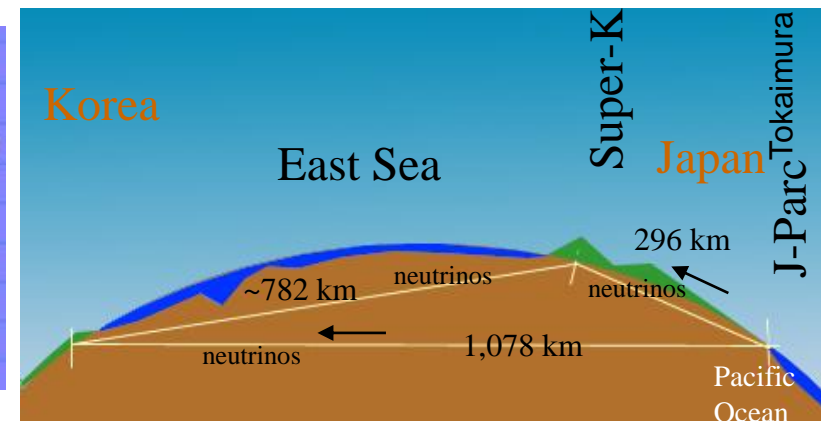
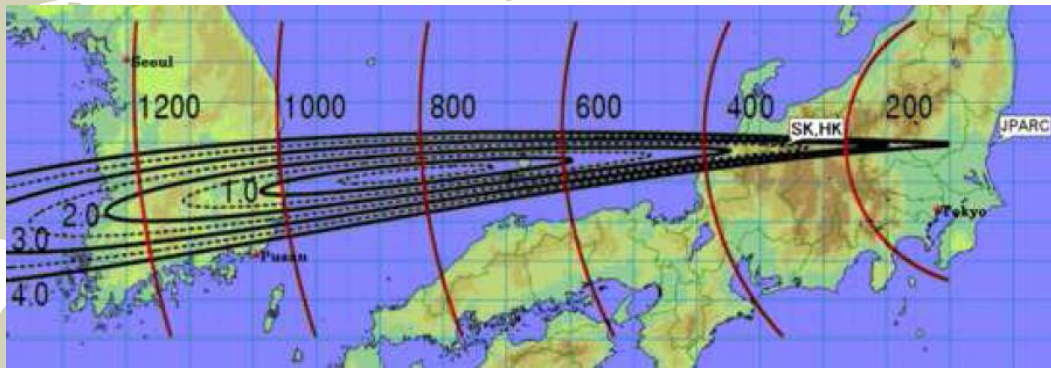
Yangyang Underground Lab
(operating)
- Dark matter, Double beta decays

Reactor Neutrino Program
- RENO (in preparation)

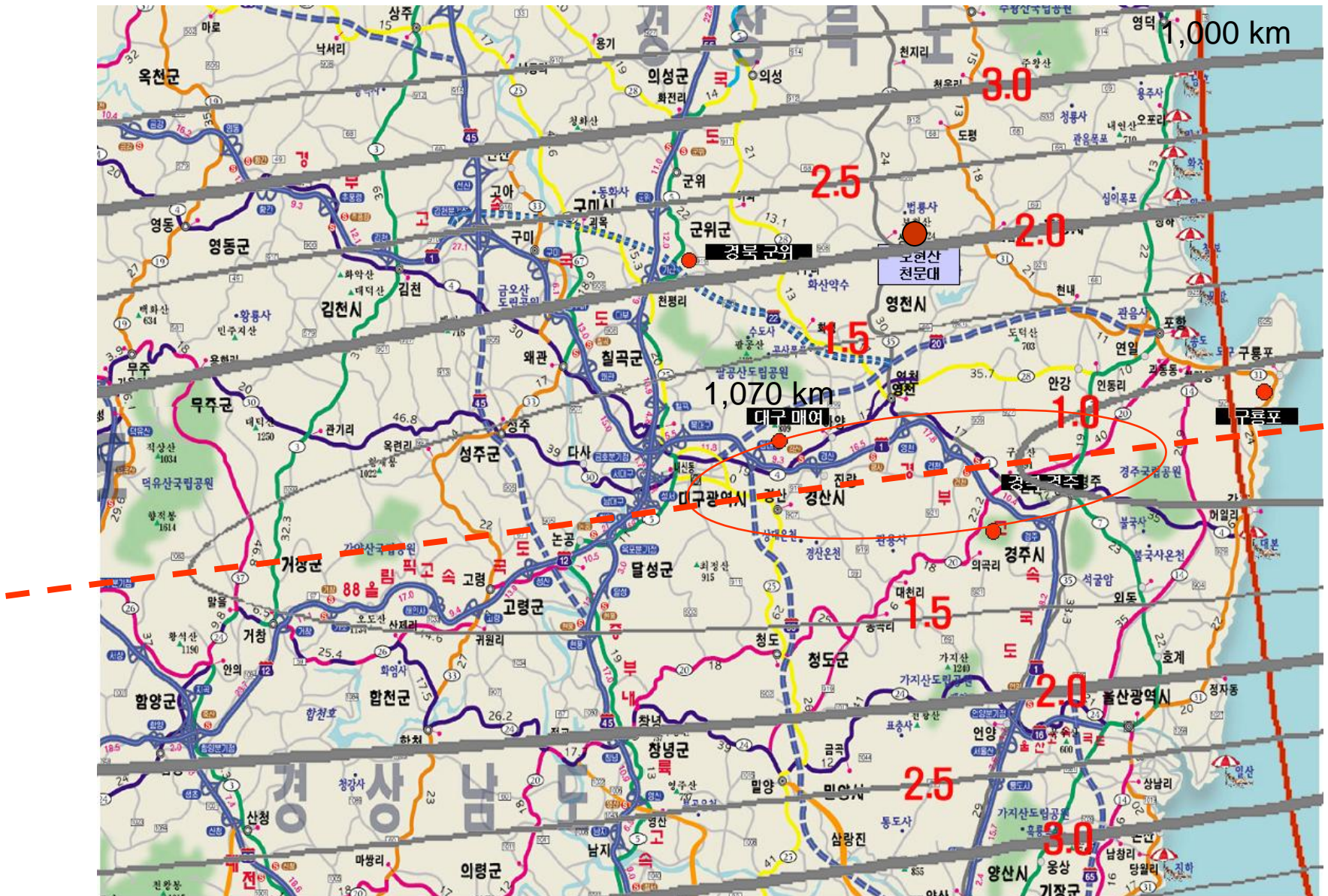
40~200 GeV Proton accelerator?
ILC 1 TeV?

LCG Tier-2s (CMS, ALICE)
LCG Tier-1 (CMS, proposal)

Long baseline neutrino Exp
- T2KK (proposal)



T2KK (Proton Decay Lab) Candidate Sites



Most of them are in solid granite.



한글의

語音

어휘

한글의

Thank you!

More Information

BACKUP SLIDES

Institute for the Early Universe (Ewha Womans University)

Institute for the Early Universe (IEU) was newly founded in December, 2008 at Ewha Womans University of Korea through the World Class University(WCU) project of the Korean Ministry of Education, Science and Technology. IEU will conduct researches, participate in major space projects and eventually produce highly trained personnel to succeed and grow the community.

George Smoot, the 2006 Nobel Prize laureate in Physics, has been appointed director of IEU and IEU brings together 6 more faculty, 4 research faculty, and 12 postdocs in fields ranging from string theory to detector hardware.

Goals of IEU:

- 1. Observations and data processing of Cosmic Microwave Background (CMB): Observations at unprecedented precision and tests of the standard model of cosmology
- 2. Important role in coming world-class satellite-borne experiments
- 3. Understanding fundamental physics in the early universe including inflation: contribute standard theories of universe and interactions of elementary particles including gravitation on concrete experimental/observational grounds
- 4. Search for the origins of dark matter and dark energy: testing the physical effects of dark energy from matter survey and acceleration measurements, and thus pinning down the mysterious constituents
- 5. Developments of innovative deep space technologies
- 6. Education of young students in the field of fundamental science and space technology
- 7. Promotion of science to Korean society

Institute for the Early Universe (Ewha Womans University)

1) Research Period : Dec. 1st 2008 ~ Nov. 30 2013

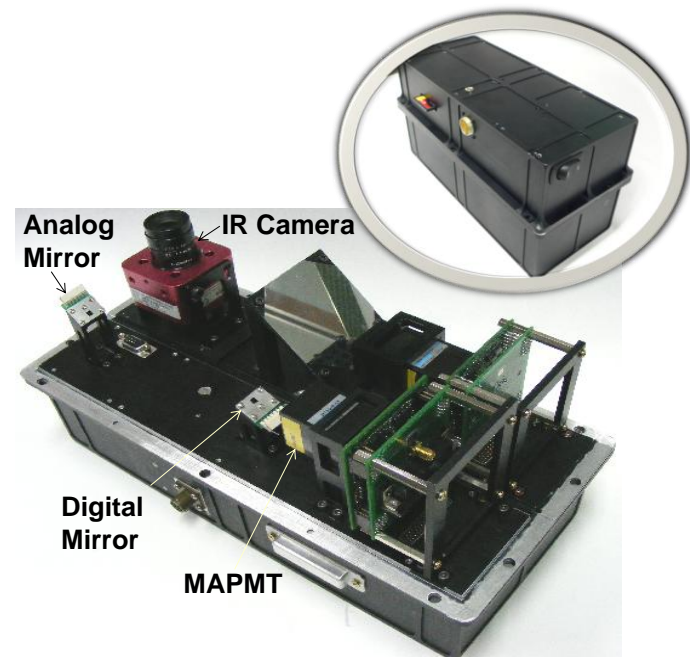
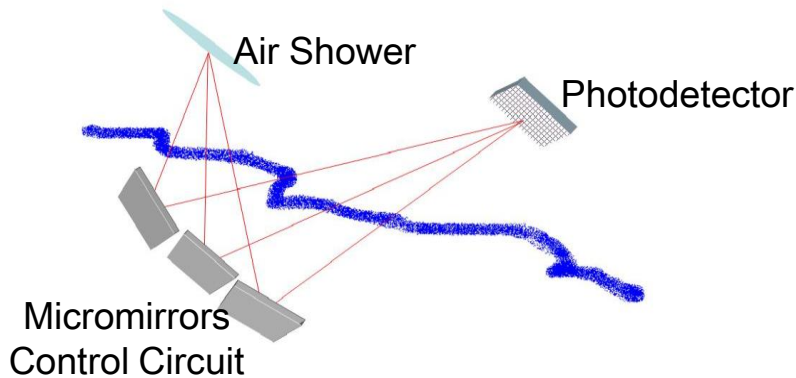
2) Total Amount of Research Fund : approximately 10 BWons for 5 years

3) People in IEU :

No.	Faculty	Dept.	Affiliation
1	George F. Smoot	Physics	UC Berkeley & Ewha
2	Eric V. Linder	Physics	UC Berkeley & Ewha
3	Uros Seljak	Physics	UC Berkeley & Ewha
4	Changrim Ahn	Physics	Ewha Womans Univ.
5	Jongmann Yang	Physics	Ewha Womans Univ.
6	IL H. Park	Physics	Ewha Womans Univ.
7	Chanju Kim	Physics	Ewha Womans Univ.

MEMSTEL (Ewha U/ U of Maryland)

- MEMS Tracking Mirror for Ultra High Energy Cosmic Rays
- 9 yr project since 2006, Ewha/U Md
 - Phase 1: to prove the MEMS based telescope concept.
 - A prototype to the ISS by the Korean Astronaut in April 2008
 - Another to an 800 km orbit in July 2008 as part of Russian program.
 - Phase 2: ~20 cm telescope for ultra fast flashes in ~2010
 - Phase 3: > 1 m telescope(s) to observe UHE ($\geq 10^{19}$ eV) cosmic rays



Korea-ALICE Outline

- Goal : Discovery and Study on Quark Matter under Extreme Conditions
 - Detector R&D and Operation of ALICE
 - Data Analysis using Grid Computing : Test of theoretical expectations
 - Brainstorming of new physics ideas : HIM
- Manpower (current status in June 2010)
 - Total : 30 Participants (11 PhDs, 8 PhD St., 8 MA St., 3 UG St.)
 - Residents at CERN : 5 PhDs (3 Profs.), 3 PhD St., 3 MA St.
 - Residents at Korea : 6 PhDs, 5 PhD St., 5 MA St., 3 UG St.
- Funding
 - Dates of start supporting : May 2007
 - 1.5 M\$ up to Apr. 2011
 - Further support will be annually updated

Korea-ALICE Activities

- Kangnung National University
 - ALICE-ToF R&D, installation and operation
 - ALICE-EM Calorimeter (Muon Detector) operation
 - Particle Reconstruction Algorithm Development
- Sejong University
 - ALICE Computing GRID Operation
 - Theoretical Calculation on Hadron Phenomena at LHC (pp and PbPb collisions)
- Pusan National University
 - ALICE-HMPID R&D and Operation
 - Gas System Control System R&D using ALICE-DCS
 - Charm Production in AA Study (Λ_c/D)
- Yonsei University
 - ALICE-TRD Installation and Operation
 - linking PHENIX-FoCAL to ALICE in future
 - Direct Photon Measurement in AA Study ($\pi_0 \rightarrow \gamma\gamma$ study)

RHIC-PHENIX

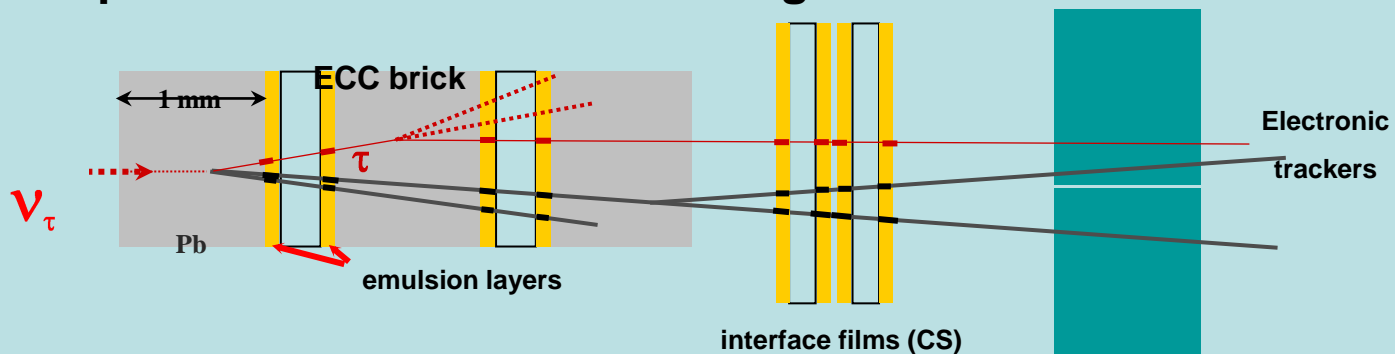
- **1991-2000:** designed, built, and installed at RHIC (BNL)
2000- : started data taking at RHIC (BNL)
- **Collaboration:** 14 countries / 70 institutions as of July 2009
- **Korean Members** (faculty only):
 - Chonbuk National University (E.J. Kim)
 - Ewha Womans University (J. Lee, I.H. Park)
 - Korea University (B. Hong, K.S. Sim)
 - Myongji University (K.S. Joo)
 - Seoul National University (J. Park)
 - Yonsei University (J.H. Kang, Y. Kwon)



OPERA

(Spokesperson A. Ereditato)

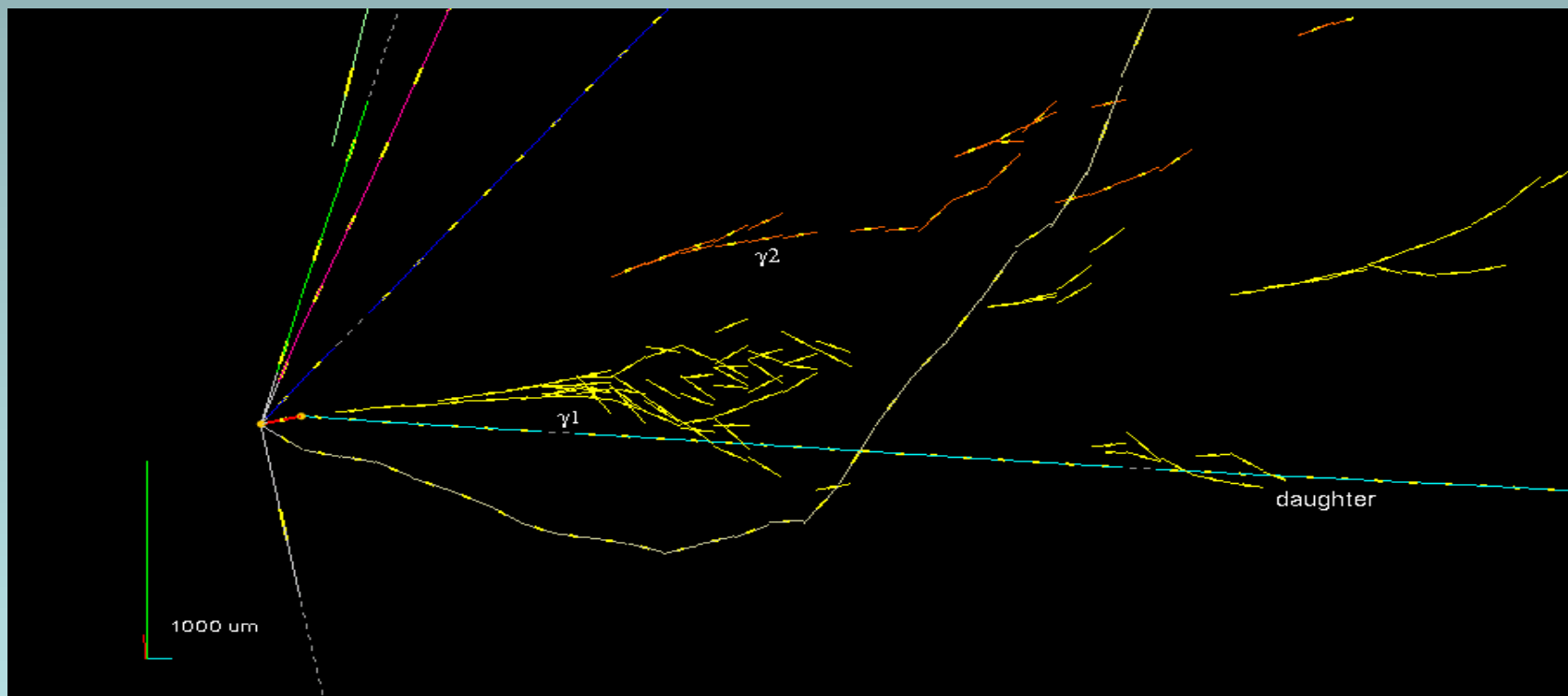
- An appearance long baseline experiment to search for muon-neutrino to tau-neutrino oscillation signal which is allowed at the 90% CL by Super-K covers the Δm^2 range of $1.5-5 \times 10^{-3} \text{eV}^2$ in the CNGS beam.
- The detector design is based on ECC tracking devices and Electronic detectors as the hybrid system for the direct observation of decay of the tau leptons produced in tau-neutrino charged current interactions.



- As the recent result one of the many billions of muon-neutrinos has likely “transformed” into a tau-neutrino that has been observed (see next page).
- This result is an important step towards the long awaited discovery of neutrino oscillations in direct appearance mode.
- Before OPERA experiment Korea team have performed the FNAL E-531, CHORUS, and DONUT.
- We are performing emulsion handling, brick x-ray exposure, emulsion analysis and OPERA shifts etc.

Observed the first tau-neutrino candidate “appearing” out of several billion of billions muon- neutrinos sent from CERN

By assuming that $\Delta m^2 = 2.5 \times 10^{-3} \text{ eV}^2$ and full mixing, we expected:
 0.54 ± 0.13 (syst) nt CC events in all t decay channels and
 0.16 ± 0.04 (syst) nt CC events in the 1-prong hadron(see fig. daughter) tau decay
channel and we observed 1 event. This result allows us to exclude at the 90% CL $\Delta m^2 >$
 $7.5 \times 10^{-3} \text{ eV}^2$ (full mixing)



Cost of the OPERA experiment (proposal)

- Cost of two supermodule and Muon Spectrometers: 48.6MCHF
- Cost of the electronic detectors: 82.7MCHF
- Emulsion readout facilities and Running cost: 17 .2MCHF

Total cost:148.5MCHF

Research Period: 2001~2015(?)

OPERA collaborators in Korea

S. H. Kim, B. D. Park, I. G. Park, J. S. Song, C. S. Yoon

Department of Physics, Gyeongsang National University,
Jinju, Republic of Korea

CQeST Overview

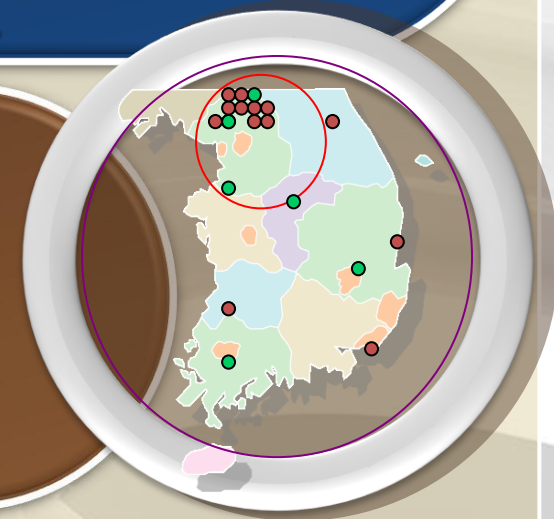
Center for Quantum Spacetime(CQeST) has been established since June of 2005 funded by the Science Research Center(SRC) project of Ministry of Education, Science and Technology(MEST) through National Research Foundation of Korea(NRF) for 9 years .

The Center is hosted by Sogang university, and consists of twenty faculty members of string theorists, field theorists, particle physicists, cosmologists from 10 participating institutes, along with many research associates and students.

Participating Members :

Sogang 7, Yonsei 1, Kyunghee 2, KIAS 2,
Hanyang 2, Univ. of Seoul 1, Seoul Nat'l Univ. 2,
Sungkyunkwan 1, Postech 1, Inje 1

Total of Institute : 9 Univ, 1 Inst.



Director : Bum-Hoon Lee (Sogang University)

Synopsis of CQJeST

Period of Research: 2005.6.1~2014.2.28

Fund

Total:

10,254 Mwons

KOSEF

- 1st : 468 Mwons
- 2nd : 886 Mwons
- 3rd : 879 Mwons
- 4th : 1,002 Mwons
- 5th : 964 Mwons
- 6th~9th : 1,026 Mwons

Sogang Univ.

- 1st : 150,000,000 won
- 2nd~9th : 200,000,000 won

CQJeST

Members('10)

Professor : 20

(Center Professor : 1)

Research Prof : 2

Post-doc : 9

Korean : 4
Foreigner : 5

Student : 9

Master's Degree : 17
Doctoral Degree : 12

Staff : 3

Other Support

KOSEF

- RND system
- Research Fund card
- Committee for Staff
- Committee for Director

Sogang Univ.

- Research Staff
- Equipment
- Space
- Administrator

CQeST Area of Research and Activity

1

String theory and quantum spacetime :

To study properties of supersymmetric solutions, integrable systems, string on curved space, mirror symmetry, moduli space of supersymmetric solutions, tachyon condensation and changes of spacetime topology, and non-perturbative nature of QCD.

2

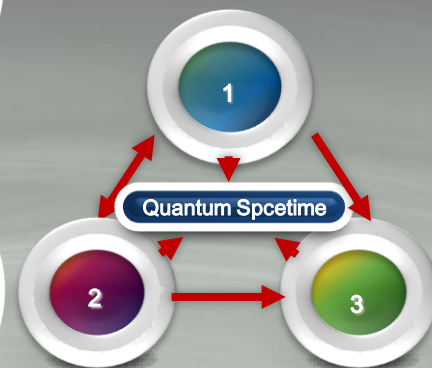
Quantum field theoretic approach to quantum spacetime :

To study quantum field theory on noncommutative space, holographic principle, quantum field theory on the expanding universe, and quantum properties of black hole and information paradox.

3

Mathematical development and experimental tests :

To study the mathematical structure of quantum spacetime of very early universe, origin of the universe, and experimental tests of string theory via accelerators or cosmic rays.



Activity Period	Division	Paper (SCI)	Conference	Seminar	Visiting Researchers	International Cooperation
2005.6~2010.6	Domestic	26	48	166	134	12
	Intenational	267	27	142	144	

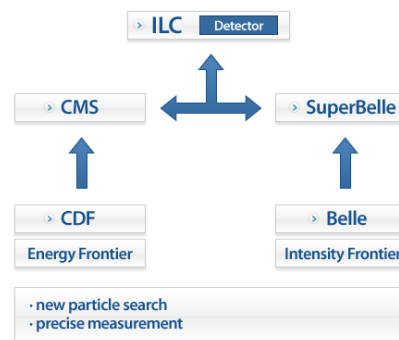
HEP at Kyungpook National University

(More than 30 Ph.Ds in HEP)

- CHEP: Center for High Energy Physics (July 2000)
 - AMS
 - CMS
 - CMS Tier2
 - ILC Accelerator
 - D. Son, G.N. Kim, E.S. Kim, W. Kim, Youngsuk Oh, Hyangkyu Park, J.S. Suh, Hyongsuk Kim, S. R. Ro, J. H. Chung, M. Lee, K. Kim, Stephanyan, and others

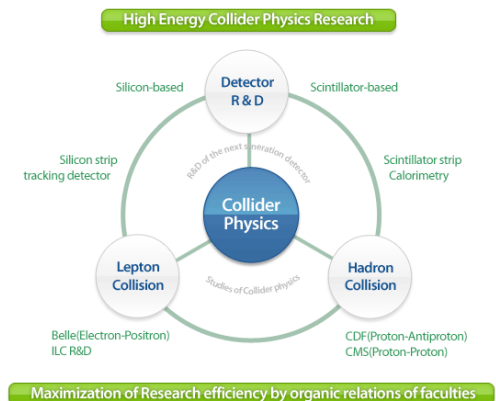
- High Energy Collider Physics Research Team (March 2009): World Class University Program
 - CDF & CMS
 - Belle & Belle II
 - ILC Detector: Silicon-, Scintillator-based tracking and energy system
 - D. Kim, T. Kamon, S. Uozumi, H. Park, H. Kim, Y. Oh, J. Kim, D. Kong, Hyunok Kim, Gul Rooh

<http://chep.knu.ac.kr/>



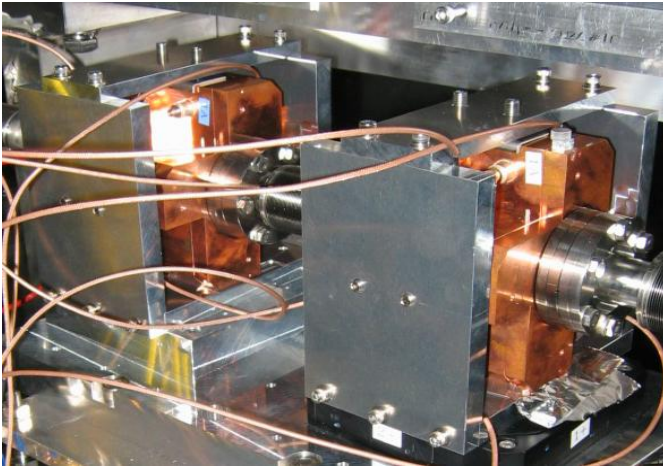
- Silicon - based
- Scintillator - based
Detector

- New Particle Searches
- Precision
measurement for
proving SM

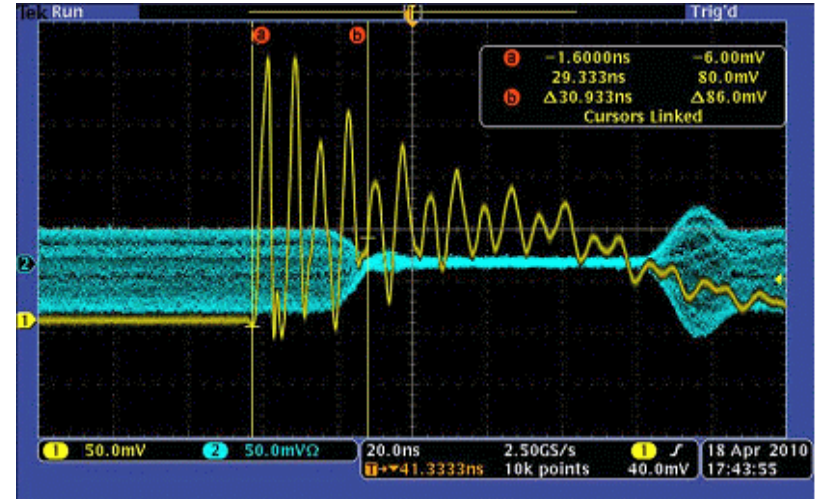


Beam test of IP-BPM with nanometer position resolution for ILC (June 2010) - Kyungpook

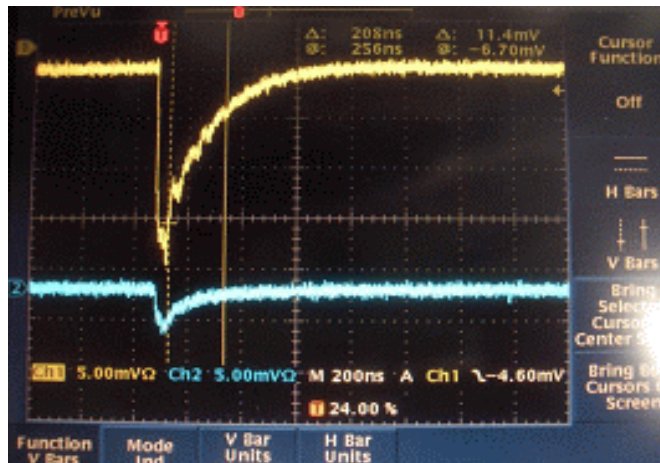
Installation at KEK-ATF2



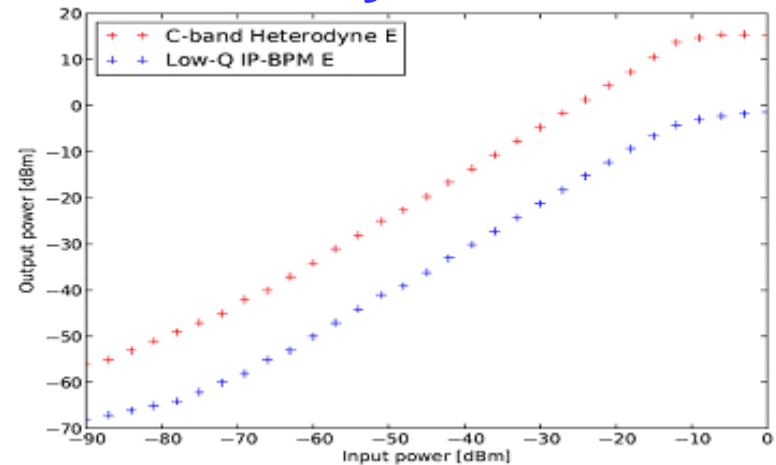
Measured latency : 17 ns



Measured waveform

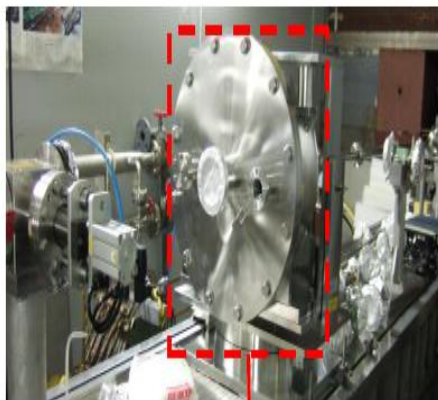


Measured linearity : 10nm resolution

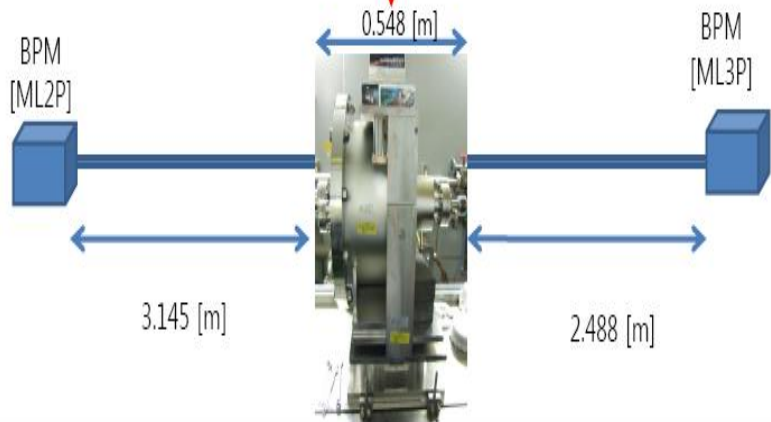


Beam test of L band-BPM for ILC Main Linac (June 2010) - Kyungpook

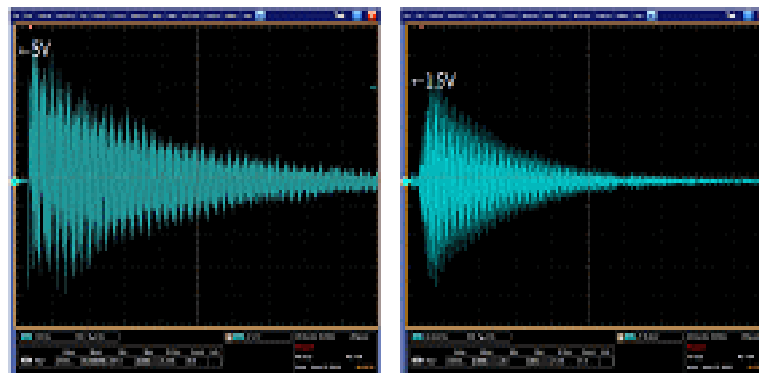
Installation at KEK-ATF



L-Band BPM is installed here



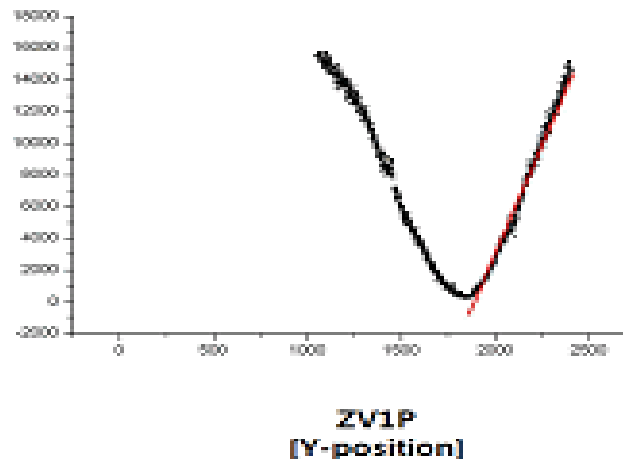
Measured waveform



Raw signal

Signal through
the 2.043GHz BPF

Measured antenna scan



Some Korean history for ILC

- A Planning Team formed at CHEP (March 2004)
- Korean ILC Workshops (4 times + 3 mini-workshops)
- PAL ILC Task Force (Jan 2005) formed
- Strategic Plannings for ILC (three times)
- ILC-Asia MoU (Aug 2005)
 - CHEP, PAL, KEK, IHEP, TIFR, CAT, IUAC
- ILC-Common Fund MoU (Oct. 2006)
- **Held Several international conferences and workshops** →
- Research Projects;
 - Int. Coop. Project (P.I.-H. Park) for Physics and Detectors
 - SRC Projects (Accelerator & Detectors)
- Several Committee Activities:
 - ICFA, ILCSC, ITRP, Parameter, LCWS–WG Coordinators

1. LCWS 2002 (Jeju)
2. 8th ACFA LCWS (Daegu 2005)
3. Committees: ITRP(Pohang 2004) and ILCSC, ICFA, FALC-RG during ICFA Seminar (Daegu 2005)
4. ILCSC, ICFA, FALC-RG during LP07 (Daegu)
5. Ecloud'07 (Daegu)
6. Asian ILC Workshop (2009, Daegu)

Through for 4 ILC Workshops in Korea and 3 Strategy Reports (2005-2008)

- We have identified some major R&D areas for ILC
- Detector areas;
 - Silicon Tracker
 - Silicon/Tungsten Calorimeter
 - Plastic Scintillator/Tungsten Calorimeter
- Accelerator areas;
 - Bunch Compression System
 - Damping Ring
 - BPMs
 - RF systems
 - Modulators and RF waveguide for ILC
 - SCRF

On-going R&D's for Detectors

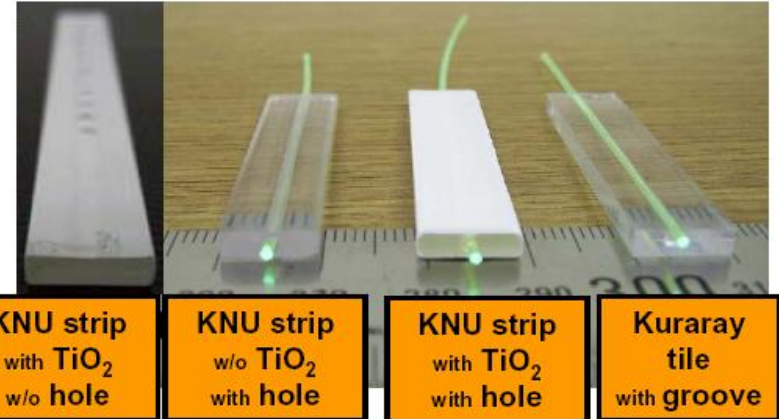
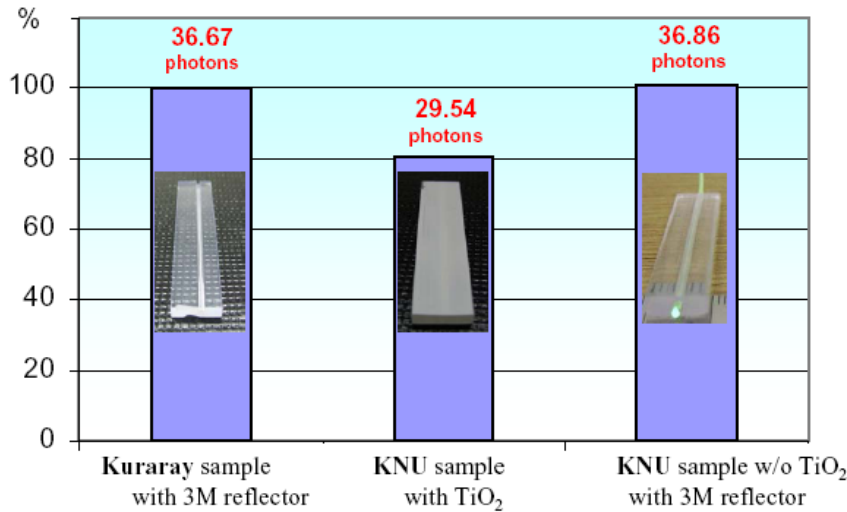
- Studies for Silicon Vertex Detector Design
- Studies for Silicon Central/Forward Tracker Design
 - KNU, YU, SKKU, HU
- Calorimetry
 - Si-Scintillator
 - EWU, YU, SKKU
 - Extruded type of Plastic Scintillator
 - KNU

KNU: Kyungpook Nat'l U. **EWU**: Ewha Women's U. **YU**: Yonsei U. **SKKU**: Sungkyunkwan U., **HU**: Hanyang U.

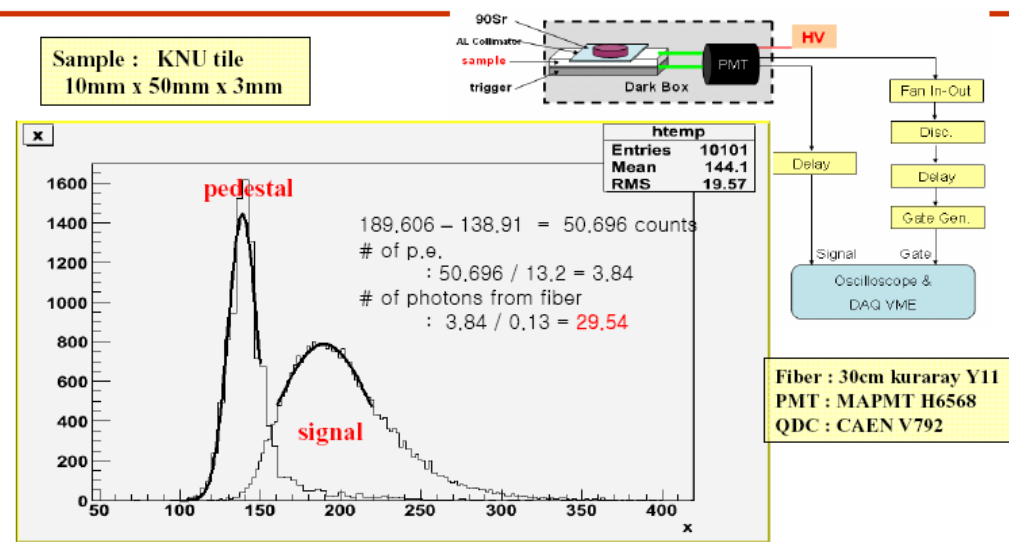
Plastic Scintillator

- Extrusion is easy to make numerous type of scintillator
- Lower cost than casting method
 - primary dopants: PPO
 - secondary dopants: POPOP

Light Yield Comparison



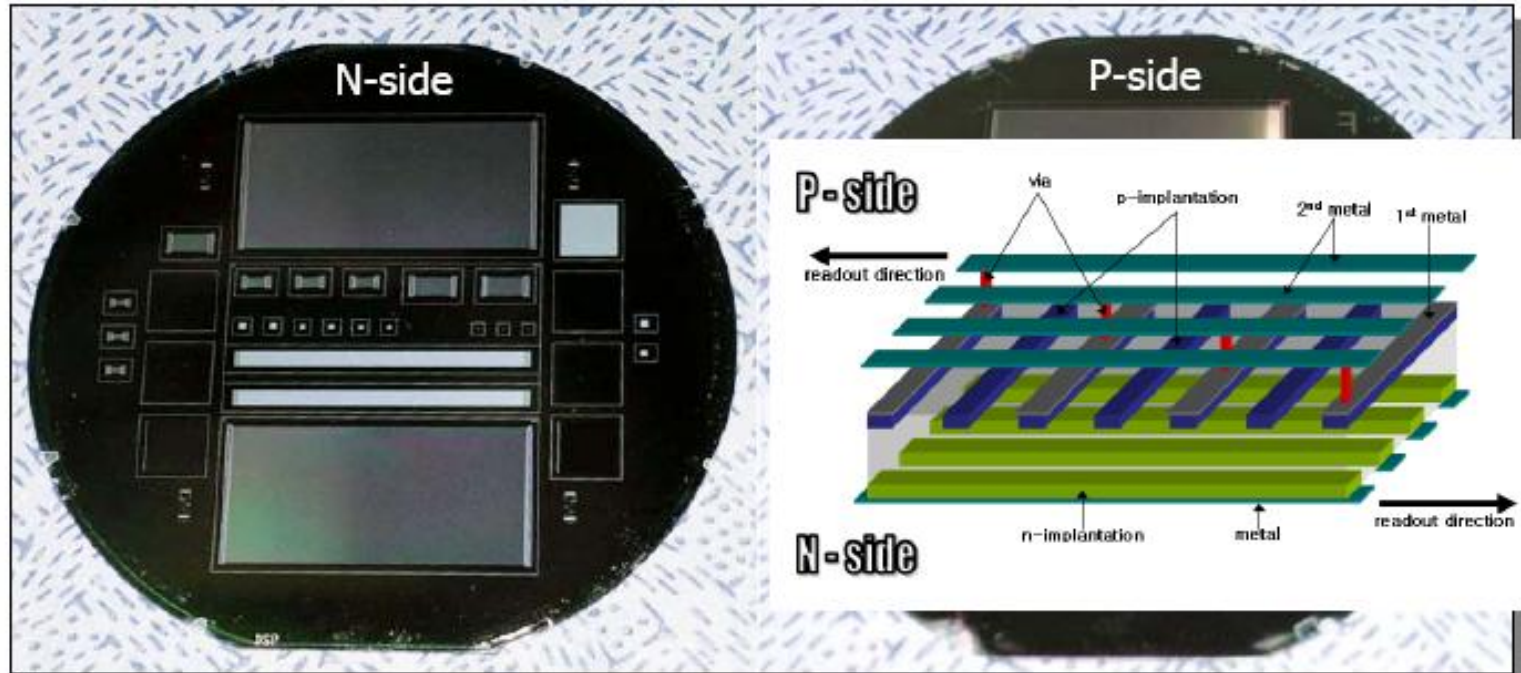
Measurement of absolute Light Yield



$$\# \text{ of photon from fiber} = \frac{\text{Pulse height (ADC counts)}}{13.2 \text{ (ADC count / 1pe)} * \text{Q.E.}} = \sim 30 \text{ photons}$$

Silicon Sensors for Trackers

DC-DSSD Prototype



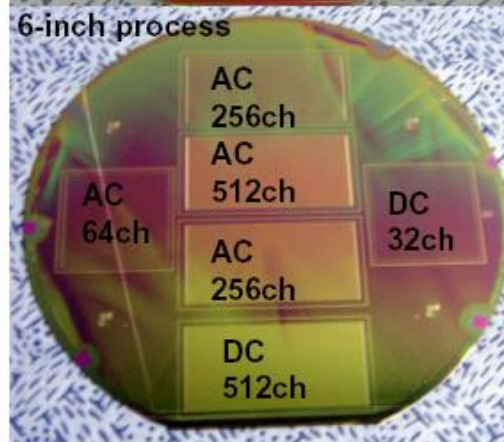
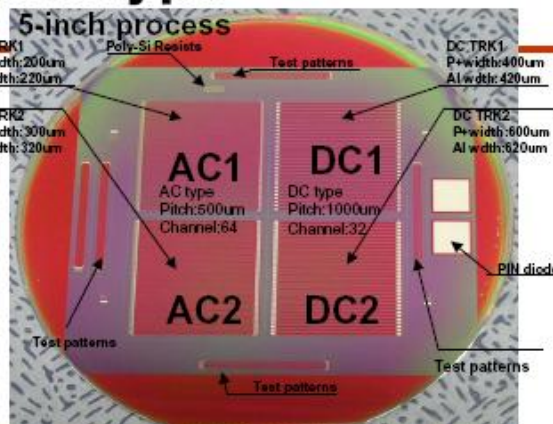
wafer	TOPSIL (5inch, high resistivity, (100), FZ, DSP)	strip width	9 μm
		strip pitch	50(100) μm
thickness	380 μm	readout pitch	50 μm
size	51 x 26 mm^2	readout channel	512(512)

Silicon Sensors for Trackers

AC/DC SSD Prototype

AC-coupled Single-sided Silicon Strip Detector

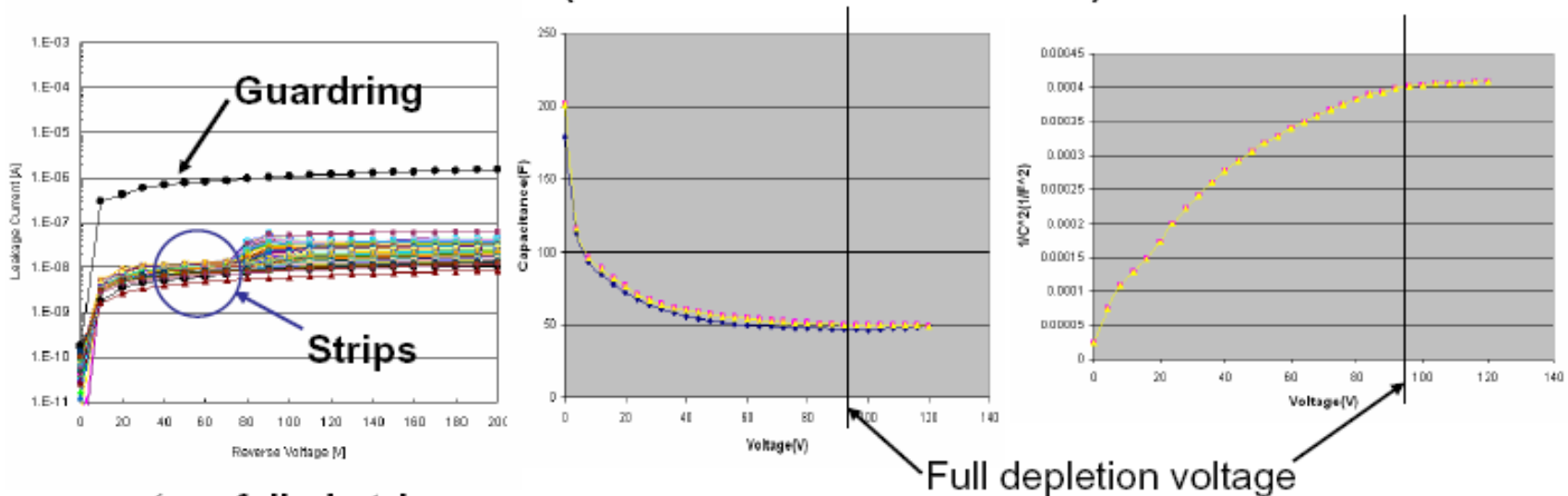
	5-inch	6-inch		
thickness(μm)	380	400		
Area (μm^2)	35000 × 35000	55610 × 29460		
Effective area (μm^2)	31970 × 31970	51264 × 25178		
SiO ₂ layer thickness (nm)	1000	250		
Polysilicon length (μm)	10	8		
Polysilicon width (μm)	13500	480		
sheet resistance(k Ω)	~25	~400		
	Type 1	Type2	Type 1	Typ e2
Number of strips	64	64	256	512
Strip pitch (μm)	500	500	100	50
Strip width (μm)	200	300	8	8
readout width (μm)	220	320	12	12



Silicon Sensors for Trackers

Sensor Measurement

Good results of sensors (characteristics on P-side)



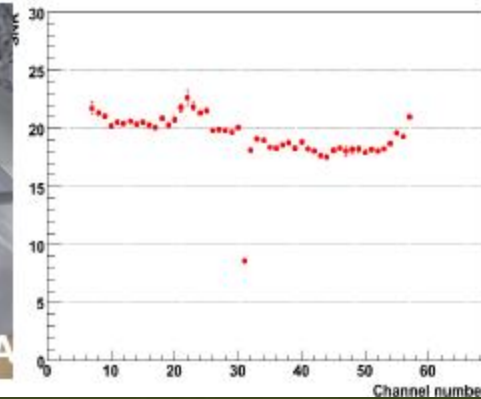
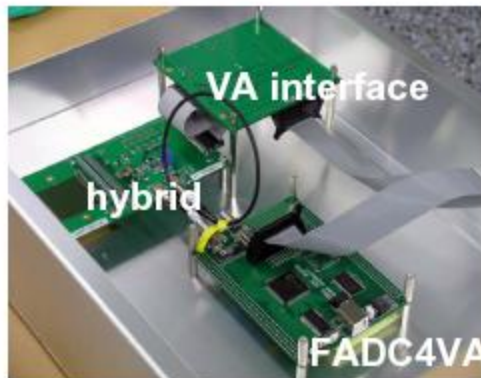
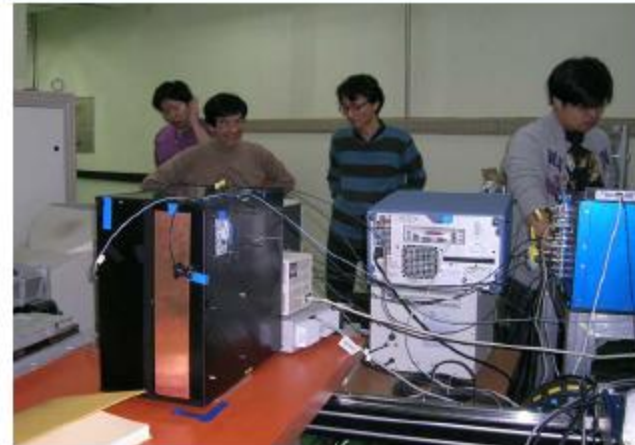
- ✓ no failed strip
- ✓ p-strip leakage current : 8~20nA/strip @ 100V
- ✓ guardring current ~ 1uA @ 100V
- ✓ guardring capacitance ~ 50pF @ 100V
- ✓ full depletion voltage ~ 95 V

Silicon Sensors for Trackers

Beam Test



VA Hybrid board



R&D for ILC Accelerator Technology

- Pohang Accelerator Laboratory
 - SRF for Pohang Light Source (single cell, 9-cell)
 - KEK-ATF2 Q-BPM Design and Fabrication
 - Prototype/2005, 11 BPMs/2006, 28 MBPs/2007
- Kyungpook National University

Damping ring	<ul style="list-style-type: none"> □ Lattice design □ Fast-ion instability and Ecloud instability
Beam dynamics simulation	<ul style="list-style-type: none"> □ Upstream RTML in RTML
RTML	<ul style="list-style-type: none"> □ Alternative ultra-short bunch compressor
HTRF	<ul style="list-style-type: none"> □ IOT
SRF Cavity	<ul style="list-style-type: none"> □ Cavity design and processing
BDS	<ul style="list-style-type: none"> □ Development of Low-Q IP-BPM and S-band BPM for ATF2 □ Ring-extraction jitter correlation study

- Pusan National University
 - **Fabrication of Prototype of ILC Cavity BPM for ATF in TM_{120}**

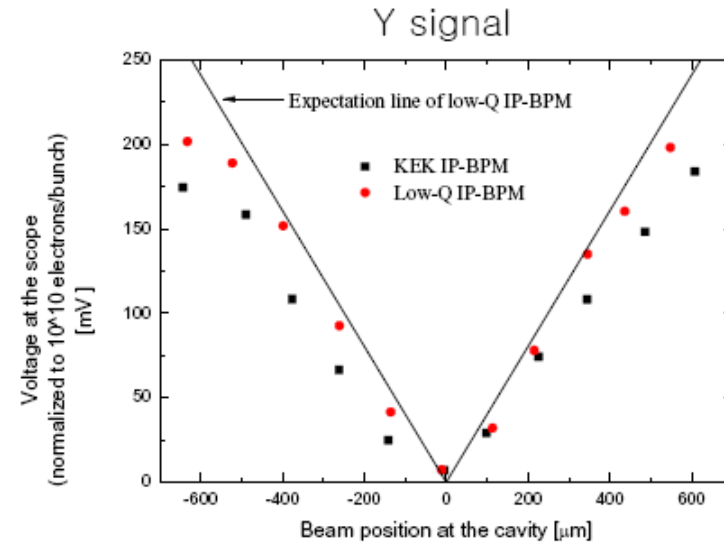
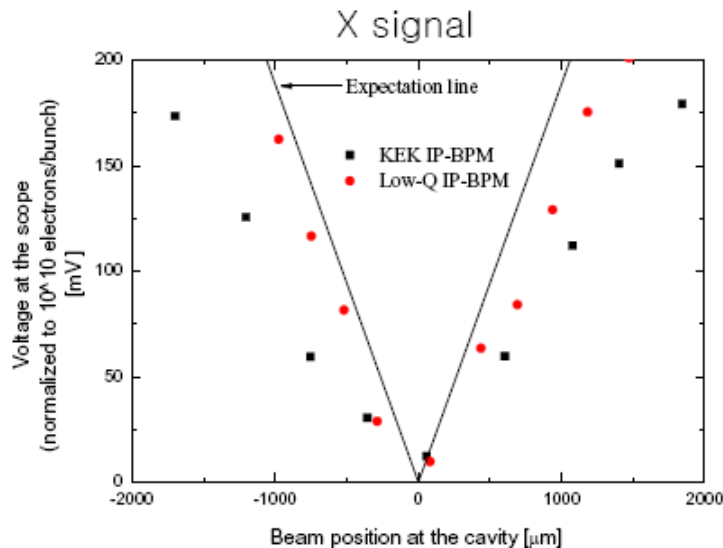
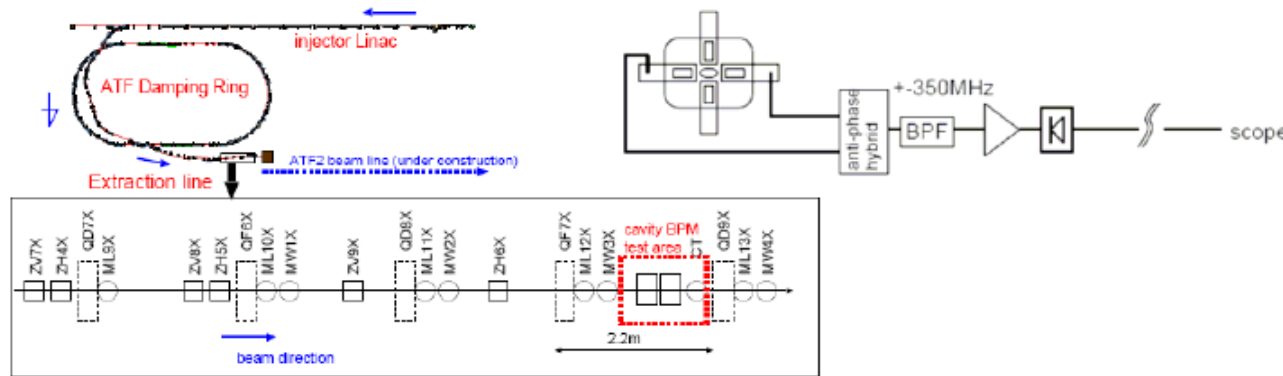
Development of Low-Q IP-BPM

Kyungpook



Installation and Tests

3. Position sensitivity



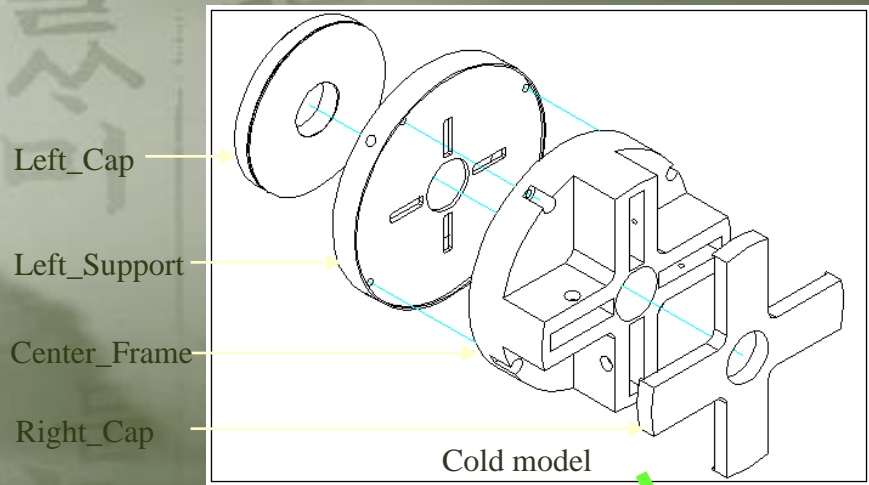
S-band BPM in ATF2

Kyungpook

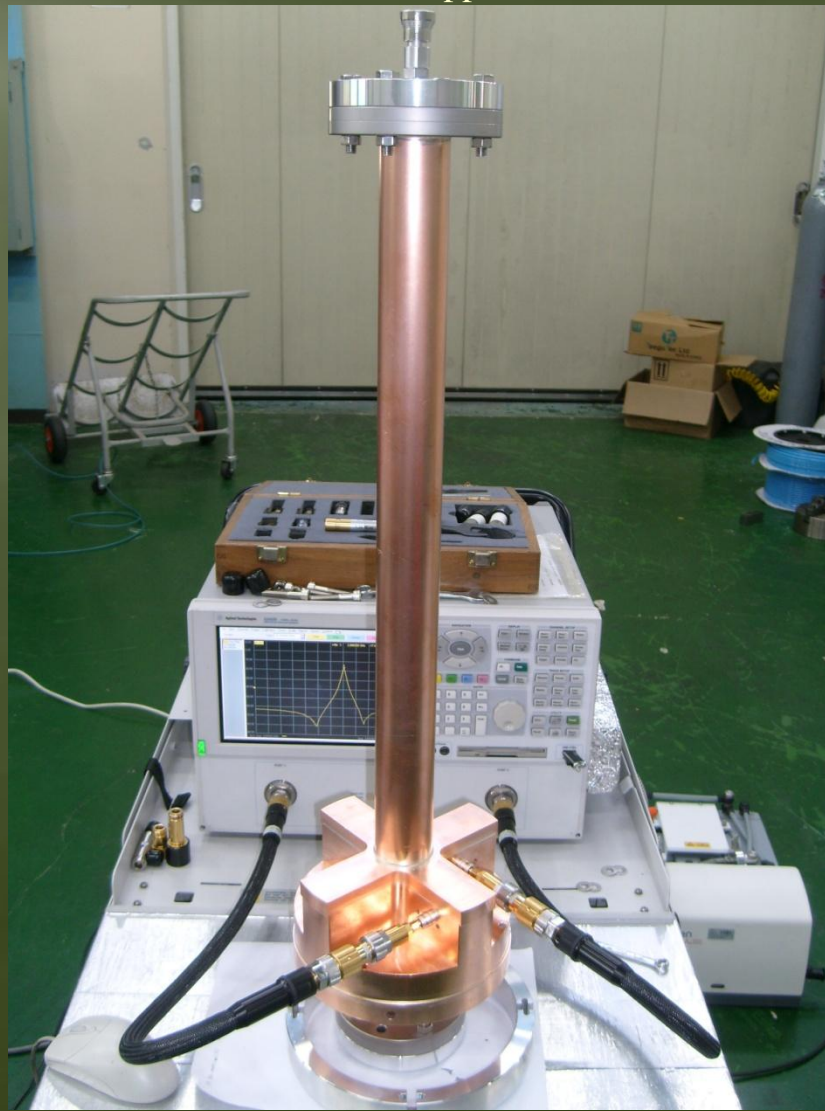
- What for with this BPM (beam position monitor) ?
 - To control beam orbit at final focus beam line in ATF2
 - To do BBA (beam-based alignment) with 1 mm at final focus beam line in ATF2 (BPM resolution of a few hundreds nm should be satisfied.)
- Requirements for the BPM
 - Dynamic range ; a few mm
 - Diameter of beam tube ; 40 mm
 - Signal decay time ; 35~ 80 ns (where, $f = 2878$ MHz, $QL = 650 \sim 1800$, longer decay time will be preferred for the electronics)

Design and Fabrication of S-band BPM

S-band BPM framework



S-band BPM under RF test
- 4 BPMs has been shipped to KEK last week



Fabrication of S-band BPM

- Design and fabrication of S-band BPM for the sextupole magnets and quadrupole magnets has been performed in Korea (at Kyungpook)
- 1 cold model of the S-band BPM has been sent to LAPP for an initial try for the installation, April, 2008.
- 4 S-band BPMs were sent to KEK to be installed in ATF2.

Machine Shop at KNU

