HEP Topics for BSI

Dongchul Son (CHEP, KNU)

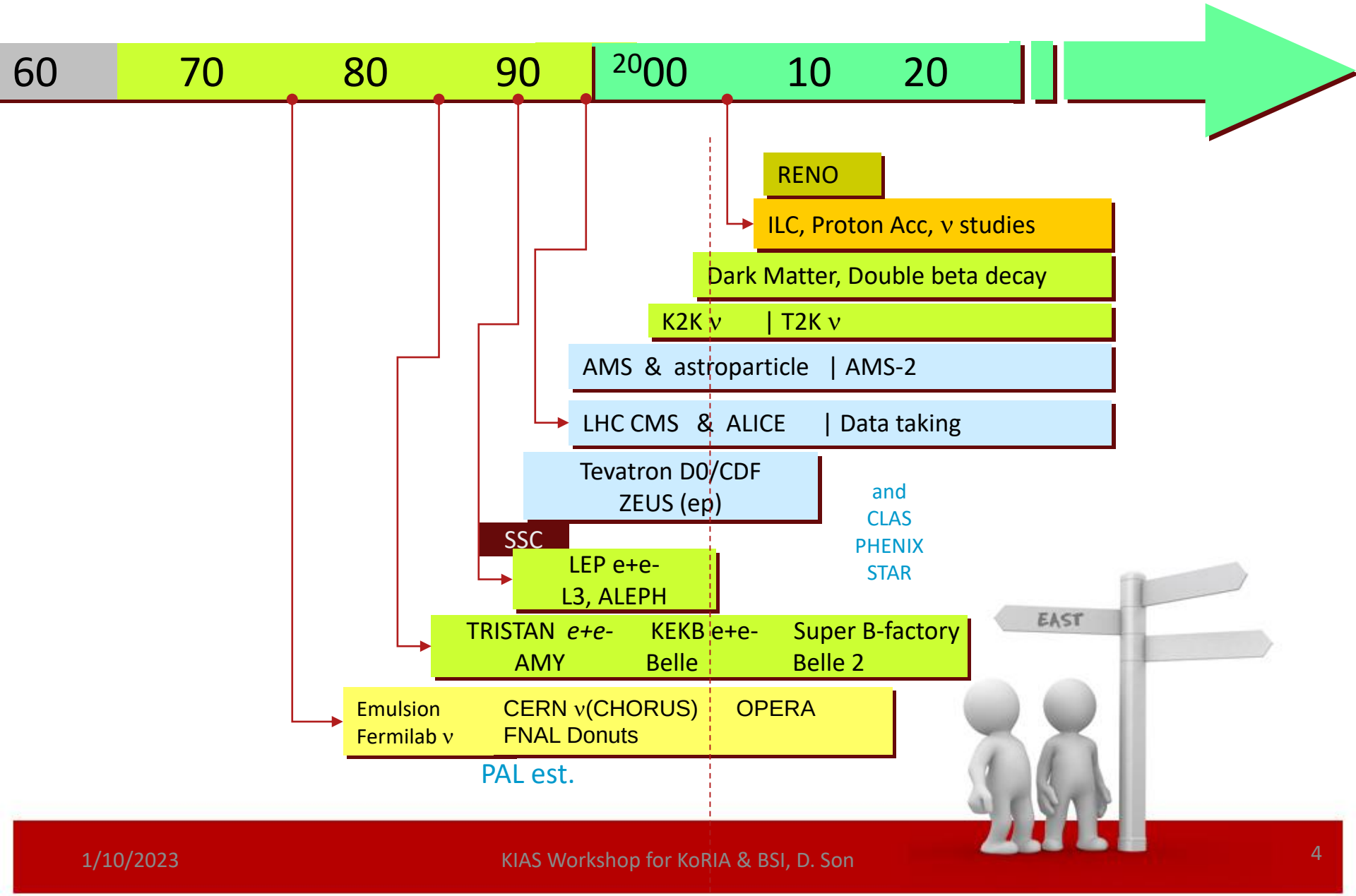
Outline

- BSI's HEP team?
  - Why?
- What are current hot issues?
- What can we and should we do?
- How teams could be organized?
- Summary and issues for discussion

BSI's HEP team? Why?

- Short history of Korean HEP
- Organizations
- Institutions and manpower
- HEP teams
- Roadmaps (2005, 2009)
- Necessity for at least one national organization for HEP

Short history of Korean HEP



HEP Organizations

(Institutes, Centers, WCU Teams)

Center of Excellence
CHEP (2000)
Kyungpook NU (host)

WCU (2009)

Center of Excellence
CQUeST (2005)
Sogang U (host)

KPS
Particles and Fields
Nuclear Physics
Astrophysics
Plasma Physics

KHEP: Association of Korean HEP (2005)

WCU-IEU (2009)
Ewha W U (host)

MEMSTEL (2006)

Korea-CERN Coop. (2007)

RENO (2006)
Seoul NU (host)

Center of Excellence
KNRC (2009)

WCU (2009)

DMRC (2000)

KODEL (1997)
Korea U

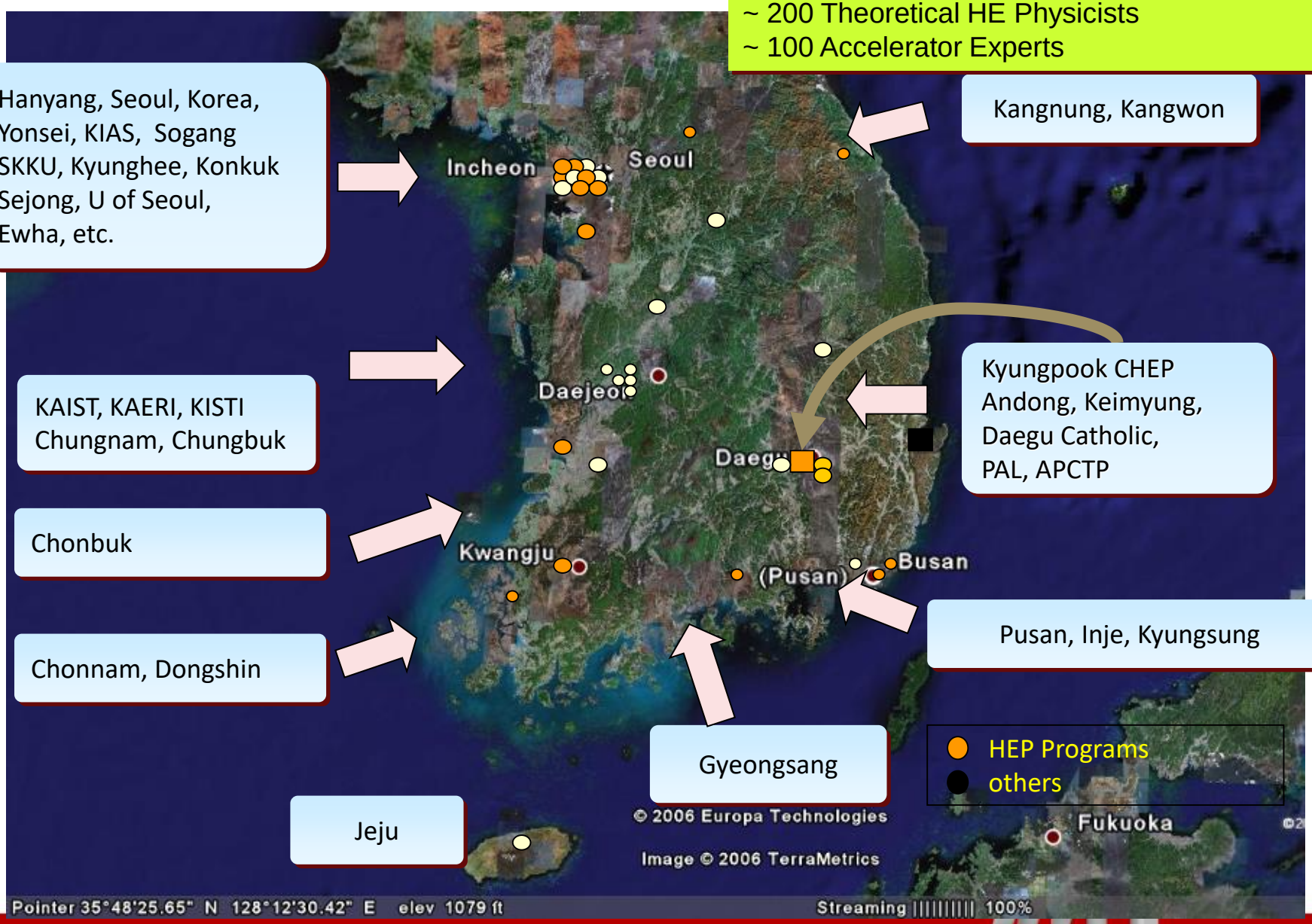
Emulsion Group
GSNU

And others (KAERI, etc.)

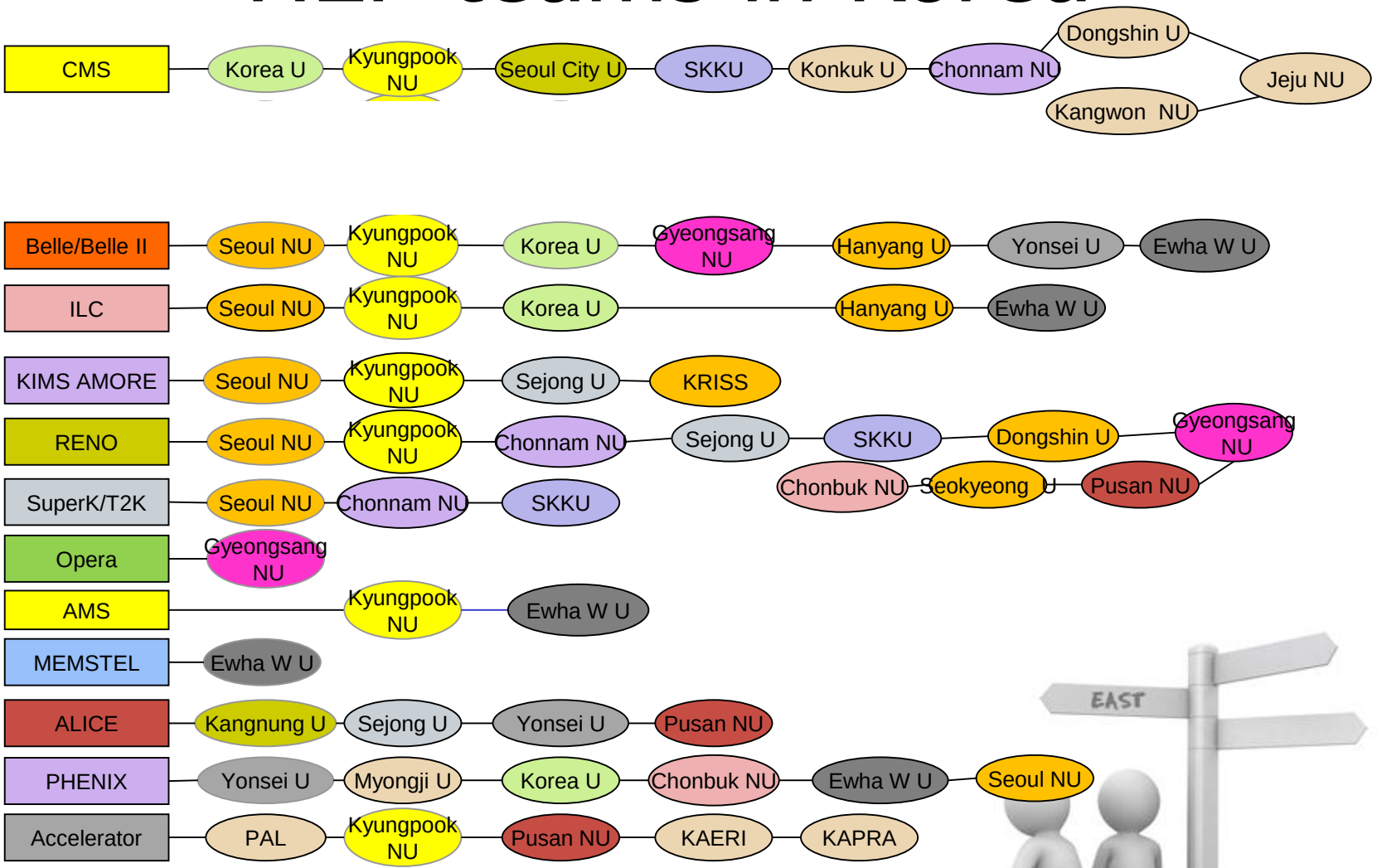
PAL (1988) POSTECH (host)
APCTP (1997) POSTECH (host)
CTP (1990) Seoul NU (host)
KIAS (1996) KAIST (host)

HEP Institutions

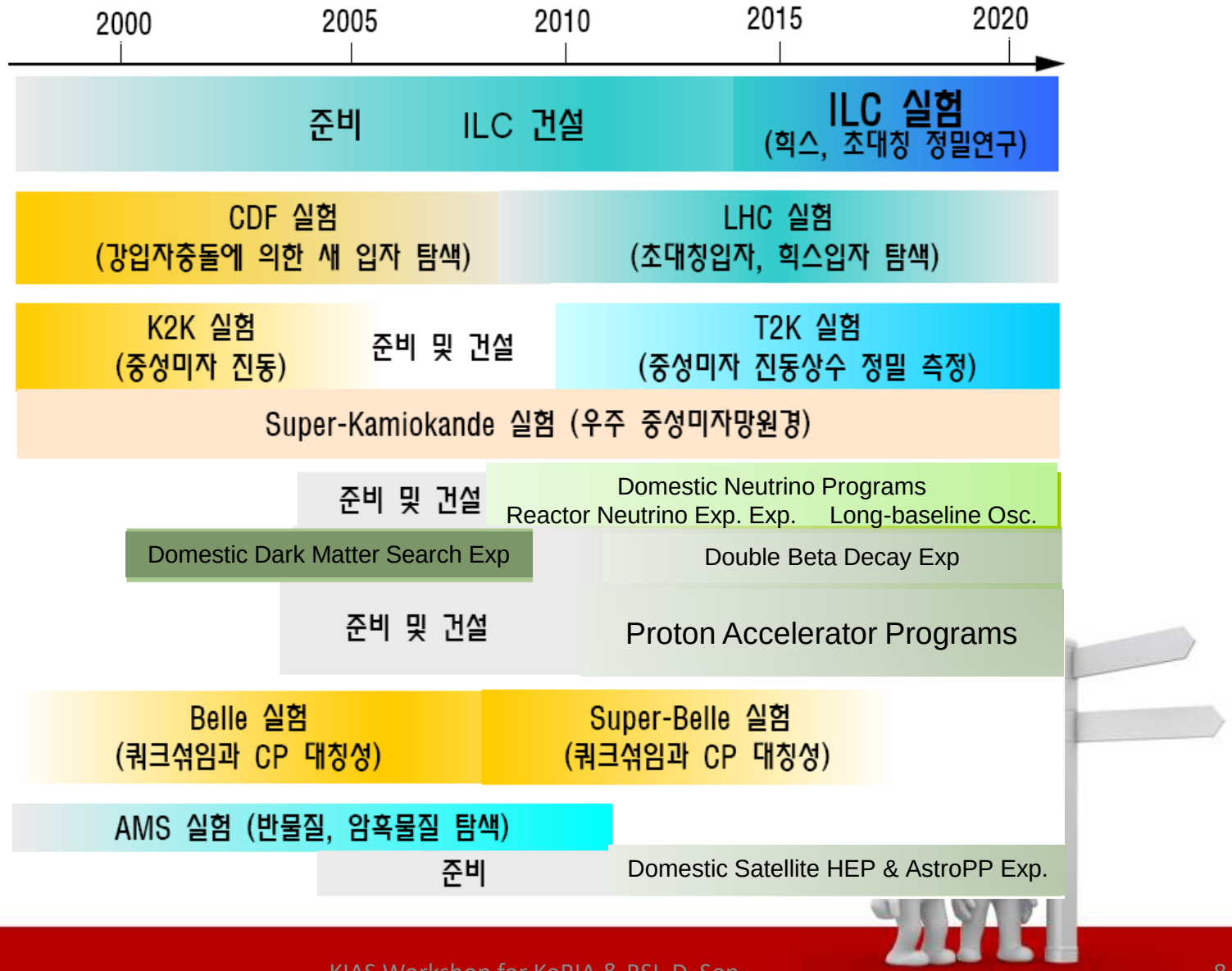
~ 57 Institutions
~150 Experimental HE & N Physicists
~ 200 Theoretical HE Physicists
~ 100 Accelerator Experts



HEP teams in Korea



Korean HEP Roadmap (2005)



Accelerator Based HEP Roadmap

(2009.4, KHEP Association)

2005 2010 2015 2020 2025 2030

PEFP — 100 MeV Proton Accelerator

RCS(1GeV) — Neutron/Muon Source

SC(1GeV) — Proton Drive (8-10 GeV) — High Power PS – neutrino factory, μ Collider

Try to connect the PEFP, KoRIA, Photon Facotry Programs with HEP Plans

KoRIA (Superconducting) — 200 MeV Rare Isotope Accelerator

Options: After 2015 Proton Drive or ILC

2nd Phase PEFP or SC of KoRIA Superconducting Cavity Technology As first priorit

ILC (Superconducting) — 500 GeV - 1 TeV e+e- collider

Smaill e-Linac for Rare Isotope production by photofission at KoRIA

Super Charm — 3 GeV e+e- collider

Options considered: ILC or Super Charm, post-ILC

Next ILC — > 3 TeV e+e-

LHC (7+7 TeV) — SLHC

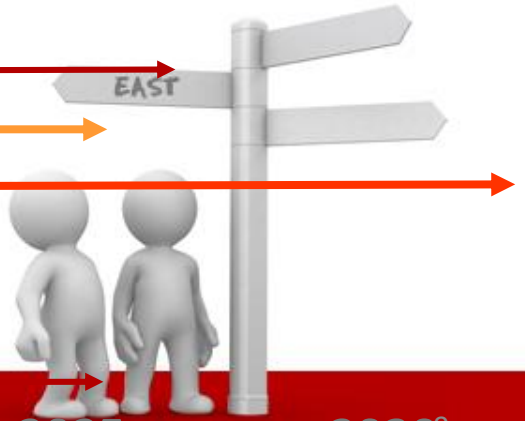
Super KEKB

ILC

J-PARC

FAIR

FRIB



고에너지물리의 미래를 위해

- 국립고에너지물리연구소 – 이휘소 연구소(가칭) 필요
  - (양성자 가속기)
  - 여러 창의적인 실험 수행 및 R/D 시설
  - 모든 사람들이 참여하는 연구소로
- 국가대형연구시설 (확정, 그러나 예산 미반영)
  - CMS Tier 1
  - 양양지하검출기시설
  - 차세대중성미자검출시설
  - 지하고에너지연구시설 : T2KK, 양성자붕괴실험 시설
    - 여러 가지 연구를 위한 지하연구시설로 활용 가능
- 국제공동연구의 전초기지
  - LHC-CMS, ALICE, Super-B factory, JPARC 등
- BSI 사업단으로서의 필요성

What are current hot issues?

Based on Reviews at the most Recent LP11 and ICHEP10

- Standard Model's Mystery
  - Where is the Higgs particle ?
- Matter-Antimatter Asymmetry ?
  - Baryogenesis
- Understanding mysterious Neutrinos
  - Leptogenesis
- Unification of forces

- Unknown dark matter and energy
  - Controversial results : positive vs negative
- Understanding the Universe more deeply
  - Ultra HE particle sources
  - Propagation of cosmic particles
- Other candidates of new physics ?

‘Yesterday’

Excerpts from
Rolf Heuer’s talk at LP11

“Discovery” of Standard Model

At the energy frontier through synergy of

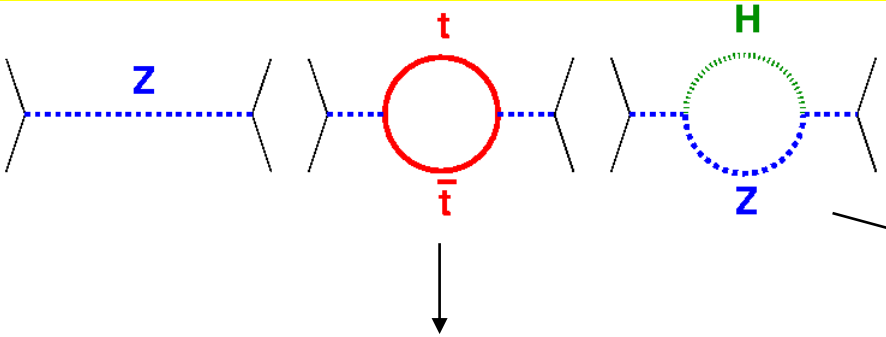
hadron - hadron colliders (e.g. Tevatron)

lepton - hadron colliders (HERA)

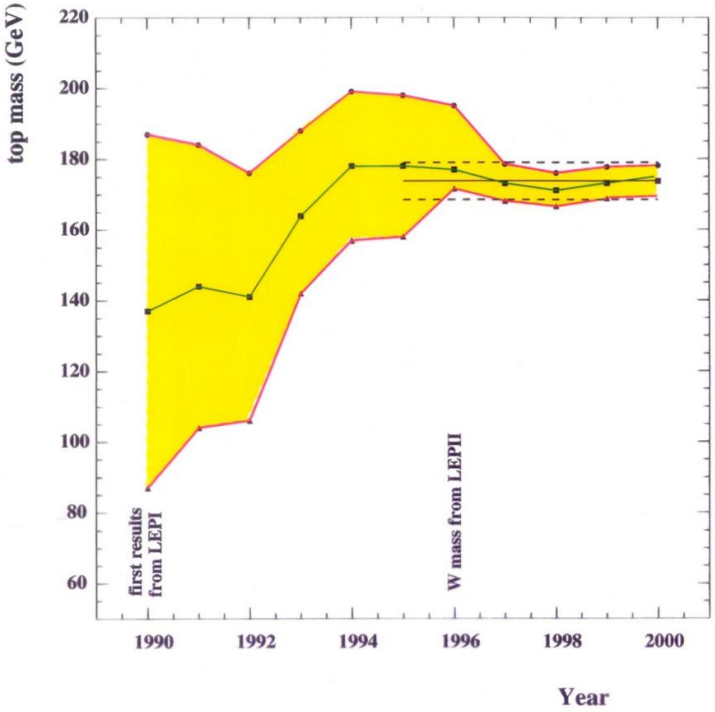
lepton - lepton colliders (e.g. LEP, SLC)

Test of the SM at the Level of Quantum Fluctuations

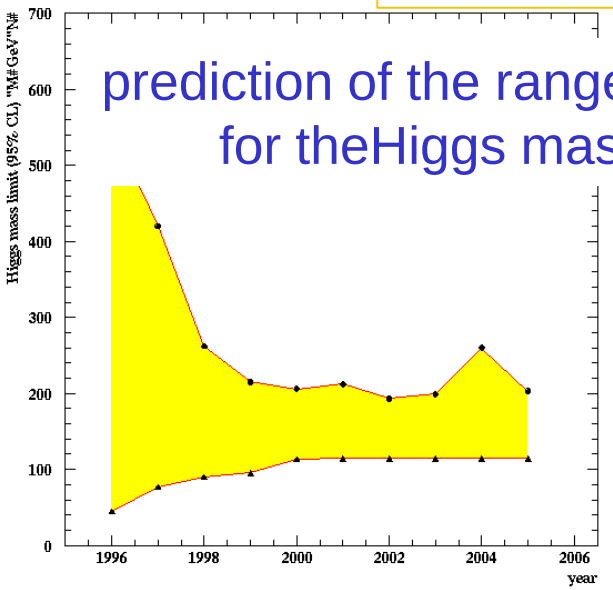
Excerpts from
Rolf Heuer's talk at LP11



indirect determination of the top mass

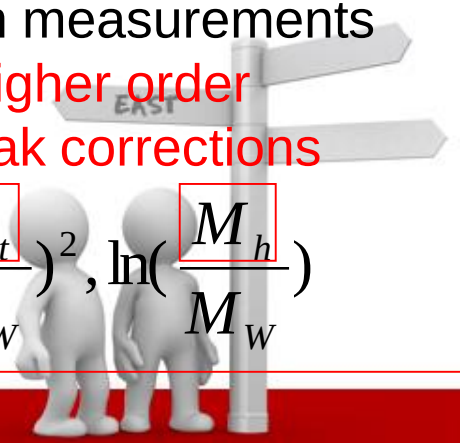


prediction of the range for theHiggs mass



possible due to
- precision measurements
- known higher order electroweak corrections

$$\propto \left(\frac{M_t}{M_W}\right)^2, \ln\left(\frac{M_h}{M_W}\right)$$



‘Today’

Excerpts from
Rolf Heuer’s talk at LP11

Exciting Times

At the energy frontier, the LHC brings us into unexplored territory:

Excellent progress

Accelerator – Experiments – Grid

Excerpts from
Rolf Heuer's talk at LP11

Key Questions of Particle Physics

origin of mass/matter or
origin of electroweak symmetry breaking

unification of forces

fundamental symmetry of forces a
matter

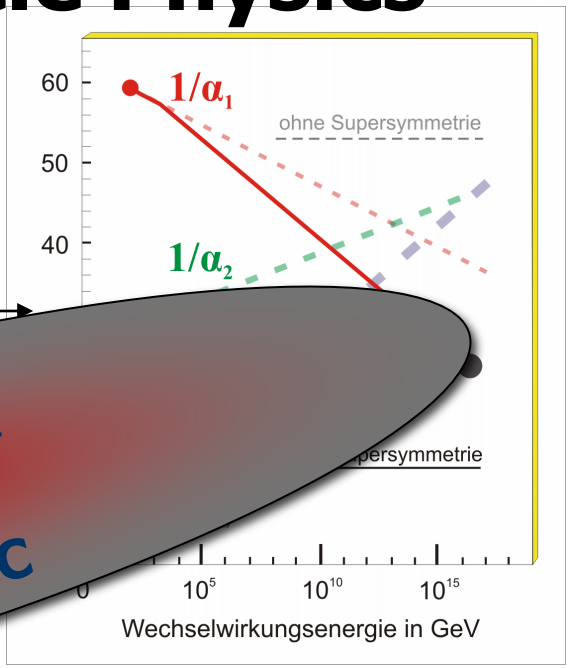
where is antima

unificatio
genera

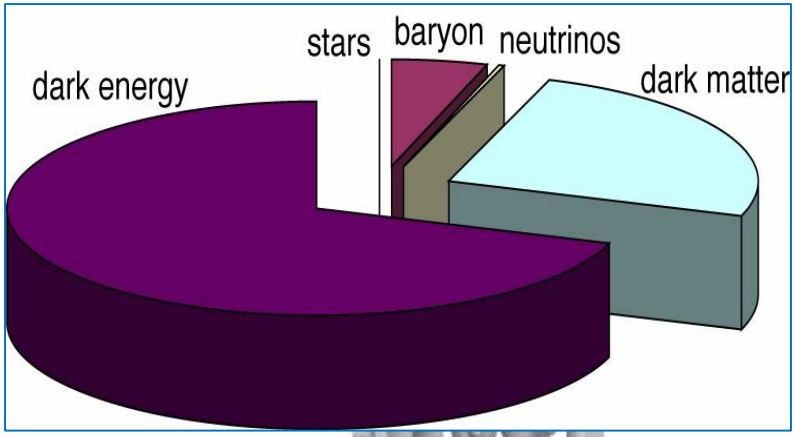
number of space/time dimensions

what is dark matter

what is dark energy



For most questions:
new particles should appear
at **TeV** scale or below
→ **territory of the LHC**



‘Tomorrow’

Excerpts from
Rolf Heuer’s talk at LP11

Key message (II)

There is a 20 years programme at the energy frontier with the LHC:

7 TeV
14 TeV design luminosity
14 TeV high luminosity (HL-LHC)

‘Beyond Tomorrow’

Excerpts from
Rolf Heuer’s talk at LP11

?

Colliders at the Energy Frontier

beyond LHC

Next decades

Excerpts from
Rolf Heuer's talk at LP11

Road beyond Standard Model

At the energy frontier through synergy of

hadron - hadron colliders

lepton - lepton colliders

LHC results will guide the way at the energy frontier

Linear Colliders: ILC / CLIC

Excerpts from
Rolf Heuer's talk at LP11

Both projects are global endeavours

Wide range of Physics Topics, e.g.

- Higgs (self) couplings
- Z, W, Top studies
- new physics

Key message (III)

High Priority Items for Linear Collider Projects

ILC and CLIC projects → LC project

Construction Cost

Power Consumption

Value Engineering

Key message (IV)

Excerpts from
Rolf Heuer's talk at LP11

All projects need continuing accelerator and detector R&D;

All projects need continuing attention concerning a convincing physics case;
close collaboration exp-theo mandatory

so that the right decision can be made when the time comes to identify the next energy frontier accelerator (collider).
Today, we need to keep our choices open.

Excerpts from
Rolf Heuer's talk at LP11

Past decades saw precision studies of 5 % of our Universe → Discovery of the Standard Model

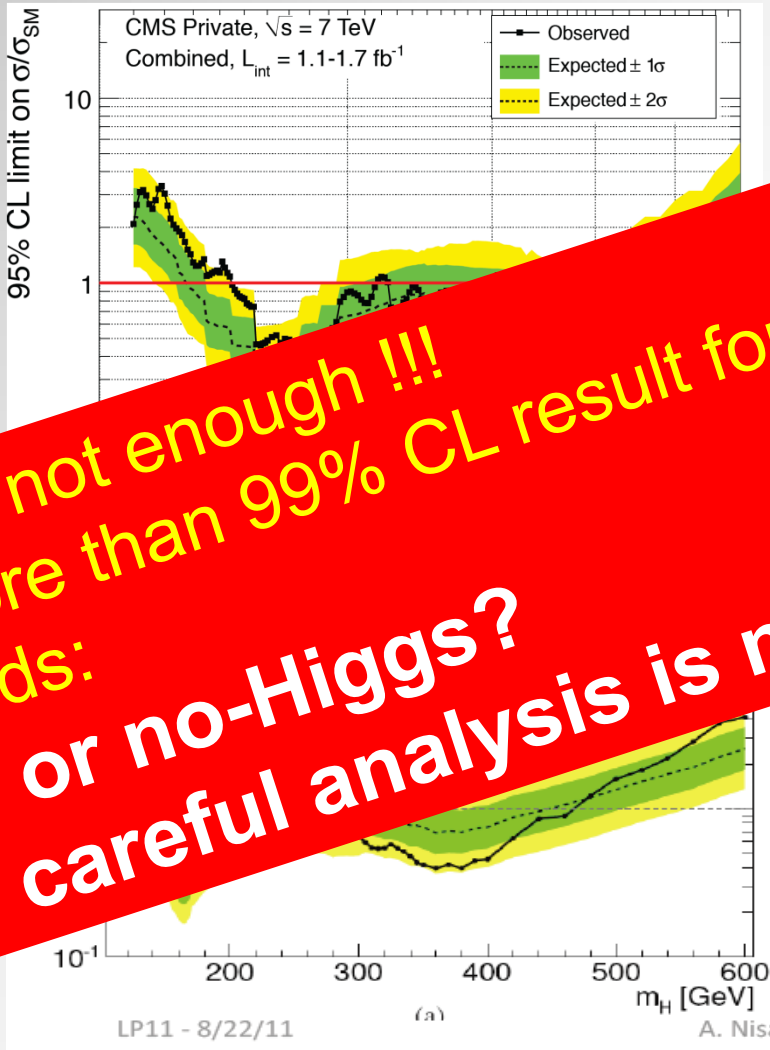
…

We are just at the beginning of exploring 95 % of the Universe

exciting prospects

Results of Search for Higgs

… to be continued



95% CL is not enough !!!
Need more than 99% CL result for discovery…
Key words:
Higgs or no-Higgs?
More careful analysis is necessary !!!

Obse

…del Higgs
…s mass excluded at
95% C.L.:

146<m_H<232, GeV
256 <m_H< 282 GeV
296 <m_H< 466 GeV

Matter-Antimatter Asymmetry and High Energy Cosmic Particles

- Belle and BaBar discovered Asymmetry in B systems
- Major CP-violation source would be from the baryon sector
- Understanding t… baryo…
- M… Fe… AMS2, CREAM, etc. are searching antimatter in the space

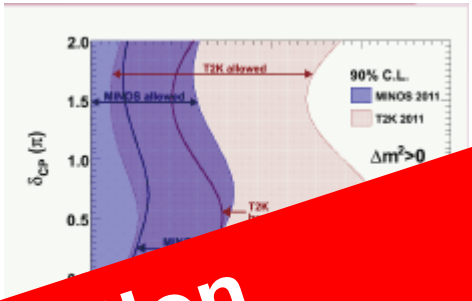
Key words: Baryogeneis, Dark Matter

Lots of data are now coming !!!

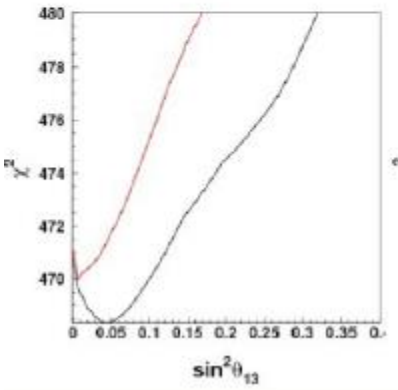
Excerpts from J Thompson's talk at LP11

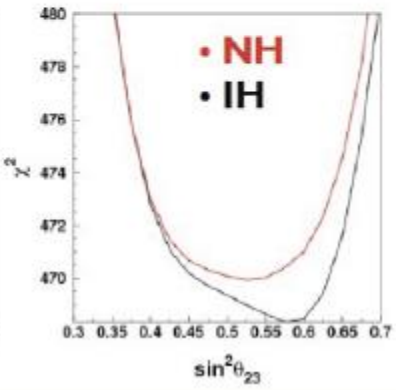
Understanding Neutrinos

- Reactor experiments + NOVA and T2K will get range of allowed δcp
- Assuming θ13 is between 5° and 10° NOvA could get at δcp and the mass hierar
- The mass hier
  neutri
  utrino 2010)
- rect and 0νββ is not seen in next generation experiments, neutrinos will be Dirac



Key words: Leptogeneis, CP-violation
Connection to Baryogensis → GUT
Long-baseline Nu, Proton decay Exp.!!!





What can we and should we do?

- 10s of billion events NOW and expect Tera-events in coming 10 yr
- Data analysis work is the most imminent and important
  - LHC – CMS/ALICE (7, 14 TeV)
  - AMS + CREAM
- Preparation for the next 10 y
  - Super-KEKB
  - Under
- and Experiments
- od example of Real Physics

Key words:
Data Analysis, Preparation (Acc. Detector)
Phenomenology

Tera-scale HEP Research !!!

A Vision of Future Korean HEP Facilities

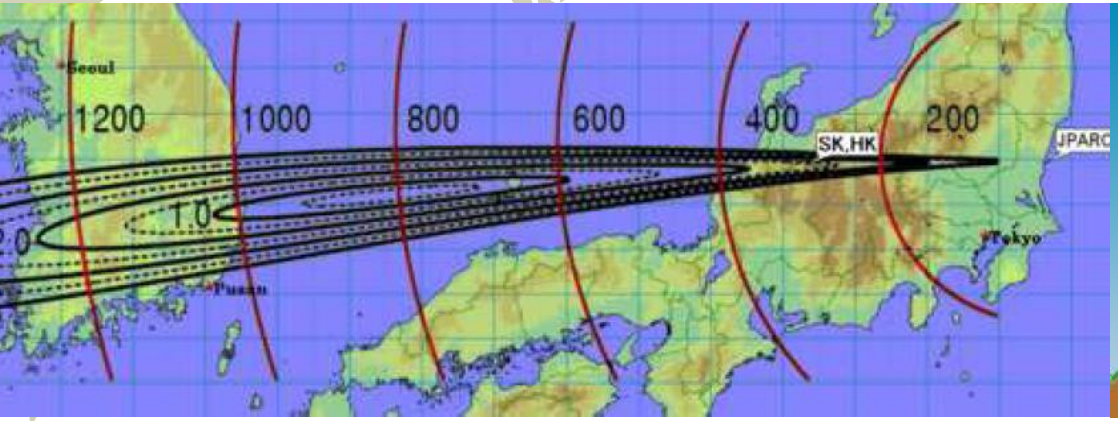
Yangyang Underground Lab (operating)
- Dark matter, Double beta decays

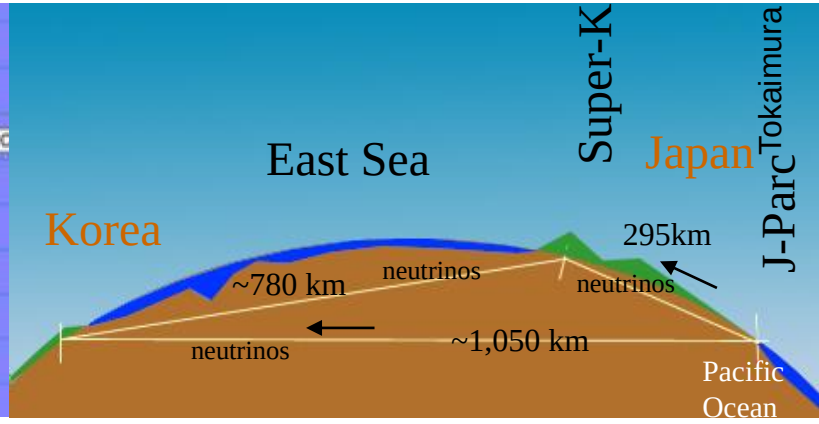
Reactor Neutrino Program
- RENO (started operation)

40~200 GeV Proton accelerator?
ILC ? (working for a proposal)

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

Long baseline neutrino Exp & Proton Decay Exp.
- T2KK (working for a proposal)





Major Research Goals

- 물질을 구성하는 기본입자와 기본 힘의 규명
- 암흑물질과 암흑에너지의 규명
- 우주의 생성과 진화에 대한 근원적인 이해
- 우주의 시공간에 대한 이해
- 미관측된 새로운 현상 발견 및 정체 규명

- In other worlds
  - Complete understanding of SM
  - Understanding of origins of Dark Matter, Dark Energy
  - Search for mechanisms for Unification of Forces
  - Establishing Baryogenesis and Leptogenesis
  - Search for New Physics BSM

연구 내용

- 표준모형의 정밀 검증과 힉스 입자의 성질 정밀 규명
- 초대칭 이론/여분차원 공간 등 새로운 이론에 대한 검증
- 암흑물질의 탐색과 규명
- 암흑에너지의 이론적 규명
- 우주의 물질과 반물질의 대칭성 깨짐과 새로운 물리 연구
- 무거운 쿼크와 경입자의 성질에 대한 정밀 측정
- 중성미자의 질량 측정 및 성질 결정
- 양자색소역학의 연구
- 새로운 물리현상의 발견
- 초고에너지 우주선 입자의 탐색과 생성, 전파 연구

Research Teams?

▣ 연구팀 -- Very rough idea but according to the KAHEP

- LHC physics team (~20명)
- Super-B physics team (~20명)
- Neutrino physics and proton decay team (~20명)
- Dark matter and double beta decay team (~20명)
- Phenomenology team (~20명) : 핵,입자,천체
- Accelerator and detector R/D and computing team (~20명)
- HE nuclear & astrophysics team (??명)

- 박사급: 120+명 + 대학원생 100명 이상 + 지원인력

Summary & issues for discussion

- Since the last decade we have now very sound and ambitious plans for HEP research
- It is a very high time to have a big stride of contributing scientifically to the world for the future , not only individually but also as a strong nation-wide effort
- Several really top-class and not-to-miss-in-this-decade opportunities are wide open to us
  - Linear Collider, Long baseline neutrino, especially
- HEP @ BSI should be a nationwide organized research team
- Suggestion of the following issues for discussion
  - Research scope and teams ?
  - HE nuclear & particle & astro- particle physics together ?
    - Suggestion of Physics cases