Impact of Pohang Accelerator to Large-scale Science Programs in Korea

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Outlines

- *Brief Facts about Korea*

- *Large-scale Science Programs in Korea*
  - *PLS at POSTECH*
  - *Hanaro, KSTAR, PEFP, ITER-Korea*

- *Government R&D*
  - *S&T budget and Policy*

- *Industrial Company for Global Competitiveness*
  - *Samsung, POSCO, Hyundai Heavy*

- *Summary*

Brief Facts about Korea

People & Language: Korean (~4,500 yrs in the area)

Area (South)**:** ~100,000 km^2 (~38,000 sq. mi.)
Population (South)**:** 48.5 million
Recent History:

1945: Divided into North and South
1950~1953: Korean Conflict
1960~1970: Modernization (Migration to cities)
1970~1980: Industrialization (Heavy Industries)
1990~2008: High-tech oriented

Leading Industries:

Electronics, Steel, Ship-building, Automobile, Chemicals, Construction, Textiles

Economy: GDP = 970 B$, 20 k$/capita in 2007
Religion: Christian (~30%), Buddhism (~30%)
Education: > 80% high-school seniors go to college

Large-scale Science Programs in Korea

On-going programs:

	(Construction period)
PLS - *Light Source:*	1988 - 1994
Hanaro - *Research Reactor:*	1988 - 1994
KSTAR - *Fusion Tokamak:*	1996 - 2008
PEFR - *Proton Linac:*	2002 - 2012
ITER-Korea – *ITER member:*	2006 - 2016

Proposals: - *X-ray FEL*
- *2nd Light Source*
- *Heavy Ion accelerator*

Pohang University of Science and Technology (POSTECH)

- *Established by POSCO, a steel company, in 1986*
- *One of the leading S&T Universities in Korea along with SNU in Seoul and KAIST in Daejeon*
- *11 Academic Departments in Science and Engineering*
- *Students: Undergraduate: 1,200*
  Graduate: 1,500
- *Faculty members: ~ 240*

POSTECH Campus and PAL

PLS Overview

- *In 1987, POSTECH, a newly established university, proposed to construct a synchrotron light source on its campus.*

- *PLS is a 3rd generation synchrotron radiation source:*
  - *2 GeV injector linac and storage ring with upgrade option to 2.5-GeV.*

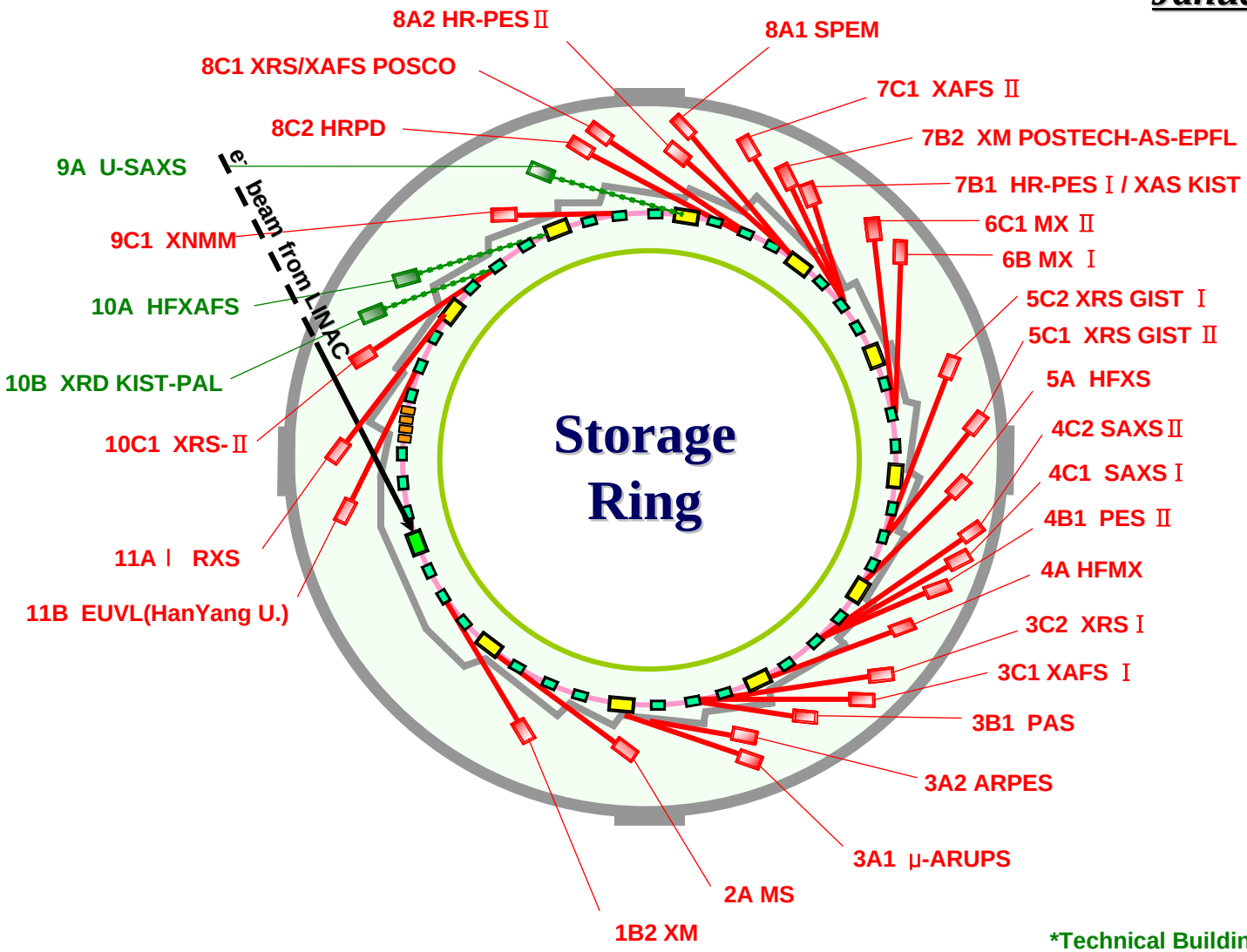
- *Construction Project: April 1988 ~ December 1994*
  - *Funded by POSCO (60%) & Government (40%)*

- *Operation: funded by Government (80%) & POSCO (20%)*

Pohang Light Source (PLS) *at PAL*

PLS Beamline Status

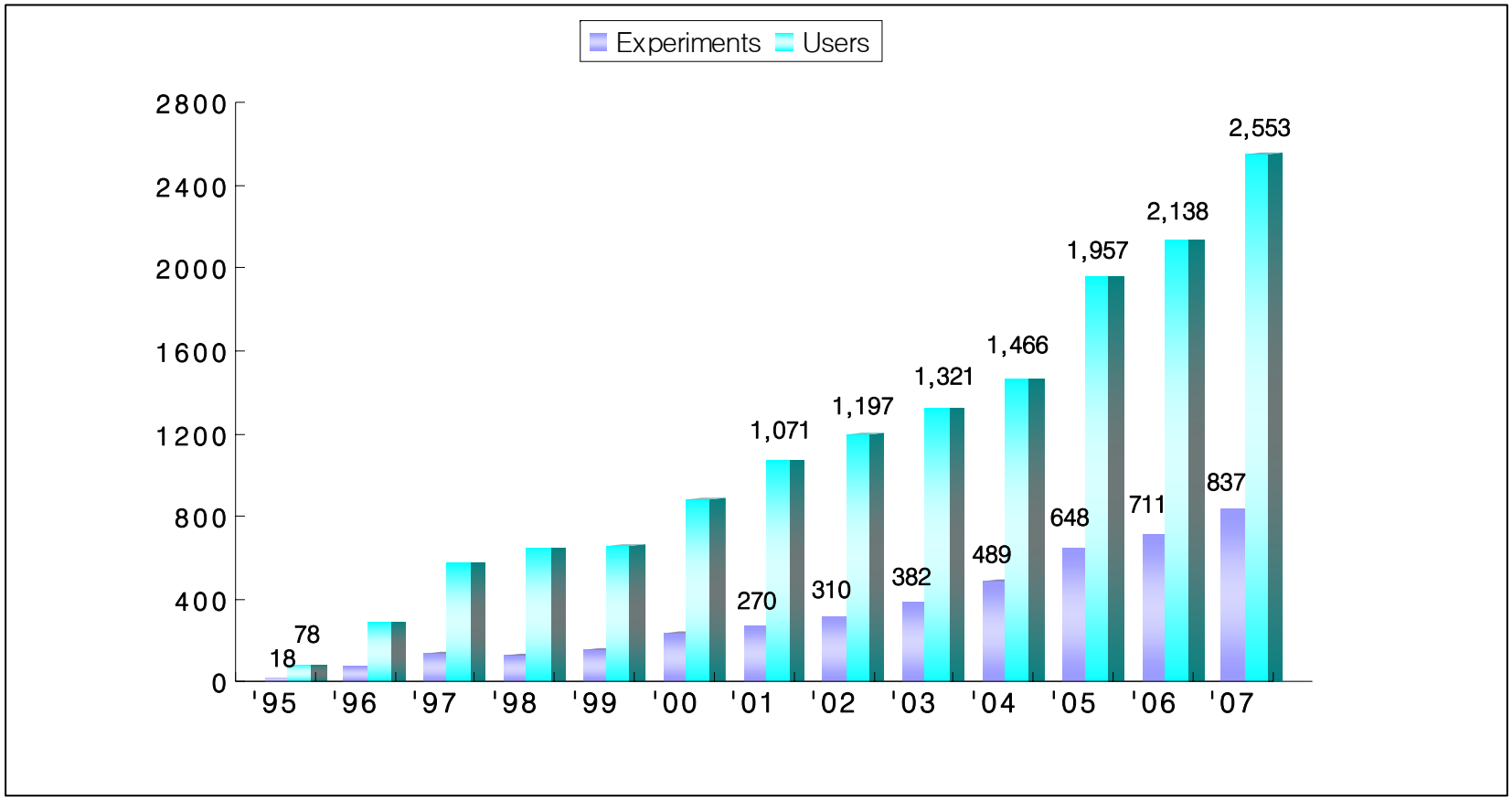
January 2008



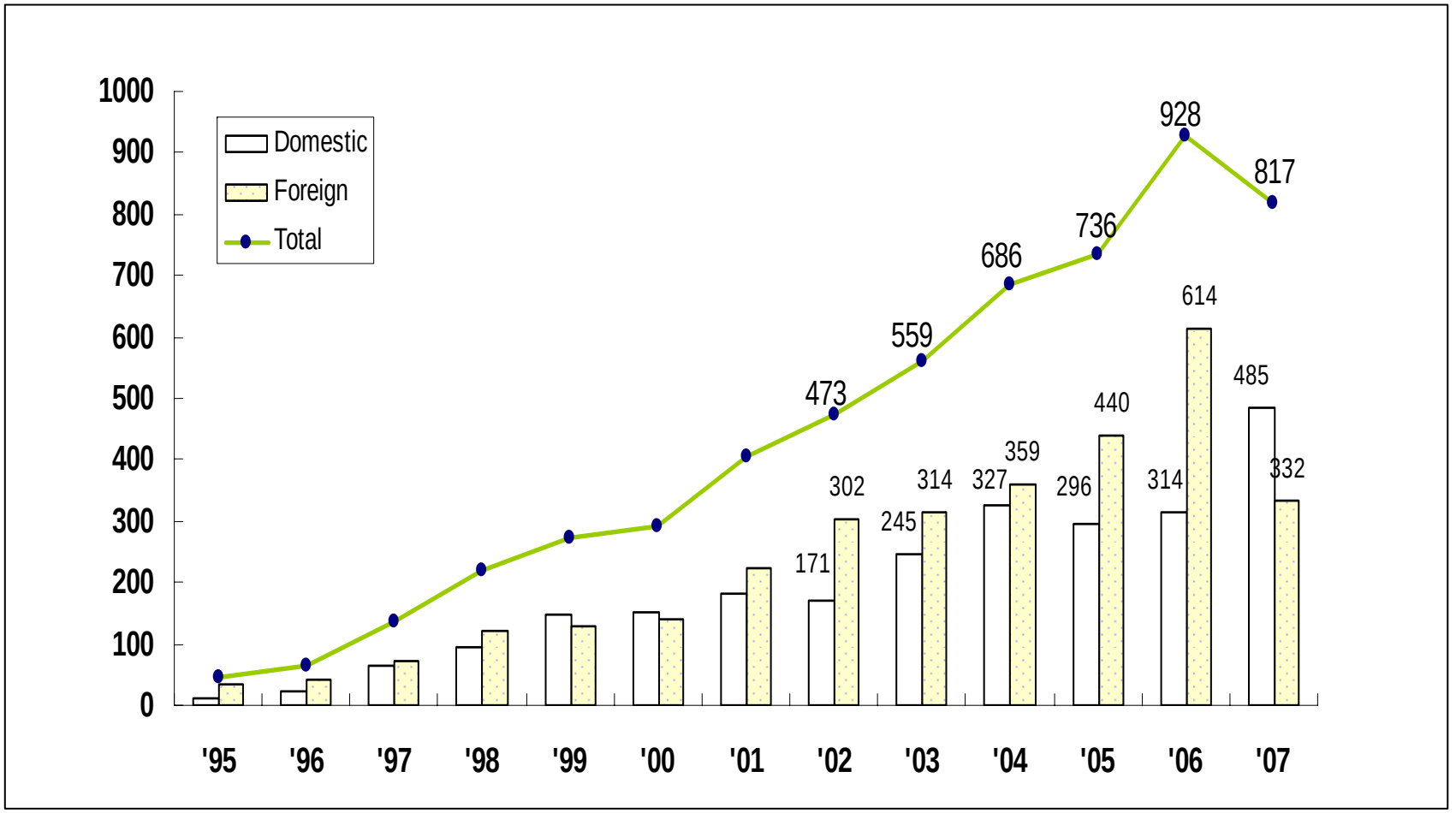
*Technical Building II : fs-THz

Construction	-------	4 beamlines
Operation	———	27 beamlines

Statistics for Experiments and Users at PAL

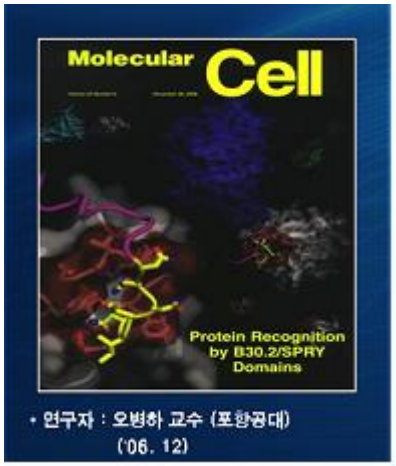


Number of Publications at PAL



Note: Data for 2007 is tentative

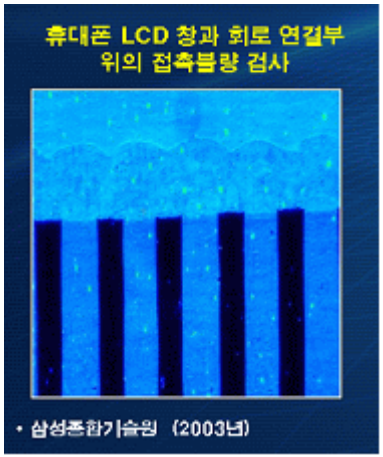
Examples of Research at PLS: Academic and Industry



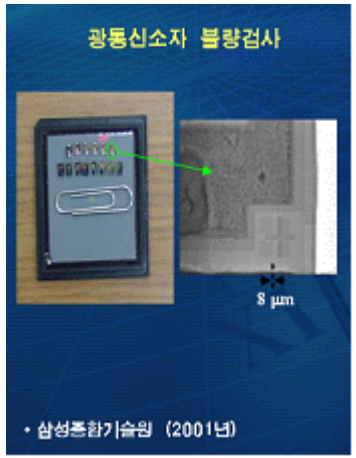
• 연구자 : 오병하 교수 (포항공대)
('06. 12)

• 연구자 : 김권규 교수 (성균관대)
김왕균 교수 (중앙대), ('05. 10)

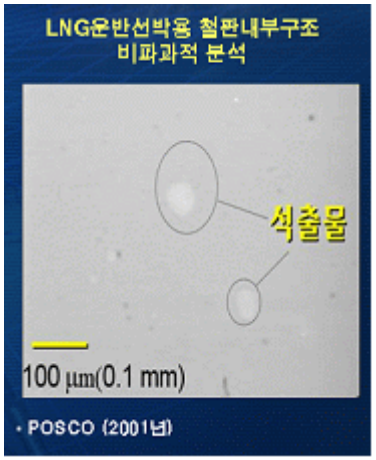
• 연구자 : 조주영 박사 (크리스탈 지노믹스)
('03. 9)



• 삼성종합기술원 (2003년)



• 삼성종합기술원 (2001년)



• POSCO (2001년)

Hanaro Overview

- *Research Nuclear Reactor*
  - *30-MW open-tank-in-pool type*
  - *20% U_3Si-Al Fuel*

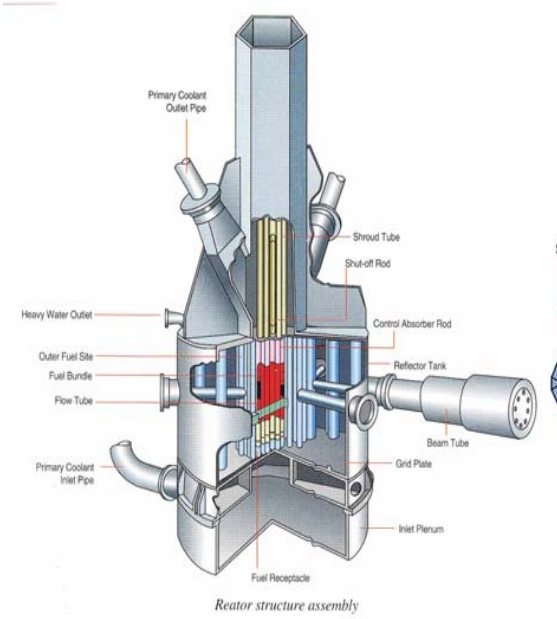
- *National users' facility*
  - *Intense neutron source for neutron science*
  - *Medical & industrial application of Radioisotopes*

- *Construction period: Feb. 1988 ~ Dec. 1994*

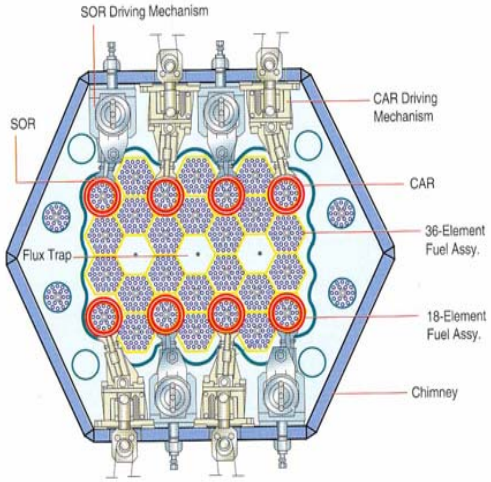
- *First Criticality Achieved: Feb. 1995*

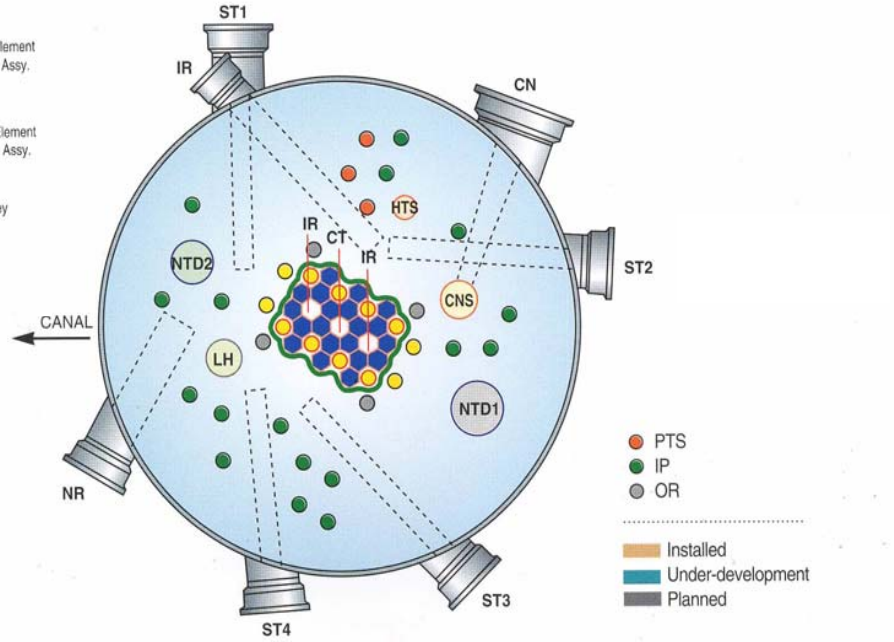
- *Construction & Operation by Korea Atomic Energy Research Institute (KAERI)*

Hanaro Reactor



Reator structure assembly





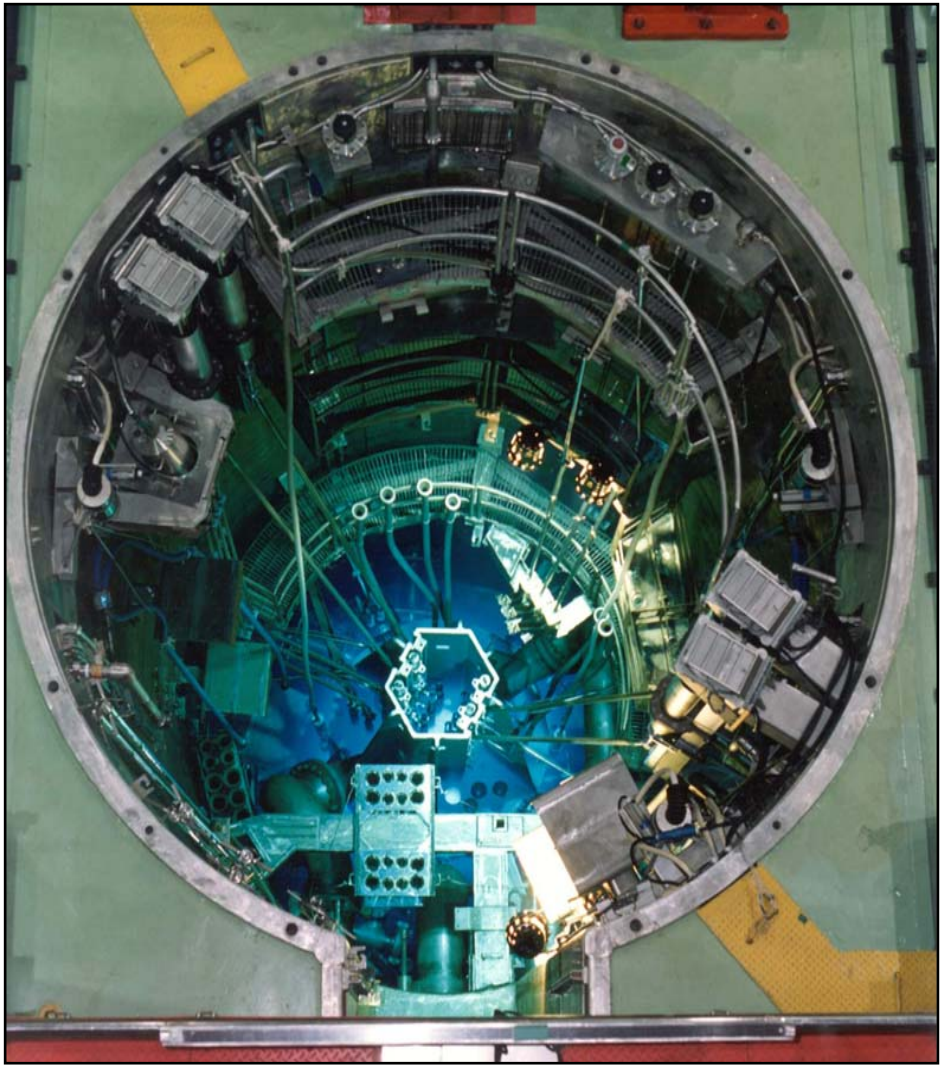
Horizontal Experimental Tubes

- ST1 : Polarized Neutron Spectrometer
- ST2 : High Resolution Powder Diffractometer / Four Circle Diffractometer
- ST3 : Neutron Reflectometer / Medium Resolution Powder Diffractometer
- ST4 : Triple Axis Spectrometer
- CN : Small Angle Neutron Spectrometer
- IR : Boron Neutron Capture Therapy Facility
- NR : Neutron Radiography Facility

Vertical Experimental Holes

- IR, CT : Capsule Irradiation Facility
- LH : Fuel Test Loop
- OR : Capsule Irradiation / RI Production
- IP : RI Production
- HTS : Hydraulic Transfer System for RI Production
- PTS : Pneumatic Transfer System for Neutron Activation Analysis
- NTD : Neutron Transmutation Doping of Silicon
- CNS : Cold Neutron Research Facility

Hanaro Reactor



KSTAR Overview

- *Fusion Research Tokamak*
  - *All Super-conducting magnets*
  - *Steady-state capable tokamak with a major radius of 1.8 m*

- *National users' facility*
  - *Long-pulse tokamak plasma research*
  - *Heating and current drive for steady-state operation*

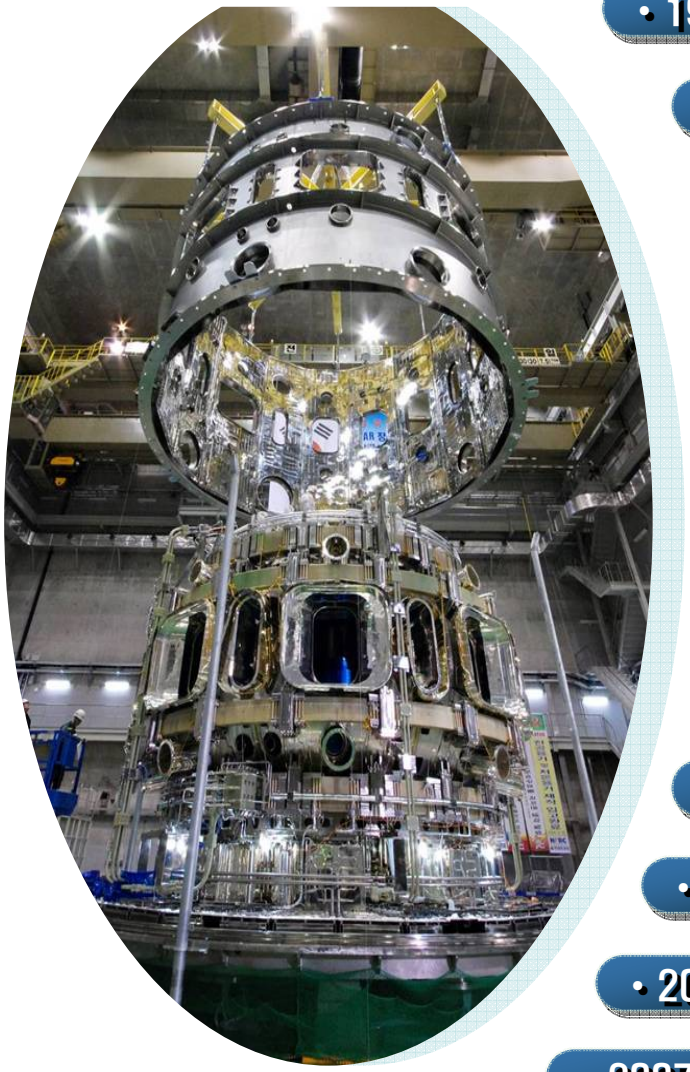
- *Project Period: Jan. 1996 - June 2008*

- *First Plasmas: June 2008 (Cool-down started in April 1, 2008)*

- *Construction & Operation by National Fusion Research Institute (NFRI)*

KSTAR Experimental Buildings

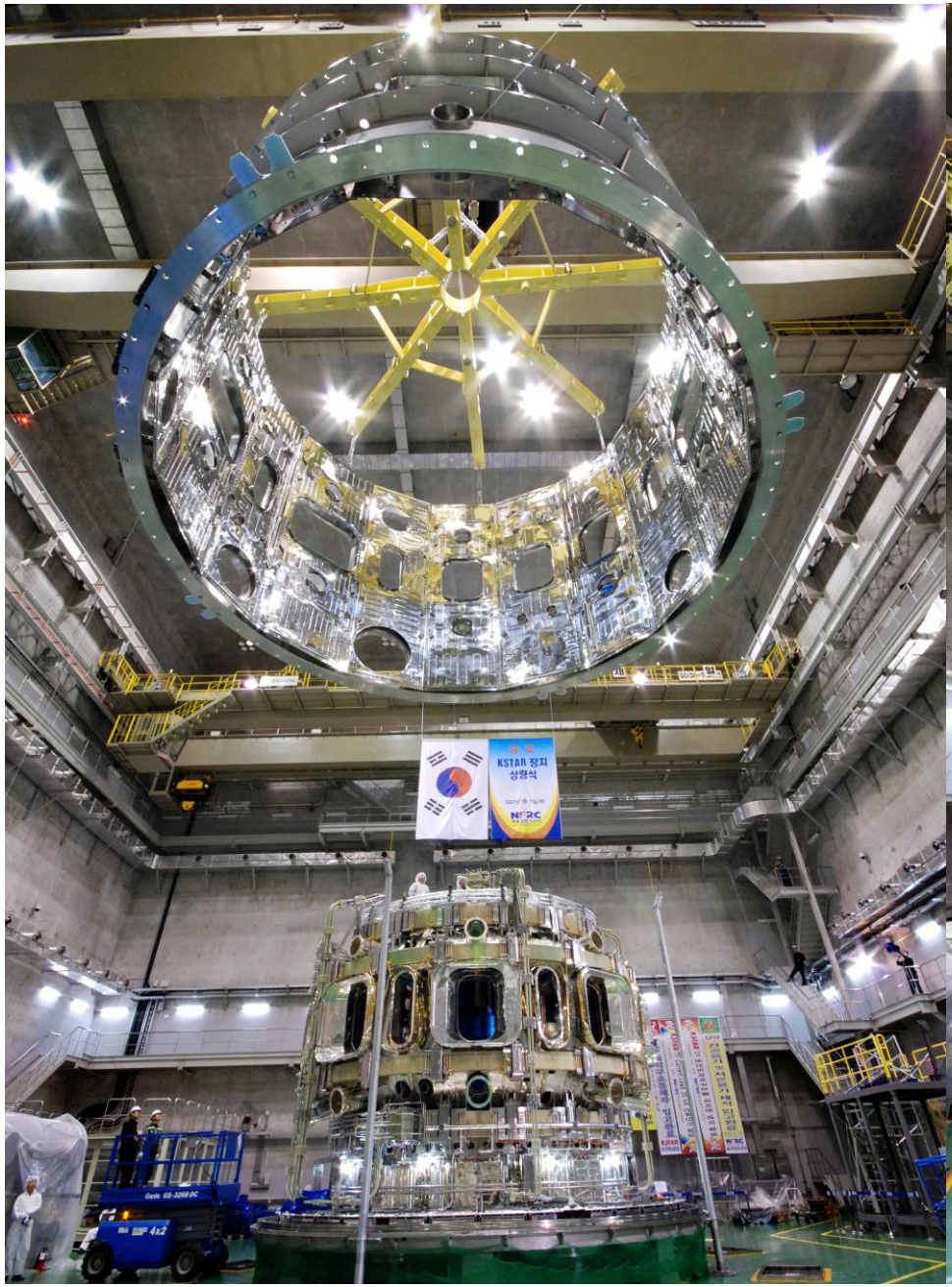
KSTAR Project Chronology

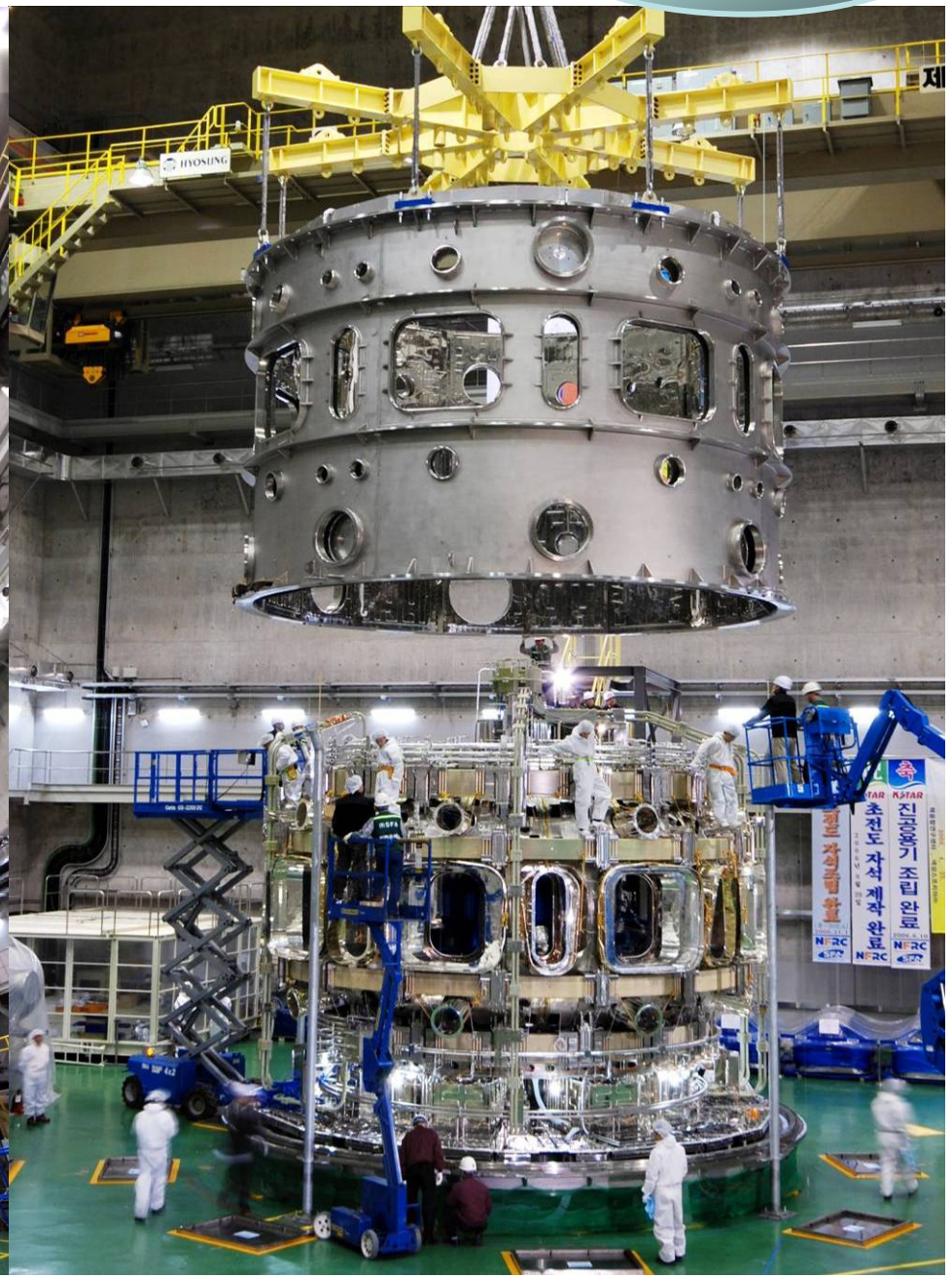


- 1995. 12. Start of KSTAR Project (Phase I)
- 1996. 11. KSTAR Concept Review
- 1997. 12. KSTAR Tokamak Systems Engineering Review
- 1998. 09. Start of KSTAR Project (Phase II)
- 1999. 08. KSTAR Magnet System Review
- 2000. 09. KSTAR EU Workshop (Engineering Review)
- 2002. 06. Start of KSTAR Project (Phase III)
- 2004. 01. Start of Assembly
- 2004. 08. Completion of VV and Cryostat Fabrication
- 2006. 03. Completion of TF Magnet Structure Fabrication
- 2006. 11. Completion of All Magnet System
- 2007. 04. Installation of Cryostat Lid

Installation of Cryostat Cylinder

2007. 1





ITER Design and Technology Development

CENTRAL SOLENOID MODEL COIL

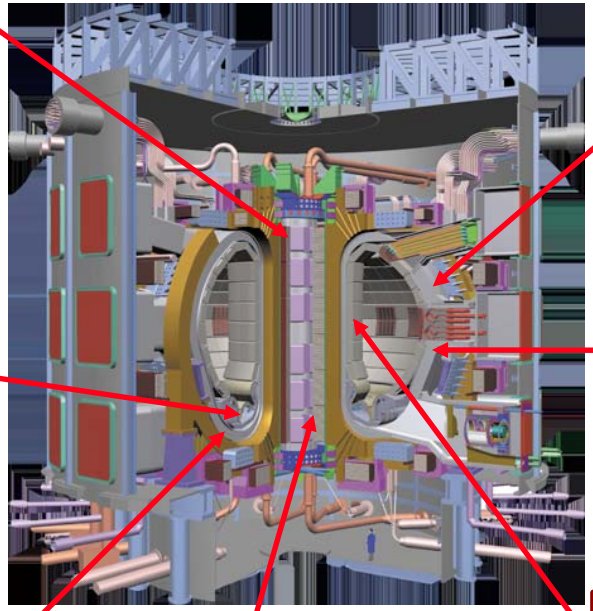
Radius 3.5 m
Height 2.8m
B_{max}=13 T
W = 640 MJ
0.6 T/sec

VACUUM VESSEL SECTOR

Double-Wall, Tolerance ±5 mm

REMOTE MAINTENANCE OF DIVERTOR CASSETTE

Attachment Tolerance ± 2 mm



BLANKET MODULE

HIP Joining Tech
Size : 1.6 m x 0.93 m x 0.35 m

REMOTE MAINTENANCE OF BLANKET

4 t Blanket Sector
Attachment Tolerance ± 0.25 mm

DIVERTOR CASSETTE

Heat Flux >15 MW/m^2, CFC/W

TOROIDAL FIELD MODEL COIL

Height 4 m
Width 3 m
B_{max}=7.8 T
I_{max} = 80kA

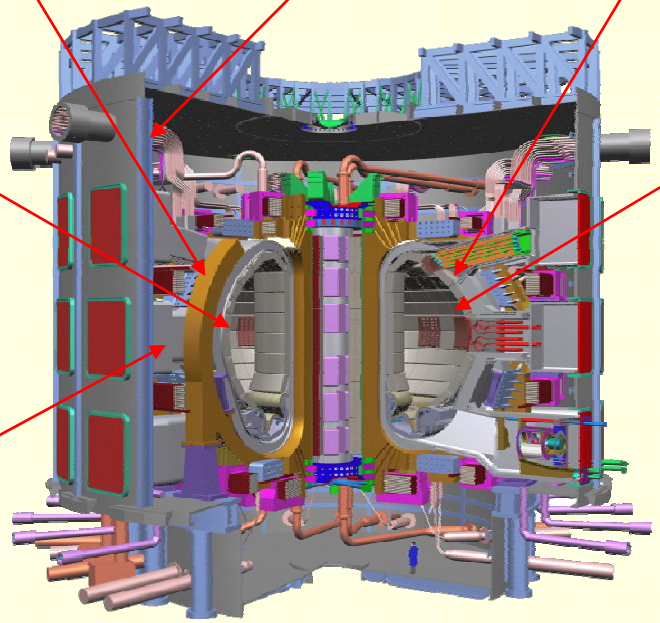
ITER-Korea Procurement Items

1. TF Conductor
Total Value (kIUA) : 215.0
KO : 20%
KO Value (kIUA) : 43.0

2. Vacuum Vessel
Total Value (kIUA) :124.2
KO : 20%
KO Value (kIUA) : 24.84

3. Vacuum Vessel Ports
Total Value (kIUA) : 78.5
KO : 76%
KO Value (kIUA) : 59.66

7. Thermal Shield
Total Value (kIUA) : 28.8
KO : 100%
KO Value (kIUA) : 28.8



4. Blanket First Wall *
Total Value (kIUA) : 87.0
KO : 10%
KO Value (kIUA) : 8.7

5. Blanket Shield Block
Total Value (kIUA) : 58.0
KO : 10%
KO Value (kIUA) : 5.8

6. Assembly Tooling
Total Value (kIUA) : 22.0
KO : 100%
KO Value (kIUA) : 22.0

8. Tritium SDS *
Total Value (kIUA) : 14.5
KO : 88%
KO Value (kIUA) : 12.76

9. AC/DC Converters
Total Value (kIUA) : 82.2
KO : 38%
KO Value (kIUA) : 31.24

10. Diagnostics
Total Value (kIUA) :137.5
KO : 3.3%
KO Value (kIUA) : 4.54

※ Total KO Value 241.34 kIUA (≒ 342.7 M€)

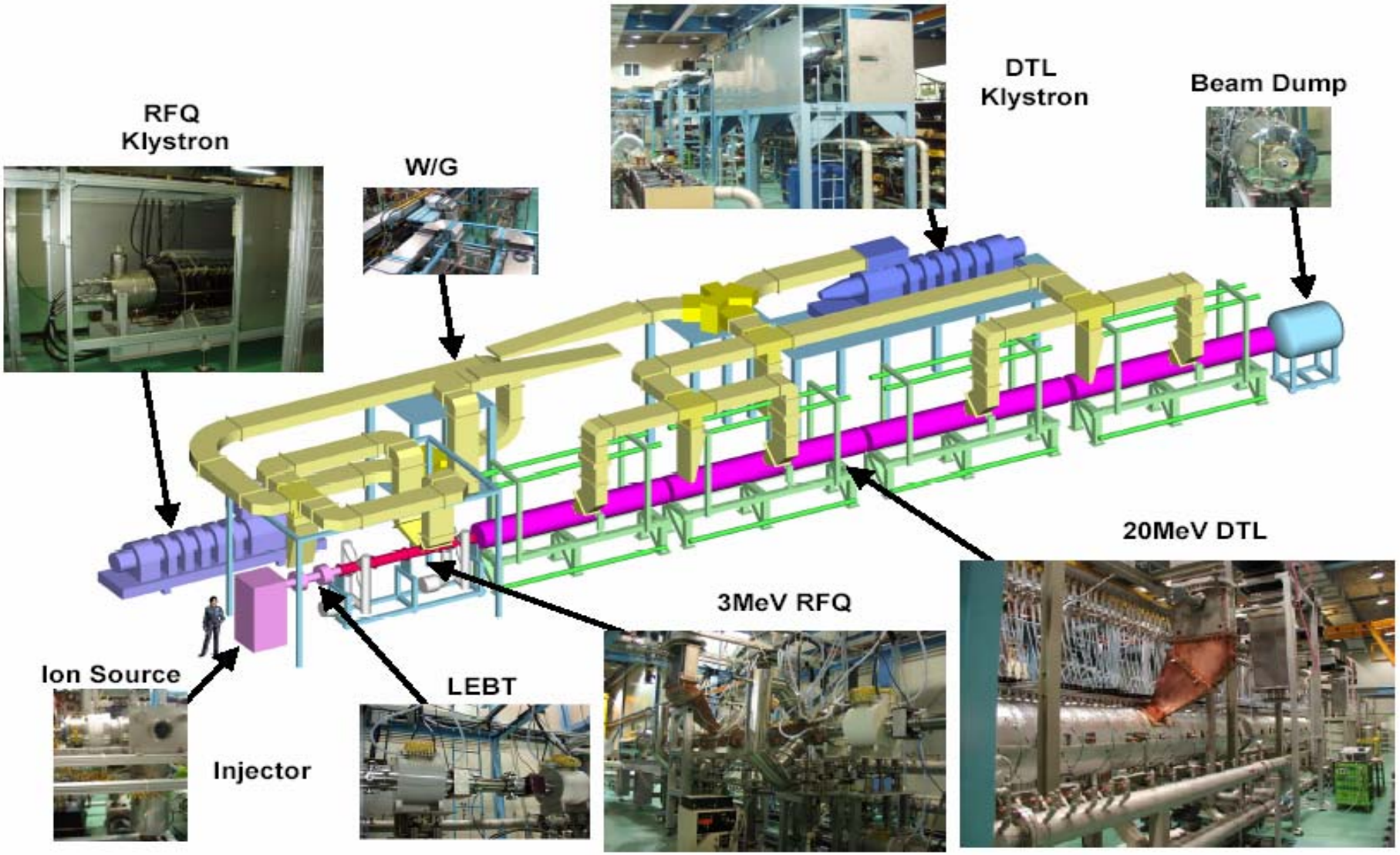
Critical Path | Tokamak Main | Ancillary

Proton Engineering Frontier Project

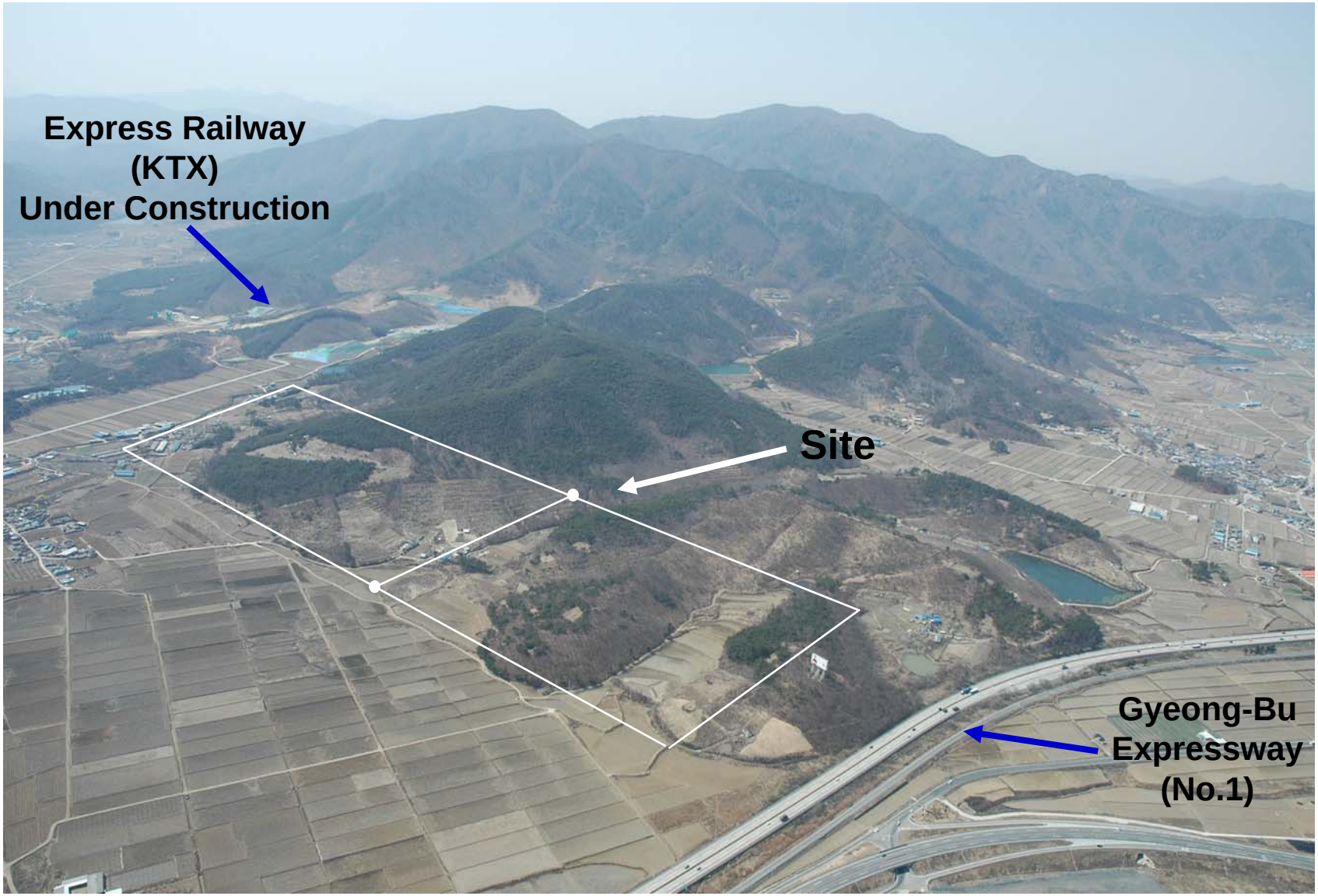
- *High-Power Proton Accelerator: Staged construction of 1.0 GeV, 20 mA proton linac*
  - *20 MeV: National Nuclear R&D Program (1997-2002)*
  - *100 MeV: New Frontier Program (2002-2012)*
  - *1.0 GeV: Under R&D Study*
- *Government decided the construction site in Gyeongju*
  - *Near KTX station (March 2006)*

- *National Users' Facility: Intense neutron source for basic and applied science research*
- *Lead Lab.: Korea Atomic Energy Research Institute (KAERI)*

PEFP 20 MeV Linear Accelerator



Proton Accelerator Site



Korean Government Reorganization

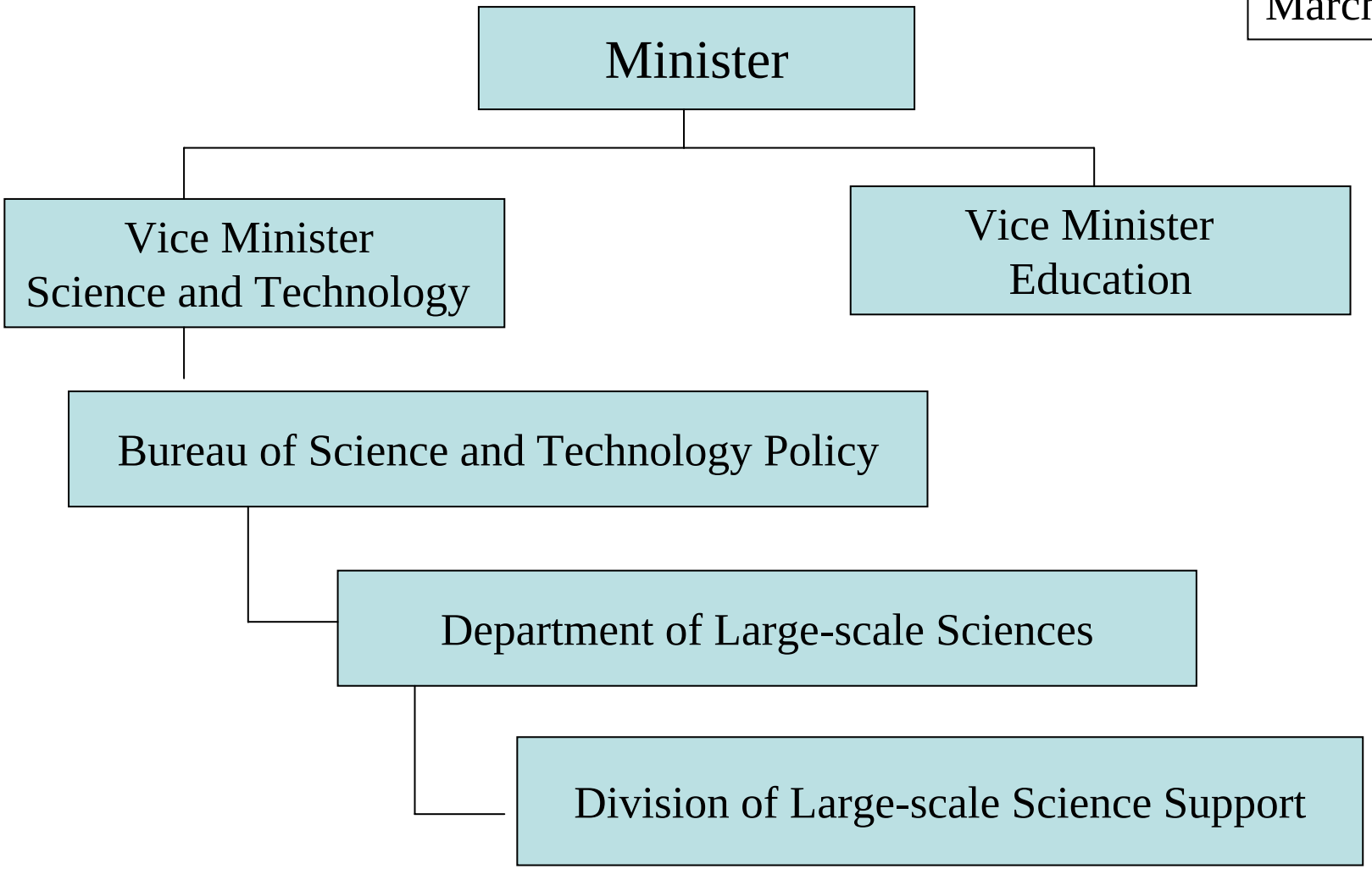
- *The new administration combined Ministry of Education and Ministry of Science and Technology in March 2008.*

- *A bureau for large-scale science programs is established*

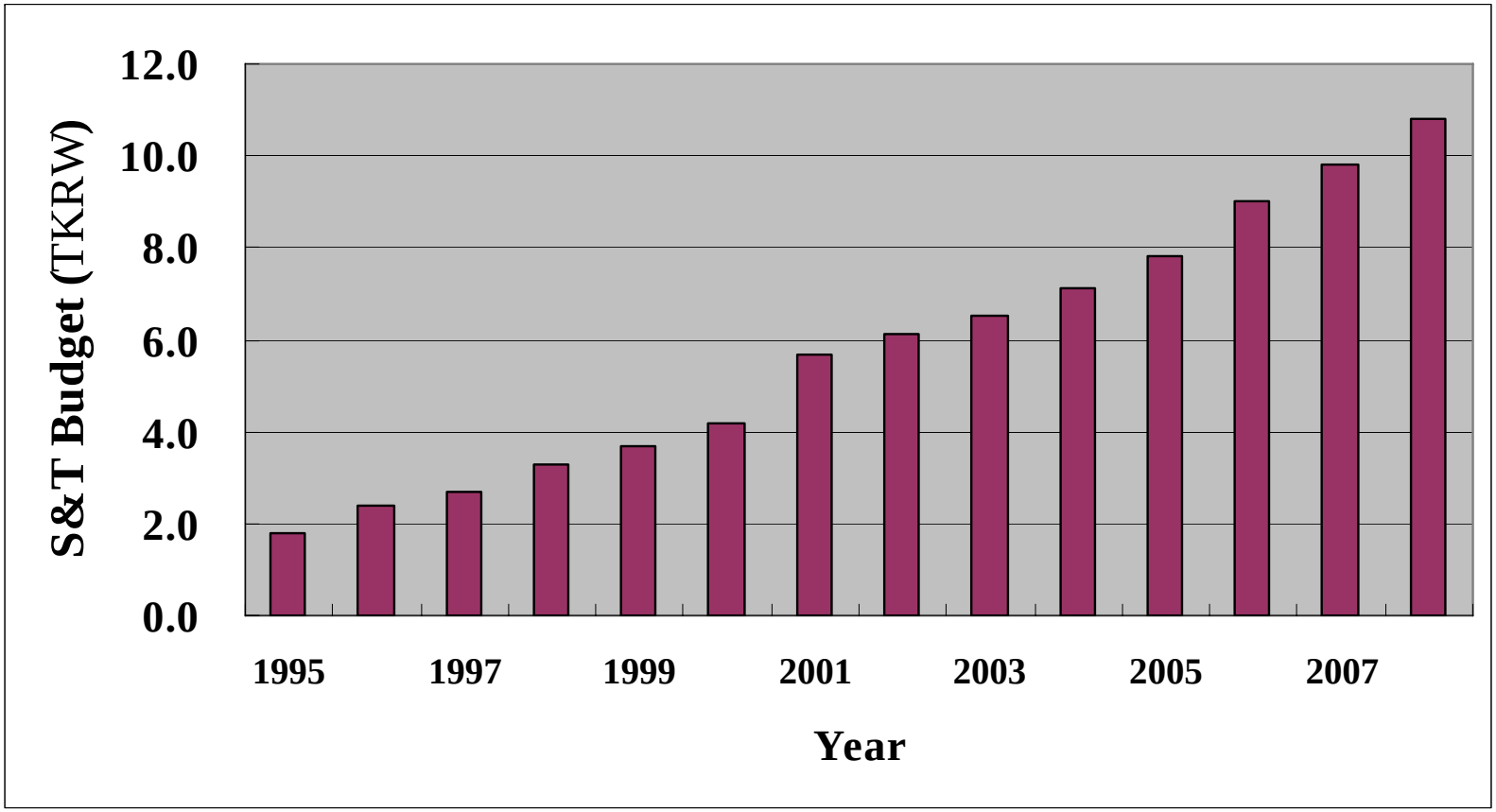
- *There are growing demands for promoting basic sciences and multi-disciplinary users' facilities*

Ministry of Education, Science and Technology (MEST)

March 2008



Science and Technology Budget in Korea



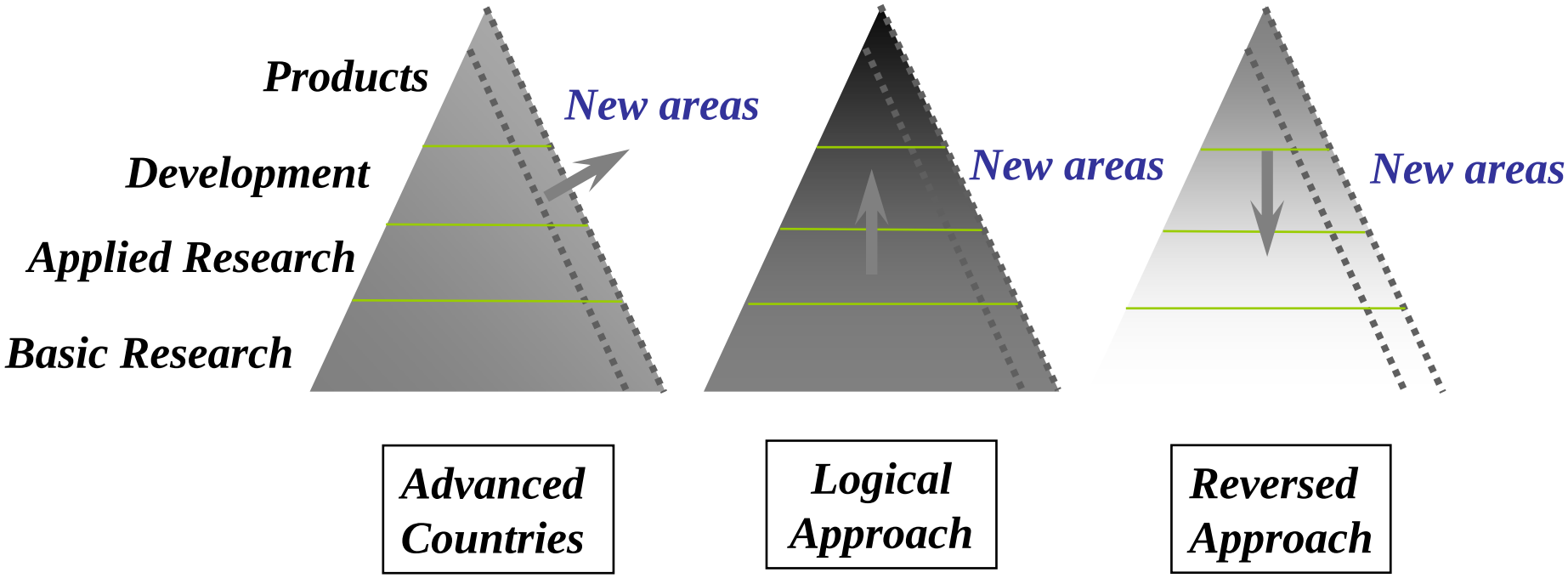
2008 Korean Government R&D Budget

- Basic Science: 3.0 T KRW
- Nano & Space: 1.8 T KRW
- Manufacturing: 1.3 T KRW
- Information Science: 1.1 T KRW
- Training & Infra: 2.0 T KRW
- Special Fund Support: 1.6 T KRW

Total: 10.8 T KRW

Note: 1 T KRW ~ 1 B U$

Types of Science & Technology Policy



Industrial Companies for Global Competitiveness

Leading industrial companies in Korea built-up their own R&D capability for global competitiveness, for examples,

Electronics
Iron & Steel
Shipbuilding
Automobile
Communications

POSCO Plants in Pohang & Gwangyang

Established:	1968
Employees:	17,300
Steel Production:	31.3 M tons (2007)
Revenue:	23.9 B$
Net Profit:	4.0 B$

Pohang Plant

Gwangyang Plant

Big Industrial Companies in Korea

	Samsung		POSCO		Hyundai Heavy	
units (Trillion KRW)	Electronics		Steel		Ship building	
	Revenue	Net Profit	Revenue	Net Profit	Revenue	Net Profit
2005	57.0	7.6	22.0	4.0	10.0	0.2
2006	59.0	7.9	20.0	3.2	13.0	0.7
2007	63.0	7.4	22.0	3.7	16.0	1.7
University	SKK University		POSTECH		Ulsan University	
Scientific Area	KSTAR SC Coil R&D		PAL Accelerator		KSTAR Vacuum Chamber	

Summary

- *Korea has successfully improved her economic condition through industrialization. The underline driving force is considered as, not only the government planning but also the trained man-power available through individual education.*

  - *Education has been the top priority in a normal family: More than 80% of high-school senior goes to colleges. (One may note that the largest student body in USA is Korea)*

  - *Trained man-power returned home for academic and industrial positions along with improved economics.*

  - *Academic research condition is now much improved to train man-power domestically.*

- *With the success of the light source, research reactor, and tokamak projects,*
  - *There are growing demands for more multi-user facilities such as light sources.*
  - *Government now established a bureau for large-scale science programs including space science and fusion research.*

- *Industry built-up its own R&D capability for global competitiveness and they start to recognize supports for basic sciences.*

- *For the large-scale science projects, we need consensus among scientists in this economy-oriented society.*