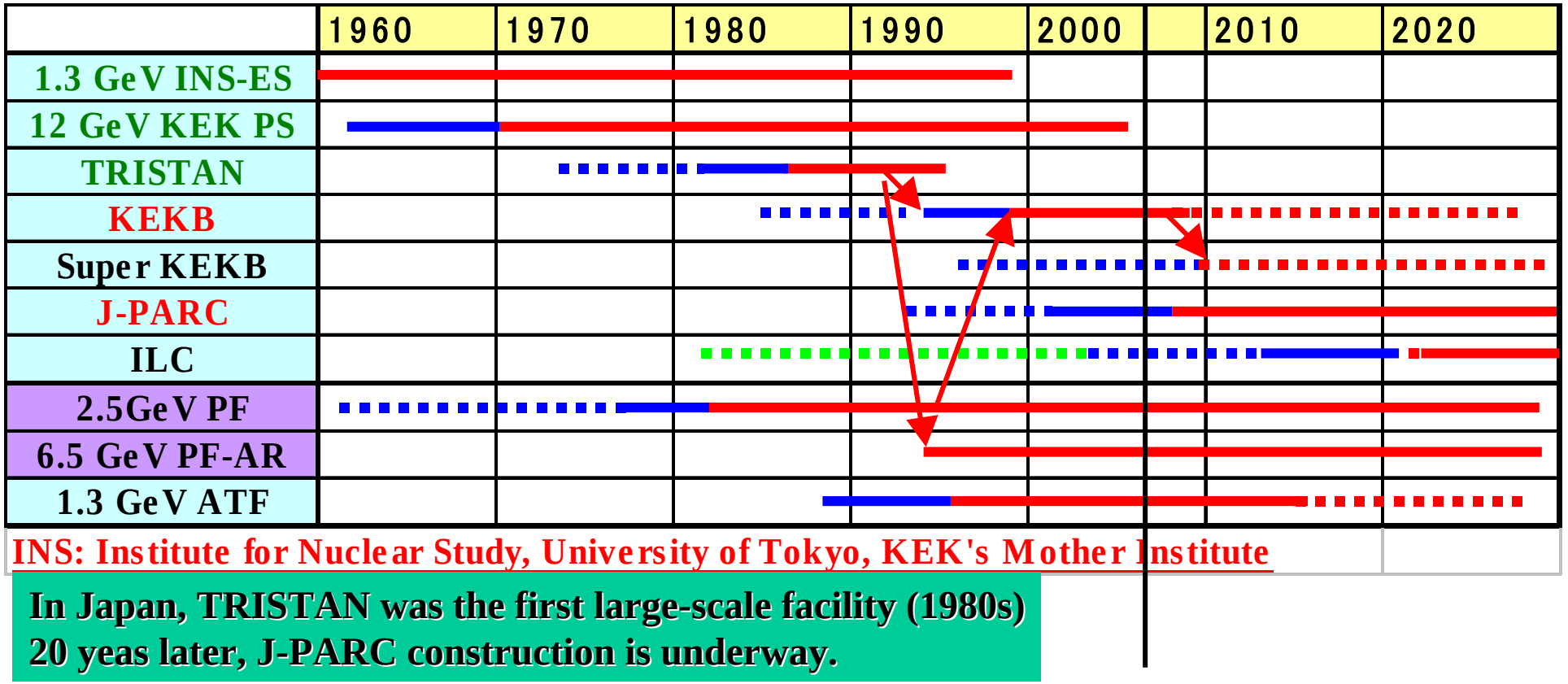
# KEK Experiences of CFS


## Masakazu Yoshioka

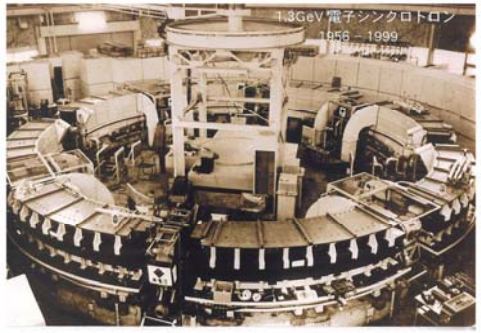
## (KEK, J-PARC Project Office)

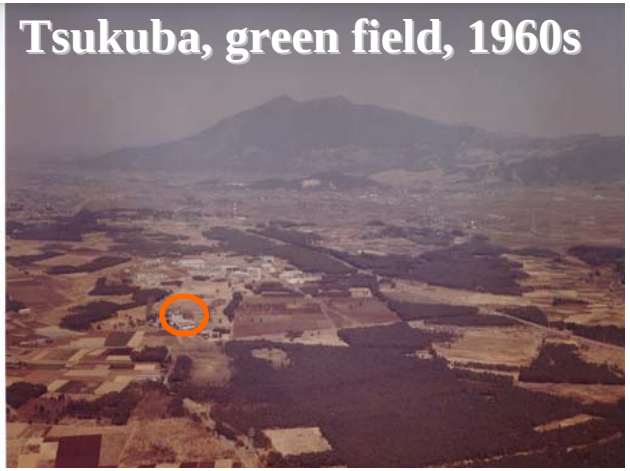

## September 10, 2007 @ CFS-AS Kick-off Meeting


**Acknowledgement:**
**Masanobu Miyahara, Tsunehiro Hanayama, Terunori Shibahara, Shigeru Takeda**



1960
1970
1980
1990
2000
2010
2020
1.3 GeV INS-ES
12 GeV KEK PS
TRISTAN
KEKB
Super KEKB
J-PARC
ILC
2.5GeV PF
6.5 GeV PF-AR
1.3 GeV ATF
INS: Institute for Nuclear Study, University of Tokyo, KEK's Mother Institute
In Japan, TRISTAN was the first large-scale facility (1980s)
20 yeas later, J-PARC construction is underway.
Now

## INS-ES in ’60s

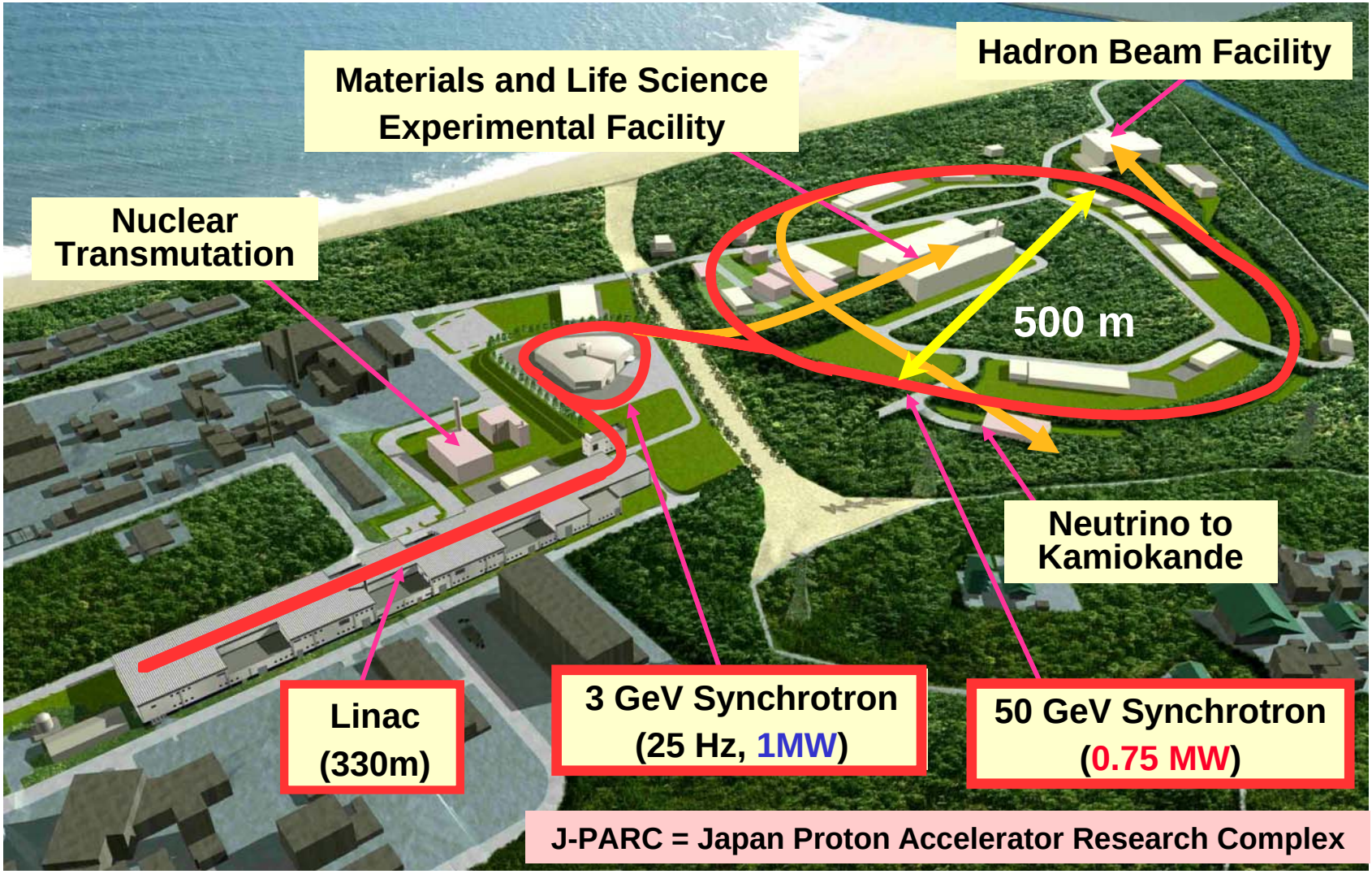

1.3GeV電子シンクロトロン
1956 – 1999


Tsukuba, green field, 1960s

By Shoji Nagamiya

J-PARC

# J-PARC Facility




Joint Project between KEK and JAEA

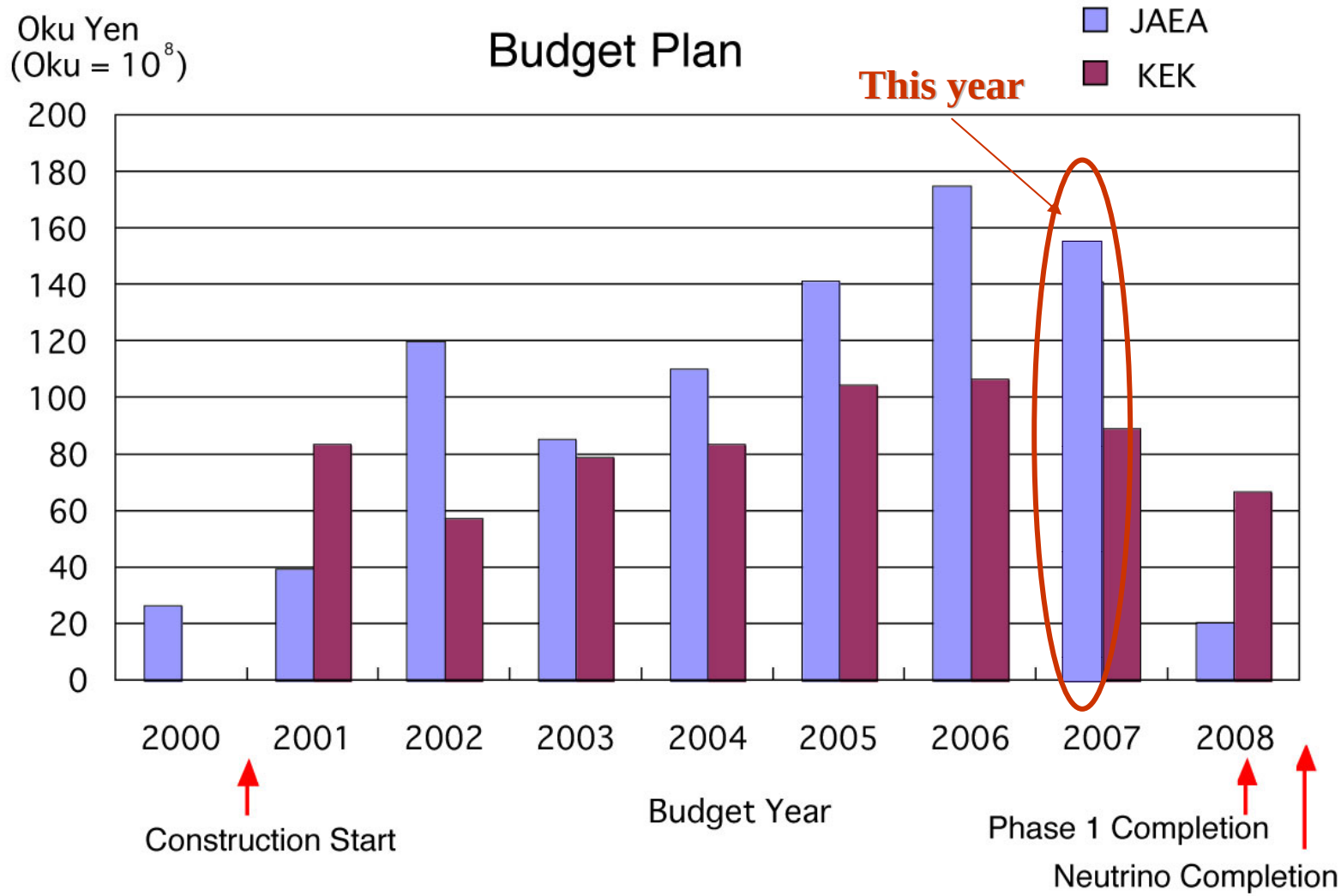

February, 2003
September, 2005

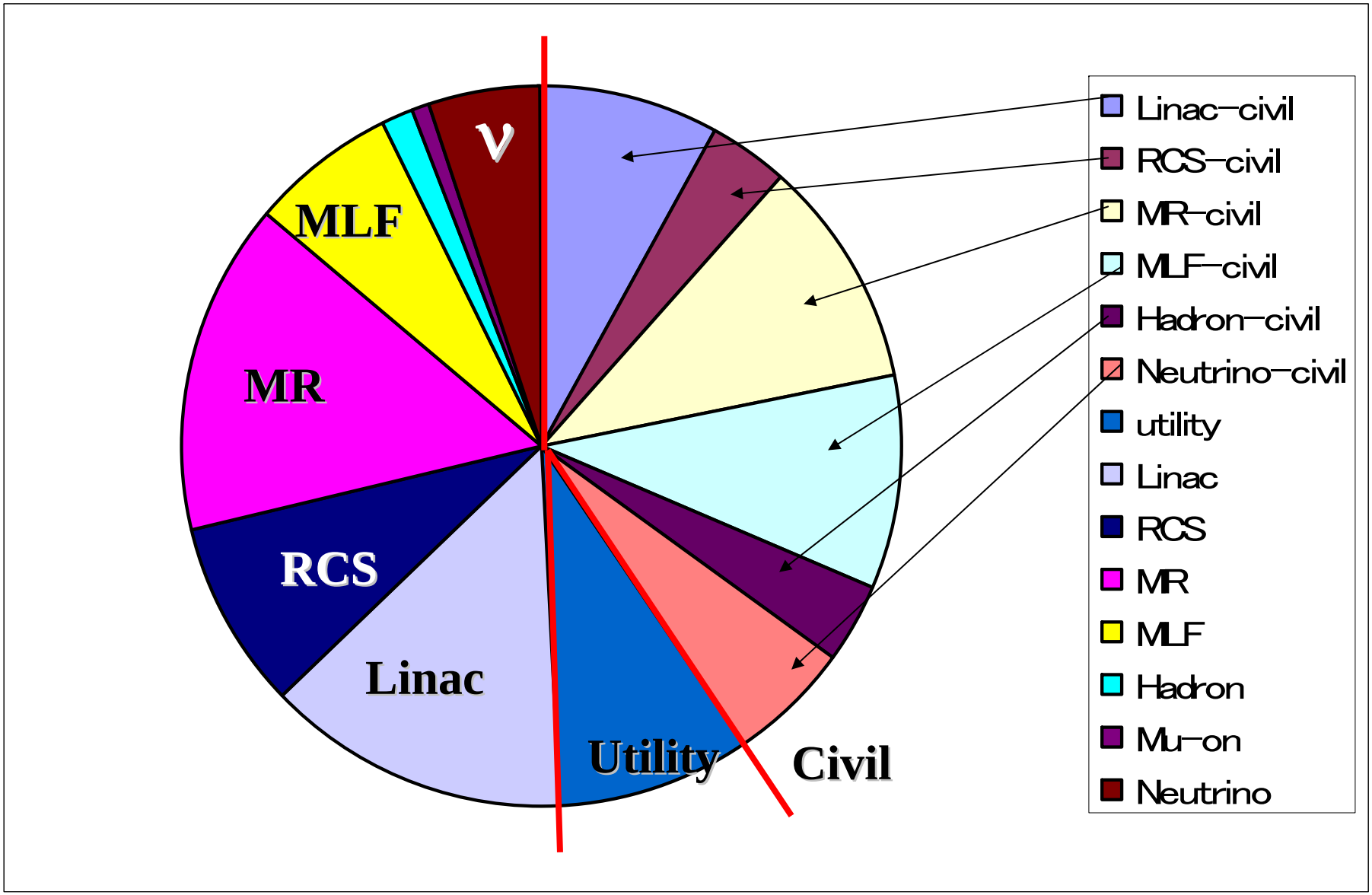
**JAEA responsibility:**
**Linac, RCS and MLF**

**KEK responsibility:**
**MR, Hadron and Neutrino**

By Shoji Nagamiya

# Construction Budget






# Budget allocation

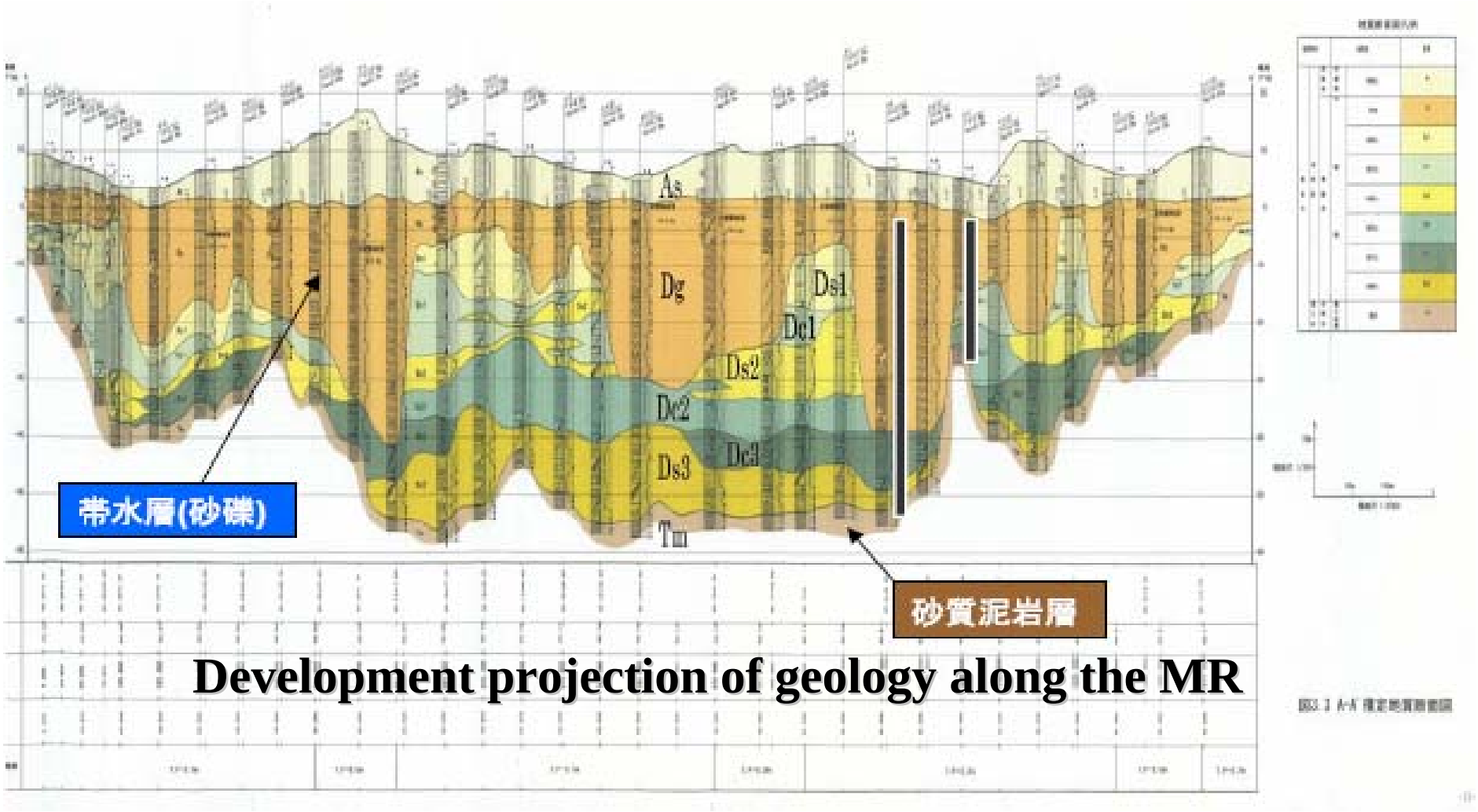
## At J-PARC civil engineering work, we have experienced every kind of problems

- **Bad geology:**
  - No scientific site selection
  - Deep bedrock, sandy mudstone with undulation
  - Thick sand gravel with flowing and abundant groundwater
  - Poor preliminary survey → need design change because of groundwater
- **Remains of salt farm**
  - need additional budget and delay of schedule
- **Reserve forest area**
  - strong constraint for the construction method and procedure
- **Goshawk (wild bird, a kind of falconine)**
  - break of construction during child-raising
- **Strong constraint related with the site problem with nuclear facility**
  - unexperienced gate control, unexperienced confusing regulations, etc. etc……
- **Contracts for civil design and real construction must be separated**
  - Incomprehensible law to keep “transparency”, poor feed back from reality to design
- **Segmentalized construction zone due to the budget schedule**
  - Complicated construction management, extra-cost, etc. etc……..

# Very bad geology

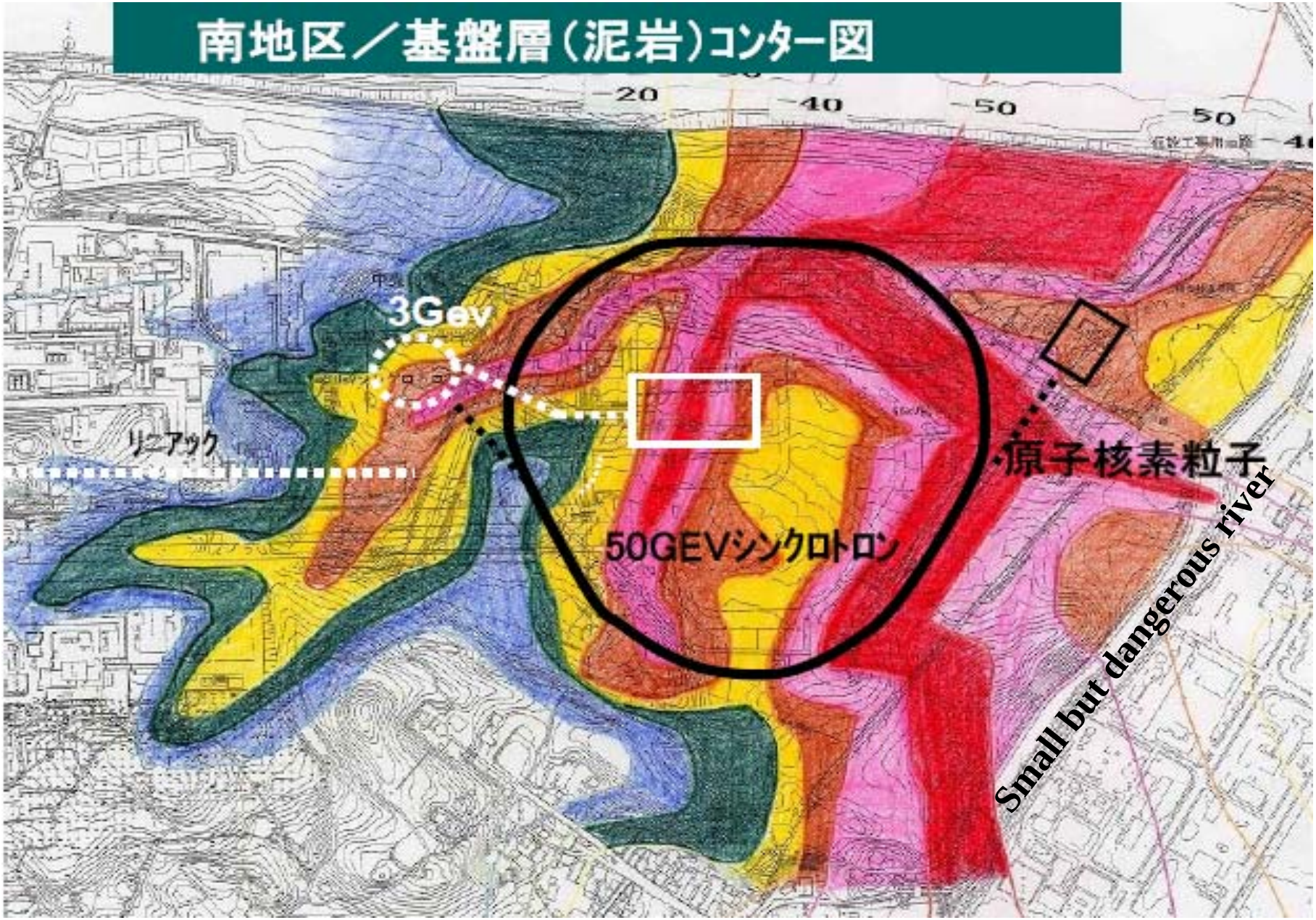
**Bed rock, deep underground, sandy mudstone with undulation**

**Thick sand gravel with flowing and abundant groundwater**



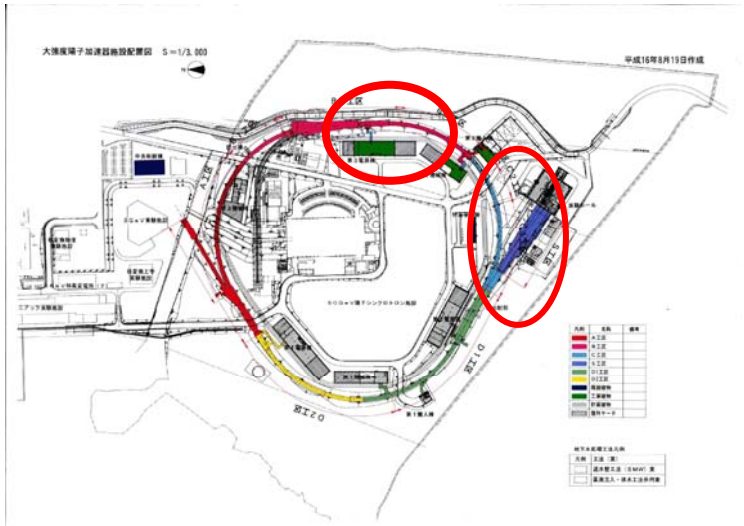

**Development projection of geology along the MR**

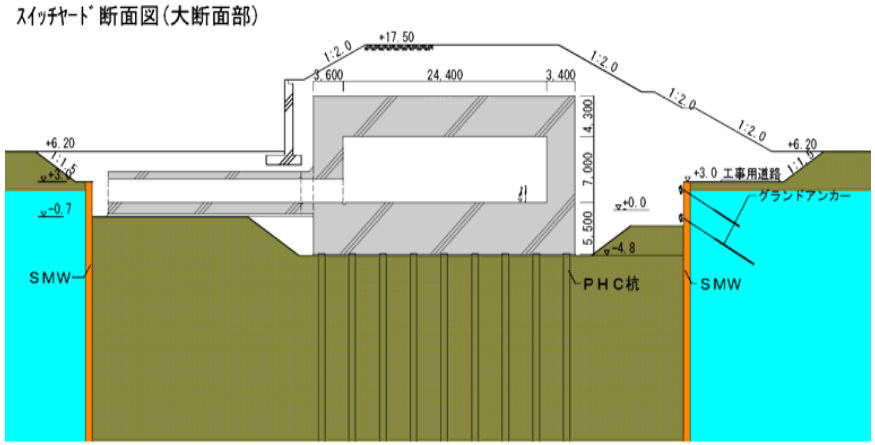
**Contour of bedrock: -10m ~ -50m, diluvial formation**



**Remains of salt farm >400 years ago**

- Need additional budget
  - 5 million dollar
- one year delay



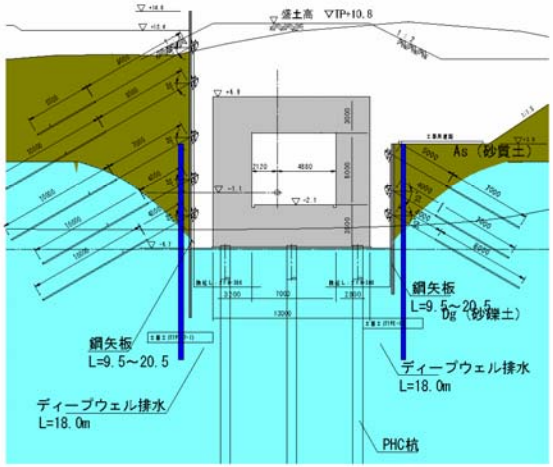



| | |
|---|---|
| **Tunnel Circumference** | **1.6km** |
| **Tunnel inner size** | **w5.0m, H3.5m** |
| **Tunnel floor level** | **-2m from sea-level** |
| **Excavation volume** | **0.8 Million $m^3$** |
| **Back-filling volume** | **0.72 Million $m^3$** |
| **Number of PHC pile** | **1400** |
| **Volume of concrete (MR)** | **0.11 Million $m^3$** |
| **Reinforcing steel** | **12000 ton** |

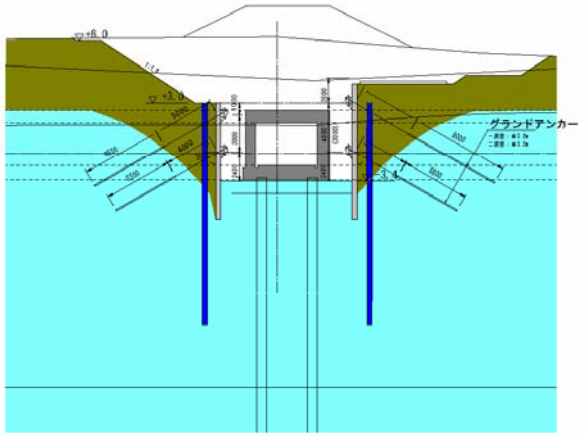
**Ground total concrete volume of J-PARC: 0.48 Million $m^3$**

| | |
|---|---|
| **Thickness of concrete of arc section** | **floor 1.2m, wall 0.8m, top 1.0m** |
| **Maximum thickness of concrete** | **5.5m** |

50GeV標準断面図（大断面部）




50GeV標準鋼矢板断面図（標準部）



# Groundwater problems

| | |
|---|---|
| Original design | pumping-up with kettle hole → design debacle! ←poor preliminary survey |
| Design changes | Deep well and seepage control method (SMW and/or grouting) |
| | volume of pumped-up water > 20kton/day |


A: Kajima JV

B, N-Arc: Taisei JV

C, DV-1: Shimizu JV

S, DV-2, NM: Tobishima JV

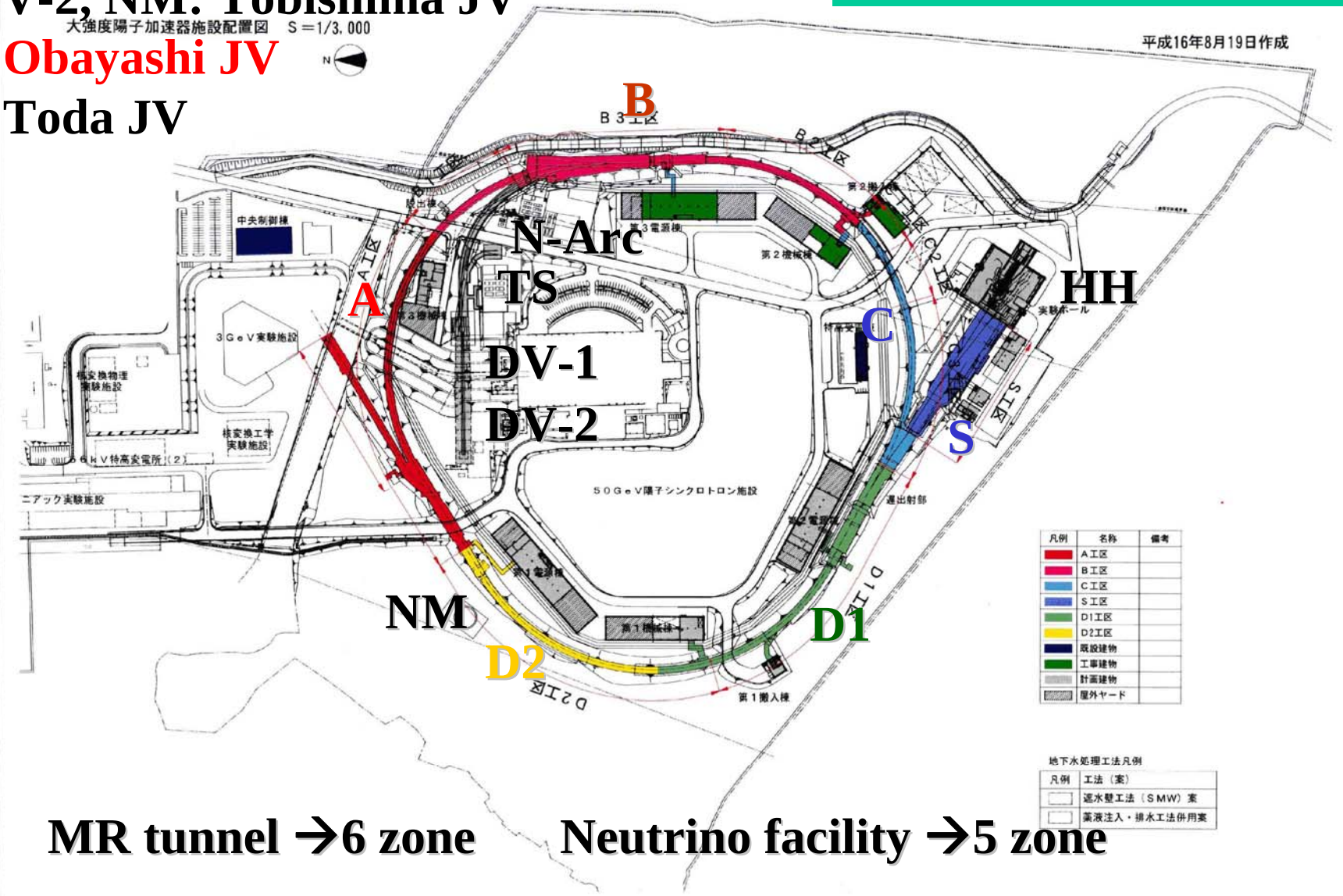
D1: Obayashi JV

D2: Toda JV

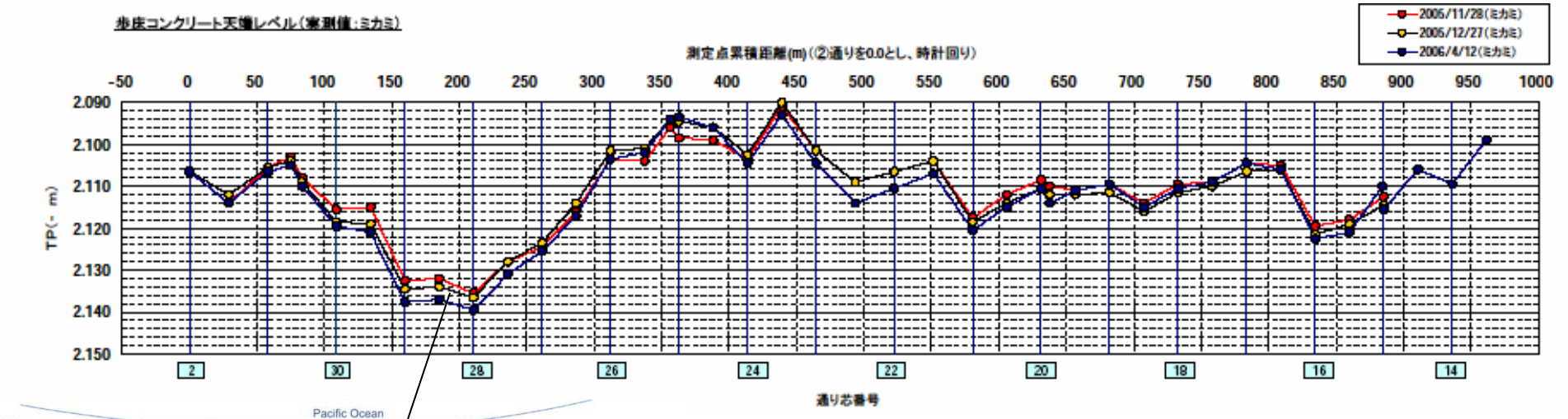
TS: Kumagai JV

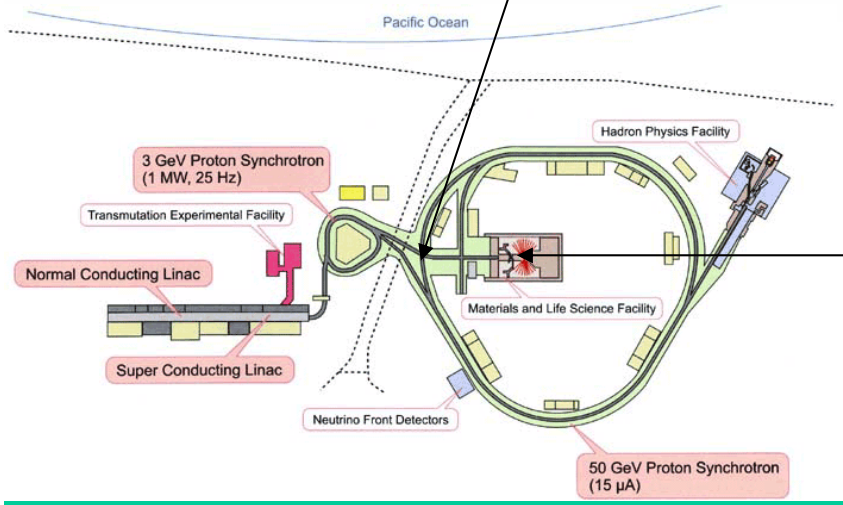
HH: Takenaka JV

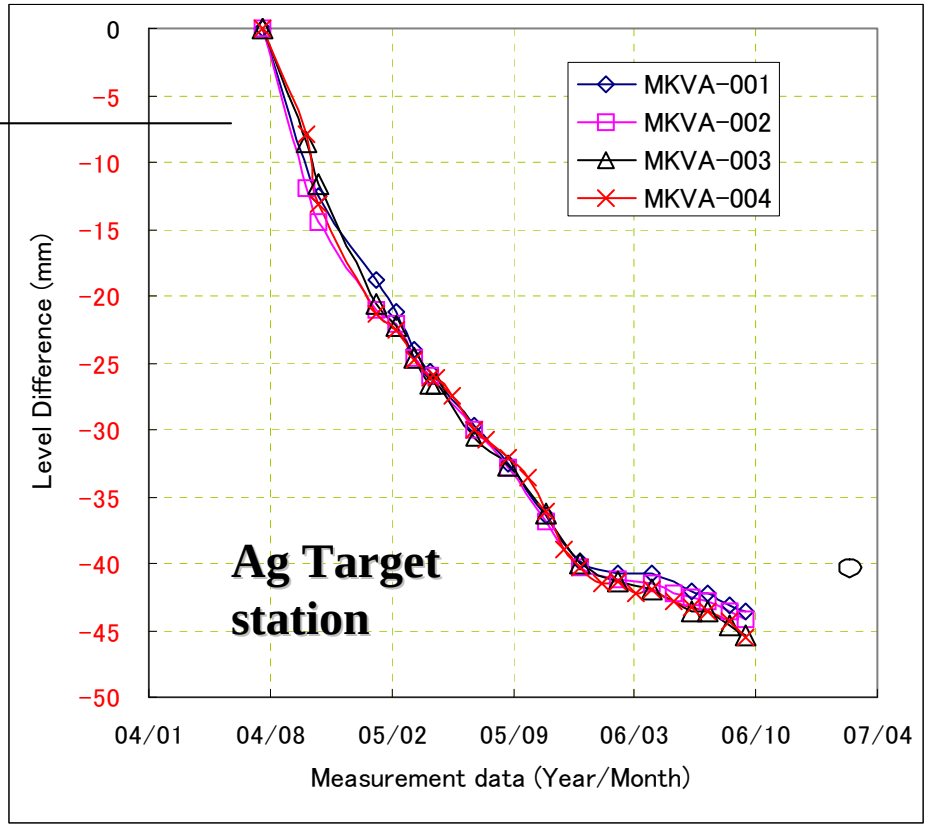
**International bidding for the contract with >720 M Yen. But no proposal tender from abroad.**




MR tunnel →6 zone  Neutrino facility →5 zone

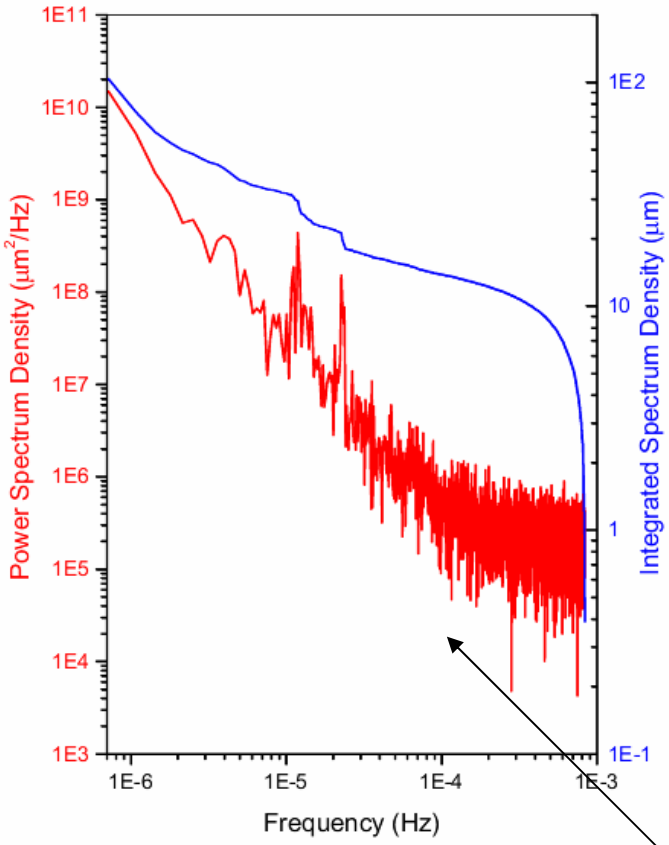


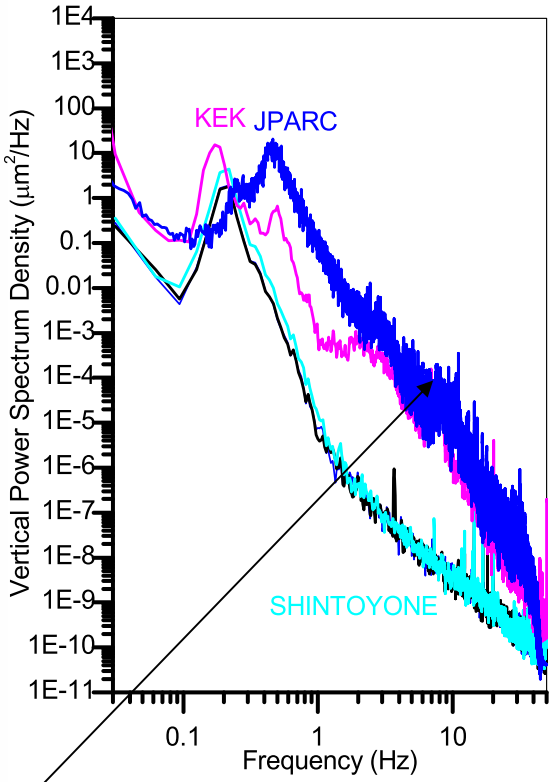



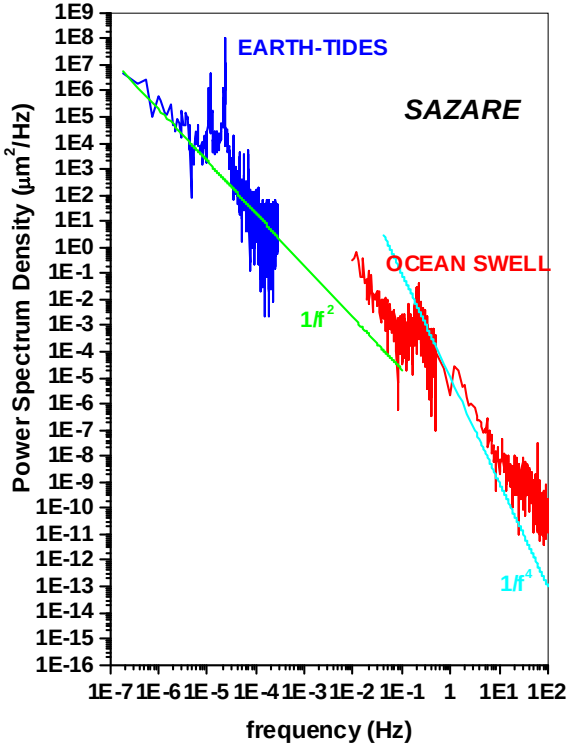




**Significant uneven settlement !**
***Yoshioka* has come to doubt the theory of pile foundation.**

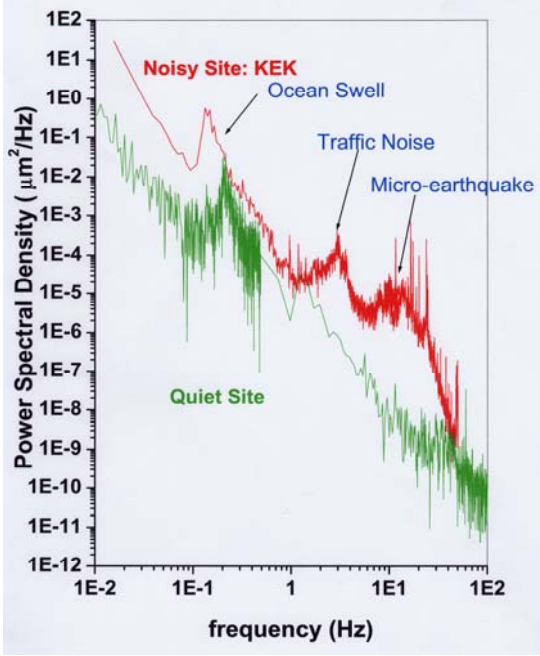
**Takenaka Corporation proposed the piled raft foundation for the hadron hall, which is very successful.**



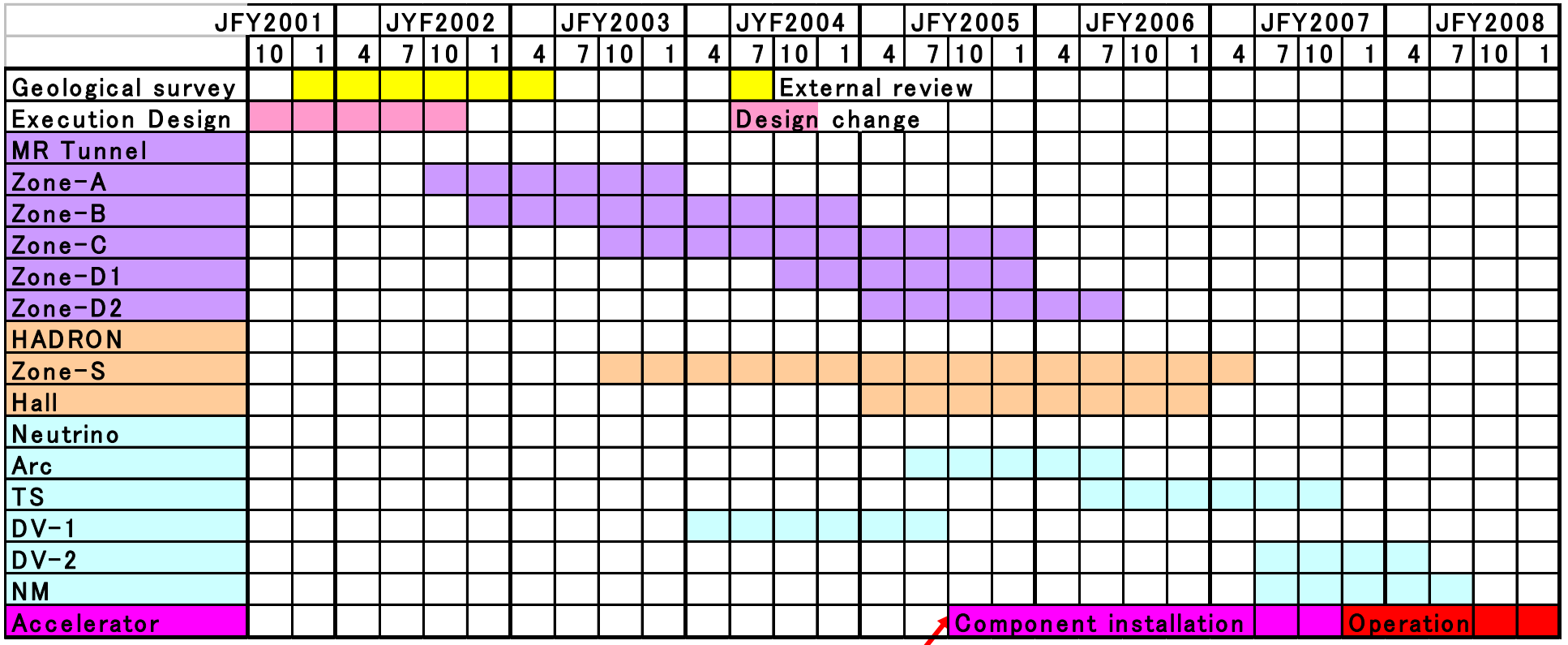




**Ground motion at J-PARC site**
**Earth-tides are clouded by ocean-tides**




**Thanks, J-PARC is not the collider**

**Work done by Shigeru Takeda**




**Accelerator components are installed into the tunnel in parallel with civil work.**

**Main problems of real civil work in the field;**

- **Poor finish of floor painting→a few thousand square-meter, almost fraud →delay of schedule**
- **Bad concrete depositing→a few hundred square-meter→delay of schedule**
- **Penetrated concrete crack→*Yoshioka's* view: mostly resulted by the mechanical stress →delay of schedule**
- **Uneven settlements→*Yoshioka's* view: problem of piled foundation →repeat magnet alignment→delay of schedule**

**Ironically,** we could have accumulated many experiences by the segmentalized construction zone.

- We could work together with five super- and three middle-ranking construction companies and accumulate a lot of experiences how to work together, how to keep the good quality, etc.
- The quality of the construction work does not depend on the company-size, but on the attitude and arrangement of the company and the character and ability of the head of the field site.
- The construction management is essentially important to keep the good quality.

## Lessons from experiences,

- Site selection should be done based on the science; geology, geography, groundwater, animals and plants, etc. (Japanese infrastructures are excellent)
- Separation of contracts for design and real construction makes poor interaction between the design team and reality → We should find out the better way!
- Ordering party should have a well-qualified team to make the design by its own ability and find out the effective relation with the consulting company (companies).
- Bidding with engineering evaluation is efficient to introduce better technology and to reduce the cost and term of works.

| | JYF1980 | | | | JFY1981 | | | | JYF1982 | | | | JFY1983 | | | | JFY1984 | | | | JFY1985 | | | | JFY1986 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 7 | 10 | 1 | 4 | 7 | 10 | 1 | 4 | 7 | 10 | 1 | 4 | 7 | 10 | 1 | 4 | 7 | 10 | 1 | 4 | 7 | 10 | 1 | 4 | 7 | 10 | 1 |
| Baseline Design | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Execution Design | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Survey for MR | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AR civil | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AR buildings | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MR civil | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MR builings | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AR accelerator | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MR acceelrator | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**TRISTAN is the 32GeV+32GeV e+e- collider consisting of a linac (500m long), an AR synchrotron(480m) and a MR synchrotron (3km)**

**Outline of the civil engineering work**

- **Piled foundation→Experimental halls and straight sections**
- **Raft foundation→Arc sections**
- **Excavation volume→ 1.2 million $m^3$**
- **Number of piles→2400**
- **Volume of concrete→0.25 Million $m^3$**

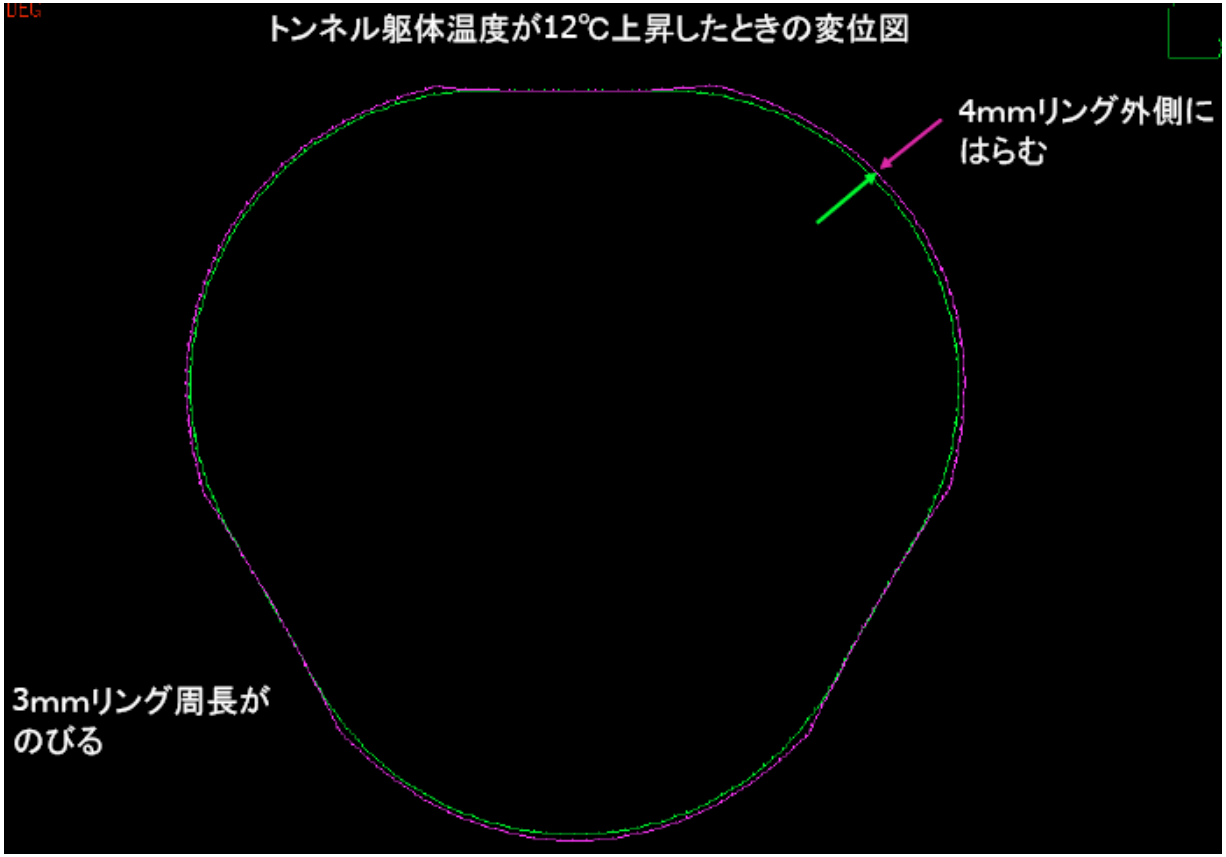
**Powerful headquarter led by Tetsuji Nishikawa**
**Powerful civil engineering team was newly created at KEK**

**Lessons for J-PARC from TRISTAN experiences;**

- **No expansion joint at MR**
  - **Expansion joint makes many troubles**
- **No steel base-plate for magnets on the tunnel floor (floor concrete is strong enough)**
  - **There is a superstition in Japan that magnets should be fixed on the steel plate.**
- **Water-tight tunnel using catalytic agent from outside of the wall.**
- **Choose special concrete with slow hydration reaction to avoid too big temperature difference in the mass-concrete between the interior portion and surface.**
- **Choose special aggregate to avoid activation of the concrete itself (no sodium).**

**Thermal expansion of the tunnel due to the temperature rise of 12 degree C (no expansion joint).**

**By Nikken Sekkei**



# *Yoshioka's comments for ILC EDR Asian effort based on the TRISTAN, KEKB and J-PARC experiences*

**Even though there are many differences between KEK's experiences and ILC, I try to find out useful case examples.**

**Main differences;**

- **O(km) → O(10km)**
- **Site is inside of the laboratory campus → outside → we can learn from SPring8 experiences They established the new facility at the green field working closely with local government.**
- **Domestic → international project**
- **No site selection → site selection**
- **Shallow underground →deep underground**

***Ordering party should be consisted in***

- **Accelerator scientists**
- **Civil engineering experts**

**Strong team should be created, which is organized by accelerator scientists and civil engineering experts, at KEK , for example. Well-qualified team only can manage and/or operate the contract with consultants and general construction contractors.**

**We should find out or we should cultivate experts, who understand requirements from the ordering party, both at the**

- **Consulting companies of civil engineering design.**
- **General construction contractors.**

**The existent budget system does not fit with ILC, which is the large-scale international project.**
**We should avoid to break into too small-size contracts, and negative effect due to the single-year budget.**

**Substantial preliminary survey for geology, groundwater, environment, etc. are needed.**

**Scientific review by the outside experts is important.**

# Thank you for your attention