KEKB facilities and operation

M. Yoshioka (KEKB Review@Feb.11,'03)

- Electricity
- Cooling water
- Air conditioning
- Building and tunnel
- Operation
- Upgrade to Super B

Electricity (1)
TRISTAN facility is converted to KEKB

Electric power consumption (requirement)

RF (1.3+0.85 A)	21.2 MW	(45.8%)
RF (no beam)	16.2 MW (Including P_{ref})	
HER, LER, BT magnet	9.2 MW	(19.9%)
Utility	8.8 MW	(19.0%)
Injector Linac	4.0 MW	(8.6%)
Helium refrigerator	3.1 MW	(6.7%)
Total (with beam)	46.3 MW	(100%)
Total electricity/year	~260 GWH/year	

Electricity (2)

- **Capacity of the KEK substation**
  - **150 MW + 25 MW (154 kV)** **→Big enough**
- **Contract with Tokyo Electric Power Company**
  Peak power **82.74 MW**
  - **~0.12% of TEPCO Max. capacity**
- **Discount** **Summer season**
- **KEK total electricity, including Proton Synchrotron, Photon Factory and others** **462 GWh/year**
- **Total rate** **46.6 Oku-yen(38.9M $)**
- **Average unit cost** **8.4 ¢/kWh**
- ***Margine of TEPCO electricity in March '03 becomes zero, due to the inspection for nuclear power plants***

Electricity (3)

- ***Industrial Electricity General Price for Various Countries in 1997 (one example among many statistics)***

Japan	**100%**	**(KEK price; 8.4 ¢/kWh)**
US	**~30%**	**(SLAC; ?)**
UK	**~45%**	
Germany	**~49%**	**(DESY; ?)**
France	**~35%**	**(CERN; ?)**

- ***Substantial competition between electric power companies is needed to realize "A reasonable price"***
  - ***Free electricity market will be extended in 2005***

KEK substation

- Two main transformers 154 kV/66 kV
- 150 MW + 25 MW

Electricity (4) Trouble

- Accidents near to KEK → Blackout for 3~4 sec
  - A few times/year
    Wet snow in early spring
    Lightning in summer or fall
    Storm (Typhoon)
  - Helium refrigerator stop : ~1 shift to recover
- Accidents far from KEK →~10% Voltage drop
  - ~10 times/year
  - Almost no damage
- So far, no trouble in substation itself at KEK!

Cooling Water System

TRISTAN facility is converted to KEKB

- **Total power consumption** — **46.3 MW**
- **Dry cooling tower** — **36 MW (77.8%)**
- **Wet cooling tower** — **8 MW (17.2%)**
- **Air conditioning, cooling fun** — **2.3 MW (5%)**
- **System problems in dry cooling tower**
  - **Dry bulb temperature** — **25 ℃ (Design)**
    - » **Poor Cooling in Summer**
  - **Inconsistent between designed and real heat load in cooling tower for klystron-body and RF dummy loads (tower >> real heat load)**
    - » **Over cooling or freezing in winter (three times so far)**

Dry Cooling tower

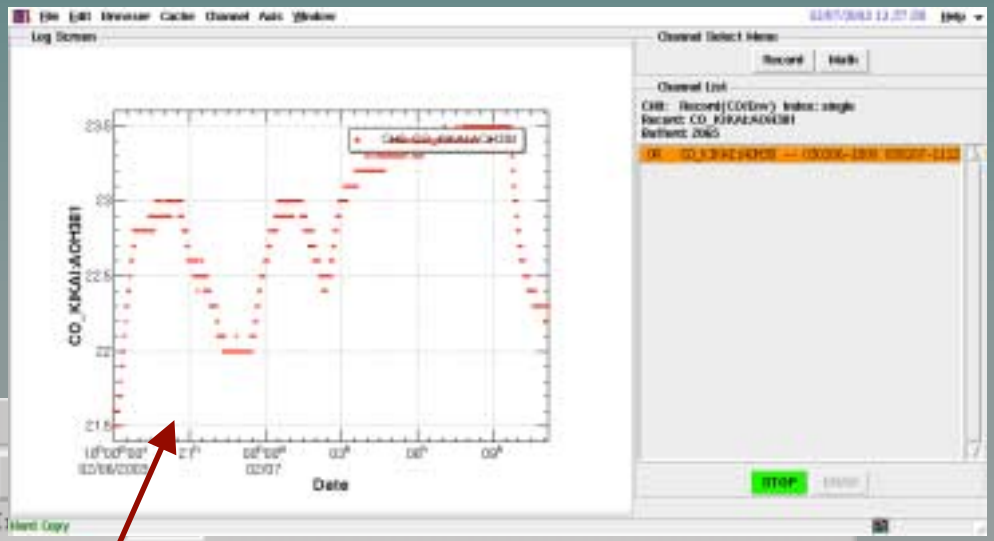
- Broken tower on the early morning of the Jan.15, 2003
- Heat load only 0.3 MW
- Capacity of cooling tower 5 MW
- Temp. -7.8 ℃
- Tower-head is frozen and burst up, but repaired quickly (~1 shift lost)

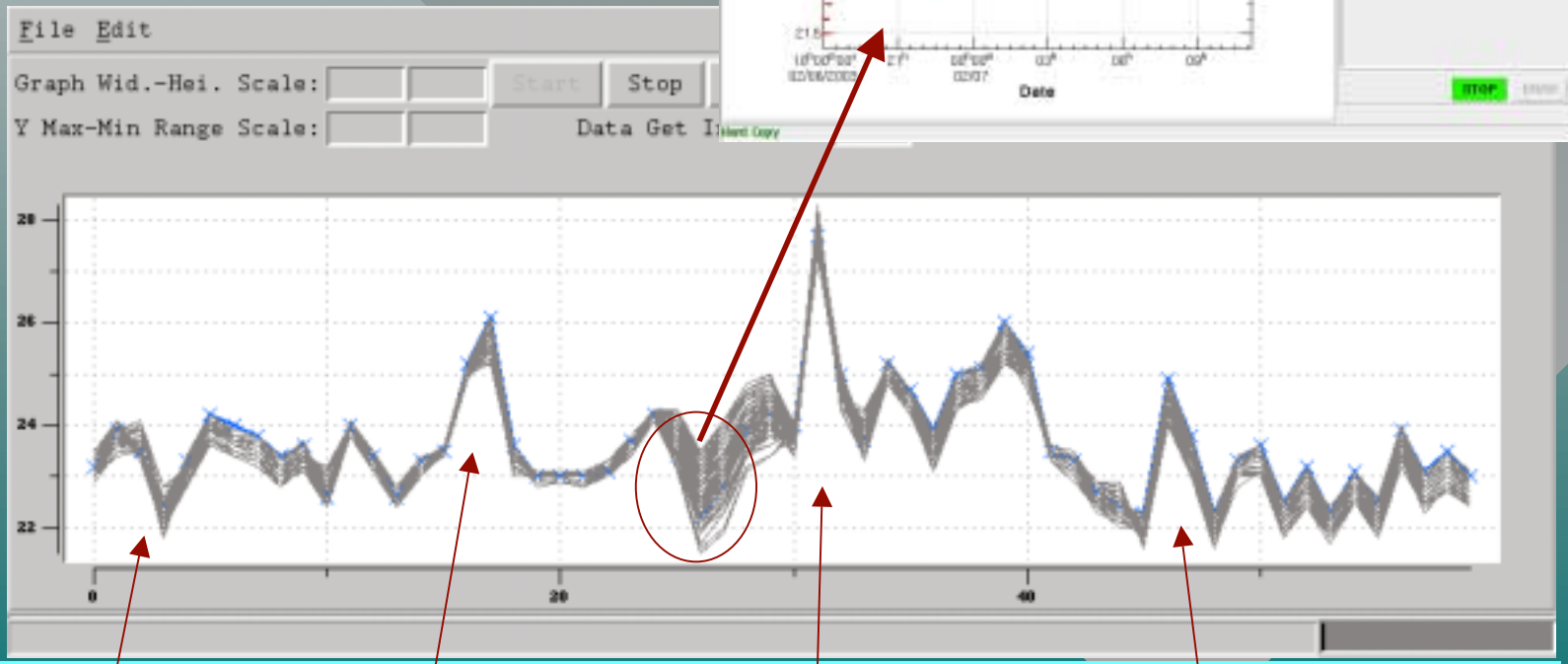
Air Conditioning
TRISTAN facility is converted to KEKB

- 3km-long tunnel is devided into 16 air conditioning-zones
- Main heat source; power cables, air cooled corrector magnets and solenoid coils
- Other heat source; water-cooled main magnets and vacuum chambers
- Total; ~1.5 MW
- Supply and return air ducts are used in the tunnel
- Temperature is set to 24℃ at all seasons
  - In winter, tunnel must be heated up when machine is turned off, to keep the temperature stable

Air conditioning (2)
Temperature in the tunnel

- below: Temp. distribution in the tunnel (17 hours)
- right: Temp. vs time
- Feb. 6, 18:00~Feb. 7, 11:00 (17 hours)



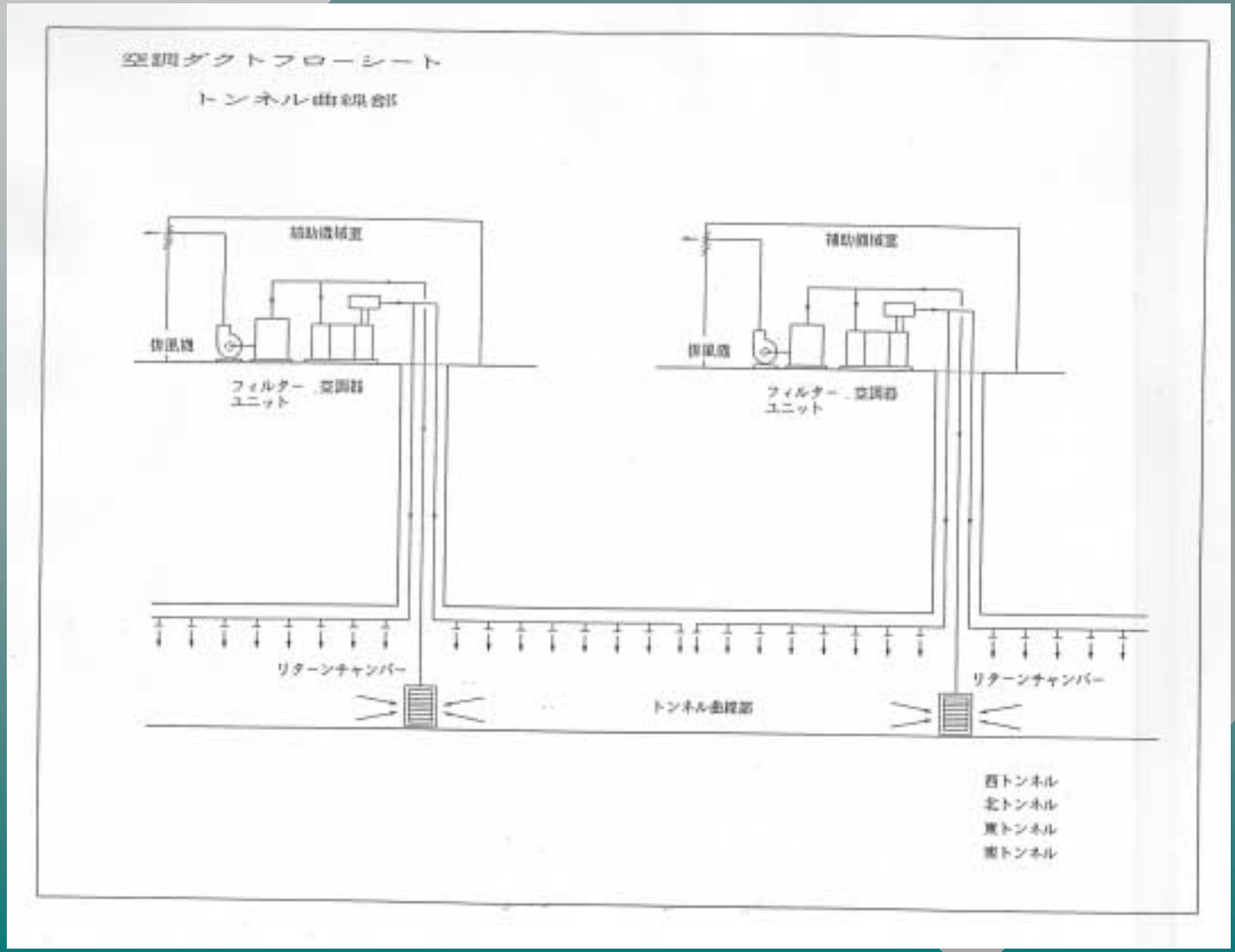


- Tsukuba
- Oho
- Fuji
- Nikko

Air conditioning(3)

Supply and return air duct in the tunnel

Air conditioning (4)

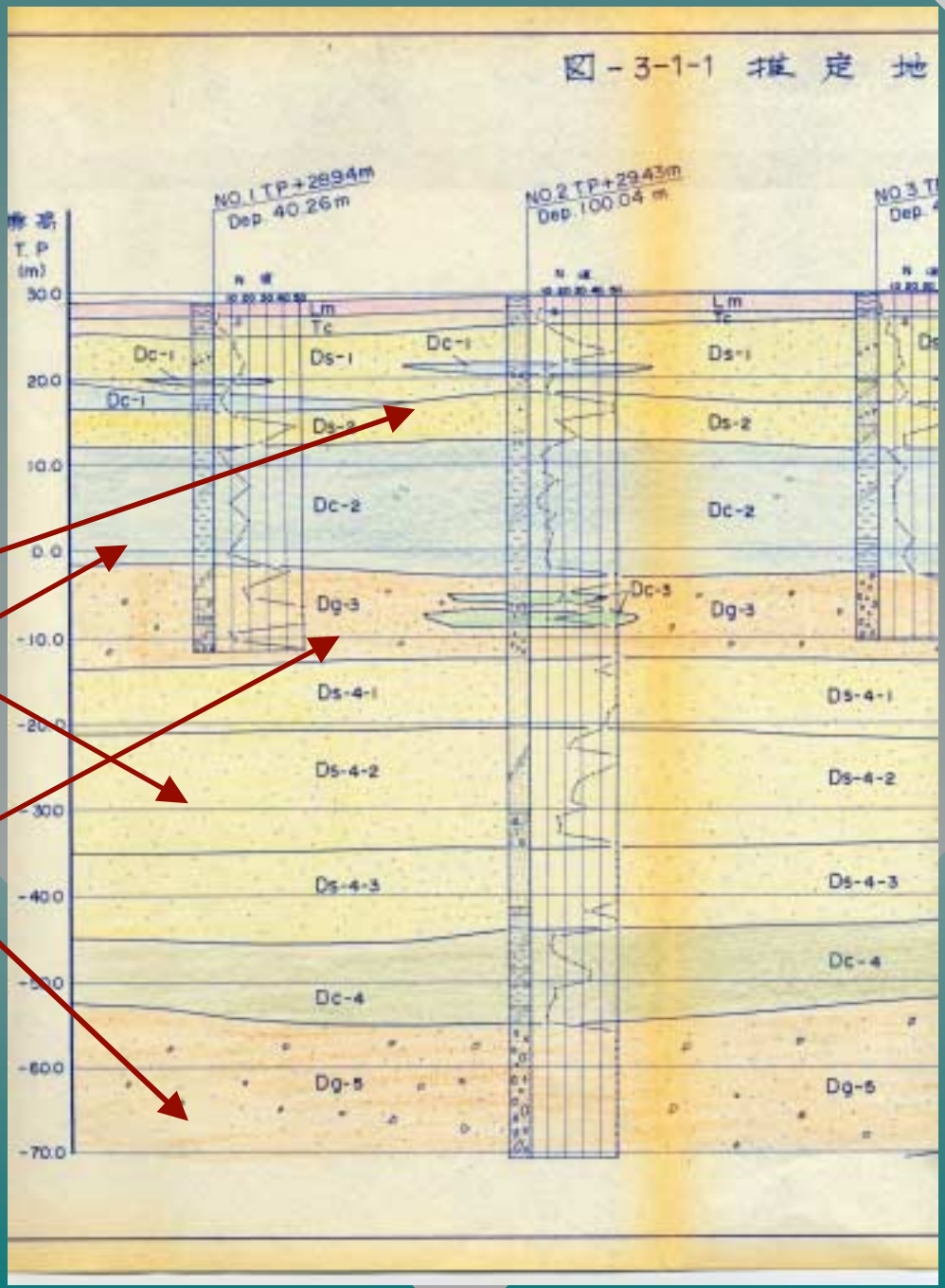


Building and Tunnel

- **Geology: Thick diluvial layers (>600 m)**
  - Consisting of many layers of clayey or sandy soil and conglomerate clay
  - Rich underground water (pumping up 500~1000 ton/day for Proton Synchrotron cooling)
- **Arc section (floor = GL - 12m, on sandy soil layer)**
  - direct foundation
- **Experimental hall (floor = GL - 16 m, on clayey soil layer which is not strong enough)**
  - 25 m-long pile foundation to sandy soil layer
- **Tunnel is divided into 60 blocks (~50 m-long each) and connected with "expansion joints" each other**
  - Flexible joint (elastic)

Geology of KEK site

- **Lm: clayey soil**
- **Ts: sandy soil**
- **Tc: clayey soil**
- **Ds: sandy soil**
- **Dc: clayey soil**
- **Dg: conglomerate clay**



Building and Tunnel (2)

- West and south arcs are sinking steadily by 1~2mm/year (maybe) due to pumping up of underground water
- Orbit length is affected by tunnel temperature, earth tide, atmospheric pressure, (probably) sunshine, and etc.
- Geology and tunnel are not so bad for B-Factory but feedback systems are needed

Operation of accelerator & facility

- Two different organizations
  - Accelerator Laboratory (98 staff for KEKB+Linac)
  - Plant & Facilities Department
    - KEK staff frequently transfer position(~3 years)
    - Few staff number (only 17 for machine and electricity)
- Two different companies (out-sourcing)
  - Accelerator: Mitsubishi Electric System and Service Corp.
    - 24 (KEKB+ Linac), 15 (Photon Factory)
  - Plant and Facilities; Takahashi Kogyo Corp. (50)
    - 32 (Machine), 18 (Electricity)
- Issues to be solved;
  - How to integrate know-how, experiences, ・・・・・
  - How to secure close contact between two organizations

Control room for; Accelerator (left), Machine and Electricity (right)

Upgrade to Super B

Key Issues from facility view point

- **Increase beam current and RF power**
  - **New houses for RF sources**
    - **Number of klystrons 24(B) /56 (S-B)**
  - **Upgrade cooling water system for RF and vacuum chambers**
    - **SR + HOM power 8 (B)/34 (S-B) MW**
  - **Rearrangement of cooling towers**
  - **Minor change of substations**
    - **Total wall-plag power 73 MW < TRISTAN**
- **Upgrade Injector Linac**
  - **Isolate from Photon Factory (very important)**
  - **New building for damping ring and etc.**
  - **Upgrade cooling water systems**
- **Study for effects about environment and/or geological stability (maybe) needed**