A Proposal of Energy Saving in the Power Supply System for Green ILC

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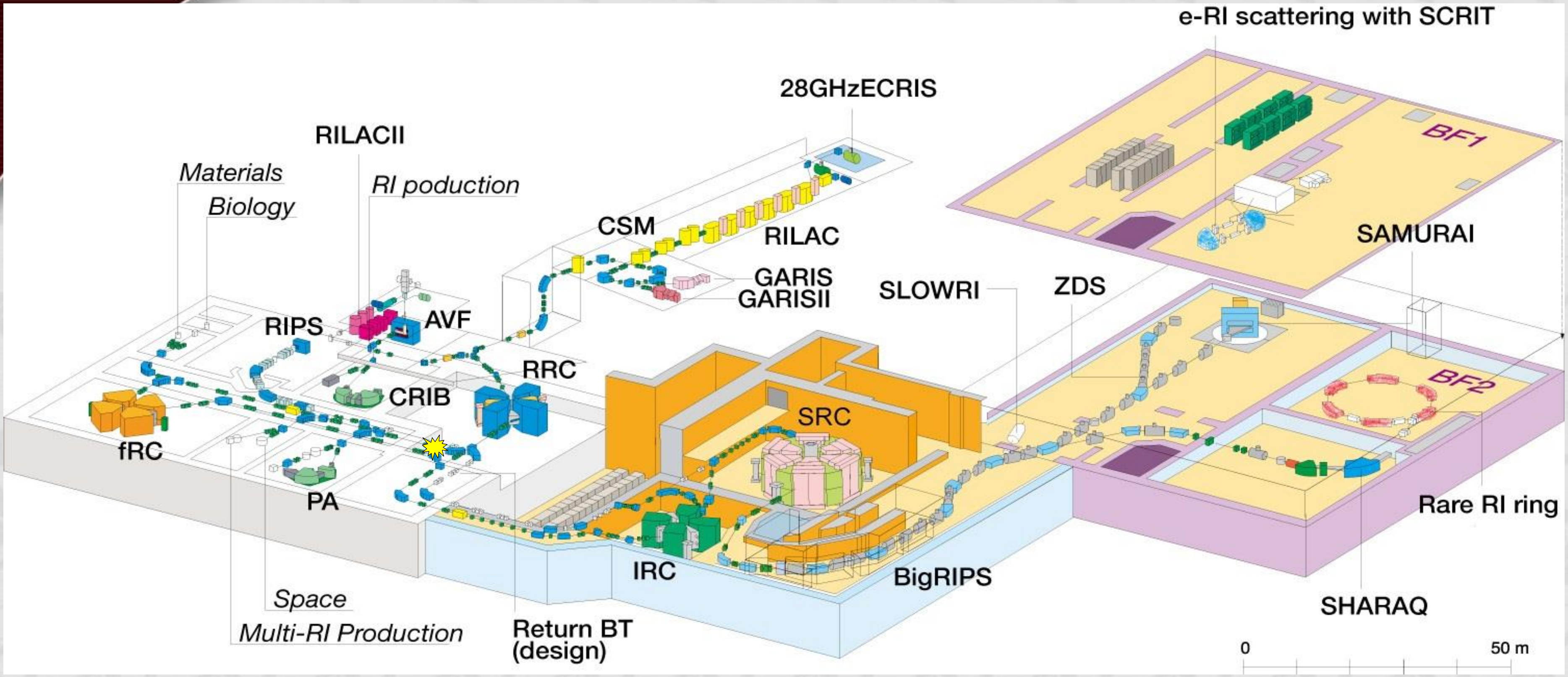
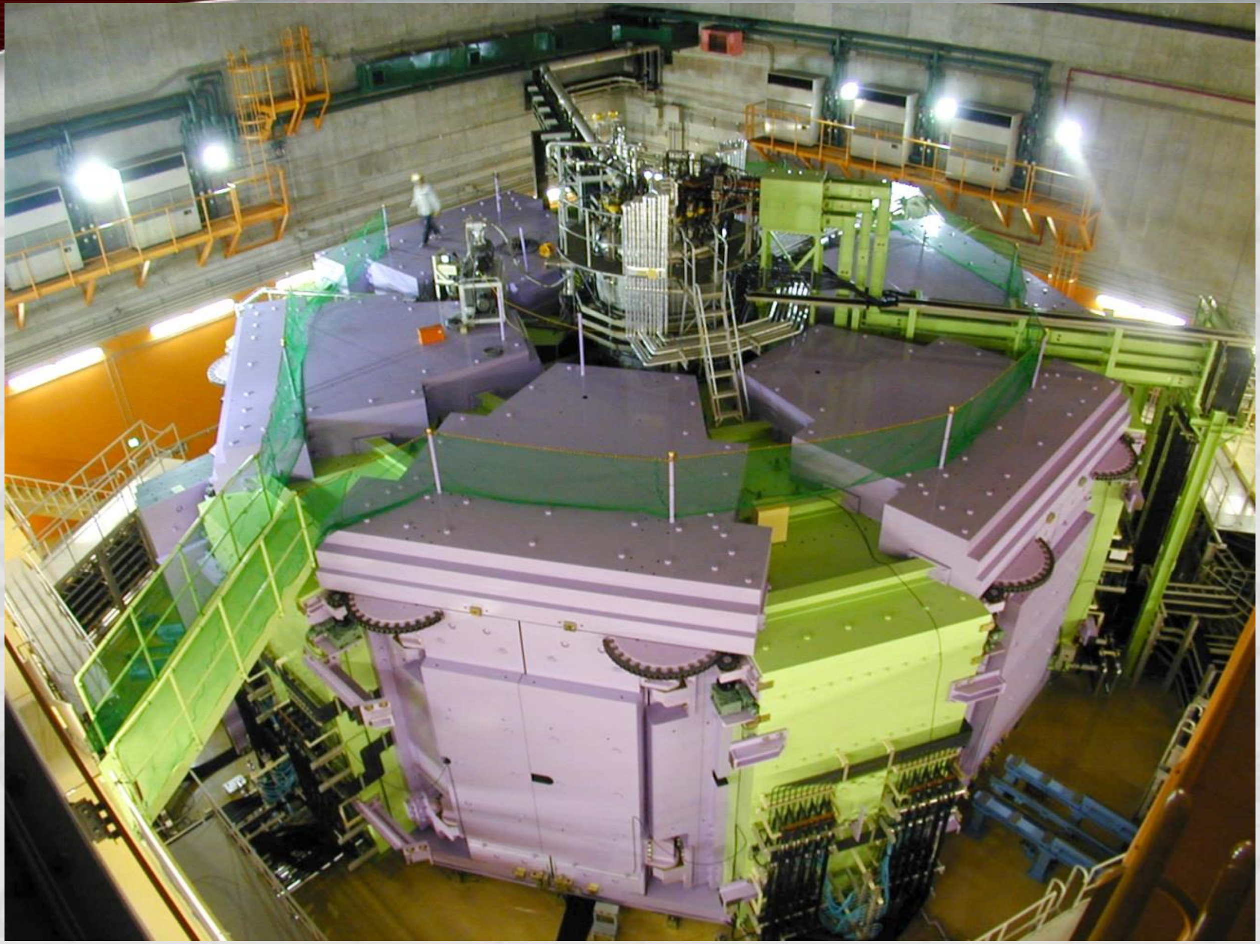
RIKEN RI Beam Factory (RIBF)



The Radioactive Isotope Beam Factory (RIBF) is a facility generating unstable nuclei of all elements up to uranium and studying their properties.

RIKEN RIBF



The world’s heaviest and most powerful cyclotron :SRC

Element 113 is Nh

Element 113.
(Nihonium)

RIBF at RIKEN

- RIKEN RIBF created the nuclei of element 113, and RIKEN got the naming right of element 113.

Nh(Nihonium)

Sustainable and high-efficiency accelerators in RIKEN

Motors (Toshiba Co. Ltd.) for cooling water are in high efficiency.

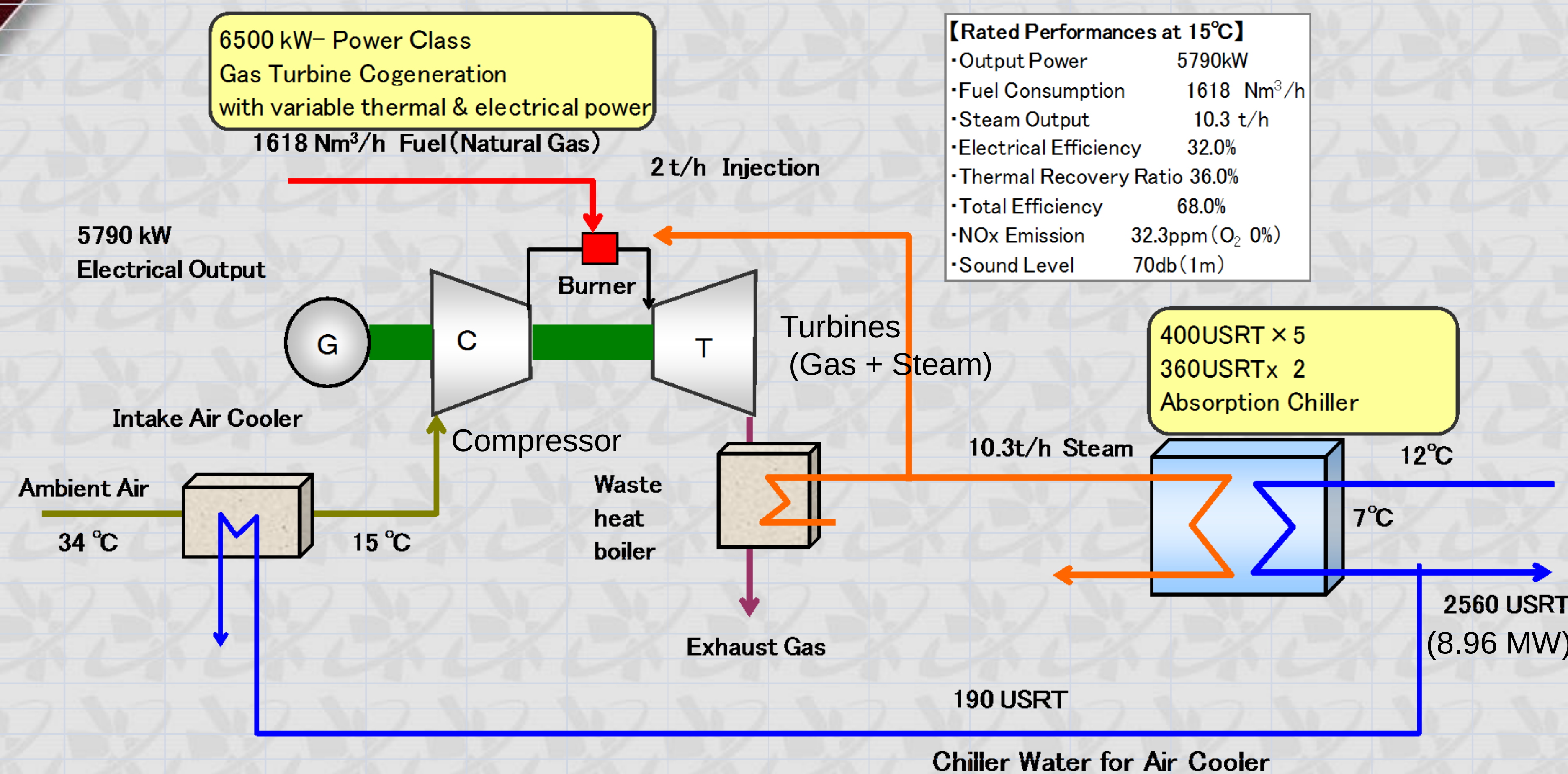
30 kW: 92.62%(High-efficient type), 91.35%(Normal type)

55 kW: 94.20%(High-efficient type), 92.30%(Normal type)

The transformer's highest efficiency is 99.4% （1.5 MVA)

CGS (Co-Generation System) at RIKEN

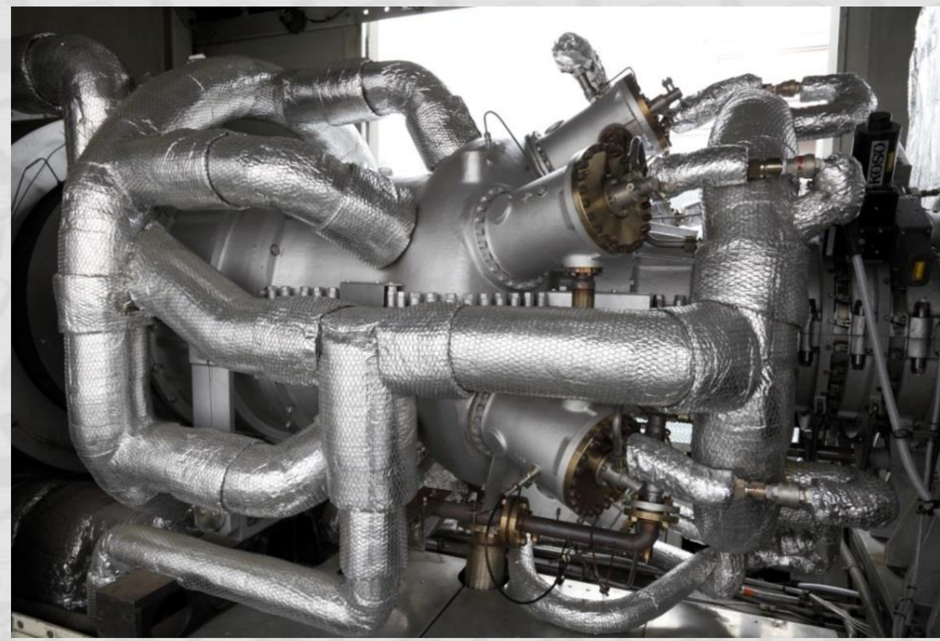
CGS output = 5.79 MW (Electric / 66 kV) + 8.96 MW (Chiller)



Co-Generation System (CGS) at RIKEN

* RIKEN RIBF consumed 18 MW when using Uranium acceleration with the world's heaviest and most powerful SRC.

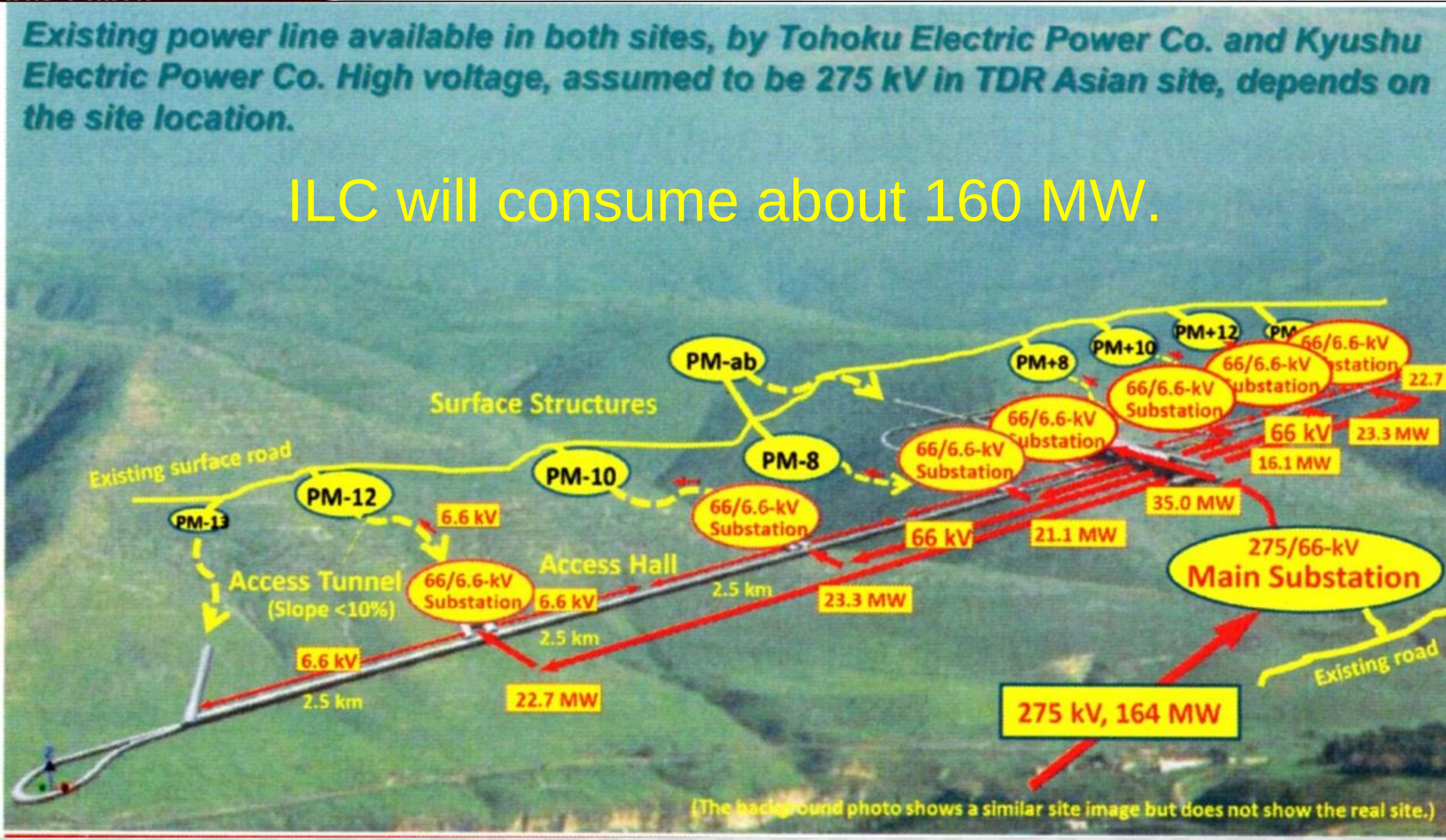
* CGS supports RIBF as UPS.



Waste Heat Boiler :WHB

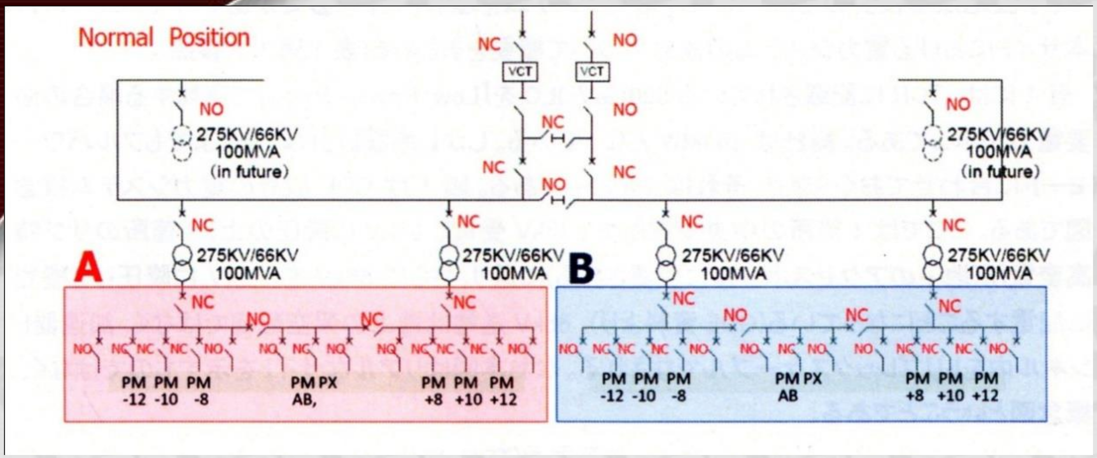
Gas Turbine Generator : GTG

Considerations on Power Supply System in ILC-TDR



Currently, Tohoku Electric Power will supply power at 154 kV, not at 275 kV.

ILC-TDR Substations

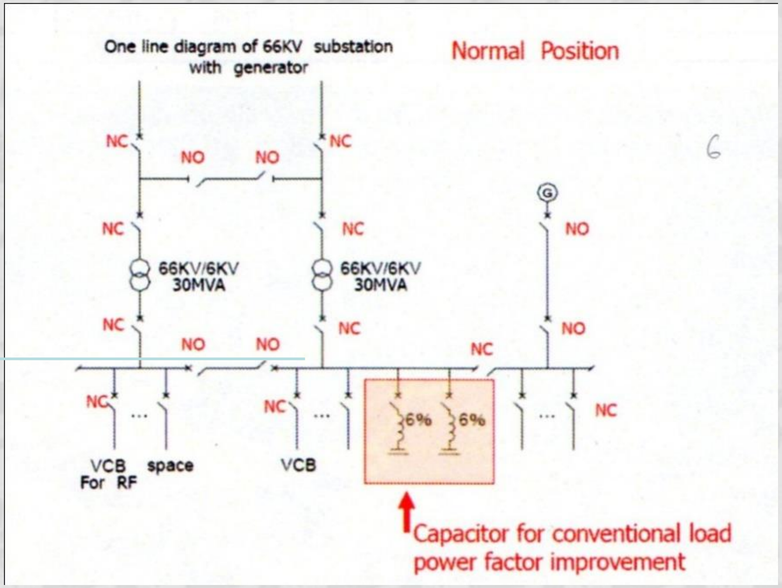


HV / HV main substation

154 kV/ 66 kV

HV / MV substations

66 kV/6.6 kV x 7 sets



Considerations on Power Supply System in ILC-TDR

- The ILC-TDR plan is the extension from the scheme in KEK and/or other HEP laboratories, 100 - 500 kV to 66 kV, and 66 kV to 6.6 kV.
- But all these transformers have loss in iron and copper.

We have an alternative plan for Green-ILC

- Currently, two independent power sources are available from Tohoku EPCO at 154 kV.
- When one fails in an accident, the other will remain operational and it will be switched within 0.06 sec.(3 cycle)

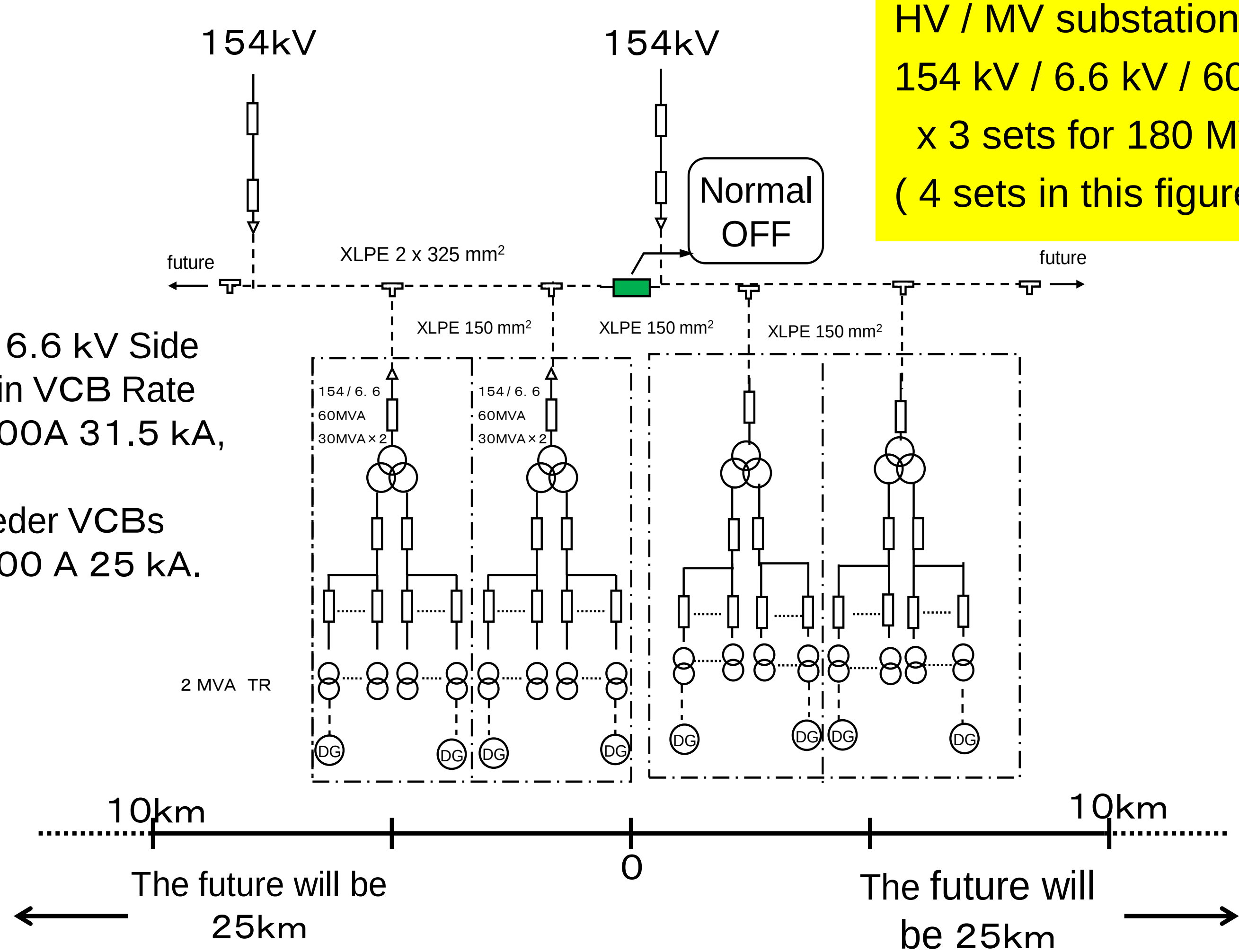
Our proposal for Green ILC

Green ILC Substation（154kV, 50Hz）

HV / MV substations
154 kV / 6.6 kV / 60 MVA
x 3 sets for 180 MVA
(4 sets in this figure)

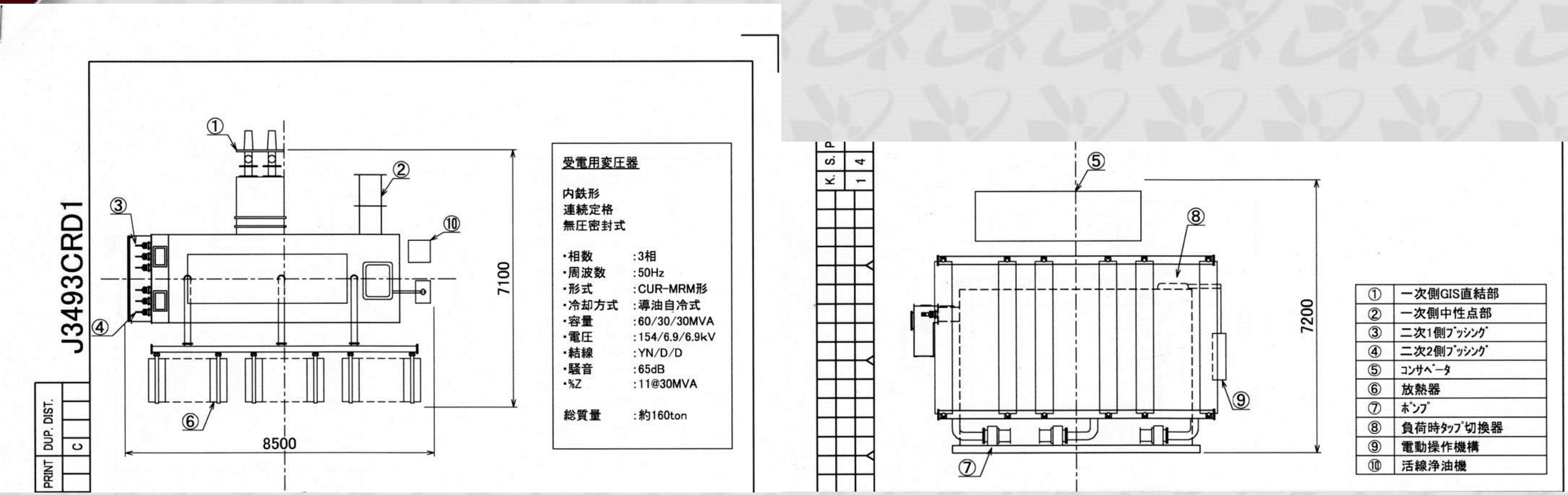
TR 6.6 kV Side
Main VCB Rate
3000A 31.5 kA,

Feeder VCBs
1200 A 25 kA.



A transformer for Green ILC

An example of transformer:



Transformer from 154 kV to 6.6 kV (by Mitsubishi Electric Co. Ltd.)

Comparison of TDR and Green ILC

- Transformer loss in ILC-TDR:
  2,230 kW (Op) + 808 kW (Maintenance)
- Transformer loss in our proposal for G-ILC:
  1,200 kW (Op) + 200 kW (M)
- Total difference : 8,280 MWh/year
- Cost difference : 99,360,960 yen /year
- Save in CO_2 emission : 632 tons/year

Particulars

- 154 kV/66 kV substation should be skipped. We can save energy and cost. We have many track records of 500 kV/6.6 kV substation.
- 3 x (154 kV, 60 MVA substation) will be constructed. The number of substations will be less than half.
- The number of transformers will be 3/18.
- Loss of 66 kV cable is larger than that of 154 kV cable.
- The dual power sources from the local power company are available at 154 kV and then the system is reliable.
- CGS is not recommended for ILC. See following slides.
- Also sustainable energy sources are used in parallel. See following slides.

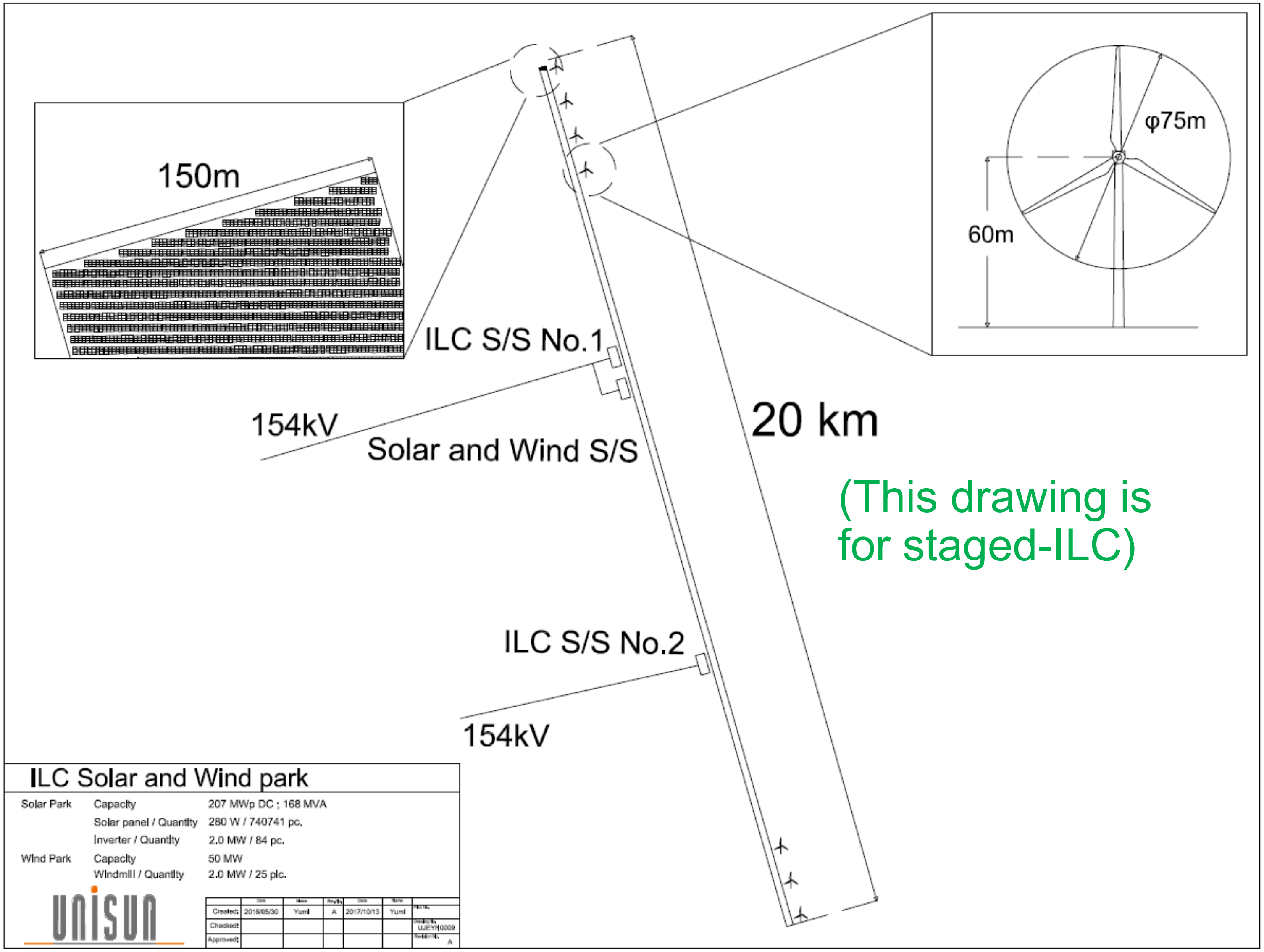
We do not recommend CGS for ILC

- **No pipe line for gas at ILC site!**
- **16,000 Nm^3/h of fuel (natural gas) for ILC-CGS.**

- **The COP of the absorption chiller is lower than turbo one. (1.3 vs 6)**
- **The turbo chiller has increased COP in 15 years. (COP: Coefficient of Performance)**
- **RIKEN installed the CGS 15 yeas ago. Now the turbo chiller is better than absorption chiller.**

Transport by trucks is not “green”

A proposal of Solar and Wind Park for ILC



This Solar Park is 2 MW.

This Solar Park is 13.5 MW.

Wind Park in mountain area

An example of Wind Park in mountain area.
(Kashima Corporation, Wind Park in Hirokawa Myojin mountain area)

Solar and Wind Energy

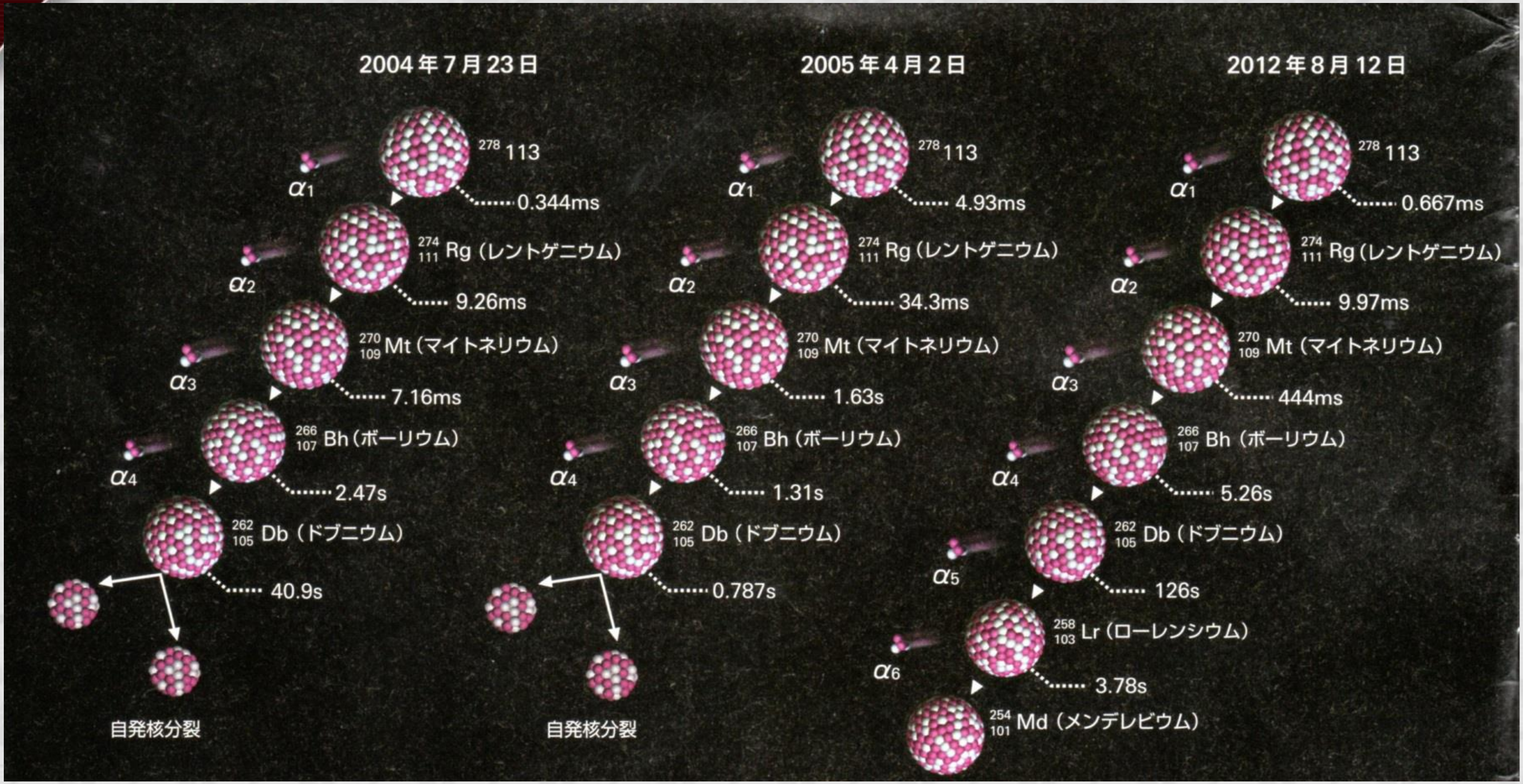
- Tohoku EPCO reported that solar power output is at maximum in high noon in their territory.
- Wind power will be at minimum at 12 o’clock in the day time, so they are complimentary and can cover each other.

Conclusions

- The dual power sources at 154 kV are available from the local power company. The system at 154 kV is reliable.
- We propose to use the transformer: 154/6.6 kV to reduce the number of substations.
- We can save 8,280 MWh/year (\99,360,960/year), and can save 632 tons/year of CO_2 emission.
- Less equipment is good for reliable operation and easy maintenance.
- CGS is not recommended for ILC due to fuel (natural gas) transportation.
- We propose to use sustainable power sources, such as solar and wind energy, as much as possible in parallel.

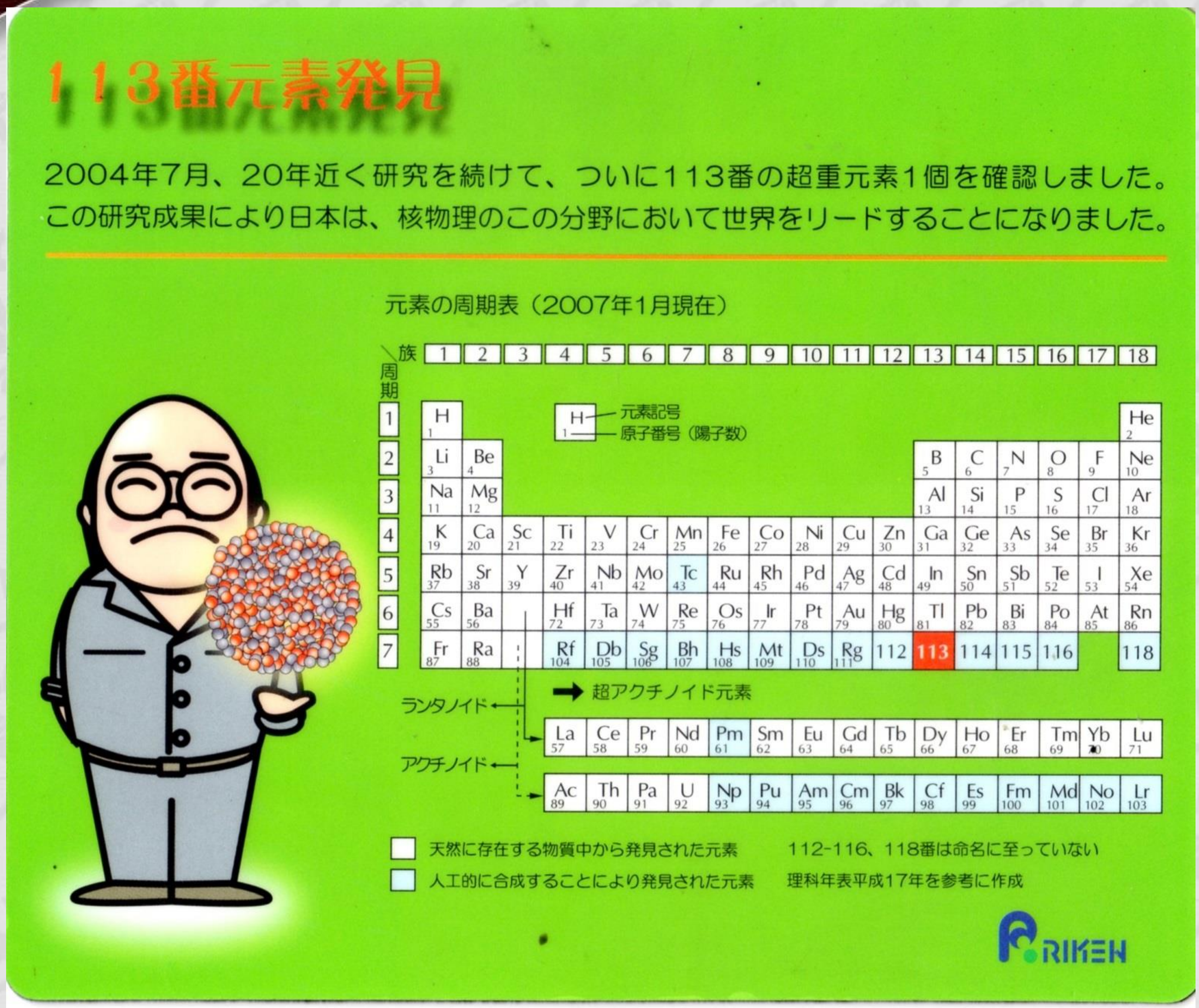
Backup slides

Nihonium



2004年7月23日
278 113
0.344ms
274 111 Rg（レントゲニウム）
9.26ms
270 109 Mt（マイトネリウム）
7.16ms
266 107 Bh（ボーリウム）
2.47s
262 105 Db（ドブニウム）
40.9s
自発核分裂
2005年4月2日
278 113
4.93ms
274 111 Rg（レントゲニウム）
34.3ms
270 109 Mt（マイトネリウム）
1.63s
266 107 Bh（ボーリウム）
1.31s
262 105 Db（ドブニウム）
0.787s
自発核分裂
2012年8月12日
278 113
0.667ms
274 111 Rg（レントゲニウム）
9.97ms
270 109 Mt（マイトネリウム）
444ms
266 107 Bh（ボーリウム）
5.26s
262 105 Db（ドブニウム）
126s
258 103 Lr（ローレンシウム）
3.78s
254 101 Md（メンデレビウム）
α1
α2
α3
α4
α5
α6

Nihonium, next will be 119 & 120



周期＼族	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	H 1																	He 2
2	Li 3	Be 4											B 5	C 6	N 7	O 8	F 9	Ne 10
3	Na 11	Mg 12											Al 13	Si 14	P 15	S 16	Cl 17	Ar 18
4	K 19	Ca 20	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30	Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36
5	Rb 37	Sr 38	Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54
6	Cs 55	Ba 56		Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80	Tl 81	Pb 82	Bi 83	Po 84	At 85	Rn 86
7	Fr 87	Ra 88		Rf 104	Db 105	Sg 106	Bh 107	Hs 108	Mt 109	Ds 110	Rg 111	112	113	114	115	116		118

ランタノイド	La 57	Ce 58	Pr 59	Nd 60	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70	Lu 71
アクチノイド	Ac 89	Th 90	Pa 91	U 92	Np 93	Pu 94	Am 95	Cm 96	Bk 97	Cf 98	Es 99	Fm 100	Md 101	No 102	Lr 103

Adsorption chiller “AdRef”

Environmentally Friendly Chiller.

Features

1. No CFCs, HCFCs used.

   Water (H_2O) is used as refrigerant.

2. Low temperature heat source.

   As low as 65 C

3. Super Energy Saving

   Only a few HP necessary

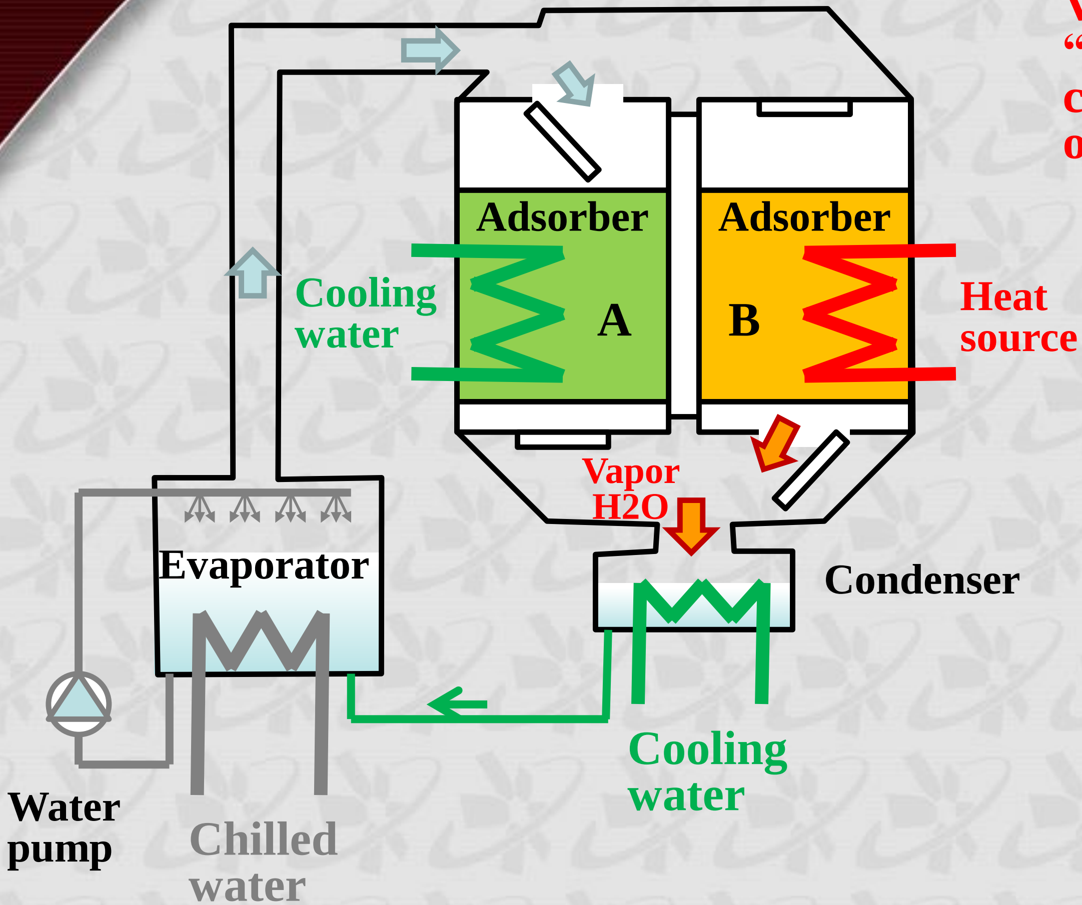
4. Easy maintenance

   Very few moving parts used.

5. Safe

   No pressure piping or refrigerant

Adsorption chiller "AdRef"



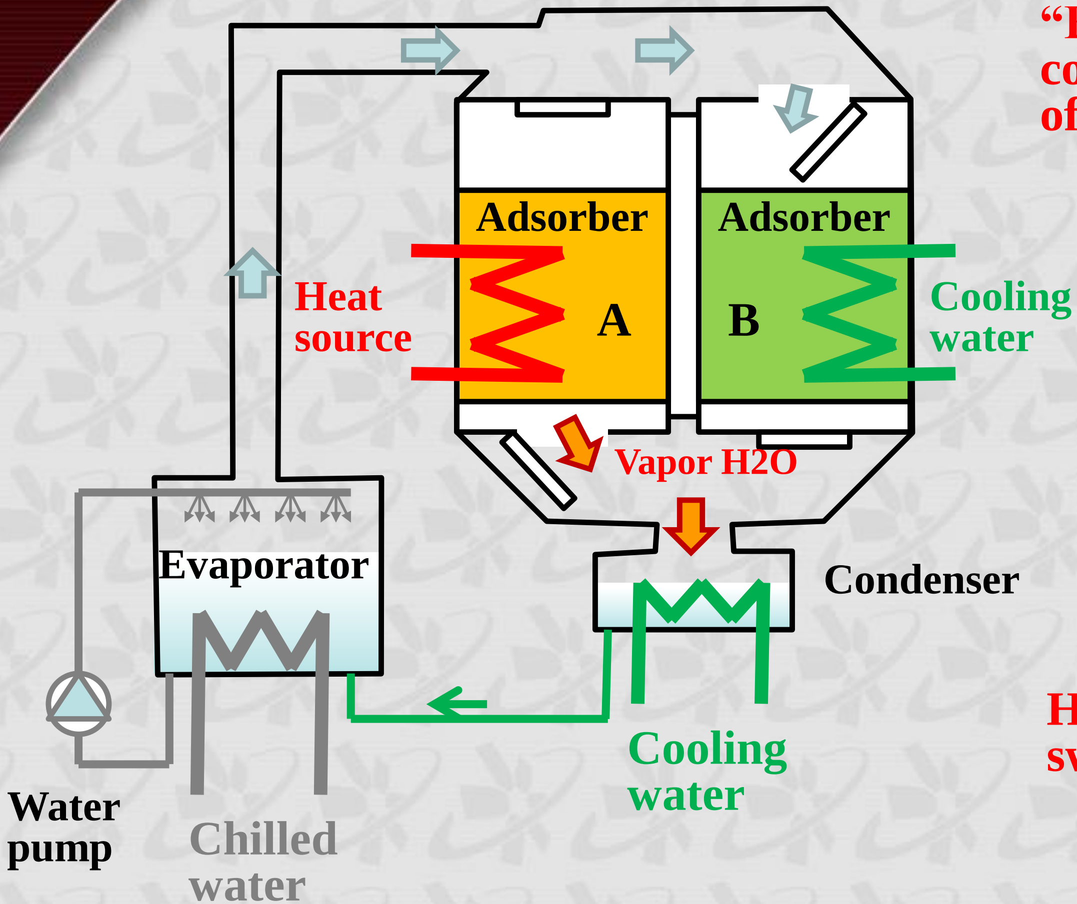
Vapor H_2O is removed from adsorber "B" by heating with warm water, and condensed in the condenser by the cool of cooling water.

Liquid water goes to the evaporator.

The adsorber "A" adsorb vapor H_2O by cool of cooling water.

Then the liquid H_2O in the evaporator evaporates, and the latent heat cool down the chilled water.

Adsorption chiller “AdRef”



Vapor H_2O is removed from adsorber “B” by heating with warm water, and condensed in the condenser by the cool of cooling water.

Liquid water goes to the evaporator.

The adsorber “A” adsorb vapor H_2O by cool of cooling water.

Then the liquid H_2O in the evaporator evaporates, and the latent heat cool down the chilled water.

Heating/Cooling of adsorber A/B is switched periodically.

Absorption refrigerator (chiller) (from Wikipedia, the free encyclopedia)

- An **absorption refrigerator** is a refrigerator that uses a heat source (e.g., solar, kerosene-fueled flame, waste heat from factories or district heating systems) to provide the energy needed to drive the cooling system.
- In the early years of the twentieth century, the vapor absorption cycle using water-ammonia systems was popular and widely used, but after the development of the vapor compression cycle it lost much of its importance because of its low coefficient of performance (about one fifth of that of the vapor compression cycle). Nowadays, the vapor absorption cycle is used only where waste heat is available or where heat is derived from solar collectors. Absorption refrigerators are a popular alternative to regular compressor refrigerators where electricity is unreliable, costly, or unavailable, where noise from the compressor is problematic, or where surplus heat is available (e.g., from turbine exhausts or industrial processes, or from solar plants).