Approach to the more stable injector linac for SuperKEKB

Hiroysu Ego

June 12, 2020

Contents

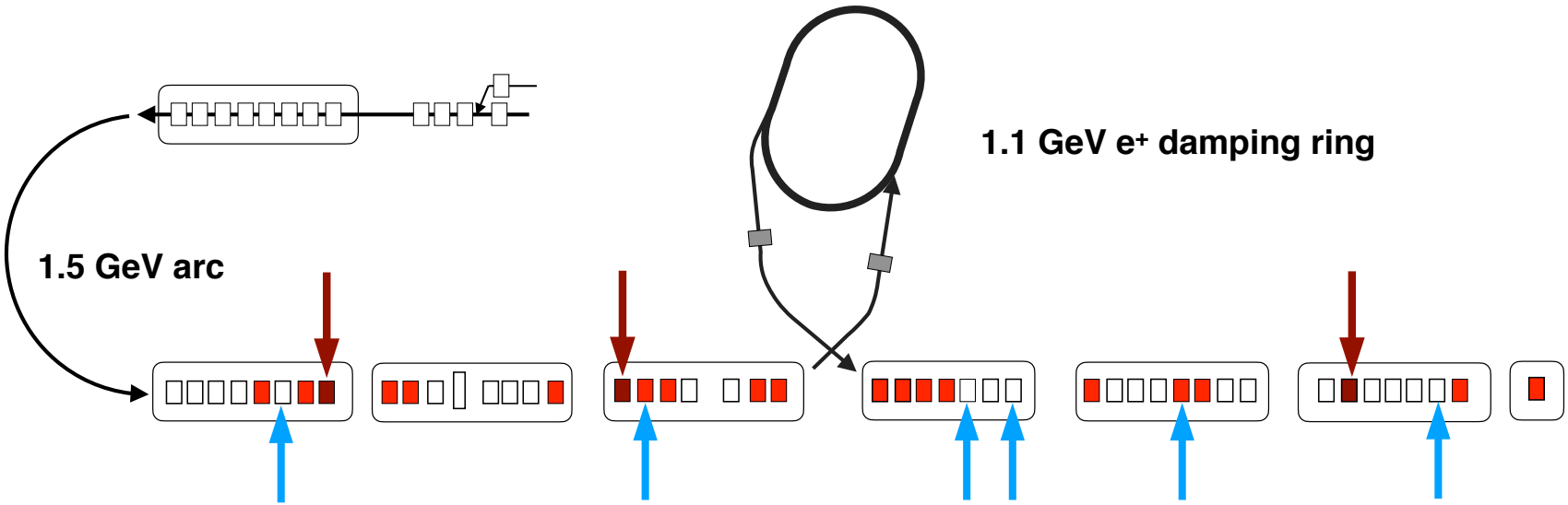
- Linac status
- Deterioration in accelerating structures
- 5-year upgrade plan in progress
- Summary

Linac status

Linac has many accelerating units with damaged structures

e^- 7.68 GeV (max)

e^+ 4.39 GeV (max)



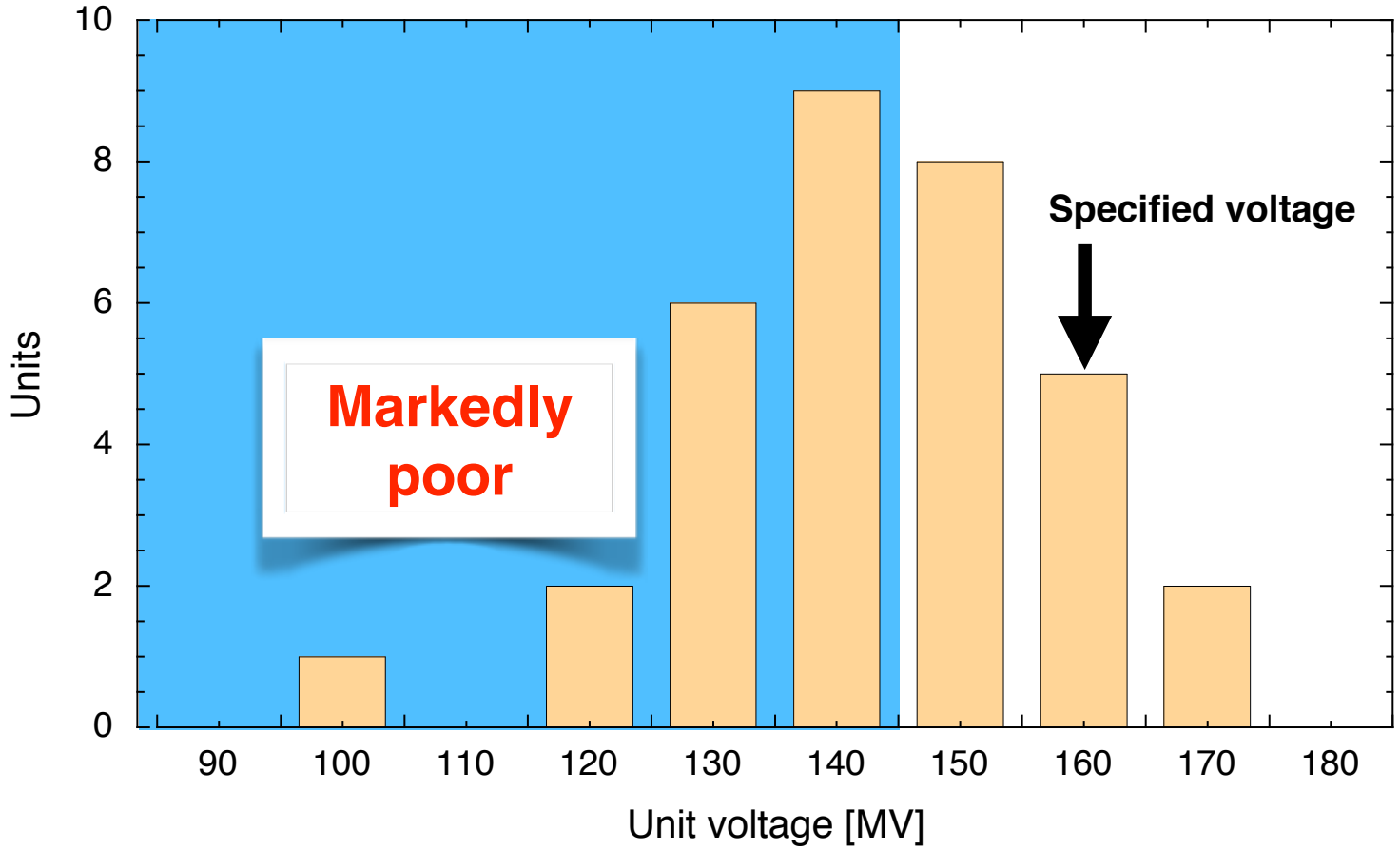
: **Damaged unit**

: **Markedly damaged unit**

: **Unit with the structure repaired temporally for water-leak**

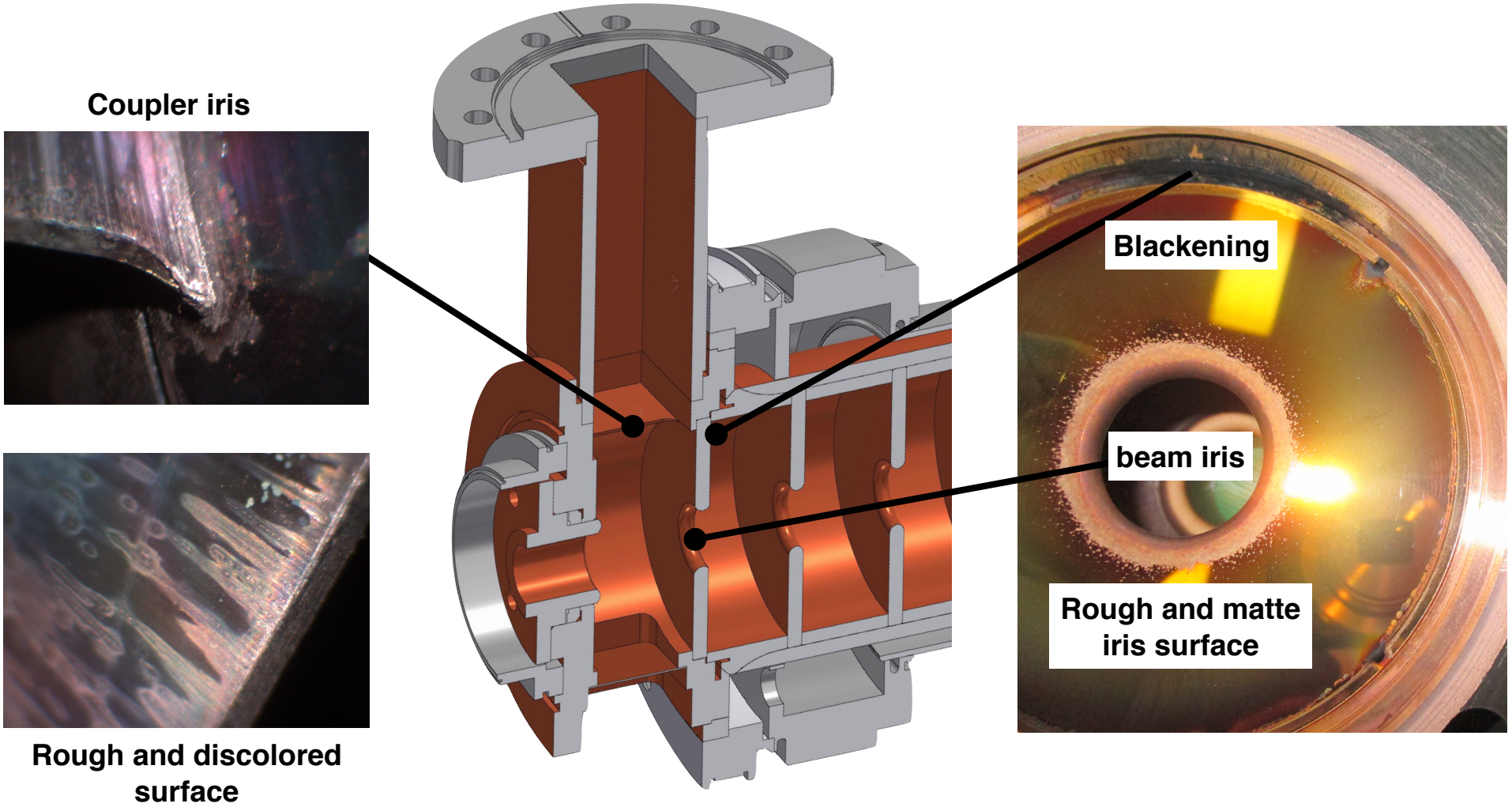
Deterioration in accelerating structure I

Many structures suffering from power reflection and/or excessive field emission



Deterioration in accelerating structure 2

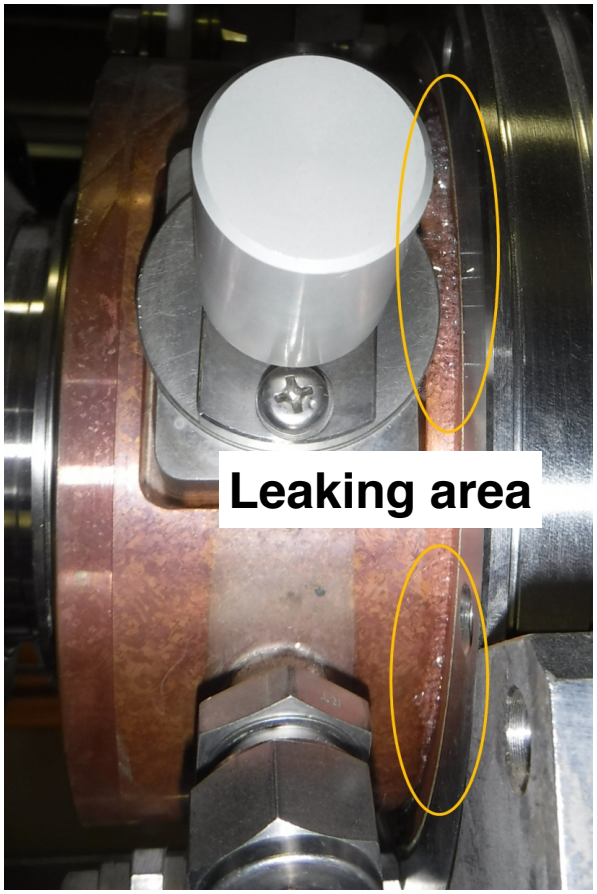
Severely damaged structure

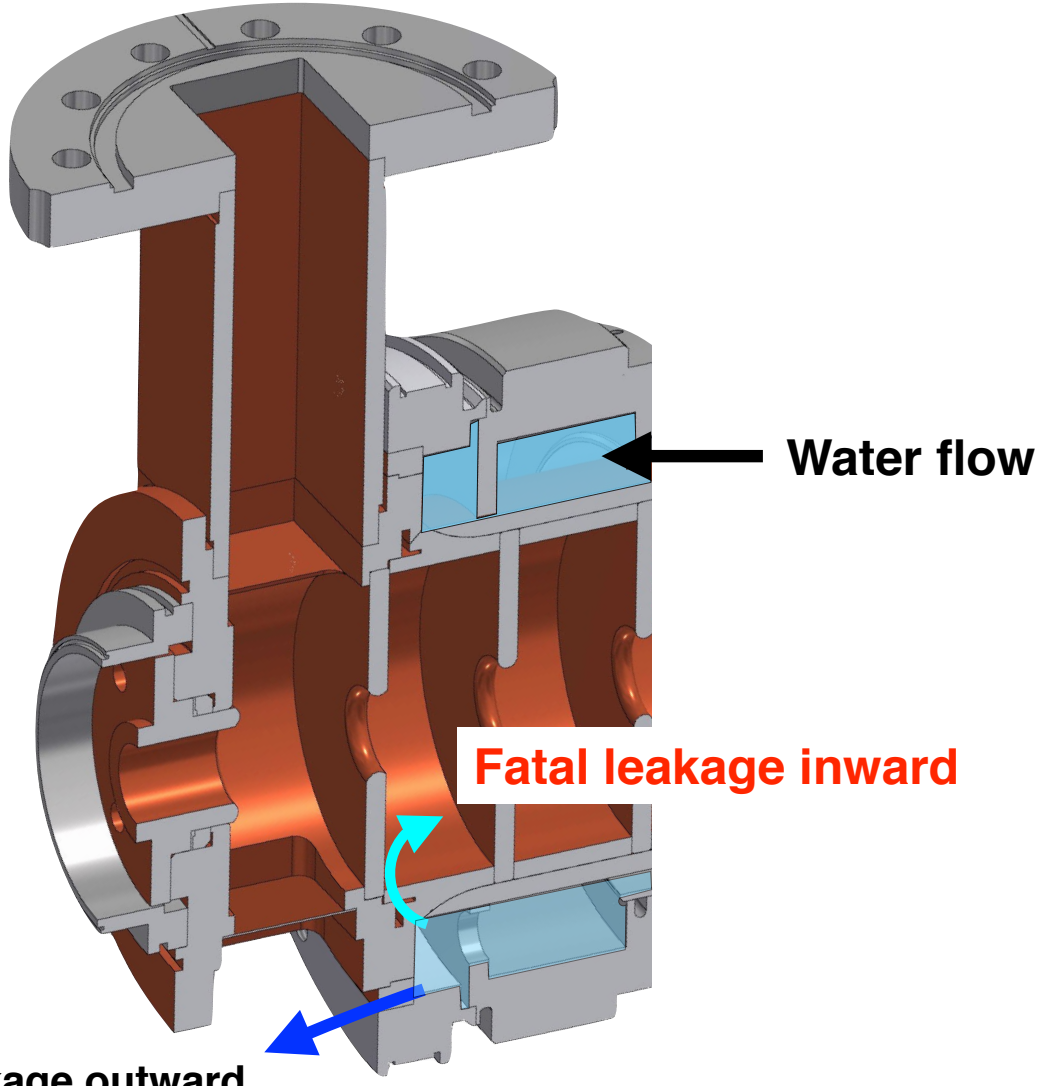


Deterioration in accelerating structure 3

Fatal case : water leakage

Water leakages occur to a few structures a year





Upgrade plan I

5-year development plan for stable operation

New S-band structures
for wiping out the markedly damaged structures

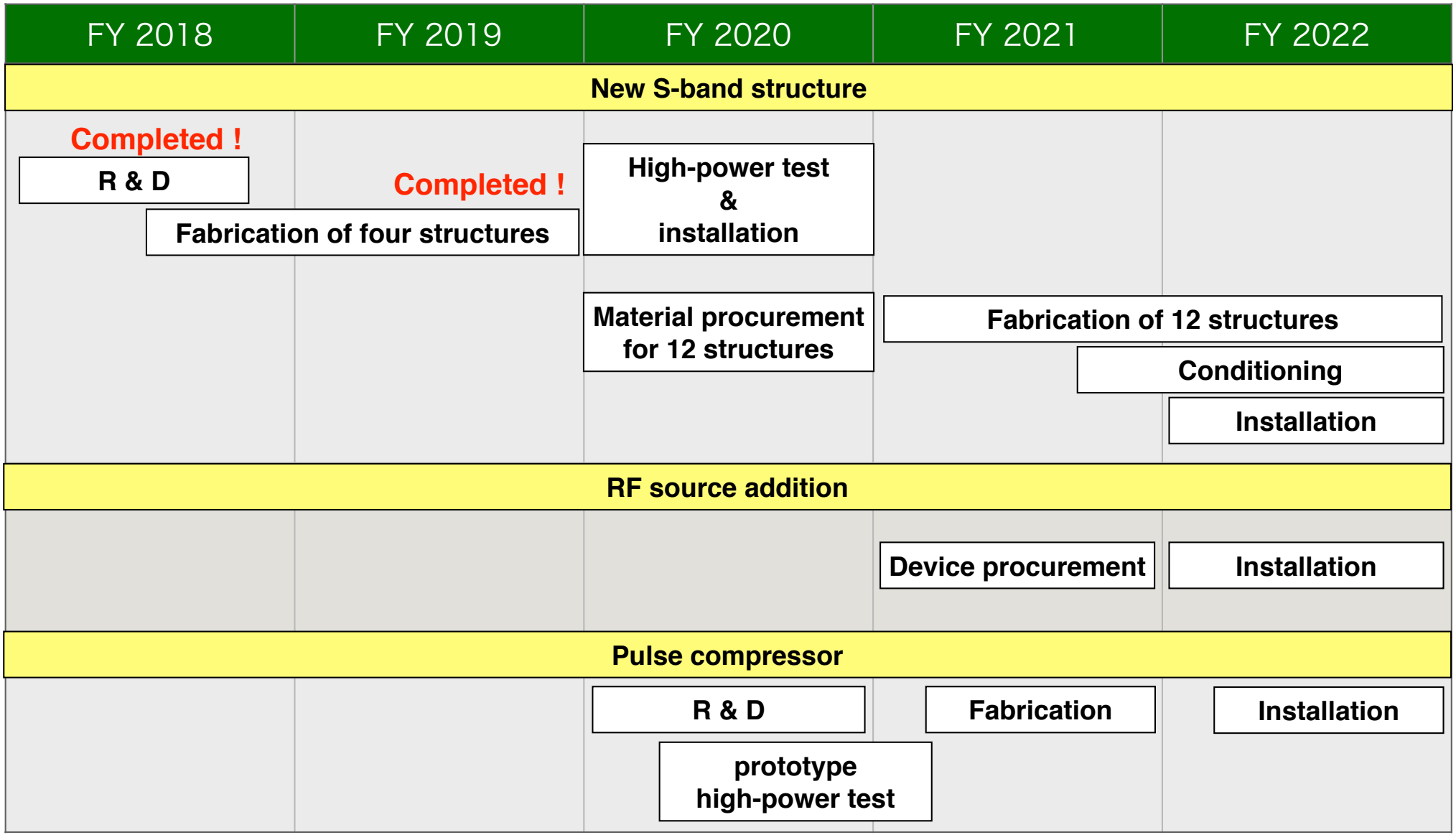
Providing an additional RF source to a special unit

Development of a new pulse compressor for the special unit

$ 4,000,000 for R&D and manufacturing 16 structures,
the pulse compressor and so on

Upgrade plan 2

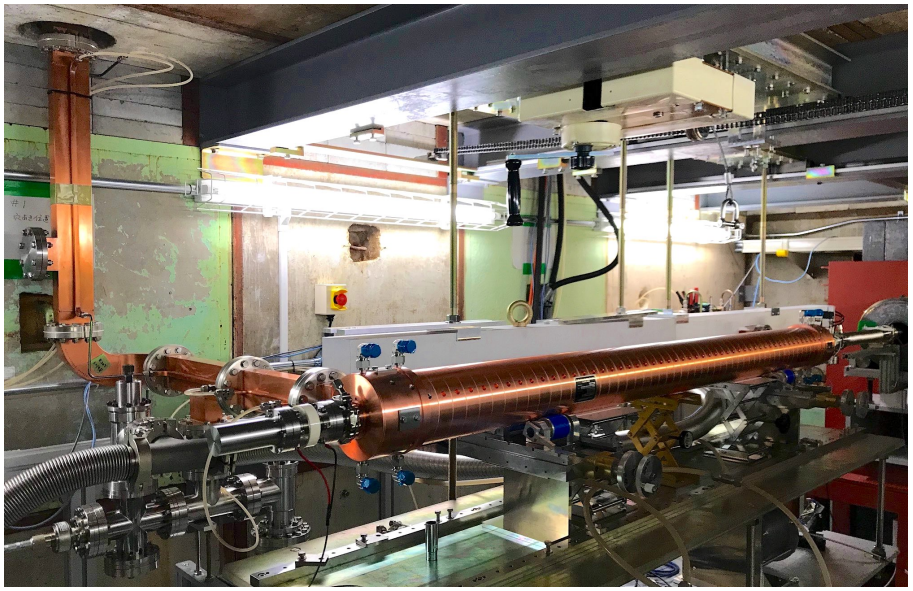
5-year schedule



Upgrade plan 3

Complete cure : new designed S-band structures

Four structures completed and under high-power tests



- **Demonstrated high-power performance as designed**
- **Stable operation at a rated power of 40 MW with extremely low breakdown**
- **Ready for mass-production**

Upgrade plan 4

Beam energy dependent on beam charge

	Low charge case	High charge case of 4 nC
HER [GeV]	7.68	7.27
LER [GeV]	4.39	4.15
Injection condition	• Long beam life • Good injection rate	• Short beam life • Bad injection rate

If we need a high charge of 4nC for injection,
the beam energy in linac reduces to 94.5% of the full energy.

Upgrade plan 5

The case of full energy acceleration but unstable

After the 5-year upgrade

	E_{CM} [GeV]	LER [GeV]	HER [GeV]	6S
Low charge injection	11.923	4.510	7.880	OK
Maximum charge injection	11.279	4.266	7.454	OK

Current status

	E_{CM} [GeV]	LER [GeV]	HER [GeV]	6S
Low charge injection	11.613	4.390	7.680	OK
Maximum charge injection	10.986	4.153	7.265	NG

Upgrade plan 6

The case giving priority to stable acceleration with two stand-by units

After the 5-year upgrade

	E_{CM} [GeV]	LER [GeV]	HER [GeV]	6S
Low charge injection	11.498	4.360	7.580	OK
Maximum charge injection	10.877	4.125	7.171	NG

Current status

	E_{CM} [GeV]	LER [GeV]	HER [GeV]	6S
Low charge injection	11.203	4.240	7.400	OK
Maximum charge injection	10.598	4.011	7.000	NG

5-year plan is necessary for the 6S operation
but insufficient for the stable operation.

Summary

- Deterioration in S-band structures progress hindering the operation of SuperKEKB
- 5-year plan wiping out the markedly bad structures
- First one of the new S-band structures tested and resulted in good performance
- Continuous manufacture of the structures indispensable for stable and sustainable operation of SuperKEKB even after the 5-year plan, especially if we should do 6S operation.
- Energy scan for the 6S operation dependent on not only the Linac status but also the life time in the storage ring and the beam injection rate.