

Approach to the more stable injector linac for SuperKEKB

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on behalf of the electron/positron injector linac

B2GM, June 17, 2019

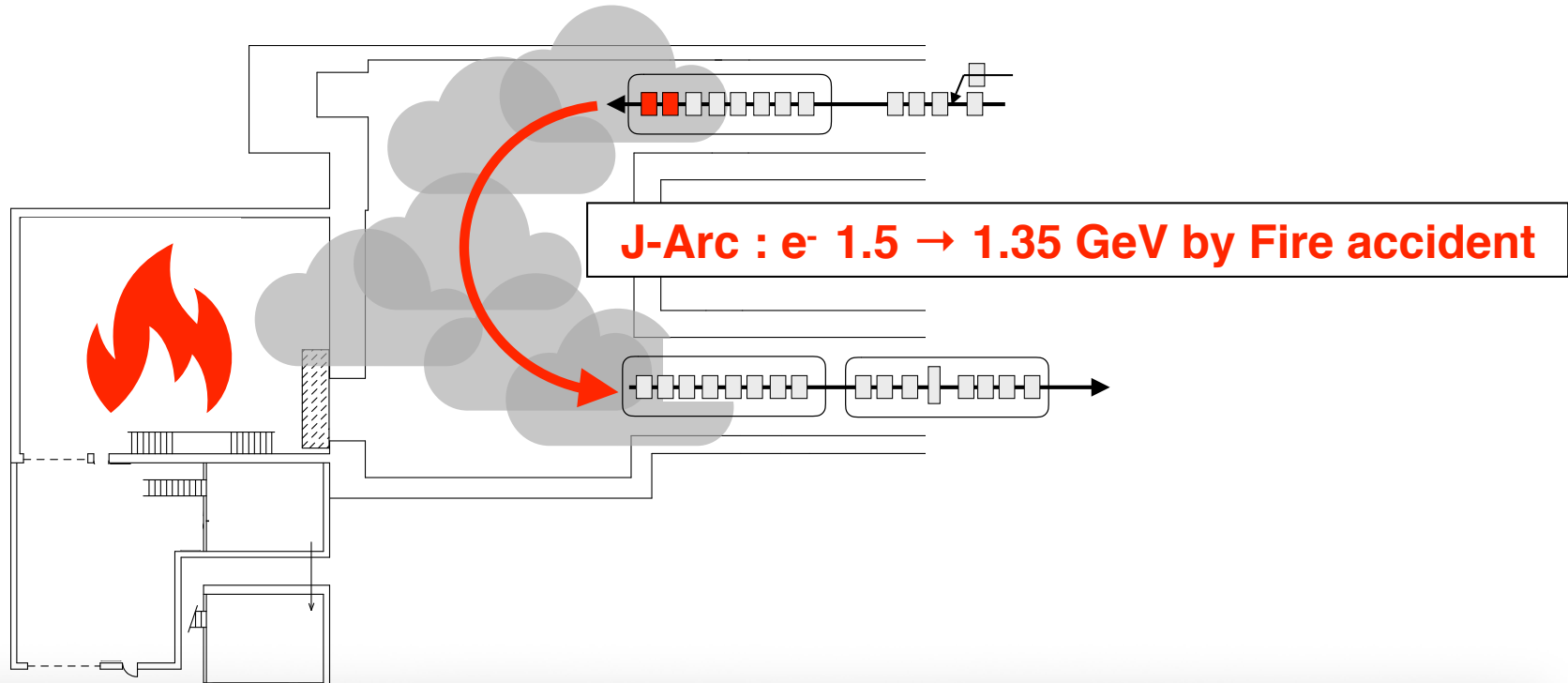
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- Summary

Fire accident

Fire in Accelerator assembly hall (Nextef)

Severe damages to the linac components in B- and C-sectors by soot attacks

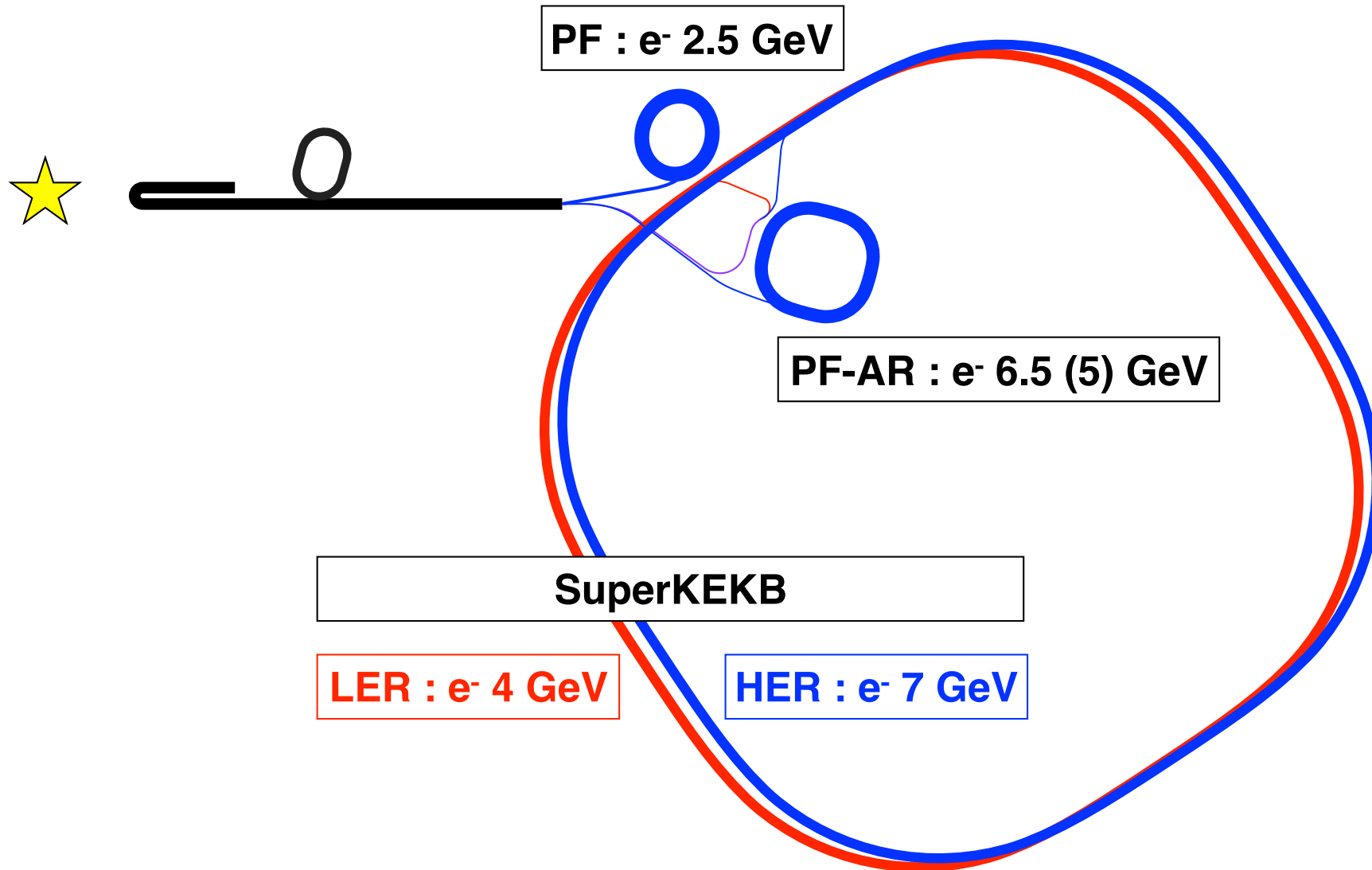


First-aid procedures done
Entire recovery of Linac in this summer
for bending-magnet power-supplies and B-7,8 modulators

Assembly hall under recovery

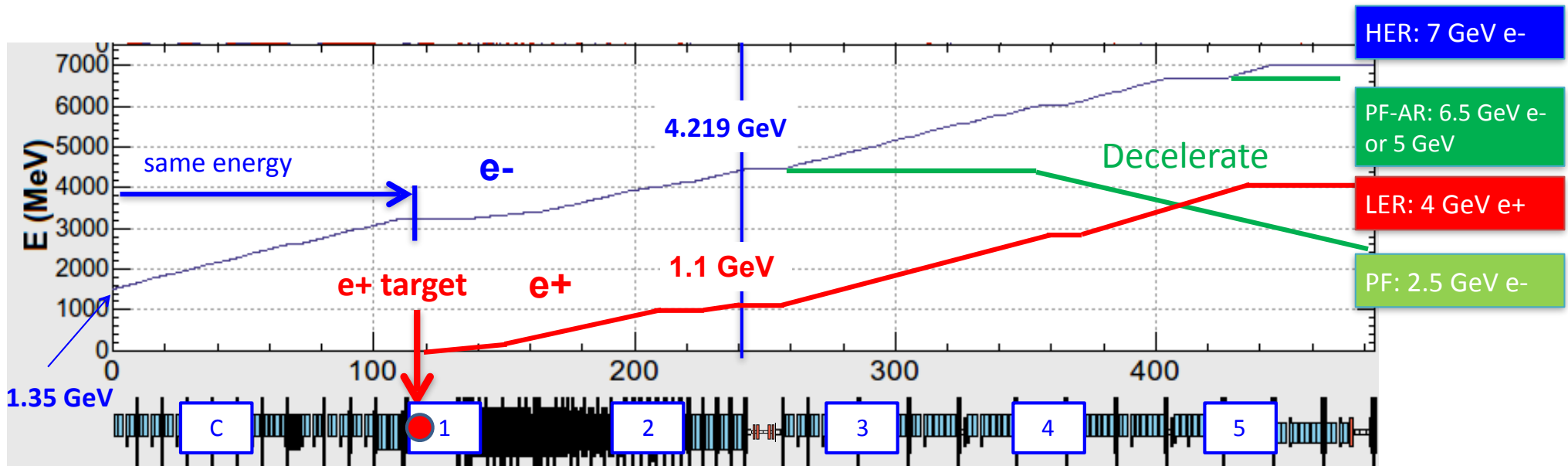
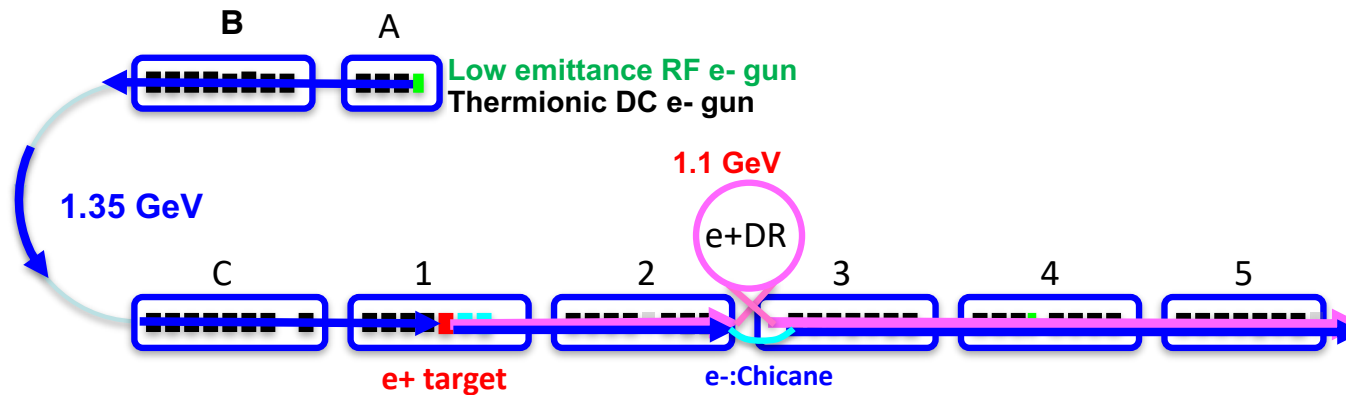
Top-up beam operation I

Top-up beam injection for four storage rings



Top-up beam operation 2

- Photocathode RF gun for **HER** injection
- Thermionic gun for **LER**, PF, PF-AR injection



by courtesy of M. Satoh

Top-up beam operation 2

Pulse to pulse switching:
rf e- gun/thermionic e- gun

Thermionic DC e- gun (GU_AT)

- e+ production e-: 10 nC (for LER injection)
- e- study/HER injection: 1 nC
- PF injection: 0.3 nC
- PF-AR injection: 0.3 nC

RF e- gun

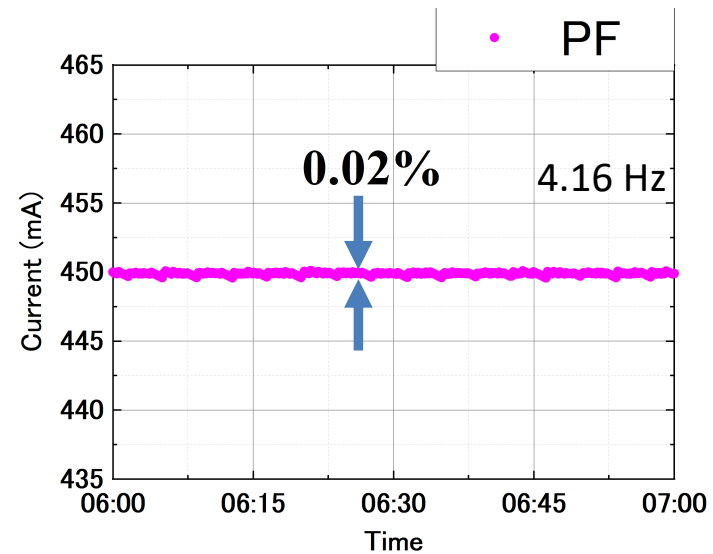
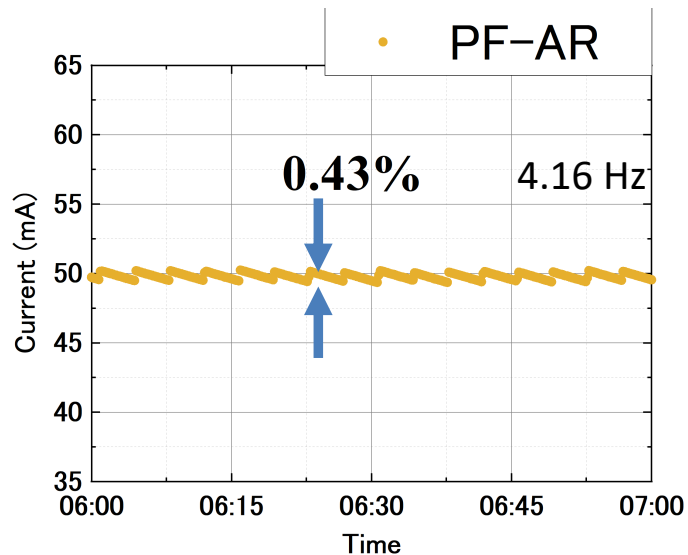
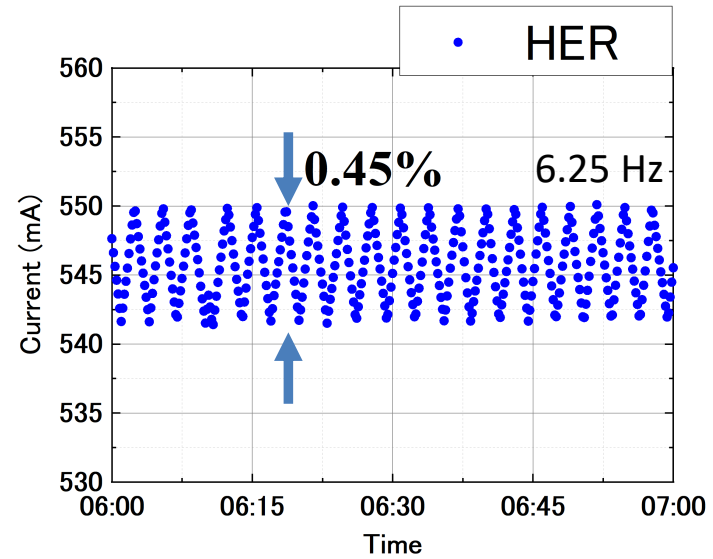
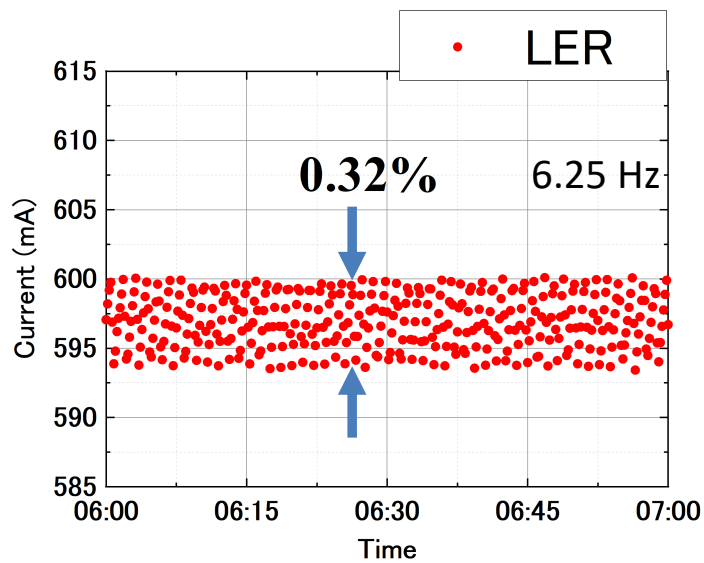
(GR_A1 for HER injection)

Pulsed bends for simultaneous top up
(since 2018 summer)

by courtesy of M. Satoh

Top-up beam operation 3

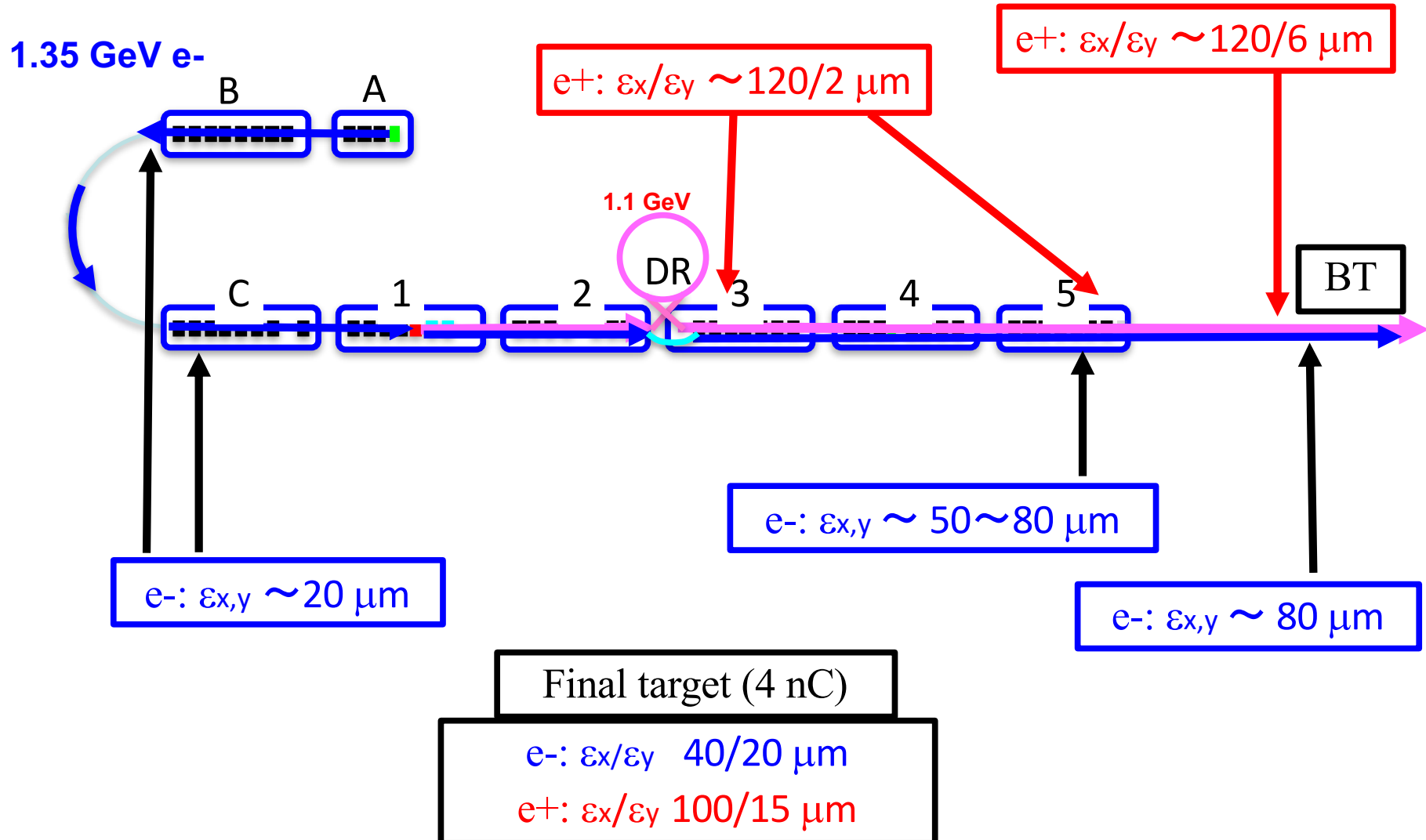
Stored current stability during simultaneous top-up



by courtesy of M. Satoh

Top-up beam operation 4

Emittance measurements (1 nC) with multiple wire scanners



by courtesy of M. Satoh

Top-up beam operation 5

- **Unstable beam-emittance growth**

→ **Increase in background noise to SuperKEKB**

Electron beam orbit jitters by dispersion leakage from J-arc

Dispersion correction and Q-magnet adjustment

Unexpected change of dispersion in the sectors after the J-arc

Orbit feedback

Horizontal dispersion leak to the accelerating structures in ECS of SY3

Introduce of curing Q-magnet

Details will be reported in the next B2GM

Deterioration in accelerating structure I

Main PF-type accelerating structures
fabricated about 35 years ago

don't work well



Mean RF parameters of the PF-type structures

r_a [M Ω /m]	57.8 (57.3 - 58.3)
τ [neper]	0.335 (0.302 - 0.368)
T_f [μ s]	0.51 (0.462 - 0.558)
$V_a/P^{1/2}$ [MV/MW ^{1/2}]	7.29 (7.00 - 7.58)

Deterioration in accelerating structure 2

Designed performance of the accelerating unit

SLED output
140 MW(mean) 0.5 us

Klystron output
40 MW 4 us

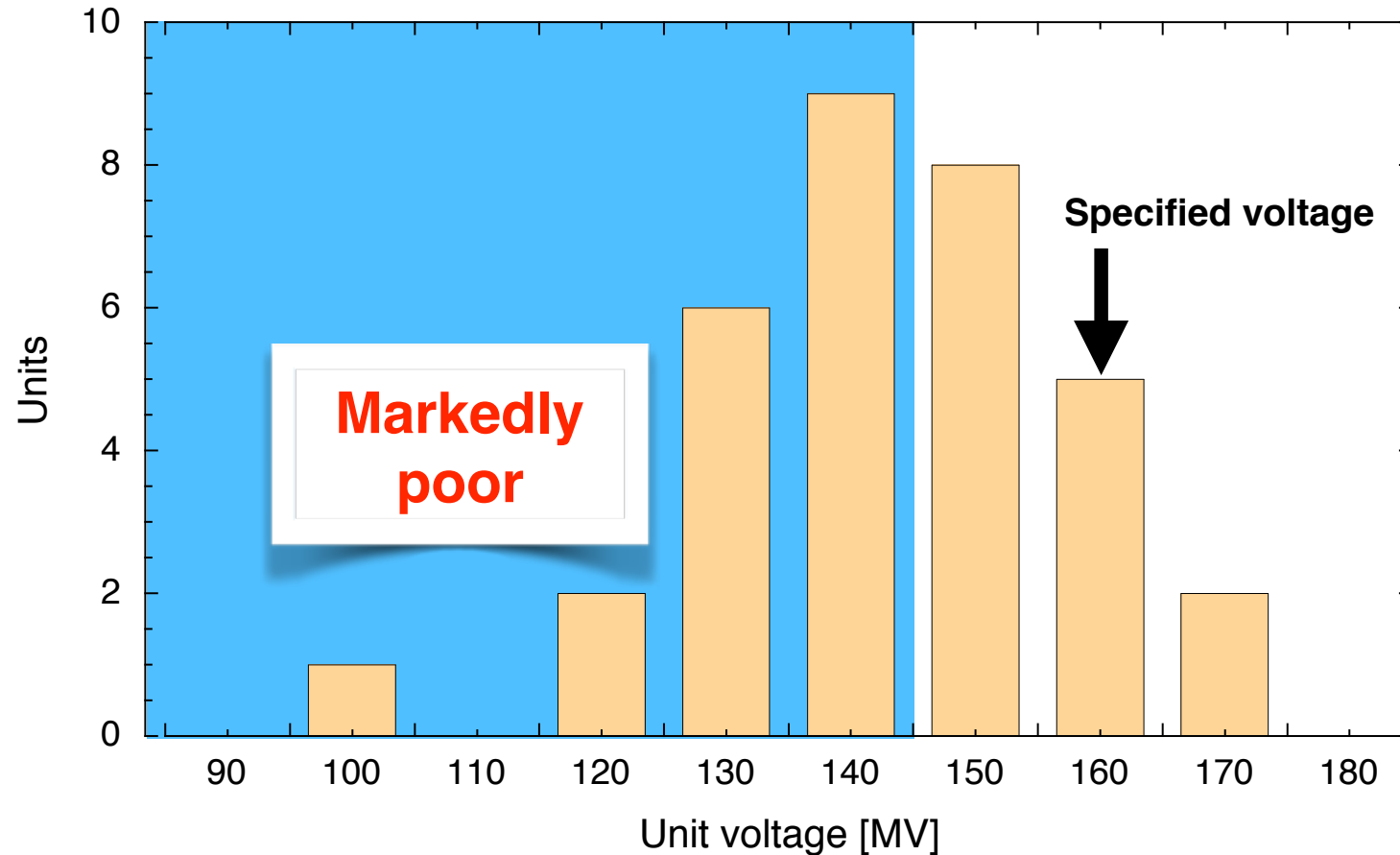
Waveguides
~10% power loss

$V_a = 160$ MV (21 MV/m)
by four structures



Deterioration in accelerating structure 3

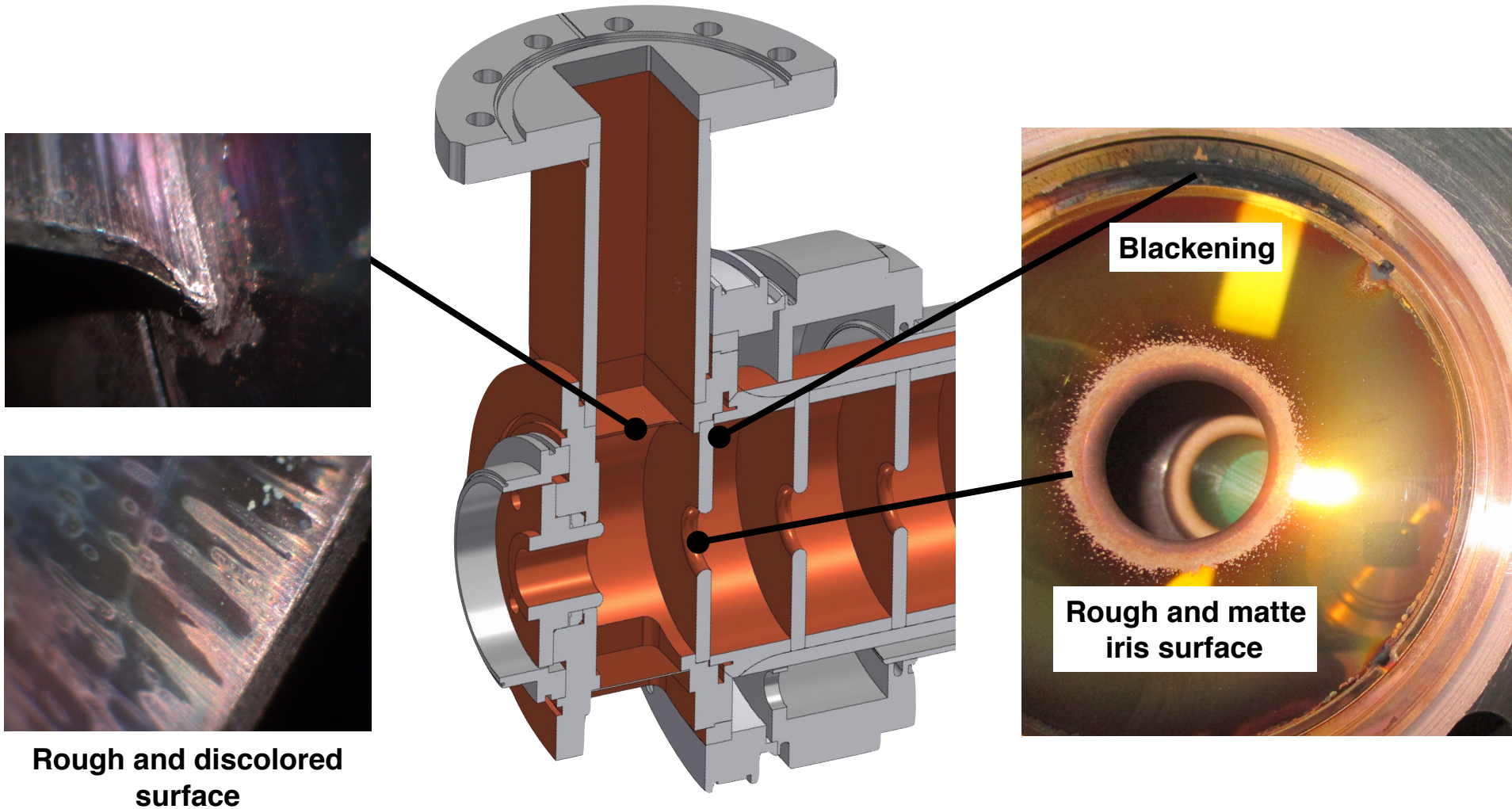
Many structures suffering from power reflection and/or excessive field emission



What's wrong with the structures?

Deterioration in accelerating structure 4

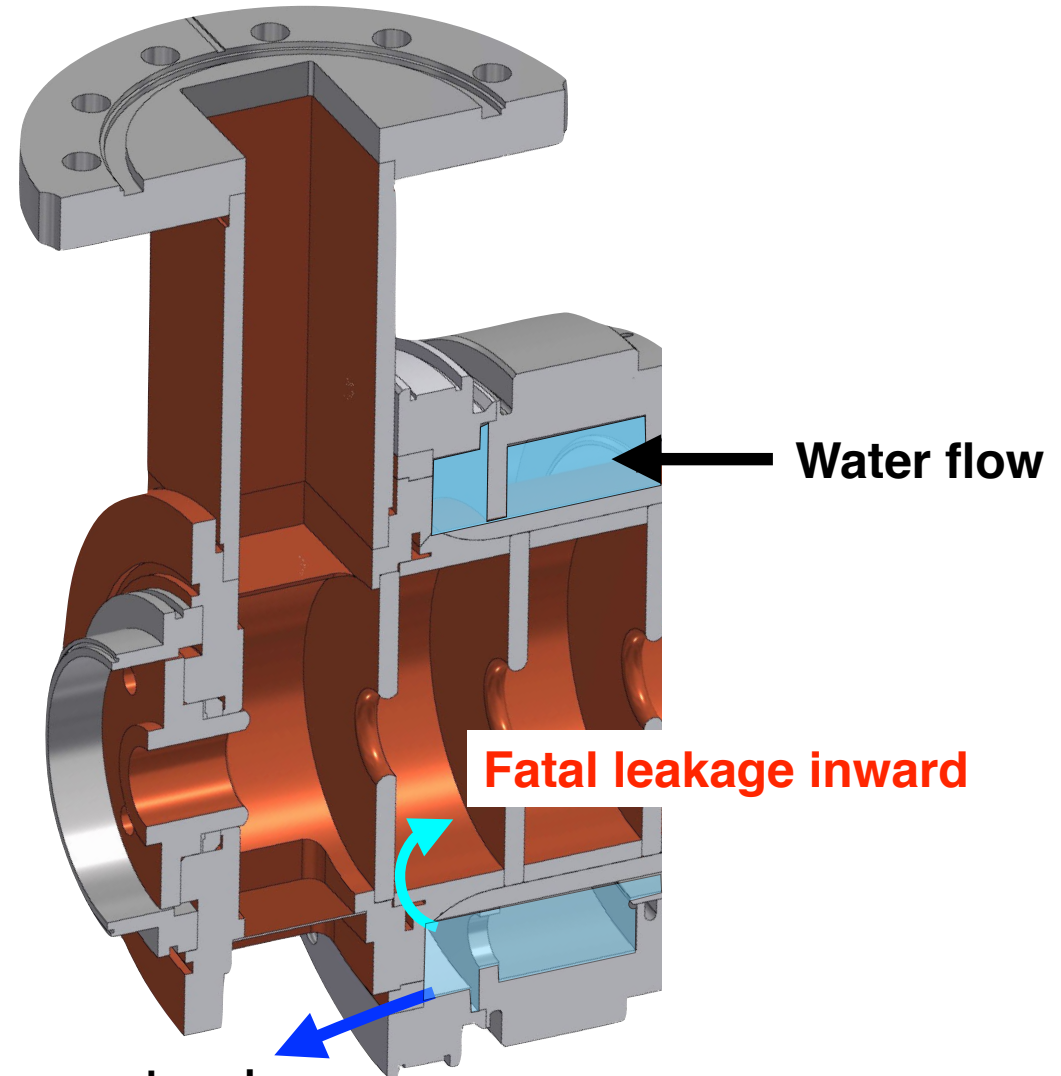
The couplers severely damaged !



Deterioration in accelerating structure 5

Fatal case : water leakage

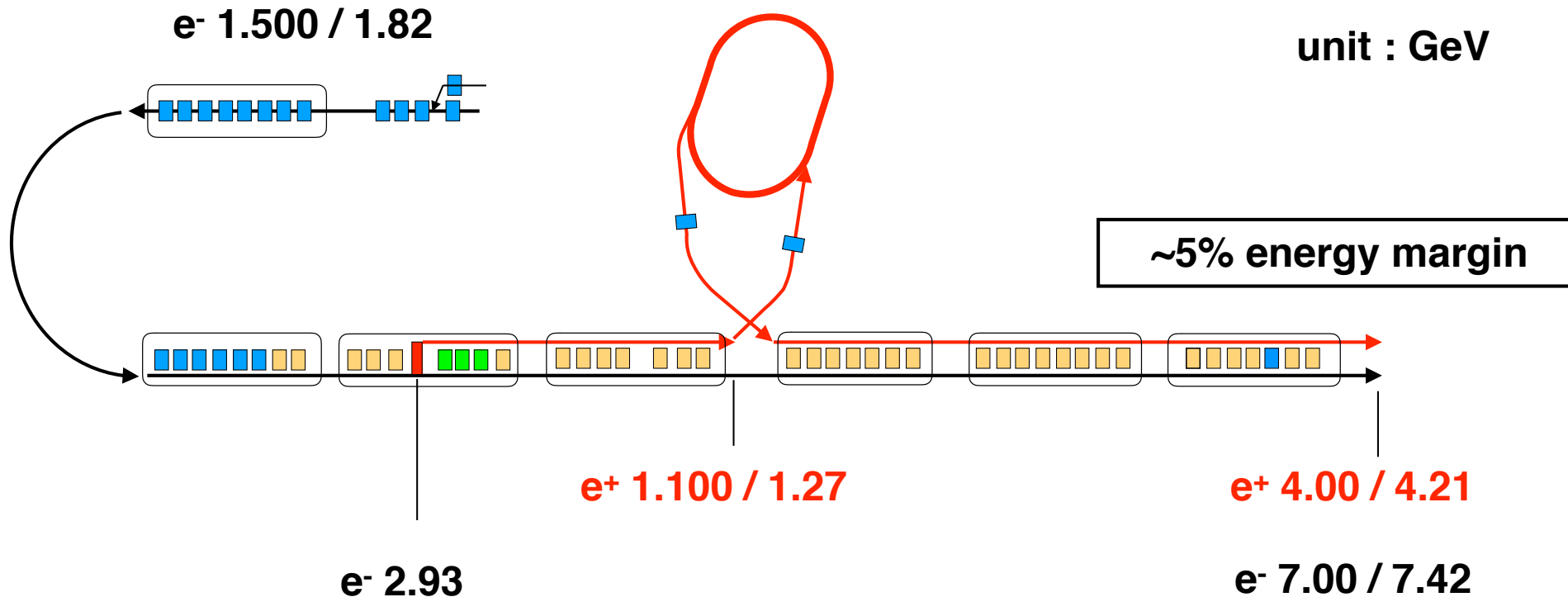
Approximately three structures with water leak a year



Leakage outward
makeshift repair with sealants

Deterioration in accelerating structure 6

Energy map required energy and available maximum energy



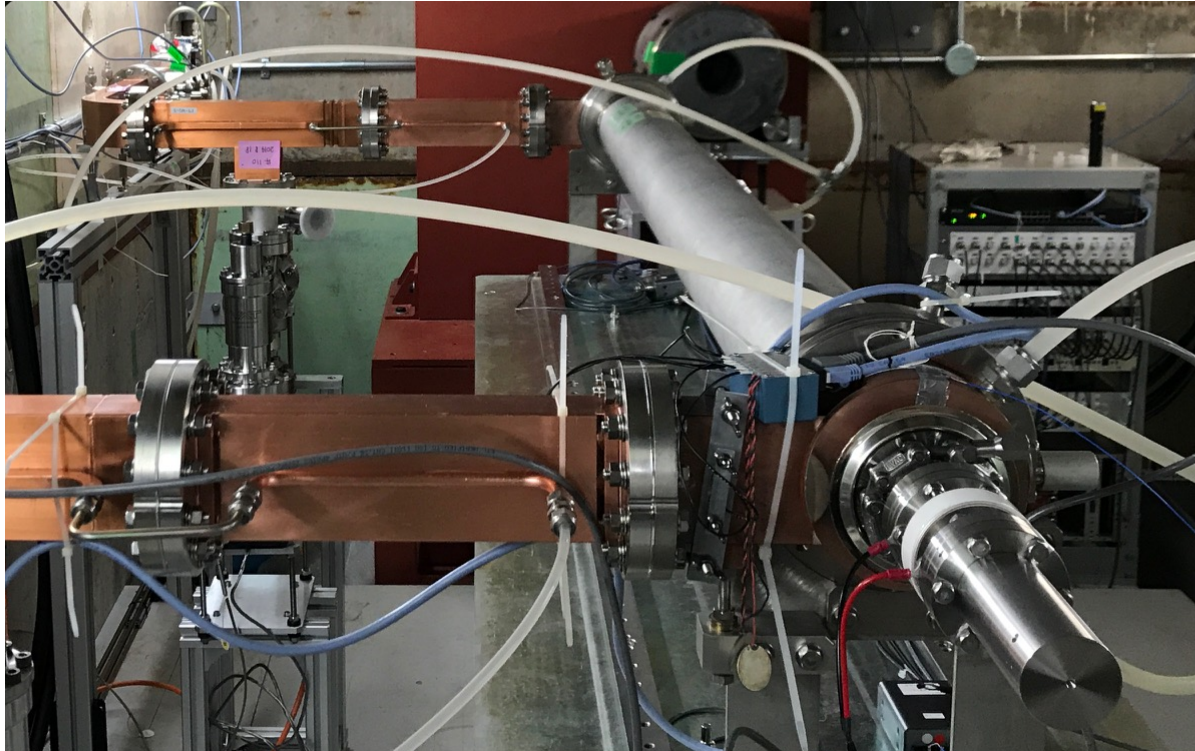
No energy margin for the 6S operation at

e^+ 4.17 and e^- 7.29

with a beam charge of 4 nC

How do we tackle the problem ?

No sound spare of PF-type structures



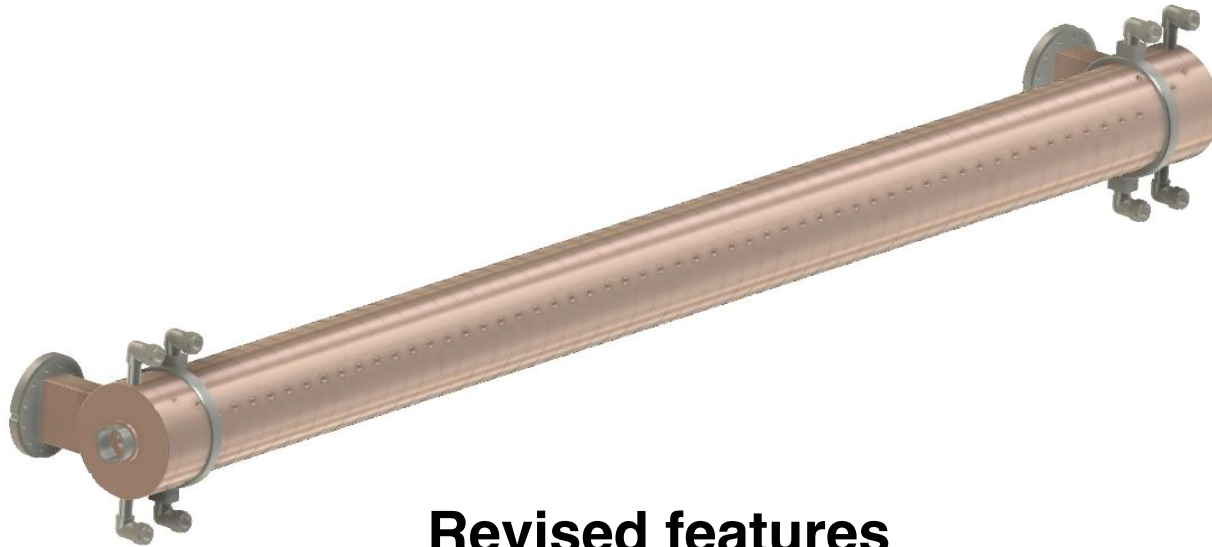
Spare structure under high-power check in the shield room

Spares also suffer from power reflection and excessive field emission

How do we tackle the problem ?

Complete cure : new designed S-band structures

Four structures under fabrication and coming in this FY



Revised features

Aiming unit voltage over 180 MV with new structures

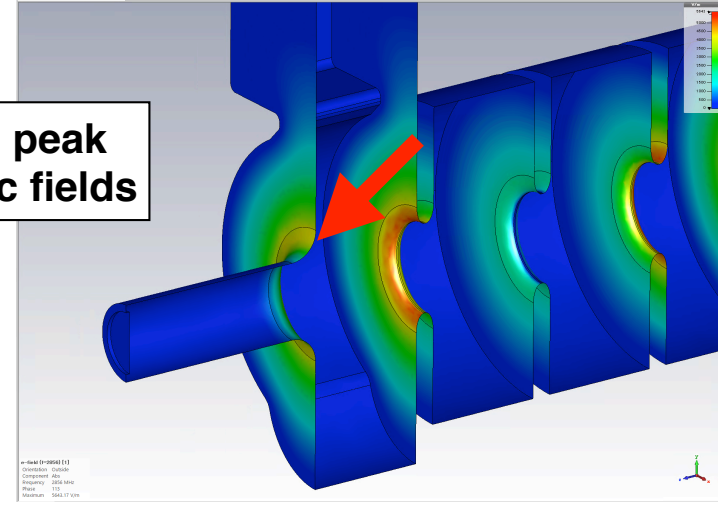
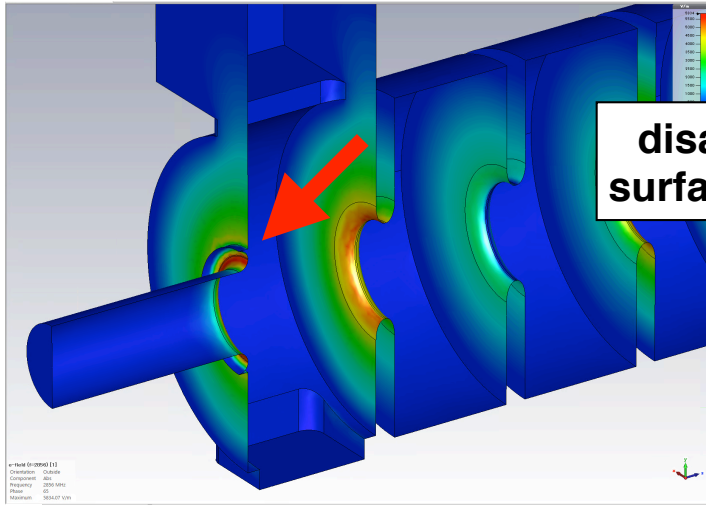
Newly designed coupler and cell-shape lowering strength of surface electric field and possibility of discharge

How do we tackle the problem ?

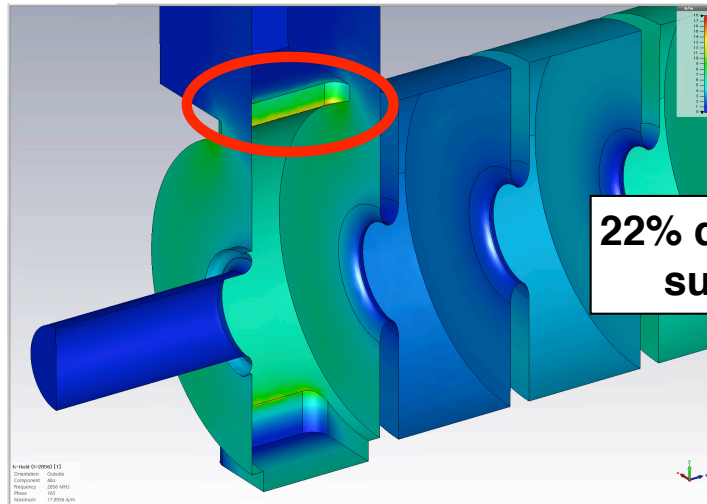
Old type coupler

New designed coupler

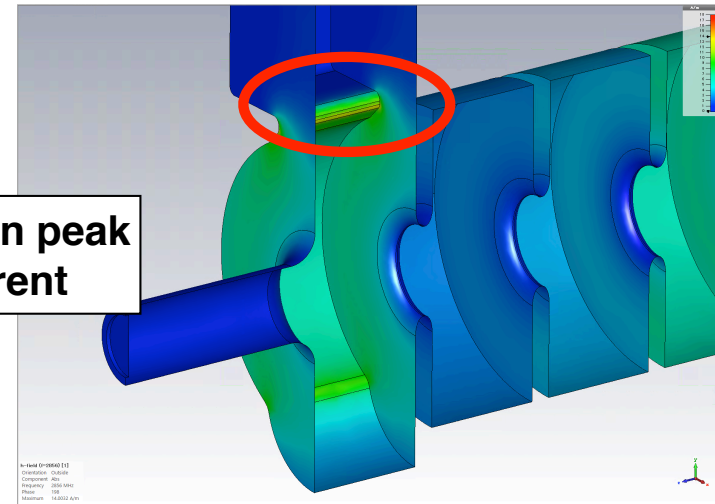
Electric field



Wall current



22% decrease in peak surface current



Summary

- First-aid procedures from the fire accident
Entire recovery in this summer
- Simultaneous top-up beam distribution to four storage rings by pulse-to-pulse switching
- Markedly deterioration of PF-type S-band structures threatening the operation of SuperKEKB
- New S-band structures coming in this FY
Continuous manufacture indispensable for stable and sustainable operation of SuperKEKB