C-band linac progress (accelerating section)

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Accelerating section for SuperKEKB

Target field gradient = 42 MV/m
for e^+ 8 GeV injection

Available power from klystron =
40 MW in 2.0 μs duration
(--> 34.4 MW with 14% wave guide loss)
for each 4.8 m accelerator length

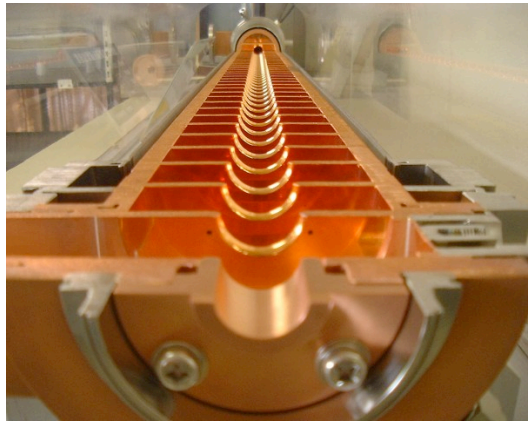
RF pulse compression = 3.4 times peak power
for each klystron

R & D strategy of accel. section

1. No special cure considered against multi-bunch wake field effect (like damped structure or choke mode cavity) because
   - the number of bunch is at most 2
   - e^+ bunch intensity is low (1.2 nC)
   - bunch interval is long (96 ns)

2. An accelerating section whose dimension is 1/2-scale of that of the present S-band section is adopted as a first prototype in order to take the shortest path to the high power test of all the components in the C-band accelerator module.

KEKB S-band accel. section

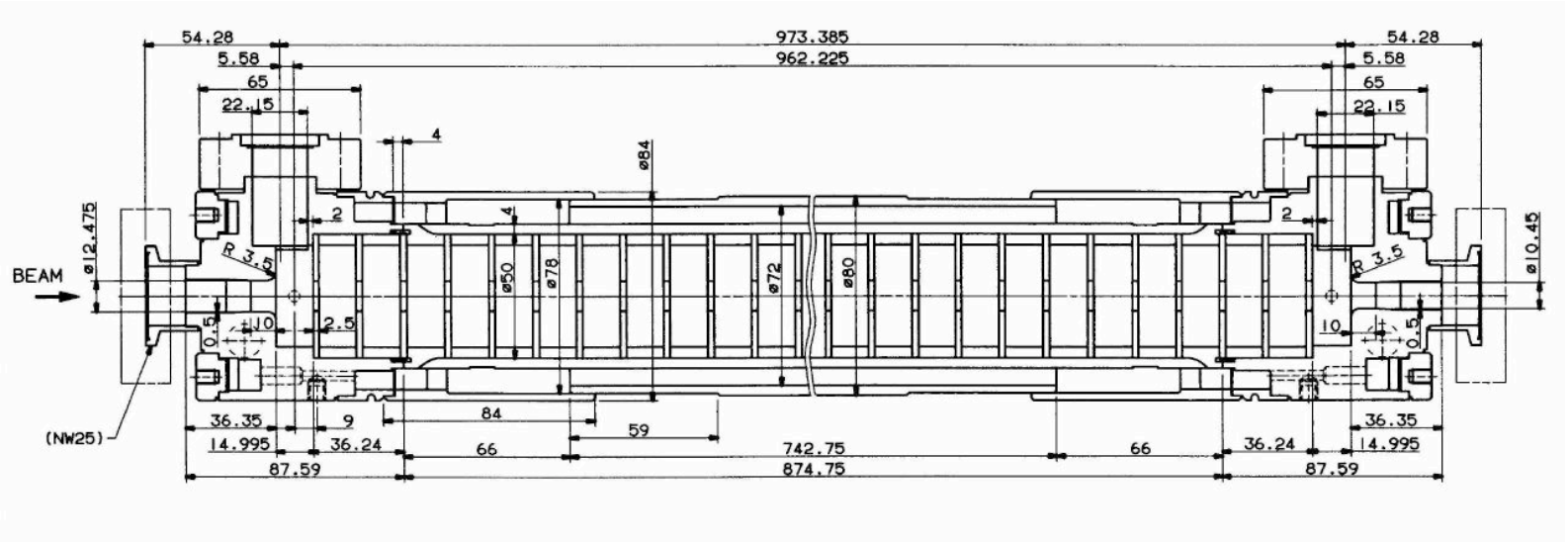


- S-band (2856 MHz)
  at 30 degC temperature
- traveling-wave, disk-loaded structure
- 2/3-π phase advance per cell
- 54 regular cells (2m-long)
- quasi-constant gradient
- formed by cupper electroplating (Not by brazing !)
- average field gradient ~ 21 MV/m with klystron output power of 41 MW x 4 μs, multiplied x3.4 by SLED and divided into 4 sections
- typical aperture (iris diameter) ~ 20 mm

C-band accel. section (First prototype)

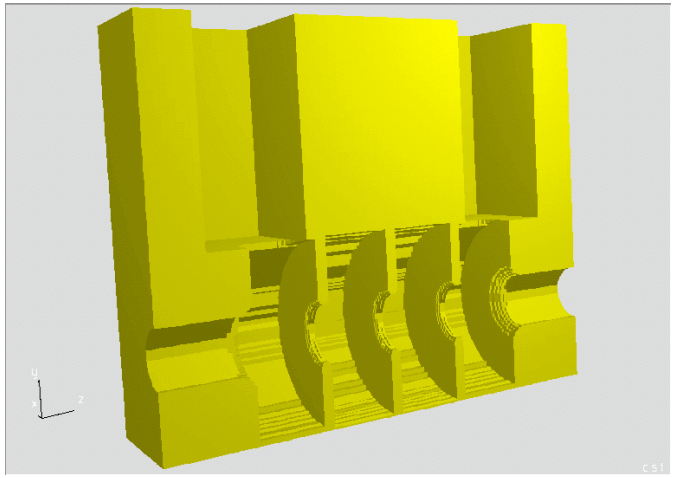
54 regular cells	1m-long			
iris diameter 2a:	12.44	~	10.41	mm
group velocity v_g:	1.9	~	1.0	%
shunt impedance r_0:	74.8	~	85.3	MΩ/m
field gradient E_{acc}:	41.2	~	39.0	MV/m

(assuming 40 MW klystron power)

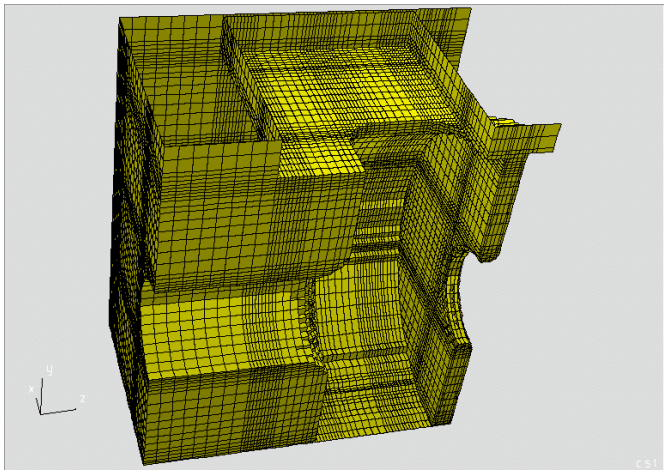


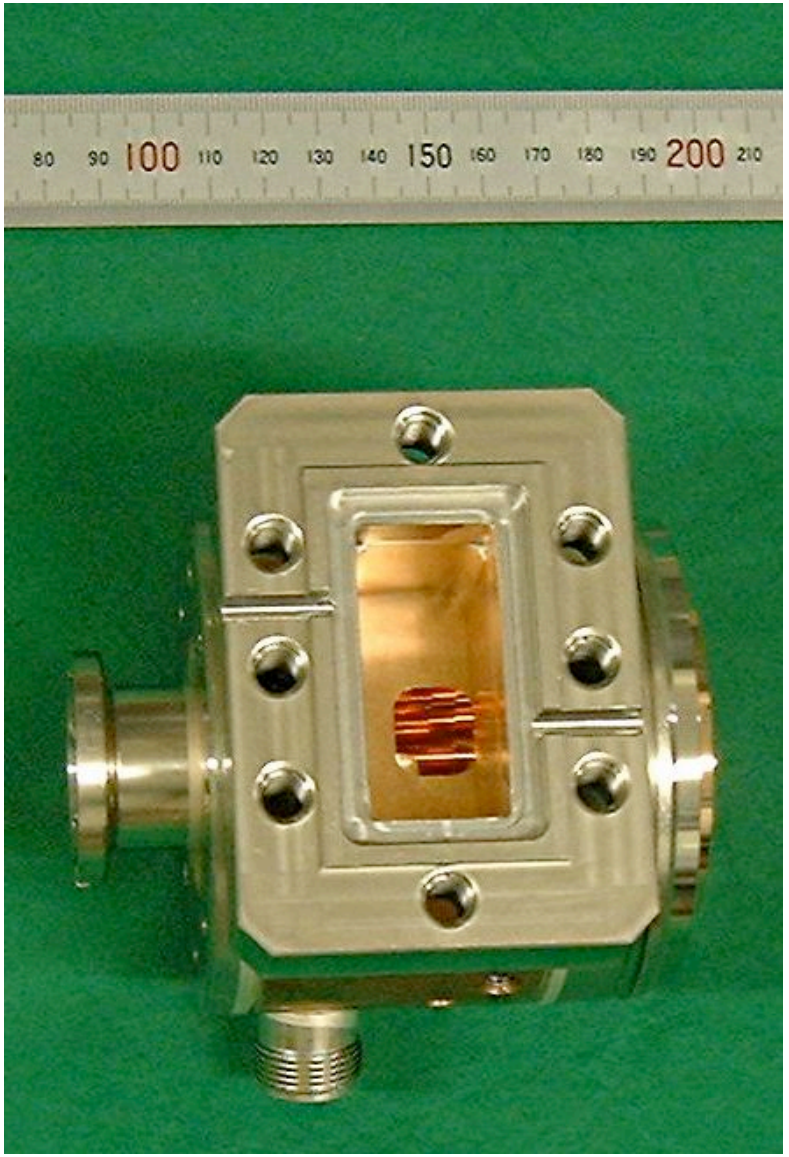
Filling Time t_F = 234 nsec
Attn. Constant τ = 0.434

Coupler

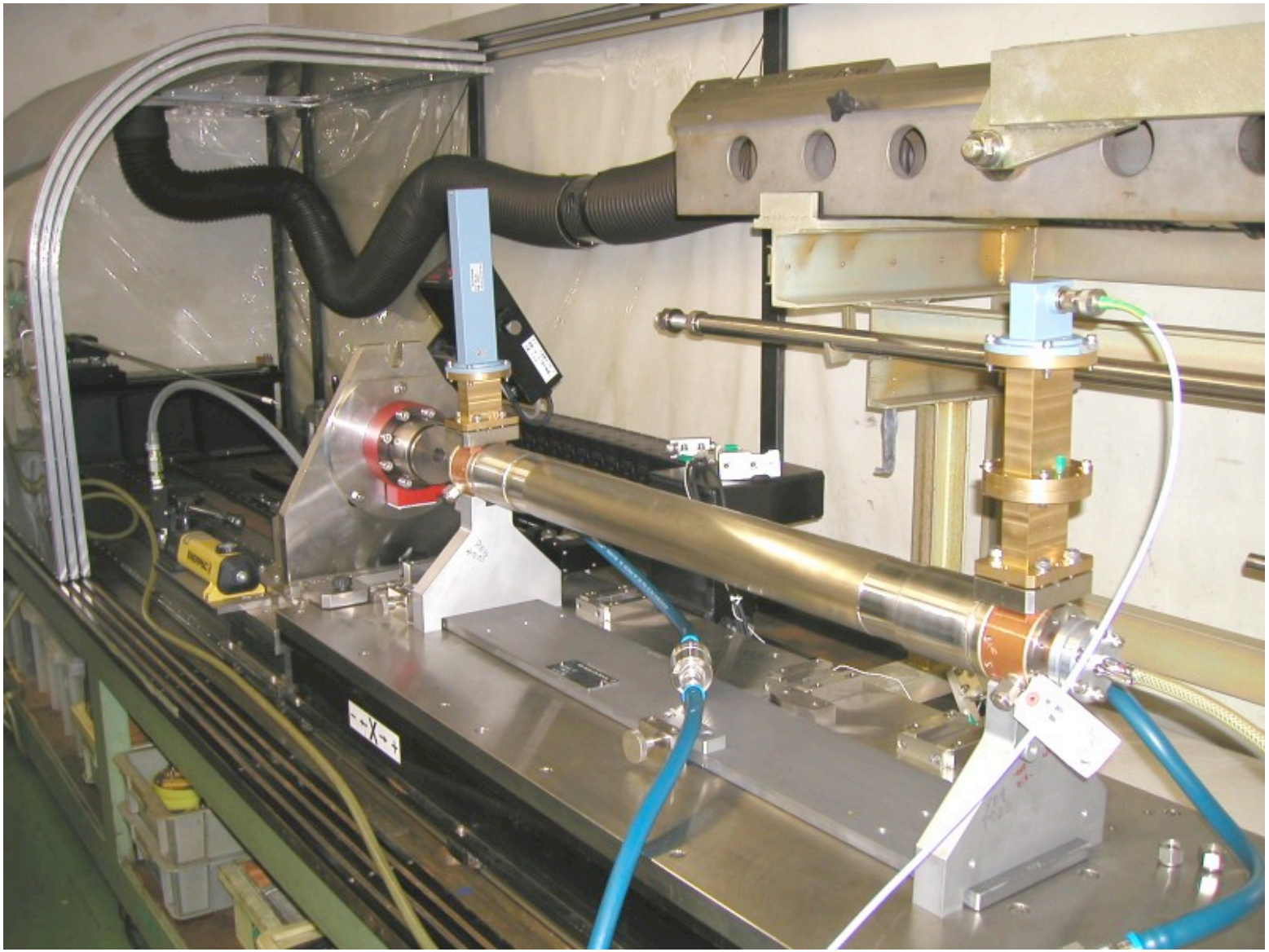


thin and sharp-edged coupler-iris



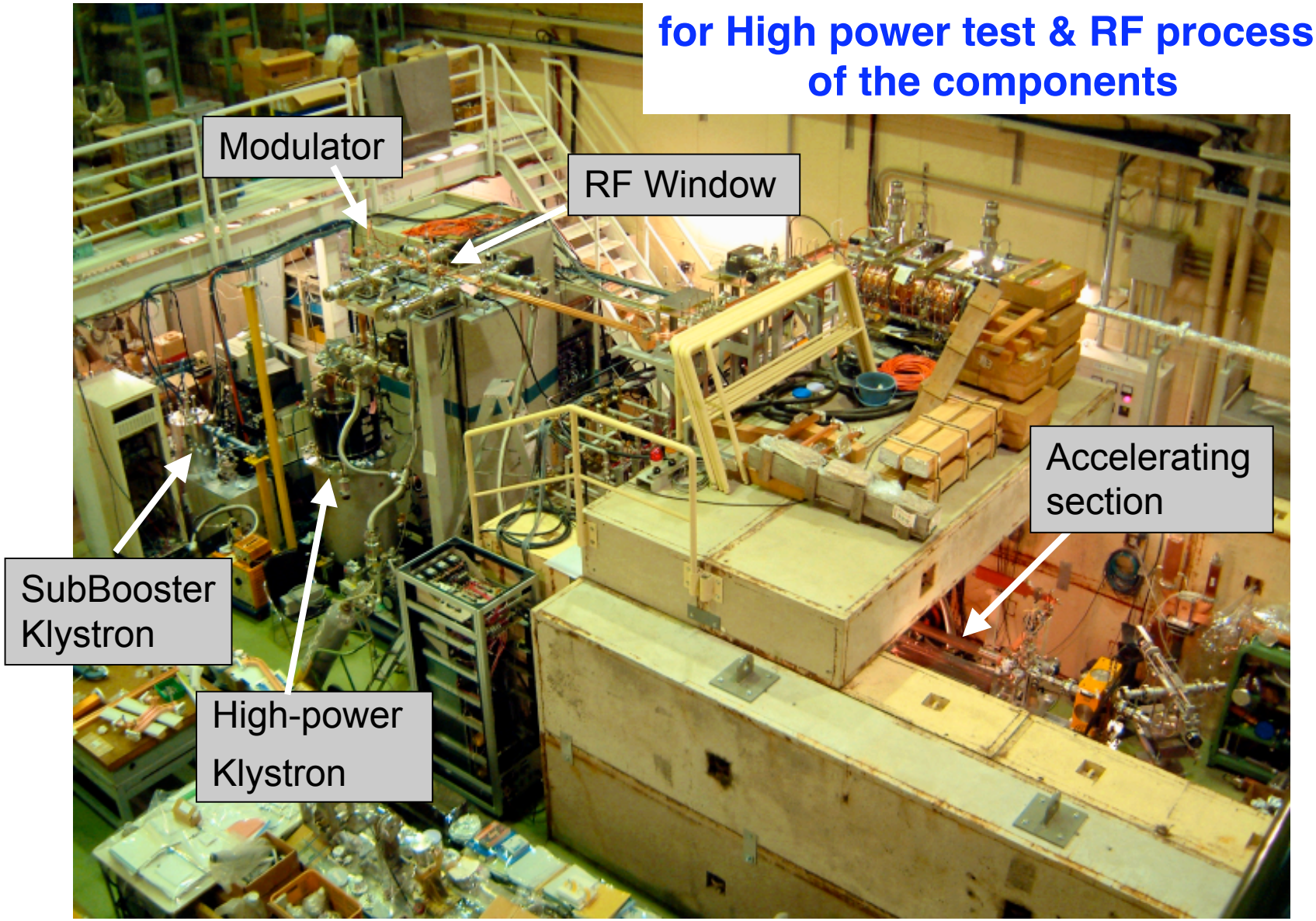


fabricated 1m-long section

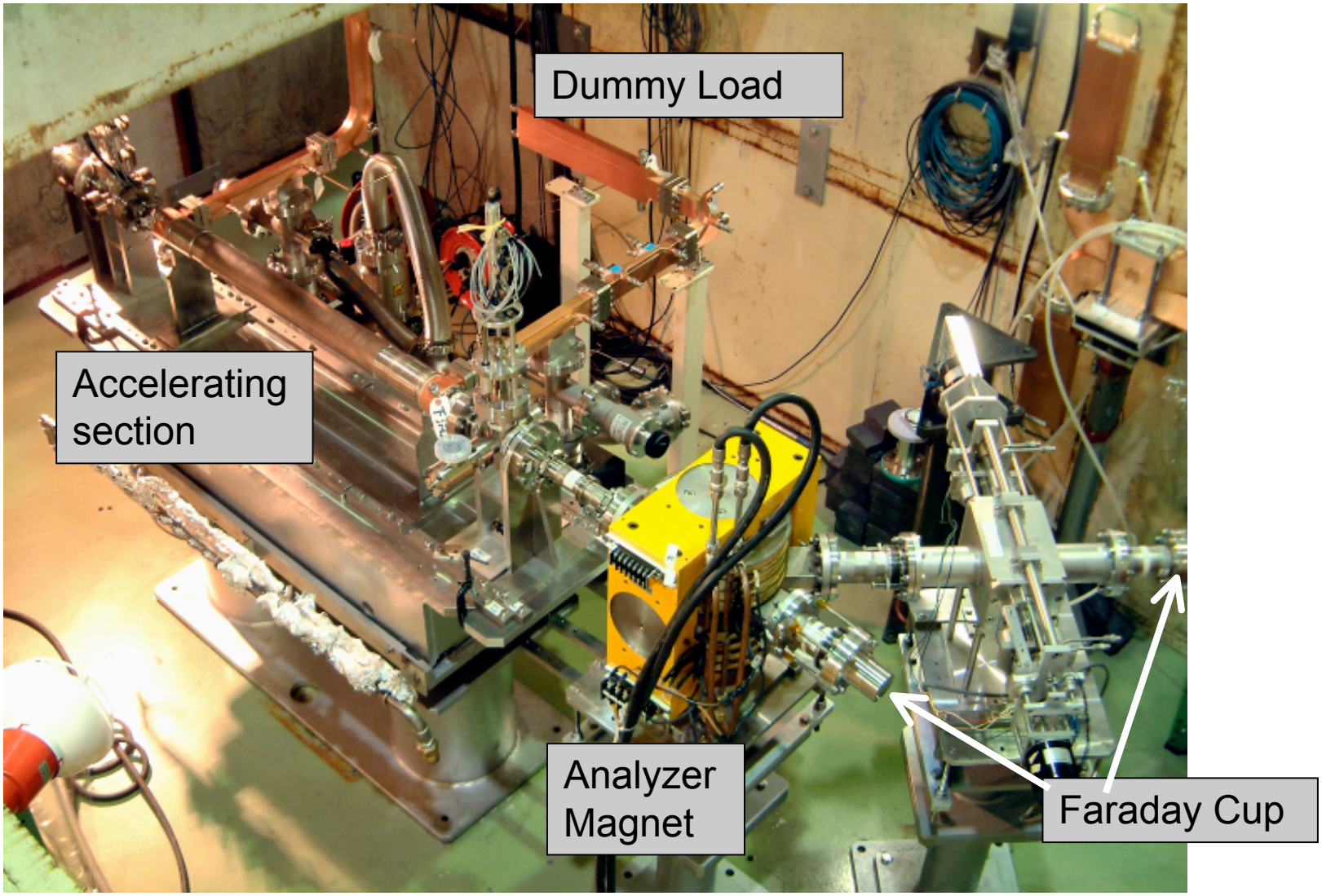


C-band Test Stand

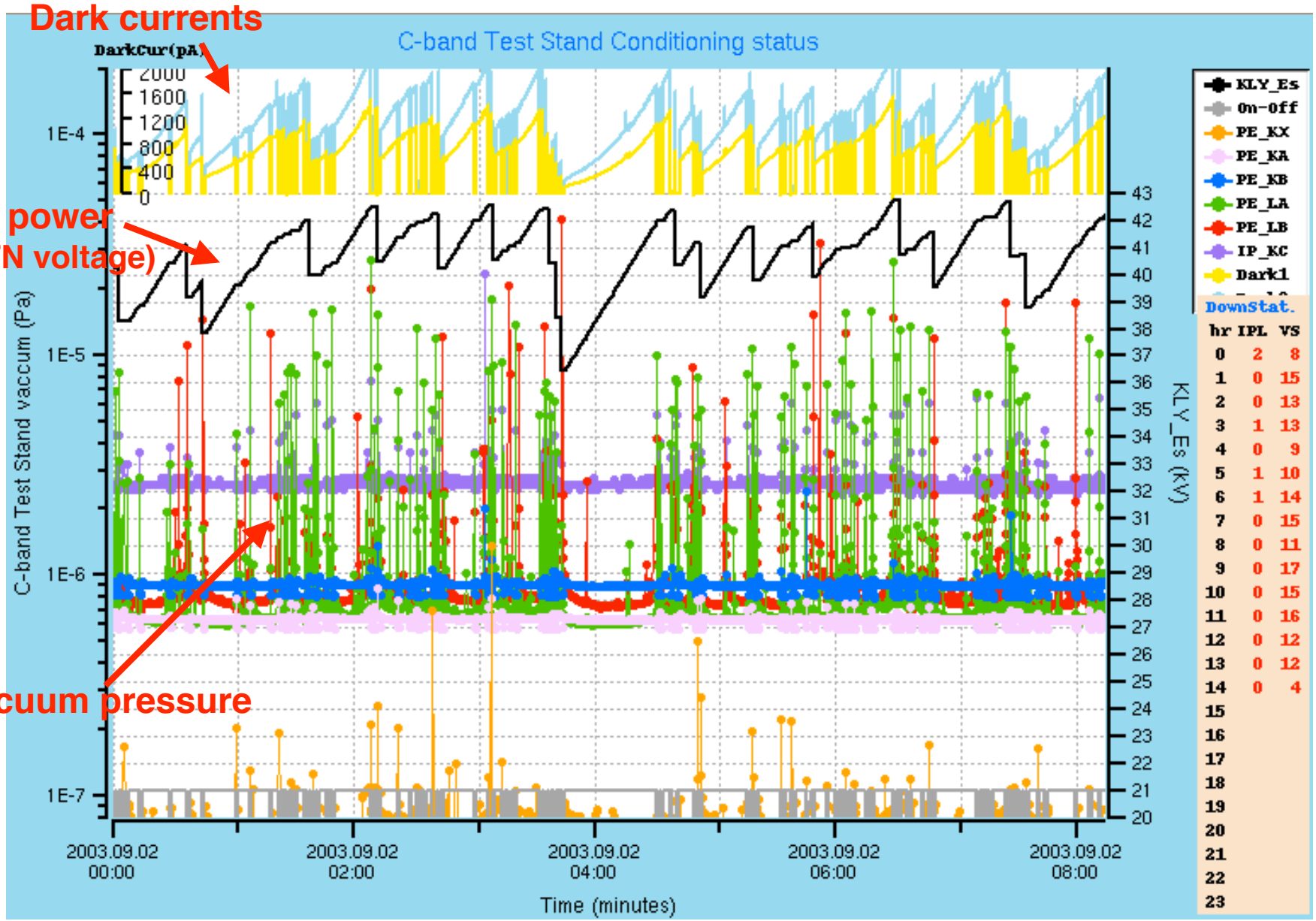
for High power test & RF processing of the components



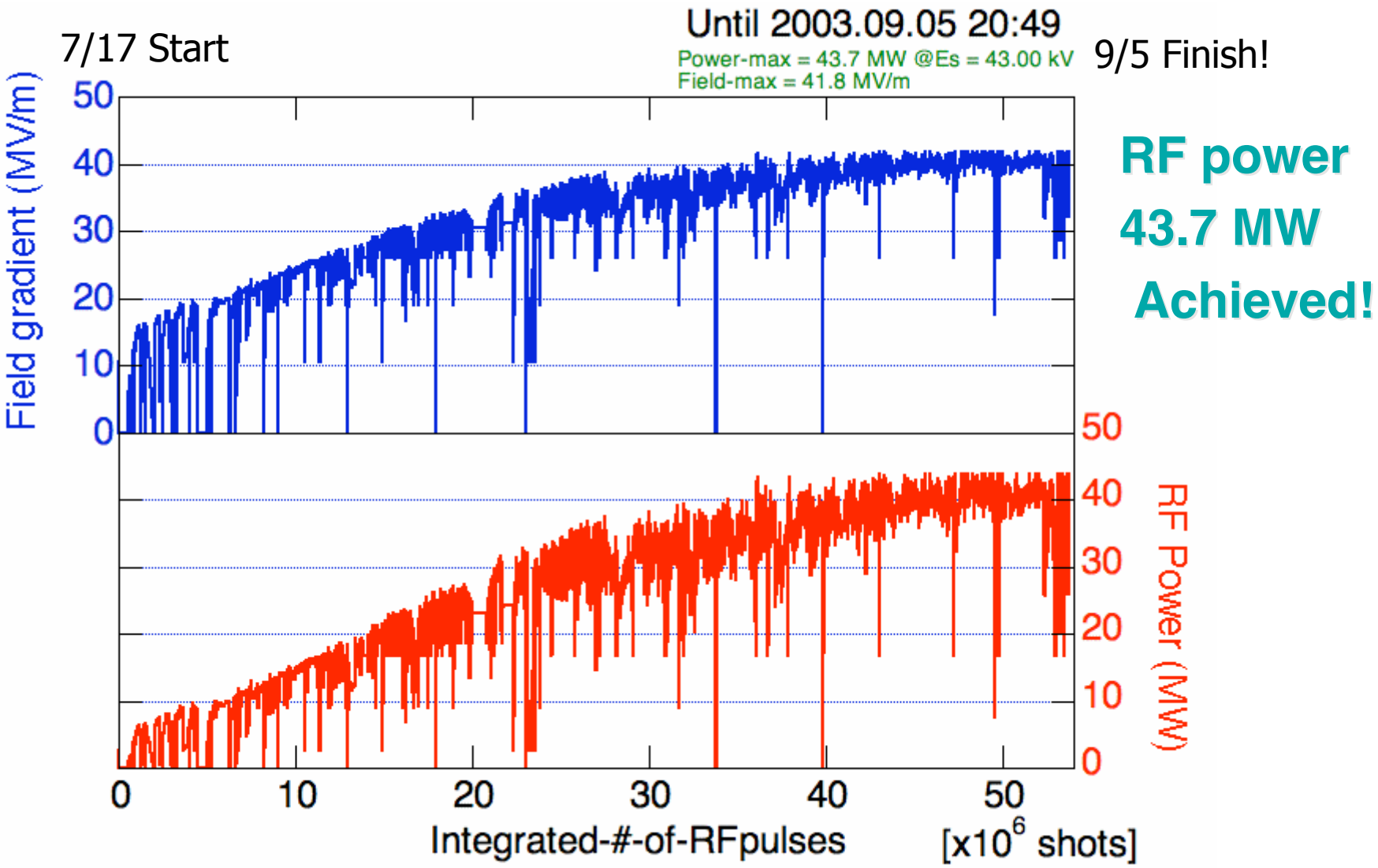
Test Stand (inside)



RF processing at Test stand

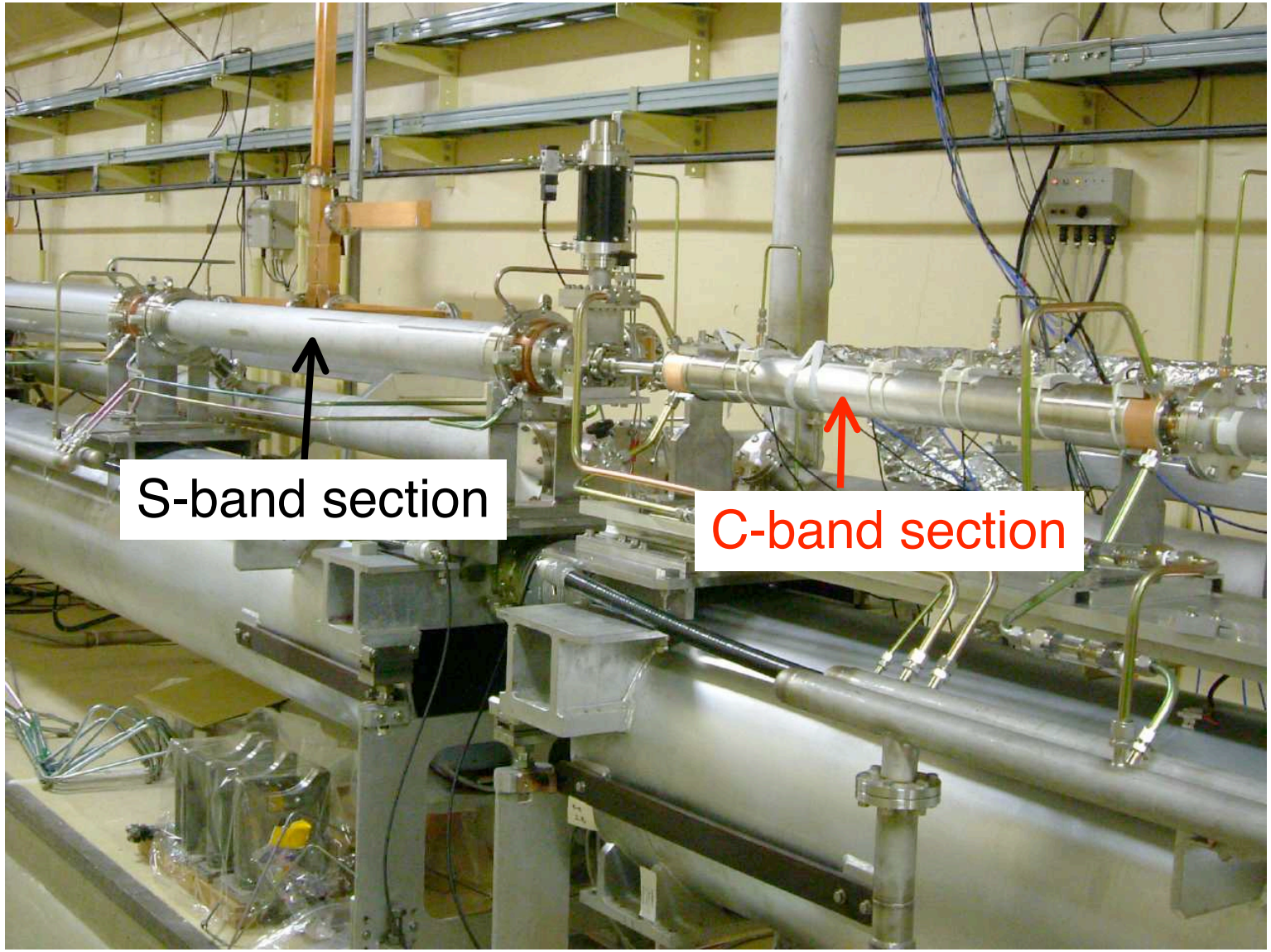


RF processing History



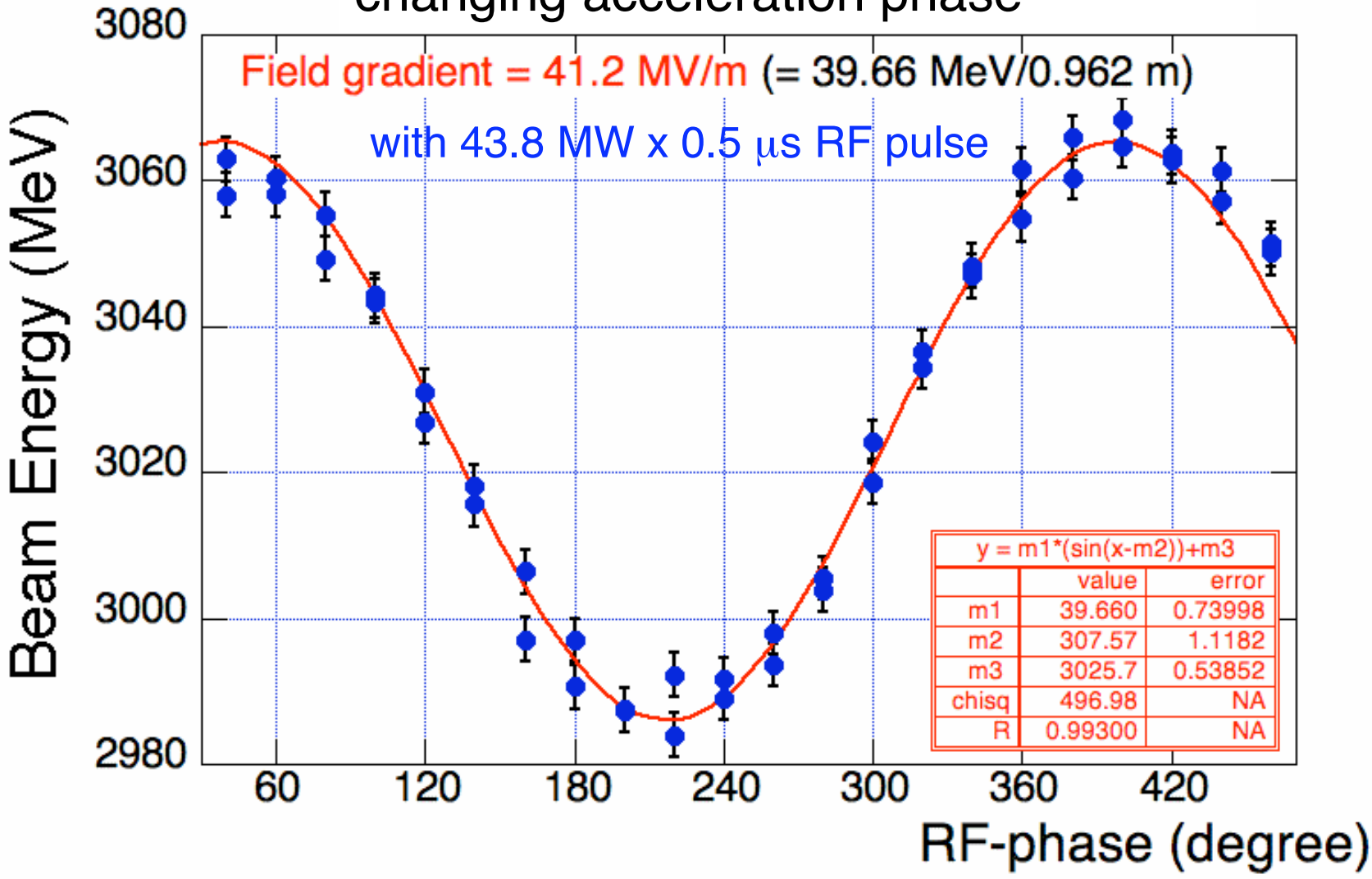
RF power 43.7 MW Achieved!

C-band accel. section installed in KEKB linac (2003 September)

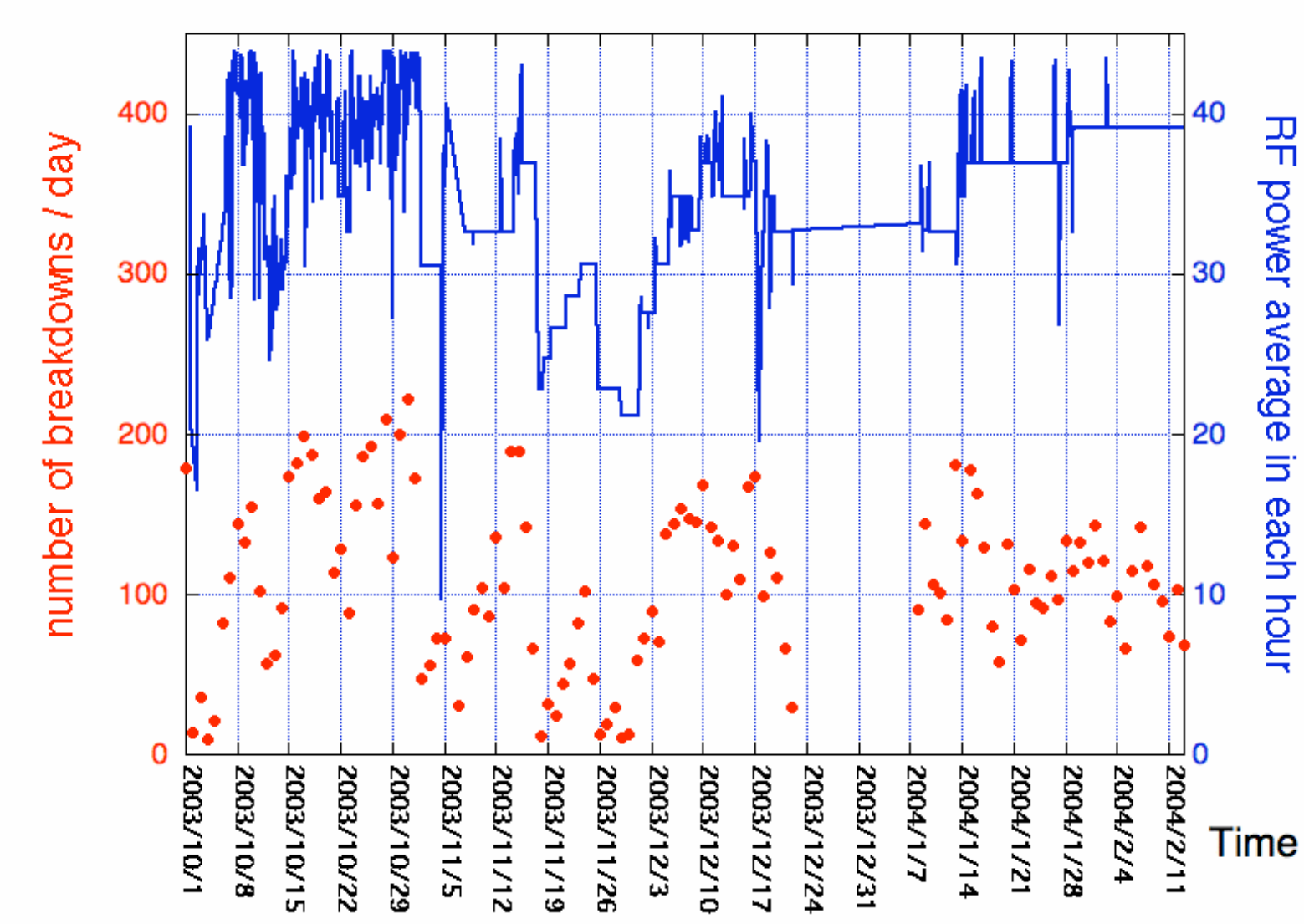


Beam acceleration study

Energy gain measured by
changing acceleration phase

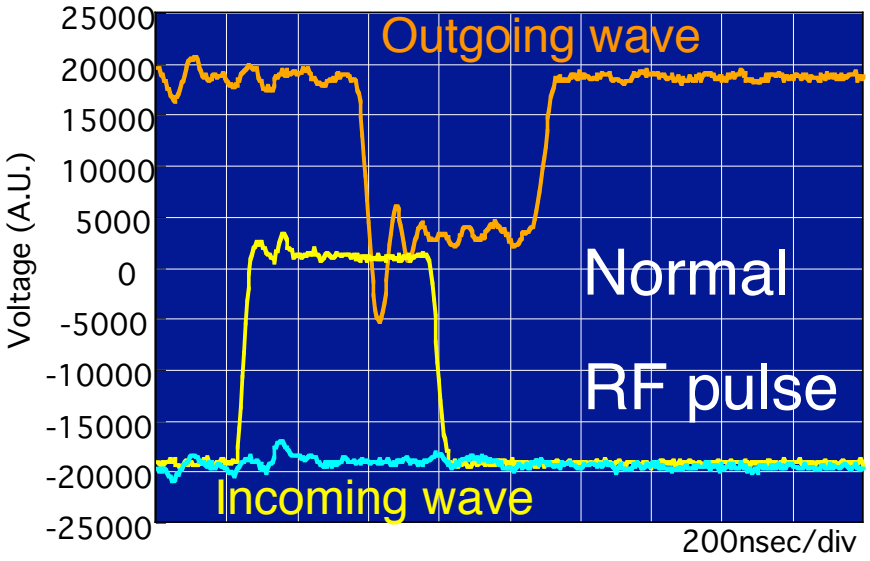


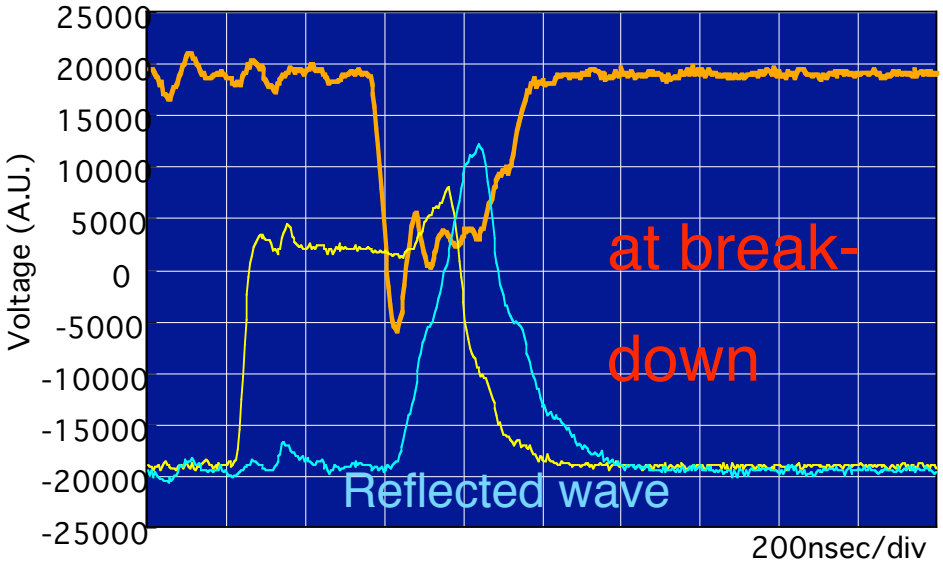
Long-term breakdown statistics

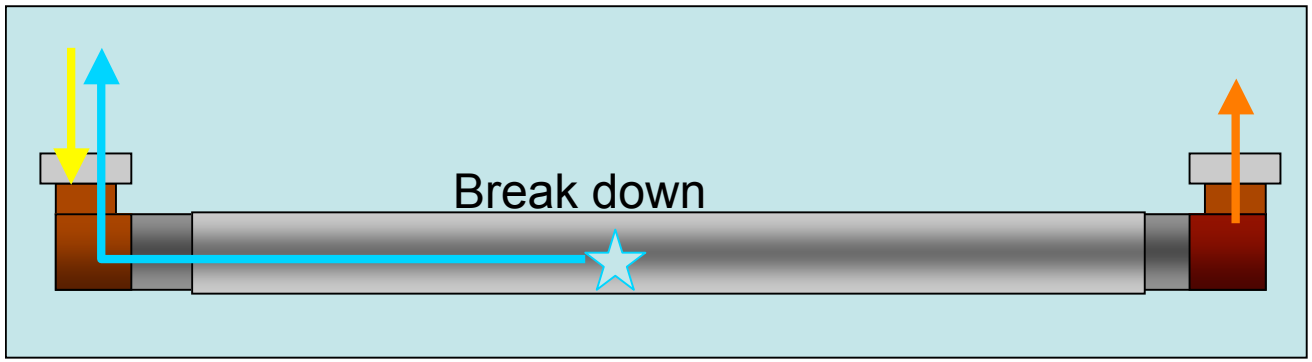


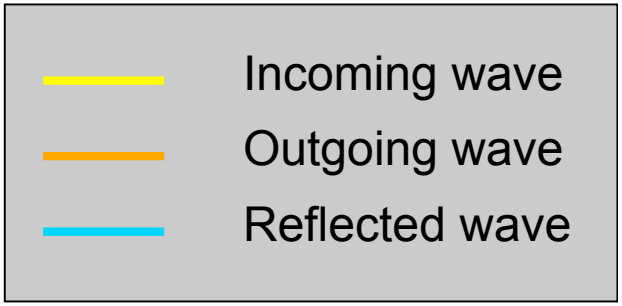
Typically, 100 breakdowns/day => 4 breakdowns/hour

RF wave form

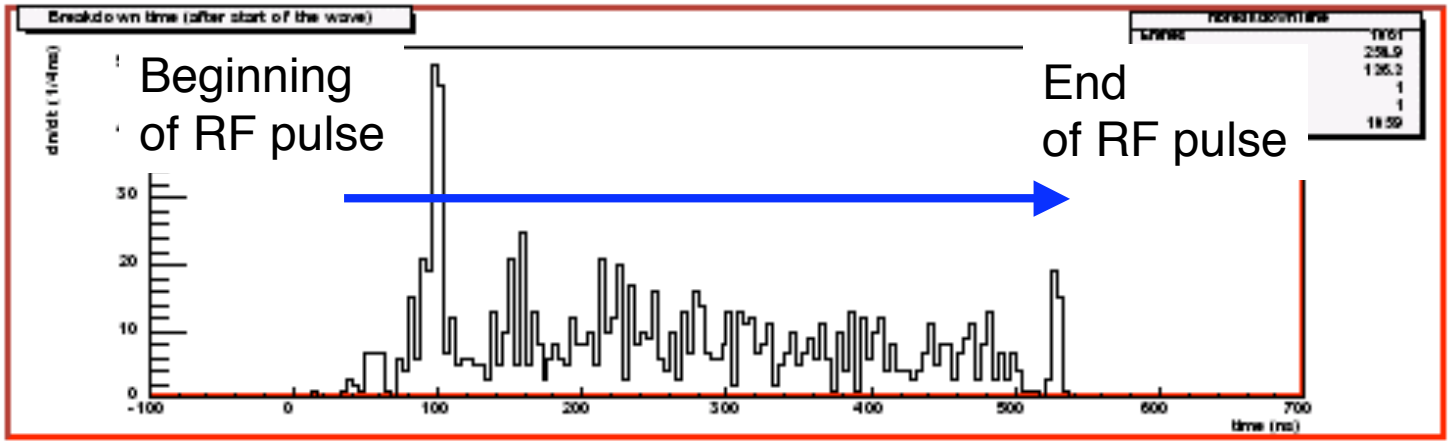

25000
20000
15000
10000
5000
0
-5000
-10000
-15000
-20000
-25000
Voltage (A.U.)
Outgoing wave
Normal
RF pulse
Incoming wave
200nsec/div


25000
20000
15000
10000
5000
0
-5000
-10000
-15000
-20000
-25000
Voltage (A.U.)
at break-
down
Reflected wave
200nsec/div

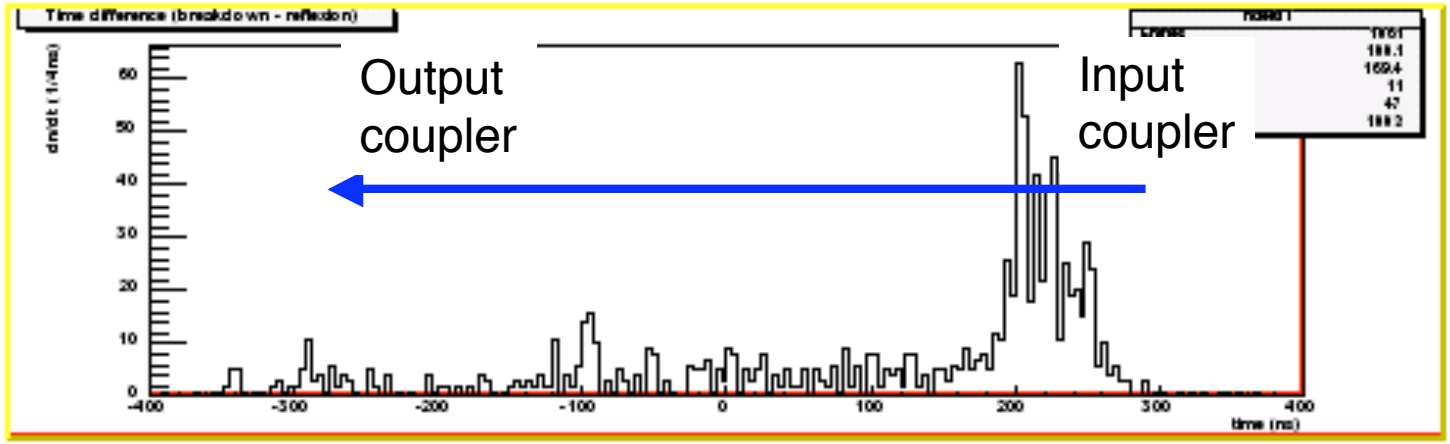

Break down


Incoming wave
Outgoing wave
Reflected wave

Breakdown location from RF signal



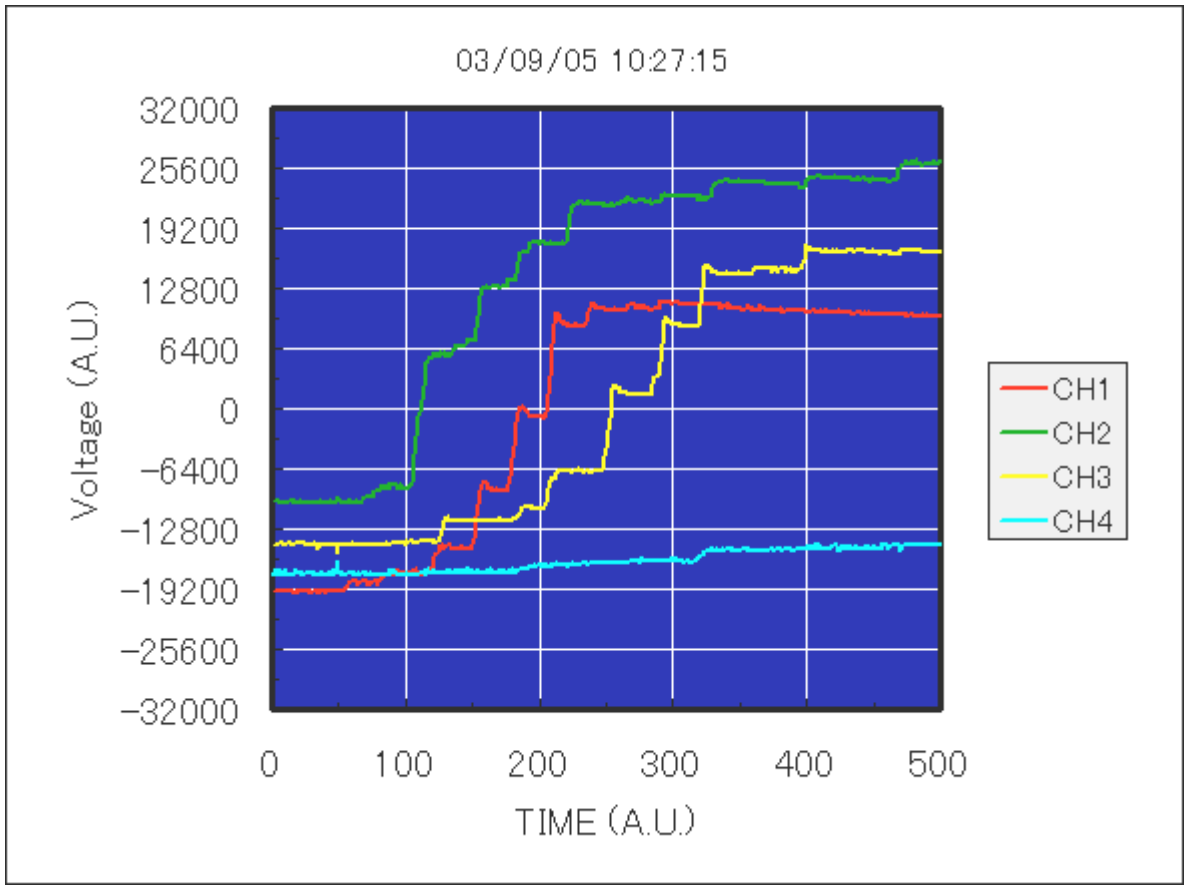
Time
information



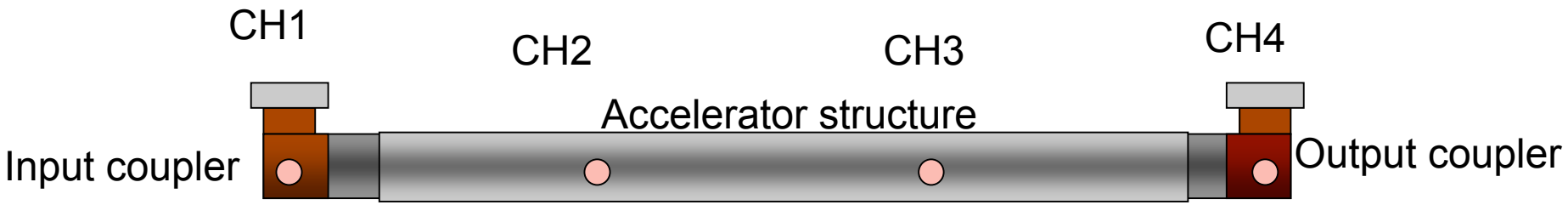
Position
information

Most breakdown occurs around the input coupler !

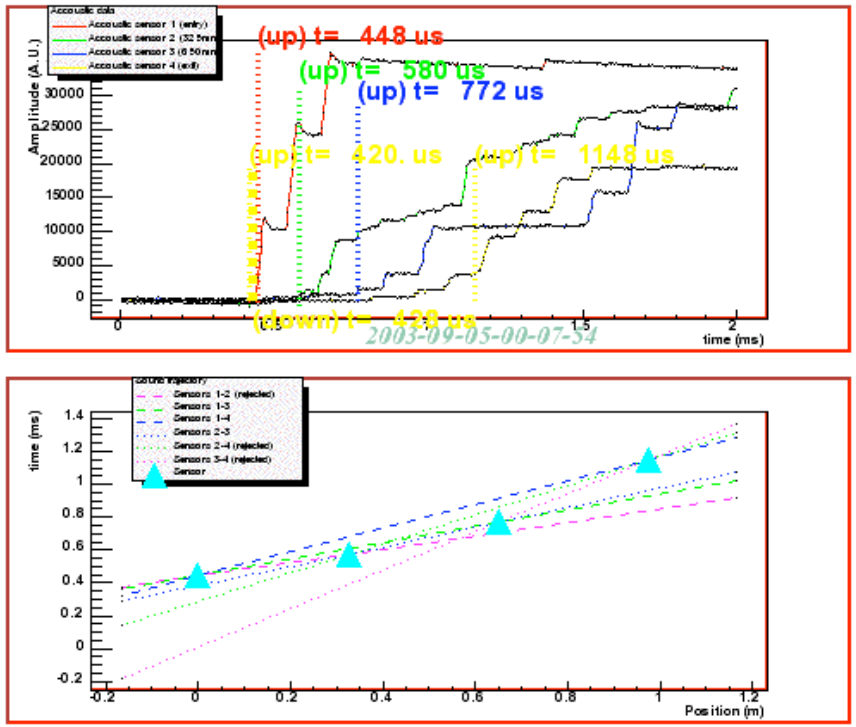
Vibration Sensors

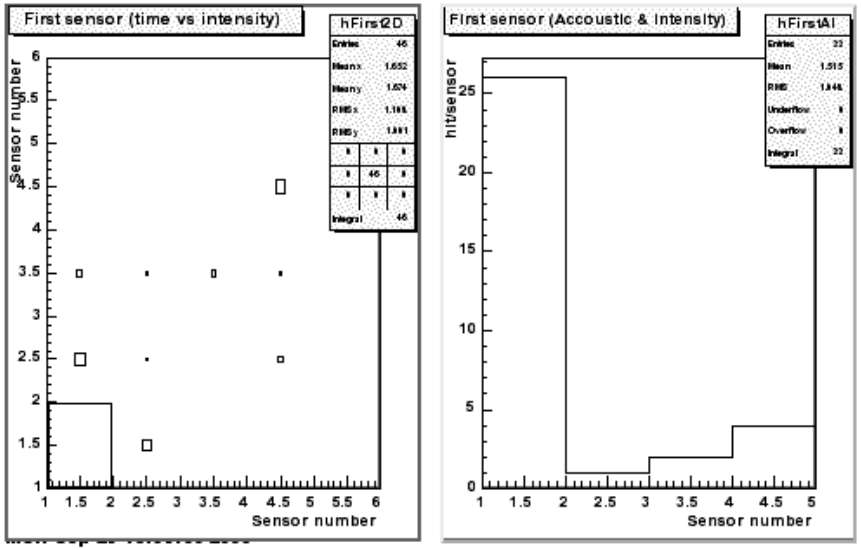


A timing information of vibration sensors gives break down location.



Breakdown location from vibration

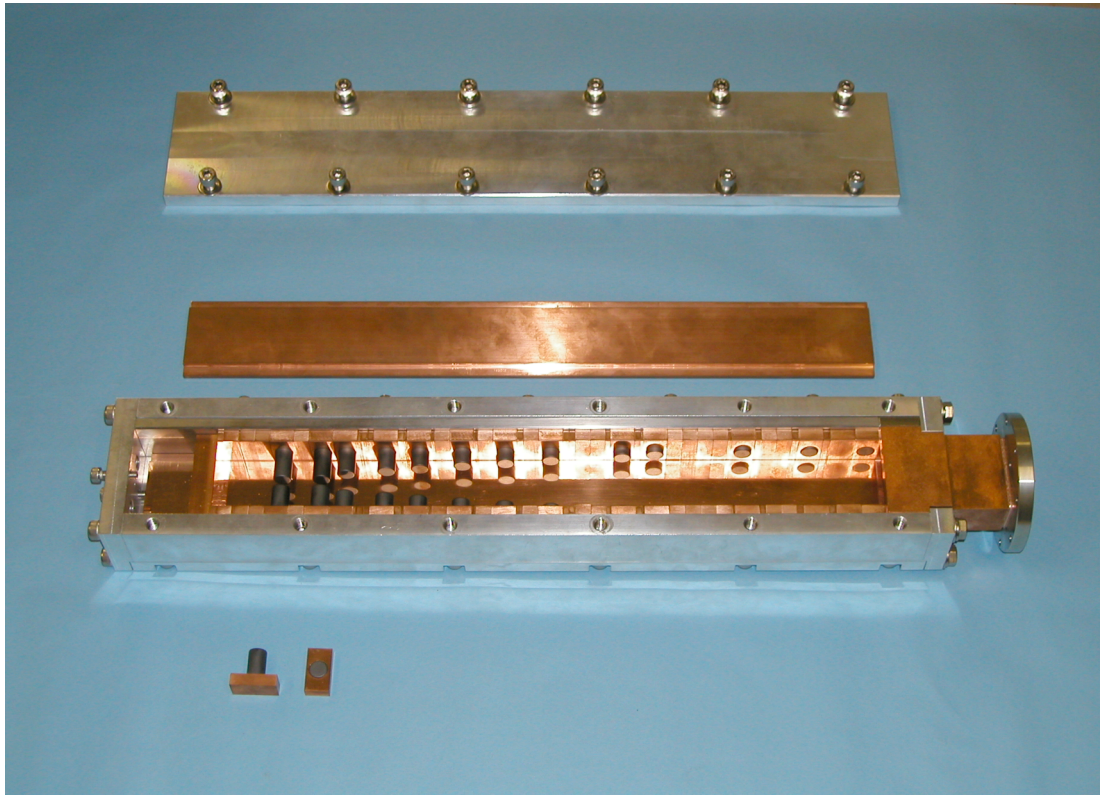


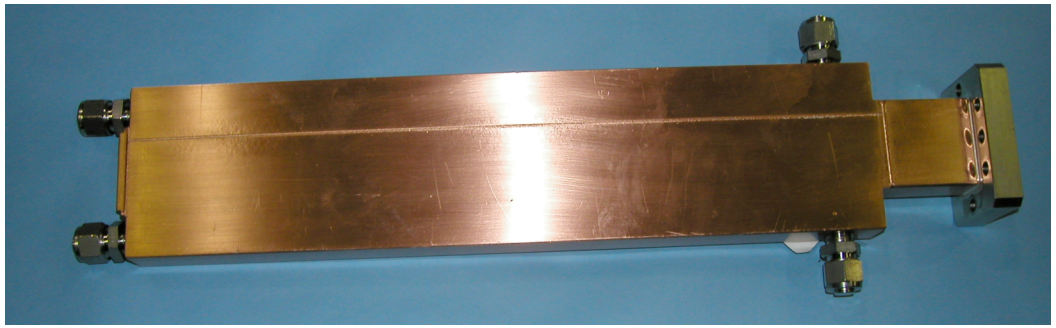


Fastest and Largest signal in four sensors

Most breakdown occurs around the input coupler !

Dummy load

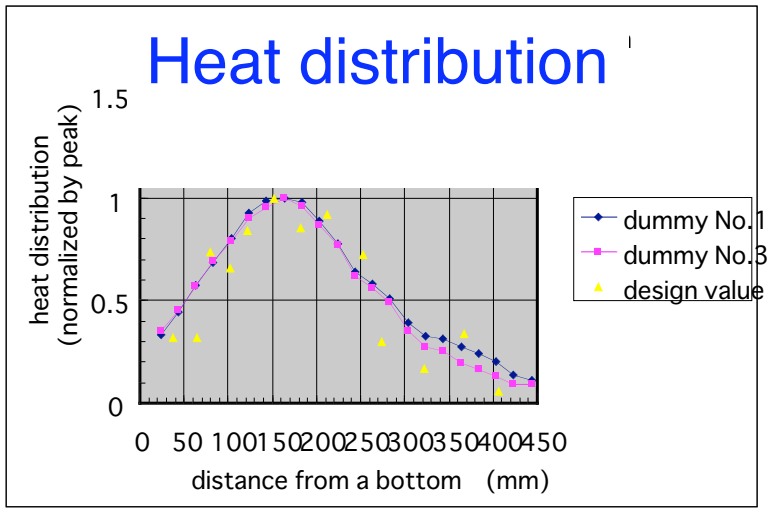




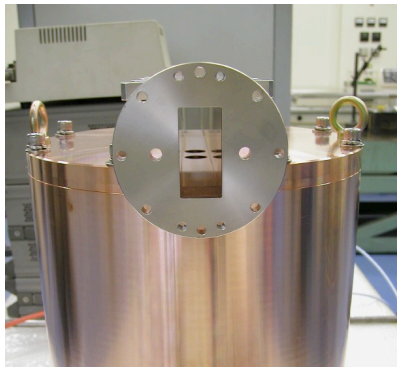
Newly designed 2kW Matsumoto-type dummy load

- 26 SiC cylinders
- SiC diameter 12 mm

High power test OK up to 2 kW !



RF pulse compressor



Low power model

- CERN-LIPS type of pulse compressor (TE038-mode cavity)
- Q_0 = 142,000 (measured)
- Coupling beta = 6 ~ 7
- Power multiplication ~ 3.4
- Study with low power model is under way to fix coupling hole dimension.
- High power test in July 2004

Summary (C-band accel. section)

- First prototype 1m accelerating section is fabricated on the design of 1/2-scale of present S-band section
- Field gradient of 41 MV/m is achieved with the klystron output power of 43.8 MW x 0.5 μs
- Breakdown is still frequent (5 breakdowns/hour) especially around the input coupler.
- Coupler shape improvement Needed !
- 2nd prototype with thicker coupler iris
  high power test in July 2004
- Dummy load OK up to 2 kW
- RF pulse compressor high power test in July 2004