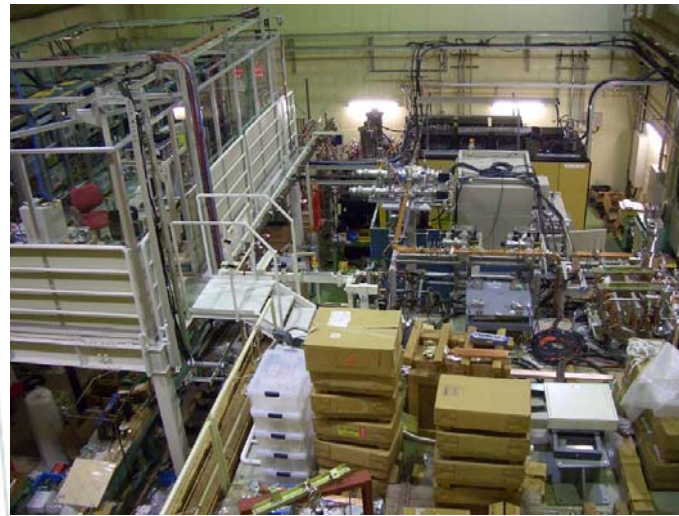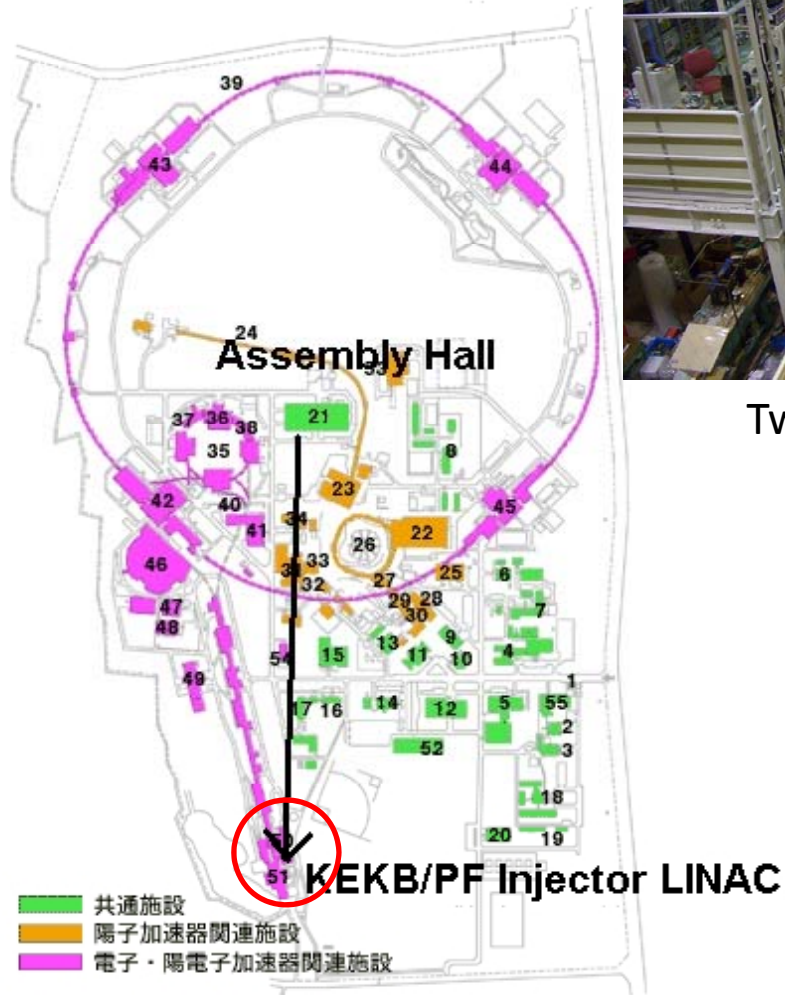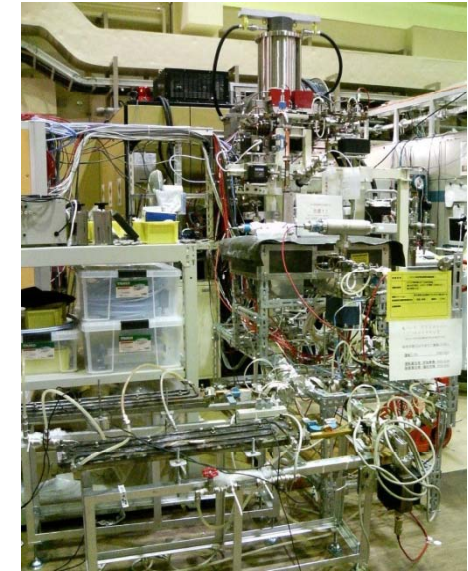# High gradient study at KEK

CLIC08,

Oct. 14-17, 2008

T. Higo
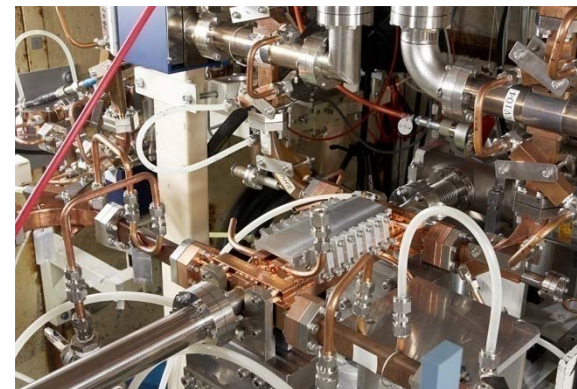
Nextef

Two klystron facility
Nextef

One klystron setup
KT-1

Inside shield room
T18_VG2.4_Disk

Assembly Hall

KEKB/PF Injector LINAC

共通施設
陽子加速器関連施設
電子・陽電子加速器関連施設

S. Ushimoto

Nextef Control System （2008）
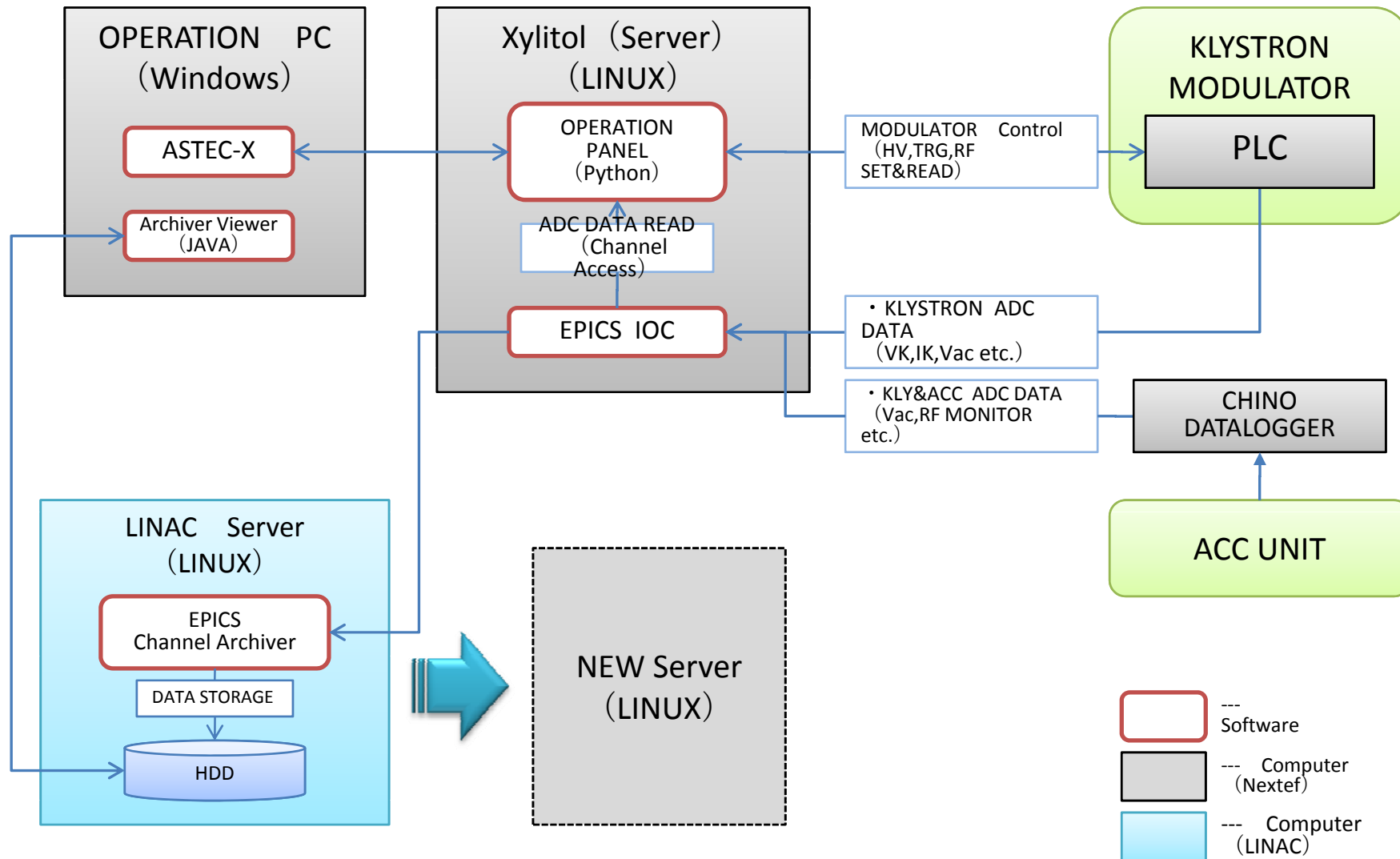
Nextef data acquisition and analysis

081009
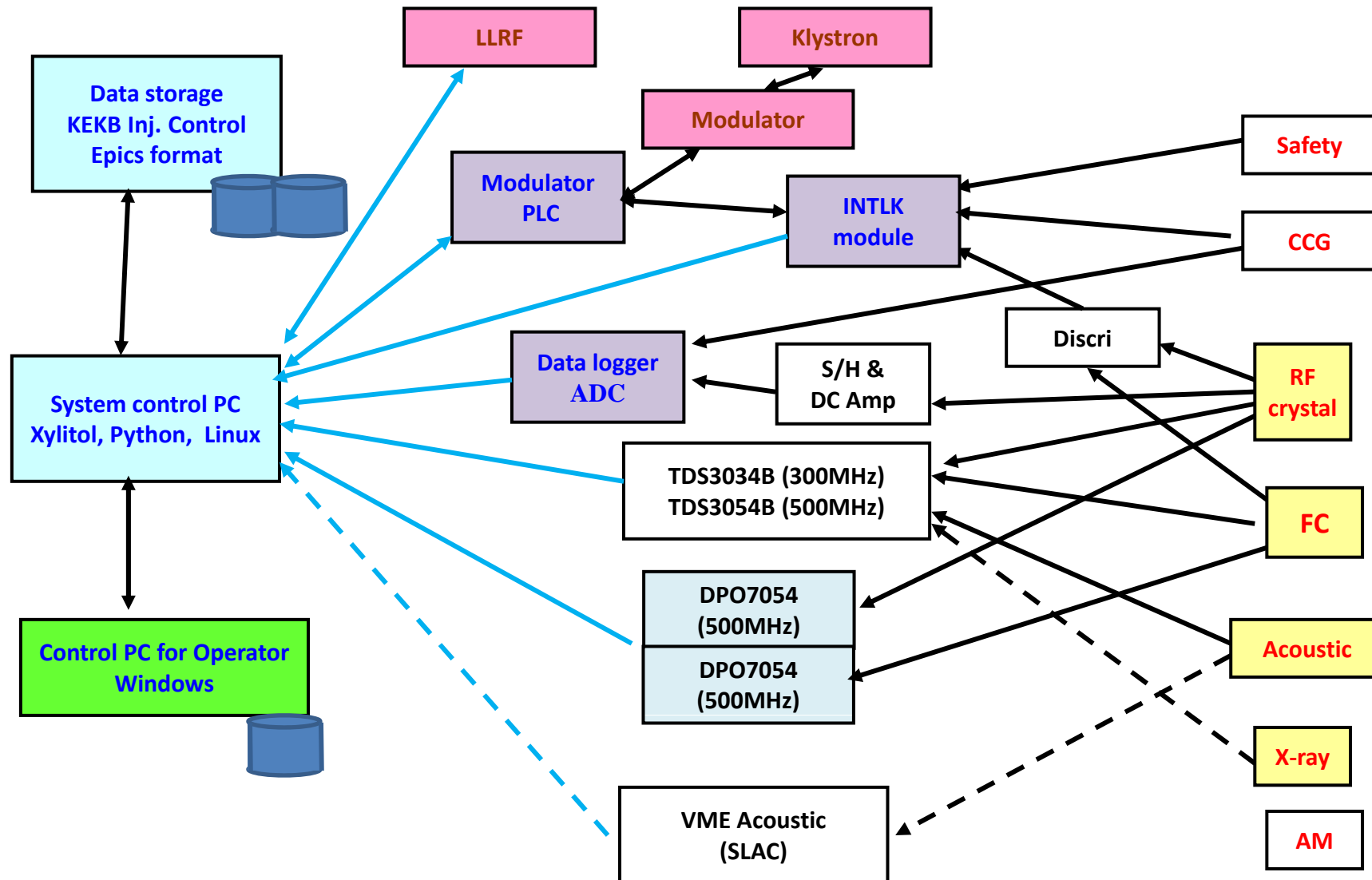
Breakdown related monitors and their recording

- At BD, DPO7054: F, Rs, Ra, T, FC-UP, FC-Mid +?? → 8 values
  - Recording 10 pulses with BD pulse at the last
  - This gives feed power level just before BD
  - Use this intensively for breakdown pulse analysis
- Nominal pulses are to be routinely recorded (not yet implemented)
  - With and without RF, take automatically
- TDS3000: Mod, S, N, S+N, S+N_refl, acoustic, X-ray, …..
  - Recording for each BD and every one hour
  - Recording last pulse and/or a few pulse shapes in png and wfm
  - These make it possible to distinguish the breakdown whether ACC origin or due to other components
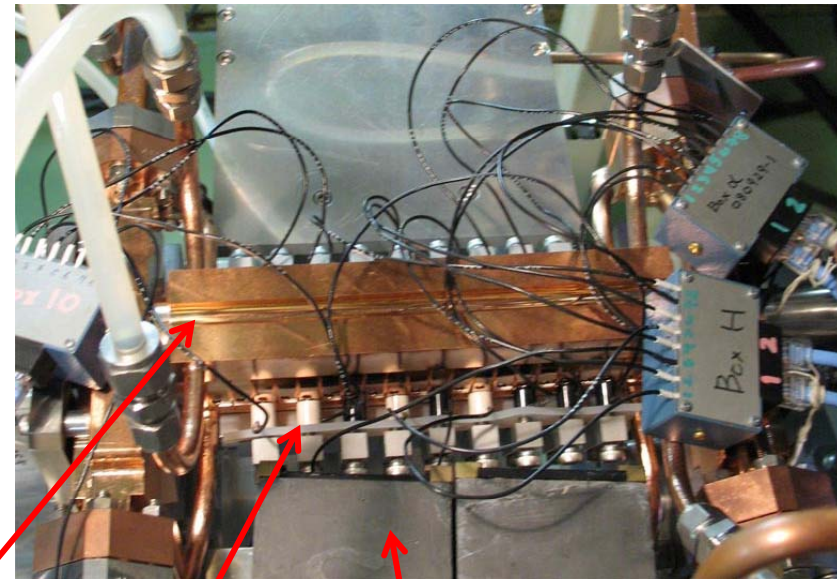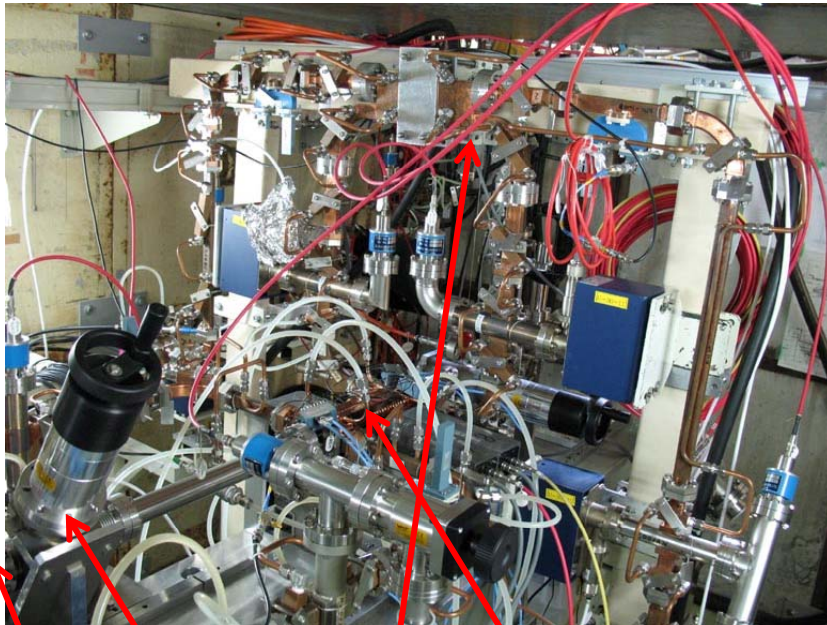
DPO being developed by Ushimoto
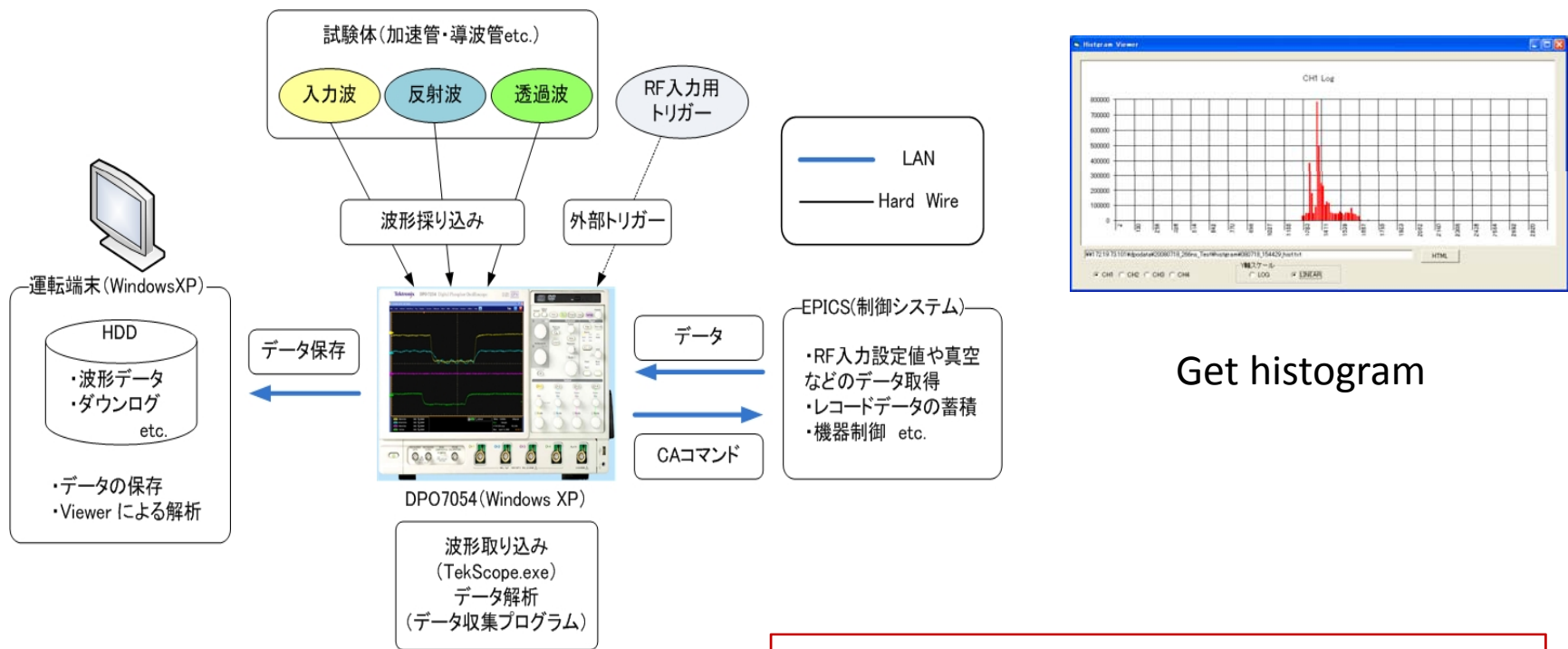
DPO system

Get histogram

Want to make this system to be our nominal power reference

T18_VG2.4_Disk #2 installed and processing started in late September
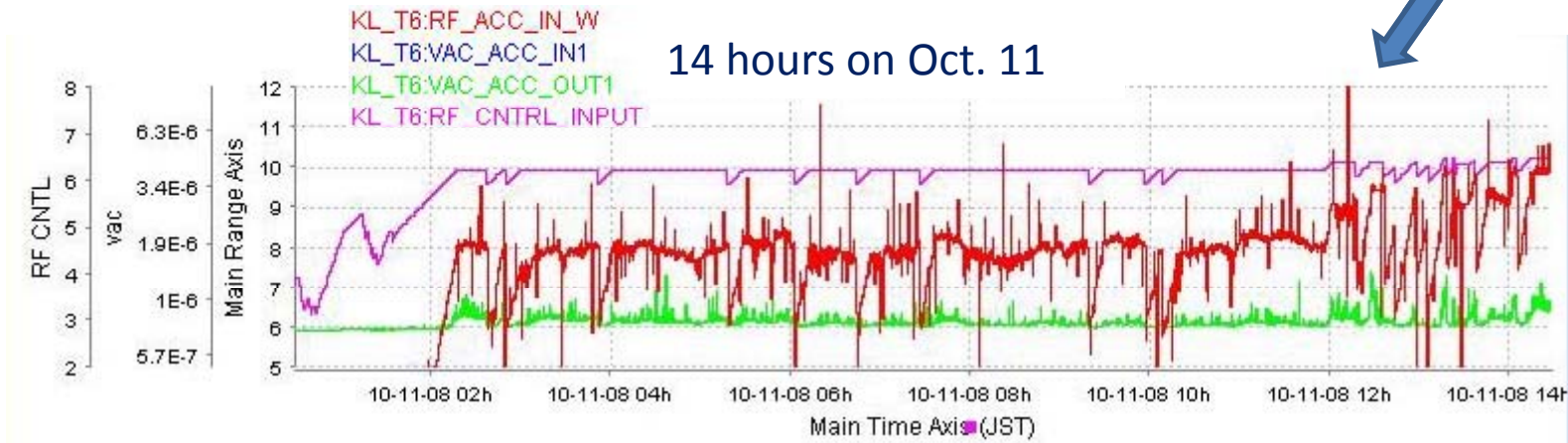

GV

SLAC
3dB hybrid

FC

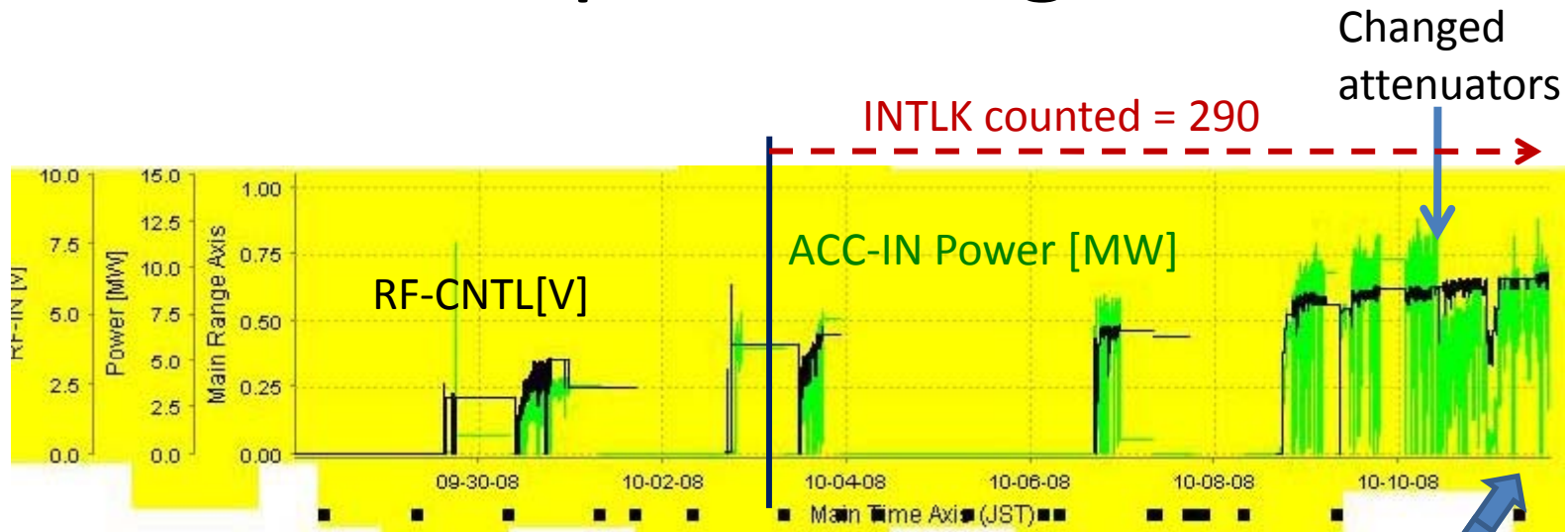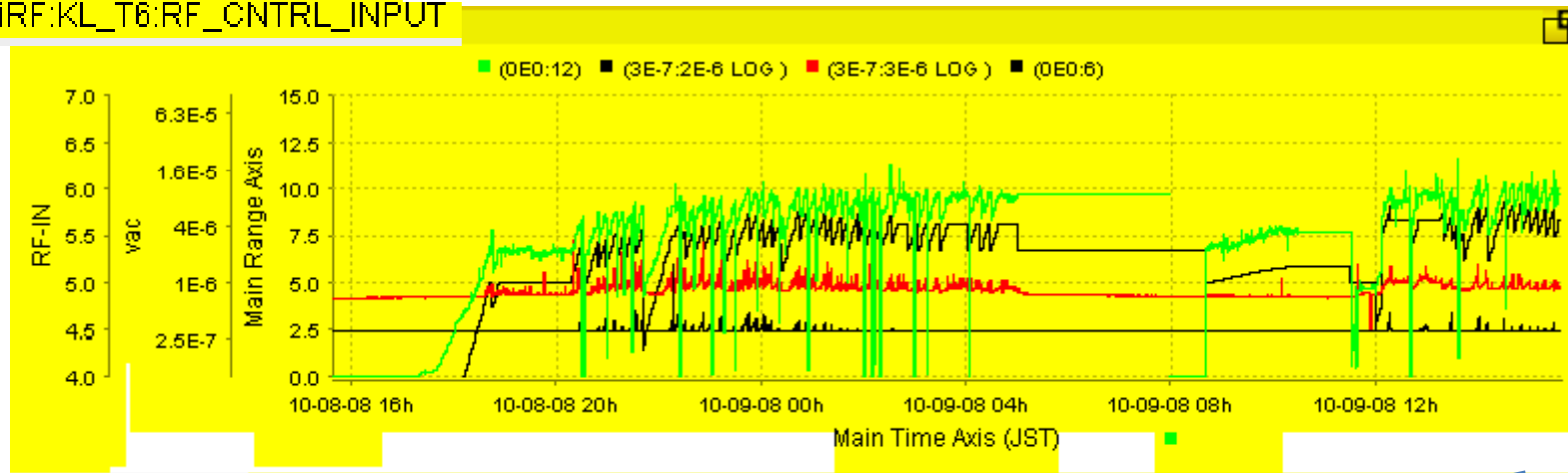T18_VG2.4_Disk

Acoustic
sensors

Plastic scinti.
& PMT

51ns processing trend

Changed attenuators

INTLK counted = 290

RF-CNTL[V]

ACC-IN Power [MW]

14 hours on Oct. 11

KL_T6:RF_ACC_IN_W
KL_T6:VAC_ACC_IN1
KL_T6:VAC_ACC_OUT1
KL_T6:RF_CNTRL_INPUT
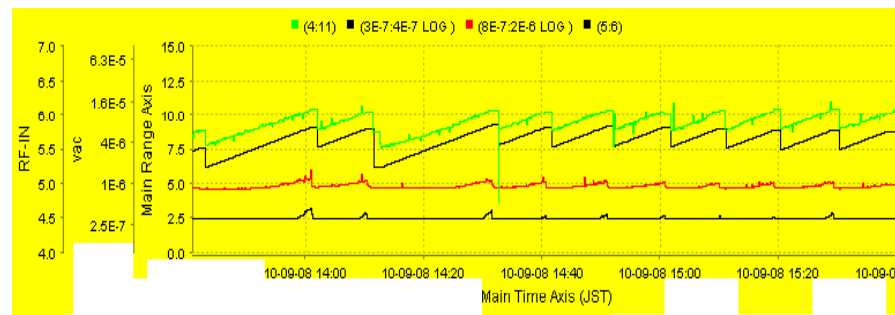
081008 16:00 – 081009 16:00

LIiRF:KL_T6:RF_ACC_IN_W
LIiRF:KL_T6:VAC_ACC_IN1
LIiRF:KL_T6:VAC_ACC_OUT1
LIiRF:KL_T6:RF_CNTRL_INPUT

INTLK due to setting reflection threshold too low, but it shows how the program does the processing. CNTL_V, Power, VAC

Power ON period at 51ns, 50Hz, 40kV

- 9/30 ~10/1 22hrs 2.5X(4/7)=1.5MW→6MW→33MV/m

- 10/2 3hrs 3.5X(4/7)=2MW →7MW→36MV/m

- 10/3 6hrs 5X(4/7)=3MW →9MW→40MV/m

- 10/6 8hrs 6X(4/7)=3.4MW →10MW→42MV/m

- 10/8~11 14:00 60hrs 7MW – 9MW →19MW→59MV/m

- ---

- Total up to now 99hrs 19MW, 59MV/m

- Total number of INTLK's since Oct. 3 including other than acc-structure such as modulator or spurious → 290 times

Power calibration

CombOut CNTLprog reading [MW] --> PPM [MW]
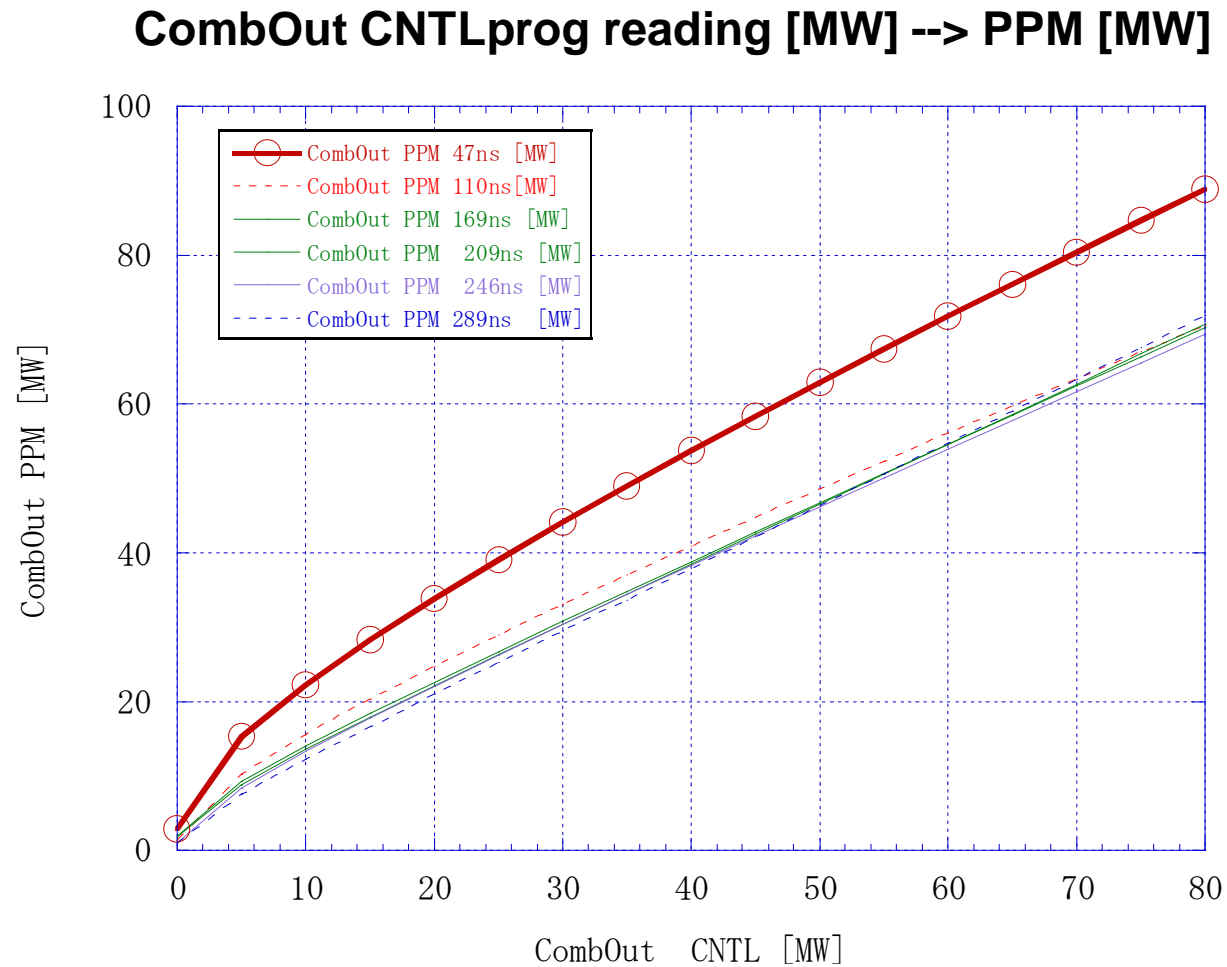


CNTL program read crystal → PH → DC AMP → ADC

Calibrated with peak power meter as nominal value

Some insufficient calibration still exists on pulse width

Checked with calorimetric method for output from structure

Initial trend compiled manually

Need to implement an easy tool for this sort of data acquisition

T18_VG2.4_Disk #2 Processing
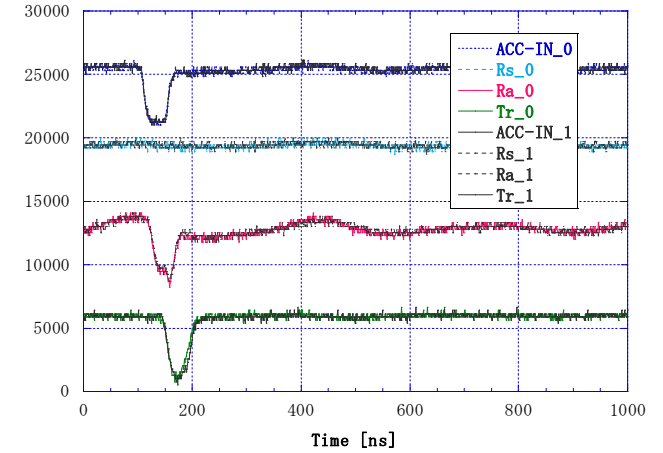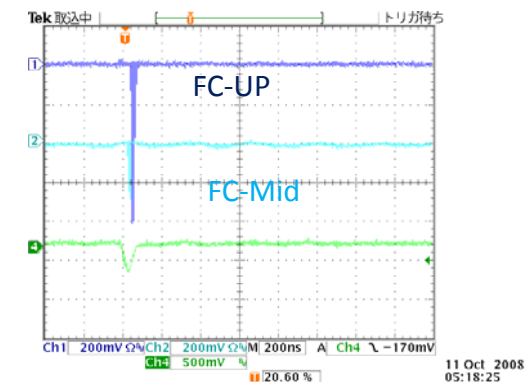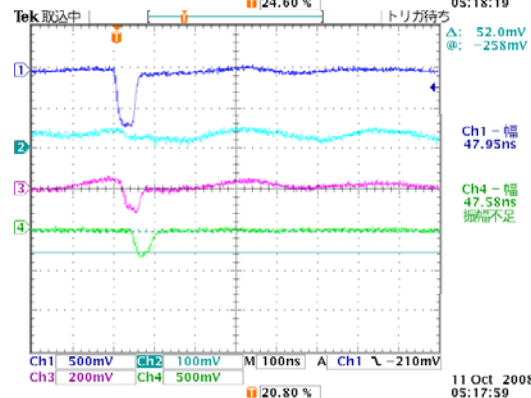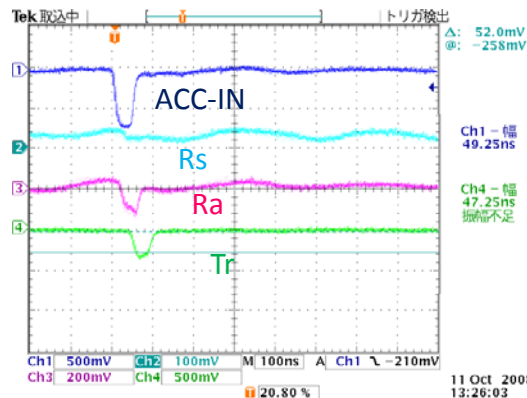**Initial startup period at 51ns, 50Hz**
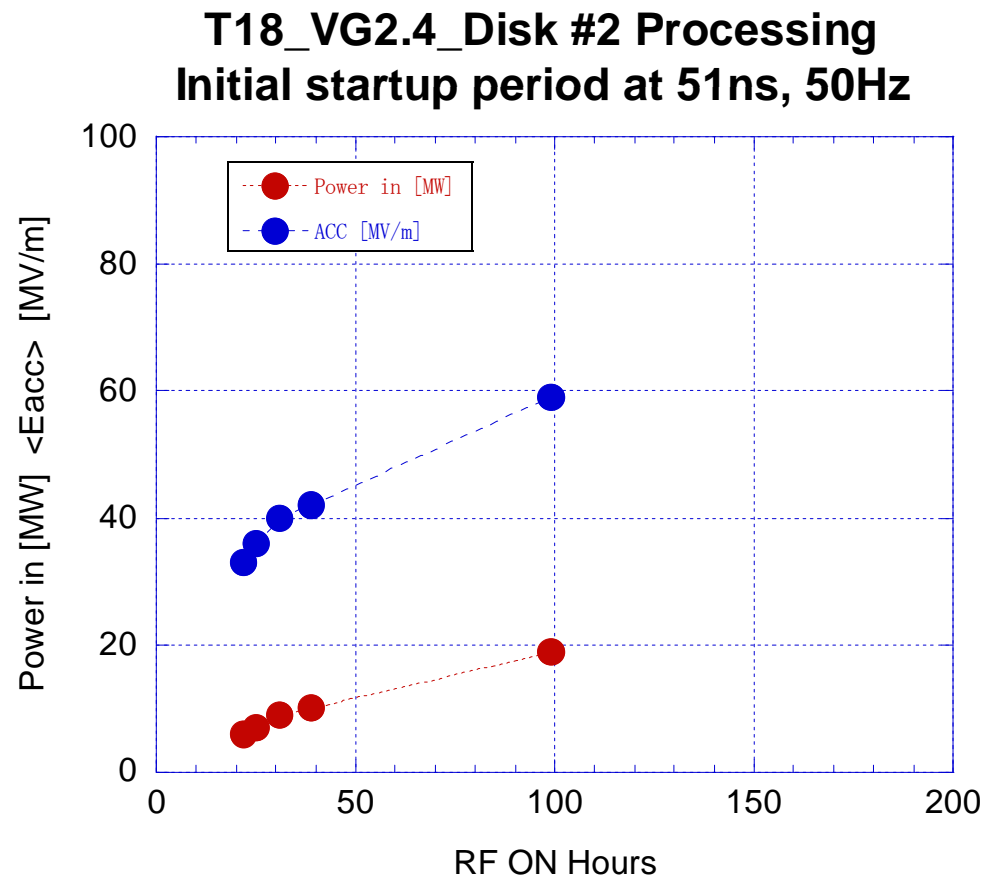
Typical pulse shape

Nominal
pulse

TDS3000

BD pulse

DPO7054

RF pulse
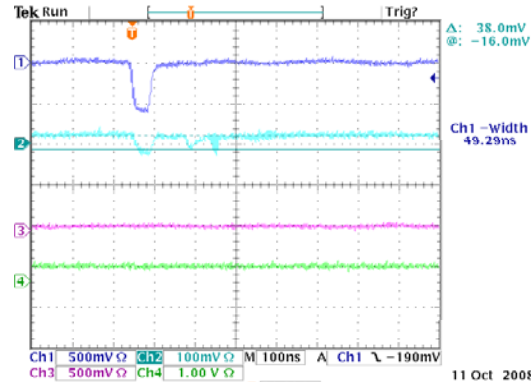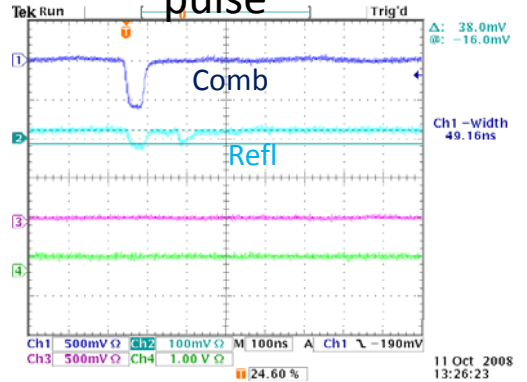
FC current pulse at BD
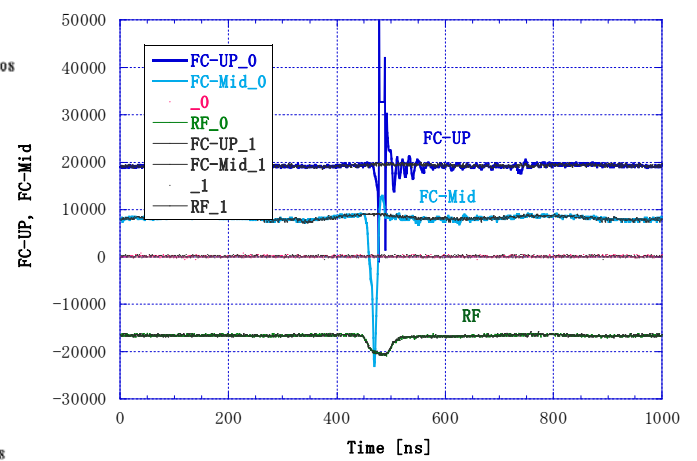
Under development

- Processing control
  - Sophistication will be done through T18_VG2.4_Disk processing period
- Data acquisition system
  - Try DPO to be nominal input power reference
  - TDS suffer from intermittent lockup
  - Data storage should be made robust with backup
- Data analysis
  - Online viewing program is needed
  - Consistent analysis through longer period is needed
- Need support from outside
  - In any of these area

Processing control for T18_VG2.4_Disk

- Step-wise pulse width setting
  - 50-110-170-210-250-290ns
- ACC INTLK
  - by jump in Rs/FC current/VAC
  - Rs, FC: Threshold setting is manual, a little above nominal
  - VAC level nominal 10^{-4}Pa
- System fault
  - by S+N_refl (reflection to the combiner of two klystron) and VAC
- Recovery from breakdown
  - Nominal recovery is automatically done by power reduction and gradual increase.
  - In case of breakdowns at considerably lower power level than the highest BD level, say below 50%, decrease pulse width by one step, manually.
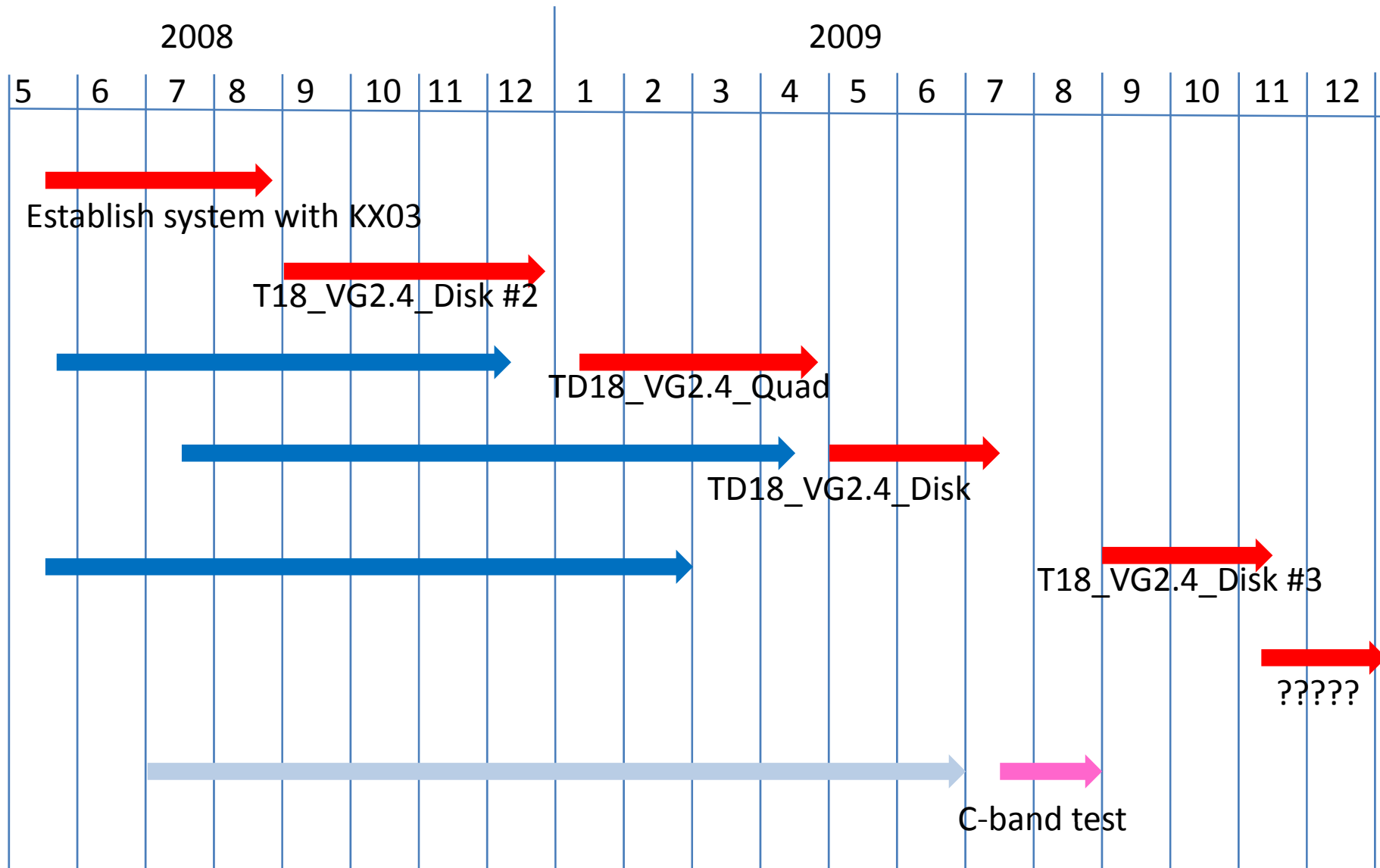
Recovery pass in (T,P) space

SLAC

CERN

KEK

20%P, 20nsT

50%P, -20%T

αP, -1stepT
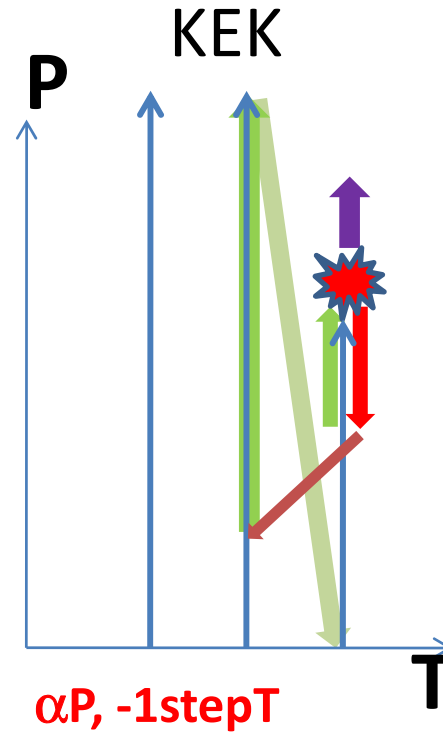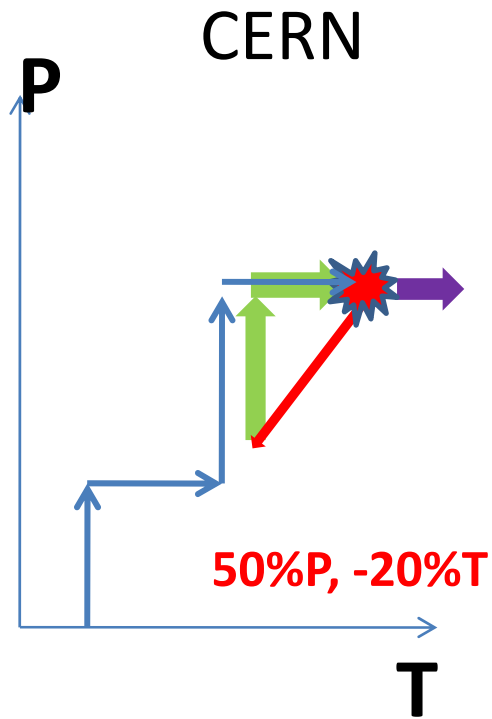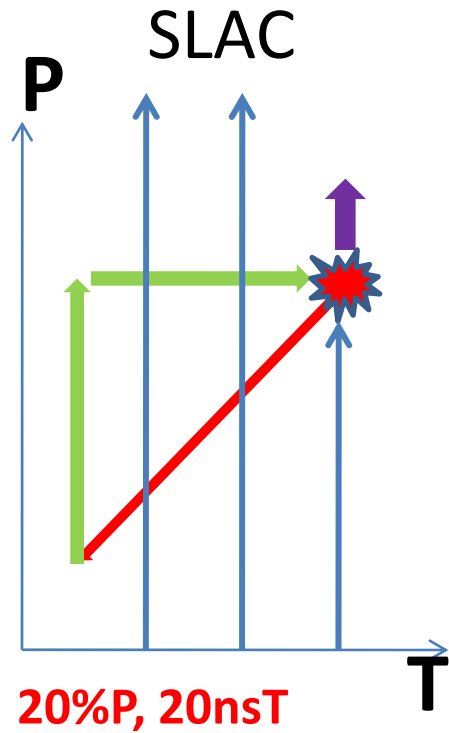
Comparison of high gradient performances among different systems

- **How to compare different high gradient experiments**
  - **Power calibration** in % level
  - **Processing protocol** processing speed, recovery manner
  - **BDR criteria** missing energy / reflection amplitude / complex reflection vector
- **What to compare**
  - BDR **at lower level** is needed
    - very high gradient ~150MV/m
    - medium ~>100MV/m
    - practical ~80MV/m
  - The **performance until reaching** the final status
  - Performance in **long-term running**
  - **Other observables** than BDR?
    - Field enhancement factor, dark current …..

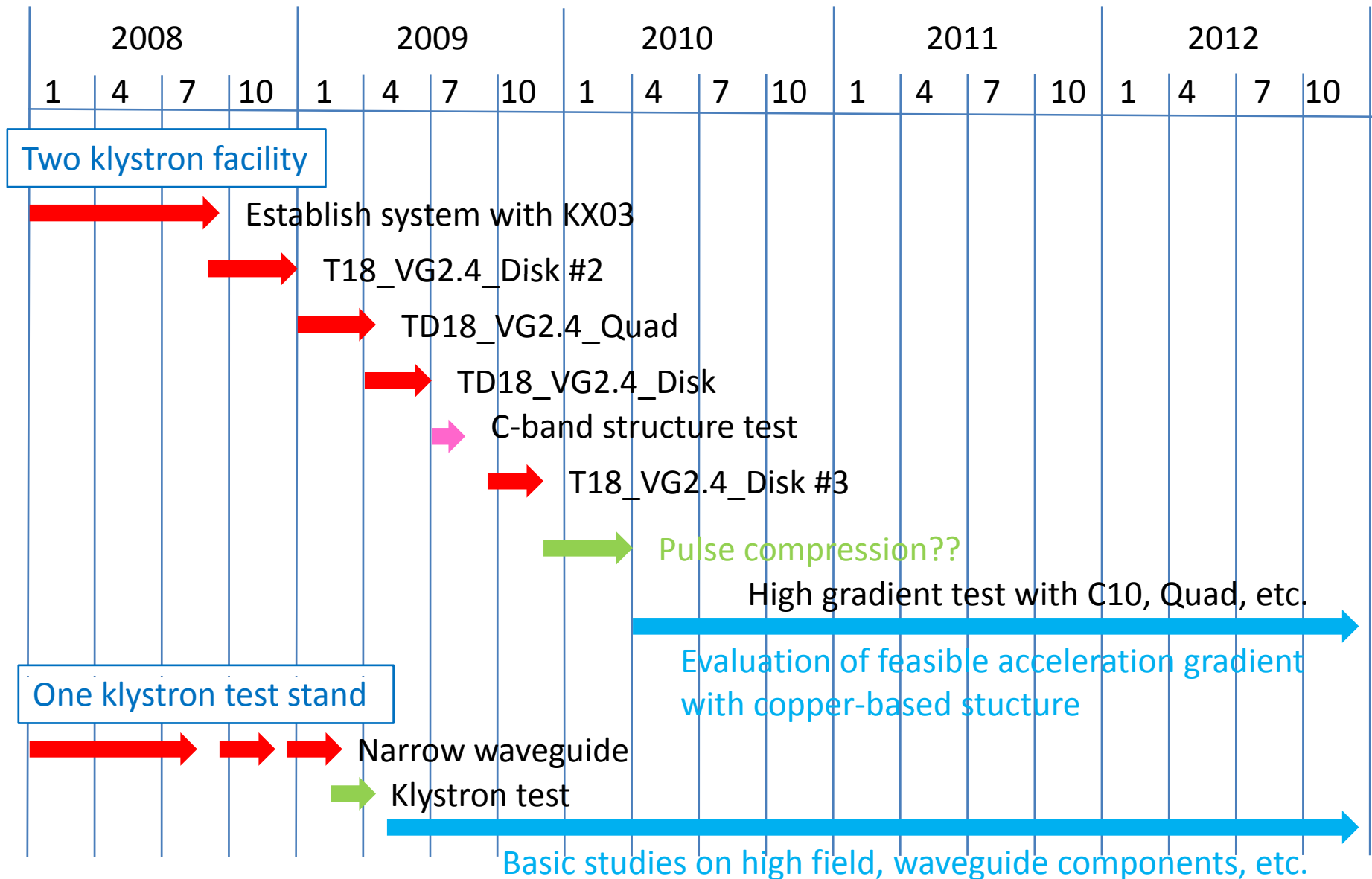# Issues for understanding the performance

- We need to discuss the way to consistently compare and understand

- Gradient level
  - 80 – 100 – 150
  - Pulse length, pulse shape, ……
- Relationship
  - Pulse heating vs BDR
  - DC Pulse / Waveguide / single cell / pulse heating

Nextef planning as of Aug. 1

2008								2009											
5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12

Establish system with KX03

T18_VG2.4_Disk #2

TD18_VG2.4_Quad

TD18_VG2.4_Disk

T18_VG2.4_Disk #3

?????

C-band test

Nextef planning

Nextef developments

- Mission
  - Close collaboration with CLIC structure developments
  - Basic high gradient study
- Nextef operation
  - Can run 24 hr/day during linac operation
  - Limited operation during linac maintenance
  - Should coexists with C-band structure activity
- Further development
  - Pulse compression in 2009? >150MW, 300ns
  - Another test stand? using power switching
 - Acquiring more klystrons?

Structure study in collaboration

- Maximally utilize the present framework
  - CERN-SLAC-KEK
  - Design-fabrication-test
  - Get info in extreme gradient / practical gradient
  - Cross-check the performance / fabrication
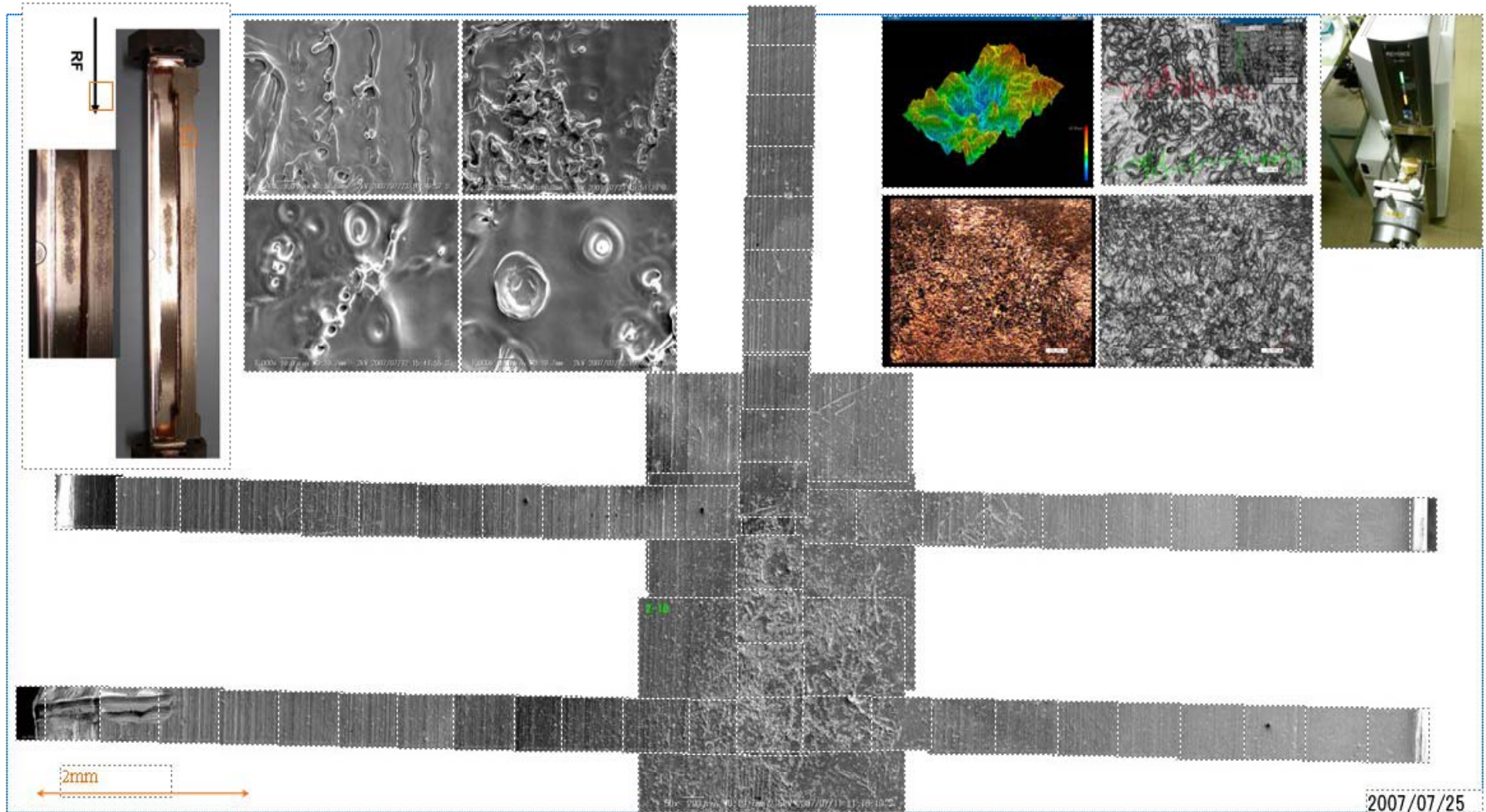- Want to expand collaboration in Japan
  - Not yet established

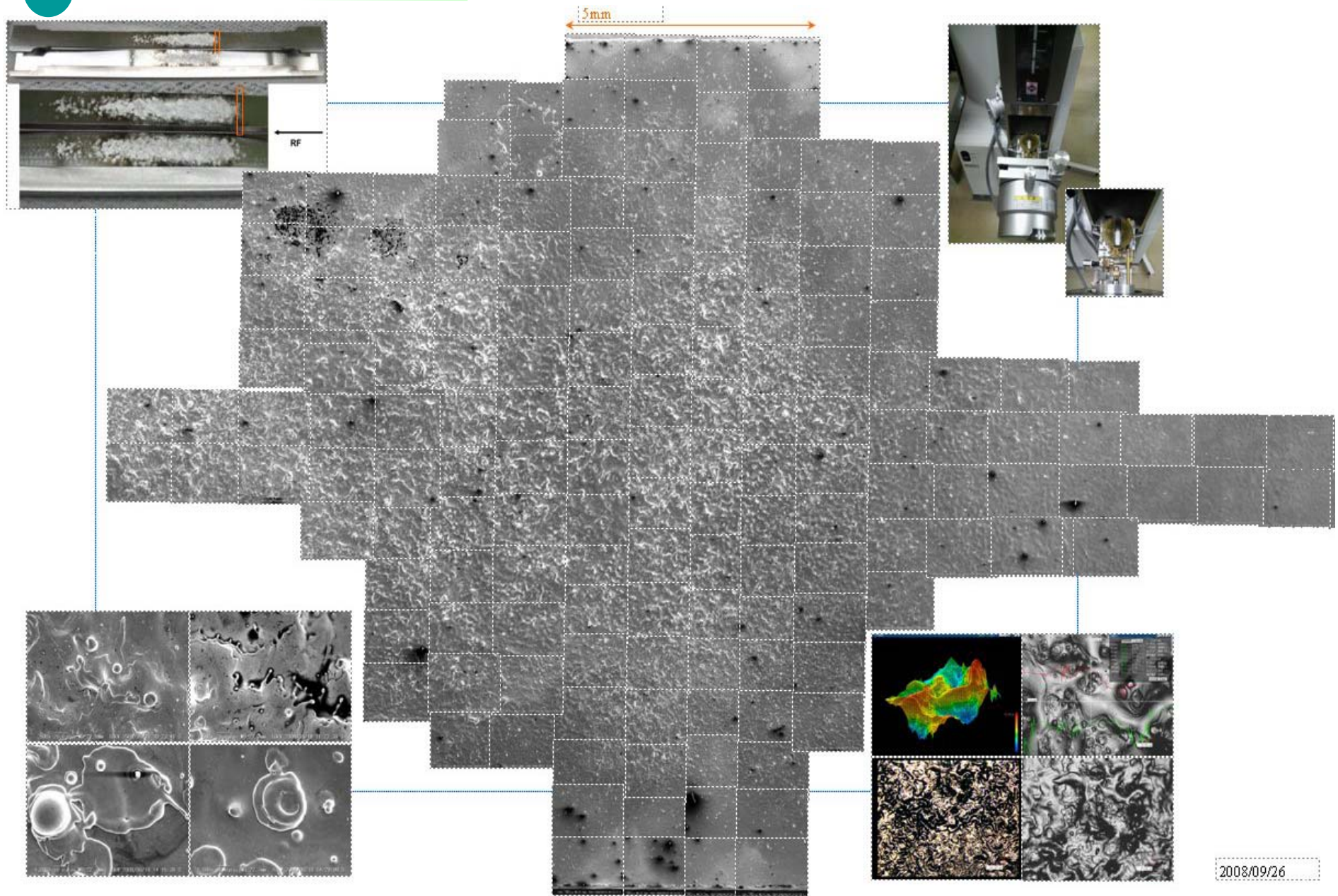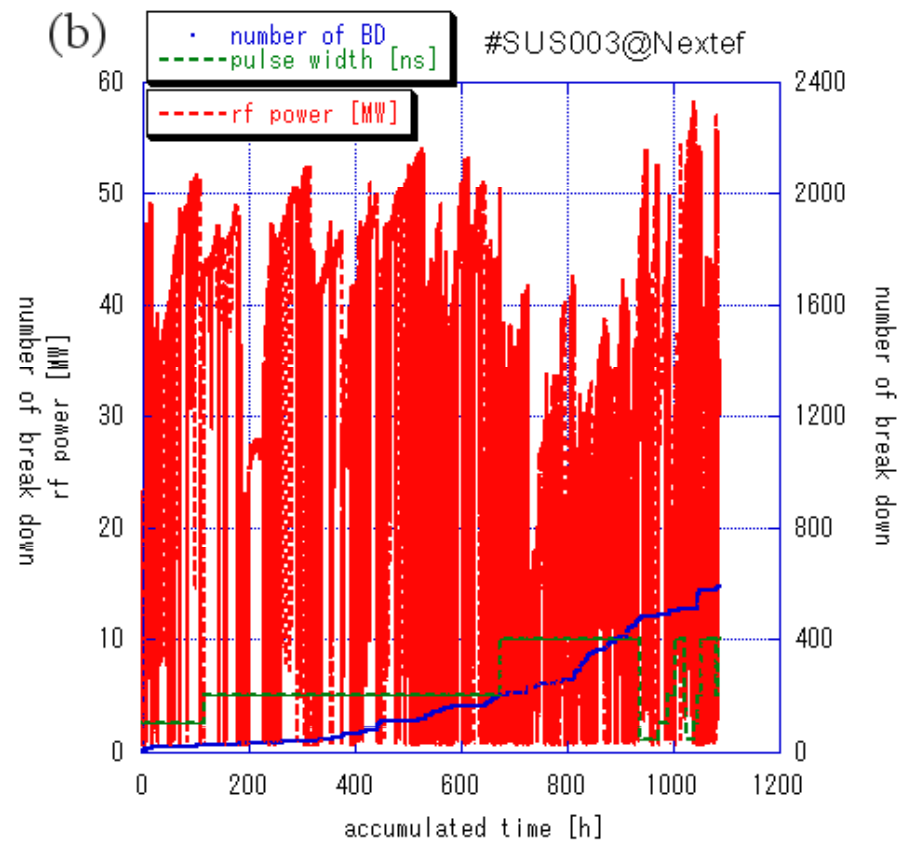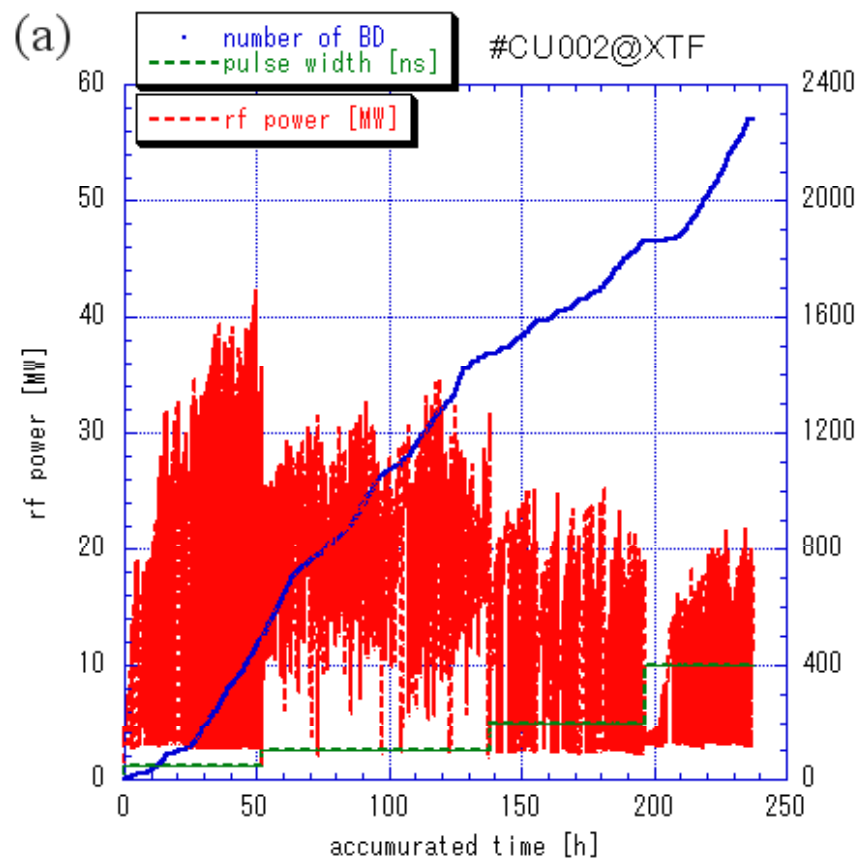# Basic high gradient study at KT-1
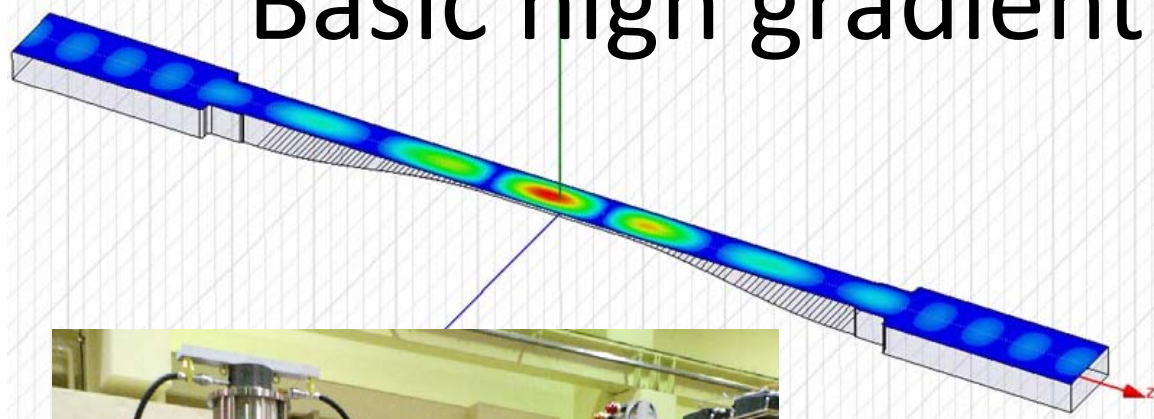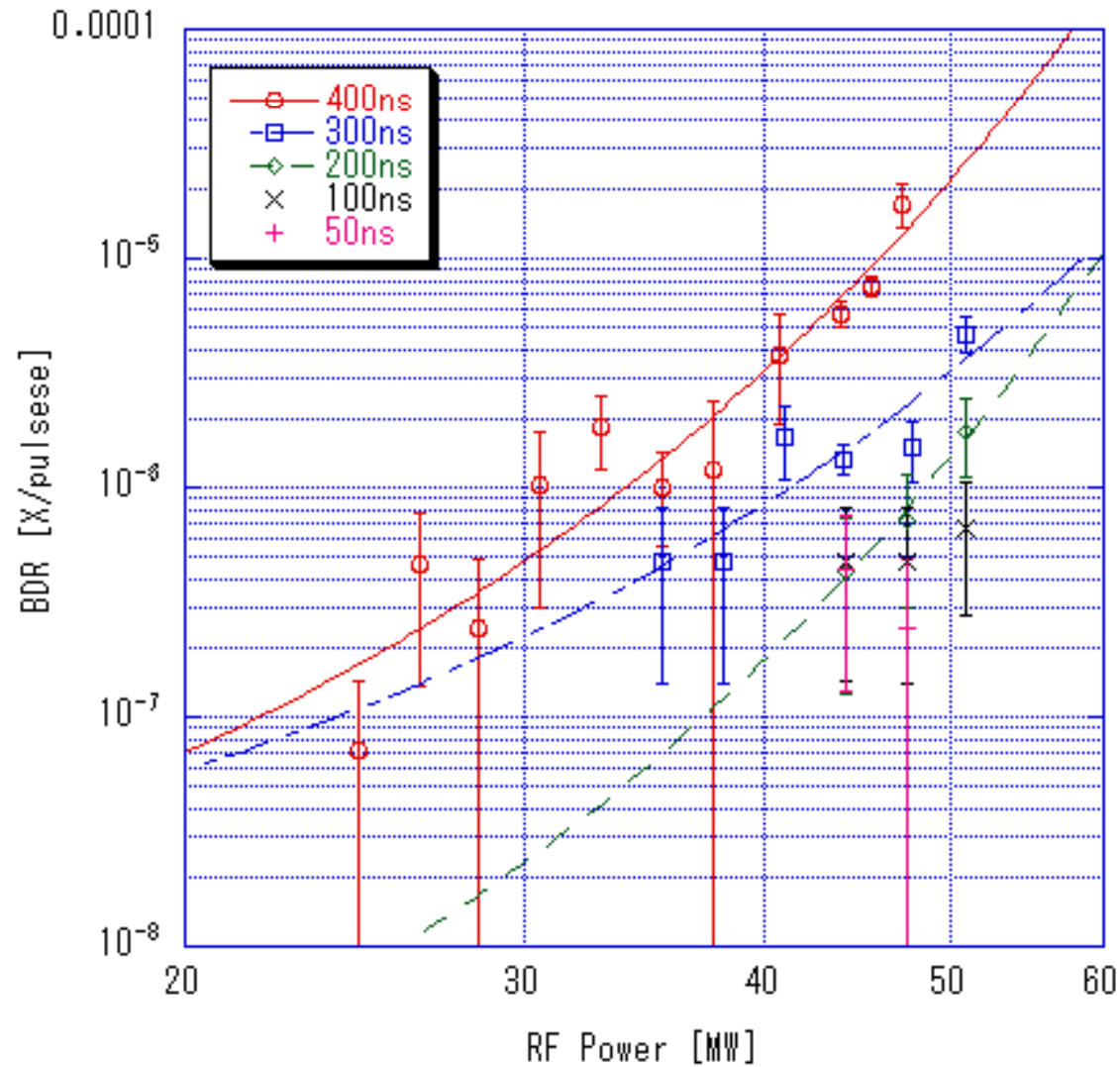

Yokoyama presentation at
LINAC08

#CU002

2mm

2007/07/25

#SUS003

5mm

RF

2008/09/26

(a) #CU002@XTF
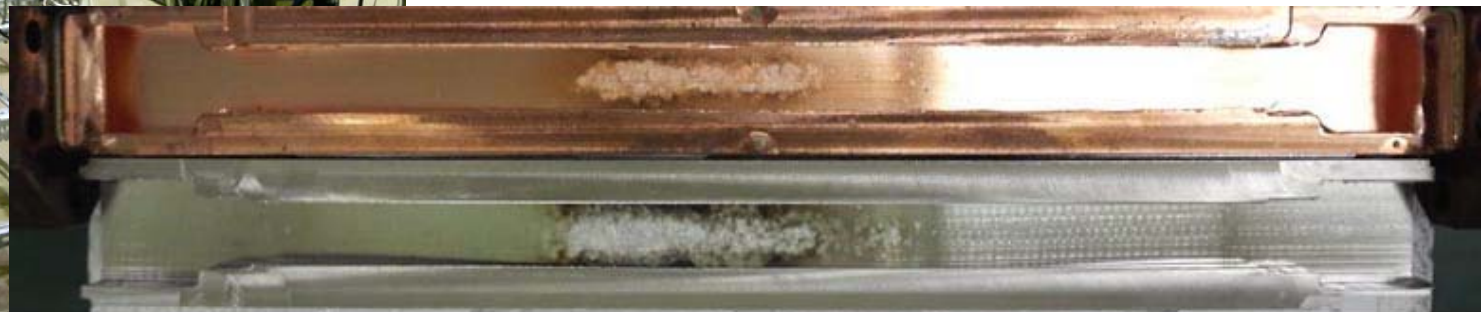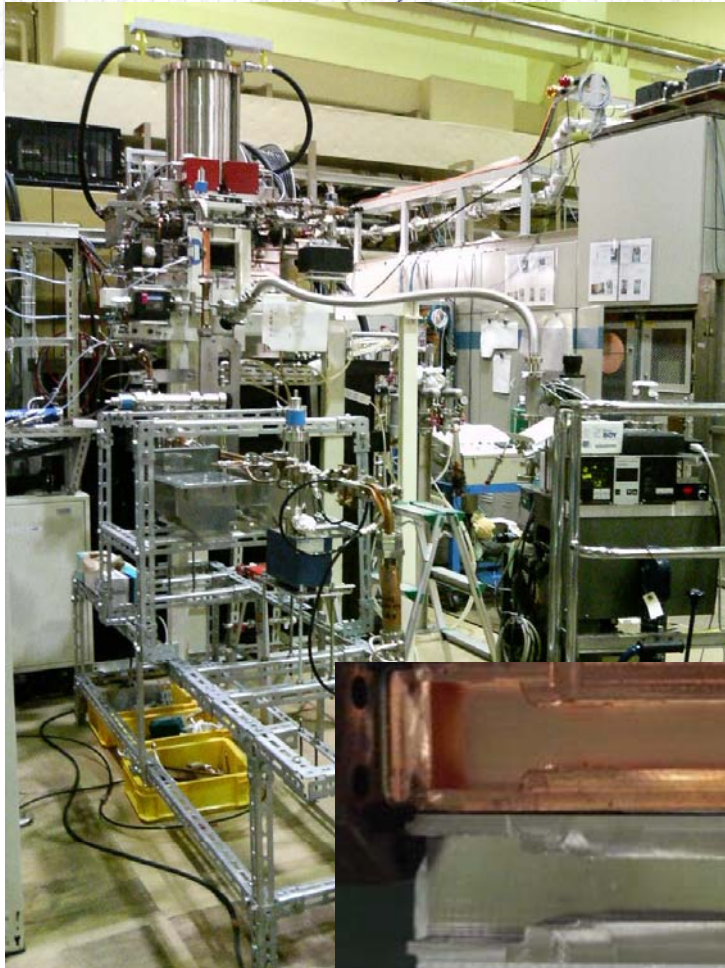
(b) #SUS003@Nextef

Very rough exponential fitting on SUS-003

Summary

- Nextef started processing of T18_VG2.4_Disk. A series of tests are in test schedule, quad, disk-damp, …..

- Further system developments are needed especially on data acquisition and analysis

- We understand it necessary to establish the quantitative comparison between tests among laboratories

- Basic high gradient test is underway with narrow waveguide