Accelerator Activities

K. Oide

14 Dec. 2010

CERN-KEK Committee

1. Crab Cavities (*) (Hosoyama, Nakanishi, Y. Morita, ...)
2. Beam Dynamics (Ohmi, Forest, Molodozhentsev)
3. Proton Accelerators (Omori, H. Kobayashi, ..., JAEA)
4. X-band Structures (Higo, S. Matsumoto, ...)
5. Linear Colliders (*)

(*) Not covered by this talk.

SIMULATION STUDY FOR BEAM-BEAM LIMIT IN HE- AND HL-LHC

K. OHMI

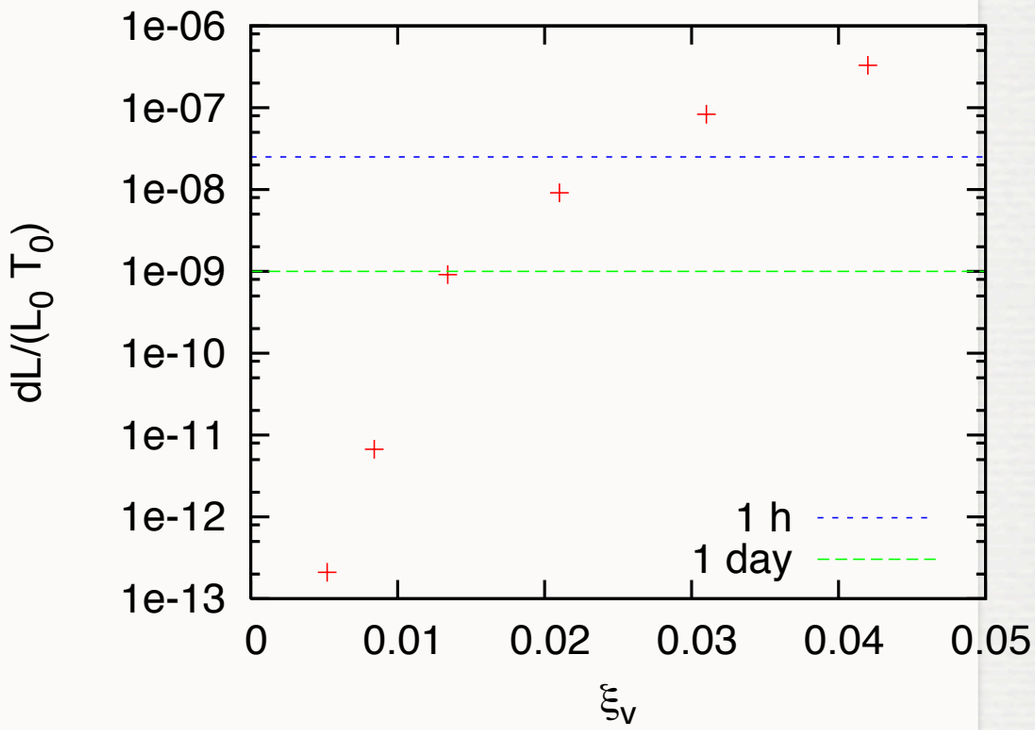
Head-on collision (parasitic collision was not included):

★ Coherent beam-beam instability

* Coherent instability occurs only at very high beam-beam parameter ($\xi \sim 0.15$), thus it does not limit beam-beam performance.

★Incoherent emittance growth

* The beam-beam limits are $\xi \sim 0.0134$/IP for 1 day and 0.025/IP for 1 hour luminosity decay time, respectively (See the right figure).
* The limit is mainly due to the crossing angle.



Luminosity decay rate for the beam-beam parameter/IP

★Effects of the x-y coupling in the beam-beam performance are negligible in LHC, as it is operated with a round beam.

CERN ACTIVITIES SINCE 2000

E. FOREST

- Development of ***FPP*** (Forest, help from F.Schmidt and McIntosh)
- Development of ***PTC*** (Forest, help from F.Schmidt and McIntosh)
- Gluing PTC and ***MAD-X*** (Forest, help from F.Schmidt and McIntosh)
- PTC routines in MAD-X (Schmidt, Skoronski, etc… Forest consulting)
- Insertion of PTC into MAD-X in a "compatibility mode". In other words, PTC can run lattices that MAD-X understands.
- Helping CERN produce some MAD-X PTC modules: this is not really my work. Anyone can use PTC and write modules based on it. (Cornell did with their BMAD)
- Creation of a Siamese and Girder type to handle special magnets linked together
- The creation of a true PTC model of the LHC. This model uses MAD-X to create its input but it is pure PTC. At present it is the most sophisticated model of the LHC. The model understands the double bore magnets as well as the girder structure that support them. In that model there are no clones as in the real machine. In MAD-X, just to give you an idea, the definition of the machine depends on is trajectory! It is a hack. Of course it is not like that in a real PTC implementation.
- Finally Alexander Molodozhentsev installed our version of ***ORBIT*** in a recent trip. We will help them with this. Amazingly, CERN was still running the version of ORBIT based on ***MAD-8***. (Well so does J-PARC!) See next slide.

KEK-CERN collaboration activity
space charge effects and machine resonances

Participants: E. Forest, A. Molodozhenstev (KEK)
Ch. Carli, M. Martini, F. Schmidt, E.Metral (CERN)

2010

→ *Continue development of the combined PTC-ORBIT code (mainly PTC part)*
→ *Installation and compilation the PTC-ORBIT code for the CERN linux cluster*
→ *Space charge effects in the CERN PS booster (preliminary computation)*

Plan for 2011

→ Further development of the PTC-ORBIT code:
→***PTC part:*** *Introduction of time-dependent bending magnets with the edge focusing effect to make a realistic representation of the horizontal chicane, required for the multi-turn charge exchange injection scheme.*

→ Usage of the PTC-ORBIT code to simulate the multi-turn injection process for new CERN PS booster.

This kind of activity will be extremely important for both KEK (J-PARC RCS) and CERN (PS booster with LINAC4).

ADDITIONAL FUTURE PROJECTS

E. FOREST

- Forest is *not sure* about the **LHC model**: too late. The MAD-9 disaster delayed everything and made them initially ultra-conservative. Schmidt reports "amazing" agreements….hum. It will take many years for these ideas to take root.

- **Spin**: there is a lot of studies at CERN that will require spin. It is already in MAD-X and, as you know, Forest already told them how to trivially extend their TWISS command to include spin.

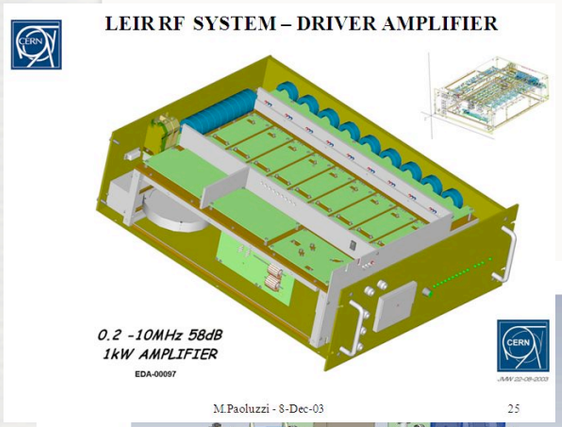
- Of course Forest is working with Barber (Abell too) and Yang(BNL) to document the ideas behind his work. They requested it.

COLLABORATION ON RF SYSTEM FOR PROTON ACCELERATORS

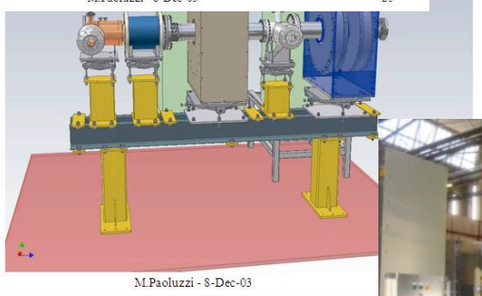
C. OHMORI, *et al*

2003-2005 CERN-KEK RF Collaboration

CERN to KEK: Technologies on semiconductor amplifiers for J-PARC.
KEK to CERN: Technologies on MA cavities for the Low Energy Ion Ring.
Effective to both sides.



100 units of the semiconductor amplifier were produced in Japan



LEIR, Mar. 2005

The Pb ions accelerated at LIER were eventually used for collisions at LHC.

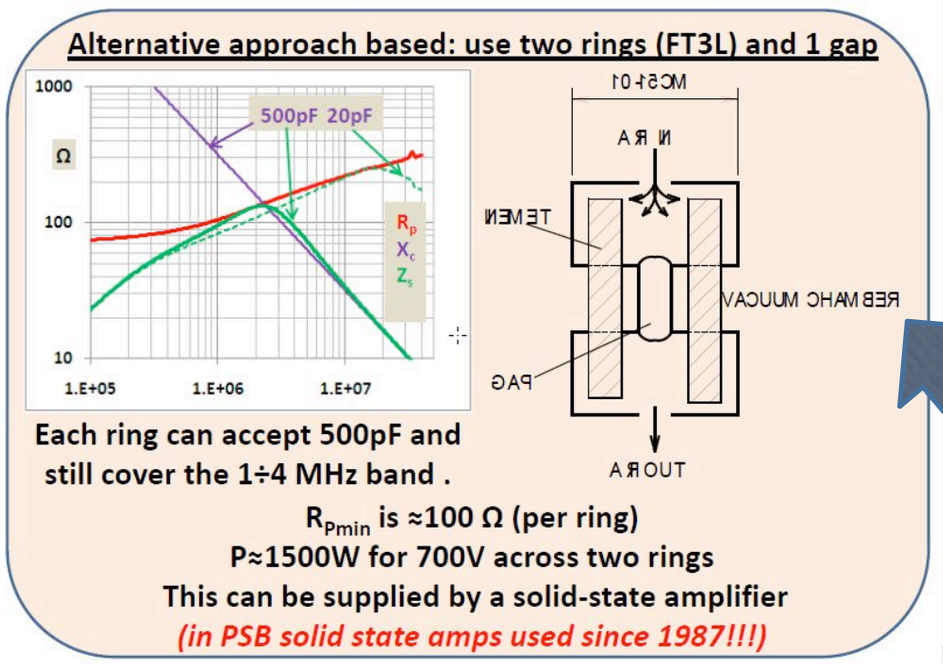
The upgrade plan of PSB:

FINEMET(new material FT3L) cavities are under consideration for the energy & intensity upgrade of PSB.
Discussions were made with Dr. Paoluzzi in Nov. 2010.

Production of the FT3L core（φ350）for PSB will be made possible by the new large furness planned at Hitachi Metal capable up to 500Φ.

2011年　4 cores
2012年　30 cores
2013年　150 cores

As there are many common subjects between CERN and KEK/J-PARC, such as MA cavities, amplifiers, LLRF, beam handling with second harminic, etc., we hope the collaboration continues, including exchange of people.



現在のフェライト空洞

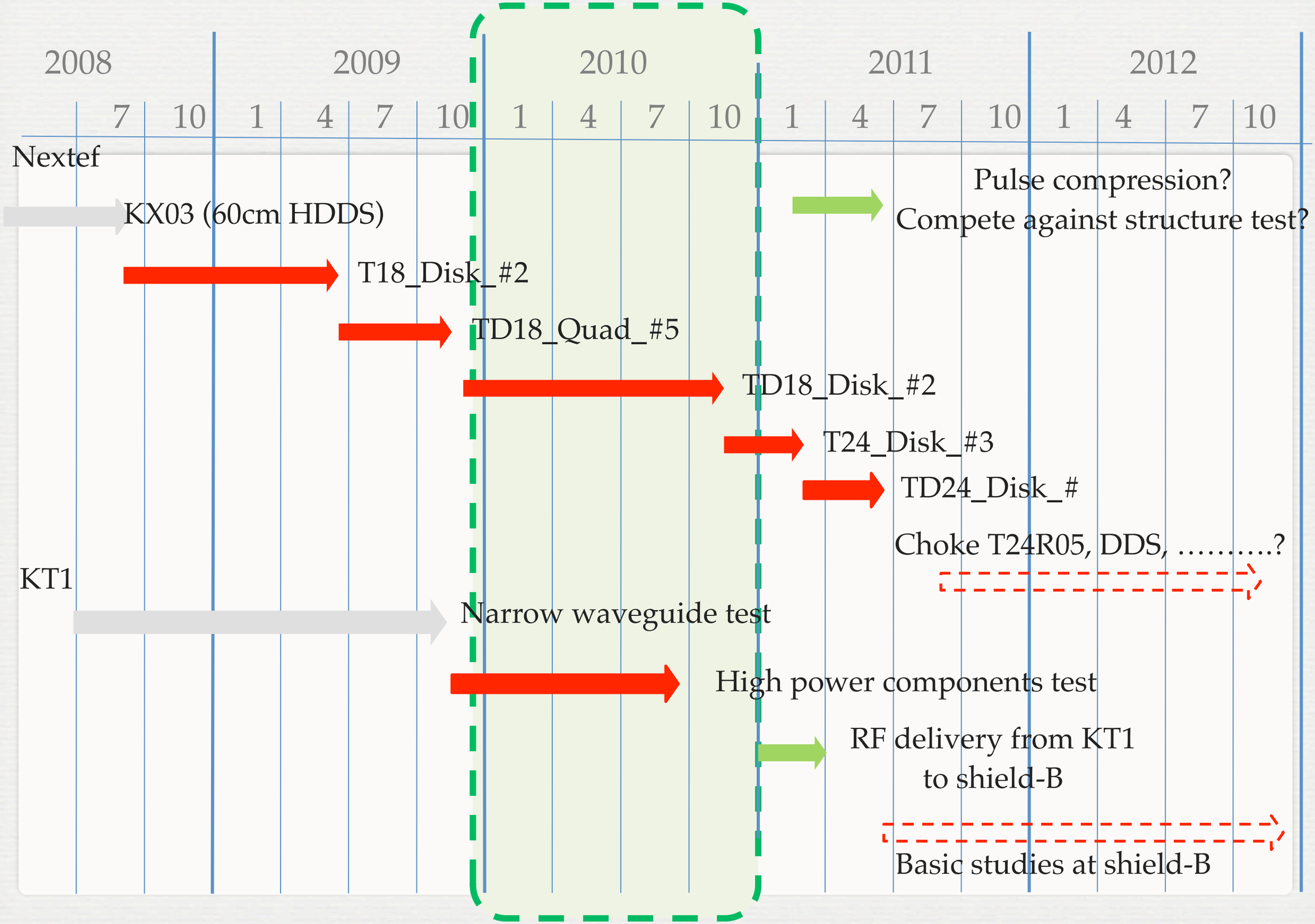
Paoluzzi:　加速器セミナー(11月24日）より http://www.kek.jp/acc/seminar/default.html

ACTIVITIES CENTERED AT CLIC HIGH-GRADIENT ACCELERATOR STRUCTURES IN JFY2010

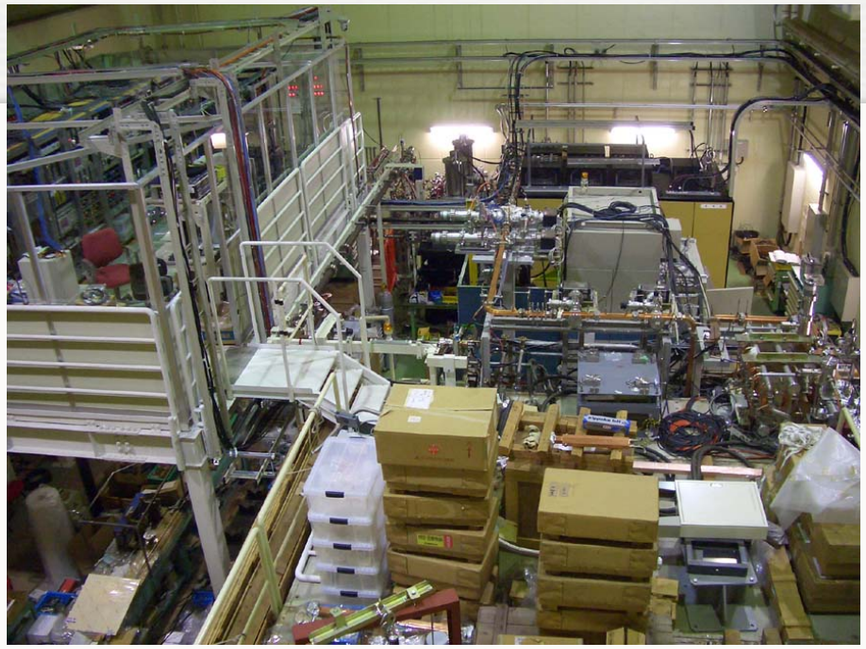
T. HIGO

- **Nextef** has been running fully dedicated for the feasibility study of CLIC high gradient accelerator structures.
  - TD18 was tested for **4000 hours** to compare with T18
  - Compared SLAC's result to KEK's.
- Nextef will boost peak power and high power stability by introducing pulse compression system.
- Nextef will establish a new test area for basic studies
- Components such as CERN-made RF loads were high-power tested.
- KEK made two pairs of prototype structures, T24 and TD24 in collaboration with SLAC and CERN.

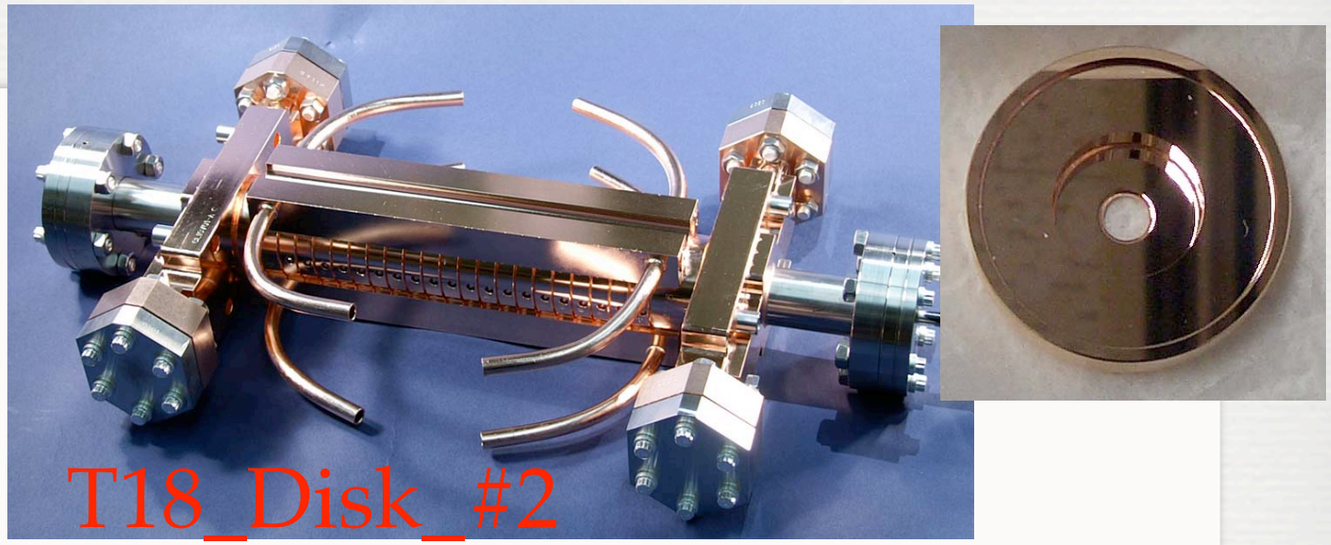
X-BAND STUDIES AT KEK



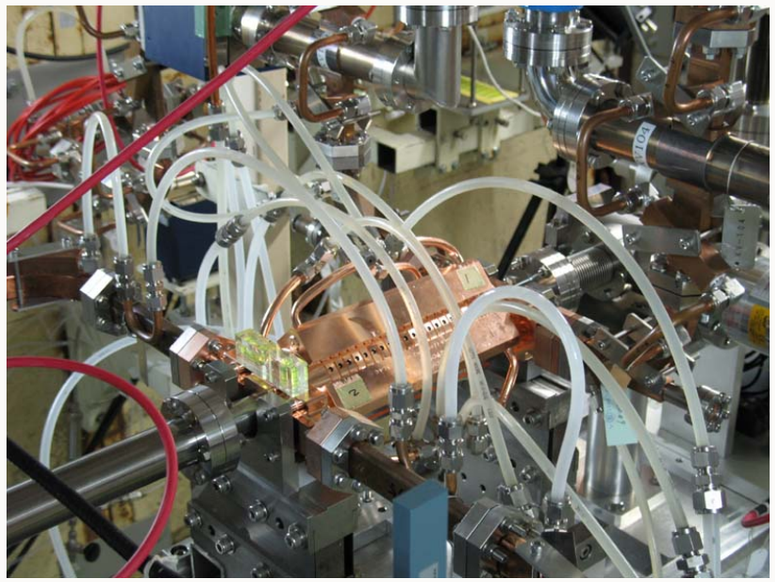
RECENT YEARS WE COMPARED T18 AND TD18



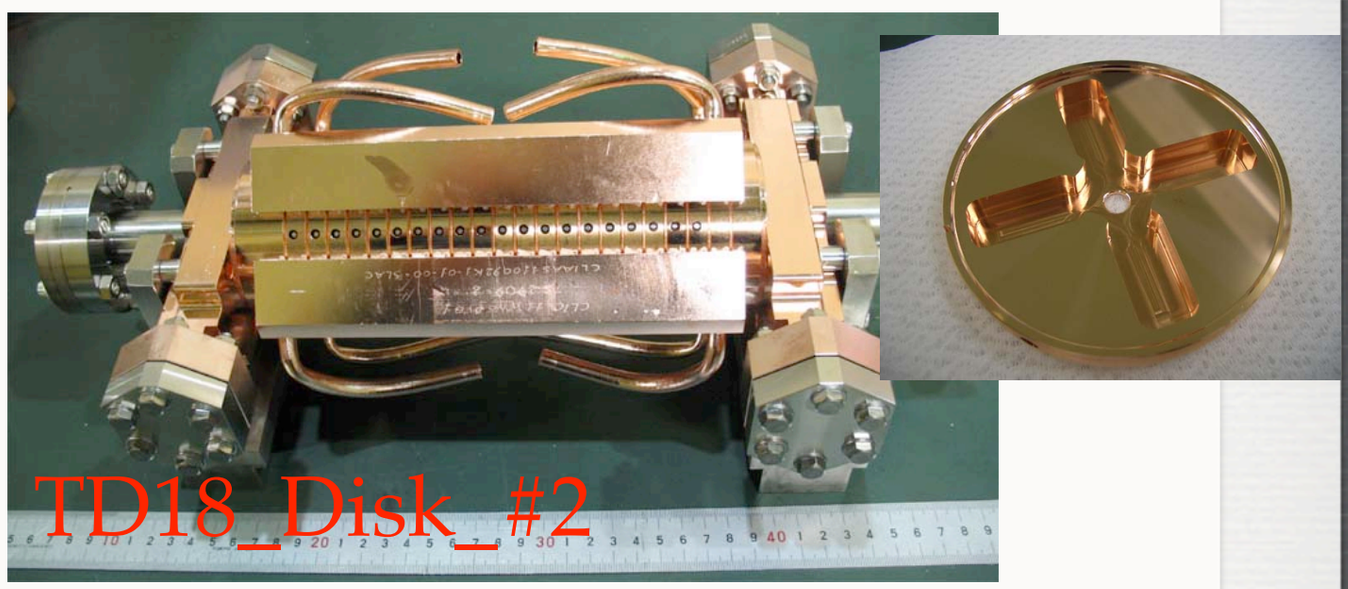
Nextef



Structure tested in JFY2009



Structure under test

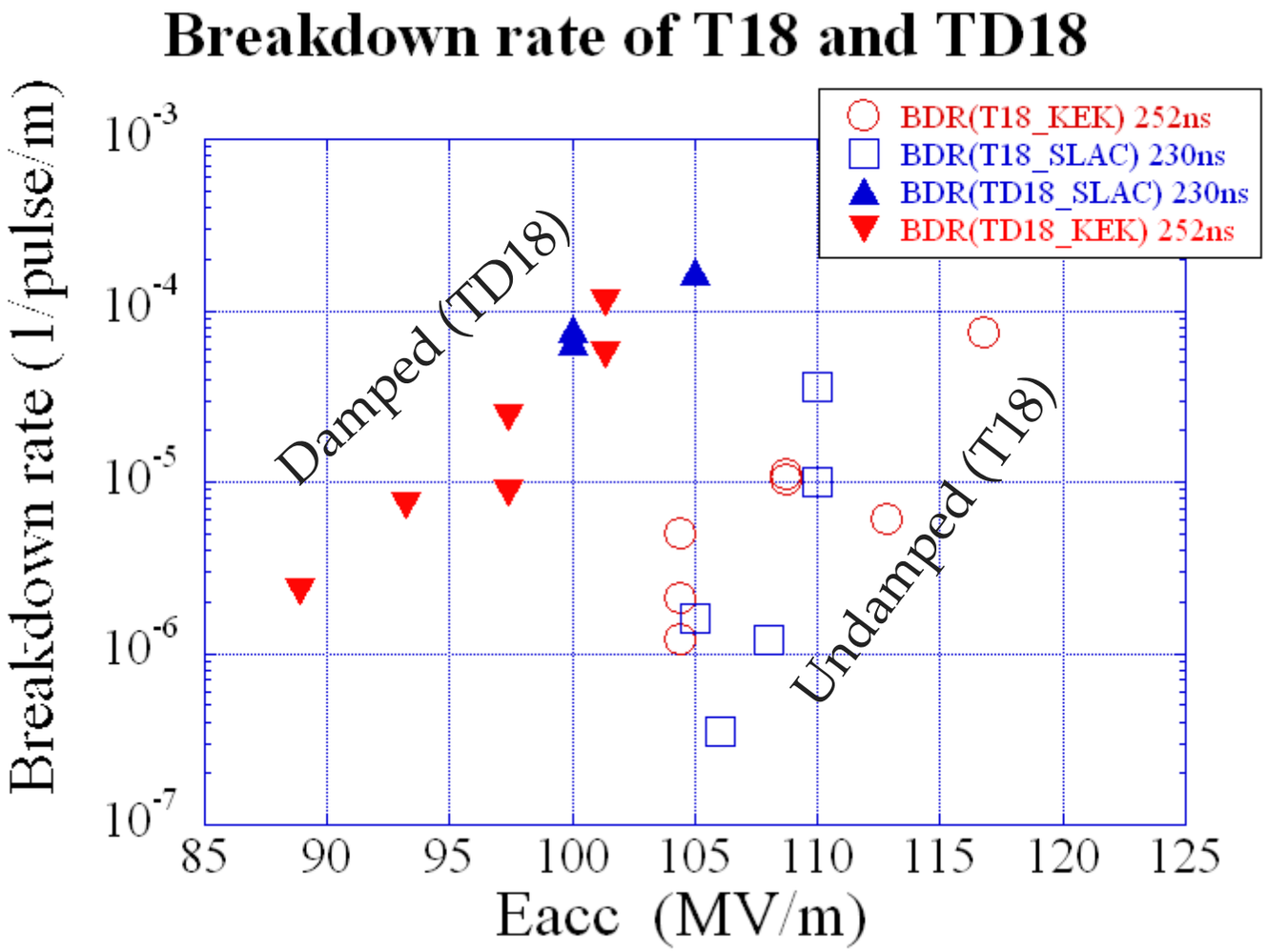


Structure tested in JFY2010

BREAKDOWN RATE WAS HIGHER IN DAMPED STRUCTURES THAN UNDAMPED ONES

△ ○ T18 (undamped) vs ▲ ● TD18 (damped)

SLAC vs KEK



KEK pursued the processing and breakdown rate evaluation in much longer period than SLAC.

KEK result basically agrees to that of SLAC.

A SPECIAL EVALUATION: DOUBLE PULSE

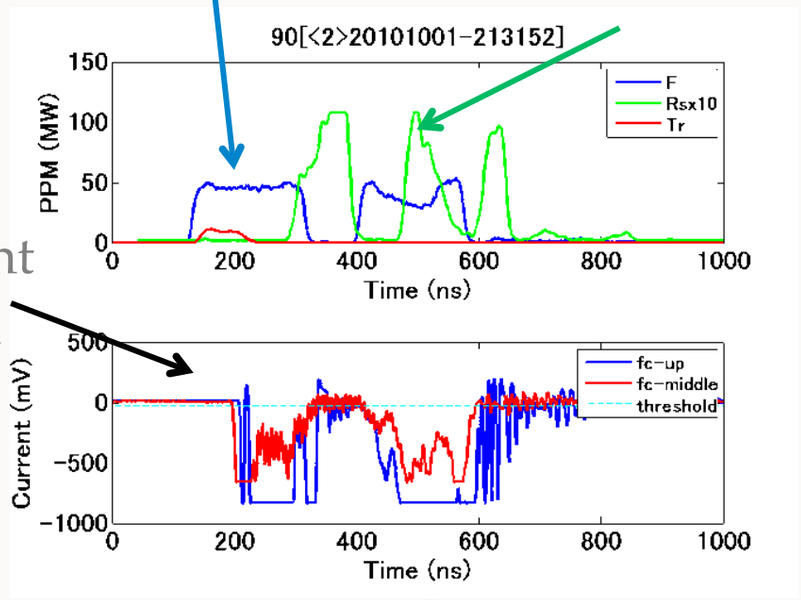
Breakdown started at the first pulse

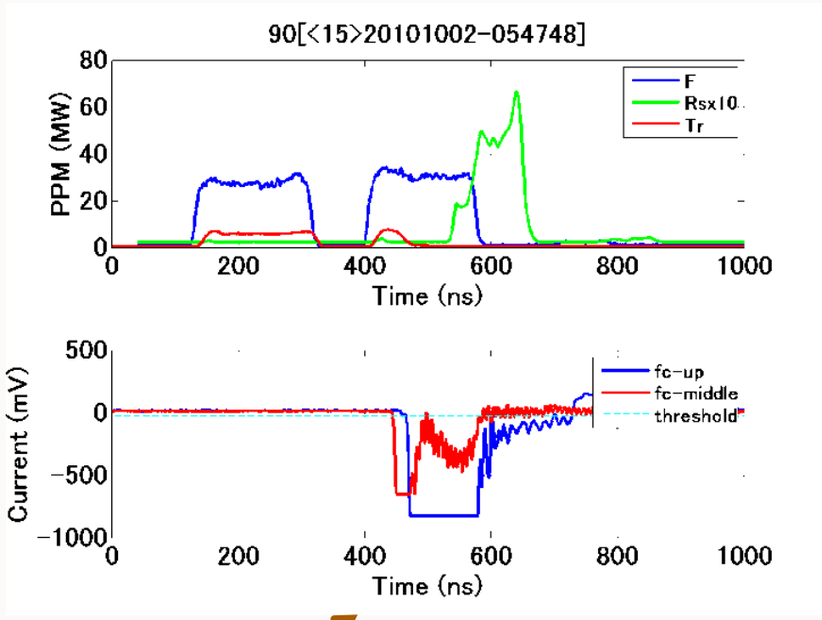
Breakdown started at the second pulse

Input power

Reflection

Current flush



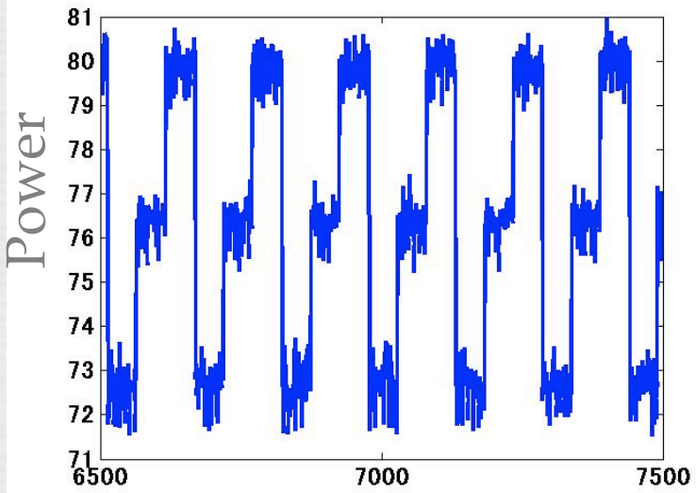


Integrated number of breakdowns

Probability of the breakdown start timing for both **the first and the second pulses are the same**. Breakdowns in two pulses are almost independently triggered.

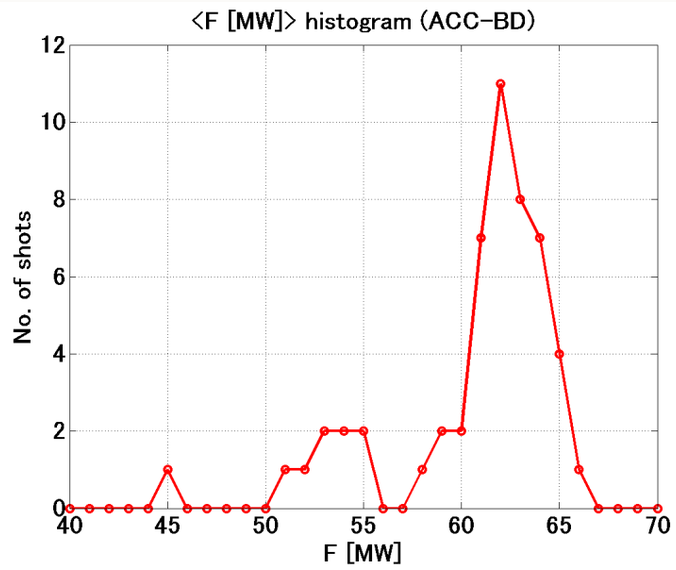
ANOTHER SPECIAL EVALUATION
SWITCHING AMONG THREE POWER LEVELS IN EVERY SECOND

Switching the power level



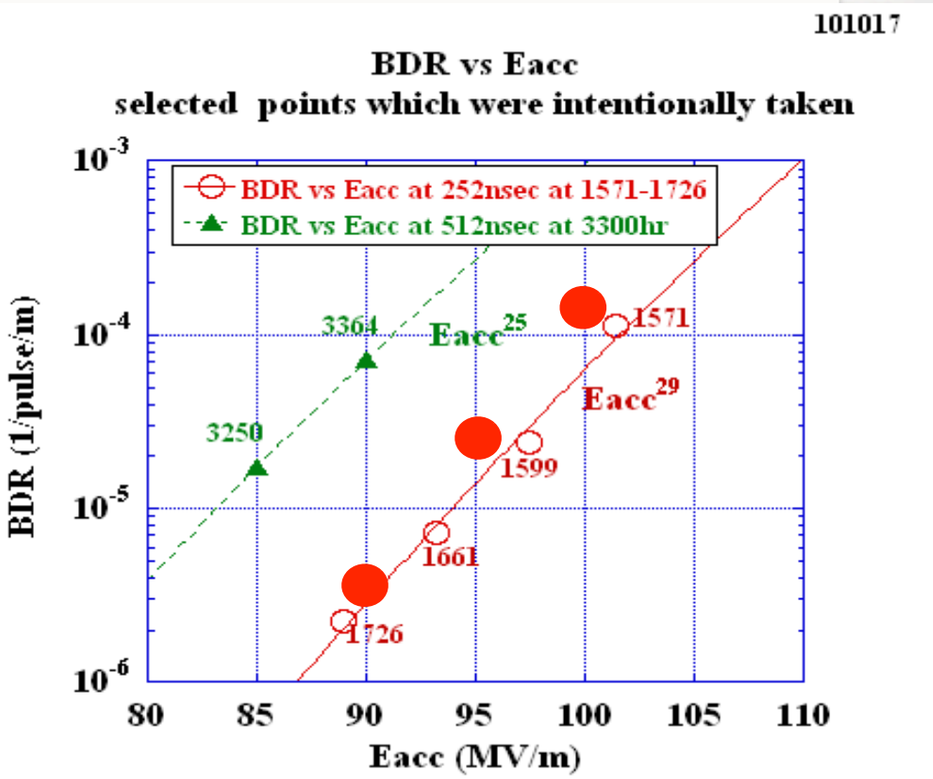
Time

Breakdown vs power level



Peak power level

Breakdown rate



The breakdown rate with three levels was just the same as the case with single power level.
No interference from nearby pulses in time.

NEXTEF IS EXPANDING!!

The pulse compression and
the KT1~B line In early 2010