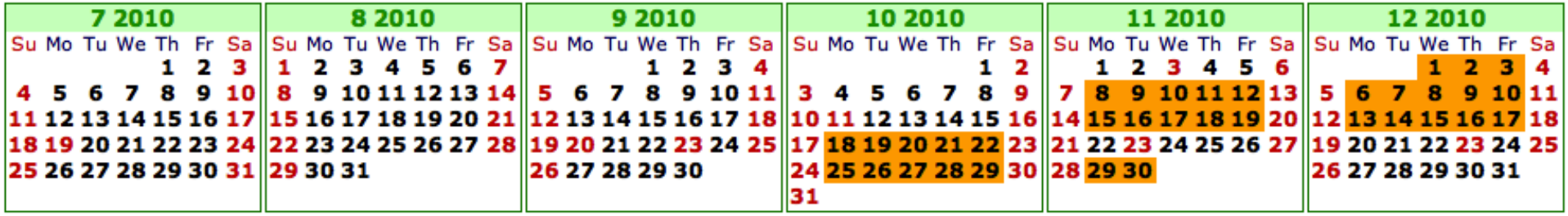
Recent Status of ATF

N.Terunuma, KEK

- **R&D highlights**
  - **3.5 cells RF Gun**
  - **Upgrade of the DR BPM Readout**
  - **Fast Kicker**
  - **4-mirror Compton Generation**
- **Hardware maintenance issues**
- **Brief report on the fire accident and the earthquake**

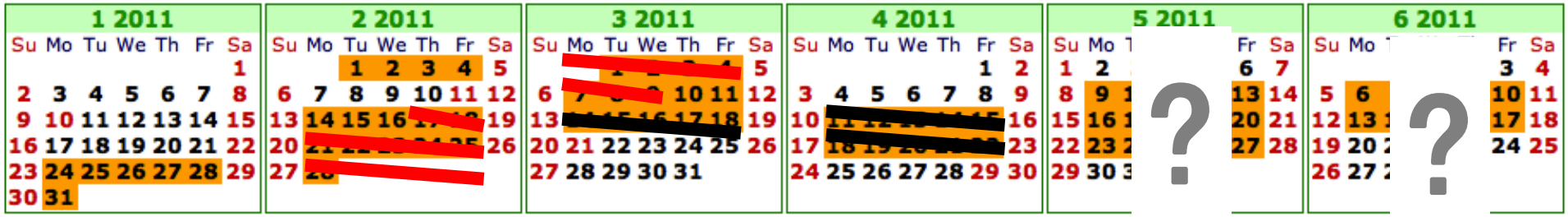
2010 Autumn/Winter Run



Beam operation: 7 weeks

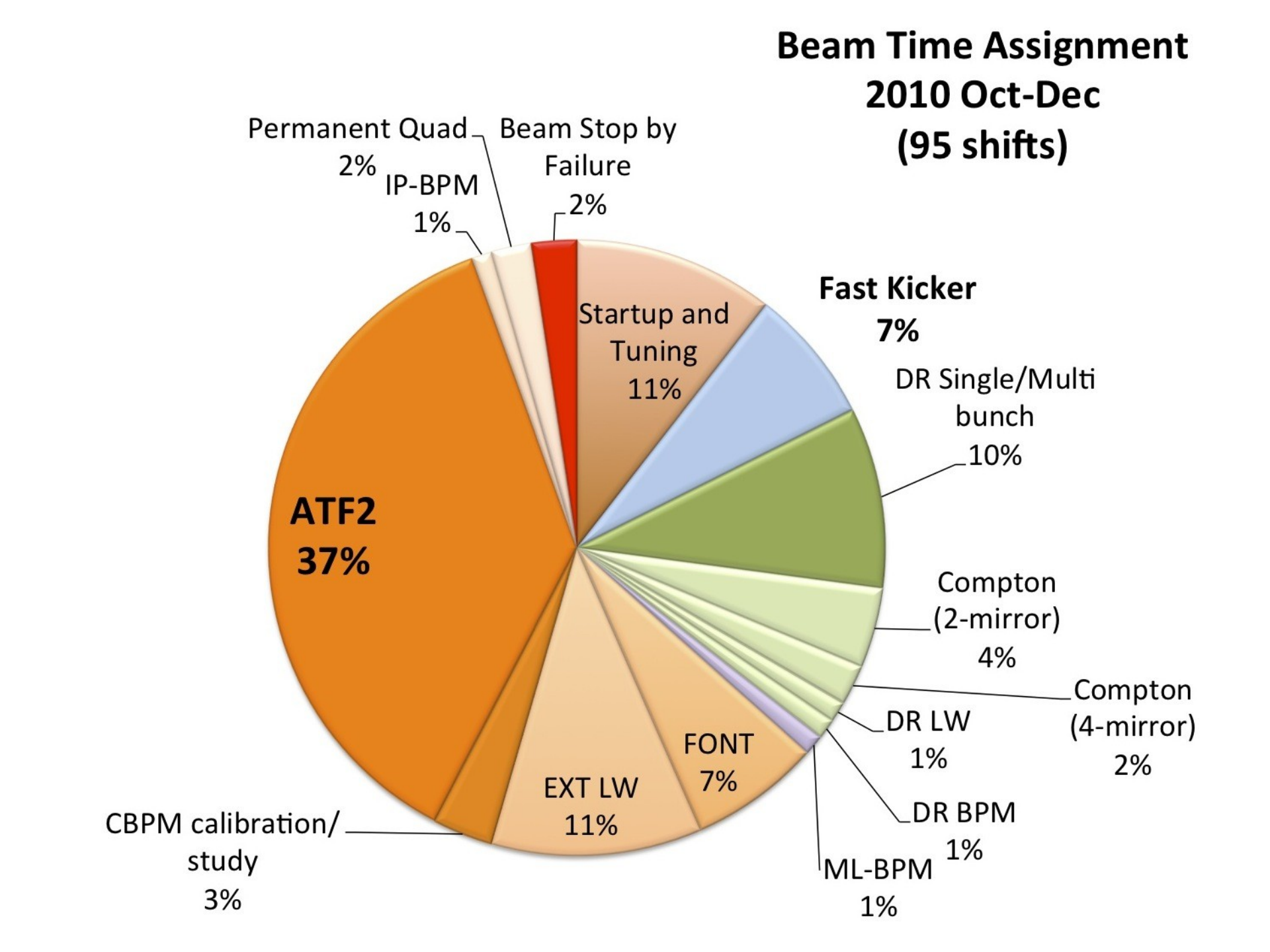
- Fast kicker mode … 2 weeks
- ATF2 continuous run … 1 week

2011 before summer

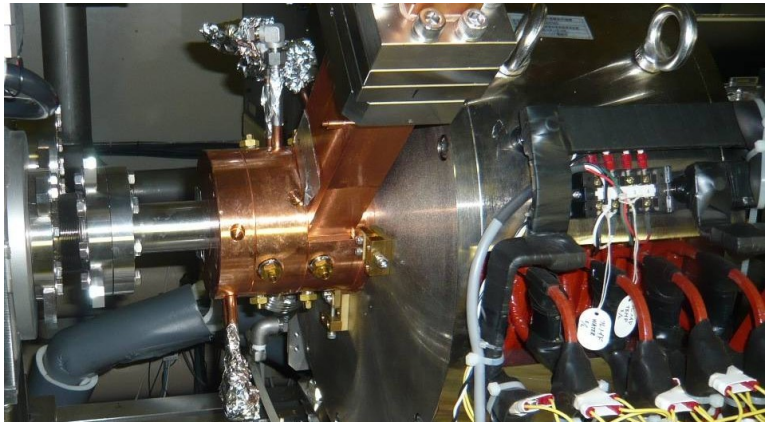


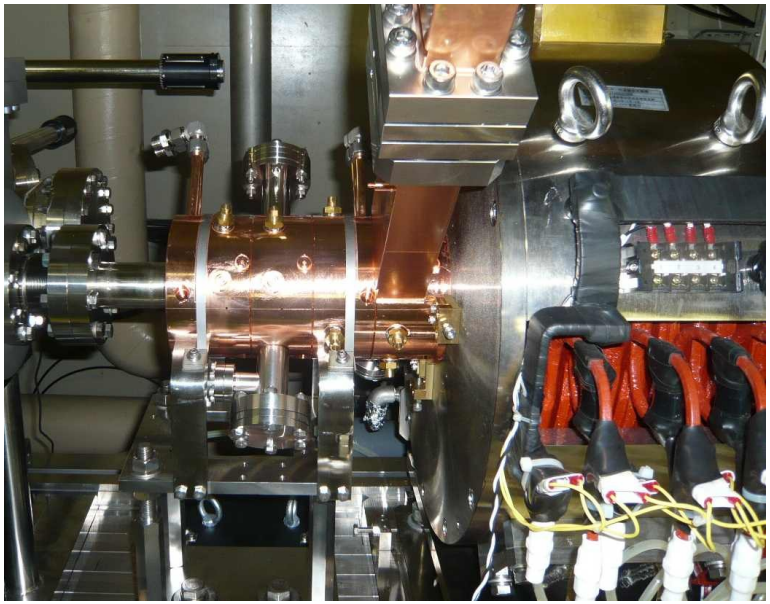
First priority is ATF2-37 nm until the end of March.

… 7 weeks


Beam Time Assignment
2010 Oct-Dec
(95 shifts)
Permanent Quad
2%
IP-BPM
1%
Beam Stop by
Failure
2%
Startup and
Tuning
11%
Fast Kicker
7%
DR Single/Multi
bunch
10%
ATF2
37%
Compton
(2-mirror)
4%
Compton
(4-mirror)
2%
DR LW
1%
DR BPM
1%
ML-BPM
1%
FONT
7%
EXT LW
11%
CBPM calibration/
study
3%

RF Gun Renewal





2009 Oct: Upgraded **1.6 cell RF gun** was installed.

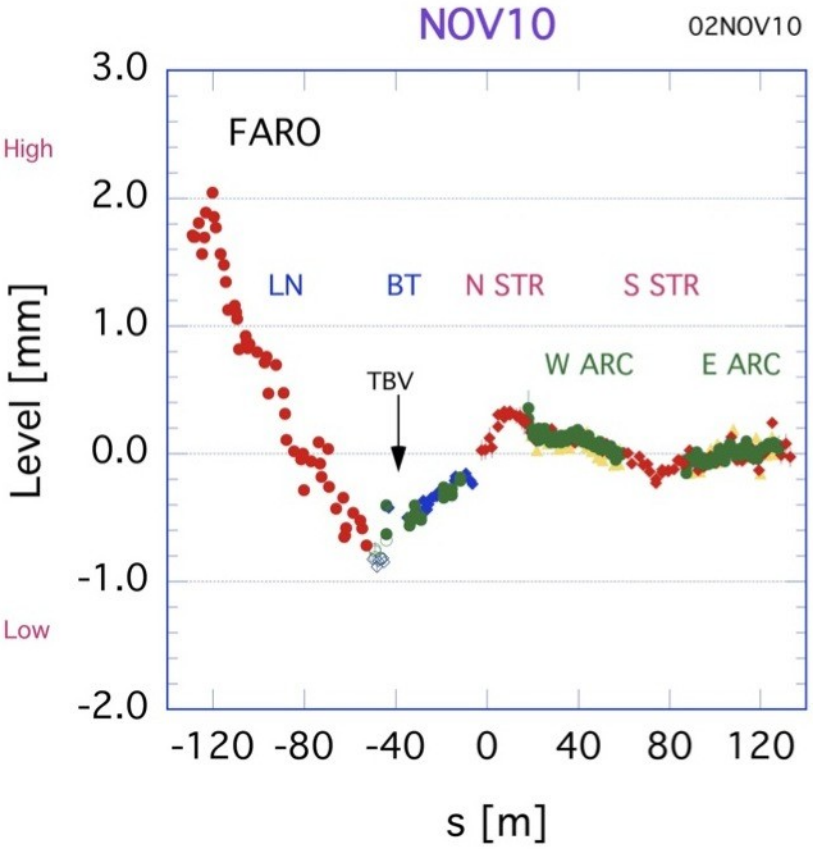
2010 Oct: **New 3.5 cell RF gun was installed** to assist the developments on Compton X-ray program (LUCX).

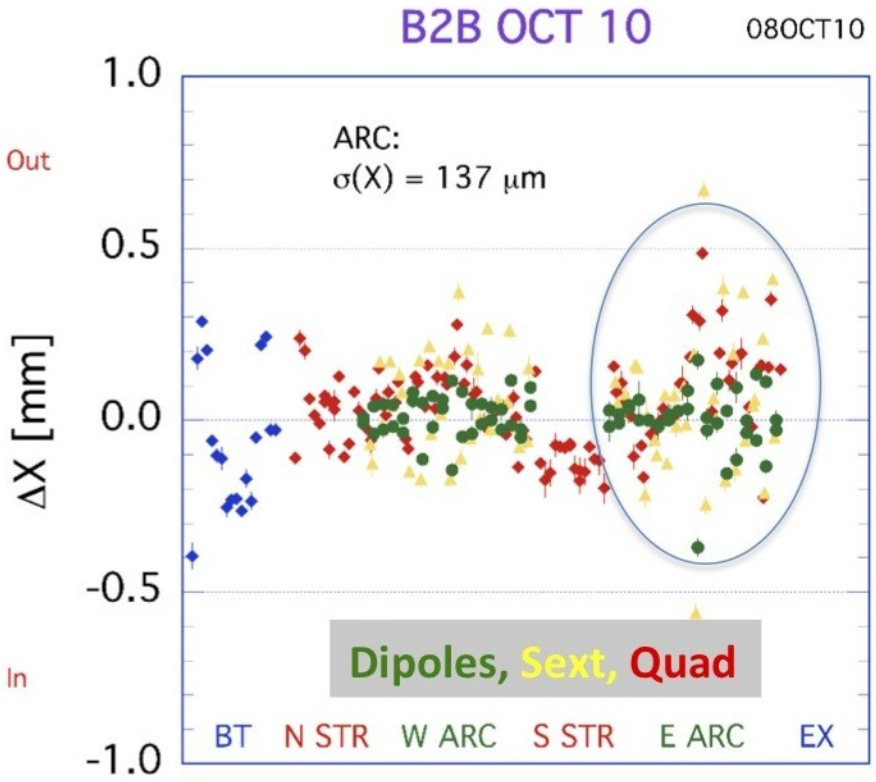
- It is a mode-separated RF gun based on the LUCX RF-gun (1.6 cell) installed in 2009.
- Increase the tolerance of phase stability
- Aim to increase the beam energy 5→10 MeV

Alignment: Gun to DR

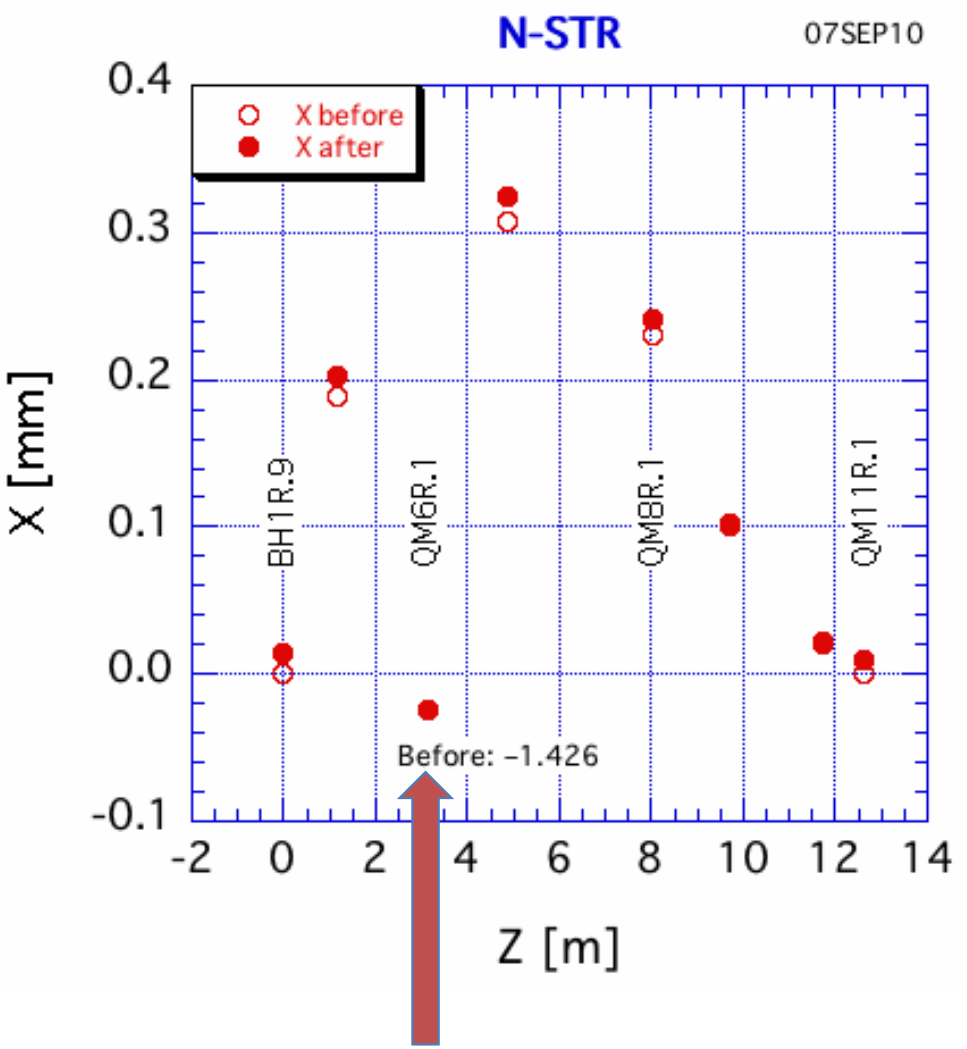
In the summer shutdown, we surveyed the magnet positions of whole ATF beam line.

We found the bigger rotation in some DR tables especially in the east arc.
→
East to north section was corrected in Jan. 2011





Alignment: DR North(Inj/ext)



During the survey of the magnet positions in summer, we found a huge position shift on QM6R.1 (just after the ext-kicker); X~1.4mm, Y~0.25mm.

We do not know when it happens.

- during the fast kicker installation in July??
- **Corrected in September**.

ATF DR BPM Hardware

Fermilab

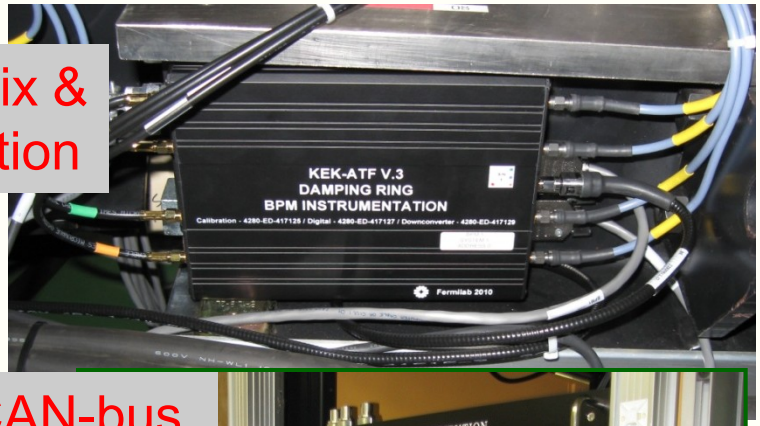
Analog downconverter (located in the tunnel)

- CAN-bus controls, IF filter, remote diagnostics, etc.

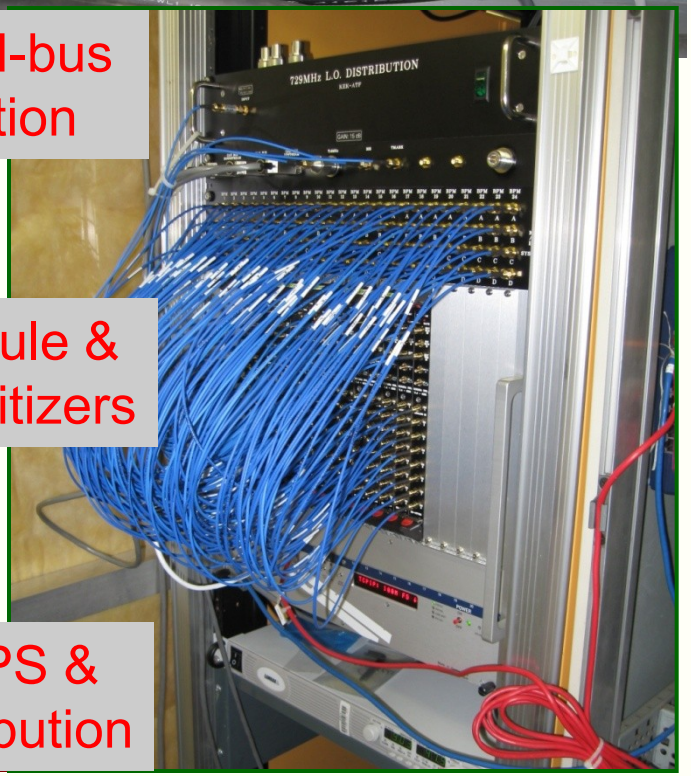
RF, DC & CAN-bus distribution. Grounding of tunnel hardware.

In-house VME digitizer

- 8-ch. ,125 MSPS ADC (serial outputs), Cylcone III FPGA, PLL-locked CLK distribution
- Able to measure Injection TBT, narrowband orbit, narrowband CAL orbit, and last turn on every injection



Downmix & Calibration



LO & CAN-bus Distribution

Timing Module & Custom Digitizers

DC PS & Distribution

Digital Signal Processing

- **No Modes** - on external trigger processes data in parallel
  - TBT Filter
    - provide magnitude per turn for position & intensity
  - Narrowband processing (Filter & Decimate)
    - Provide magnitude of I,Q for position & intensity
    - Store array of I,Q per channel for readback
  - Raw ADC data to RAM
    - diagnostic readback
  - Programmable trigger delay per channel (adc samples)
- Any data type (NB, TBT, Raw) can be readback after each trigger
  - All data will be read out as I,Q pairs
  - Caveat: The CAL tone has to be disabled for TBT data
  - Each board pulls IRQ when data is ready

Fast kicker study

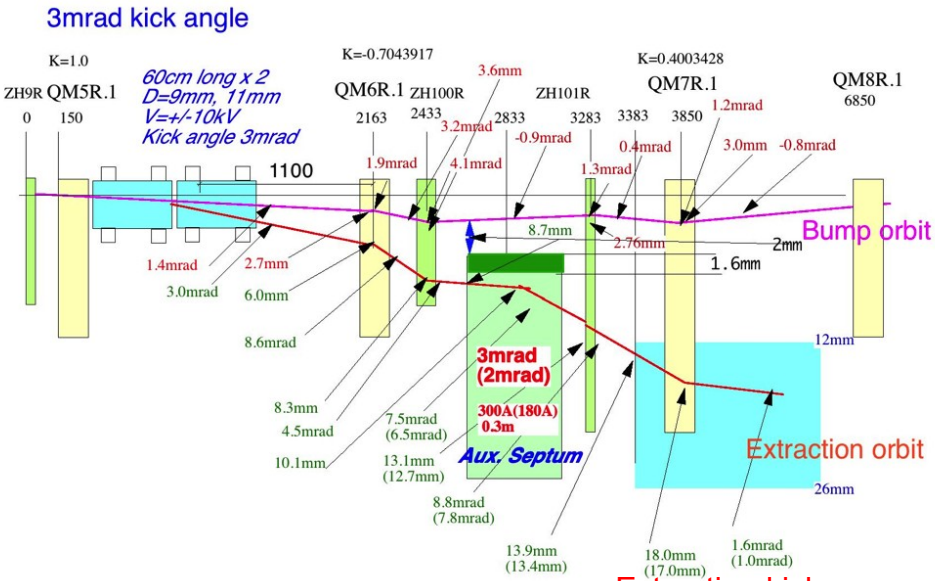
Machine Time

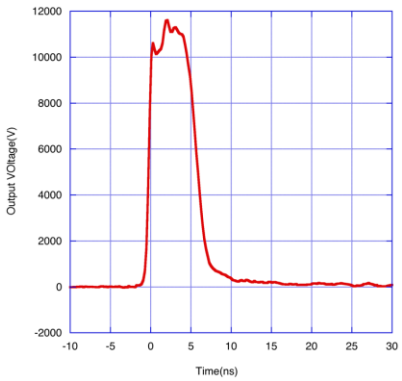
2011/10/18~10/29(2 weeks)

TB meeting
2011/01/14 T.Naito

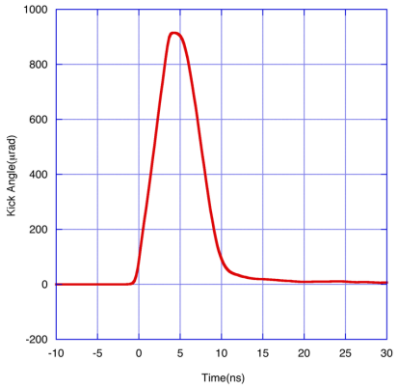
Beam extraction test(1)

- The beam extraction test was carried out to confirm the performance of the strip-line kicker.
- The pulsed magnet kicker was replaced to two units of 60cm long strip-line kicker.
- To help the lack of the kick angle, a local bump orbit and an auxiliary septum is used.

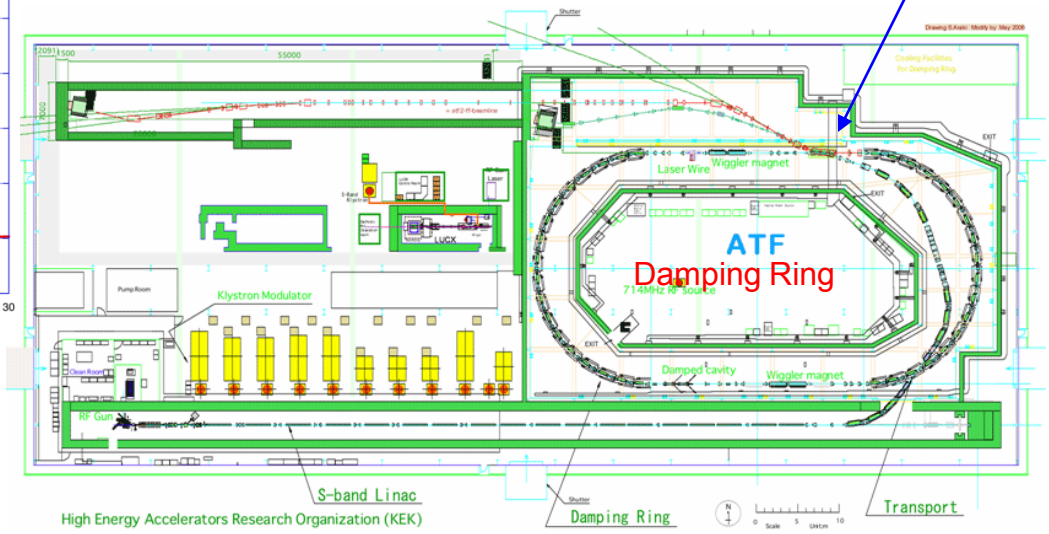




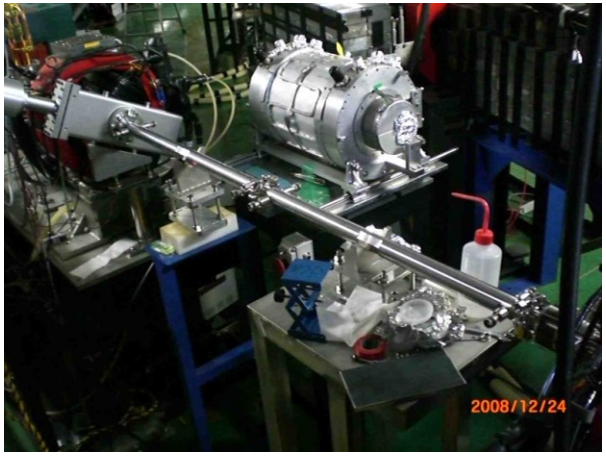
Kicker pulse (10kV)



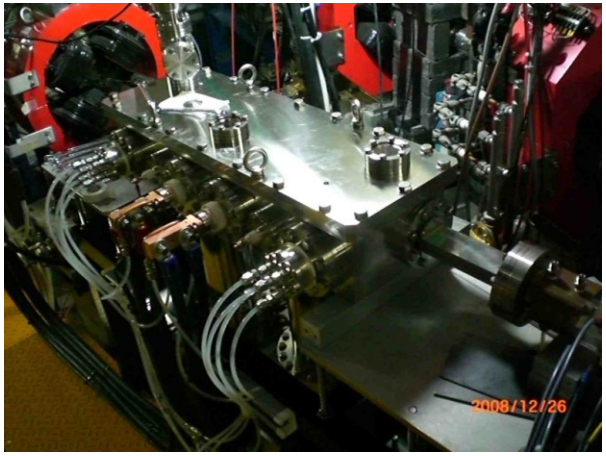
Kicker field



Pictures of the installed components



Strip-line electrodes



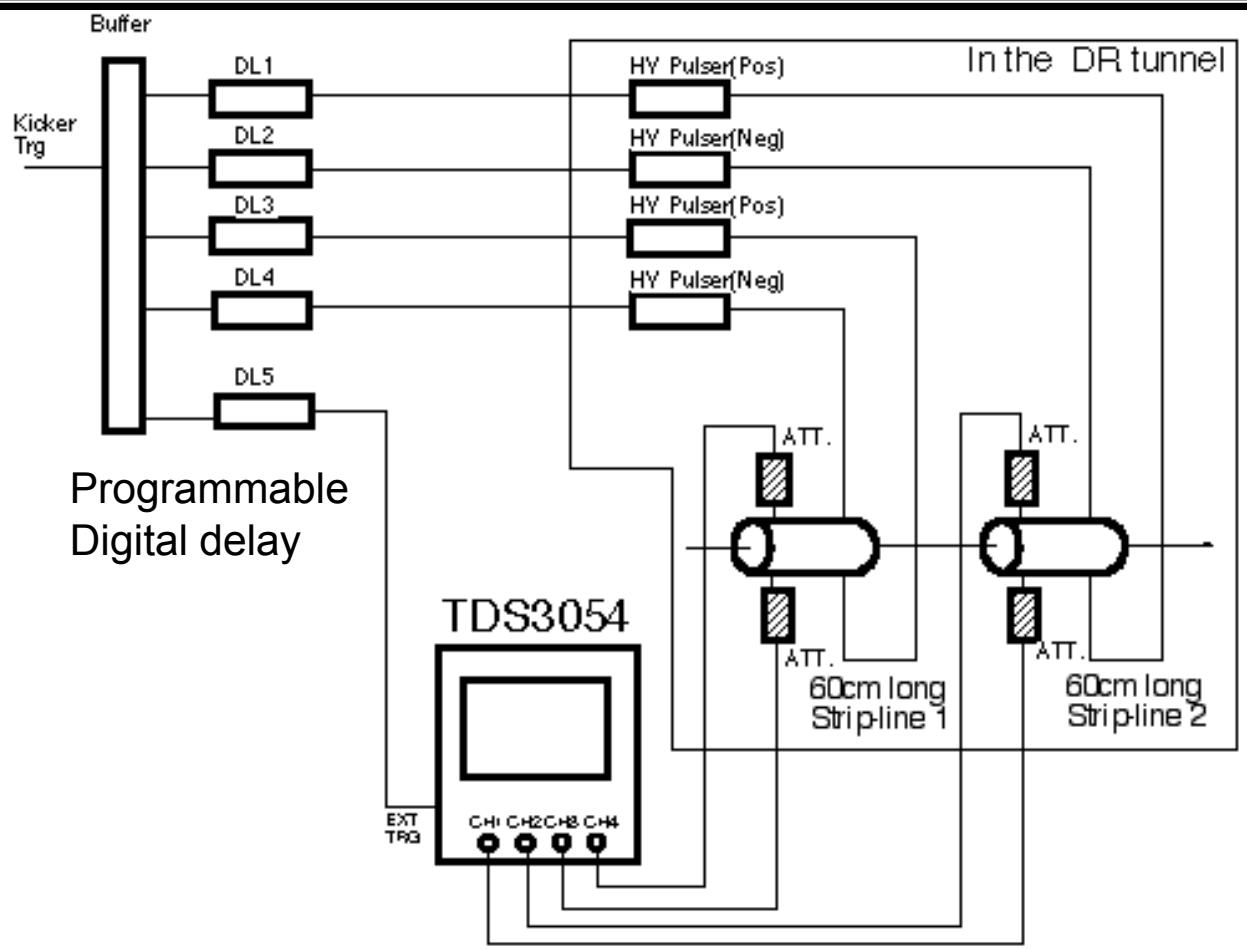
Aux. Septum

FDI pulsers

Bump PS and Septum PS

Trigger timing FB for Strip-line kicker

20080115 T.Naito

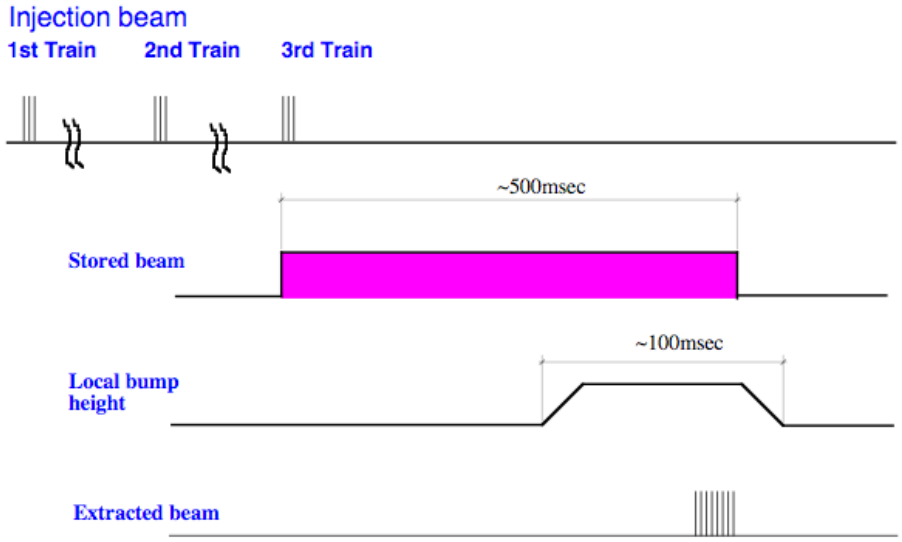


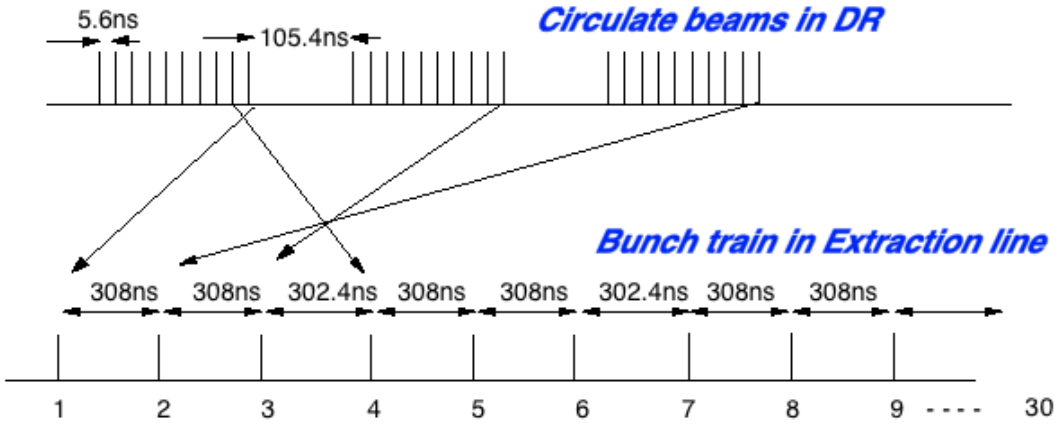
Precise triggers for each pulser and the timing control is required. The pulse measurement by the scope and the timing control by digital delays consist the trigger timing feedback. The step of the digital delay is 60ps. The trigger system could keep the pulse timing in the range of 200ps.

Beam extraction test(2)

The time sequence is that ,

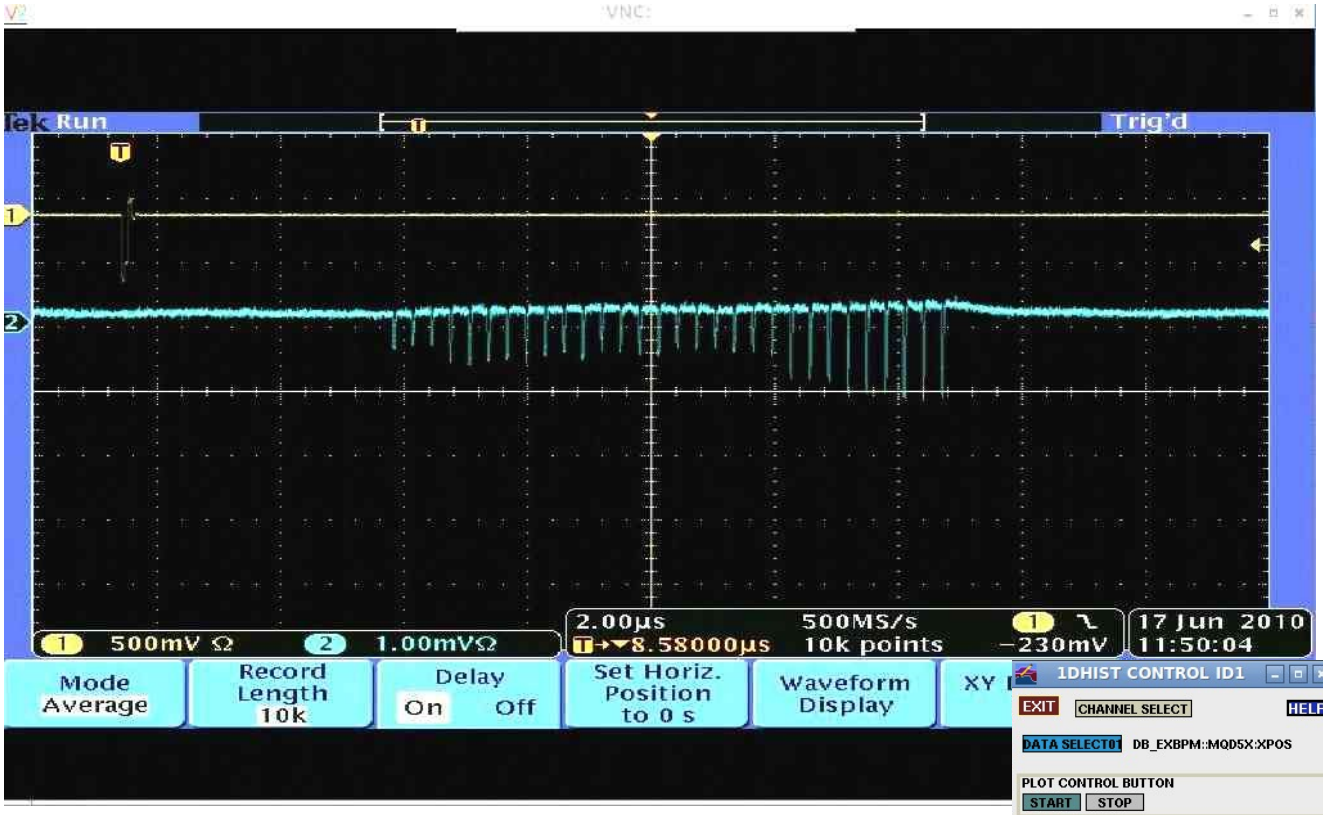
1. 10 bunches with 5.6ns bunch spacing beam is injected to the DR three times, 30 bunches total.
2. The local bump orbit is excited gradually after all of beam is damped.
3. The beam is kicked out bunch-by-bunch by the strip-line kicker.
4. The local bump orbit is return to zero.

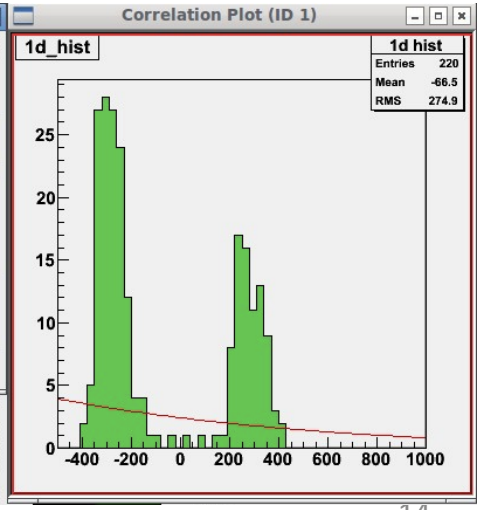




Multi-bunch extraction (30 bunches) with 308ns bunch spacing

2010/06/17

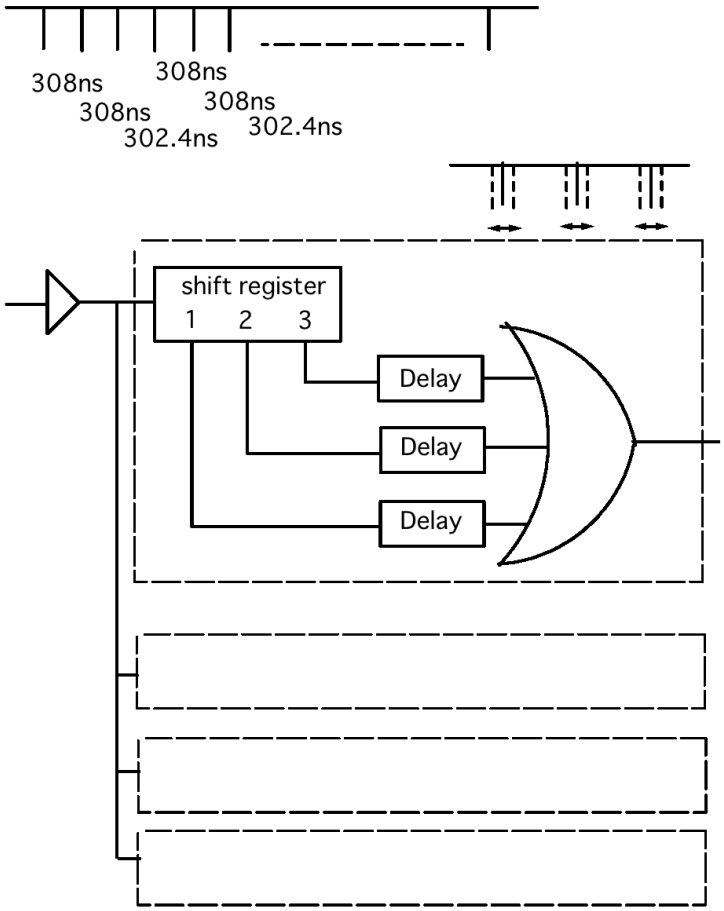




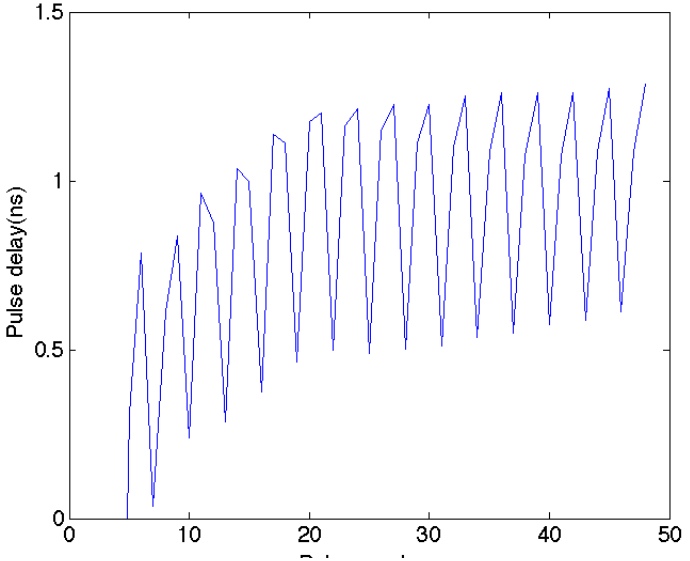
The intensity of each bunch is not flat and unstable.

The horizontal beam position was distributed to two position.

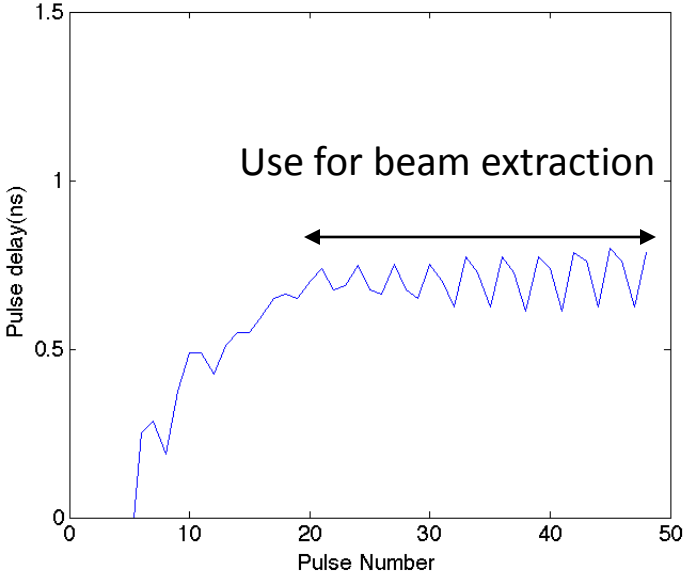
Pulse train delay adjustment circuit



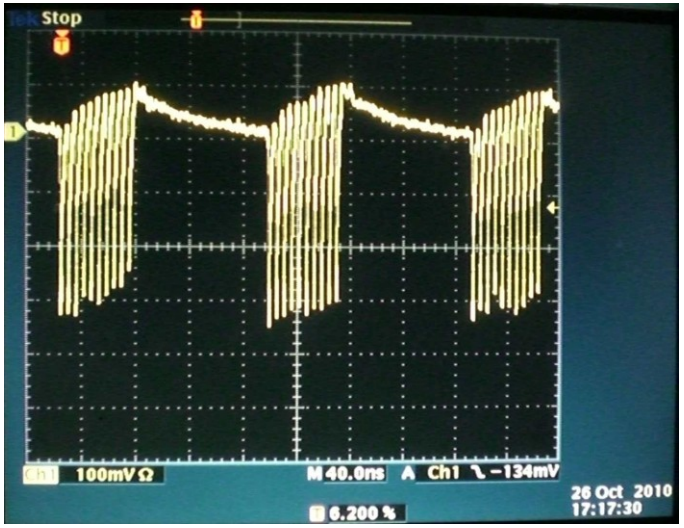
w/o delay



with delay

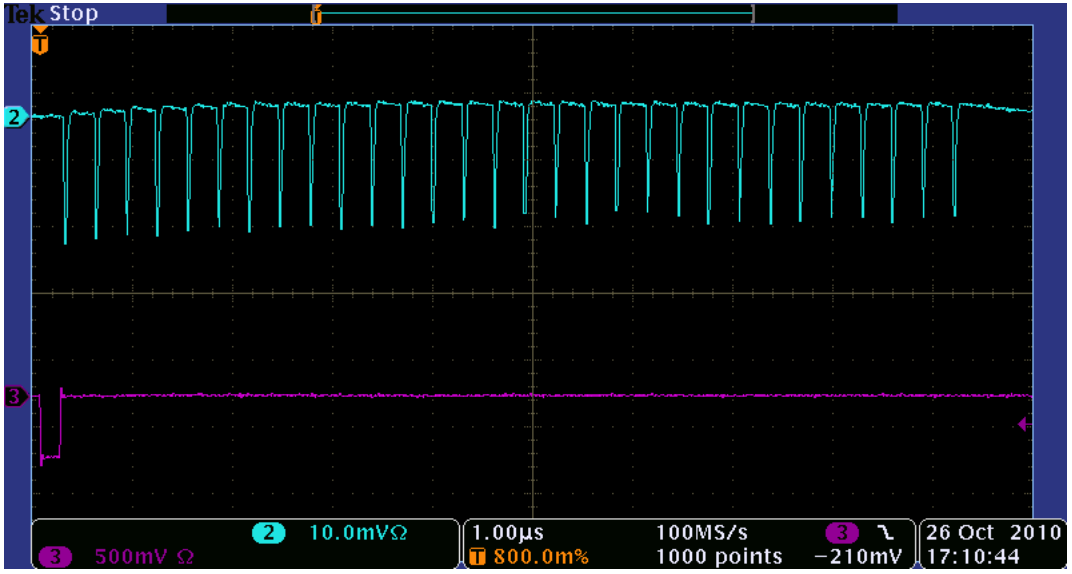


Multi-bunch Beam in the DR and the extraction line



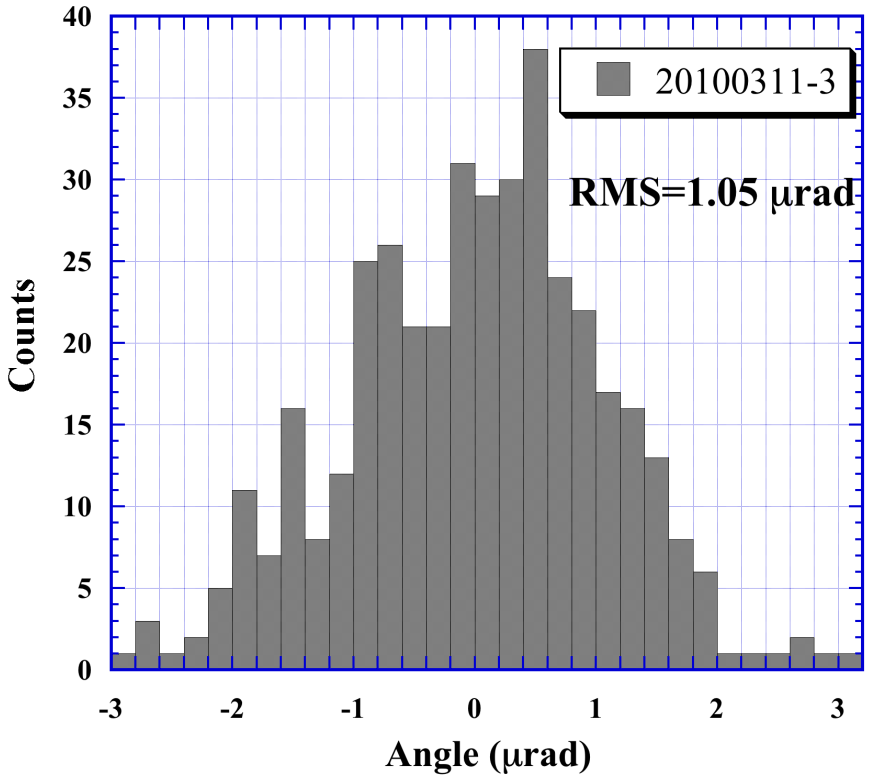
30 bunches of the beam are stored to the DR, stably.

Stable beam extraction was confirmed at the extraction line. The beam reach to the beam dump without any beam loss.



2010/October

Kick Angle Stability



Kick angle stability was evaluated by the cavity BPMs at ATF2.

1.05 μrad/4.6 mrad
= **3.5×10^{-4}**

It still has a jitter due to the timing jitter.

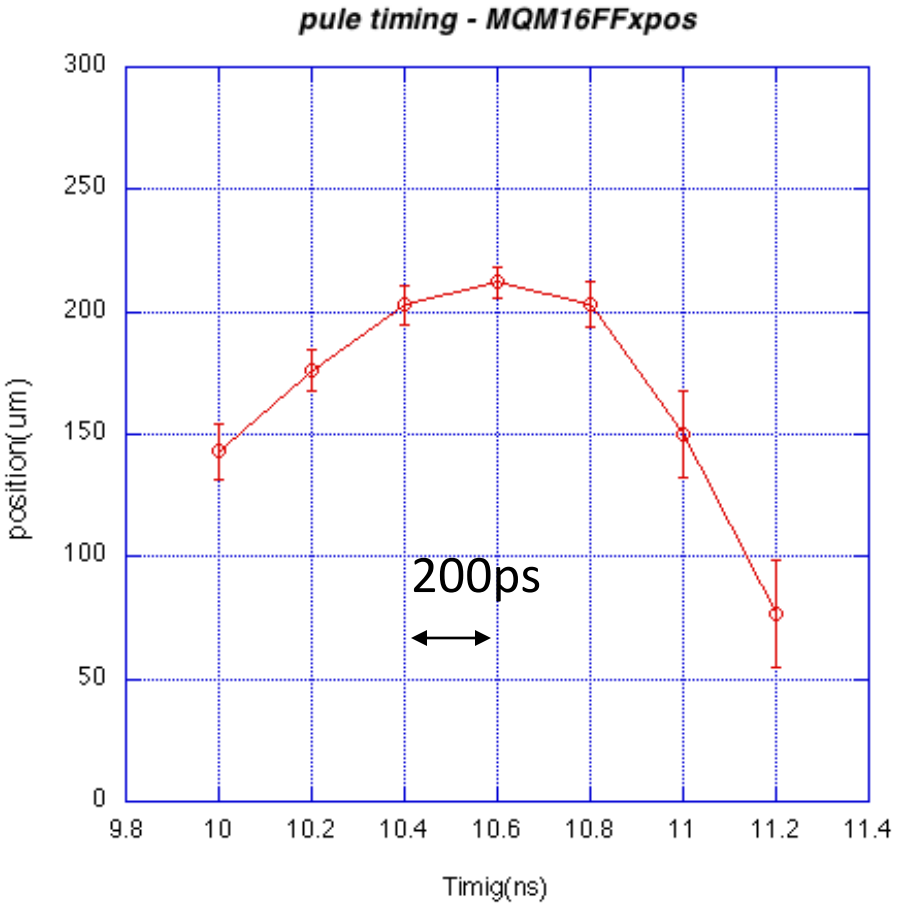
Comparable to that of the conventional Pulse Kicker

Ex: ATF double kicker

2.8×10^{-4}

(single: 9.4×10^{-4})

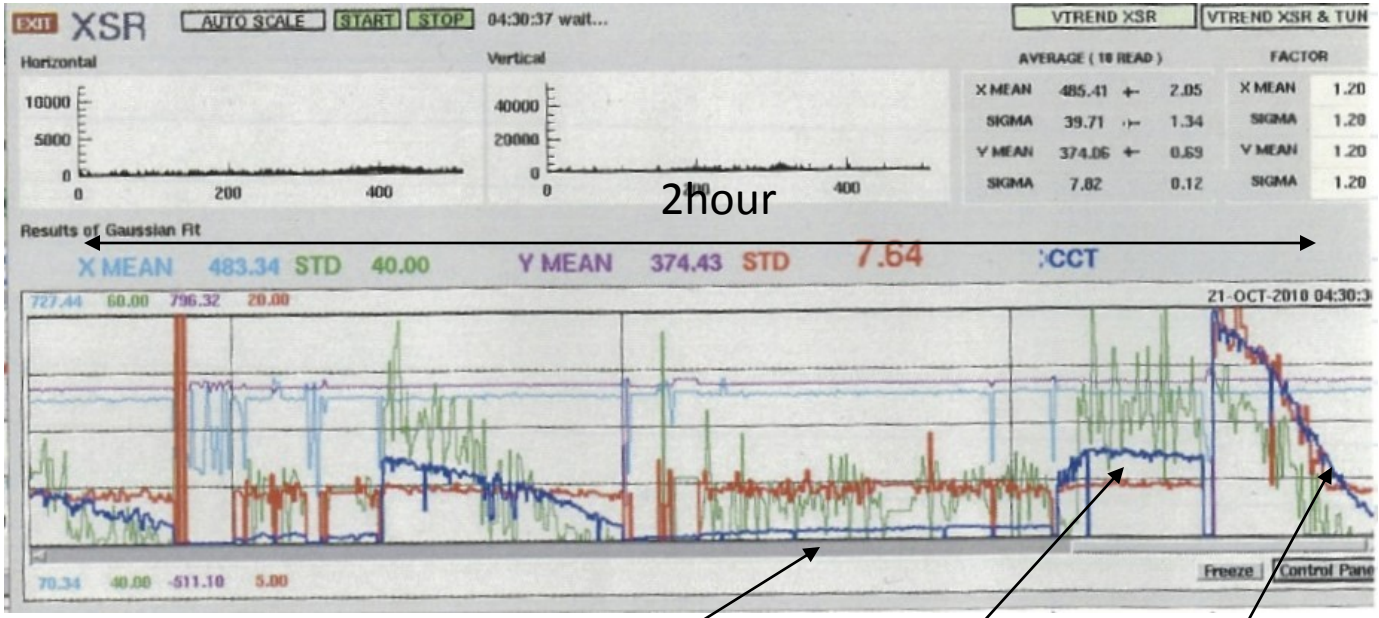
Profile of the kick field and the jitter



Plot shows the beam position at MQM16FF BPM, when scanned the kicker pulse timing. There is no flattop of the kick field and the jitter increased at the both side of the peak.

To make stable beam kick, careful timing adjustment of four pulses is needed.

Problem: Stored beam intensity in DR



Blue line: current
Red line: v size (XSR)

single bunch
1 train

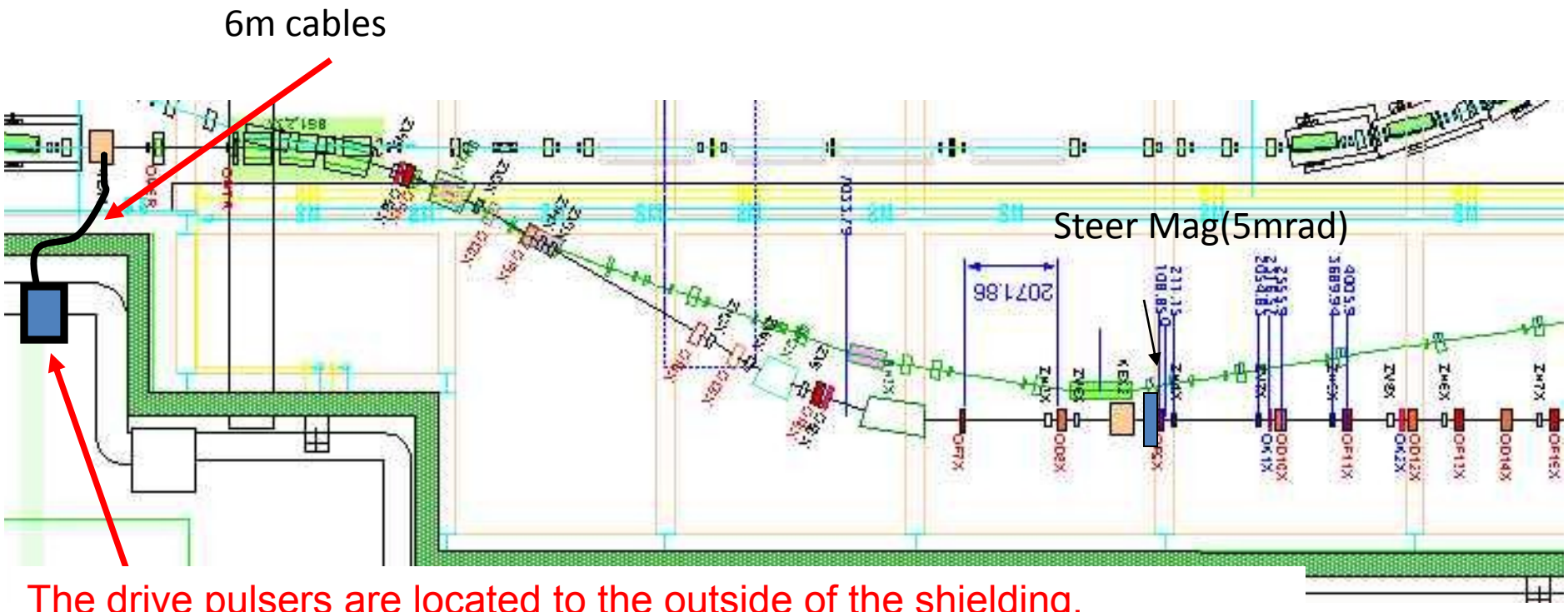
9 bunch
1 train
Itot=2×10^{10}

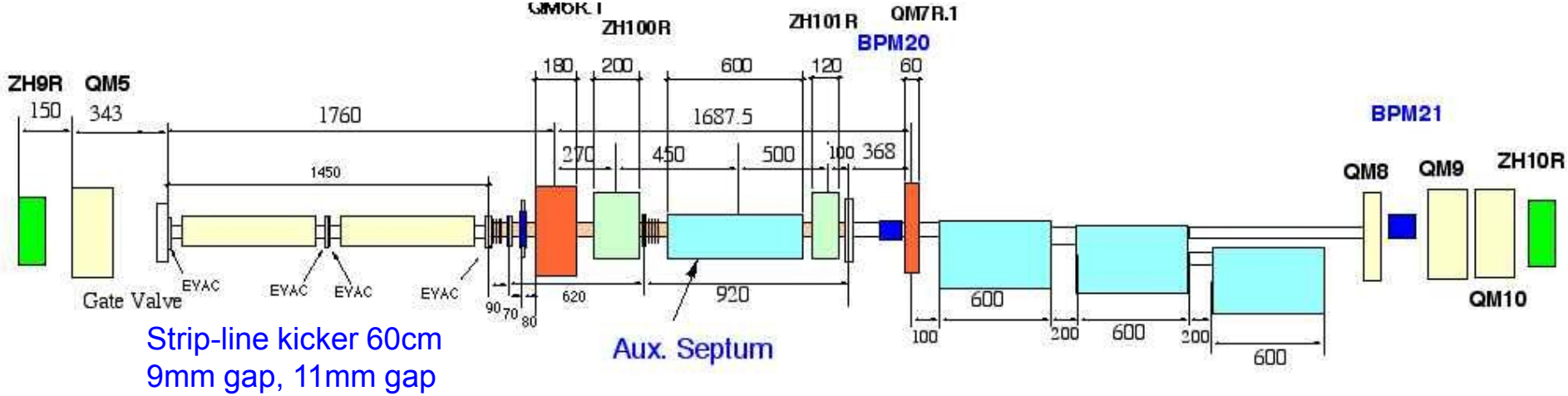
9 bunch
3 train
Itot=6×10^{10}

The stored current decreased gradually when the multi-bunch operation. The current decrease depends on the stored current. Several minutes after the beam stop, the situation recovered. We suspect the heating of the strip-line electrode made such a happeninig.

ATF geometrical constraints → shorten the electrode gap to get a sufficient kick

Kicker and PS location





Summary and Next step

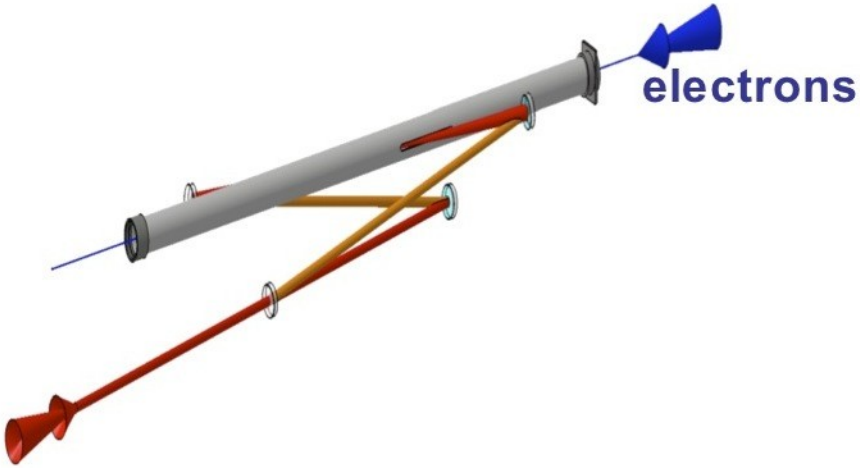
- Fast kicker performance was confirmed by the multi-bunch beam extraction from the ATF-DR to the ATF2 extraction line.

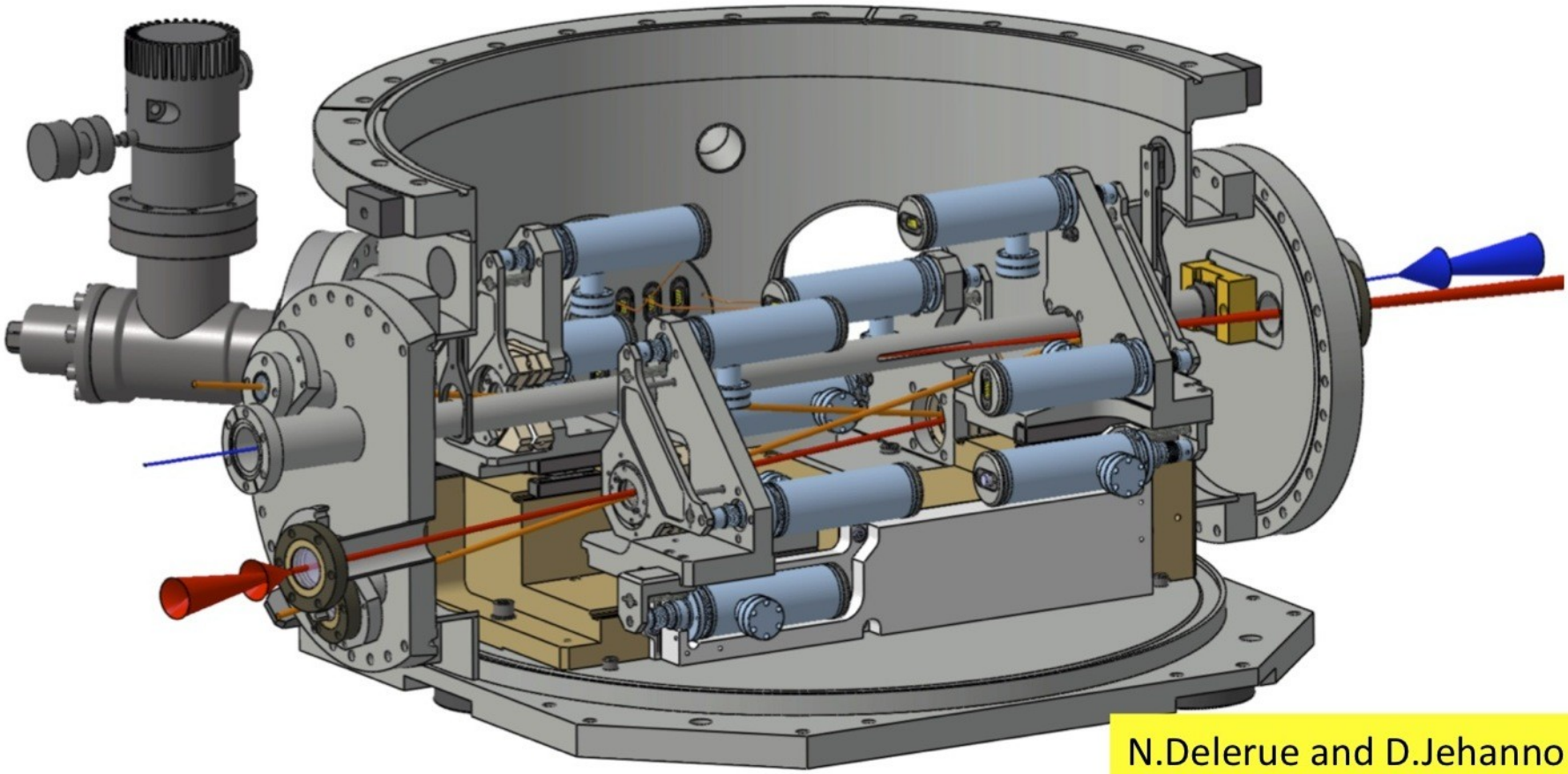
- The kick angle stability 3.5×10^{-4} was measured for the single bunch beam. The multi-bunch kick angle and the stability were measured.

For the next step, we have to clear following problems,

1. High current beam storage is limited by the horizontal aperture of the strip-line(9mm).
2. The stored current reduction have to cure.

LAL 4-mirror laser-cavity





N.Delerue and D.Jehanno

Mightylaser Milestones

2010

08 | 09 | 10 | 11 | 12

Installation

No laser

No laser

07/27

08/21
Laser locked to 4M cavity

08/30
4M cavity alignment to beam

09/06
4M cavity connected to beam

4M cavity locked to ATF Clock
09/24

10/25

1st Compton gamma observed

11/01
Laser Failure

12/08
Compton gamma observed

Laser shipped
to Zurich

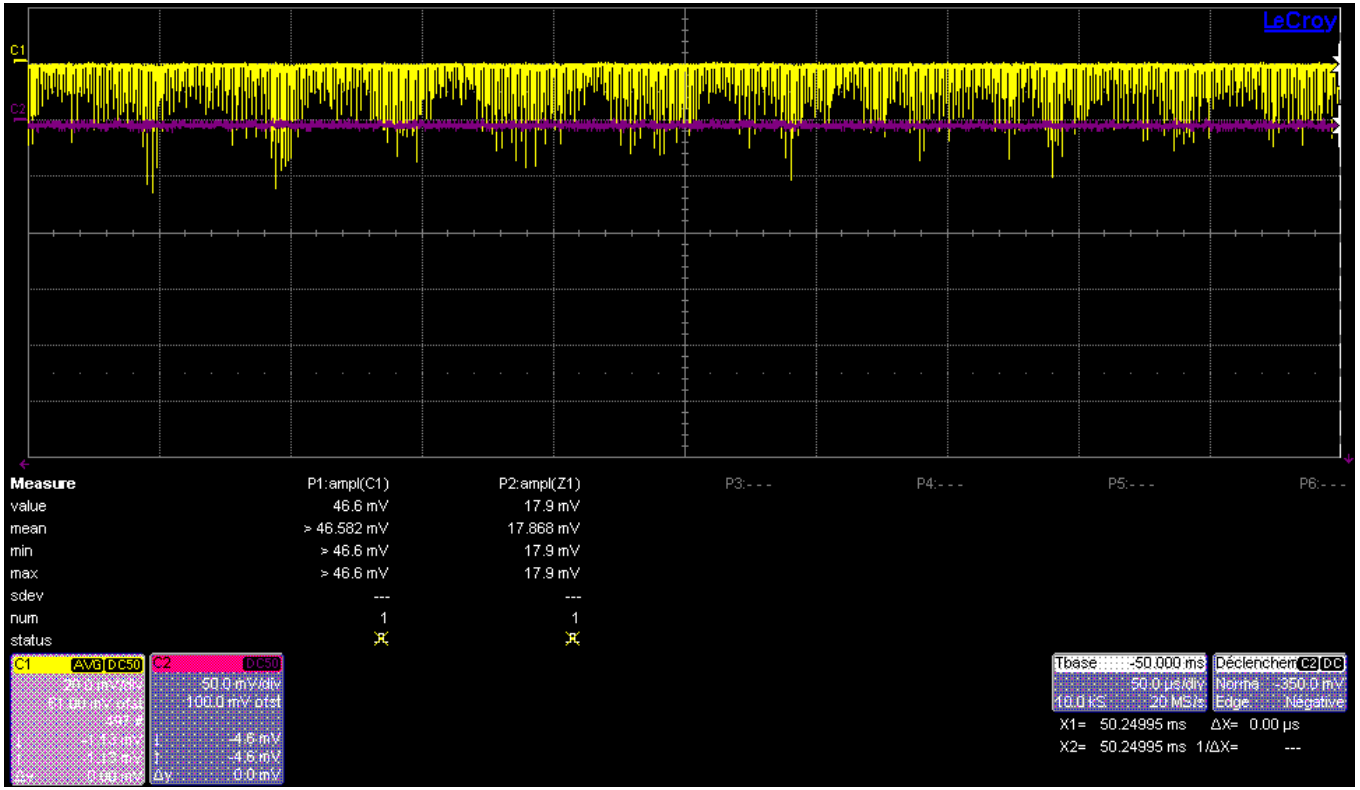
11/17
Laser repaired

Laser shipped
to Zurich
HW update

12/20

N.Delerue and D.Jehanno

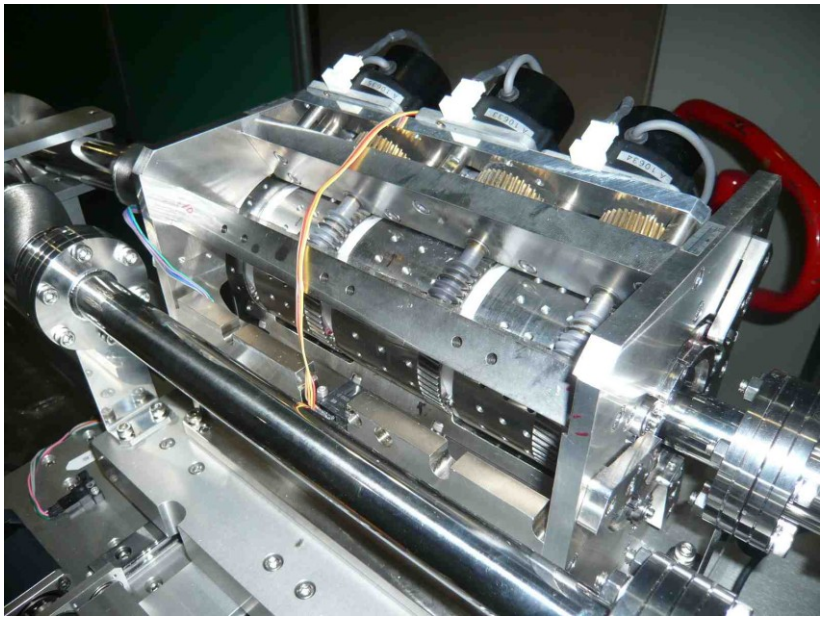
Compton production



- Production of Compton photons (yellow trace) achieved regularly during weeks where the laser was available.
- Our cavity can remain locked on the ATF beam for more than one hour.
- However we see laser power fluctuations in the cavity indicating that our locking must be improved.

N.Delerue and D.Jehanno

Extra beam operation on Dec 23rd
Permanent Magnet Final-Quad (Kyoto Univ.)



The magnet was assembled in Kyoto Univ in last fall.
It was delivered to KEK from Kyoto in the end of November.

- Field measurement by a rotating coil was done.
- It was temporally installed in ATF2 line from Dec. 21st to 25th.
- Demonstration with beam was done on Dec. 23rd for the master thesis.

- Results should be reported in next meeting (ATF2 or TB).

Fire Accident on the LINAC Klystron Modulator

A PFN capacitor of the renewed #0 modulator exploded and burned out on Feb. 16, 2011. (only~1,200 hours operation)

We needed three weeks to recover the accident.

- Exchanged the modulator #0 ← #10(ECS)
- Improved the failure sequence of the new modulators (i.e. for #8 operation).

A beam came back on March 10!

But… about a day later,

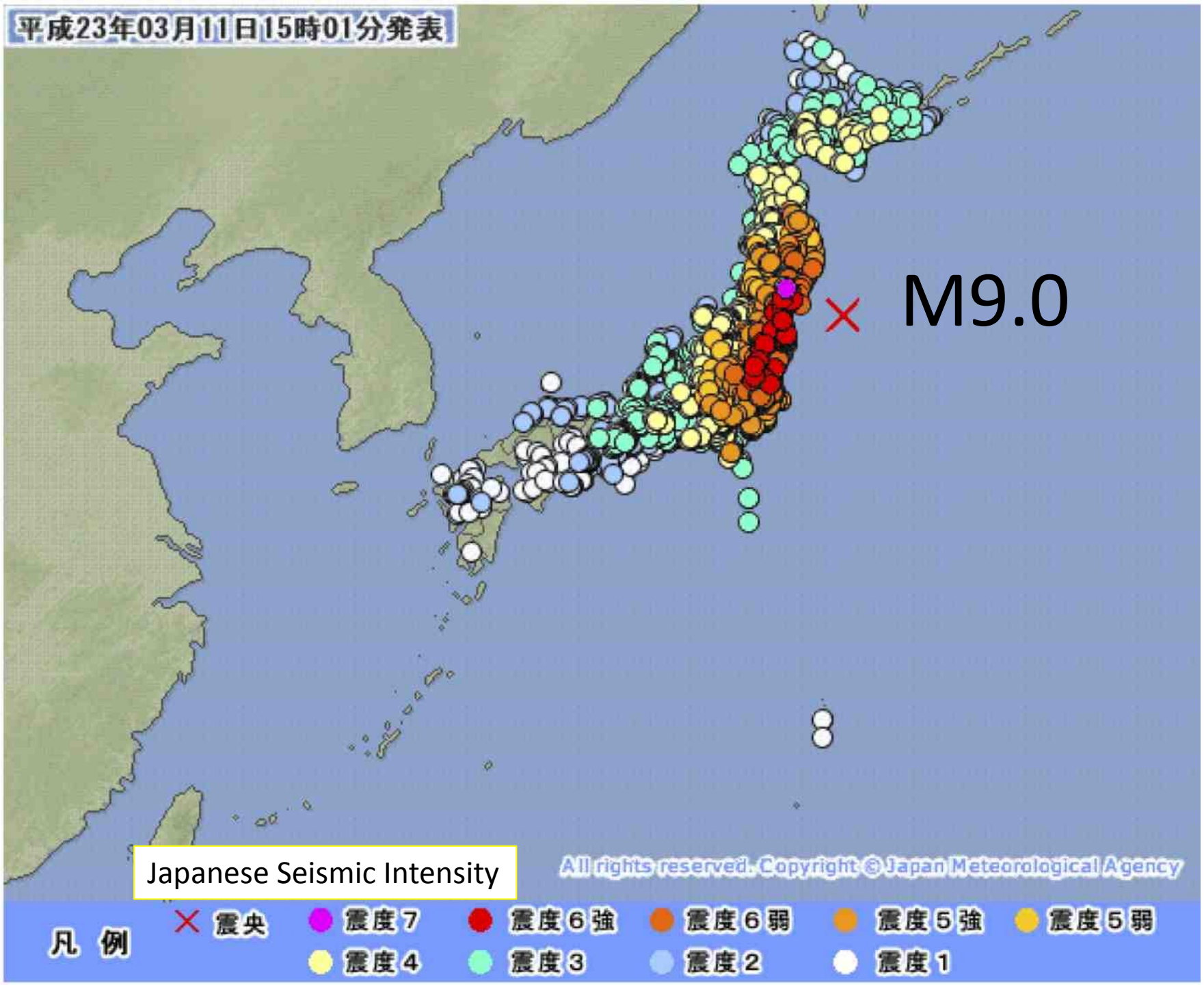
Terrible Earthquake (M9.0) hit Japan.

Damage on the ATF facility

M9.0 Earthquake on 2011/Mar/11

Very quick investigation
with a flashlight under a power outage

N.Terunuma, KEK


平成23年03月11日15時01分発表
M9.0
Japanese Seismic Intensity
All rights reserved. Copyright © Japan Meteorological Agency
凡 例
震央
震度７
震度６強
震度６弱
震度５強
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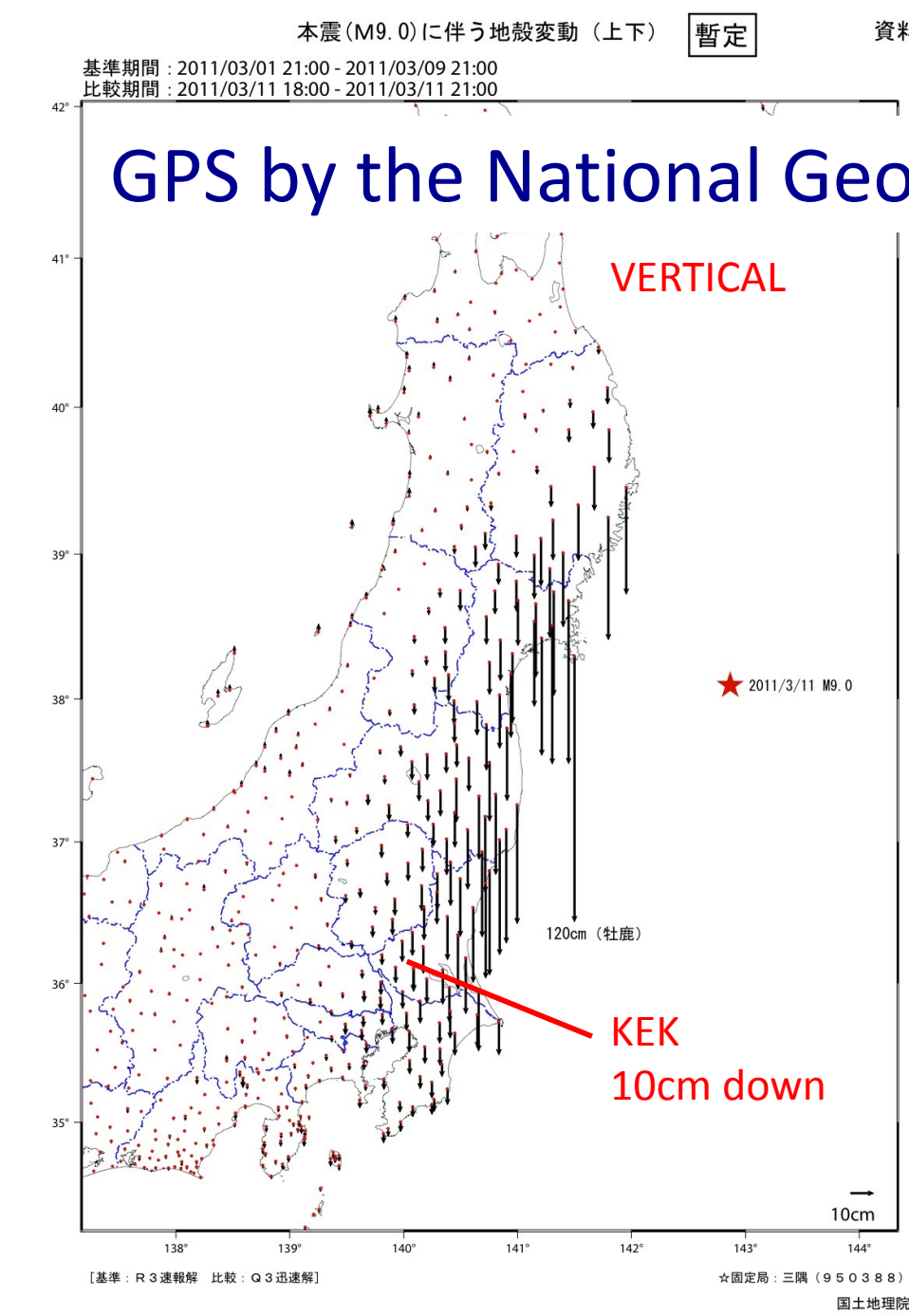
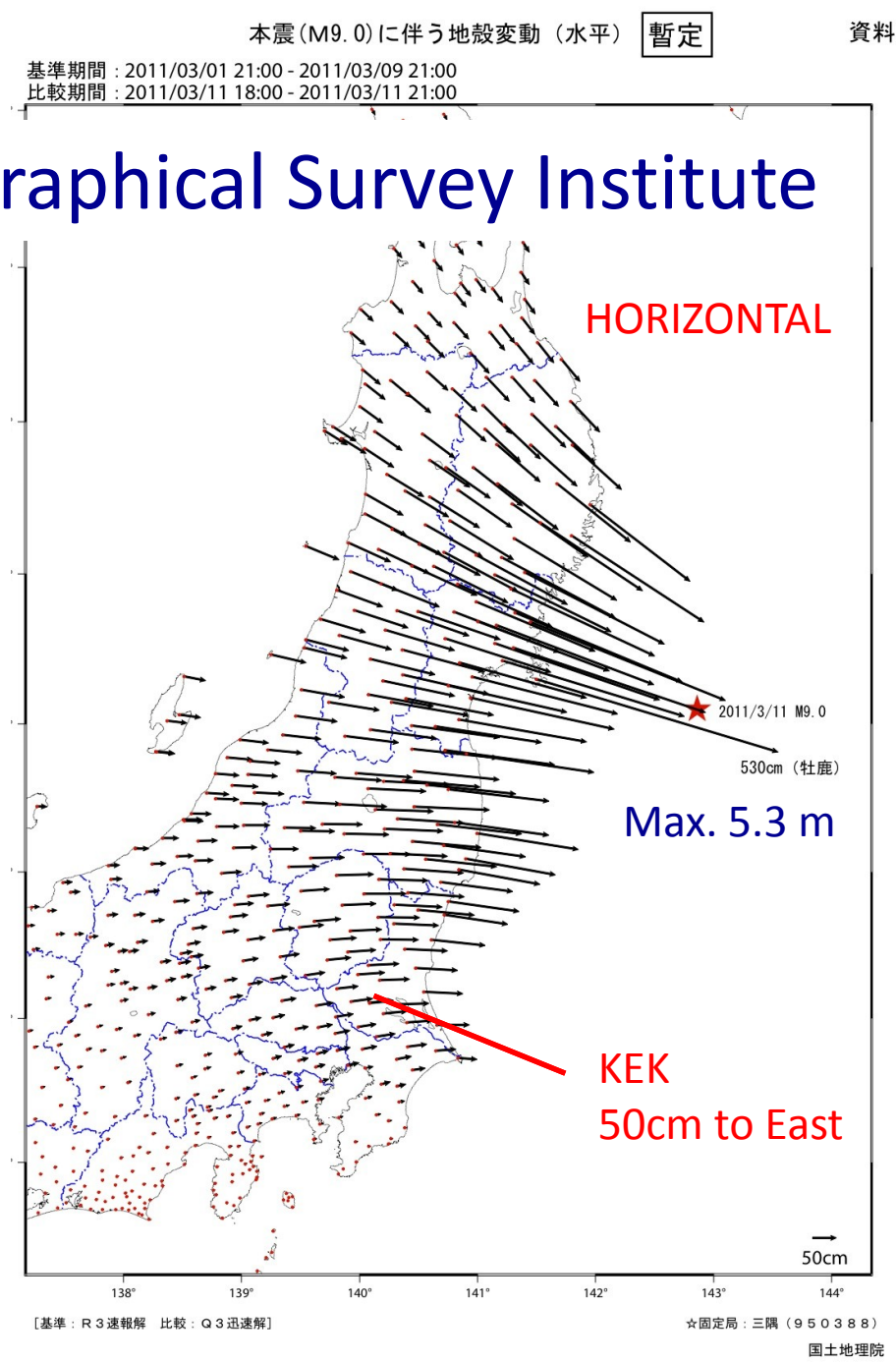
震度２
震度１

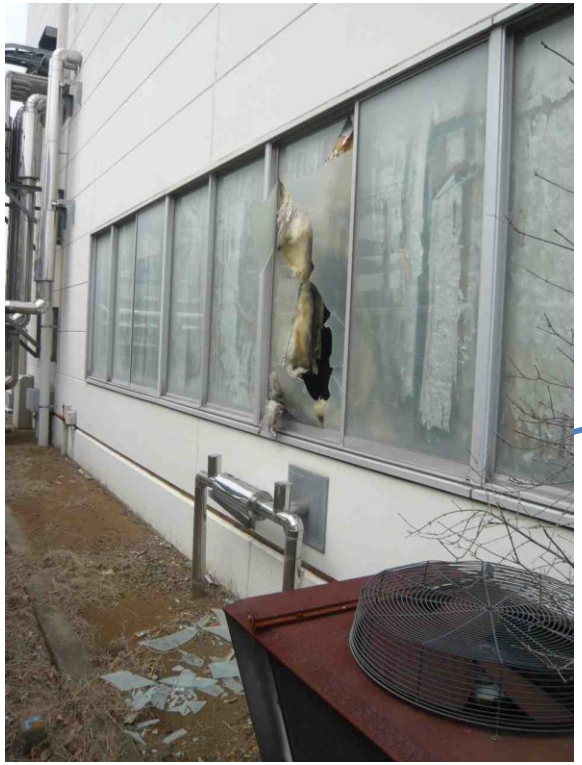
GPS by the National Geographical Survey Institute

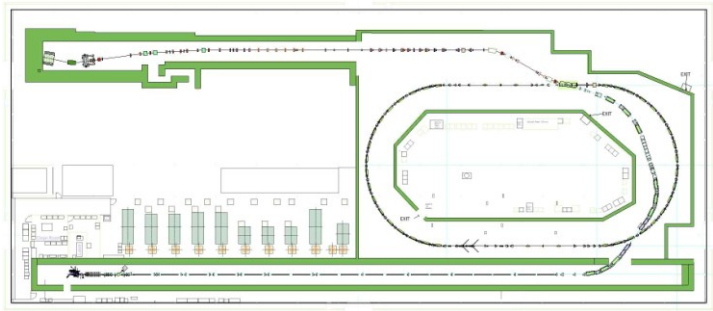




ATF Building looks fine…

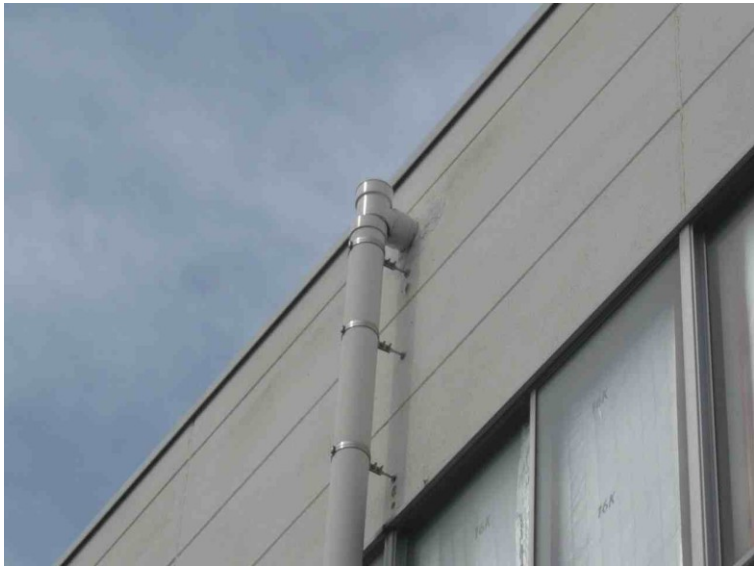
Facility Outside Damages





Shutter x6

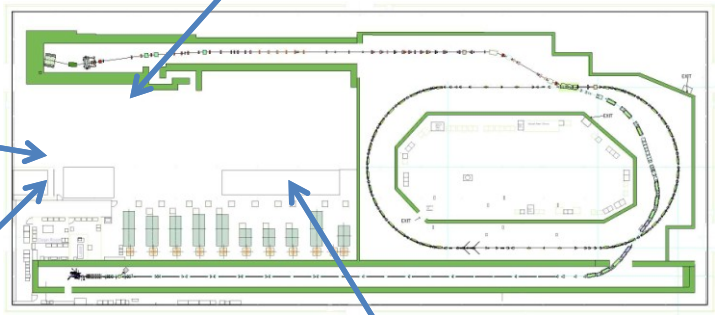
Drain pipe x ?



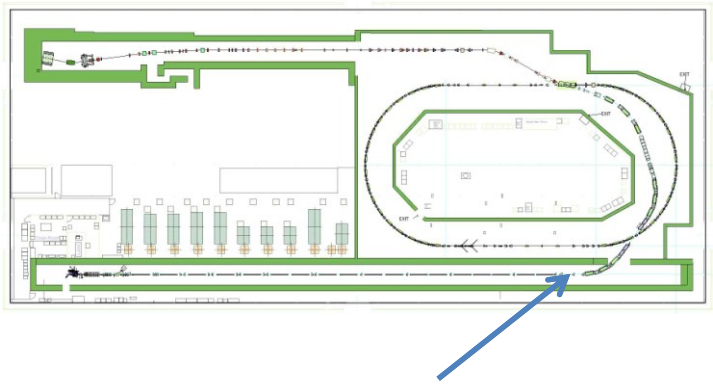
Facility Damages

Main power cables for the ATF building

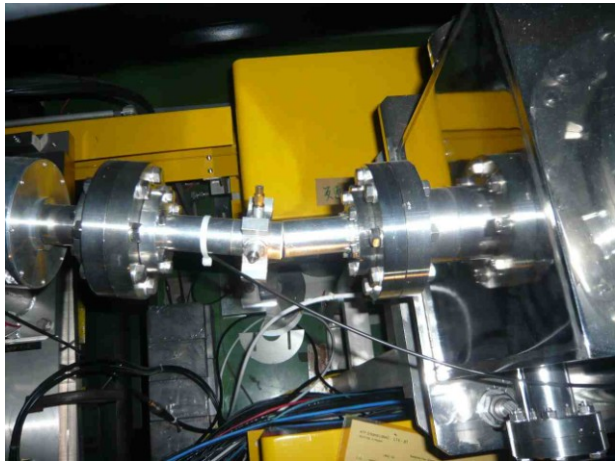
Not well fixed blocks.



ATF LINAC



It looks NO severe physical damage except for the end section.
A small table moved then connections were broken. It seems easy to recover.

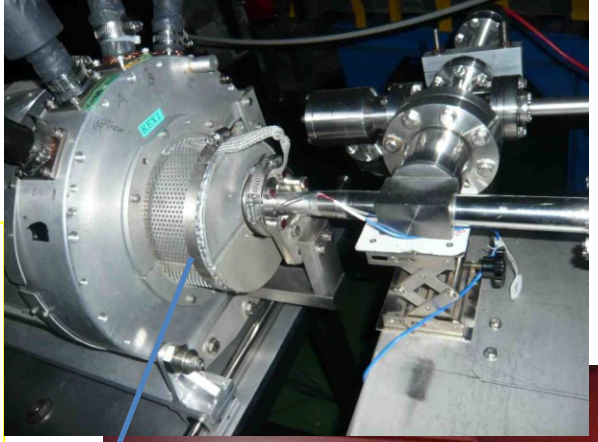


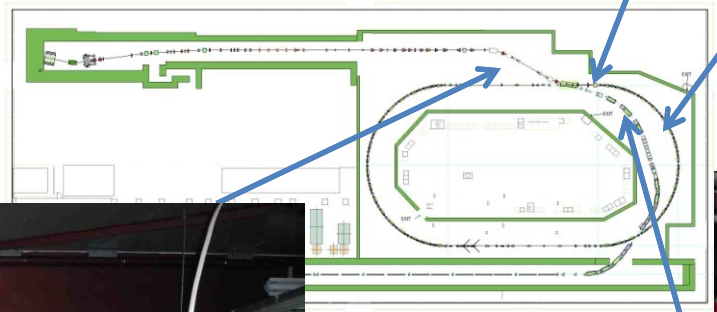
BT/DR(half)

Half of the DR, deep side, could not survey because of the safety.
It looks NO severe physical damage on the beam line.

Minor damages:

1. Expanded bellows of the ceramic chamber for SLAC kicker
2. Fallen Pb blocks and fluorescent lights



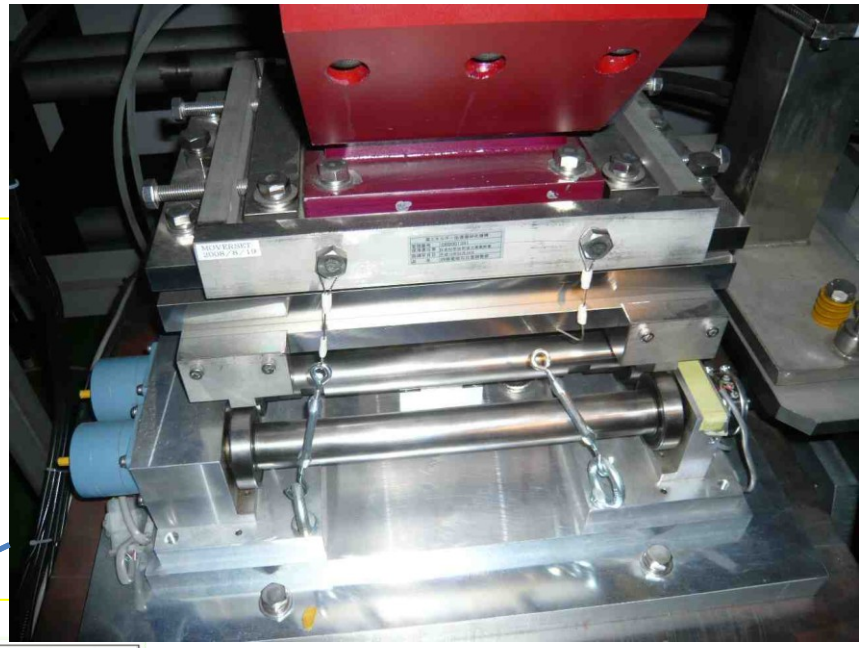


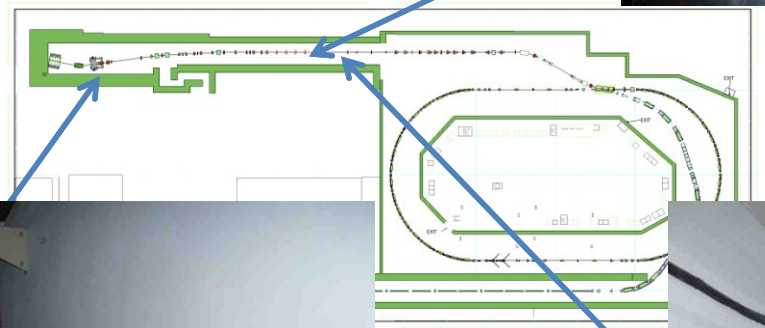
ATF2 beam line

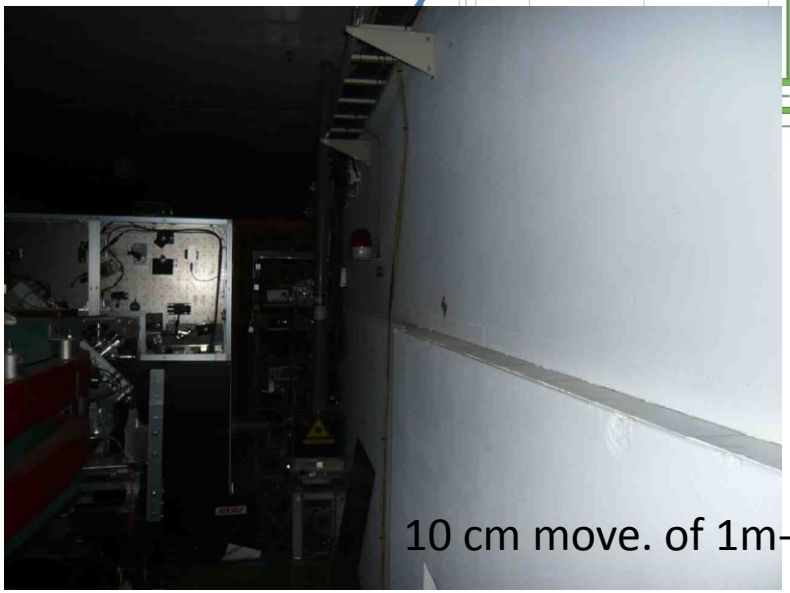
It looks NO severe physical damage on the beam line.

Minor damages:

1. Some of the mount-safety wires for magnets were broken.
2. Side-shield blocks moved max.~10 cm.







10 cm move. of 1m-wide blocks

Recovery procedure…

Now the access to the ATF building is temporary inhibited.
The KEK Facility division will do…

1. inspection of the building safety
2. **re-establishing the power line (cables)**

Then, a detail investigation and repairs for the ATF accelerator will be started step by step.

We will do our best to recover as soon as possible,
But the followings should be taken into account.

- Priority to recover other facilities in KEK;
  i.e., Photon Factory including KEKB linac, J-PARC, etc.
- Public power outage