R&D Plan on Clearing Electrode using the KEKB LER

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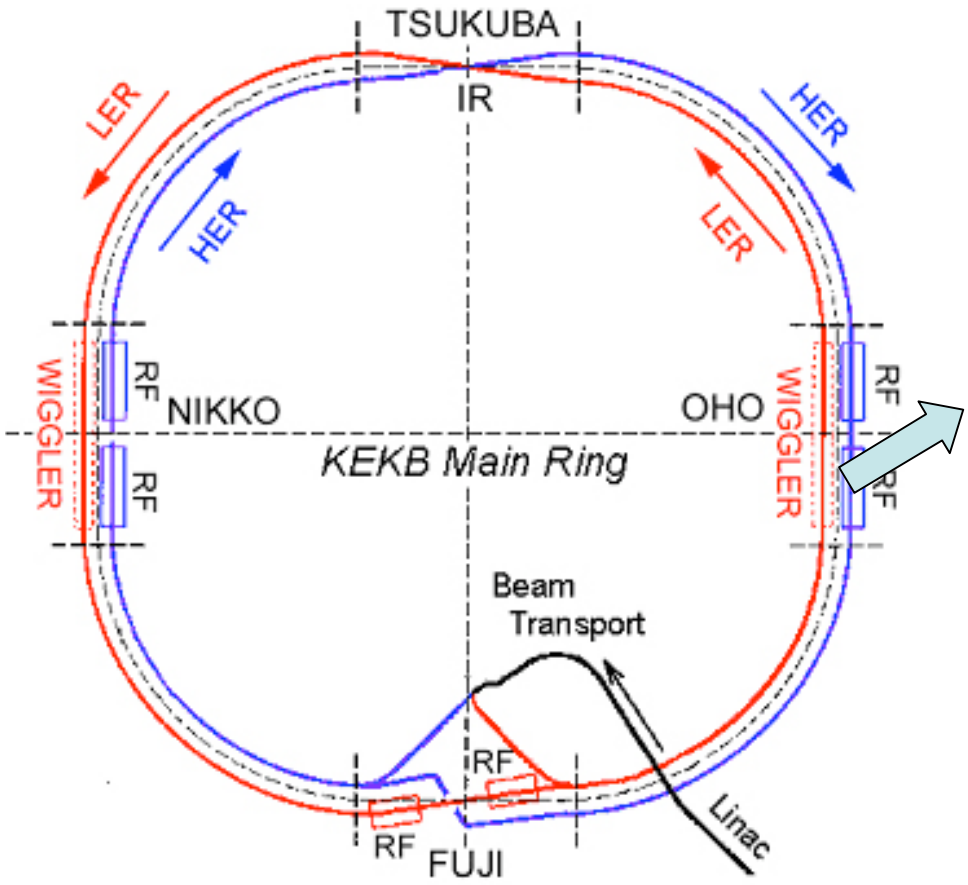
2007. 07. 31 at KEK

Goal

- Establish the technique of clearing electrode for ECI
  - Available for high current machine
    - Power dissipation into the electrode
  - Low beam impedance
- Demonstrate the effect on electron cloud formation
  - Measurement of cloud density
- Note: It should be still important to develop the electrode technique as a backup solution.
  - A surface with δ_{max} (Max. SEY) may be OK…..

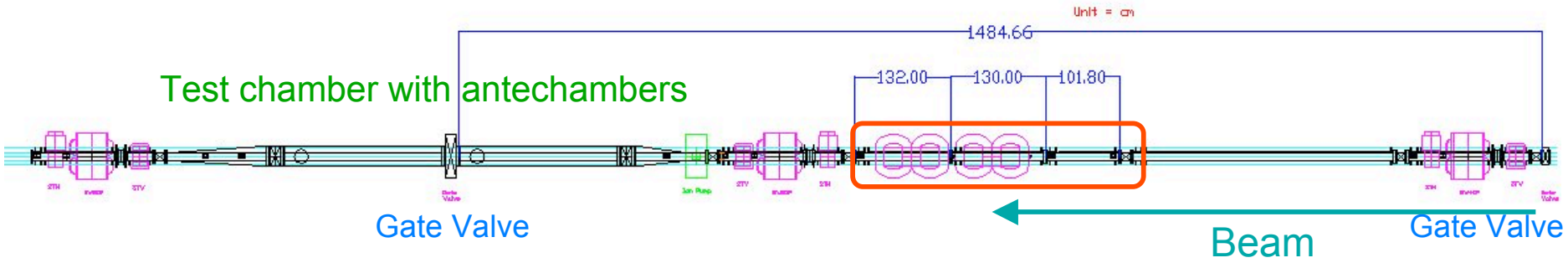
Location

- OHO wiggler section (Straight section)



Location

- One wiggler at the most upstream side



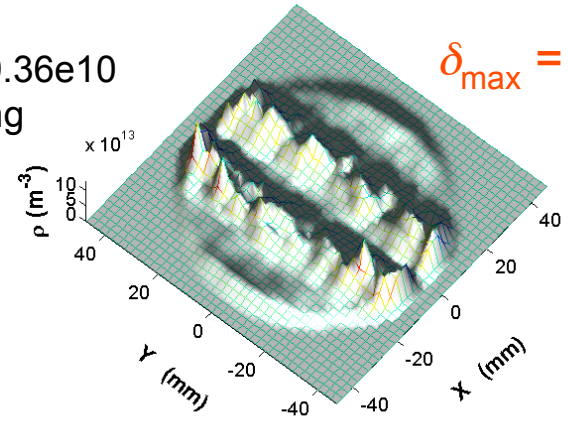
  - About 15 m section between gate valves
  - Magnetic field:0.75 T
  - Effective length: 346 mm
  - Aperture (height): 110 mm
  - Very weak SR from upstream

Electron Density

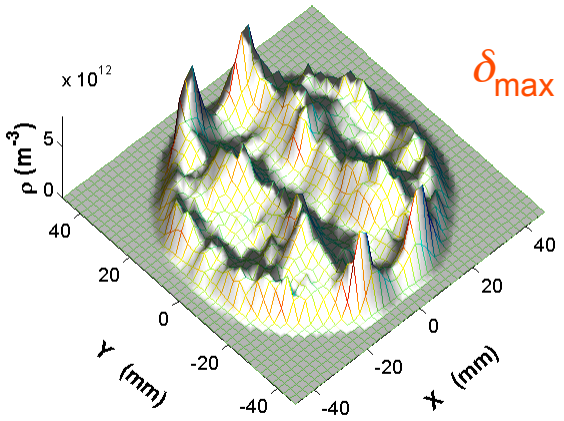
- Calculation by L. Wang

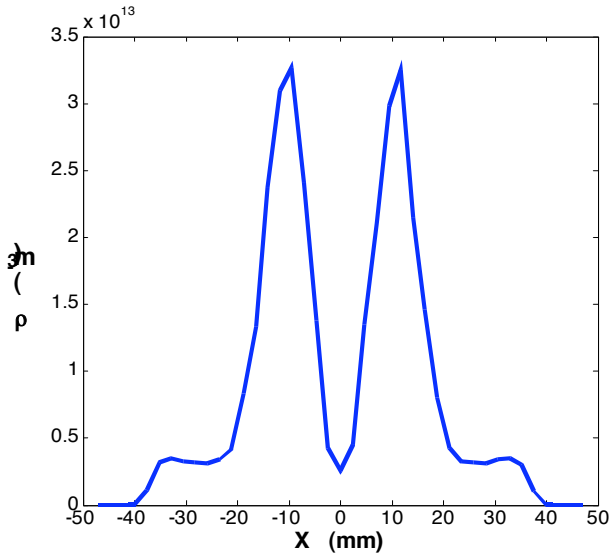
R-pipe=38mm
bunch intensity=9.36e10
3.5 Bunch Spacing

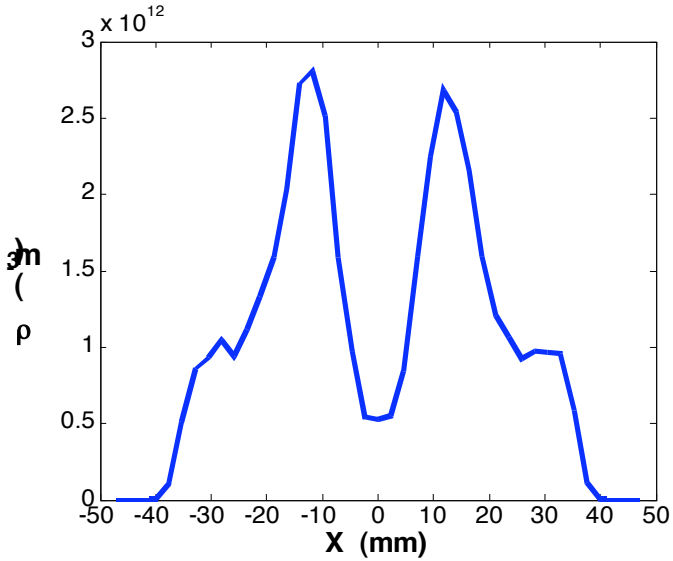
δ_{max} = 1.4



δ_{max} = 1.0

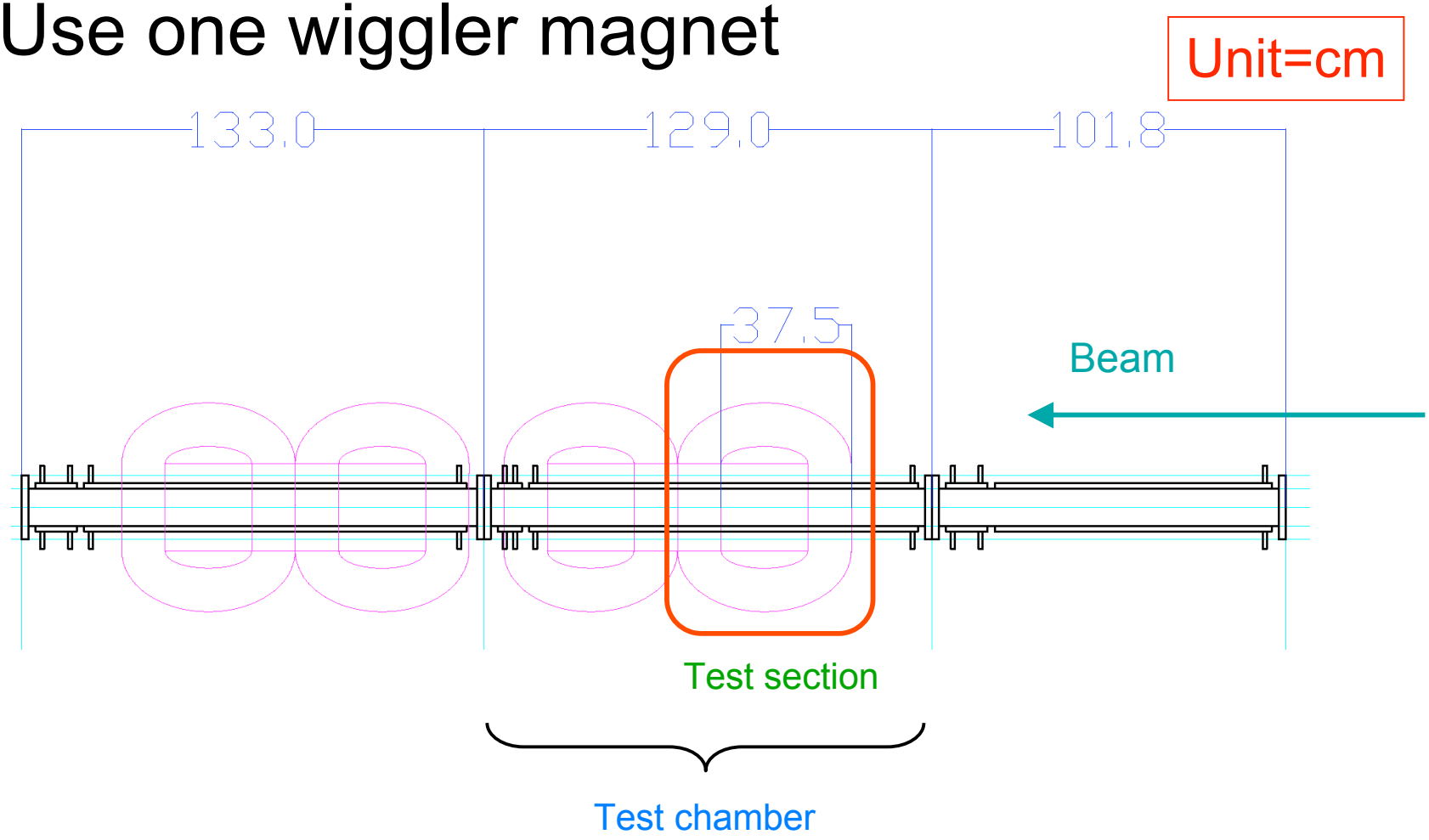






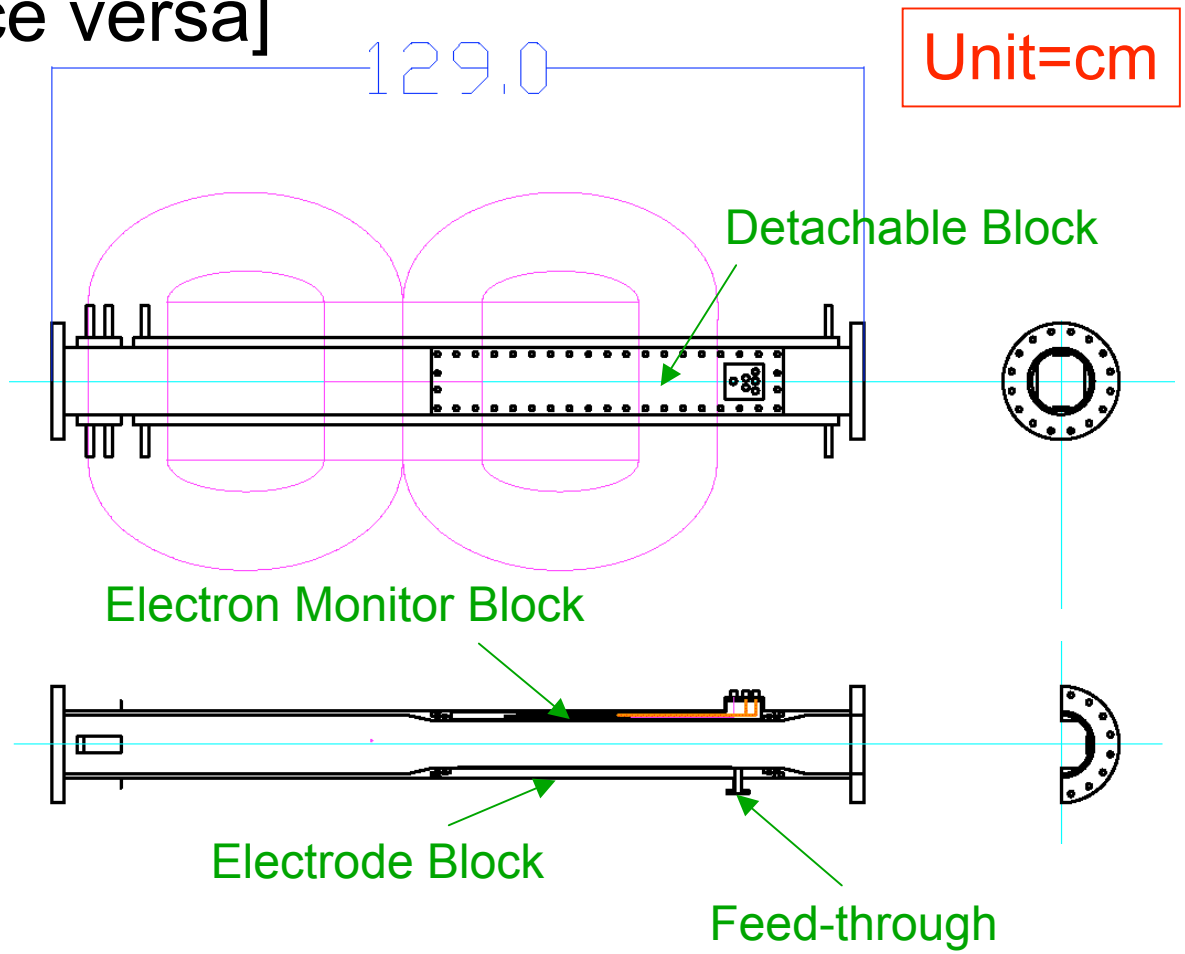
Layout

- Use one wiggler magnet



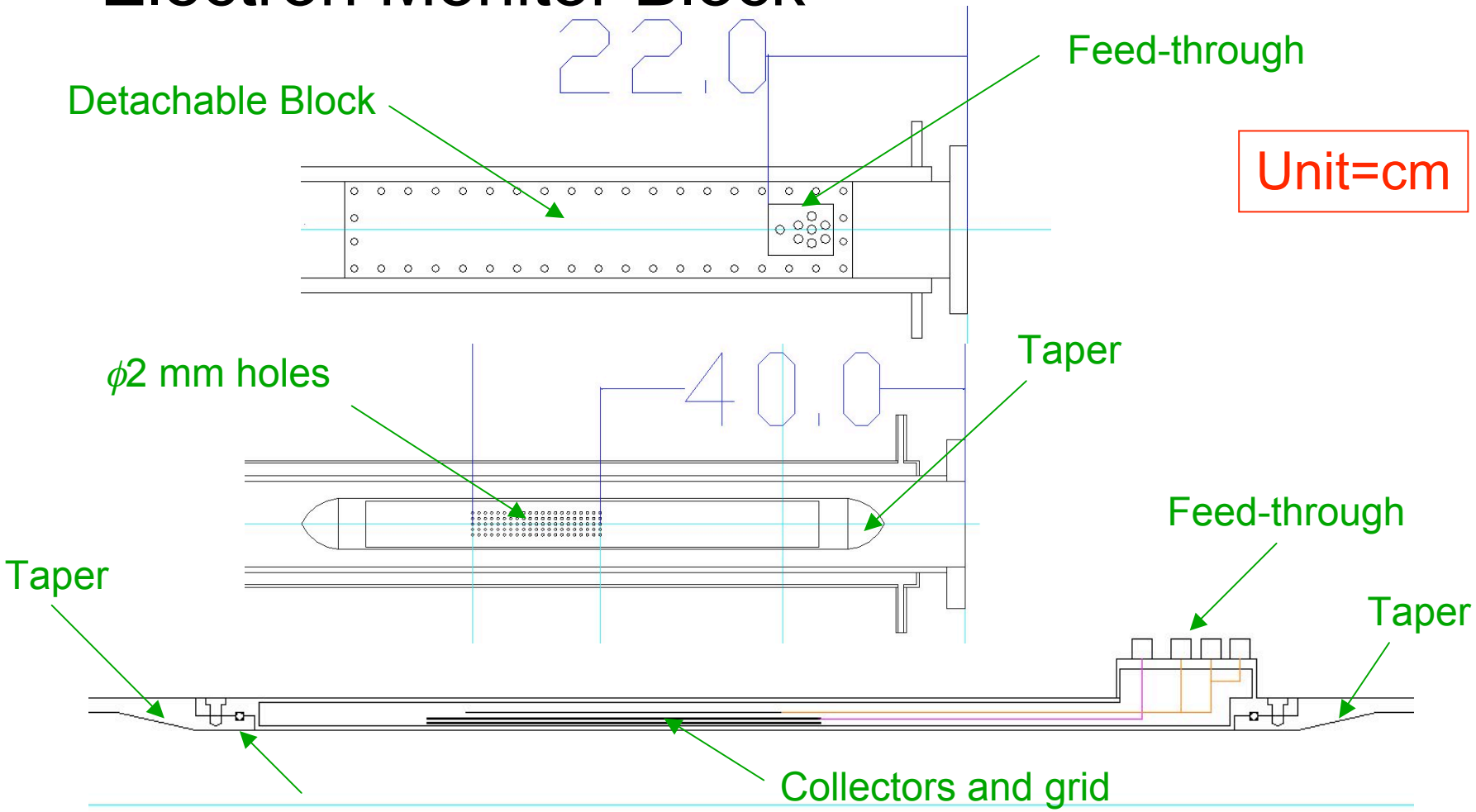
Test chamber

- One electron monitor (Up) and one electrode (Bottom) [or vice versa]
  - Now strip type electrode is considered.
  - Electron monitor and electrode are exchangeable.



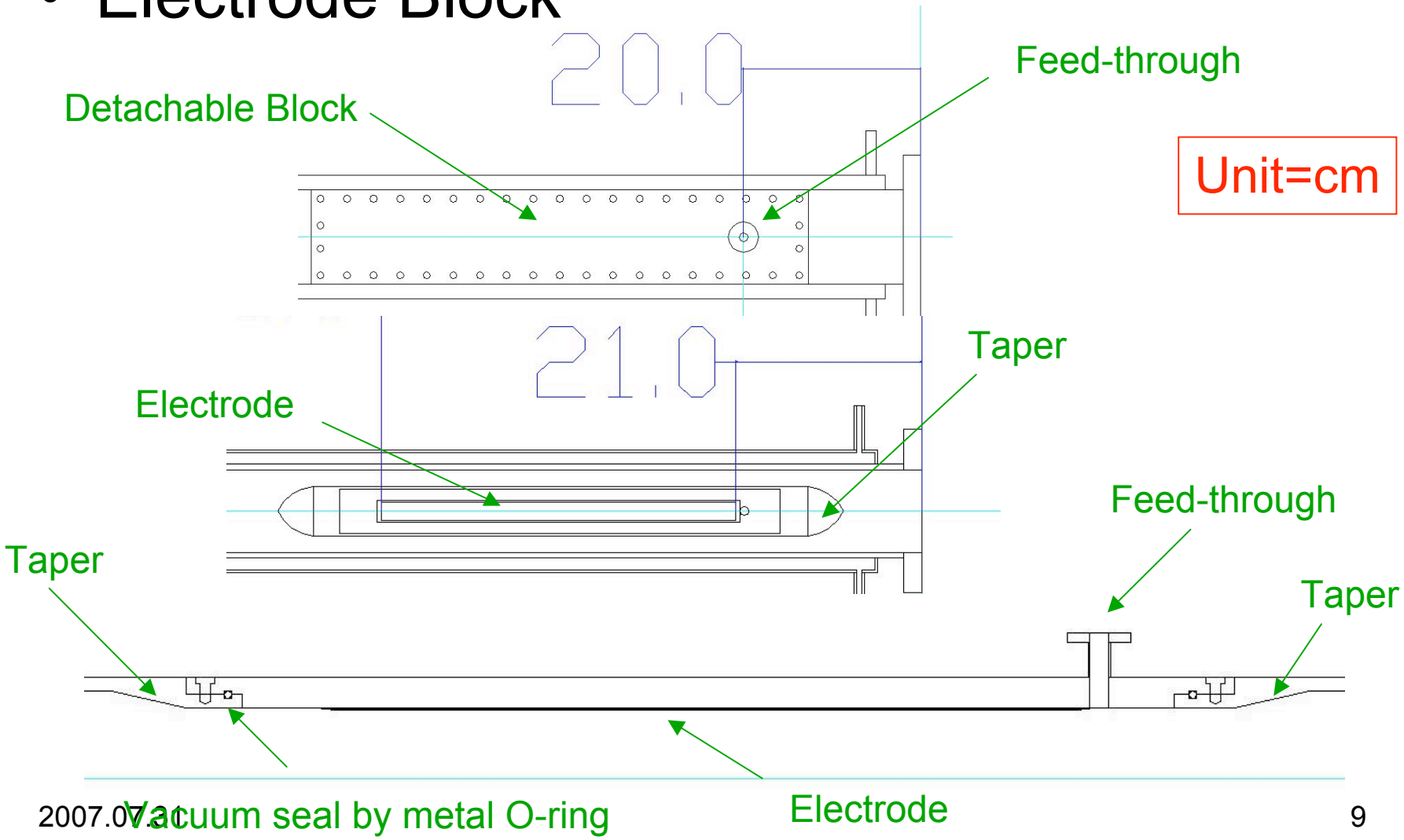
Test chamber

- Electron Monitor Block



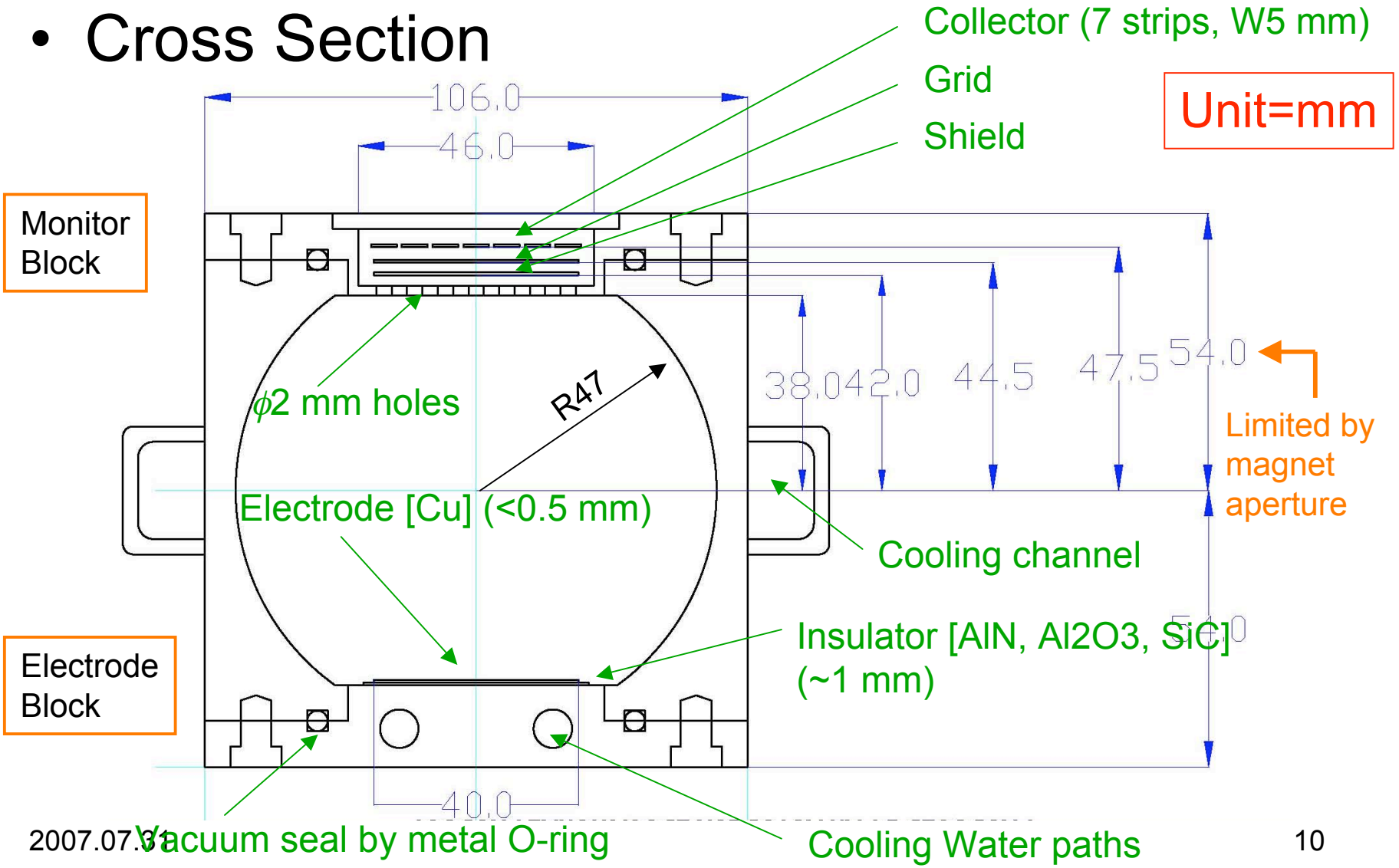
Test chamber

- Electrode Block



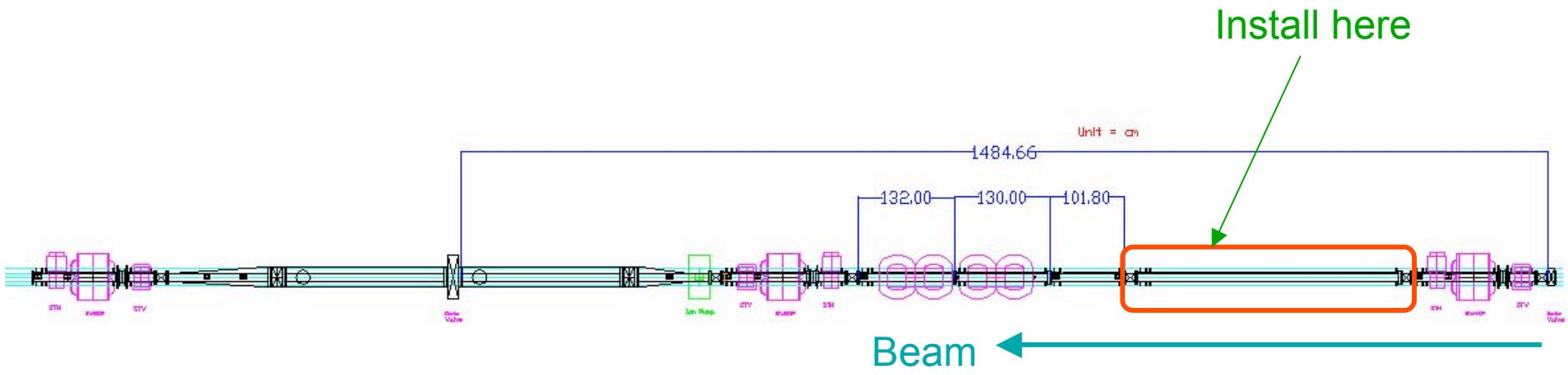
Test chamber

- Cross Section



Beam Test

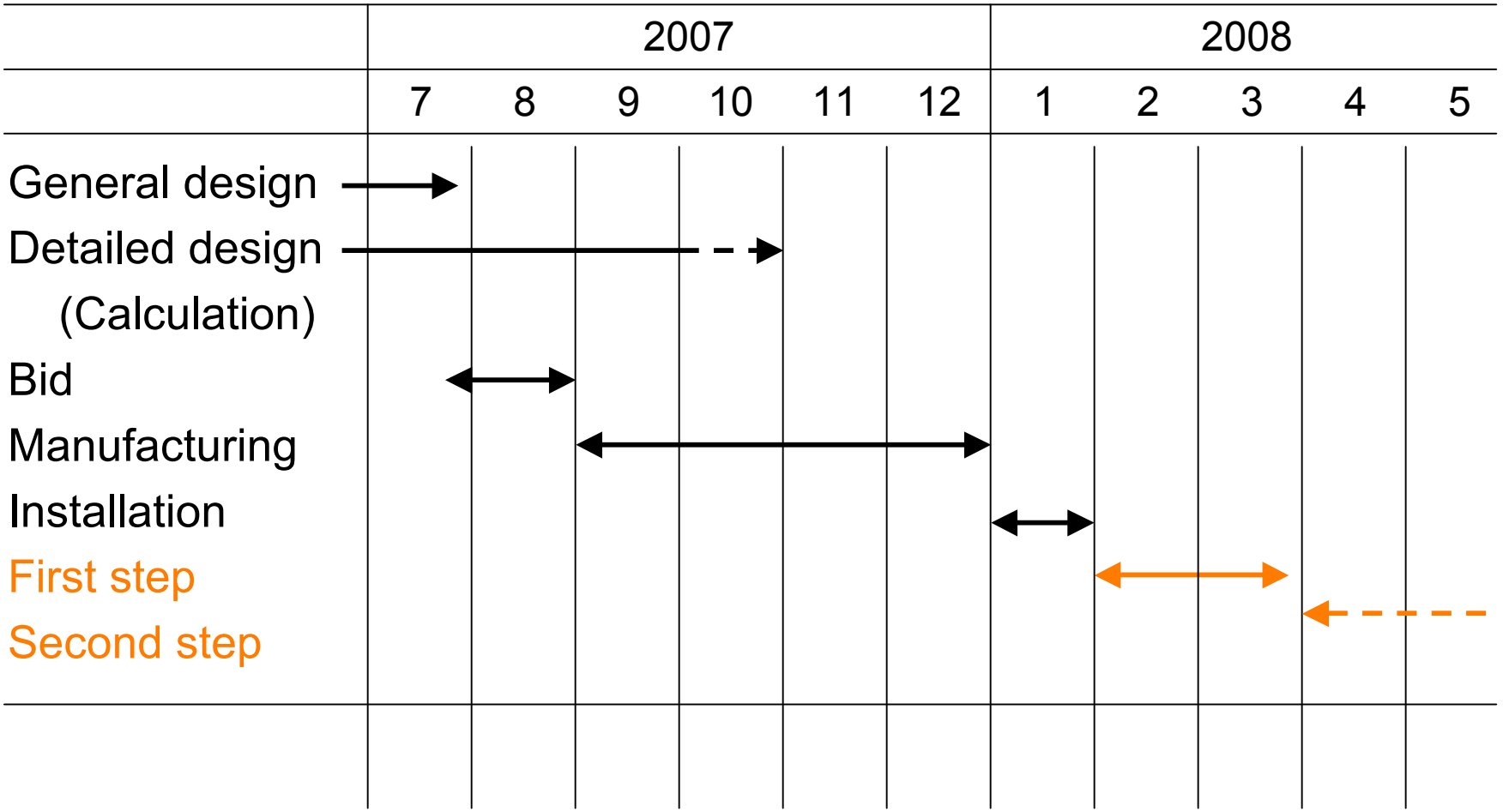
- First step
  - Install outside of magnet (upstream side)
  - Check the heating of electrode
    - Measure temperature of the test chamber and the cooling water.
  - If possible, with electron monitor
    - Measurement without magnet?



Beam Test

- Second step
  - Install into the wigger magnet
    - Magnet should be halved.
  - With electron monitor
  - Measure the difference of the electron currents with/without applying voltage to the electrode
    - Voltage
    - Positive and negative
  - Change electrode structure
    - Groove surface and include also another bullet with
    - TiN surface

Plan


2007
2008
7
8
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12
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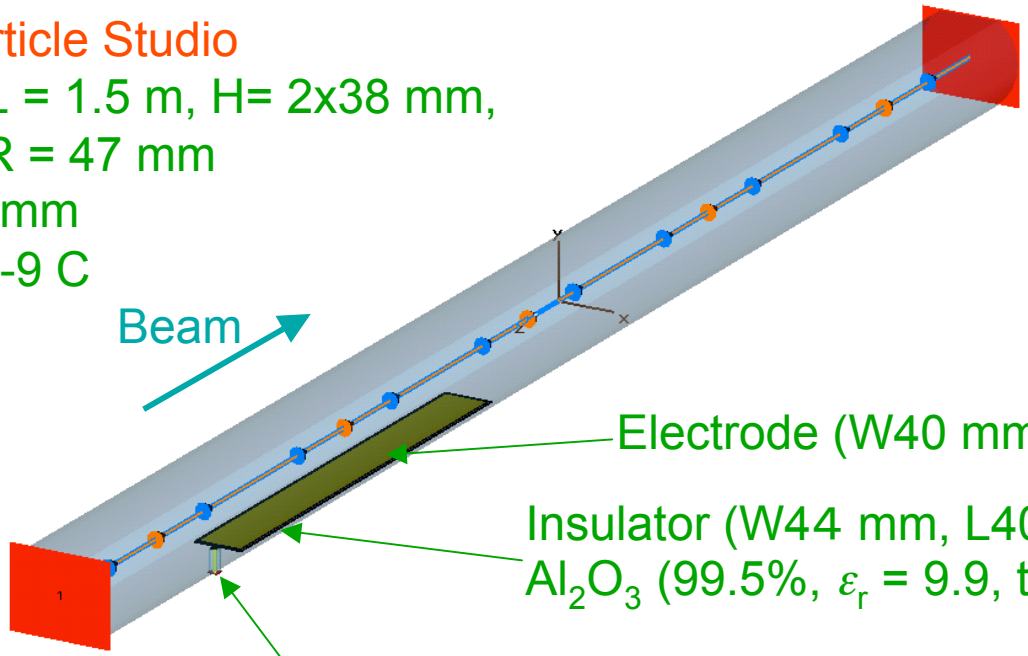
5
General design
Detailed design
(Calculation)
Bid
Manufacturing
Installation
First step
Second step

RF calculation (Preliminary)

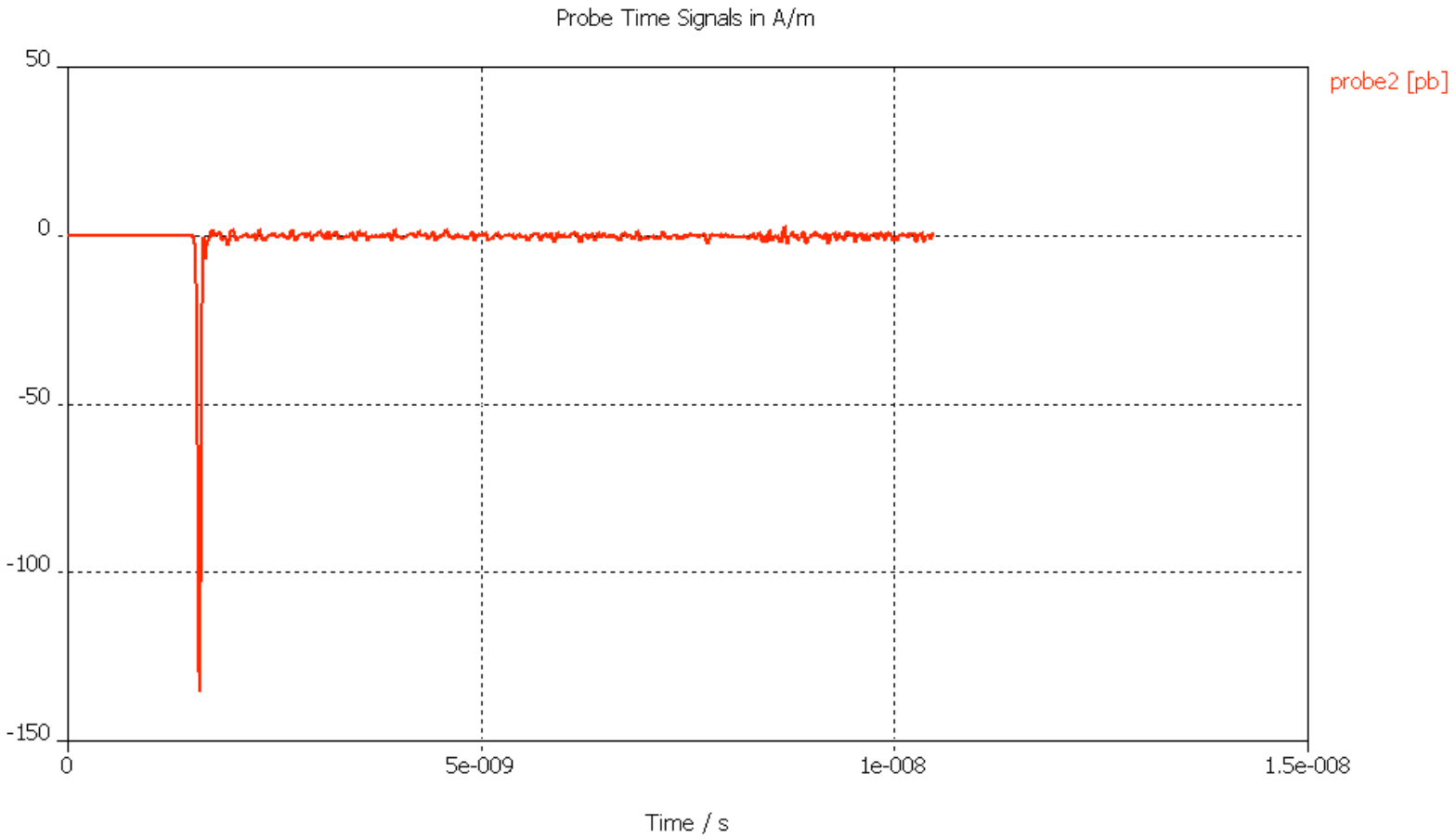
- Calculation of RF properties has just started.
  - Particle Studio, MAFIA, GdfidL,,,
  - Wake potential, Impedance, Loss factor, Input power
  - Optimize the electrode structure and materials

By Particle Studio
Pipe: L = 1.5 m, H= 2x38 mm,
R = 47 mm
σ_z = 6 mm
q = 1E-9 C



RF calculation (Preliminary)

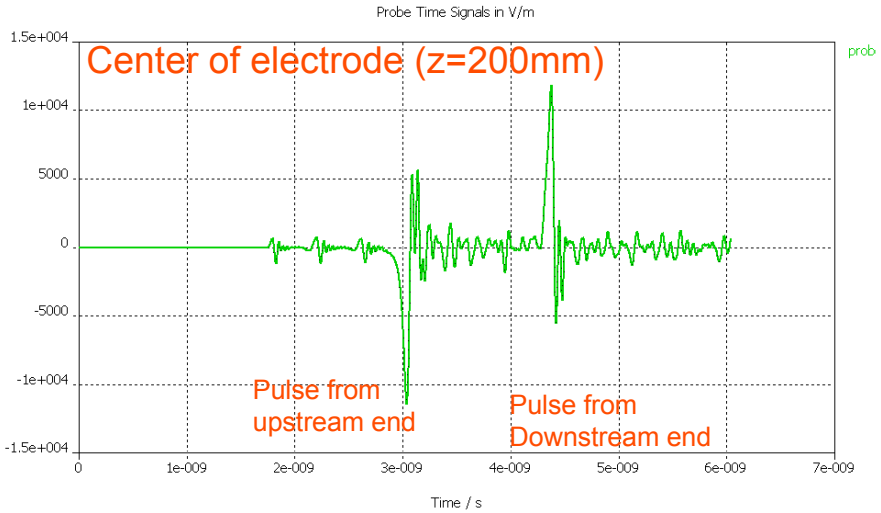
- Surface current on electrode

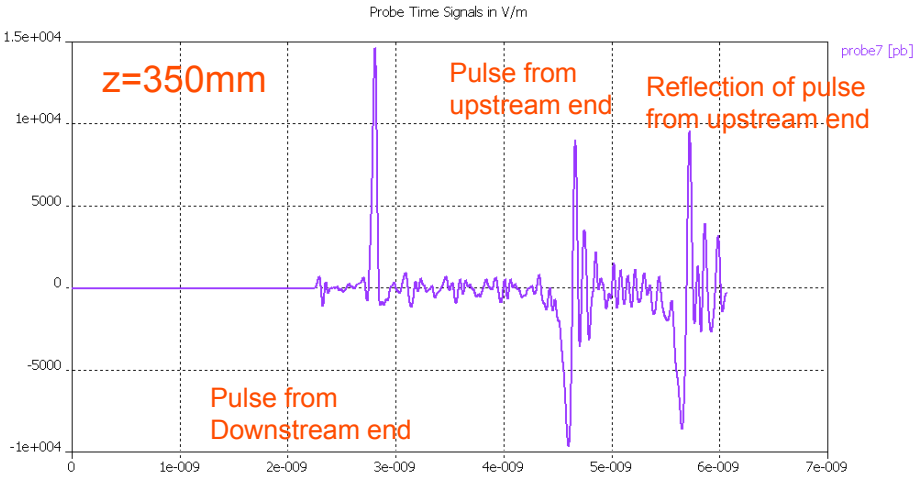


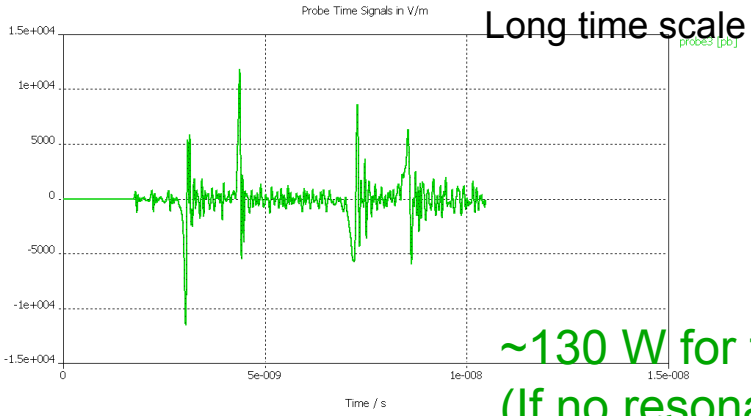
~10 W for 1389 bunches 1.7 A

RF calculation (Preliminary)

- E_y inside of insulator (Al_2O_3, ε_r = 9.9)

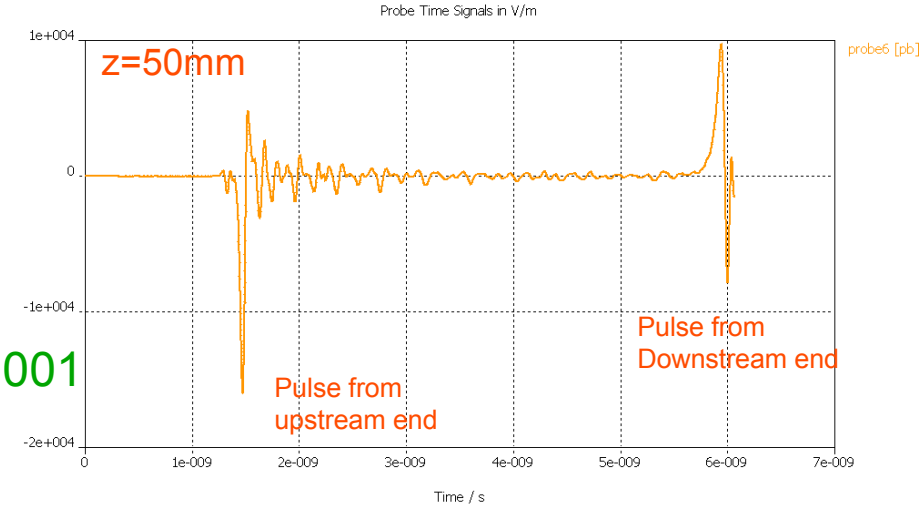






Long time scale

~130 W for tanδ=0.001
(If no resonance)



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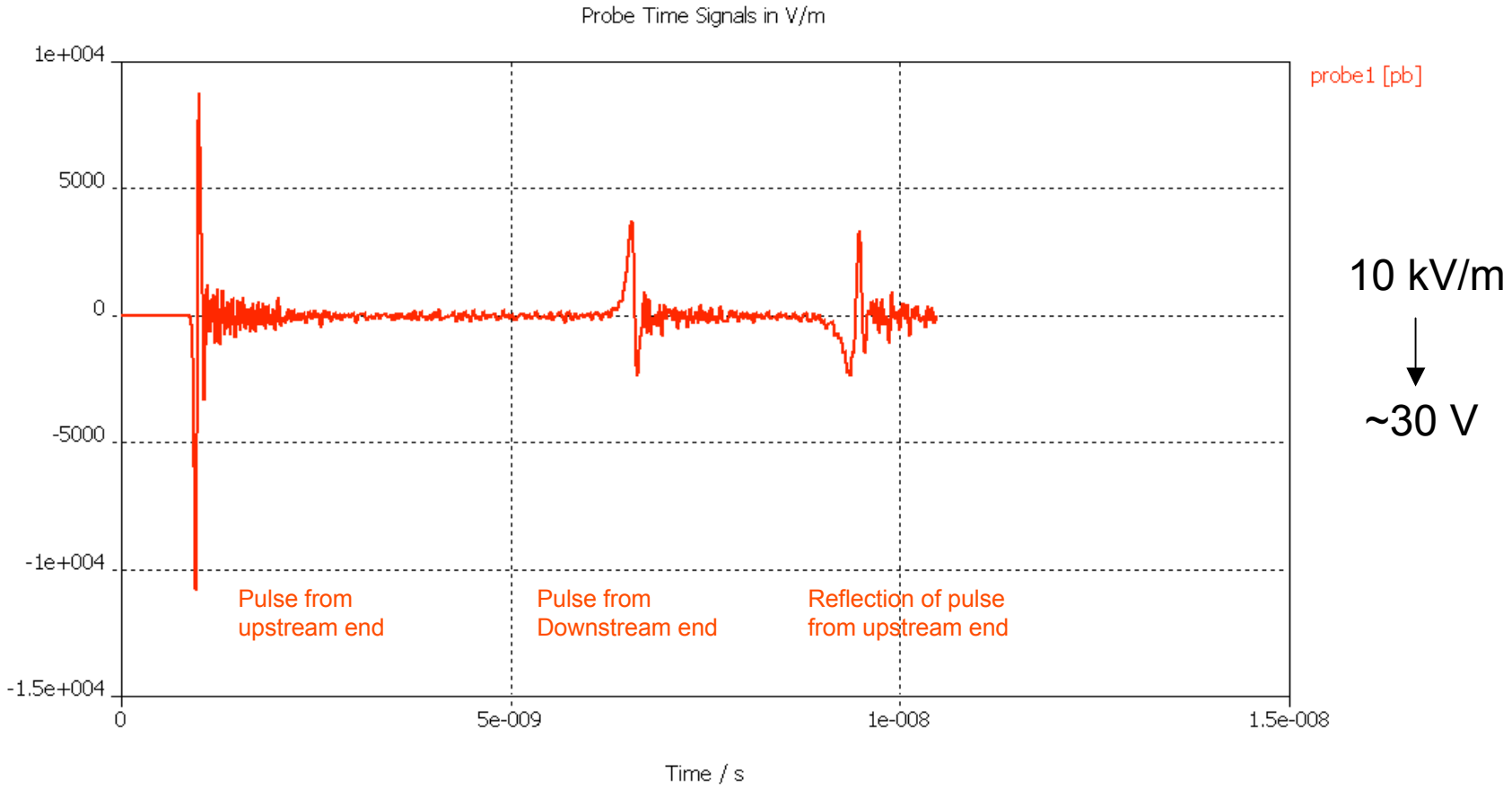
RF calculation (Preliminary)

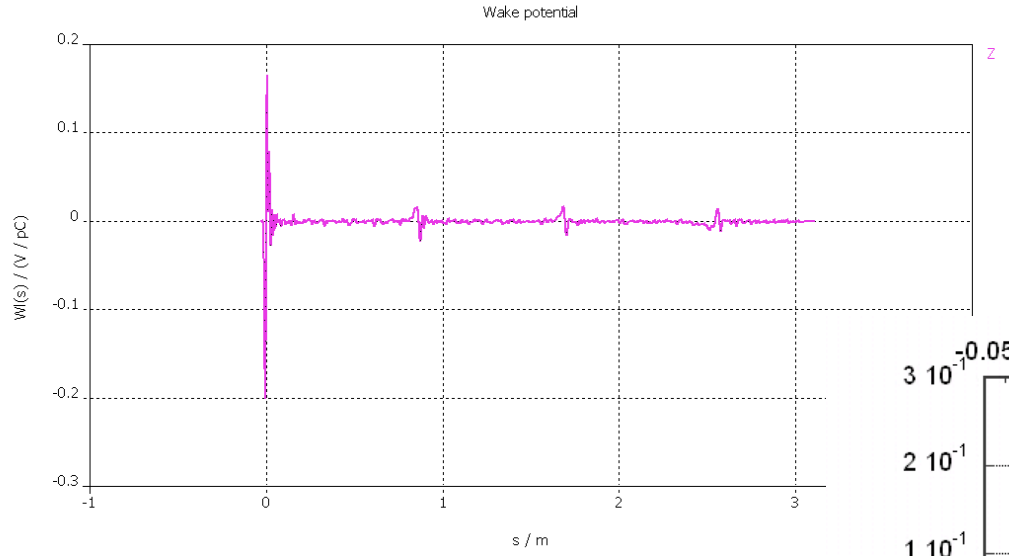
- Output signal from feed through (E_z)



No difference for the position of feed-through

RF calculation (Preliminary)

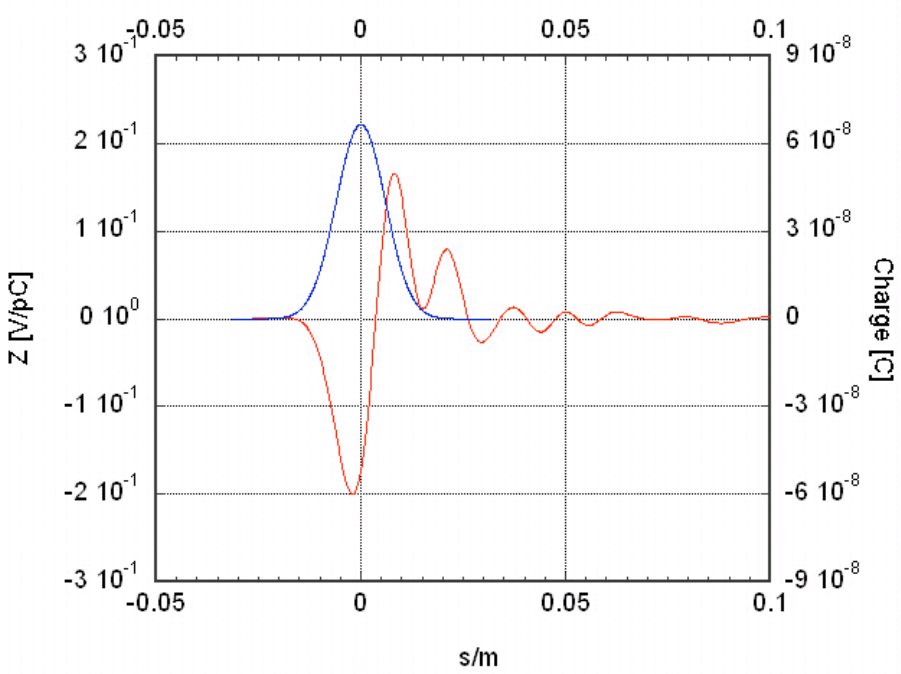
- Wake potential (z)



k = 6.9x10^{-2} V/pC

P = 1.4 kW (total)!

for 1389 bunches 1.7A



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RF calculation (Preliminary)

- Wake potential (z), By Fukuma-san

Simplified model

chamber 50 x 50 mm (square)
length of electrode 400 mm

width of electrode 40 mm

infinitely thin conductor on the dielectric

thickness of dielectric 1 mm

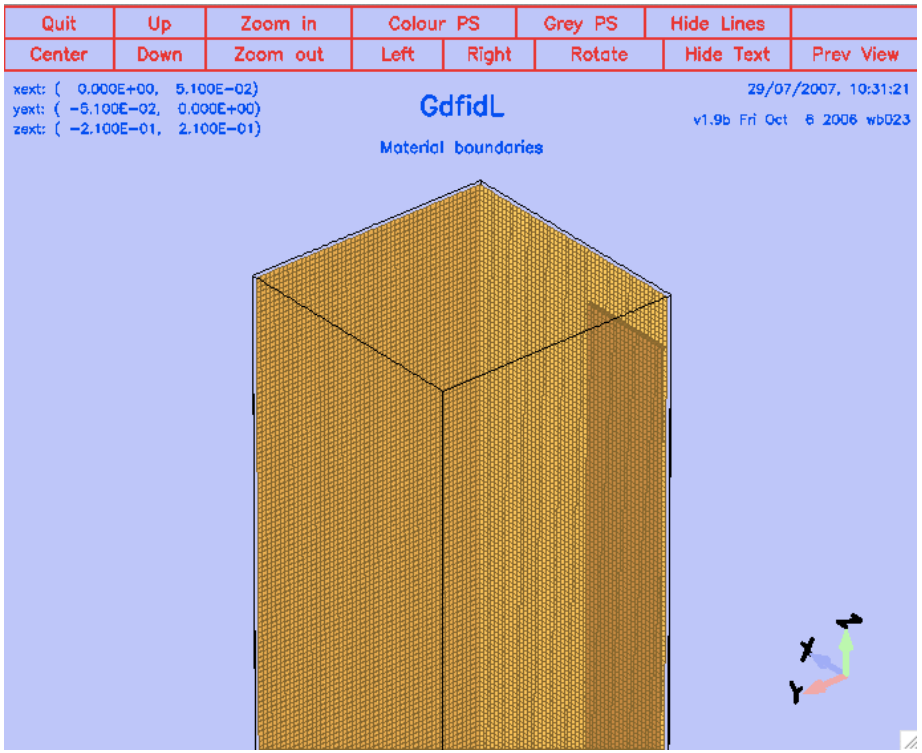
relative dielectric constant ε_r 9.9, tanδ=0

bunch length $\sigma_z = 6$ mm

no port to feed high voltage

assume 4-fold symmetry,
i. e. two electrodes - up and down

By GdfidL



Characteristic impedance of electrode : 3.0 Ω

RF calculation (Preliminary)

- Wake potential (z), By Fukuma-san

By GdfidL

Napoly integration : yes, hollow beam : yes

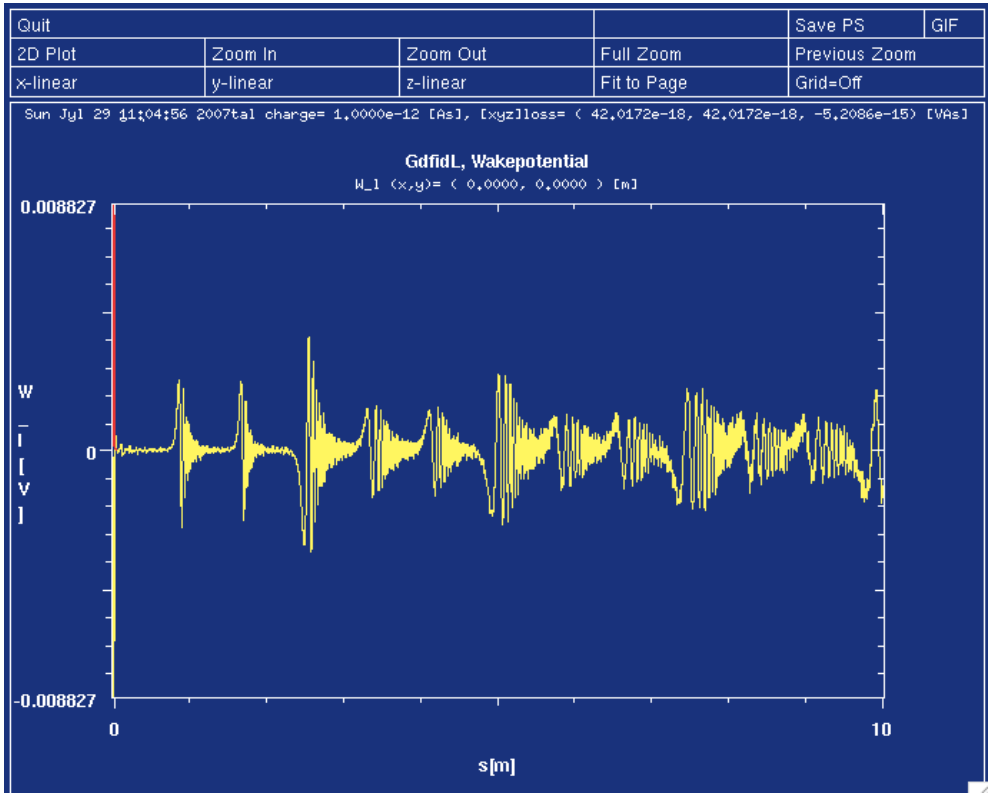
with ceramic

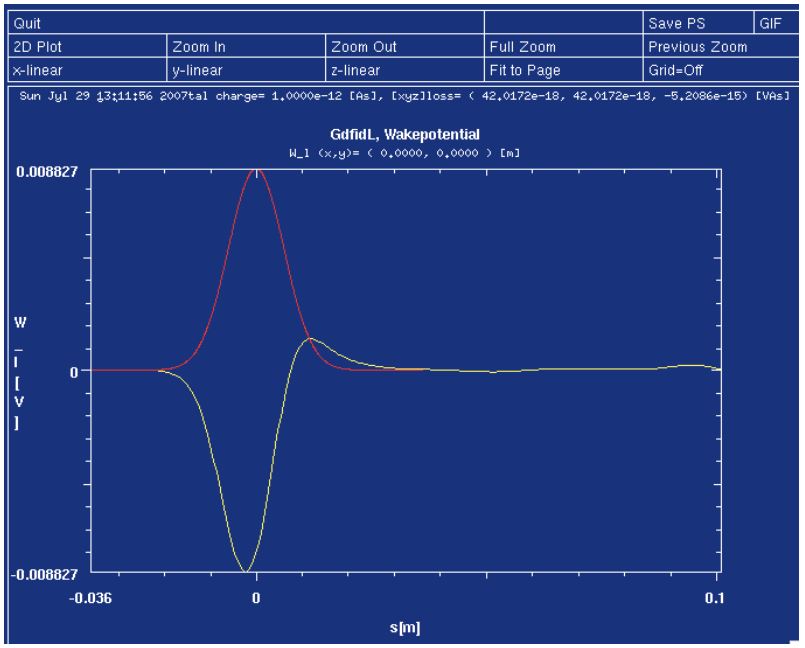
W_L(max)=0.009 V/pC for 2 electrodes

loss factor k=5.2 10^{-3} V/pC for 2 electrodes

P = 110 W !

for 1389 bunches 1.7A





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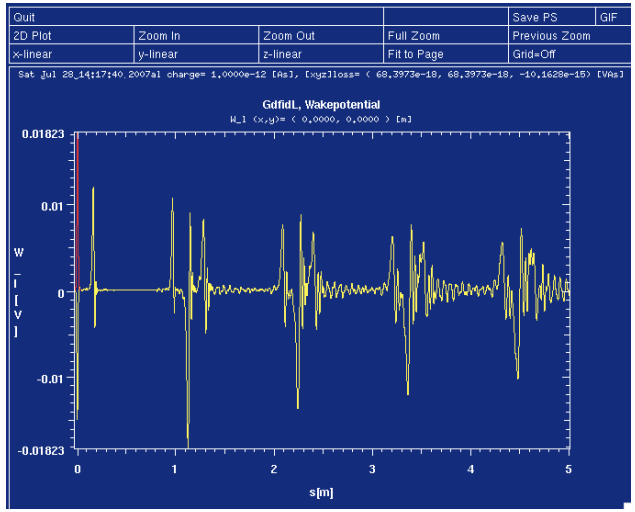
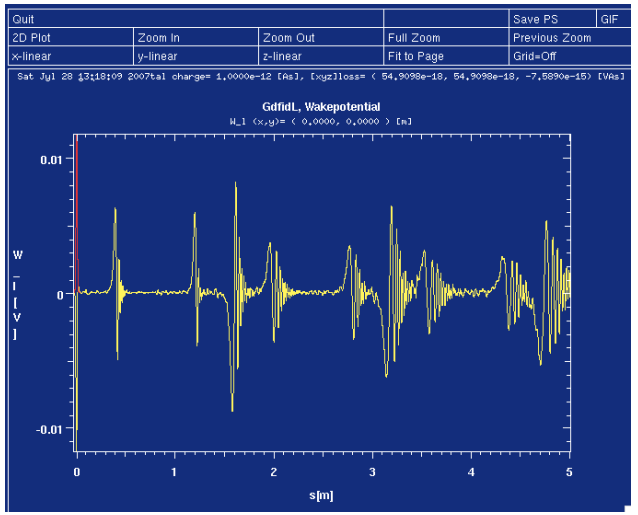
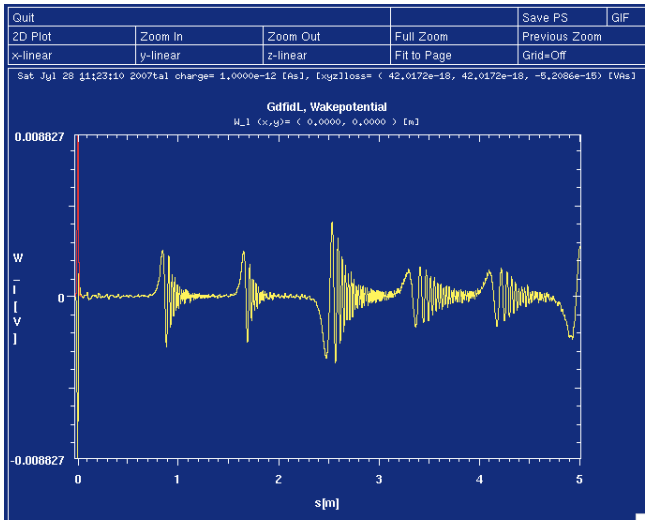
$\varepsilon_r = 2$



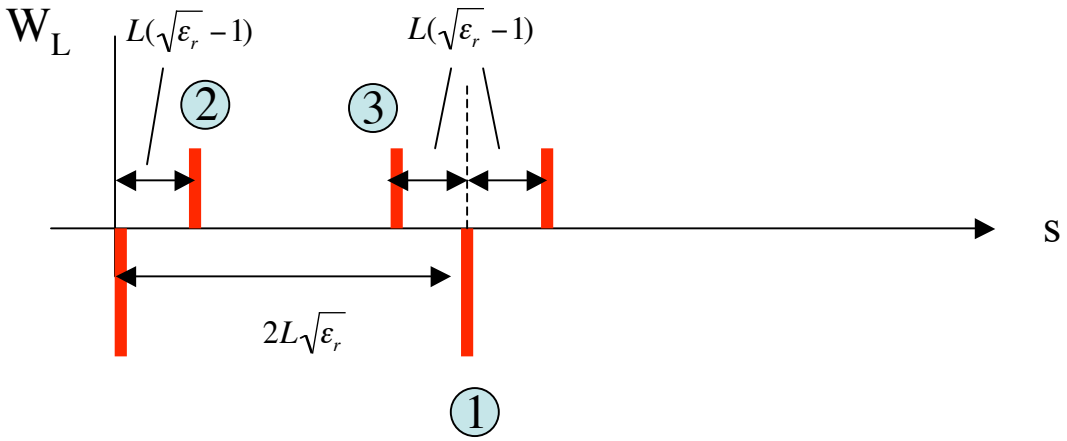
$\varepsilon_r = 4$



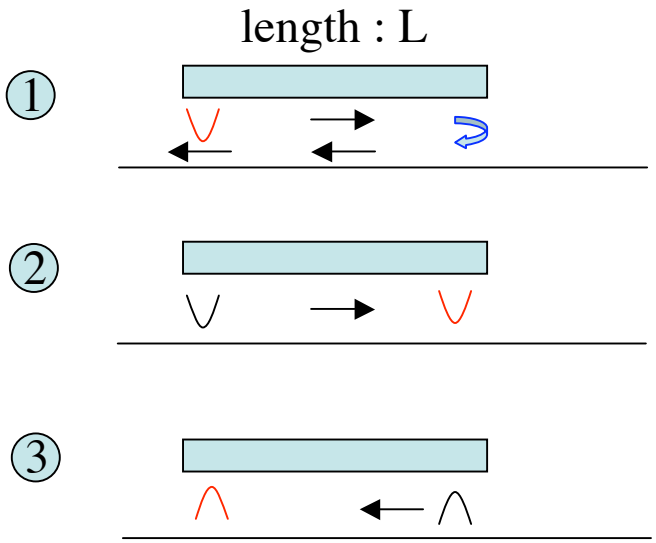
$\varepsilon_r = 9.9$



By Fukuma-san



By Fukuma-san



RF calculation (Preliminary)

- Wake potential (z), By MAFIA

chamber R47 , 38x2 mm height
length of electrode 400 mm

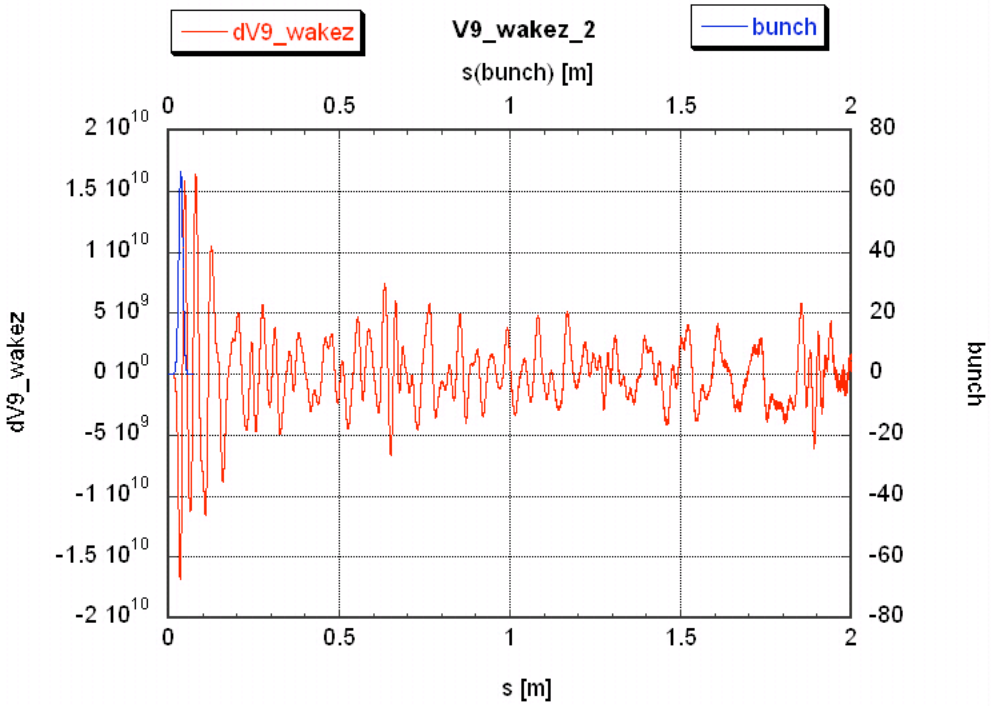
width of electrode 40 mm

Direct method

thickness of dielectric 1 mm

relative dielectric constant ε_r 9.0, tanδ=0

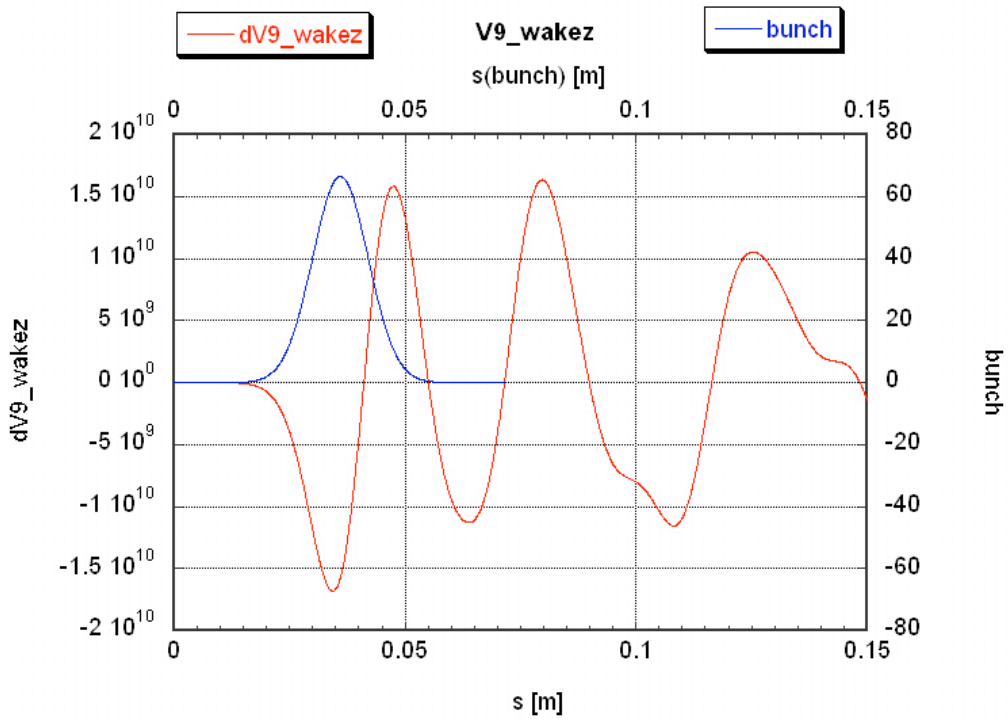
bunch length $\sigma_z = 6$ mm



Different from others!

RF calculation (Preliminary)

- Wake potential (z), By MAFIA



Loss factor = 8.0×10^{-3} V/pC

P = 170 W !

for 1389 bunches 1.7A

Near to Fukuma-san's (GdfidL),

Shape of Wake(z) is quite different

? ? ? ?

RF calculation

- Continue the calculation
  - Check each other
  - Refine model
  - Estimate heating power

- In any way, the cooling will be required.