# First beam test of the tilt monitor in the ATF2 beam line

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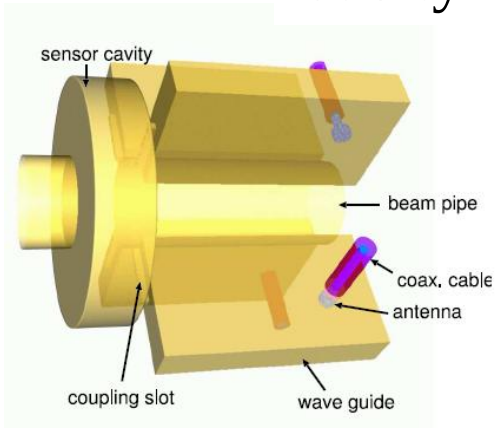
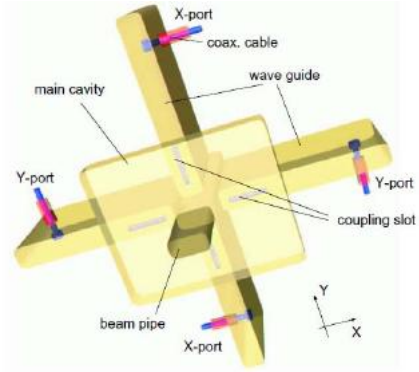
# Overview

- Cavity beam monitors
- Basic principle
- Prototype design
- Parameter test
- Beam test
- Summary & plan

# Cavity beam monitors

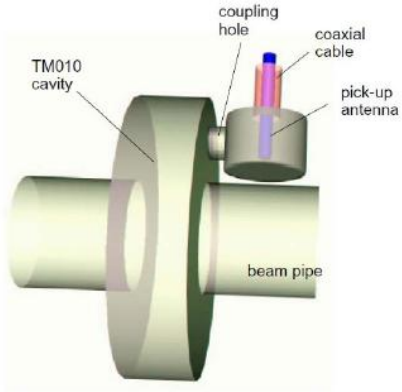
## Cavity BPM



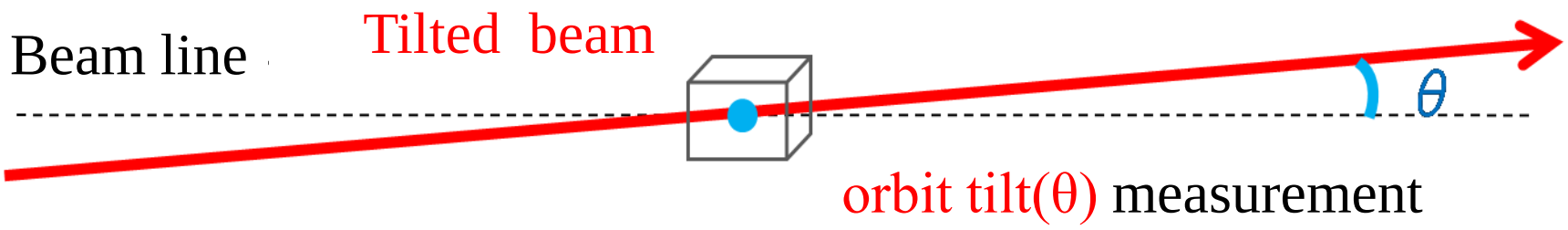

position measurement

## Reference cavity




charge measurement

## Tilt monitor

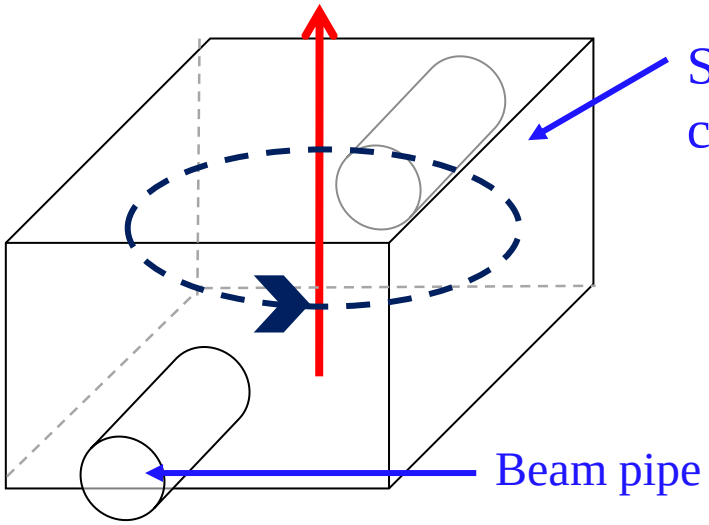


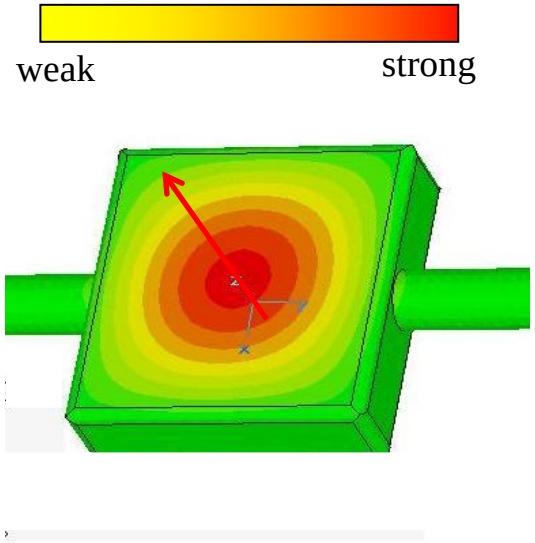

orbit tilt(θ) measurement

Tilt monitor can measure the beam orbit tilt in a single monitor

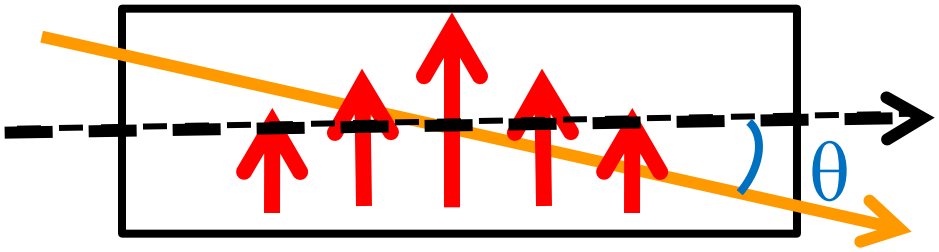
# Basic principle

Use the most basic resonant mode , called monopole mode




Tilted beam




Excited by the beam loading

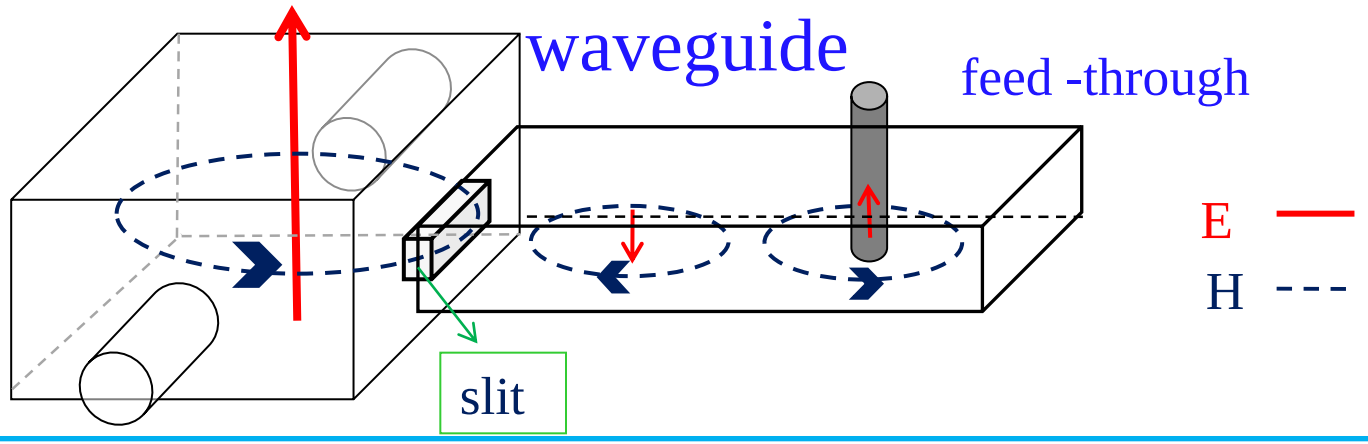
After the beam passes,

U(monopole)$\propto \theta^2$

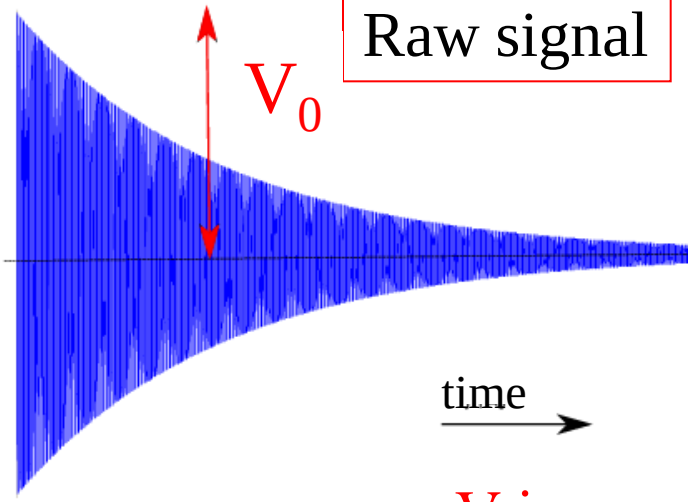
# Signal extraction

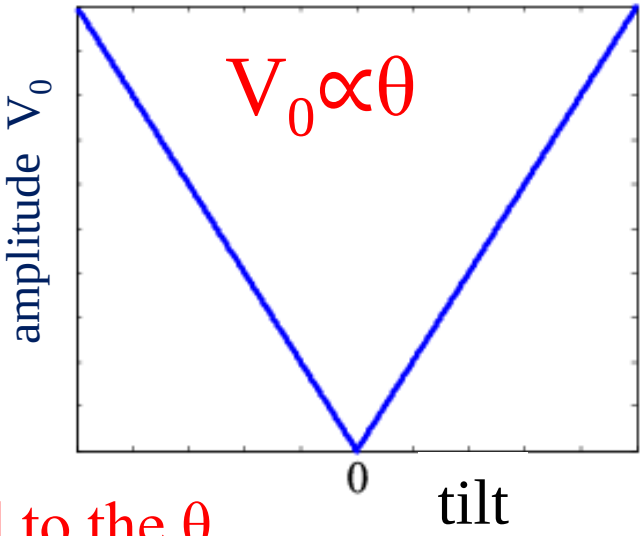
The way to extract

slit ⇨ waveguide ⇨ feed-through ⇨ Coaxial cable




Raw signal




V is proportional to the θ

# Prototype design

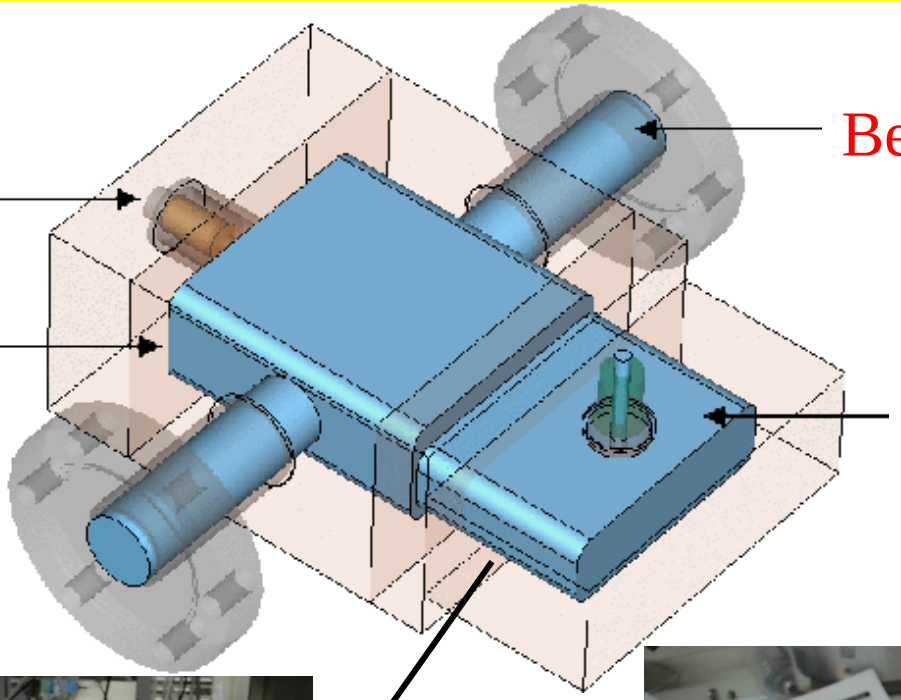


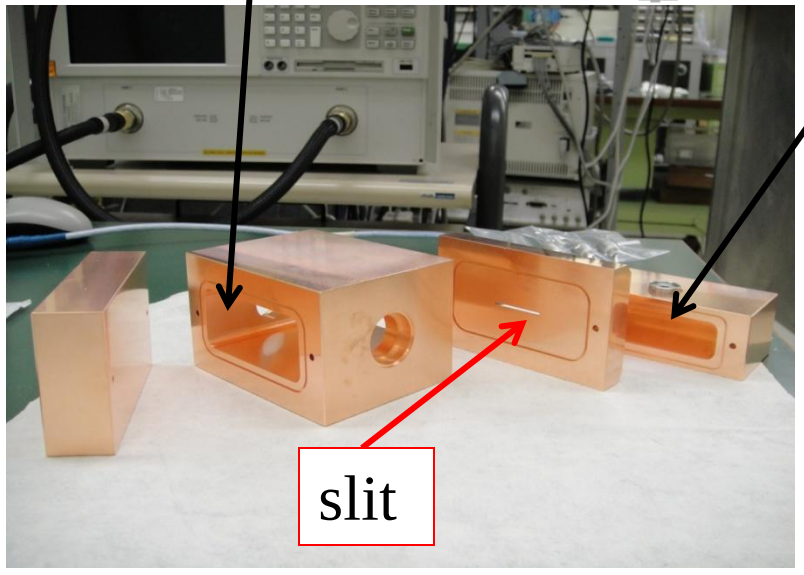
Frequency tuner

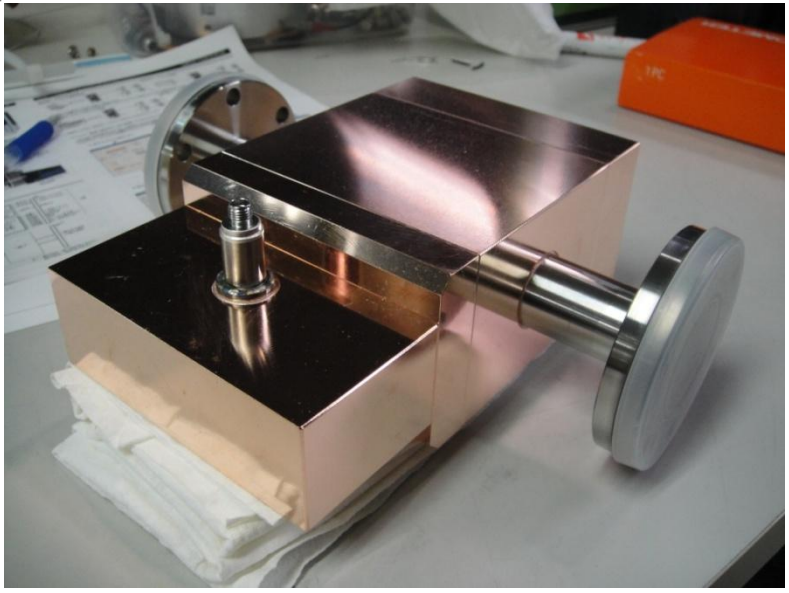
Sensor cavity

Beam pipe

Waveguide Feed-through





# Expected performance

Cavity beam monitor is limited by the thermal noise

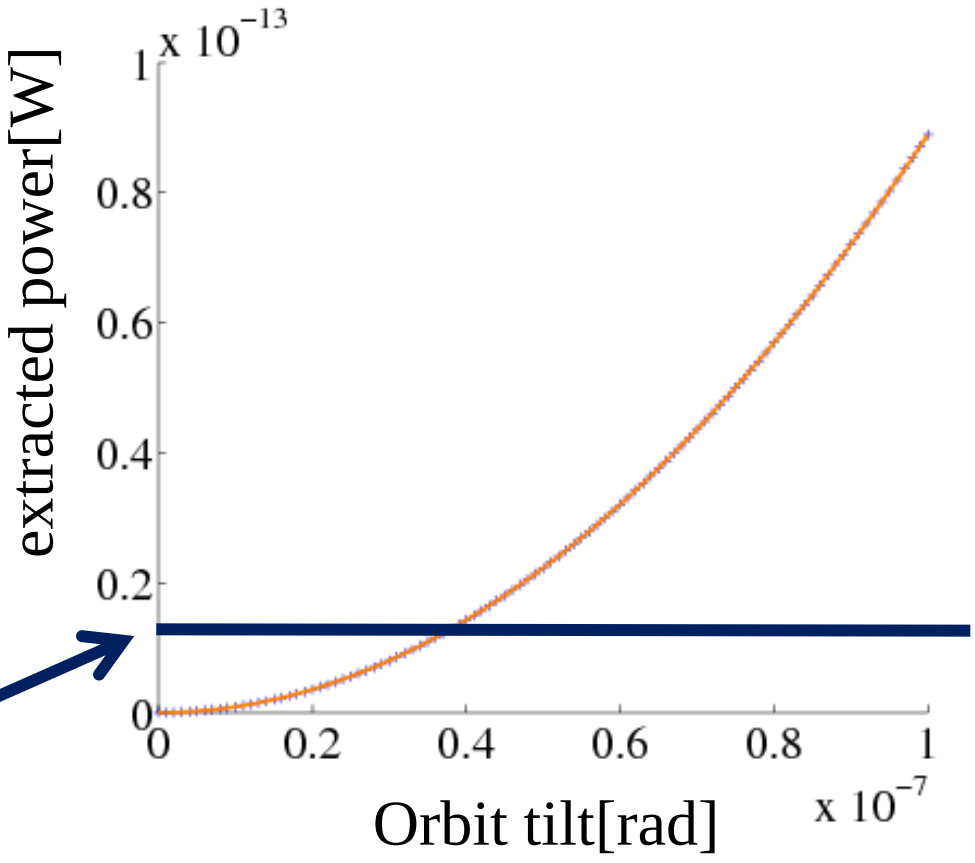
## Thermal noise

Determined by
temperature(T), bandwidth(Δf)

$$P_{TN} = K_B T \Delta f$$

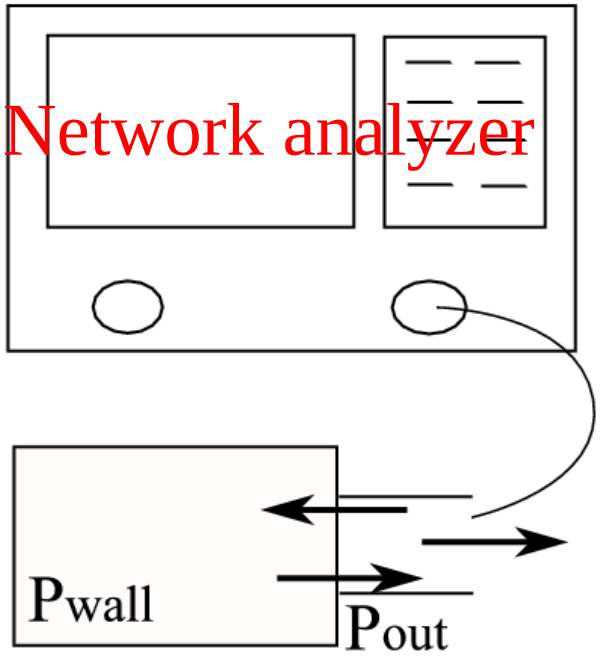
Room temperature 300[K]
bandwidth ～3MHz

$$P_{TN} = 1.24 \times 10^{-14}\,[W]$$

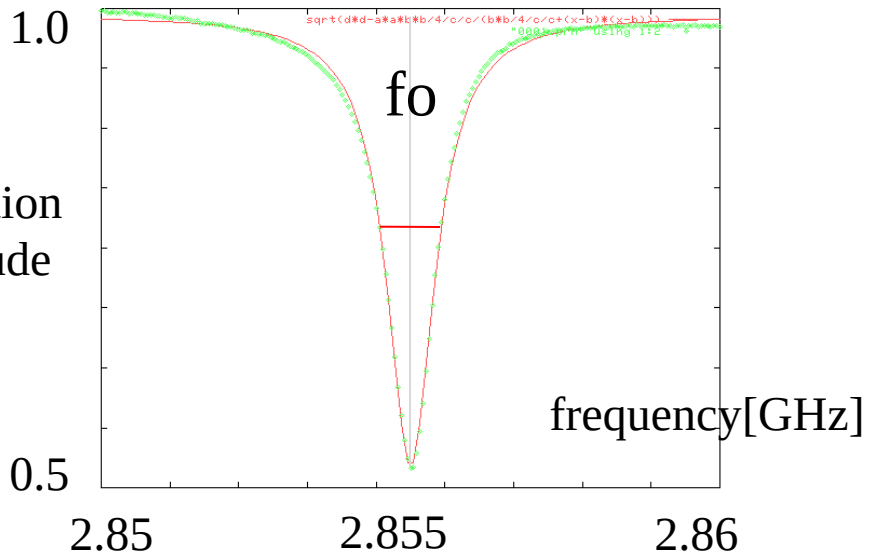



Expected limitation: about 35 nrad

# Parameter measurement




Resonant curve

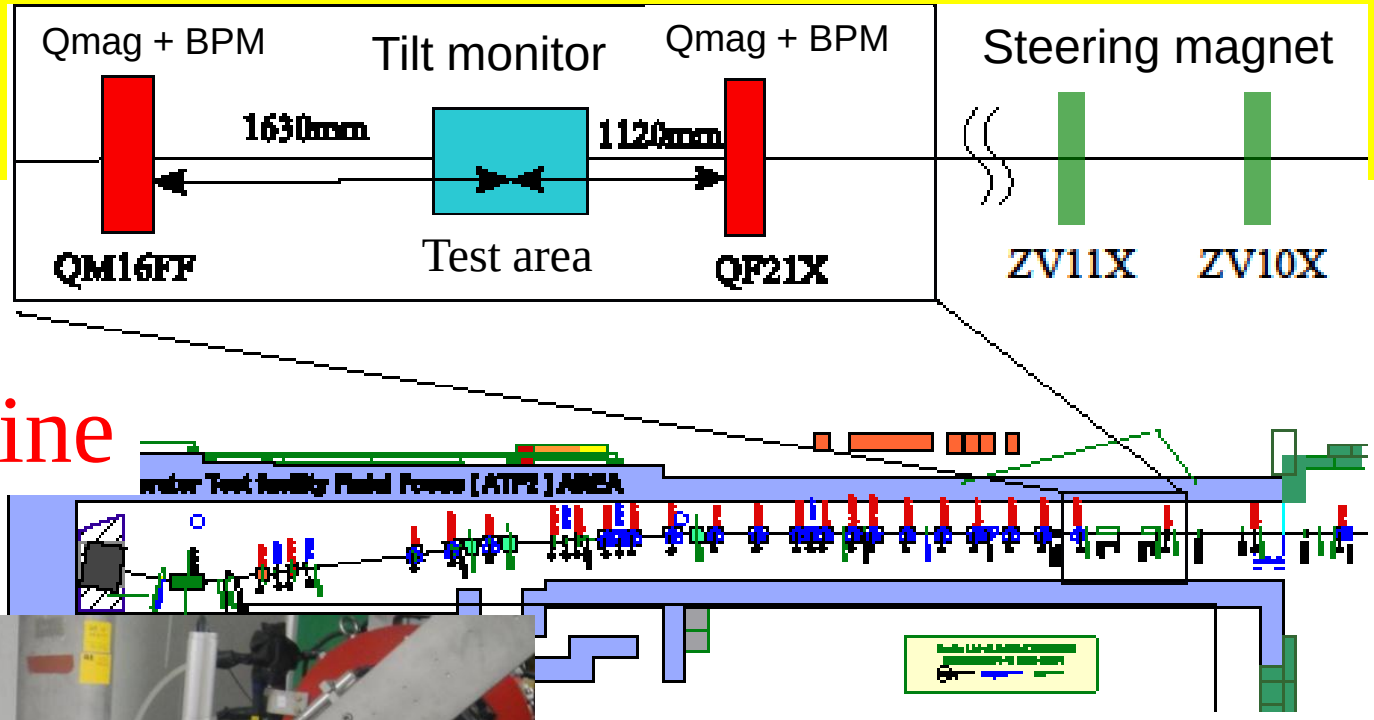


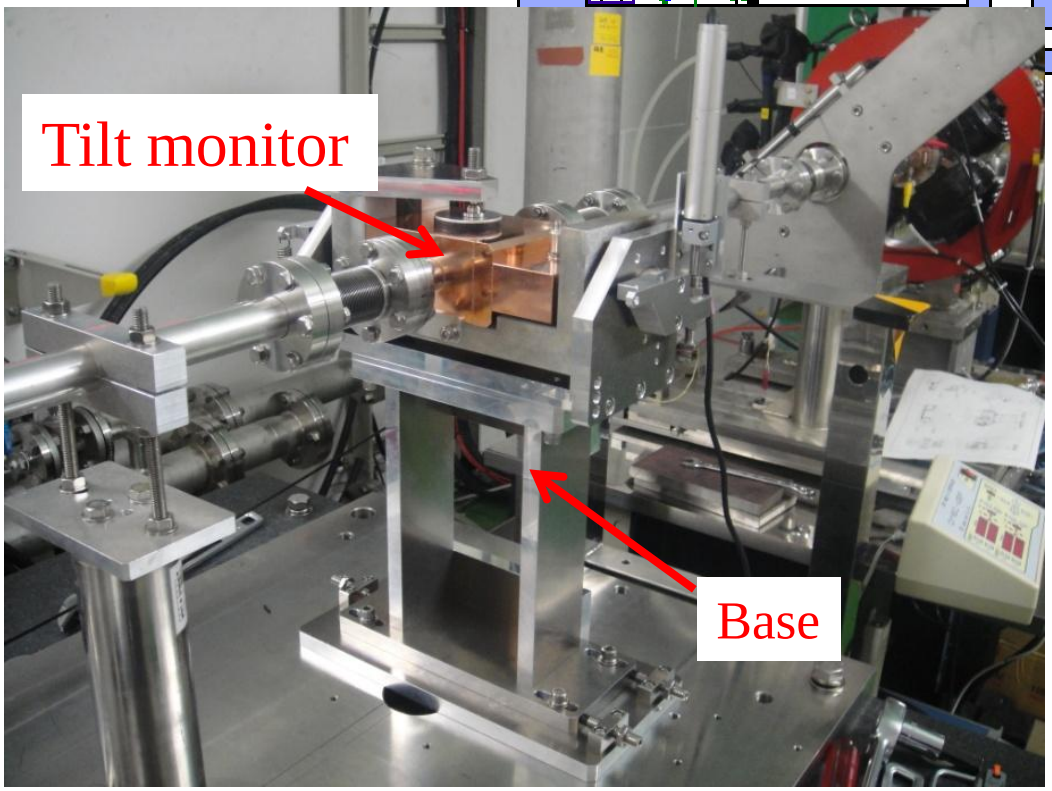

| | **Measurement** | **Designed value** |
|---|---|---|
| Frequency | 2.8554 GHz | 2.856 GHz |
| Loaded Q | 2978 | 2650 |
| Unloaded Q | 10128 | 10000 |
| External Q | 4220 | 3350 |
| Decay time | 156nsec | 150nsec |

# install

KEK-ATF

## ATF2beamline



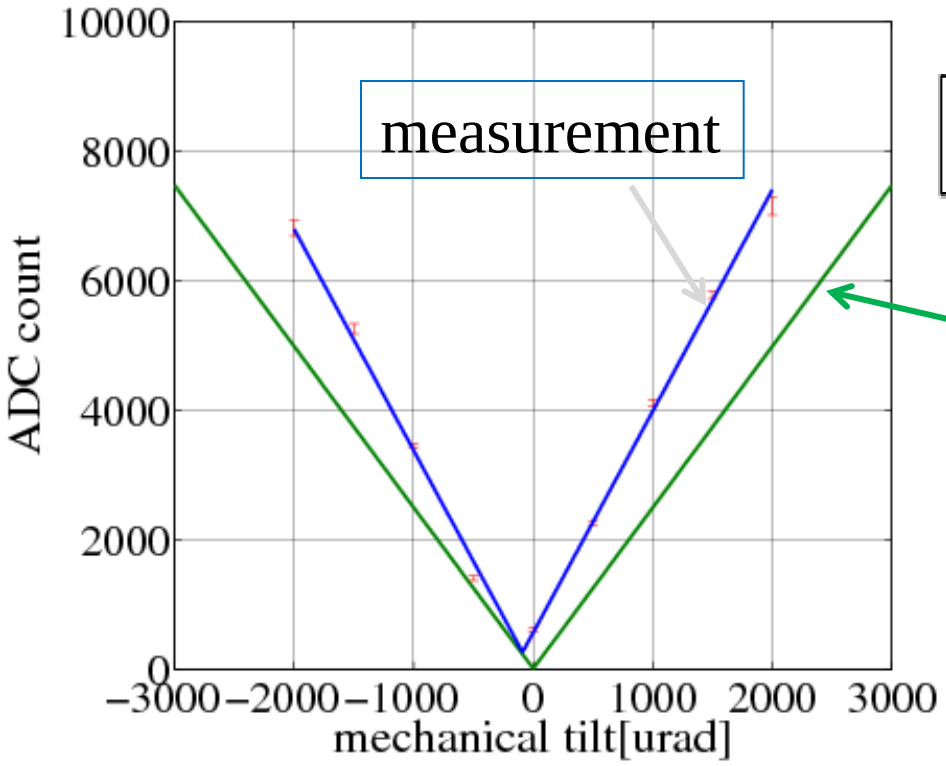



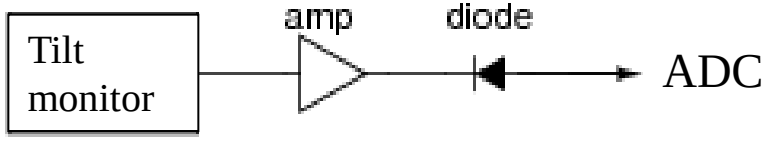

Base:Rotation mechanism

Range: -15mrad ~ +15mrad

Connected to
the local network

# Confirmation of the basic principle




Simulated value

Simulated output power

+

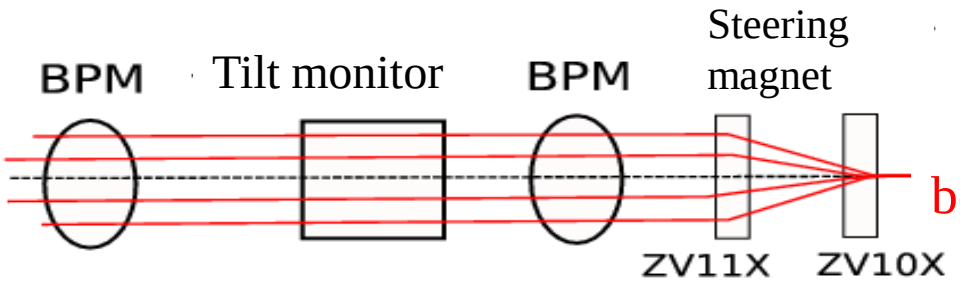
Measured gain

Measurement value was 1.14 times by simulated value

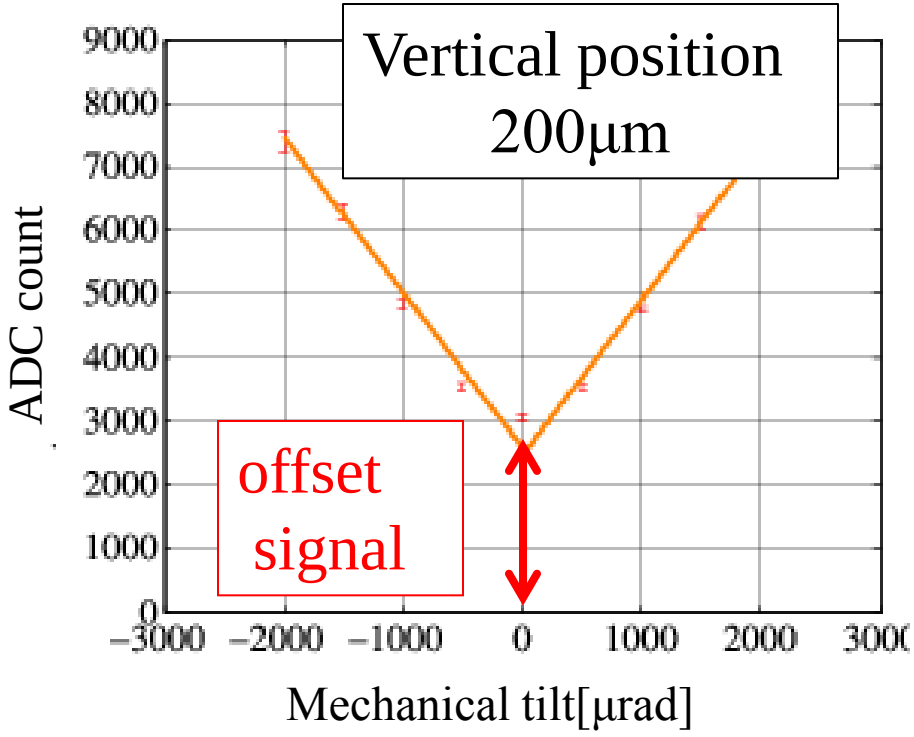
Confirmed the basic relation:

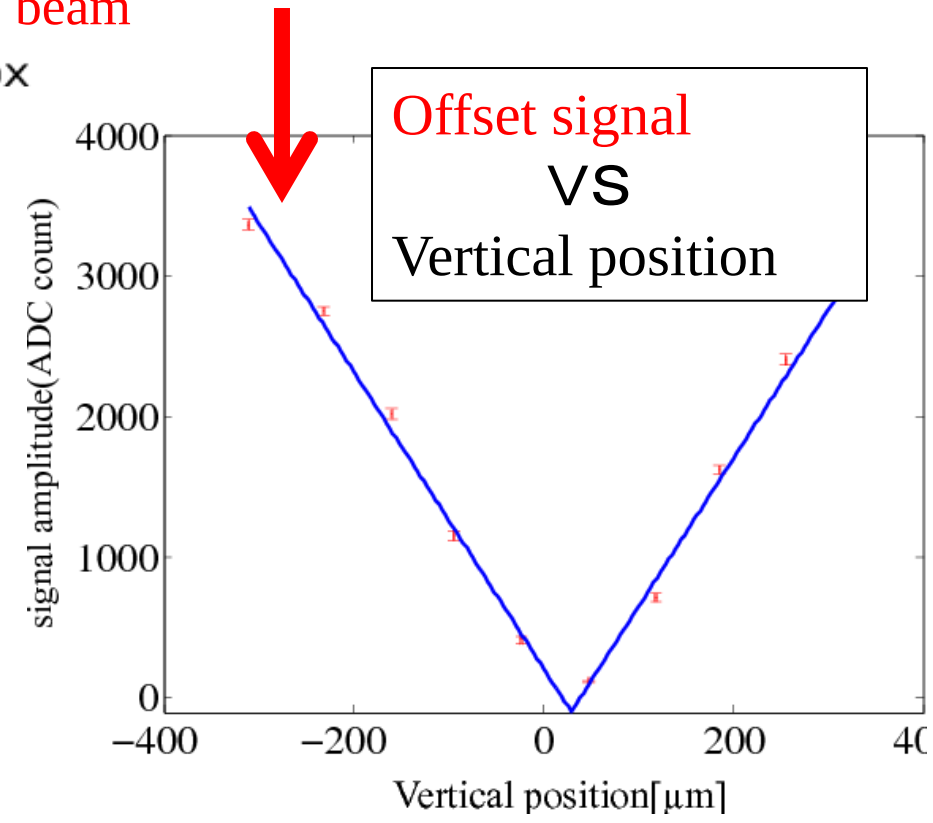
extracted amplitude is proportional to the tilt.

# Vertical position dependence



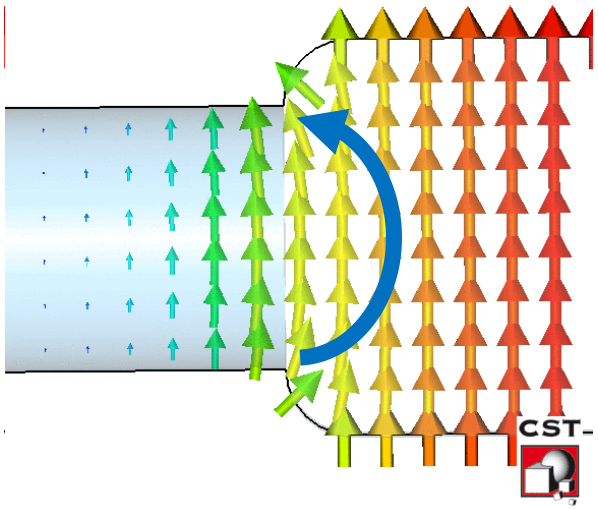

Translate the beam by
Using two steering magnet



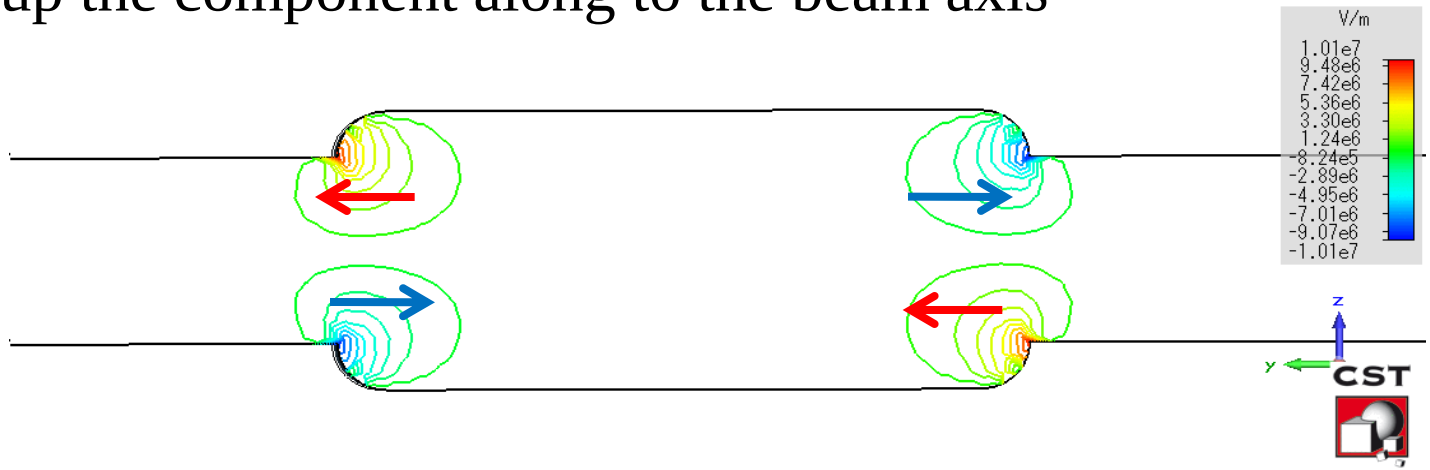

Offset signal is proportional to the vertical position

# Reason of the position dependence



The beam pipe disarrange the electric field of the monopole mode

Pick up the component along to the beam axis

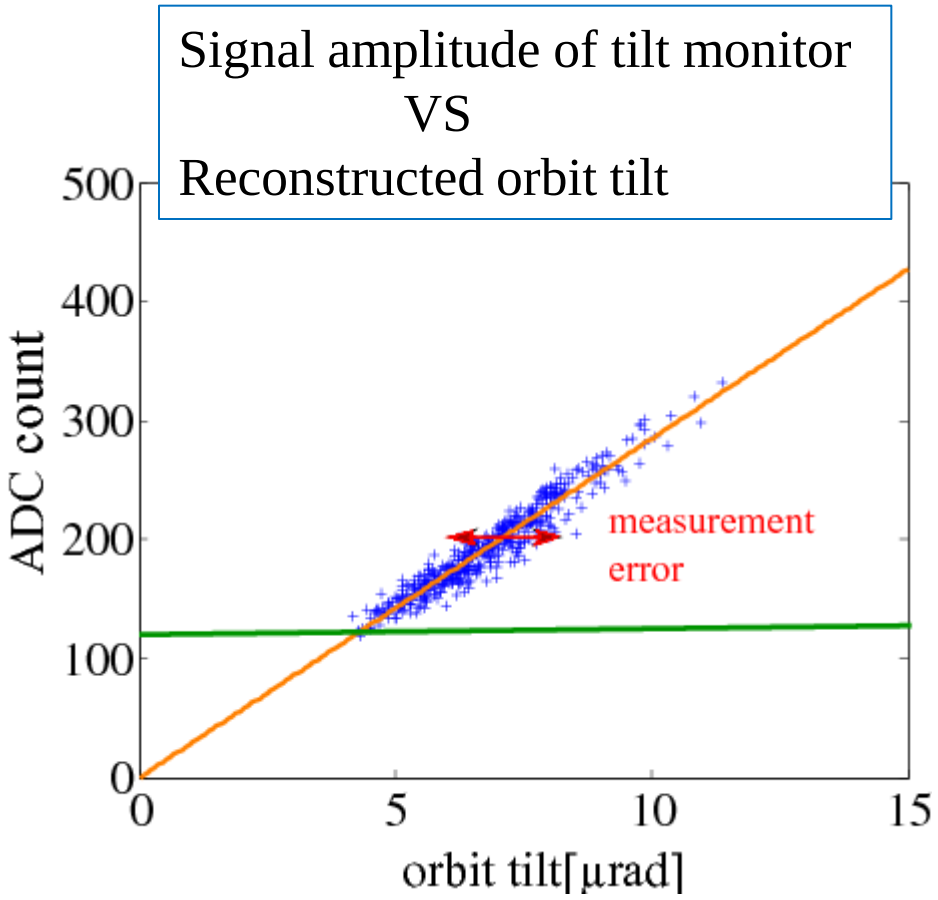


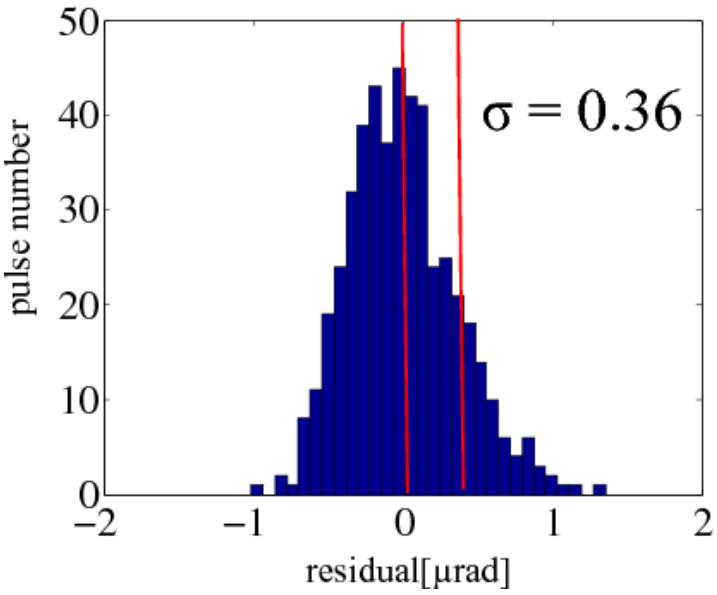

We can cancel the position dependence
by adjustment of phase changing

$2\pi$

# Orbit jitter measurement

Rotation mechanism was fixed
Measurement of the μrad jittering for each bunch
The orbit was reconstructed by the forward and backward BPMs




$\sigma = 0.36[\mu\text{rad}]$

# consideration

Measurement accuracy 0.36μrad

We used the low gain amplifier due to the large mechanical tilt

1ADC / 0.25 μrad
Noise of total system / 1.5ADC

0.38μrad

limited by the ADC unit

We are preparing the higher gain electronics
Practical resolution will be evaluated in the next Beam test

# summary

- We have studied about the tilt monitor.
  This monitor measure the beam orbit tilt solely with high precision

- The prototype model was completed.
- After measurement of the cavity parameters,
  we installed in the ATF2 beamline  for the beam test

- Beam test
  we confirmed the basic proportional relation
  measurement of the vertical position dependence
  measurement accuracy is estimated 0.36 μrad

- We are preparing a higher gain electronics
  We will measure the practical resolution in June