Status of the tilt monitor

topics

- principle
- designing
- performance
- test schedule
- summary

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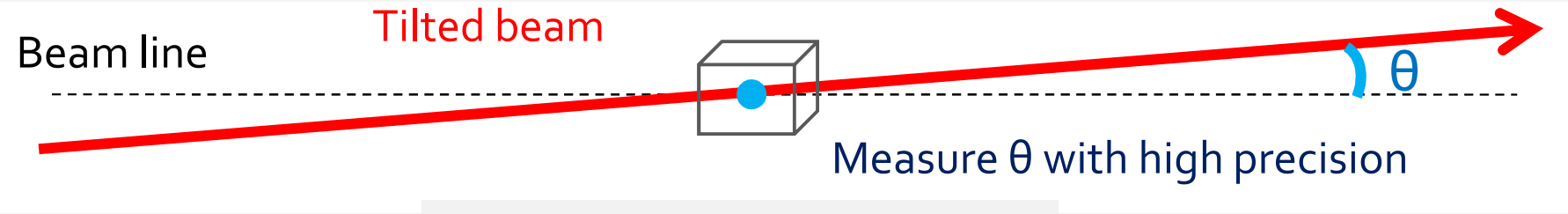
About tilt monitor

Tilt monitor is a new type of the Cavity beam monitor

Measure the beam orbit tilt in a single cavity



Independent tilt data

Direct tilt signal from a single cavity
No influence of the beam position

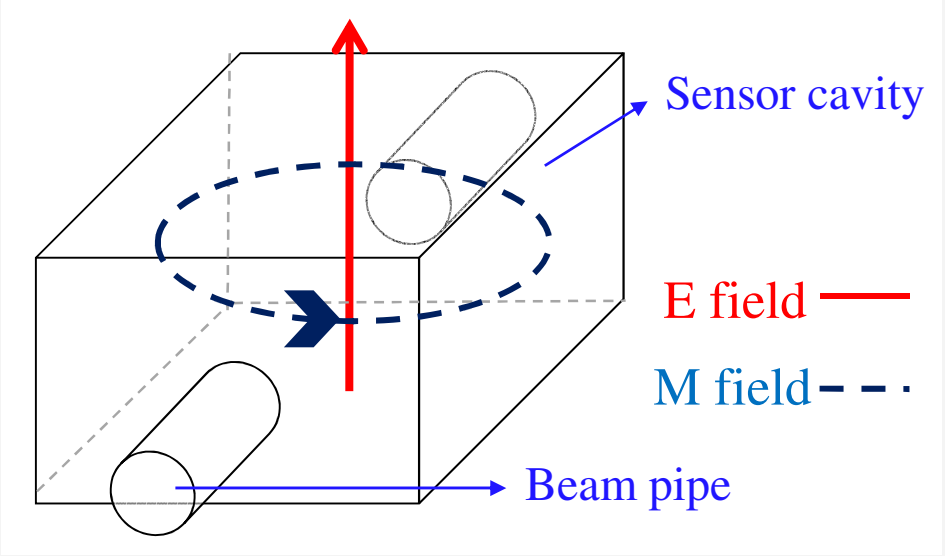
We are going to test the prototype model in this winter

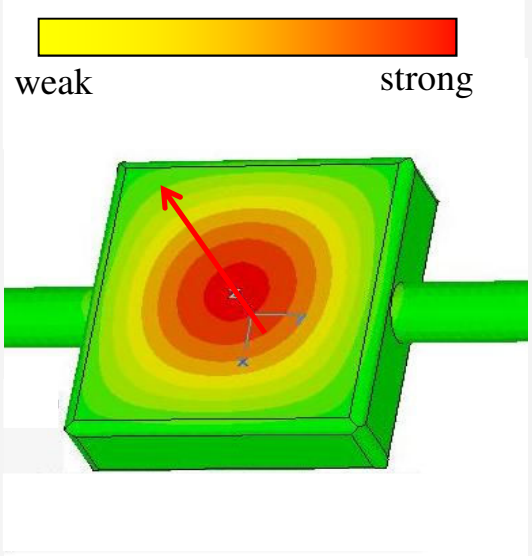
Additional orbit tilt data to IP BPM
Combination with the BPMs

Under study

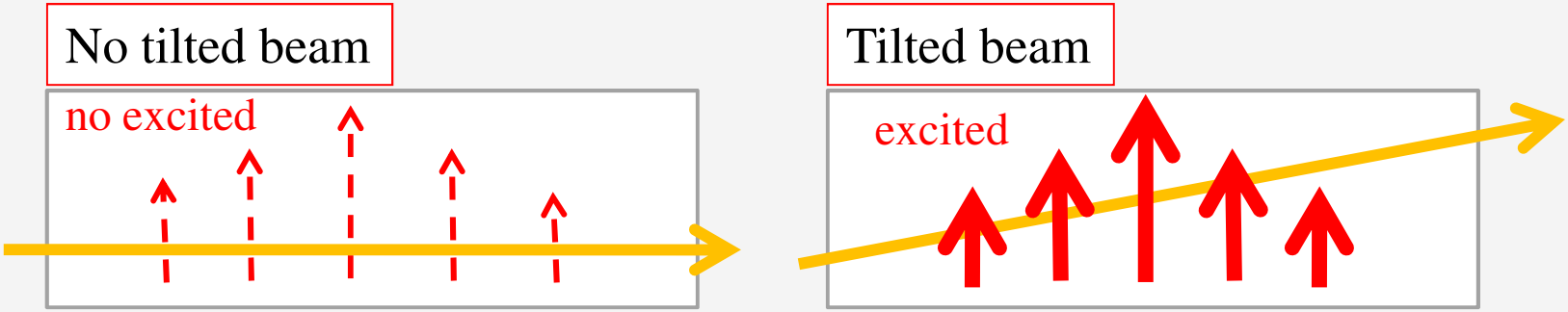
Principle

Tilt monitor uses the “monopole mode”





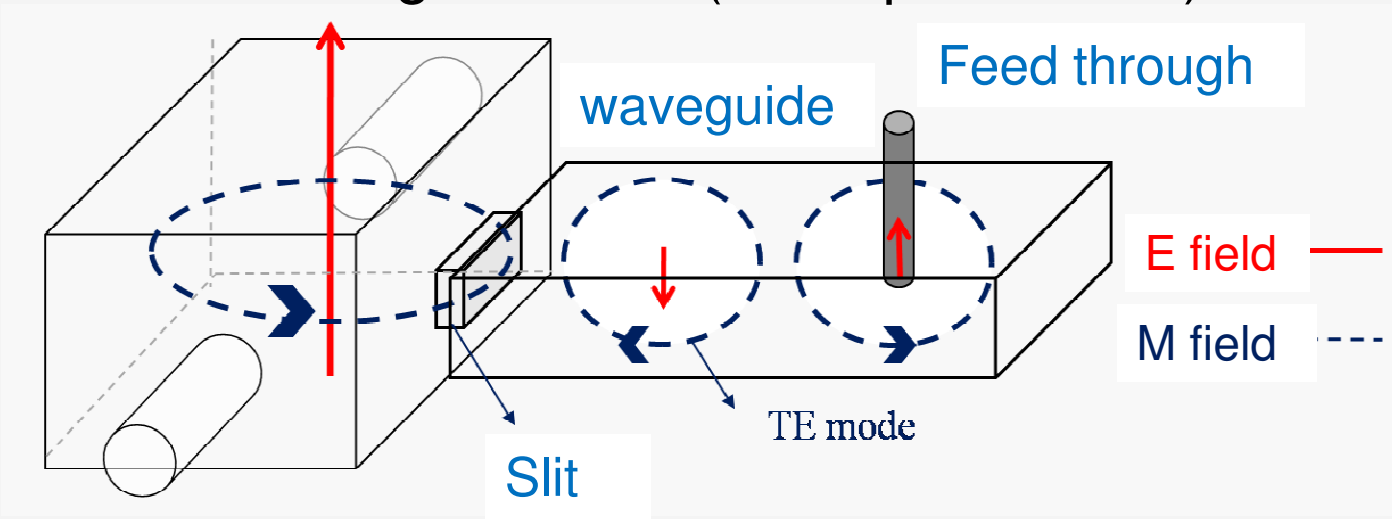
monopole mode is excited by the beam orbit tilt



Energy of the monopole mode $\propto \theta^2$

Signal extraction

Extraction of the magnetic field(monopole mode)



slit

↓

waveguide

↓

Feed through

Extraction of the M-field to waveguide
Suppression of the other modes

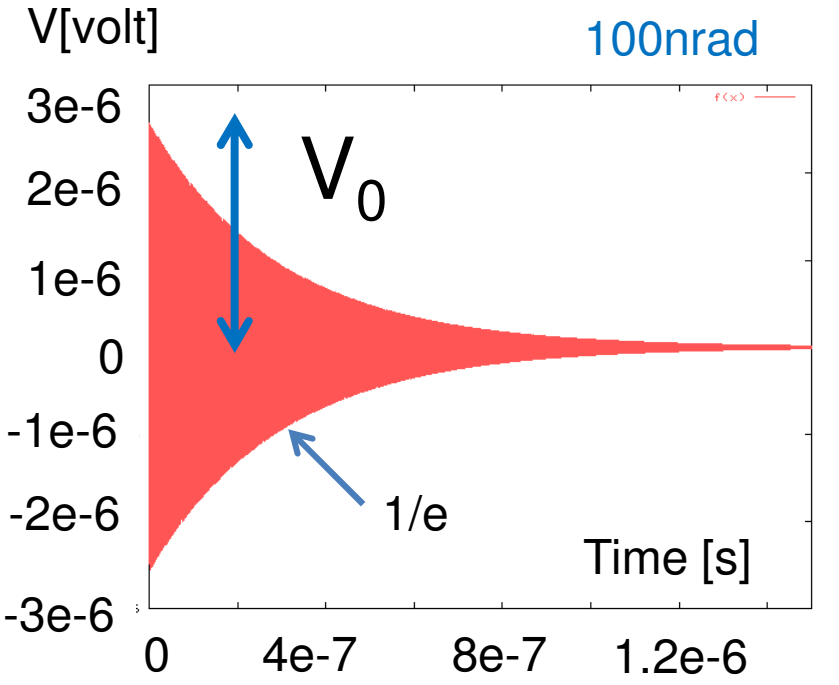
Transmit the M-field in TE mode

Extraction to the coax. cable $V_0 \propto \theta$

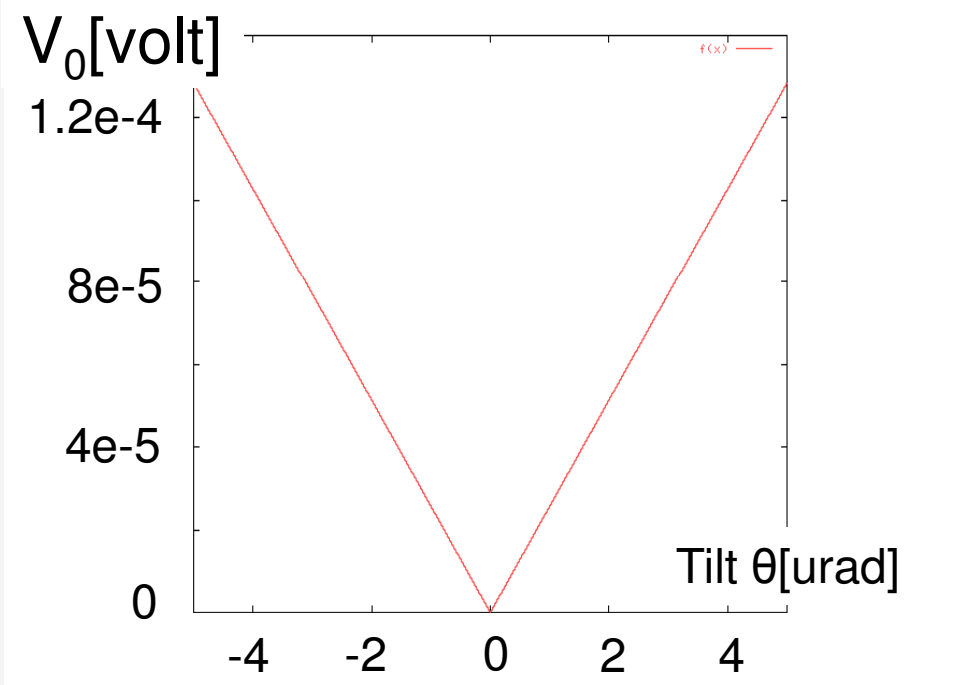
Amplitude detection

Extracted signal is the RF signal (GHz)

Raw signal



V_0 versus θ



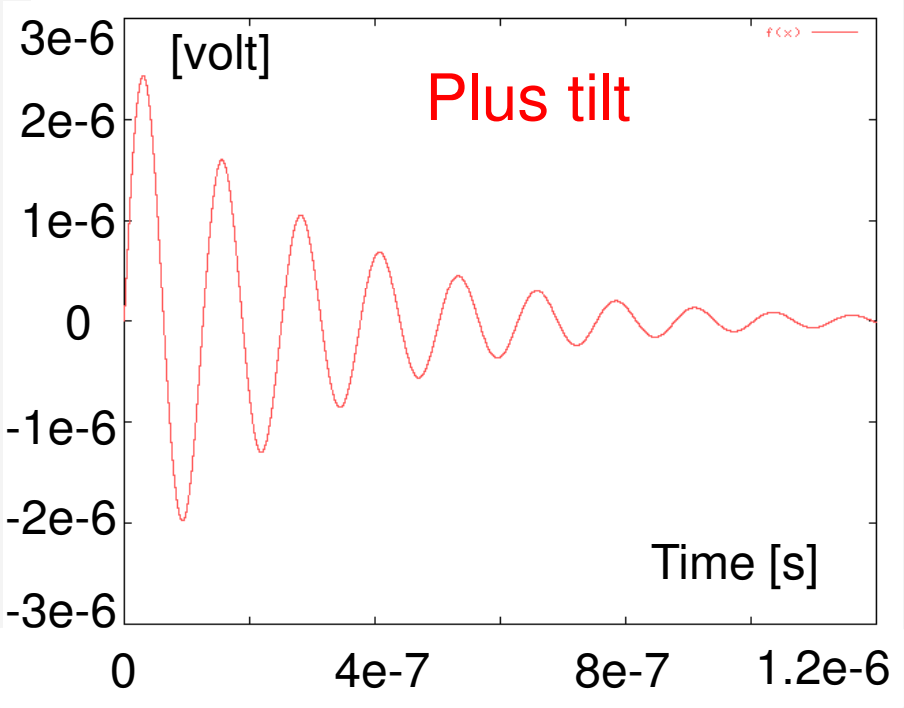
The amplitude V_0 is proportional to the tilt angle(absolute value)

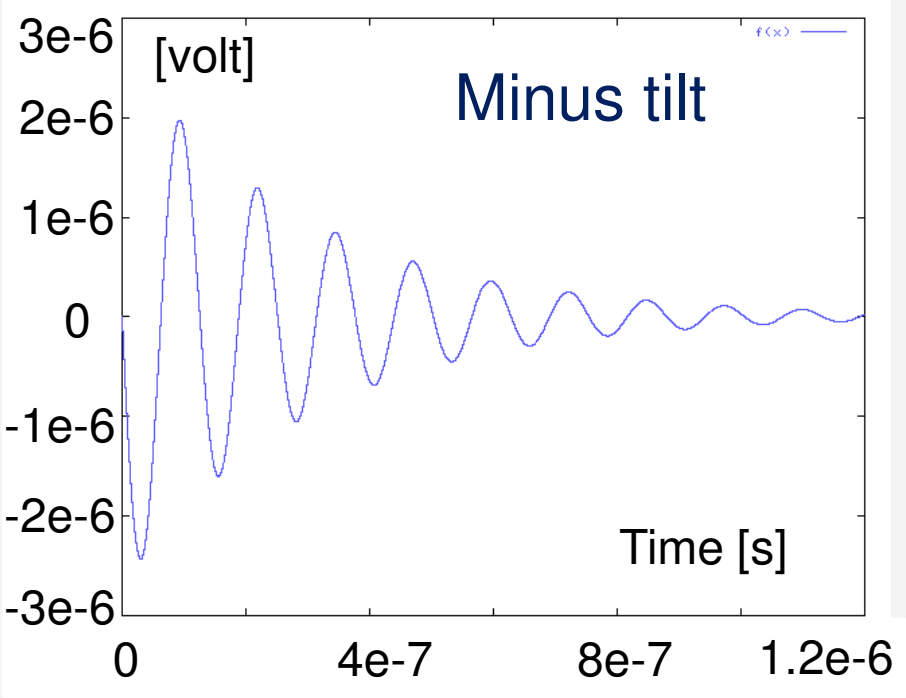
We have to measure the phase for plus-minus determination

Phase detection

RF signal is converted to low frequency by mixer

50MHz

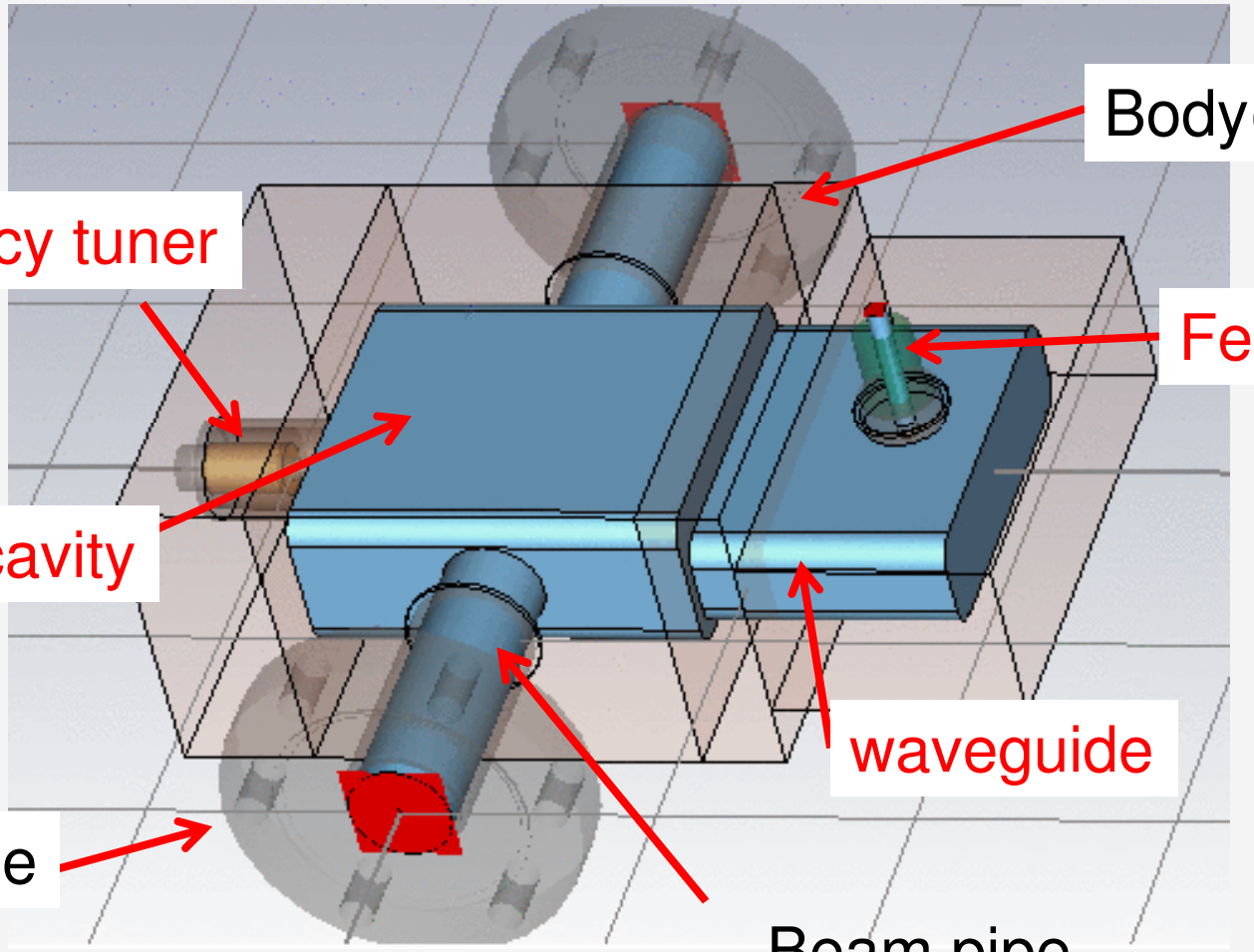




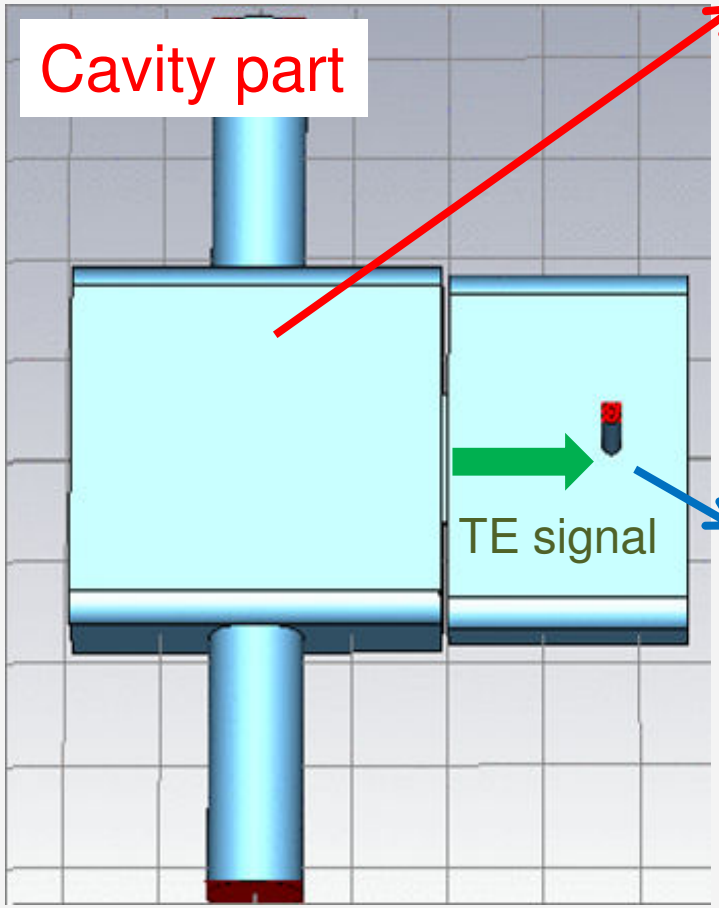
The plus-minus can be determined by phase difference

There is π/2 difference

Prototype design



Design Concept 1



Sensor cavity

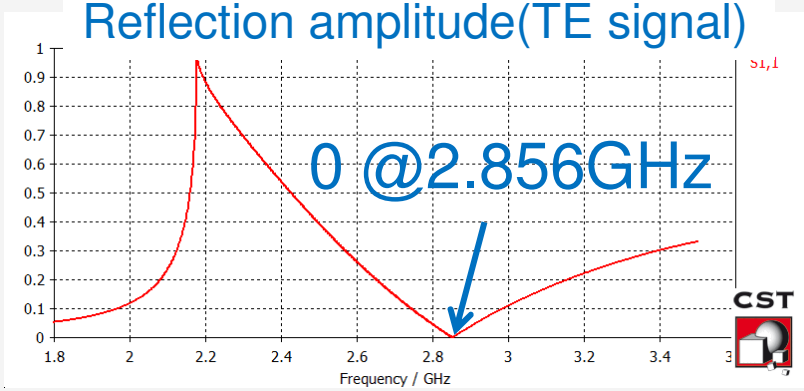
The excited energy becomes as large as possible

Frequency 2.856GHz

(same as S-band BPM)

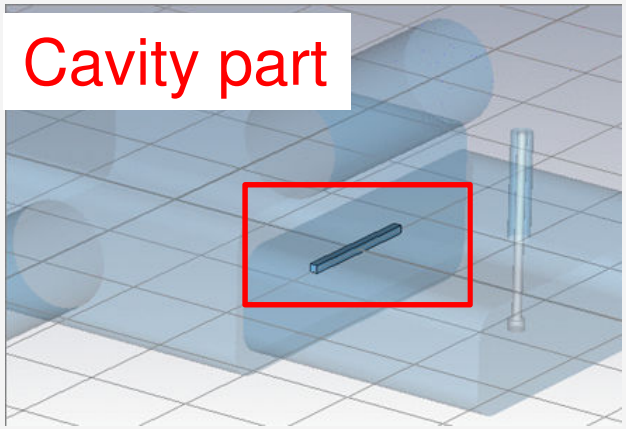
Waveguide + feed-through

TE signal is extracted from feed-through perfectly at 2.856GHz



Design Concept 2

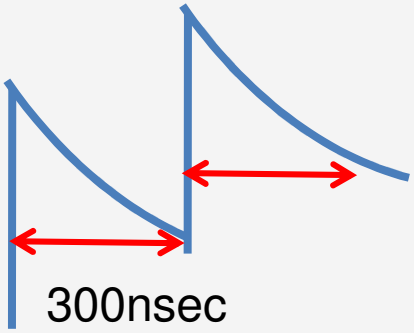
Slit



Slit determine the extraction power

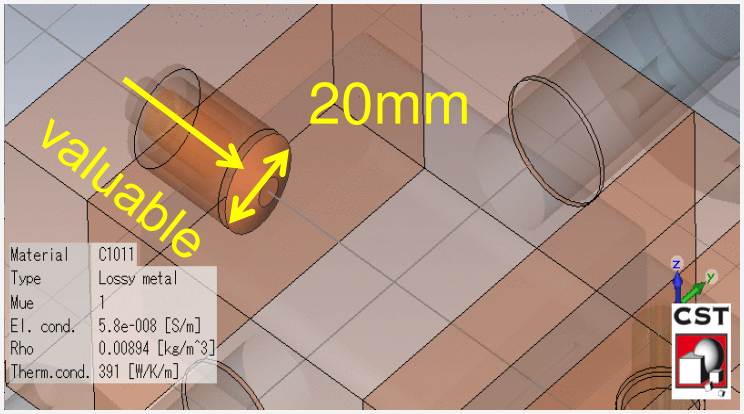
Q value 2600

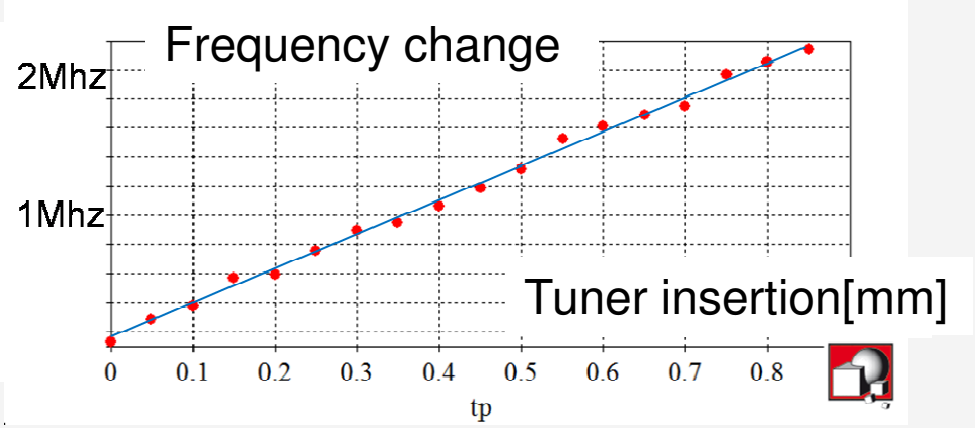
Decay time ~300nsec
(ILC bunch interval)



Frequency tuner

Tuner can tune Frequency finely by valuable part of the cavity wall





Performance

The sensitivity was restricted by Thermal noise.

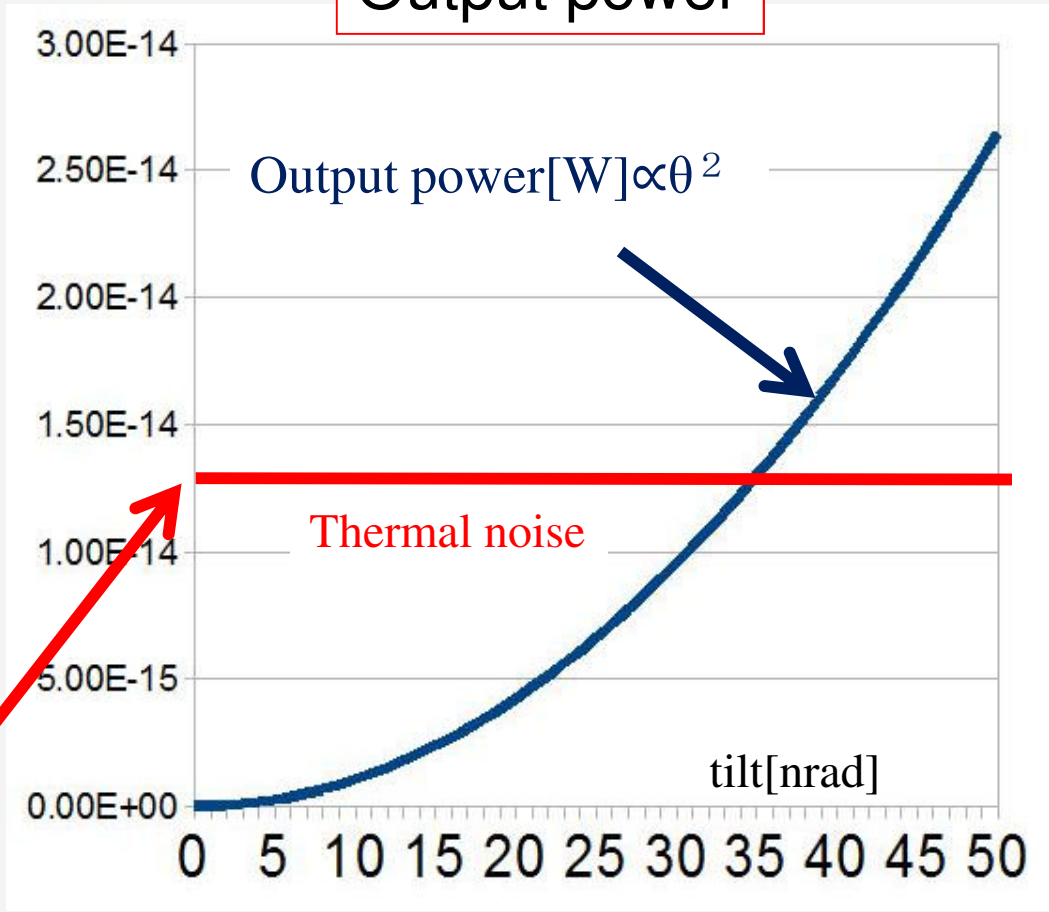
Thermal noise

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]

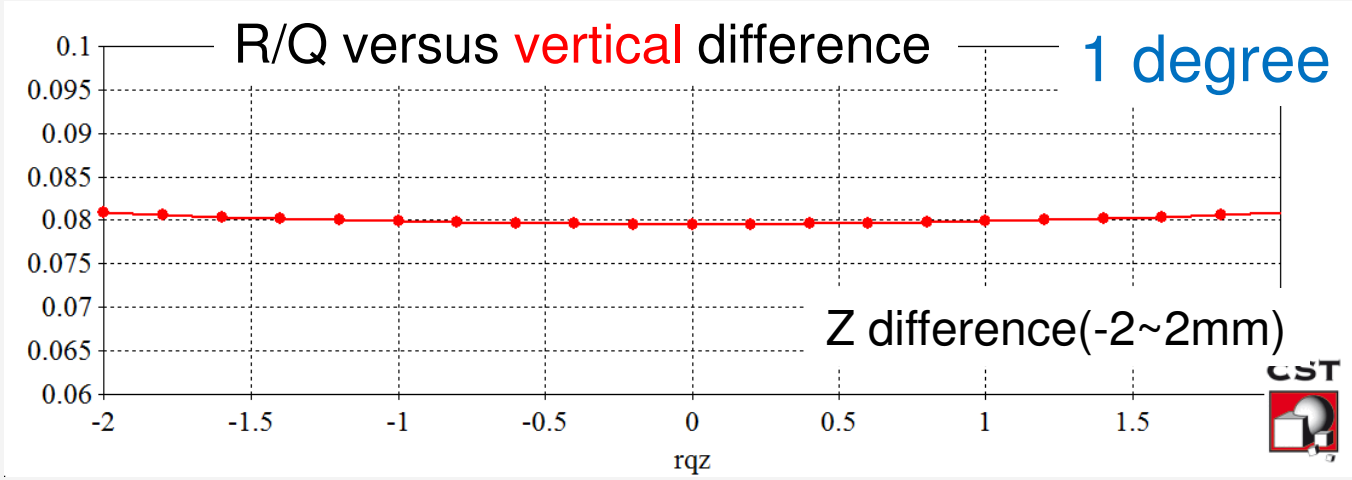


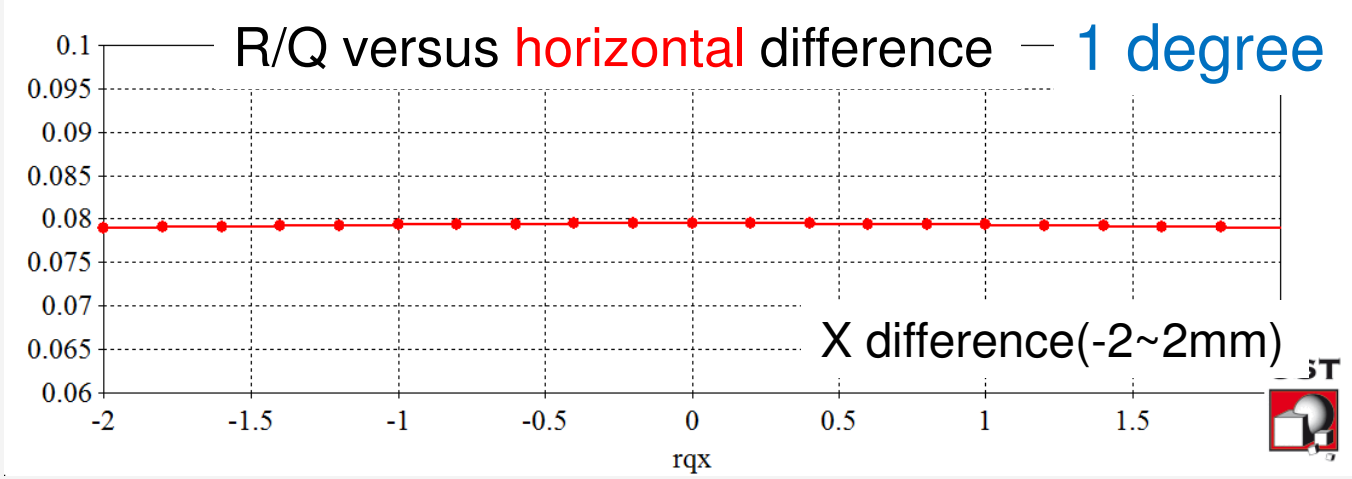
Expected performance: 35 nrad

No Influence of the beam position

R/Q(θ²) versus beam position difference

Energy ∝ R/Q(θ²)





We can almost ignore the beam position difference.

Time schedule

month

9 Machine works

10 Brazing

Cold test

11 Beam test

12

Now status

We ordered the prototype in early 9

The machine works will be done 30th 9 (Today)

Prototype will be completed in middle 10

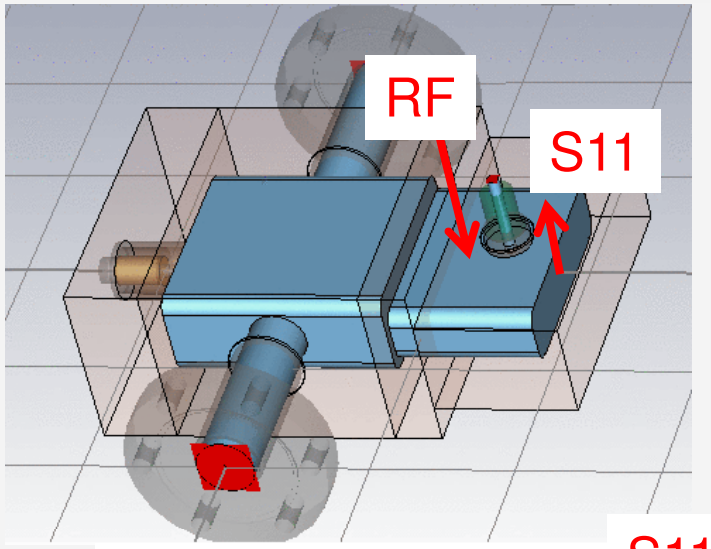
One port RF measurement

Confirmation of the design

Measurement of Frequency and Q-values

ATF2 beam line

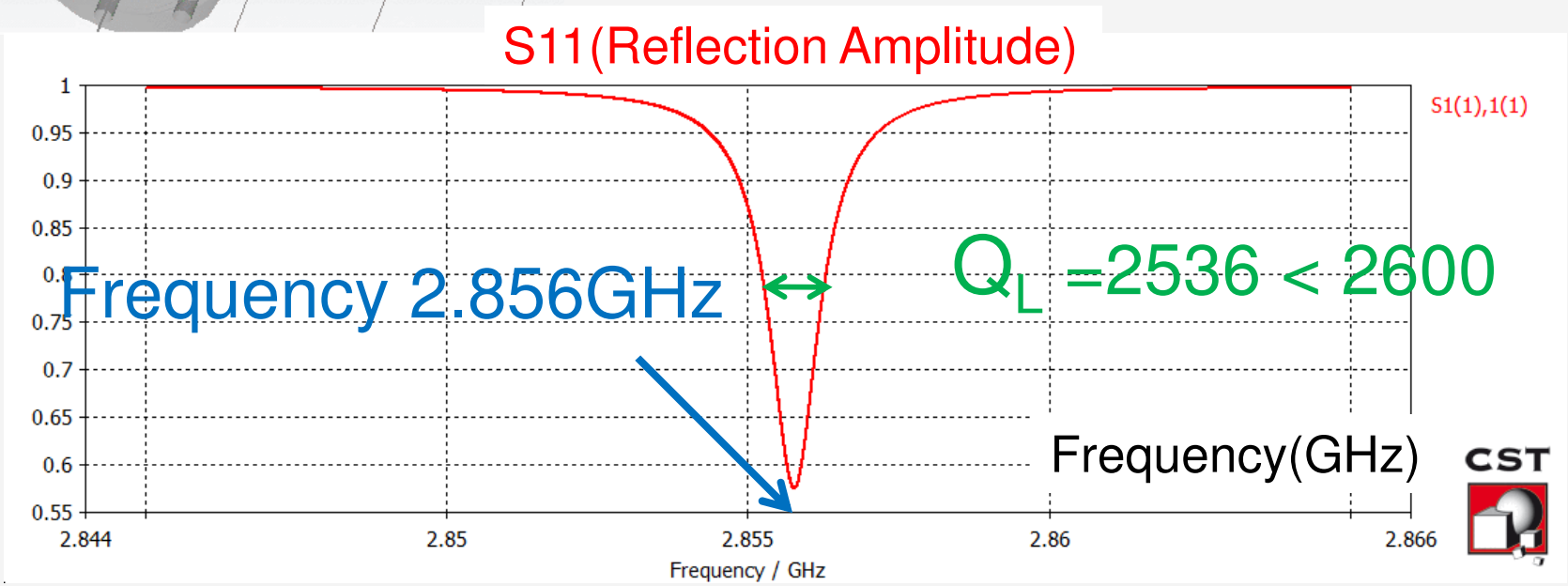
One port RF measurement (simulation)



Measurement of the S11 parameter

S11 shows the resonant curve

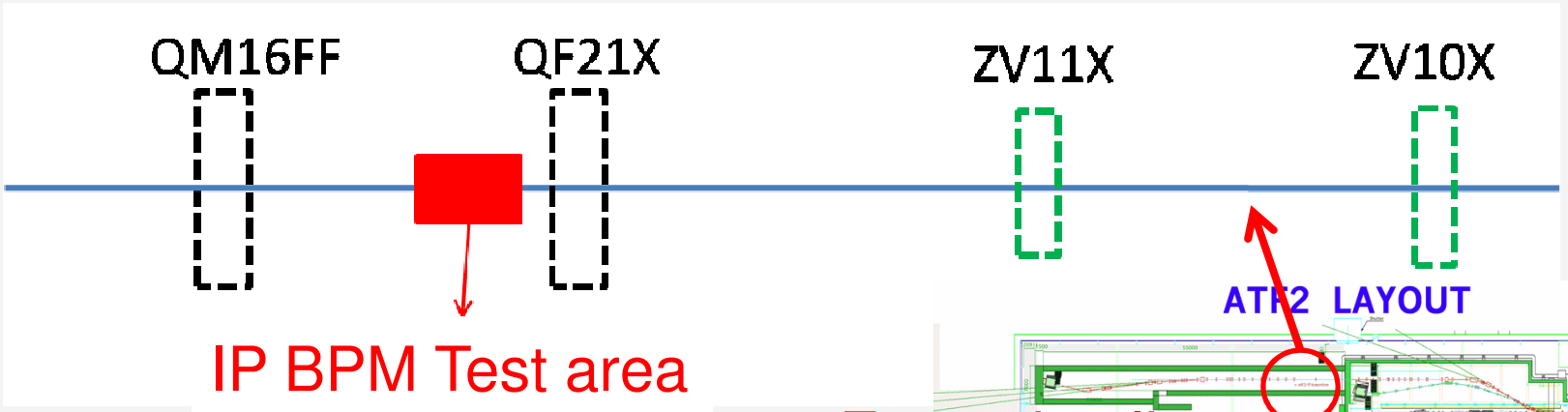
We can caluculate the Frequency and Q



In the Cold test. Network analyzer can measure the S parameter

Beam Test

Upper stream of the ATF2 beam line



- Confirmation of the principle
- Calibration

Comparing with orbit tilt from 2 position data(Q-BPMs),
We can evaluate the signal for tilt angle.

Summary

We have studied about the tilt monitor and designed.

The expected sensitivity of the prototype is 35nrad

The prototype will be completed in mid October.

After the Cold test,
We will confirm the principle and performance .

PLAN

We will study the specific usage with ATF2 Flight Simulator.

Effective install place
Combination of BPMs and tilt monitor