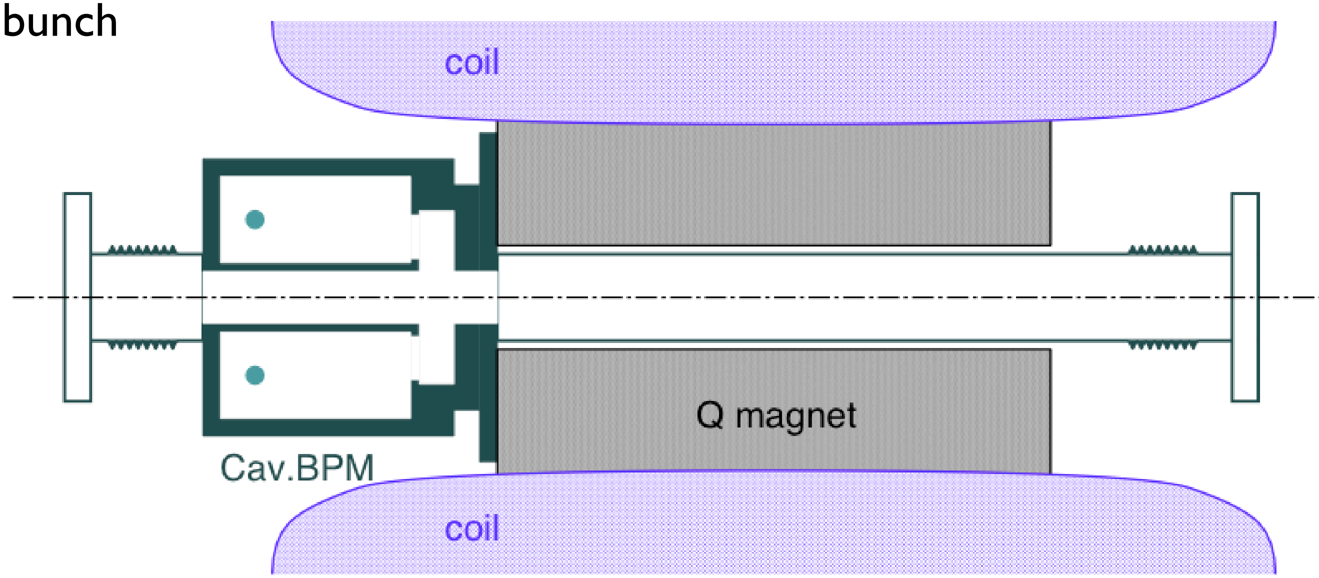
# ATF2 Cavity-BPMs

HONDA Yosuke
21 Jun. /05
BDIR2005 (London)

- Q-BPM (quadrupole magnet)
- IP-BPM (interaction point)

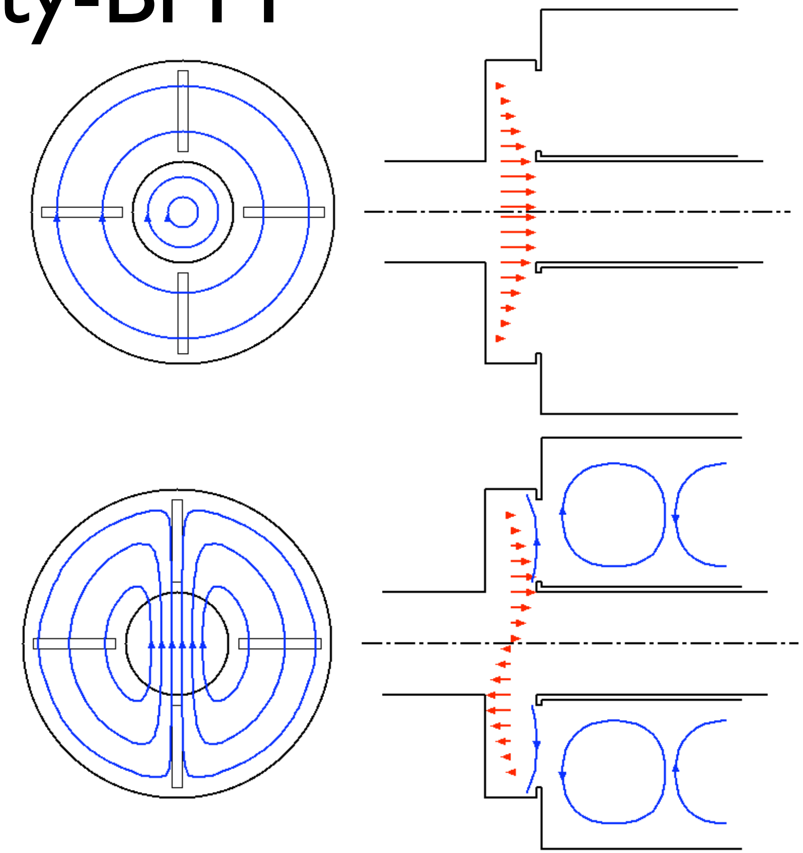
# Concept/requirements of Q-BPM

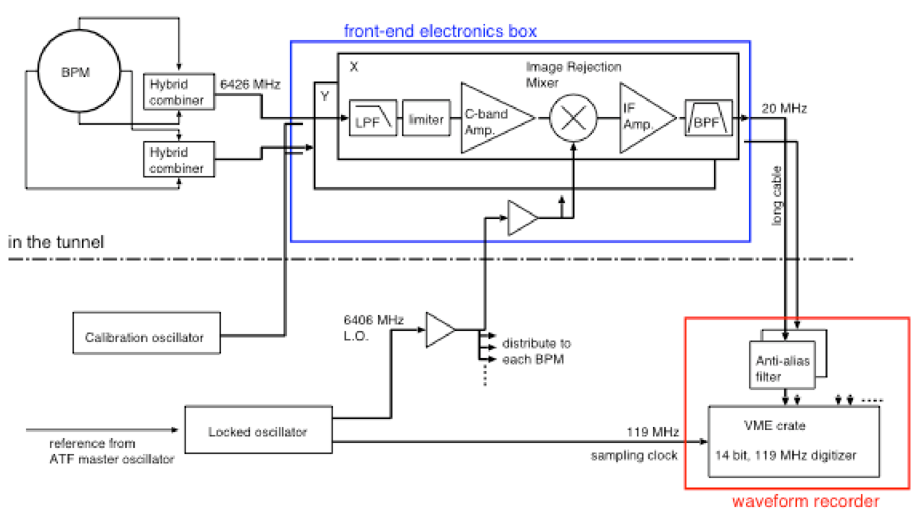
- Q-BPM
  - Rigidly attached on each Q-magnet (22 sets).
  - Make sure the beam orbit to be within a few micron from the field center.
- Performance
  - resolution : 100 nm by single path measurement
  - accuracy: the center/calibration have to be stable within a few micron.
  - measurable range : 500 um (determined by the elec. circuit's saturation).
  - x-y isolation : better than -30dB
  - multi-bunch : 300 nsec bunch spacing
- Others
  - compact in transverse size
  - large aperture is preferable
  - work with 357 MHz multi-bunch

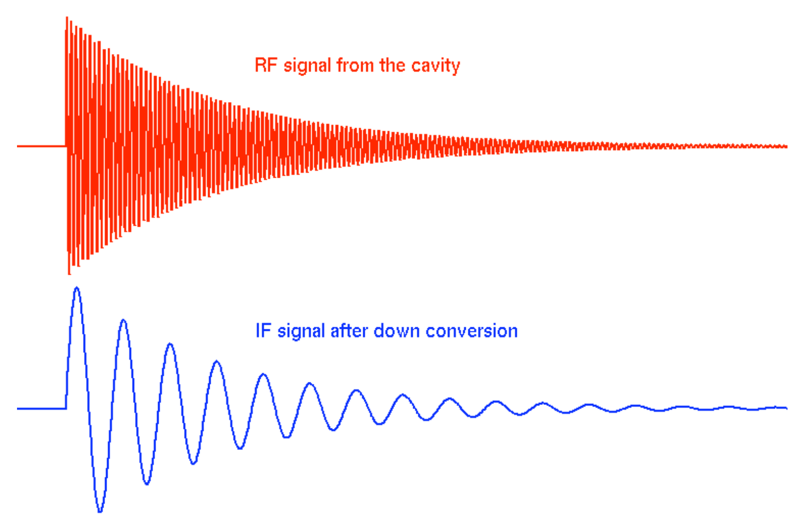


# Principles of Cavity-BPM

- Cavity-BPM
  - Beam excites various modes, TM010, TM110,...
  - Dipole mode's amplitude is proportional to the beam position and its charge.
- Feature
  - The electrical center (no dipole mode excitation) is determined only by the structure.
  - High resolution if detected by a high gain electronics though the range will be limited.
- Issues
  - Common mode rejection
  - x-y mixing
  - contamination from angle signal (phase detection)
  - high-gain, low-noise electronics

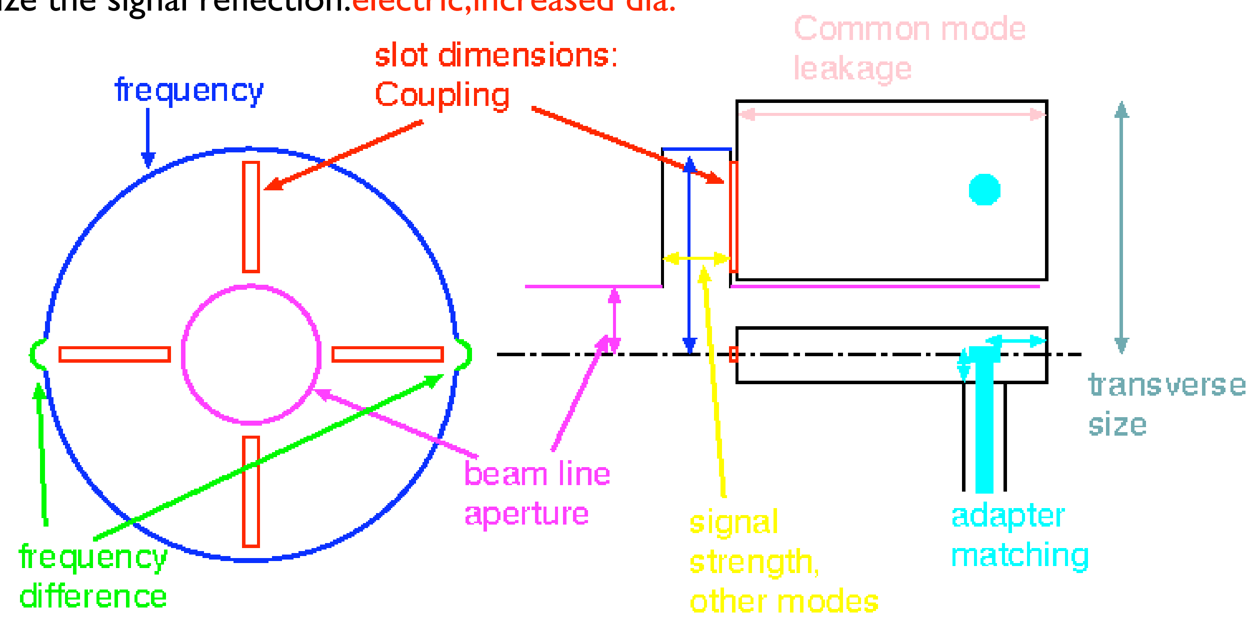




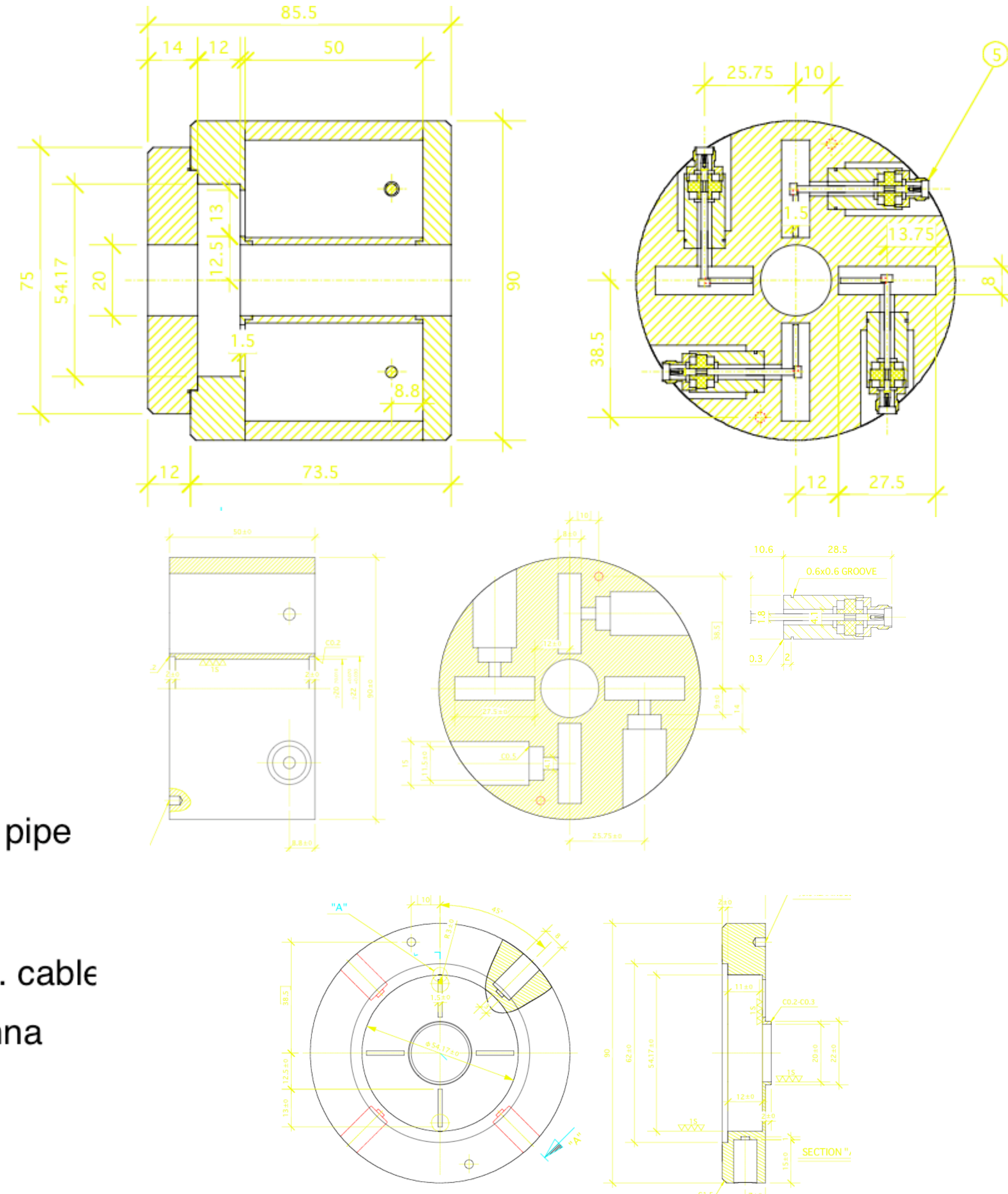
# Design work

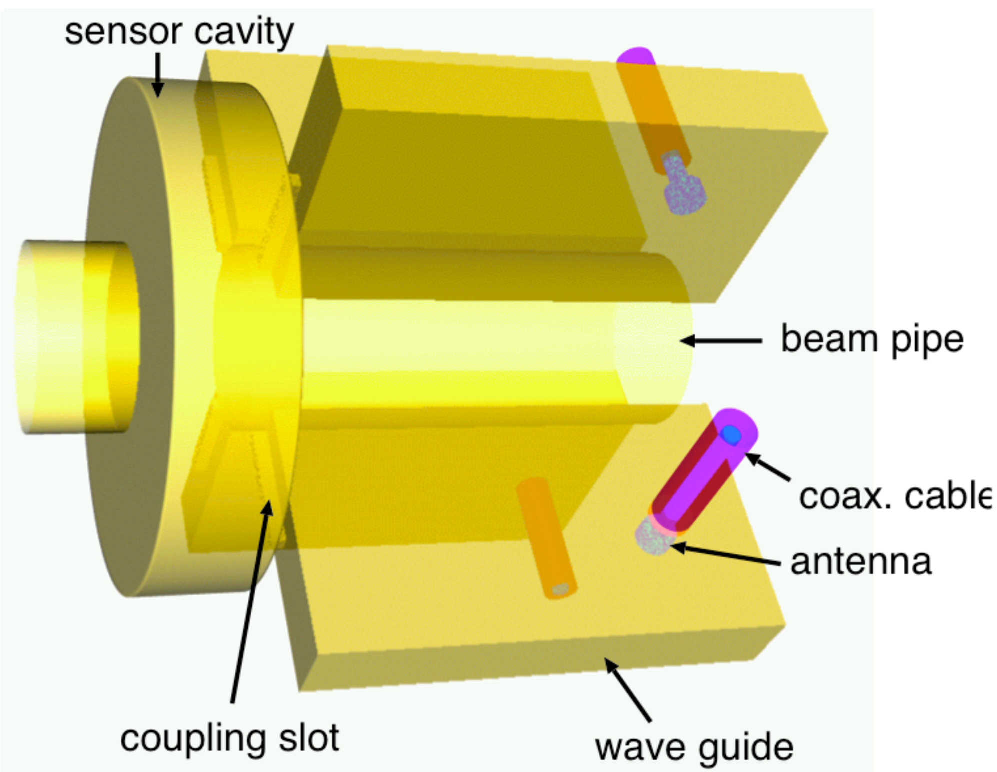
- Keep the basic design of existing ones (experiences in the ATF)
  - Pill-box cavity, TM110 mode, C-band (optimal for ATF's bunch length)
  - Magnetic coupling by slots placed on the end plate
  - 4-ports to keep symmetry
- Decay time
  - Digital wave form recording prefers long decay time, but needs enough signal power. Qext=14000, slot's demensions: 1.5mm,13mm,1.5mm(width,length,depth)
- Frequency
  - Coherent addition in the case of 357 MHz M.B.. 6426 MHz+- a few MHz
- Aperture
  - Enough aperture to reduce background by beam halo. 20mm. dia
- X-Y isolation
  - introduce frequency difference by dents on the rim. 1 MHz
- Wave guide
  - Commmon mode rejection. 50mm length
  - Matched coax. adapter to minimize the signal reflection.electric,increased dia.



# Technical design

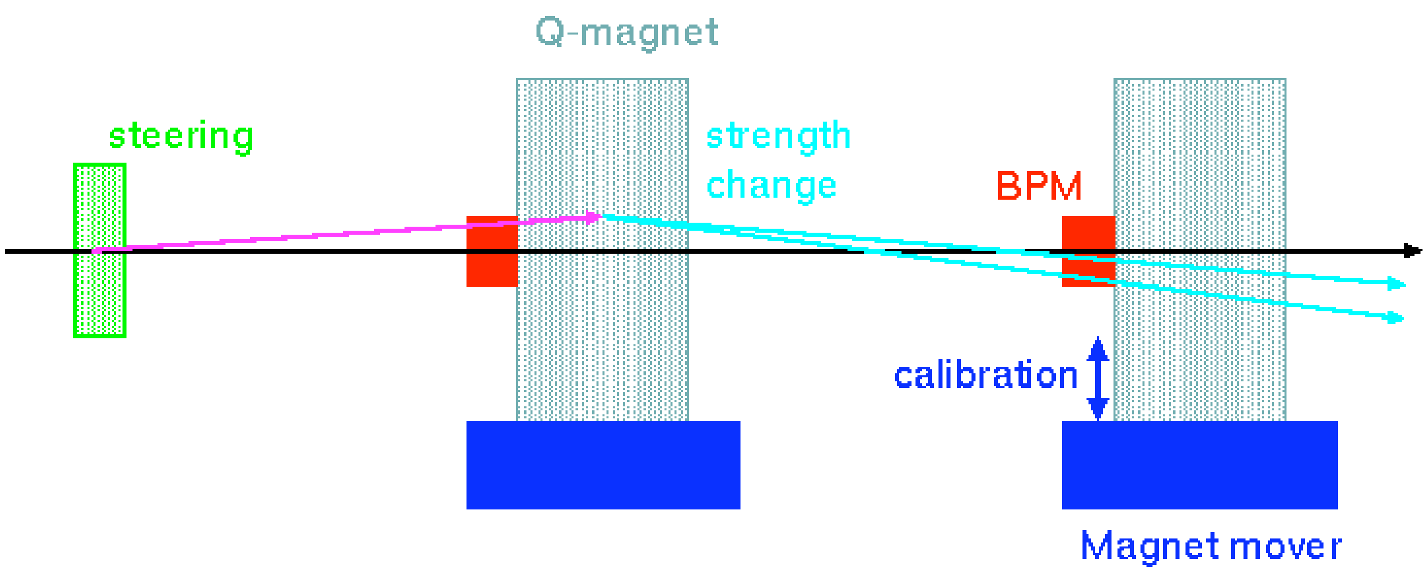
- Electronic design was almost completed.
- Technical design, engineering tests are on going in PAL.



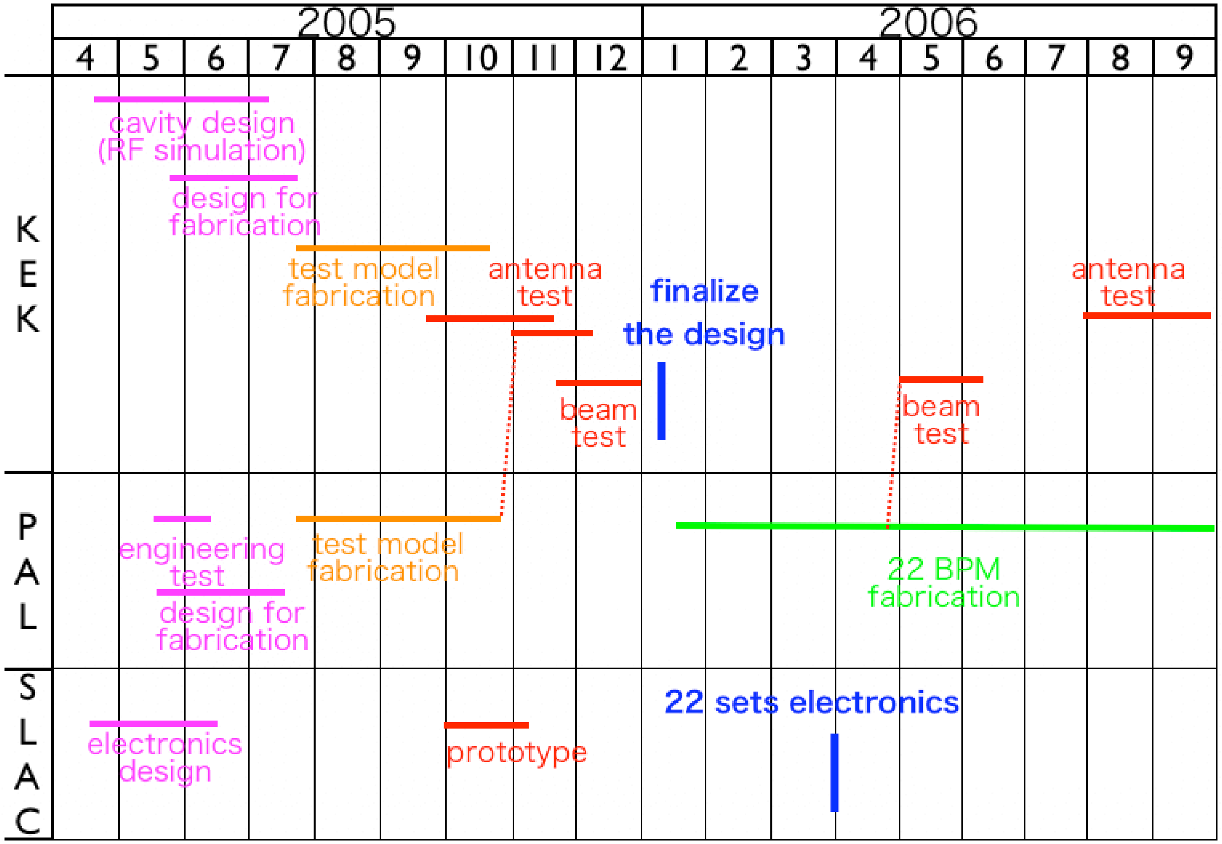
# Commissioning

- Measurable range is only 500 micron.
- First, reduce the sensitivity (increase the range) with additional attenuators.
- Calibration using magnet movers.
- Offset measurement by beam based method.
- Correct the BPM position during maintenance period.
- Remove the attenuators.
- Calibration (routinely ?)



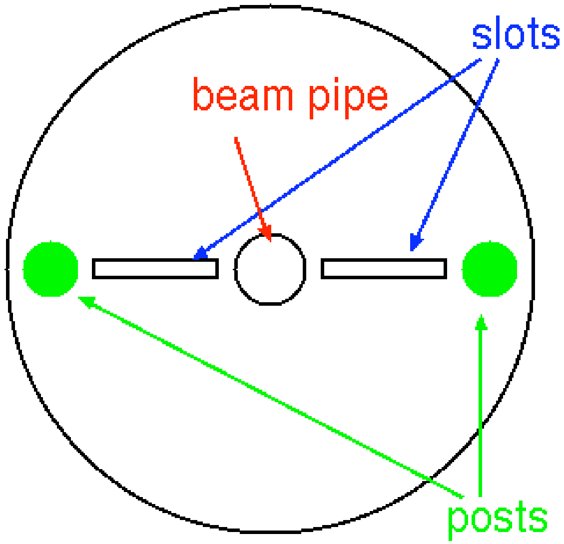
# Schedule

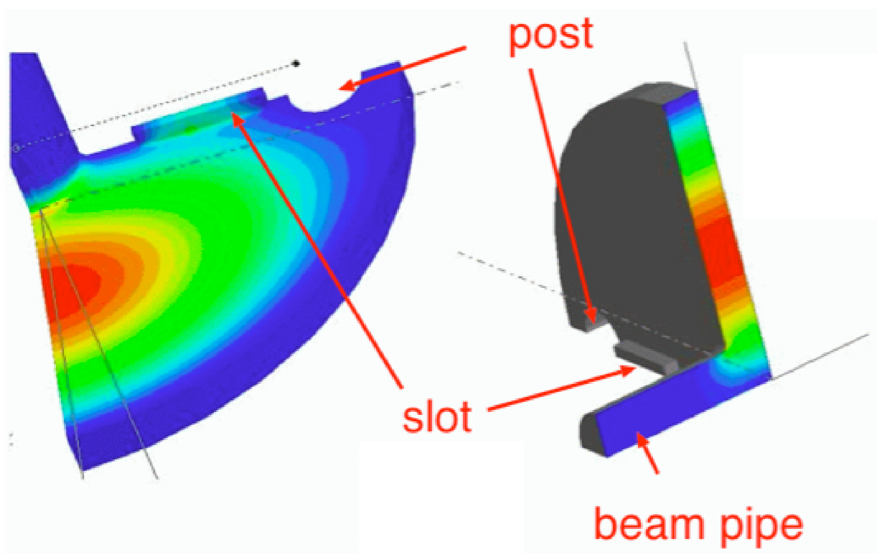
- So far, on time.
- Technical drawing will be finished soon, then start thinking how to attach on the magnets, etc..
- Test model (cavity without a beam pipe)
  - Prototype to test over-all fabrication and its quality. (PAL)
  - A cold model to check the design. (KEK)
- Test with a beam is important. It will be done using the test model, also with the prototype electronics.

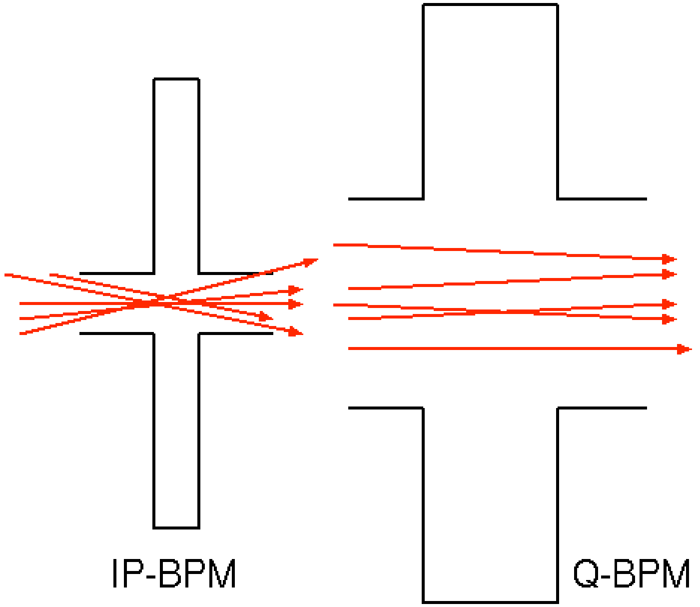


# Challenges in IP-BPM

- IP-BPM
  - Measure the beam jitter at the IP.
- Performance
  - resolution : 2 nm by single path measurement.
  - measurable range : a few um.
- Challenges
  - contamination from x-jitter
    - introduce big frequency difference in X-Y dipole modes.
  - contamination from angle-jitter
    - thin cavity gap
    - need to reduce the beam pipe aperture to keep sensitivity.
- Stance to design
  - not too optimized for ATF2 only

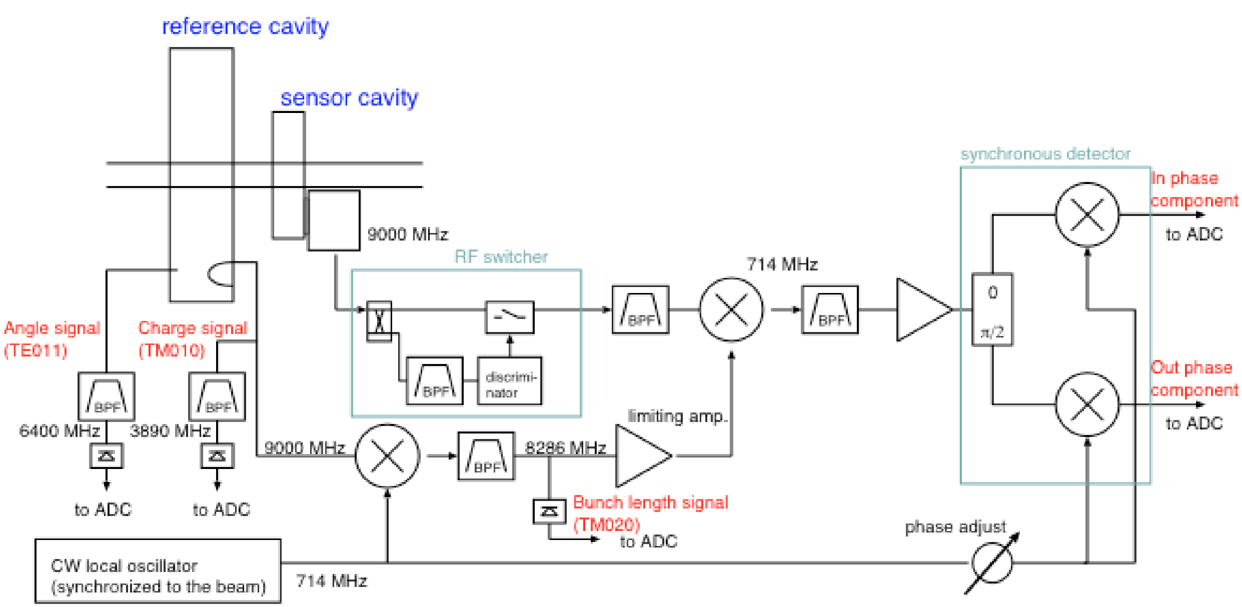


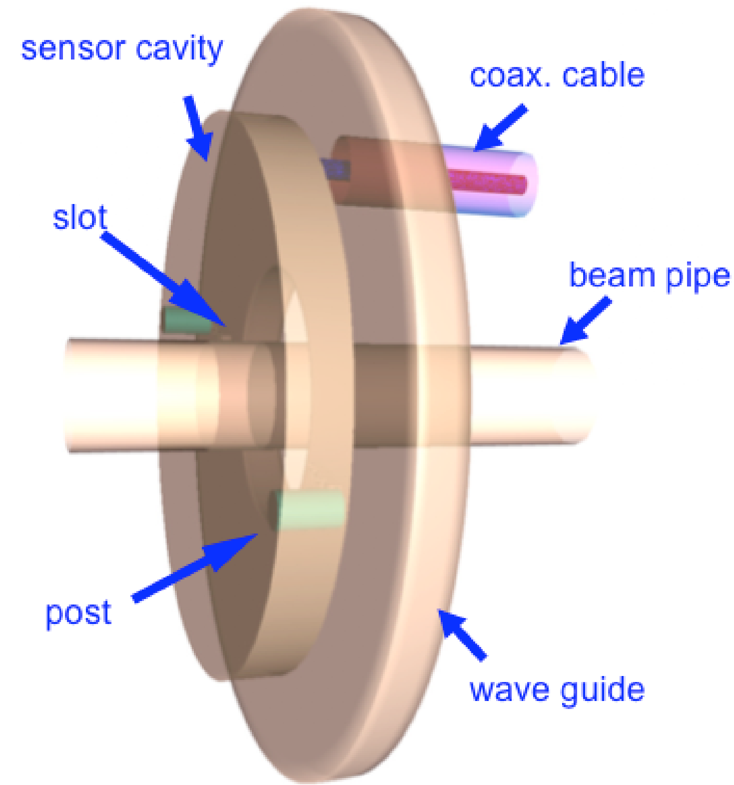



# IP-BPM design

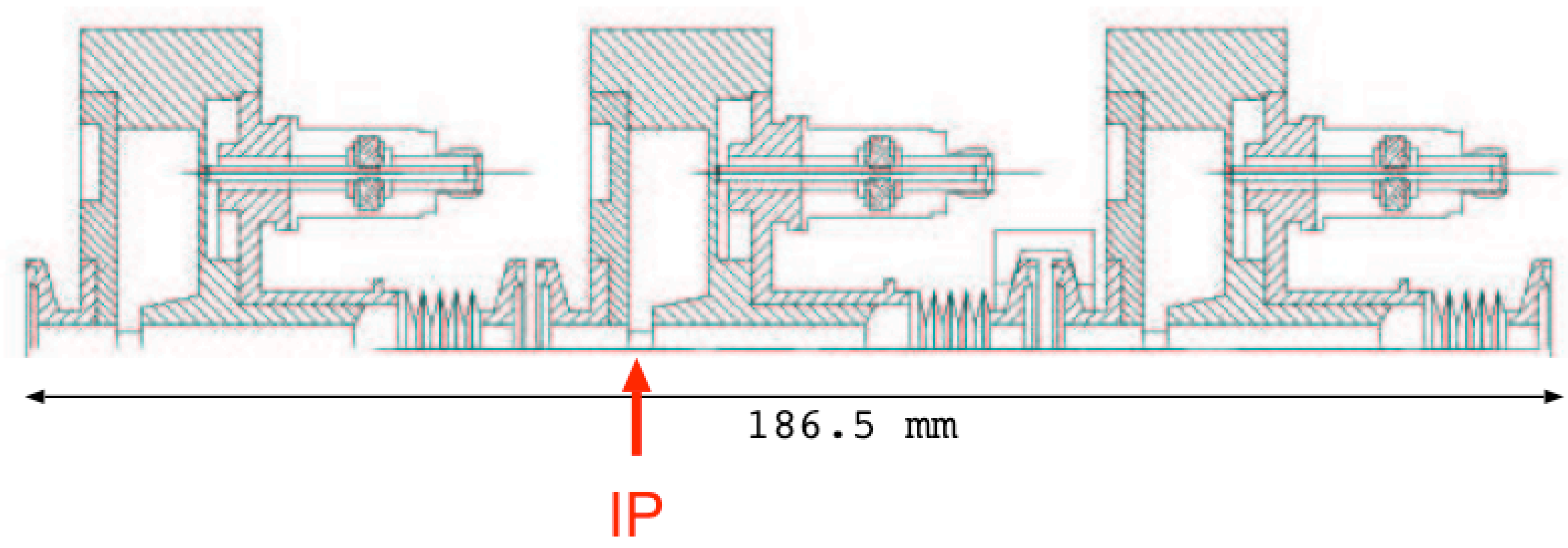
- Structure
  - frequency is 9 GHz.
  - read out only Y direction, coupling=2.0.
  - common mode cancellation in the wave guide included in the structure.
  - small cavity length for angle insensitivity: 200 urad angle ~ 1 nm offset (overall)
  - small beam apertrure in order to increase the signal.
- Electronics
  - RF switcher to reject the transient signal in the leading edge.
  - Two-stage down conversion
  - resolution : 1~2 nm.



# Layout

- Layout
  - Three (or six) sensor cavities, YYY, YXYXYX.
  - Reference cavity to give the phase, charge and angle information.
- Setup
  - Precise (10 nm resolution) movers to calibrate the sensitivity.
  - Precise beam steering or over-all mover to set in the range.
  - Stabilization is necessary.



# Summary

- Q-BPM
  - Designed starting from the existing design + modifications.
  - Design for fabrication, installation, commissioning
  - Test will be done with a prototype model (including beam tests).
- IP-BPM
  - Idea and conceptual design.
  - Start to look in detail.
  - Prototype fabrication and test.