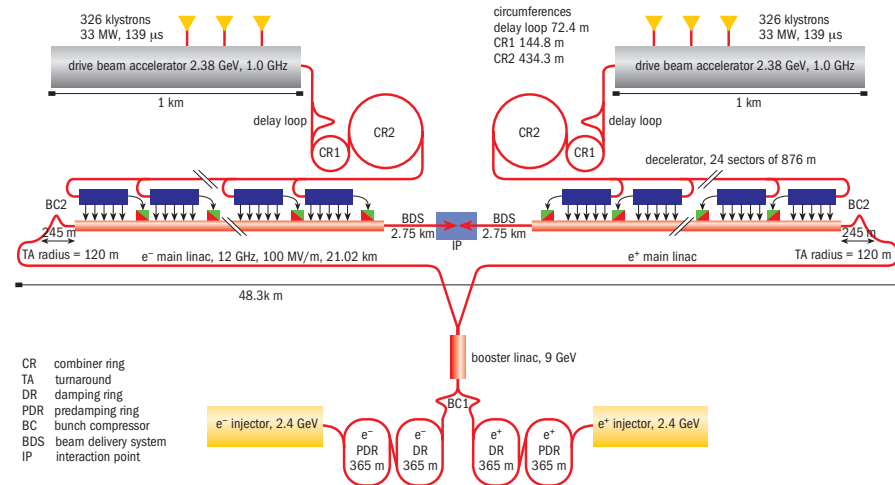


Cavity Beam Position Monitor for CLIC

S.T. Boogert, **F. Cullinan**, A. Lyapin,
N. Joshi, J. Towler, J. Snuverink
John Adams Institute
at Royal Holloway, University of London

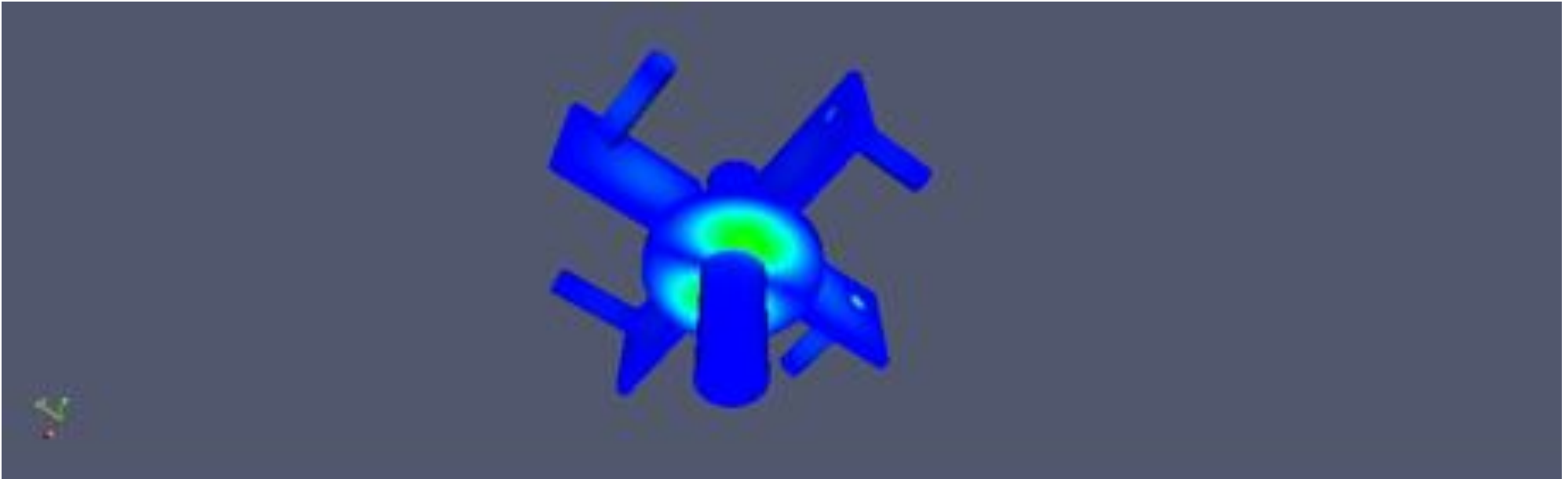
Future Linear Collider

Strongest requirements in terms of scale and performance



| Collider | ILC | CLIC |
|---------------------------------------|------|-------|
| Number of high resolution cavity BPMs | >200 | ≈5000 |
| Bunch charge/nC | 3 | 0.6 |
| Minimum bunch spacing/ns | 154 | 0.5 |

Cavity BPM Principle

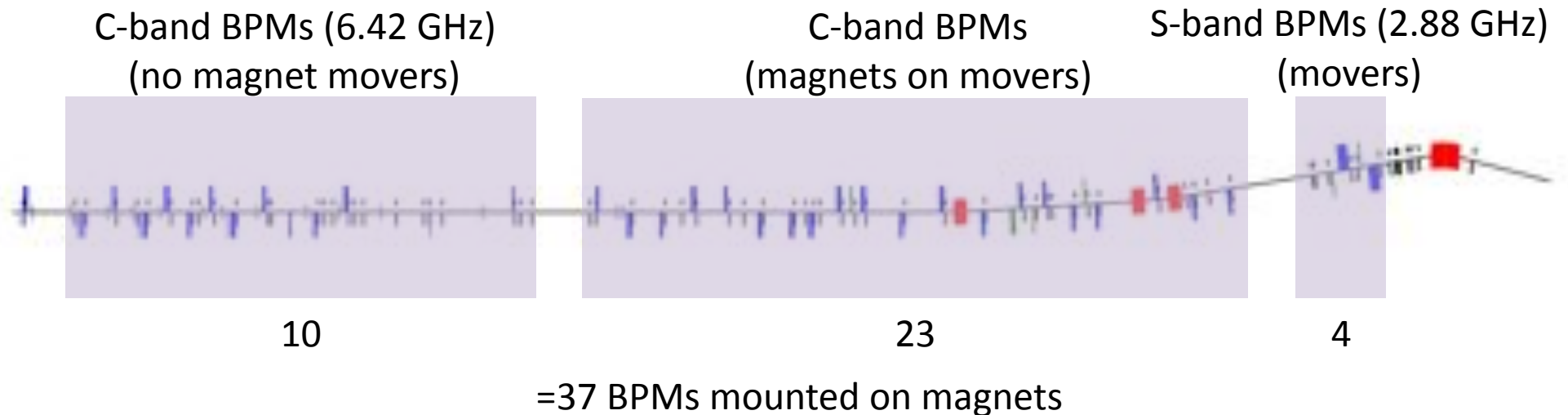


+ Reference cavity
Charge normalisation and beam arrival phase

+ Receiver electronics
Gain, down-mixing and filtering

ATF2

Scaled down final focus system for a future linear collider



System working as required - $\approx 250\text{nm}$ resolution over a $\pm 1\text{mm}$ dynamic range with worse resolution over a wider range

Jitter subtracted calibrations are becoming routine - 1% scale stability

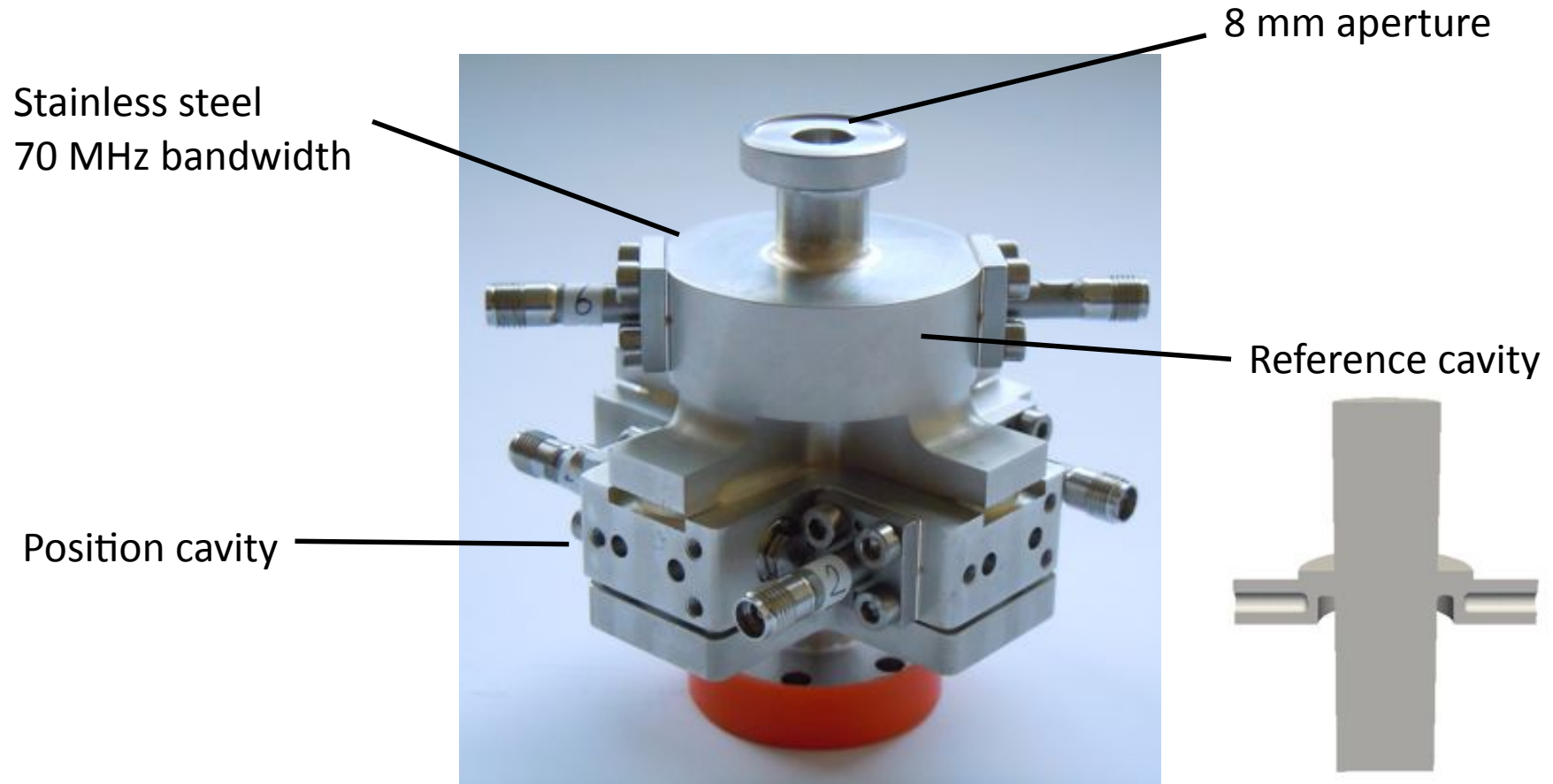
Timing corrections - $< 1.5^\circ$ phase stability

Multibunch processing developed for 154ns bunch separation

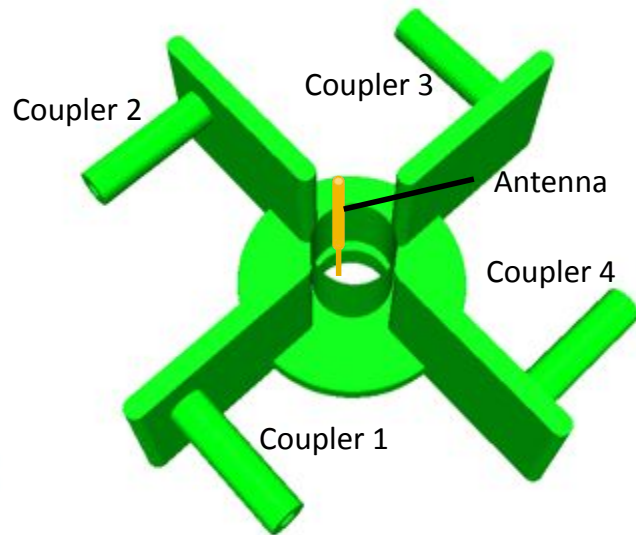
Y.I. Kim et al., 2011, "Cavity Beam Position Monitor System for the Accelerator Test Facility 2", PRSTAB, 15 (4).

15 GHz Prototype Cavity BPM for CLIC Main Beam

Designed at Fermilab National Accelerator Laboratory



RF Measurements



Position cavity:

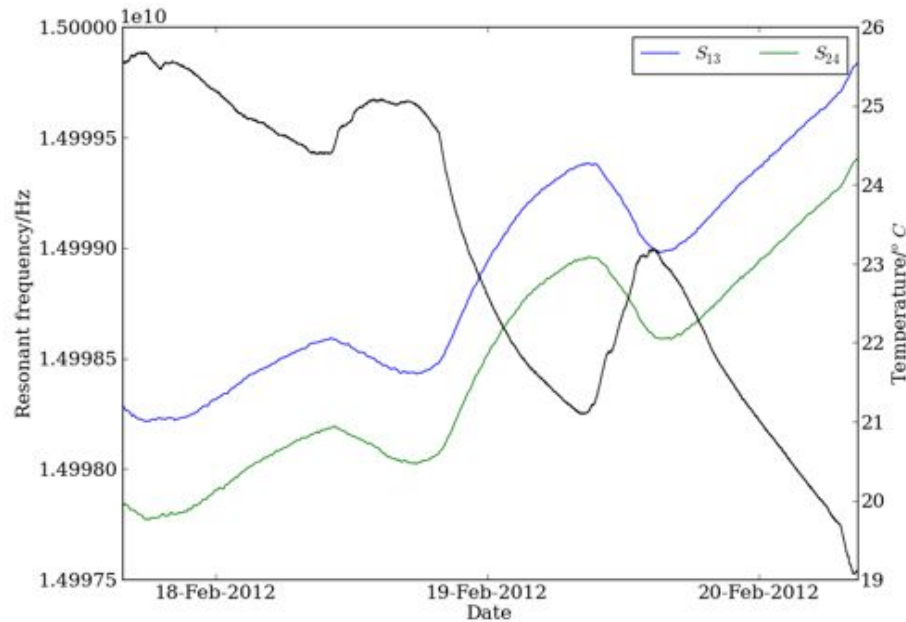
| Parameter | Predicted | Before brazing | After brazing |
|------------------------|-----------|----------------|---------------|
| Resonant frequency/GHz | 14.990 | 14.992 | 15.012 |
| Loaded Q | 274 | 224 | 198 |
| Internal Q | 450 | 306 | 292 |

Reference cavity:

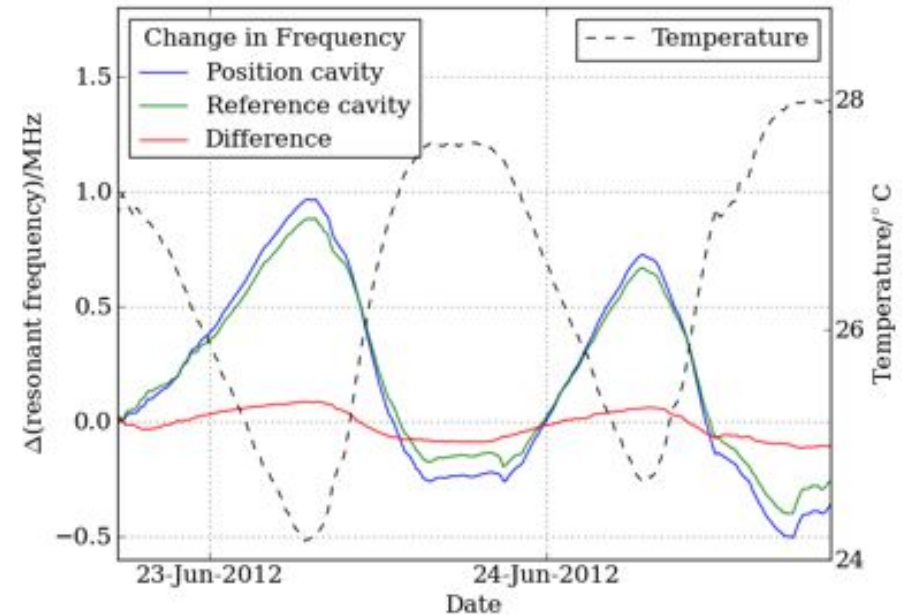
| Parameter | Predicted | Before brazing | After brazing |
|------------------------|-----------|----------------|---------------|
| Resonant frequency/GHz | 14.999 | 14.960 | 14.997 |
| Loaded Q | 150 | 74 | 130 |
| Internal Q | 383 | - | 357 |

Temperature Stability

Position cavity at RHUL, February:



Both cavities at CERN, April:



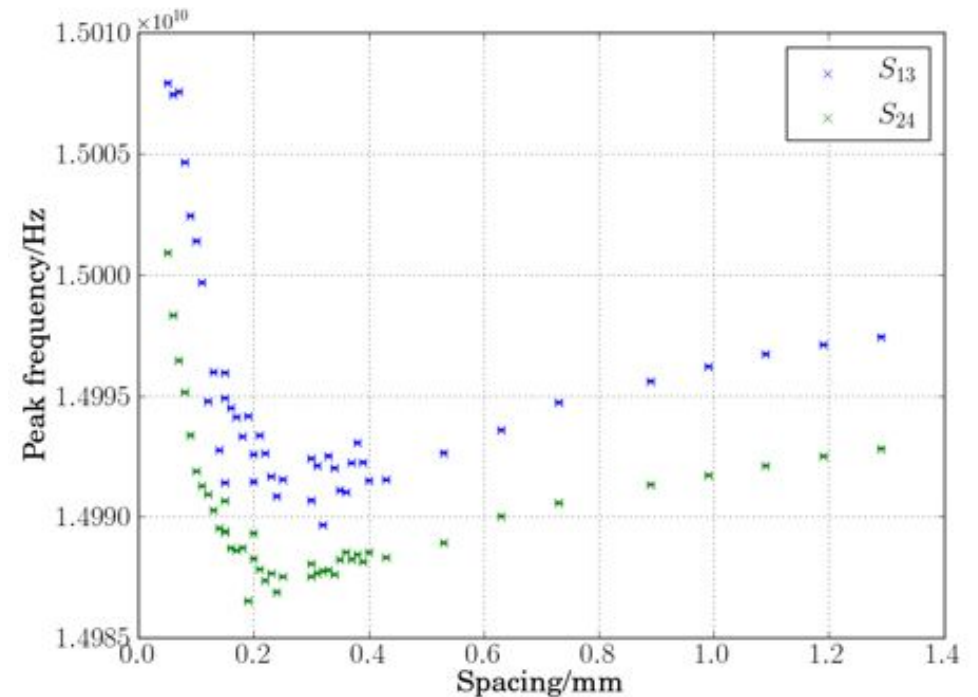
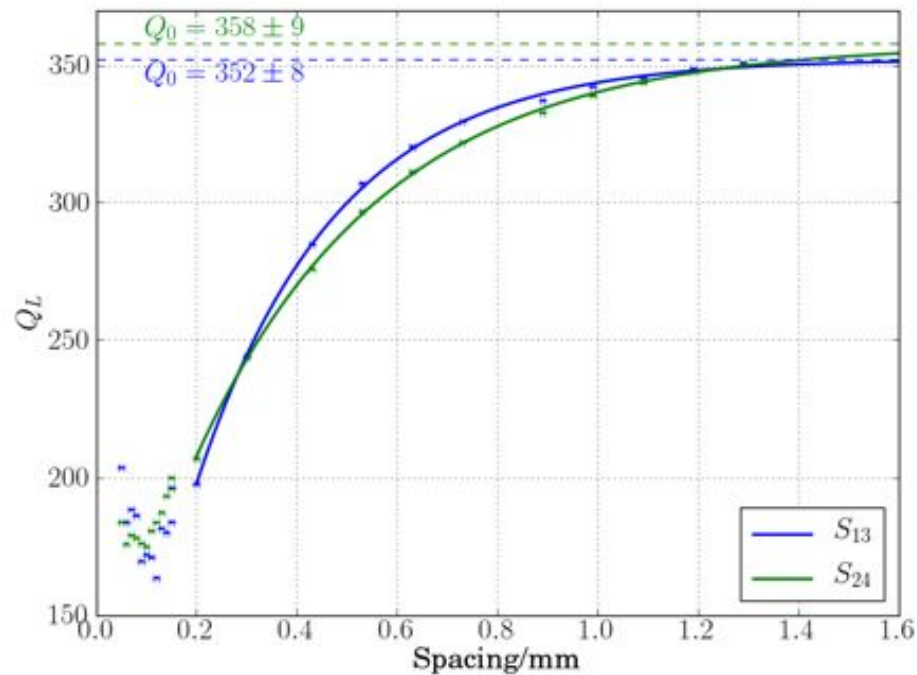
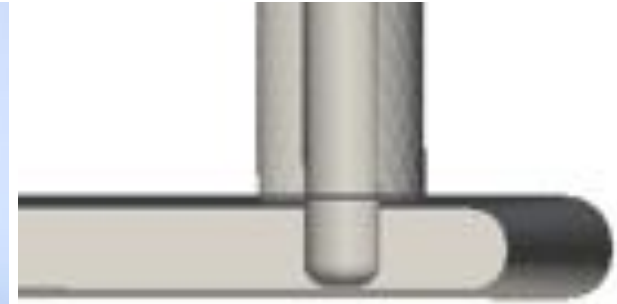
Temperature sensitivity of position cavity much higher after brazing:

$-247 \text{ kHz}/^{\circ}\text{C} \rightarrow -359 \text{ kHz}/^{\circ}\text{C}$

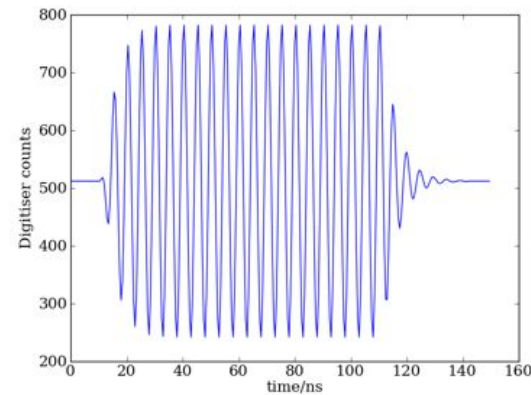
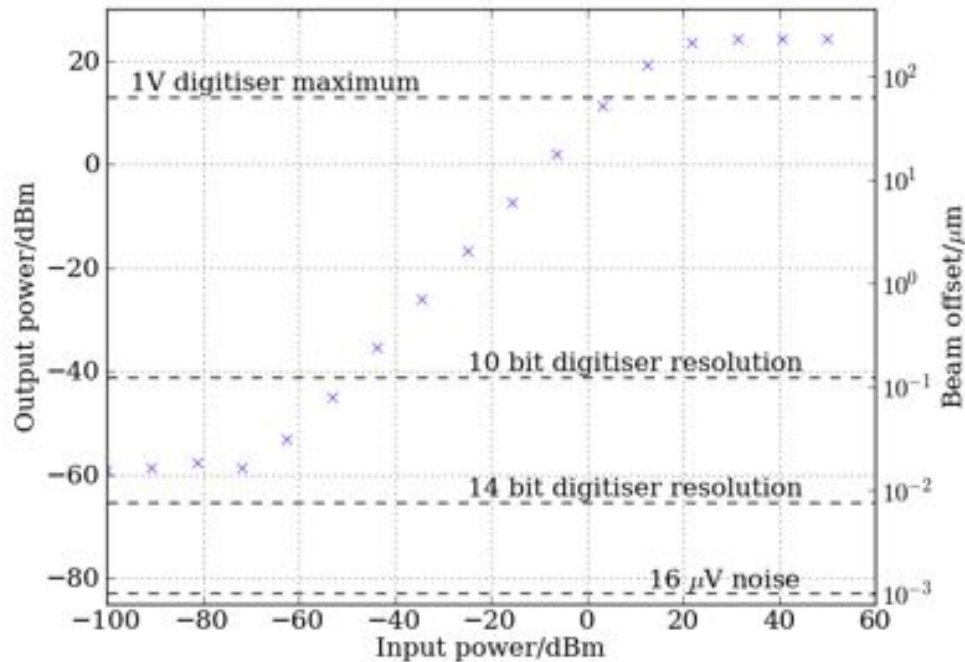
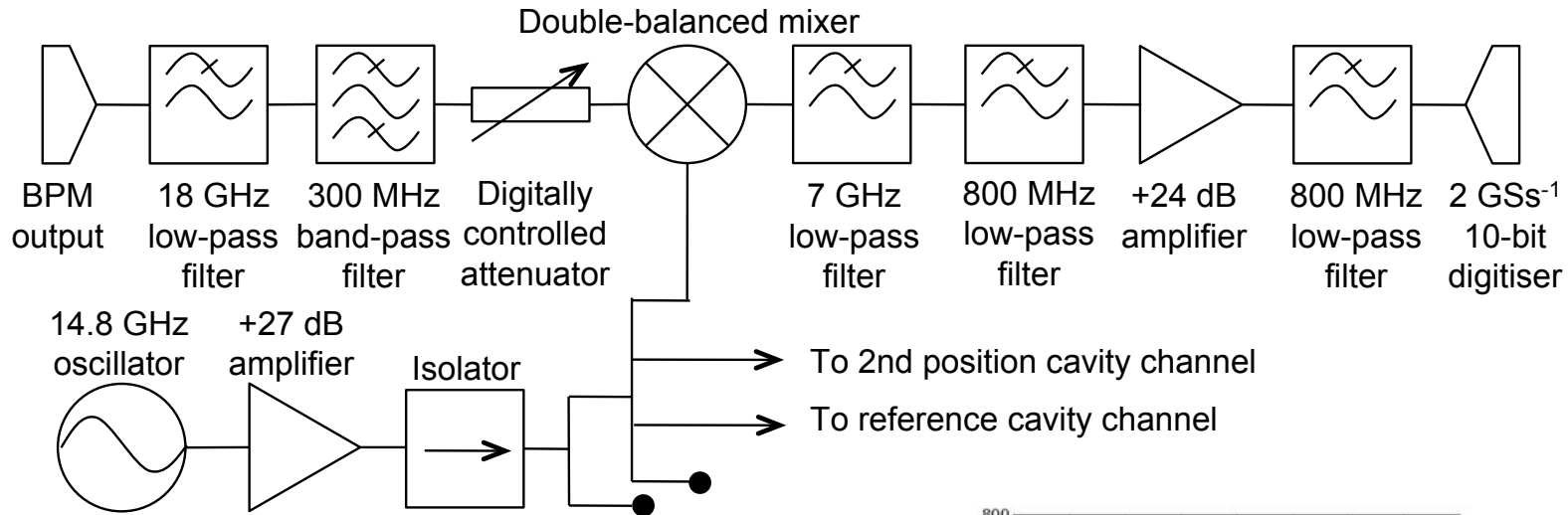
Significant difference between the two cavities: $51 \text{ kHz}/^{\circ}\text{C}$

Feedthrough Antenna

Design separation 0.22 mm
differs from minimum loaded
quality factor $\approx 0.1\text{mm}$



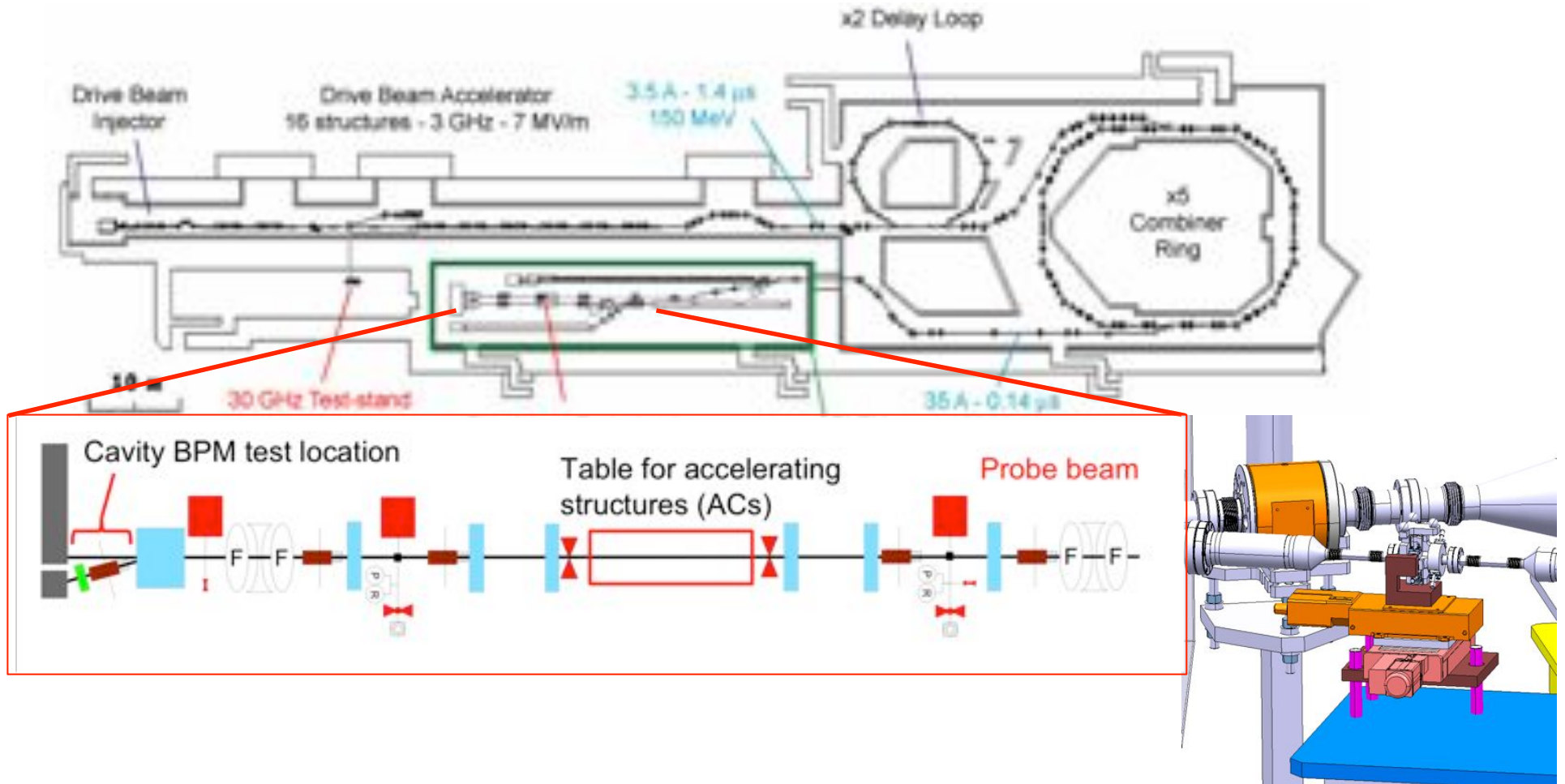
Signal Processing



Digital processing:
 Digital demodulation
 Deconvolution of single bunch waveform
 Principle component analysis

CTF3 Installation

Feasibility study of CLIC beam combination and two-beam acceleration



Summary

- Future linear colliders rely on precise beam position measurements
- High resolution cavity beam position monitors can fulfill requirements
- System at ATF2 fully operational and stable
- A cavity beam position monitor has been designed for CLIC
- A prototype has been built to be tested on CTF3 probe beamline
- Comprehensive RF measurements have been made
- Redesign may be necessary
- Testing to begin in November