WF monitor measurements

in TBM and TBTS

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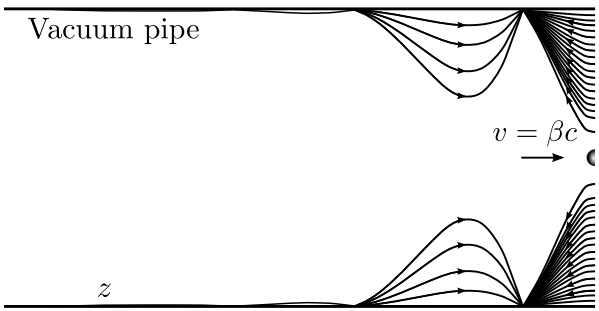
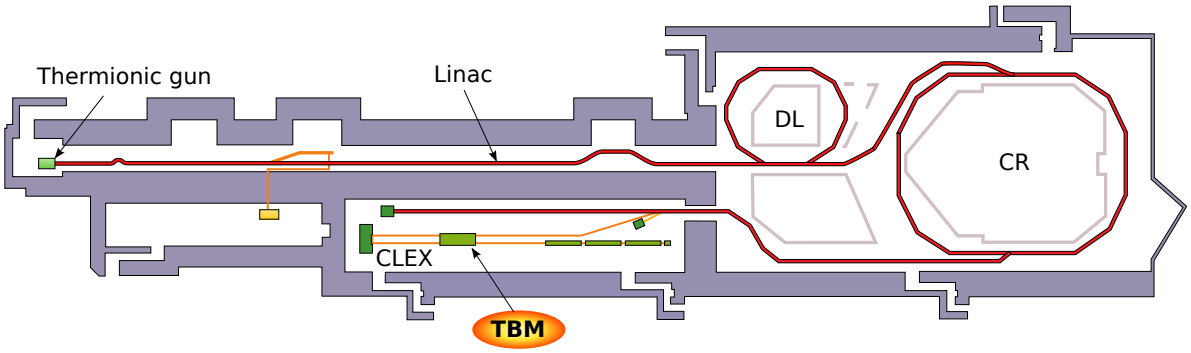
Outline

Introduction

- In order to achieve the necessary luminosity for CLIC, we need to preserve a small main beam emittance.

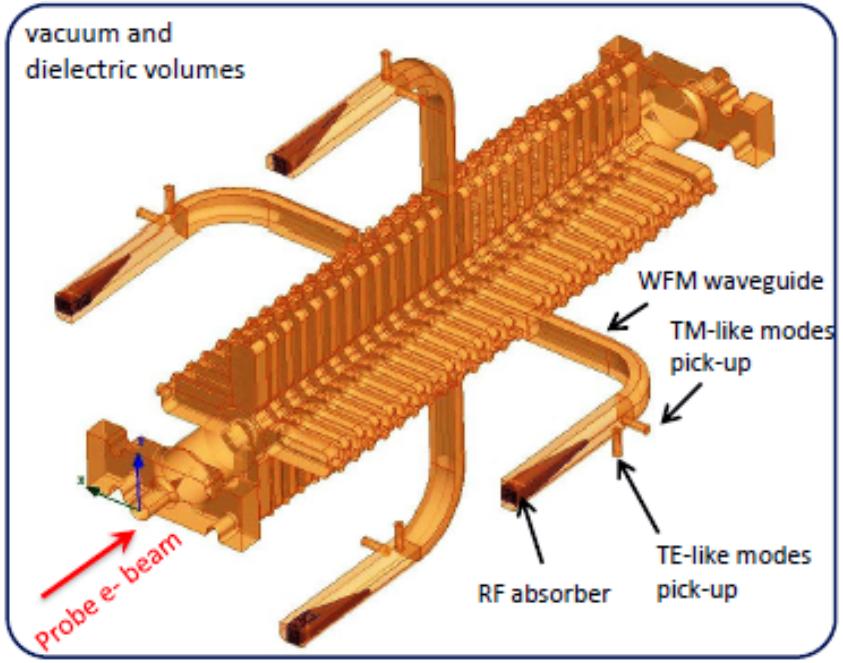


- One cause for emittance blow-up can be transverse wakes in the accelerating structures, which can kick the beam.
- Dipole wakefields depend on the beam offset from the axis, so we need to *minimize the beam offset* in the structures.
- Wakefield monitors (WFMs) finds the beam position based on these wakes. Then, alignment of the accelerating structures can be done, and this is foreseen after 1-to-1 steering and DFS.
- For CLIC, the specification is an alignment of the accelerating structures of 5 μm.

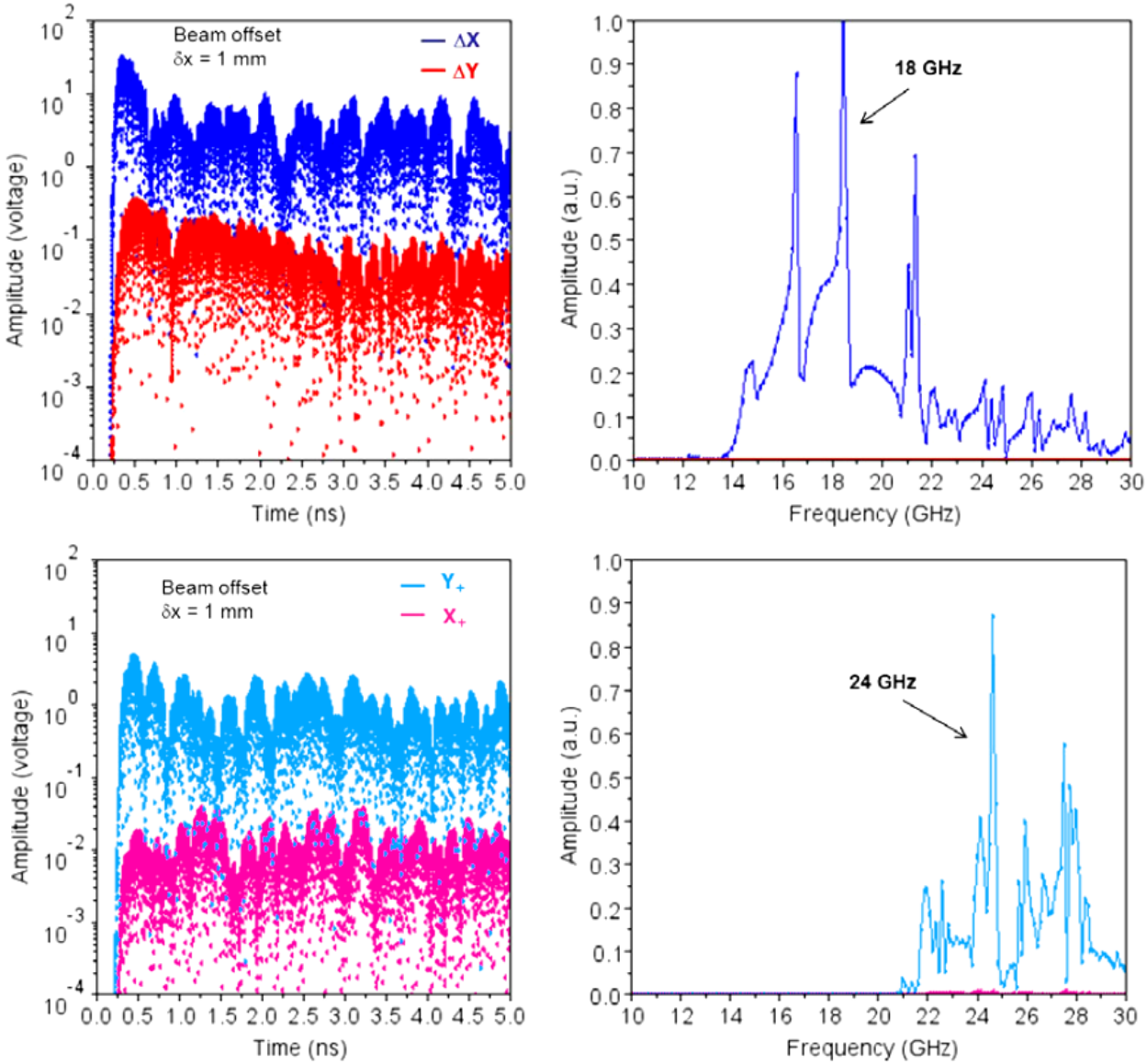


Wakefield monitors in CLIC

- TD24 accelerating structures: 24 normal cells and 2 matching cells
- 4 damping slots for each cell
- 4 bent waveguides with rf absorbers make up the wakefield monitors.
  - In CTF3, the bent waveguides are currently installed on the 2nd cell, not the middle one
  - 2 coaxial rf pickups are installed on different sides of each bent waveguide. One measures TM-like modes, and the other measures TE-like modes.
- In CTF3, the signals picked up are measured using log detectors.



Available modes, found with GdfidL



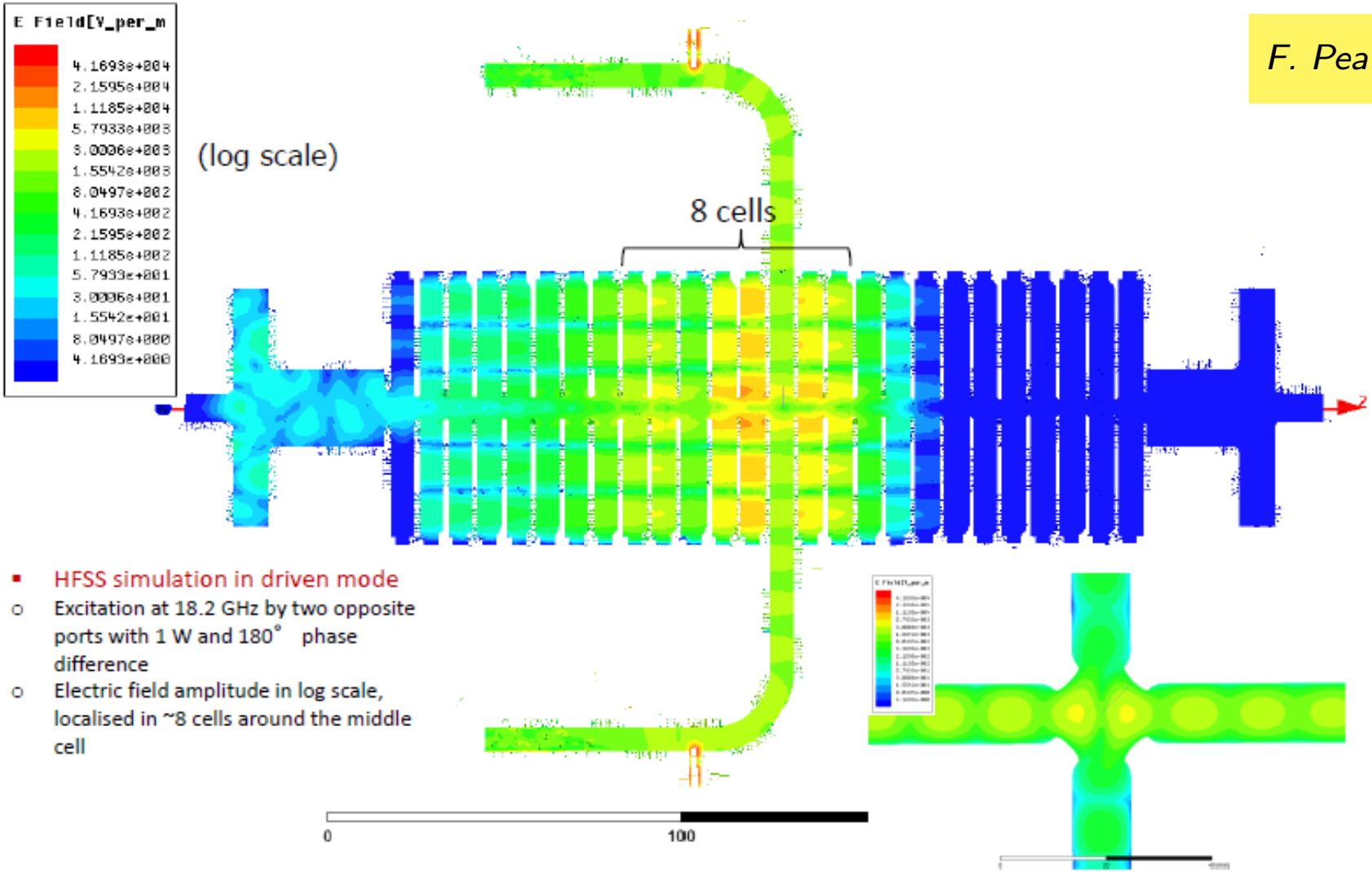
TM-like modes

TE-like modes

F. Peauger

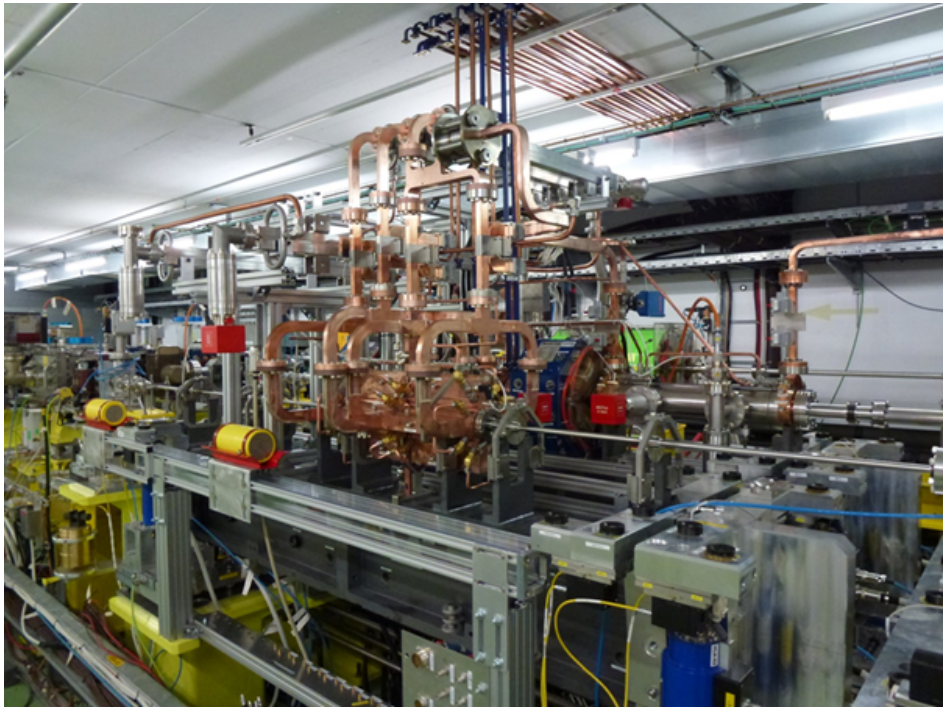
18 GHz TM dipole mode – electric field map

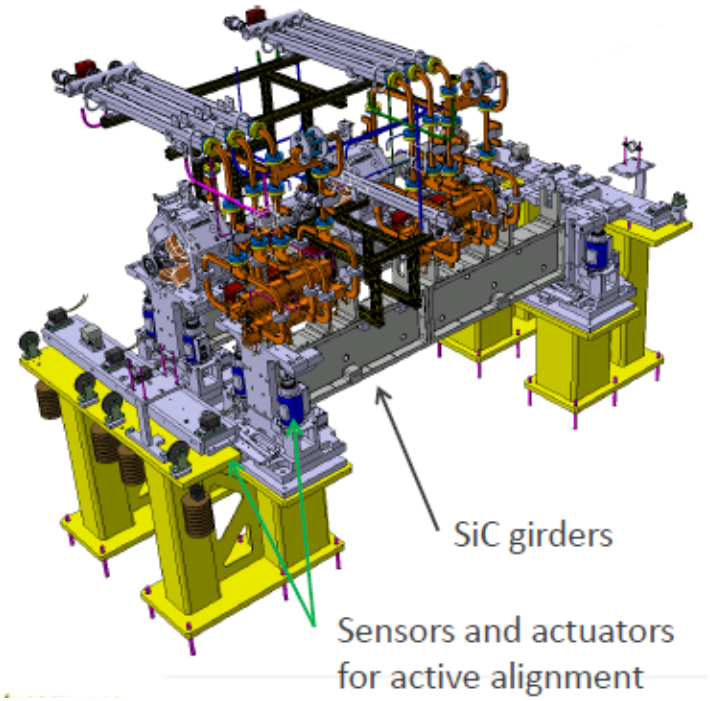
F. Peauger



- HFSS simulation in driven mode
  - Excitation at 18.2 GHz by two opposite ports with 1 W and 180° phase difference
  - Electric field amplitude in log scale, localised in ~8 cells around the middle cell

The Two-Beam Module in CTF3





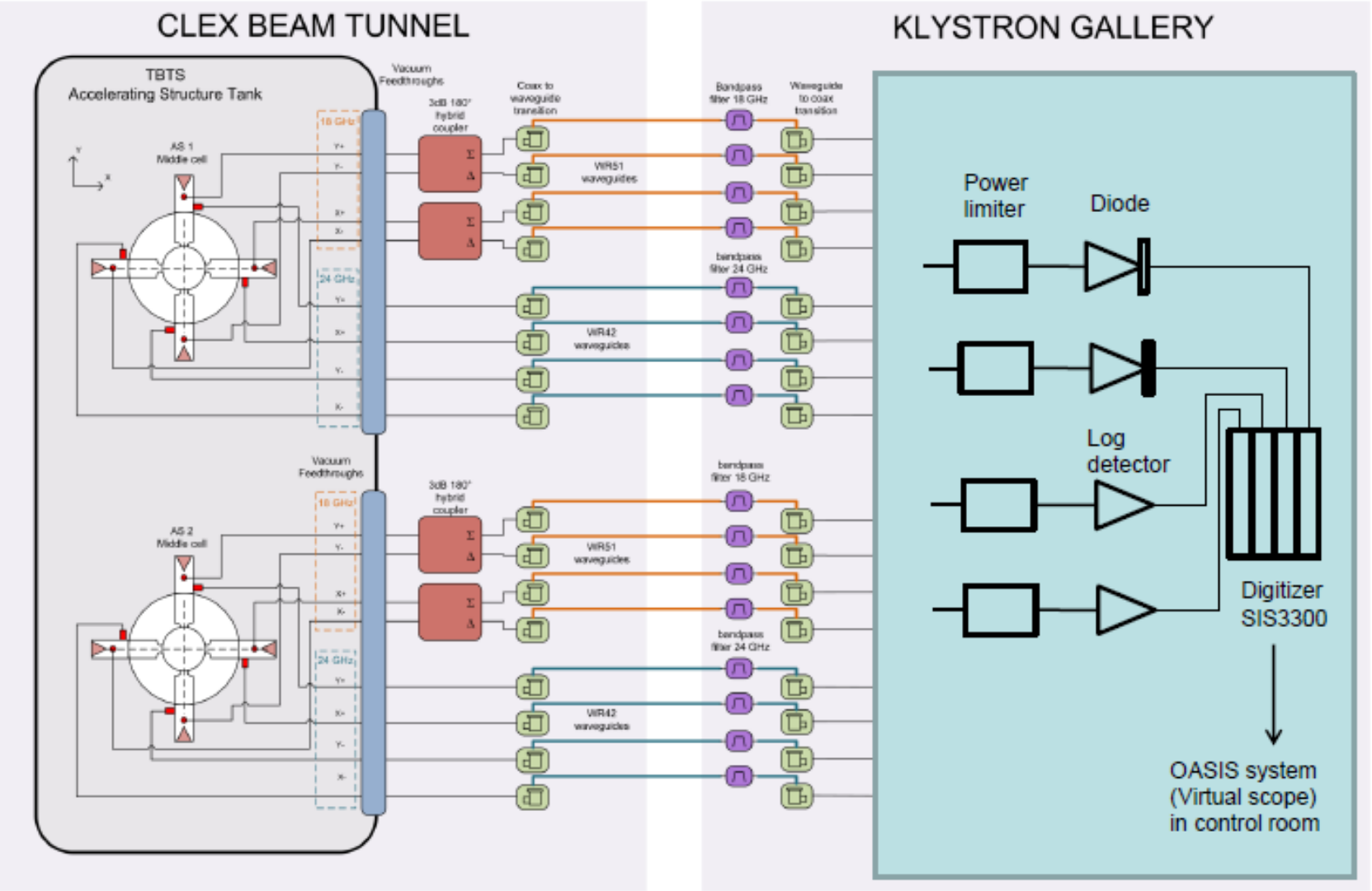
Drive beam

- 2 PETS
- 2 Quadrupoles
- 2 Stripline BPMs

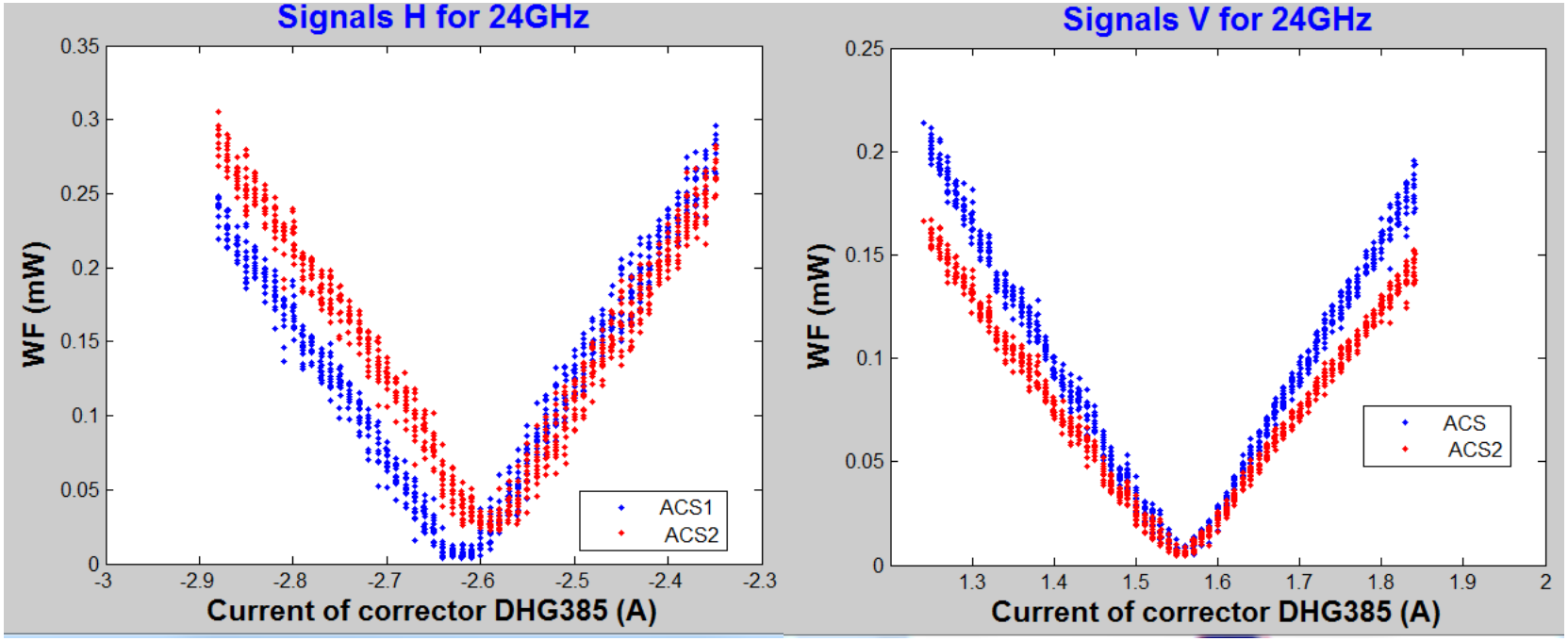
Probe beam

- 4 Accelerating structures (2 superstructures)
- 2 WFMs
- $4 \times 2 \times 2 = 16$ WFM signals

WFM signal connections in CTF3



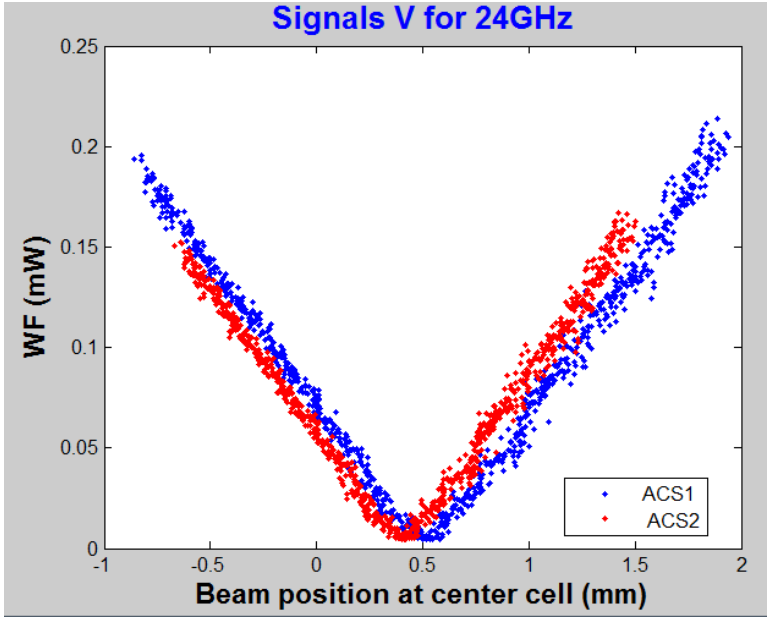
TBTS measurements (i)

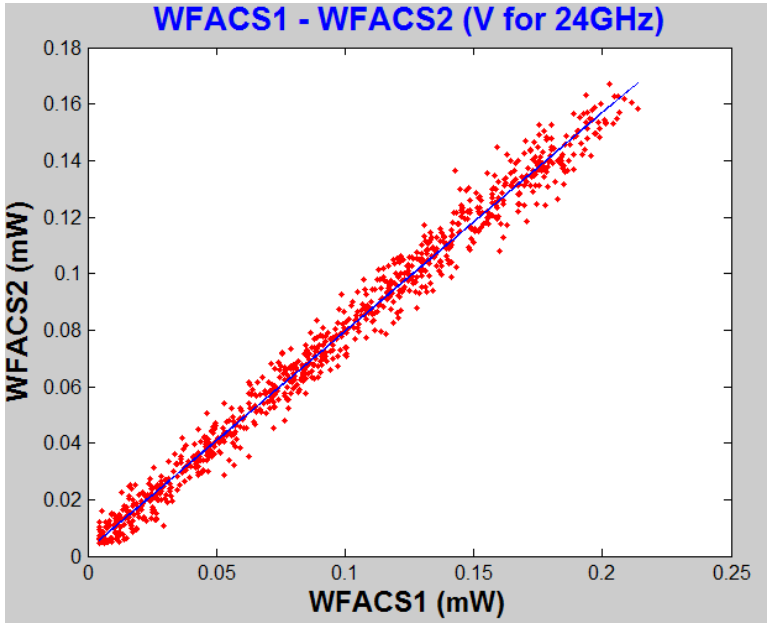


Wakefield signals as a function of corrector current
(Changing a single corrector)

L. Navarro

TBTS measurements (ii)





WF signals as a function of beam position

(Originally position on downstream screen, adjusted to the ACS position)

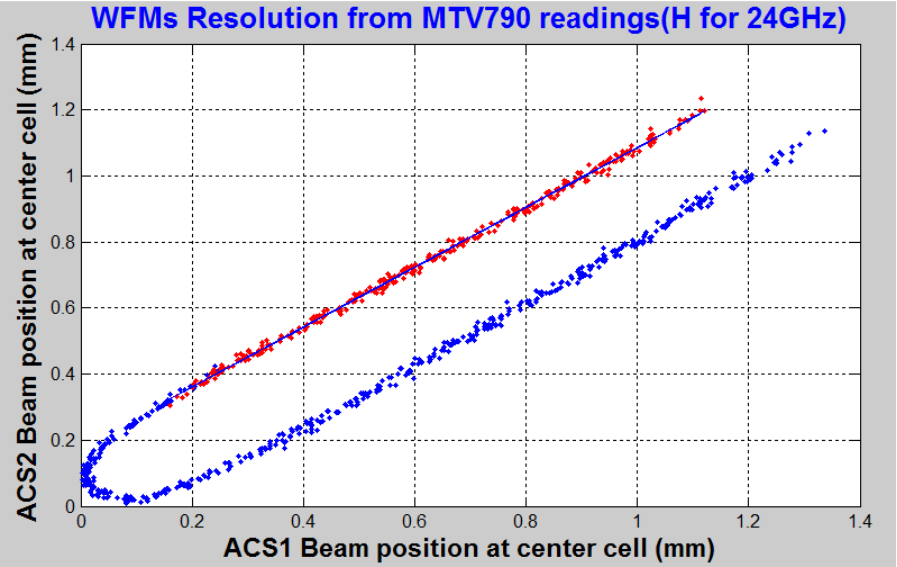
WF signals correlation

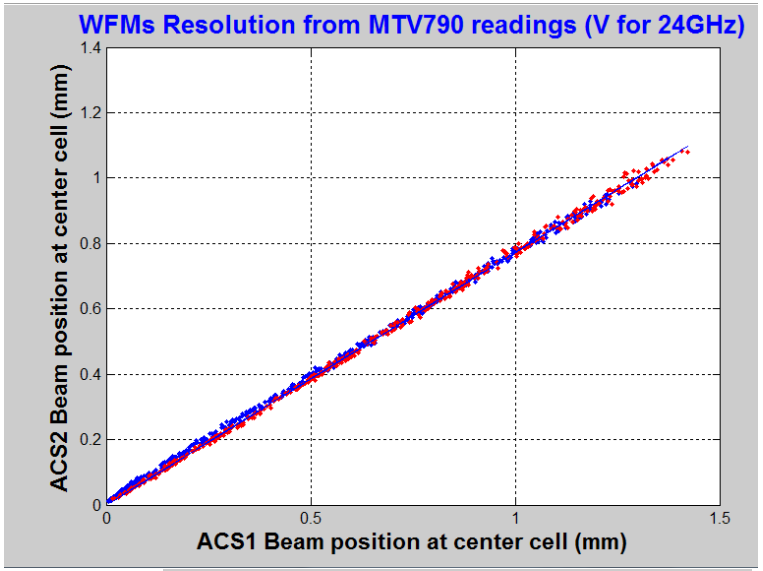
(Signals in ACS2 vs. signals in ACS1)

L. Navarro

TBTS measurements (iii)

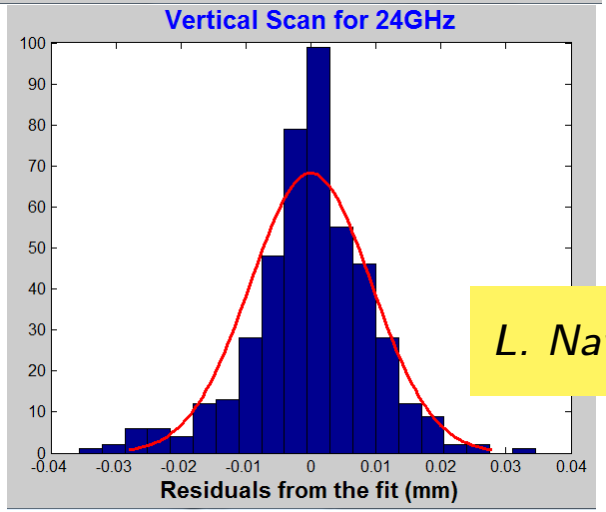
Beam position correlation
(a misalignment was found in the horizontal plane)





Right: Residuals of the vertical fit

With scaling, the resolution can fulfil the CLIC requirements



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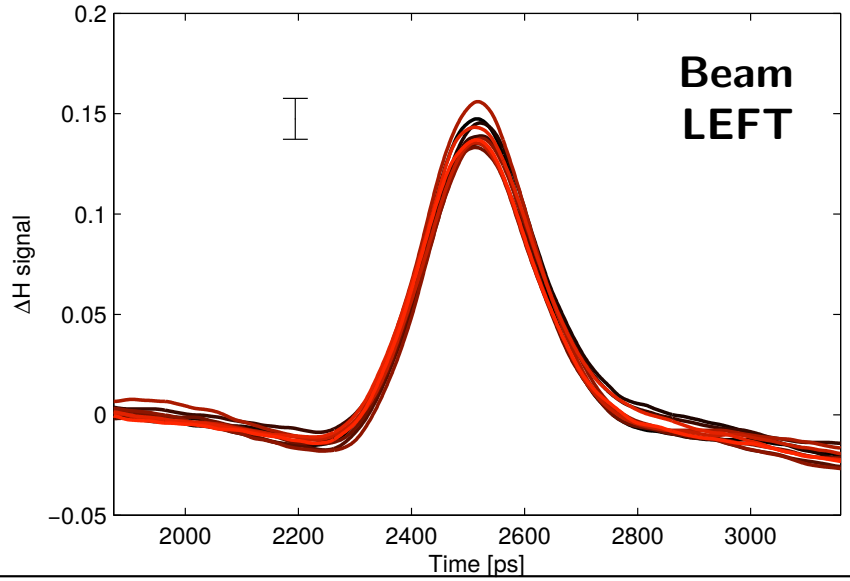
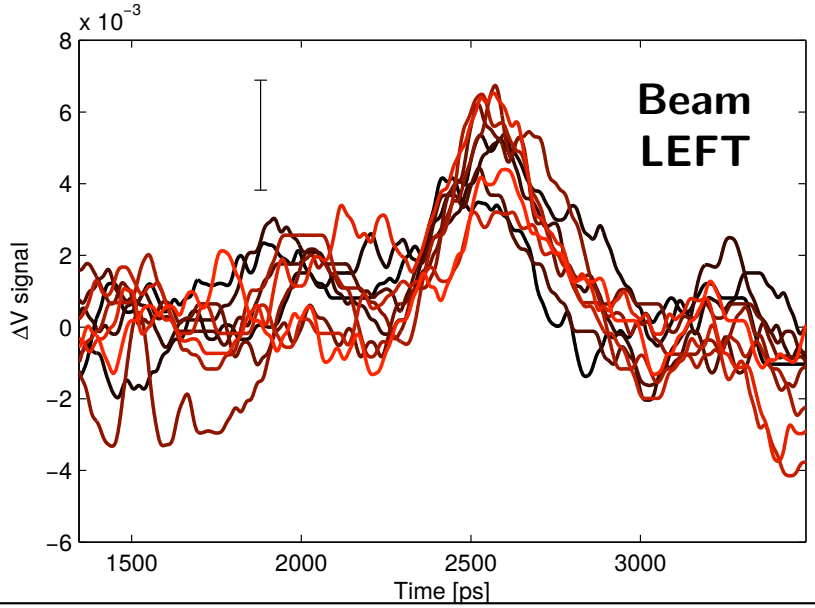
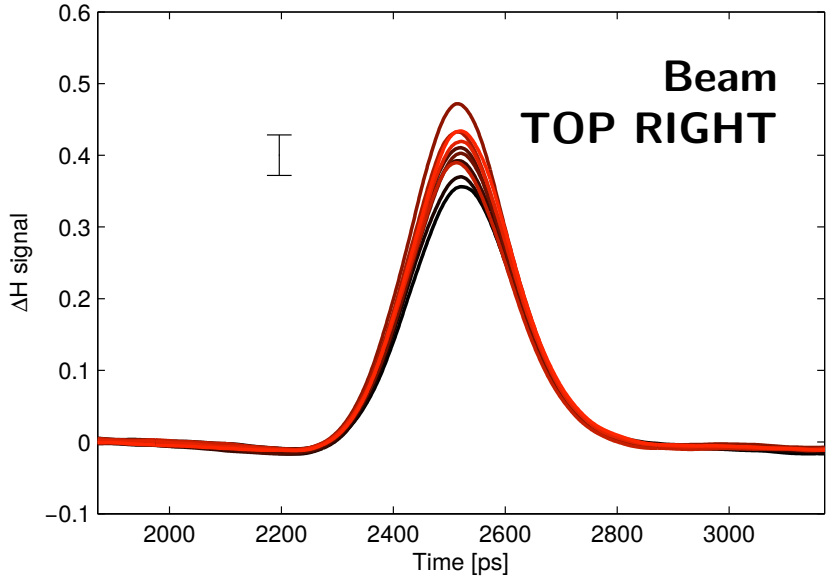
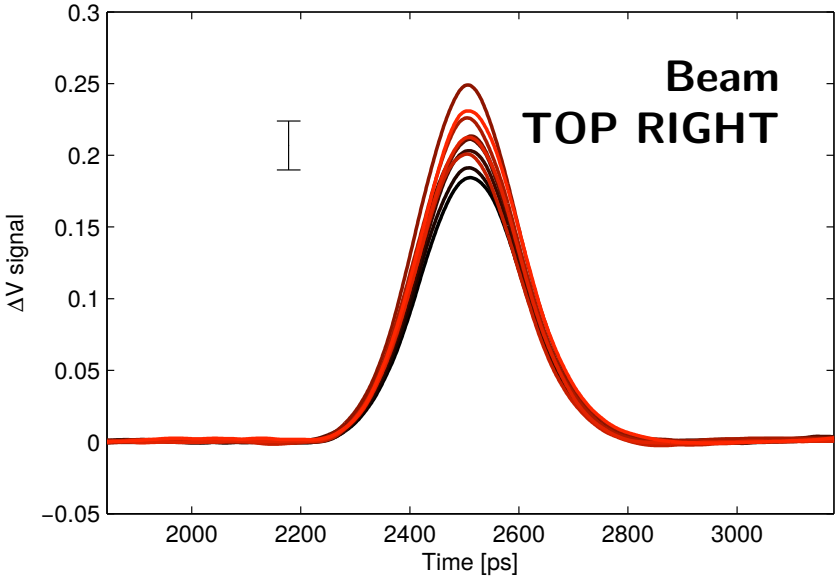
First results in TBM: Delta signals at 18 GHz

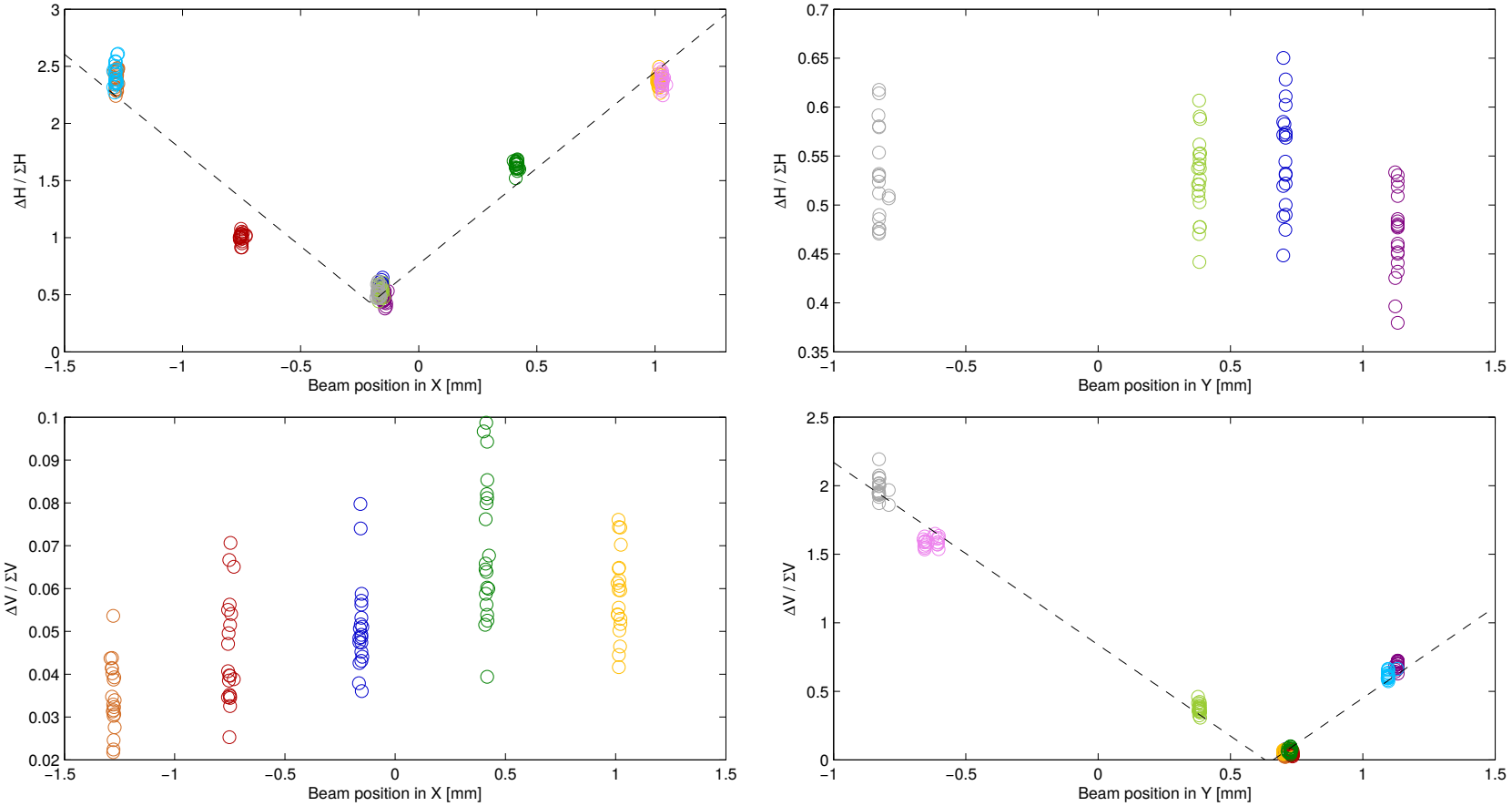




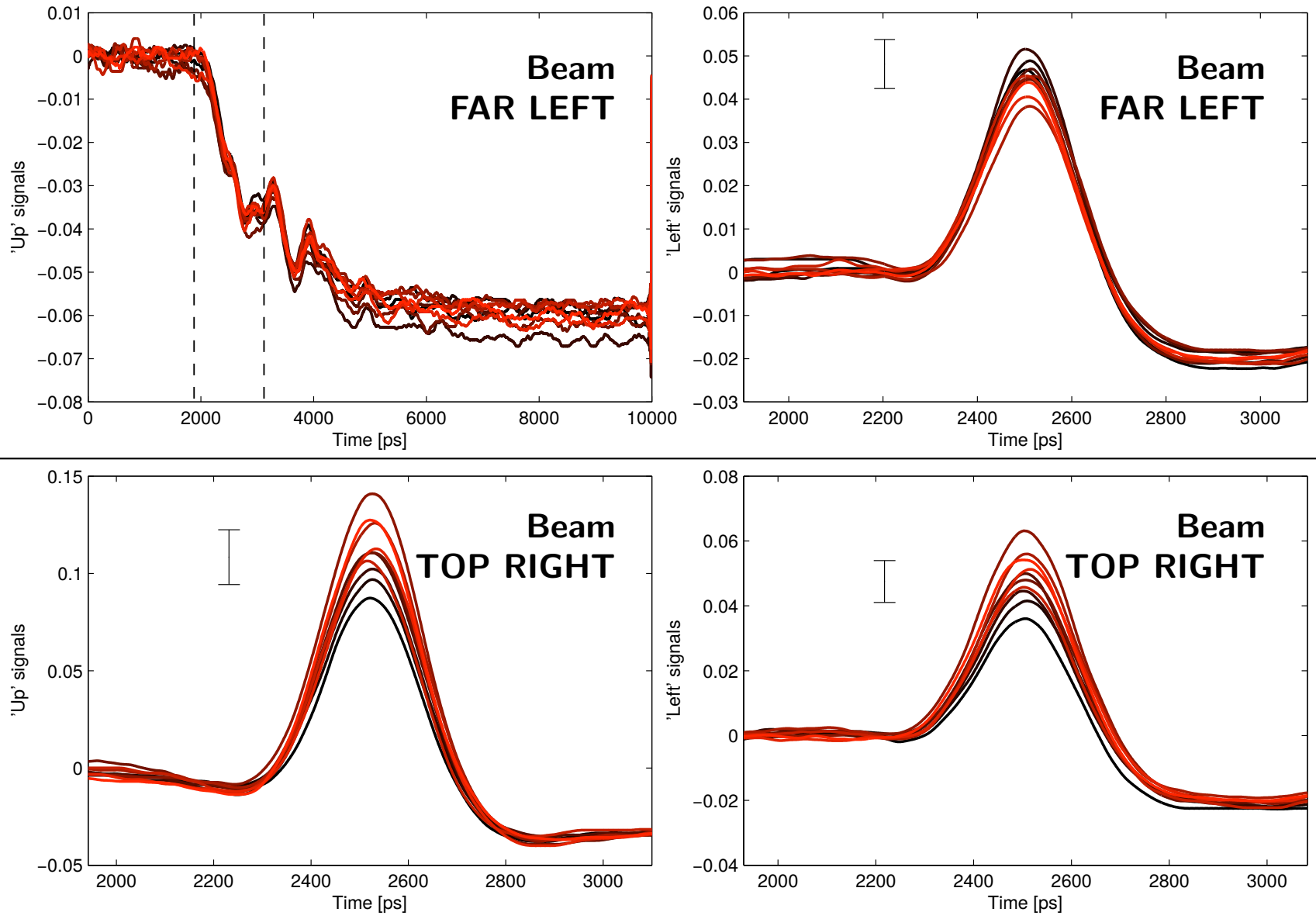




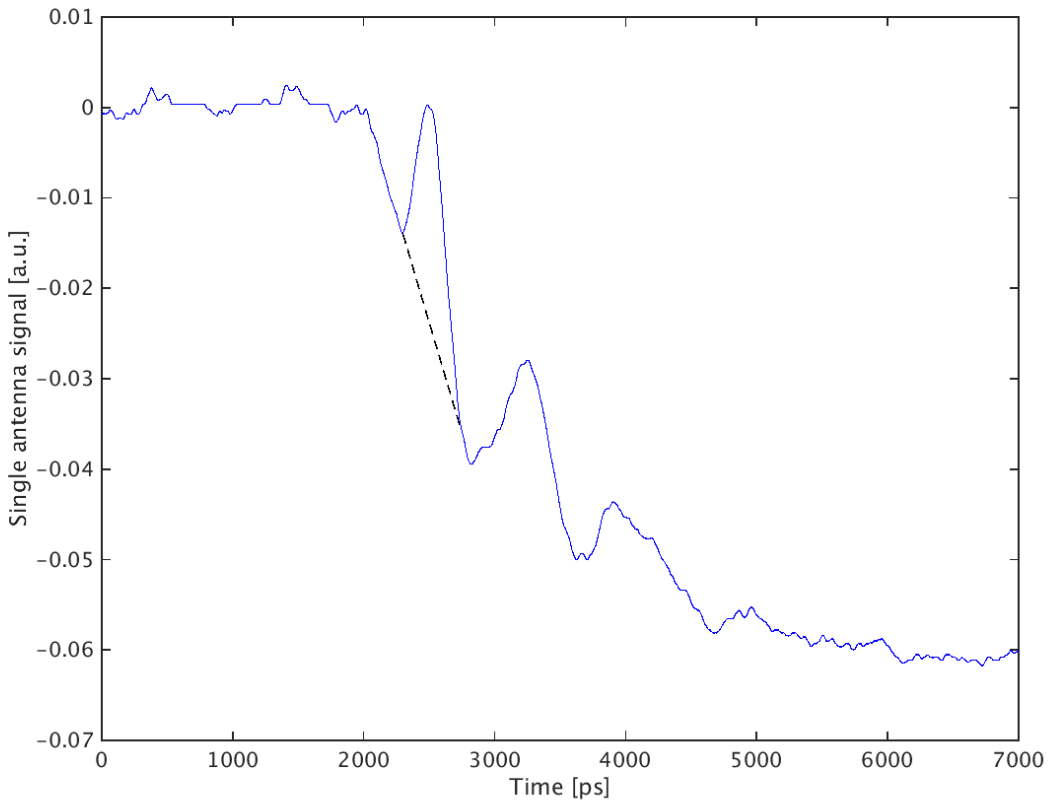
Delta signals over sum signals, vs. position (all at 18 GHz)



Single antenna signals (24 GHz)



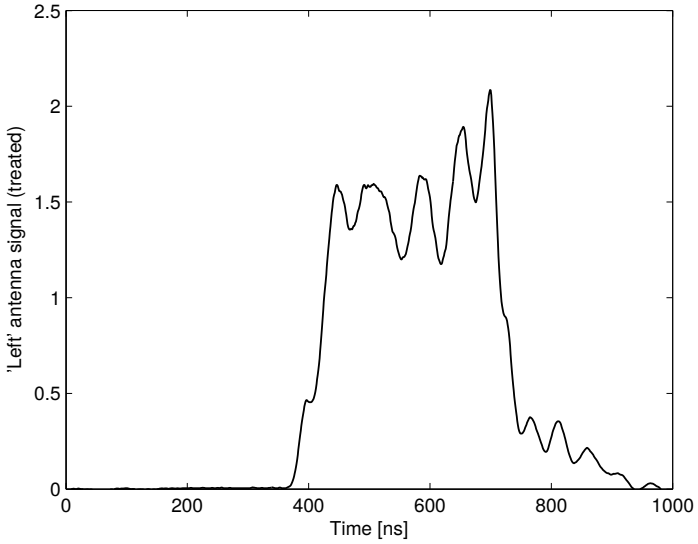
Background issues (24 GHz)



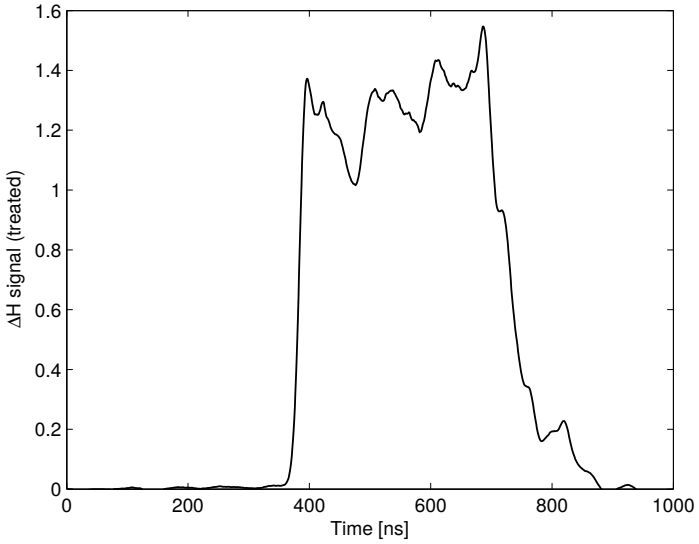
Possible peak detected as zero, because of the strange looking background signal!

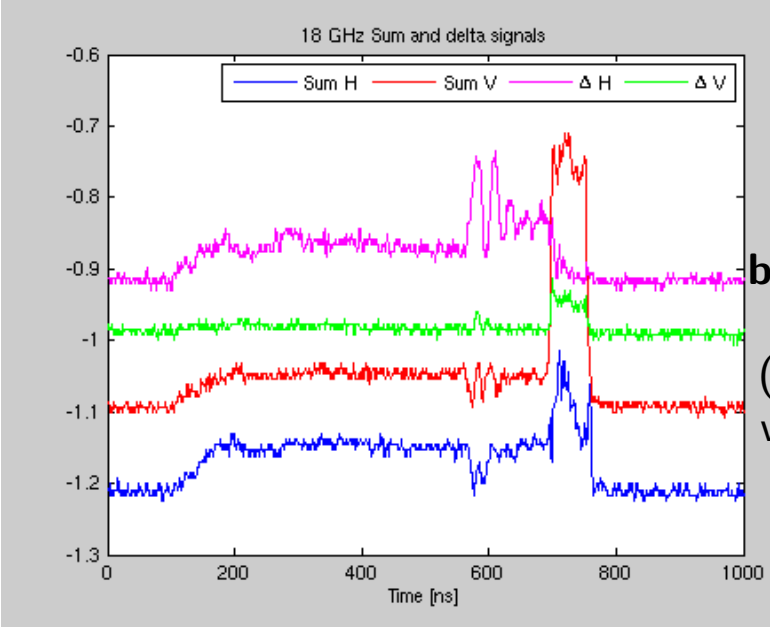
(Background somewhat different between datasets, so it is challenging to subtract)

Drive beam noise in WFM signals

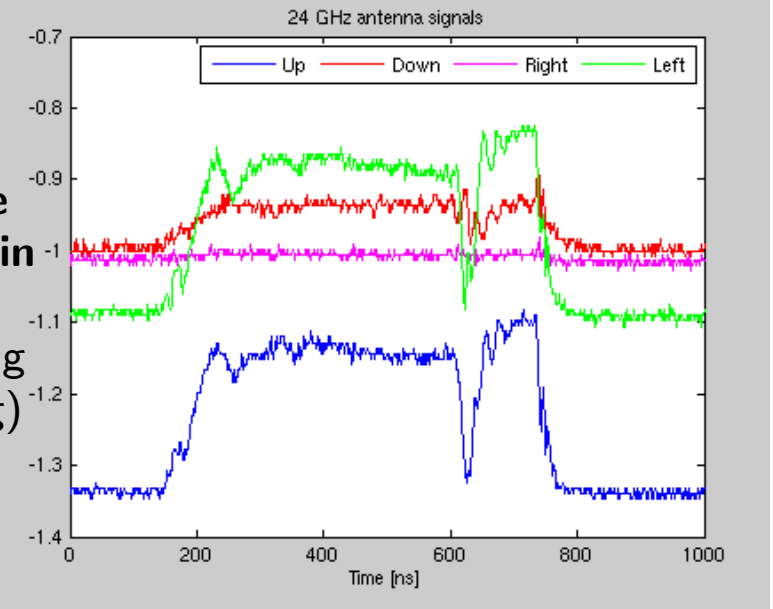


Drive beam in TBM

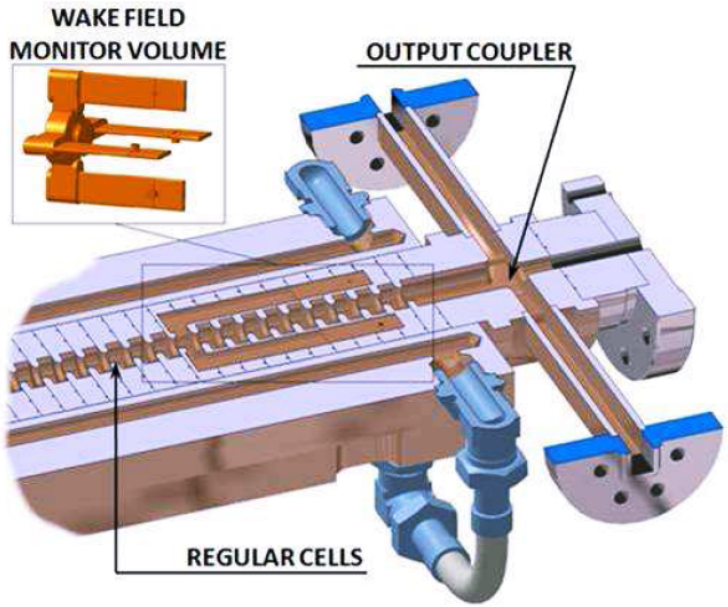


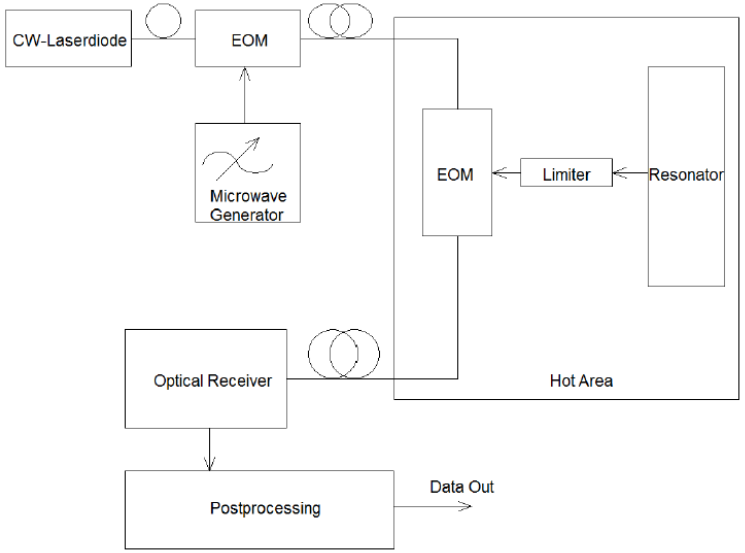


Drive beam in TBL (timing wrong)

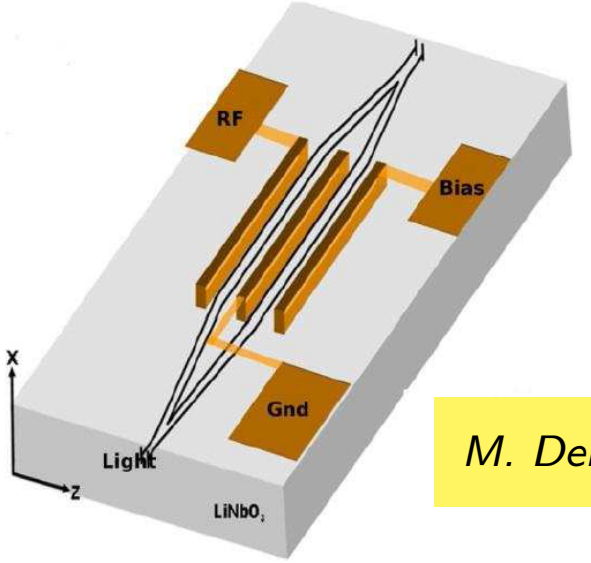


The PSI electro-optical front-end





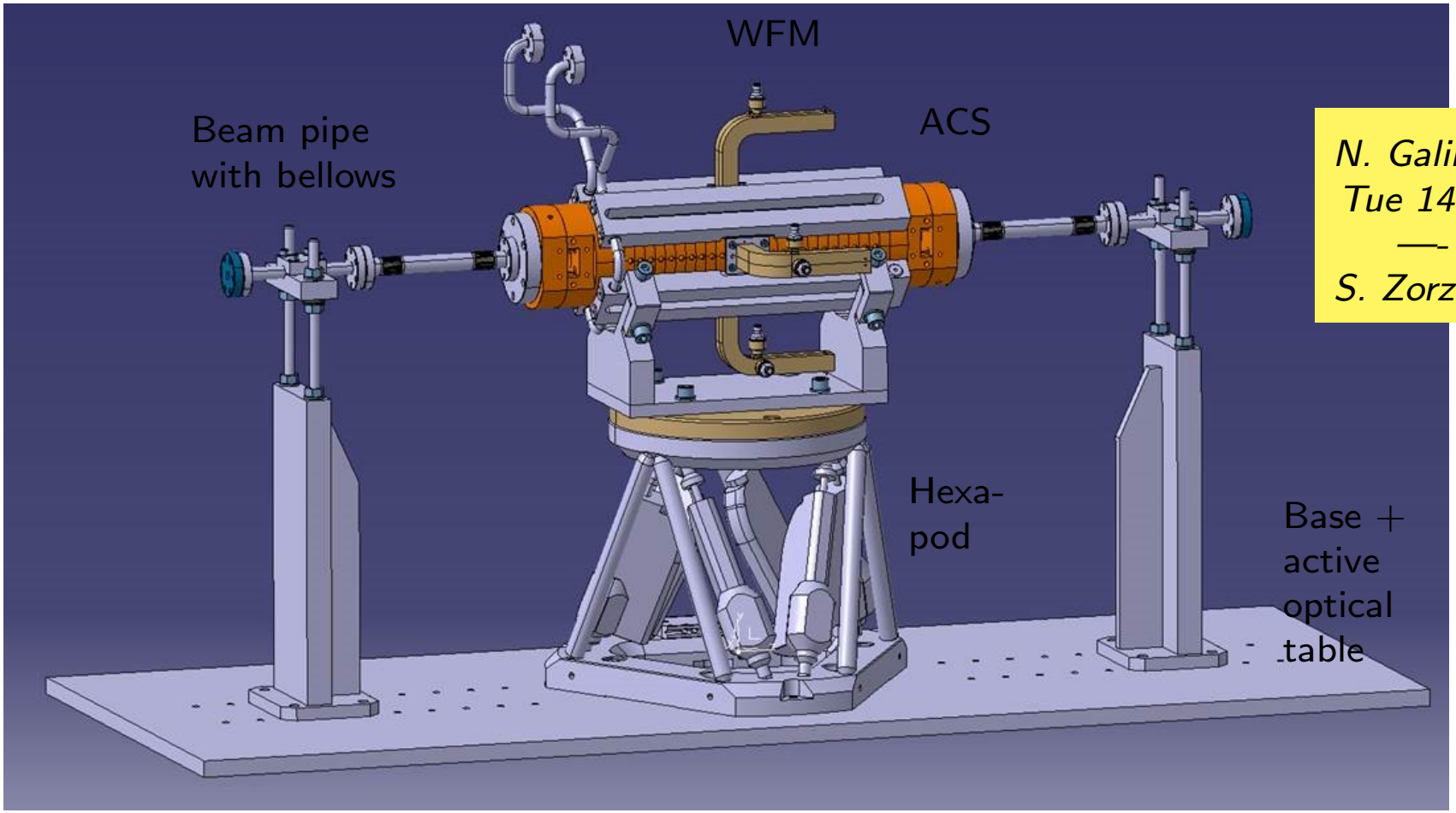
- New WFM front-end, based on an electro-optical approach
- Radiation hardness well understood, can carry signals with negligible EM interference
- Use of Electro-Optical Modulators, that via the applied electric fields change the phase delay of light paths in a $LiNbO_3$ crystal and enables QAM modulation
- Possible testing in the TBM this year?



M. Dehler

Other WFM measurements in CLIC

- Test stand under construction
- S parameter measurements, and excitation with charged, offset wires
- Promising simulations in HFSS



N. Galindo
Tue 14.10
—
S. Zorzetti

Summary and Outlook

Summary

- CLIC WFMs use 18 and 24 GHz dipole modes for beam position measurements
- Measurements in TBTS gave a good resolution and revealed a horizontal ACS misalignment
- First measurements done in the TBM. However, some issues with background (especially from the drive beam)

Outlook

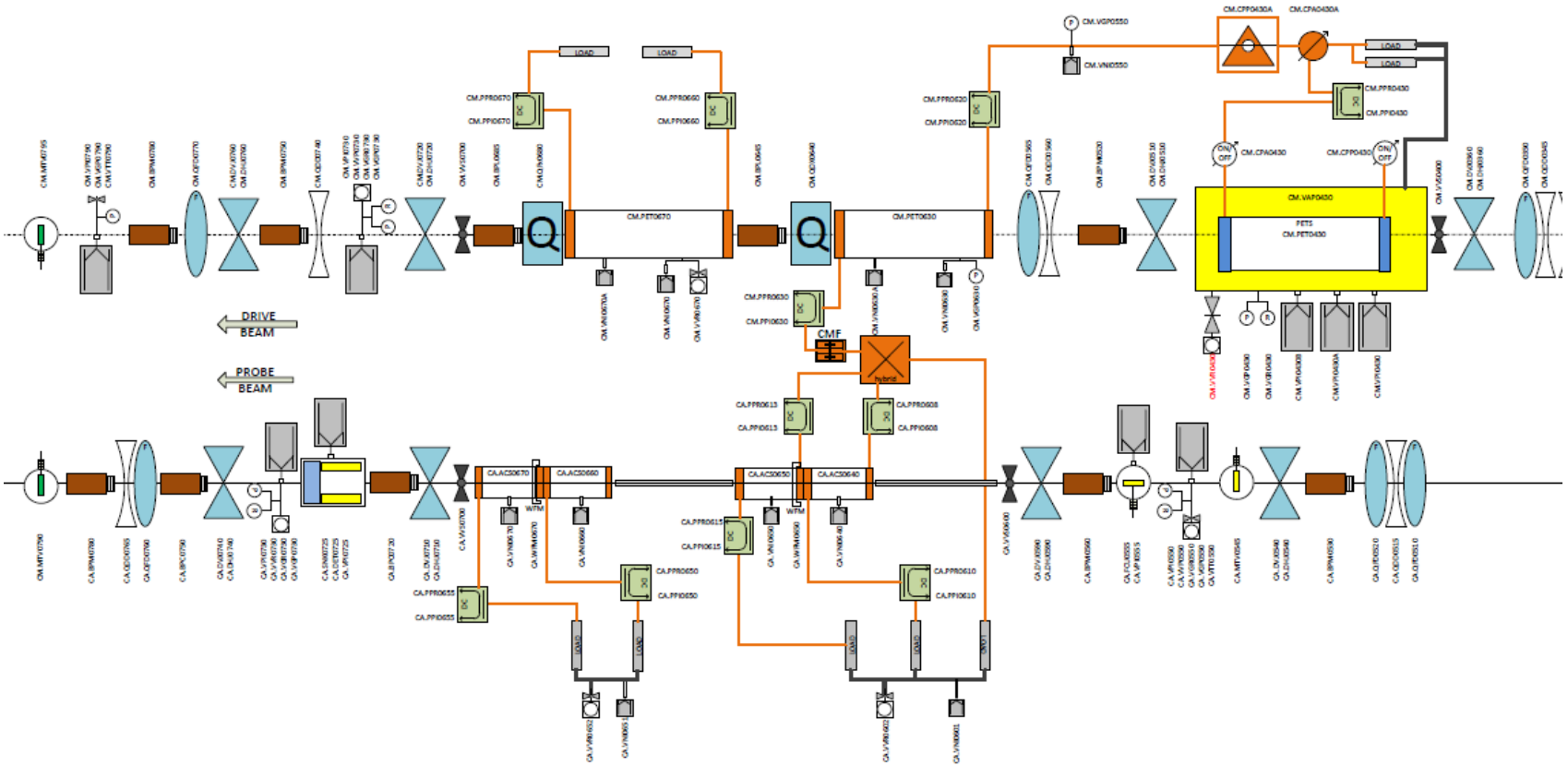
- March/April: Restart measurements in TBM
- Presently a large amount of DB noise – should be improved (shielding etc.)
- Collaboration with M. Dehler (PSI), investigate the use of an electro-optical front-end, possibly testing it in CTF3
- Possible front-end collaboration with the electronics lab in the University of Oslo
- Use Ace3P/Cubit for WFM simulations, revisit design

Thank you for your attention!

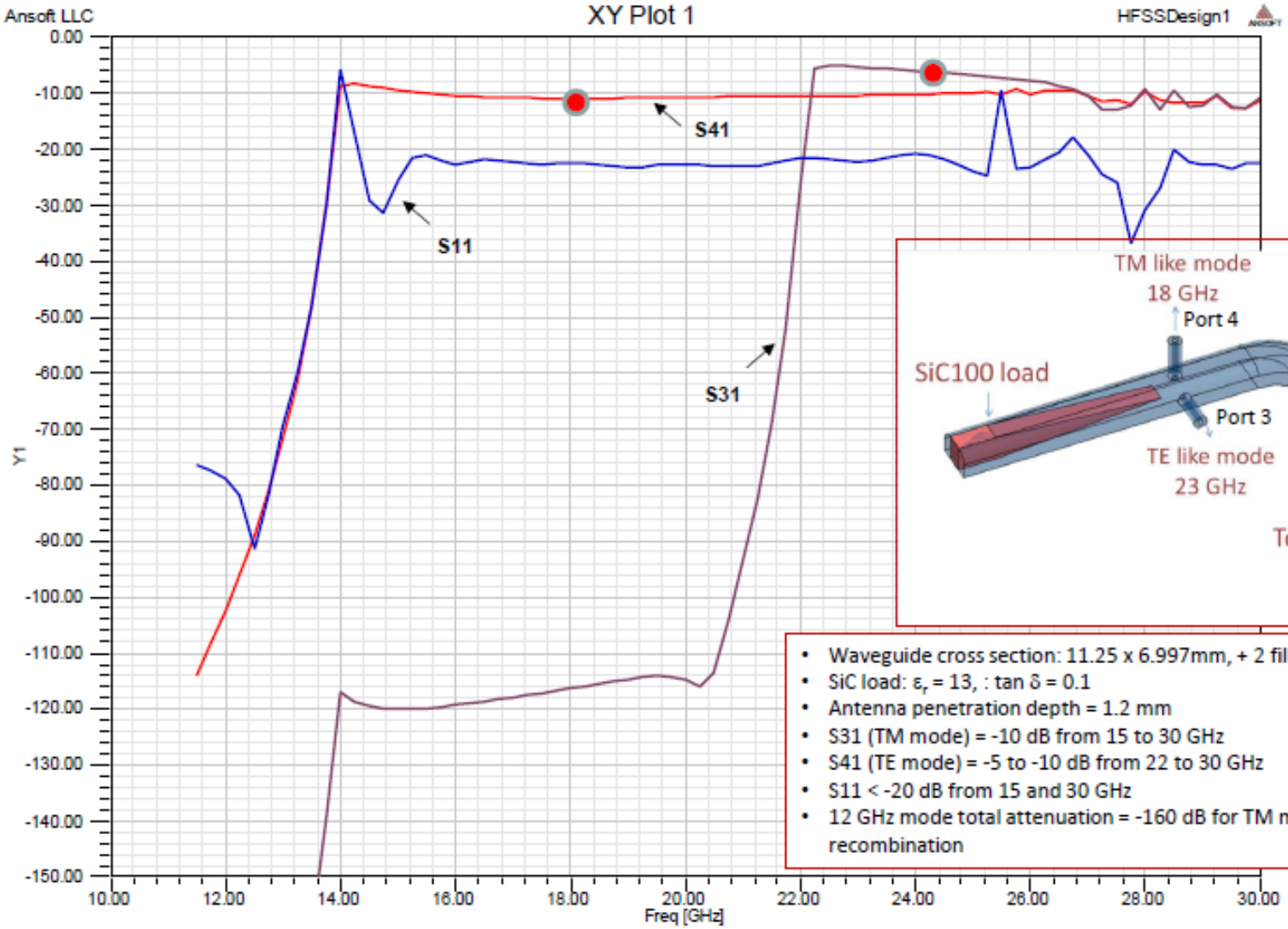
Special thanks to Wilfrid Farabolini, Luis Navarro, Natalia Galindo, Nuria Catalan, Micha Dehler, Roberto Corsini, Alexej Grudiev, Erik Adli, Jürgen Pfingstner, Danish Nawaz and Steffen Döbert

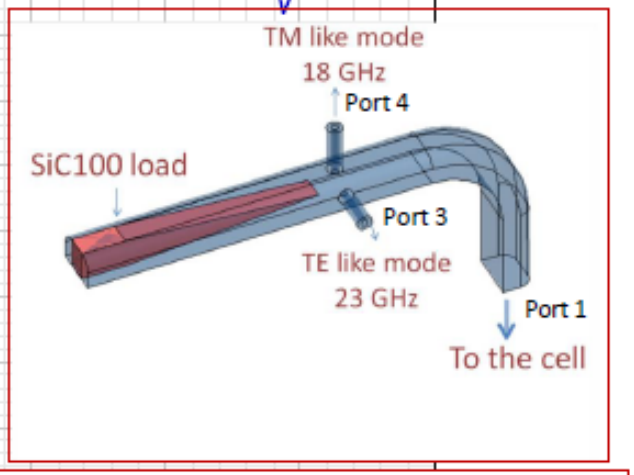
Extra slides

TBM schematic



CLIC WFM S-parameters

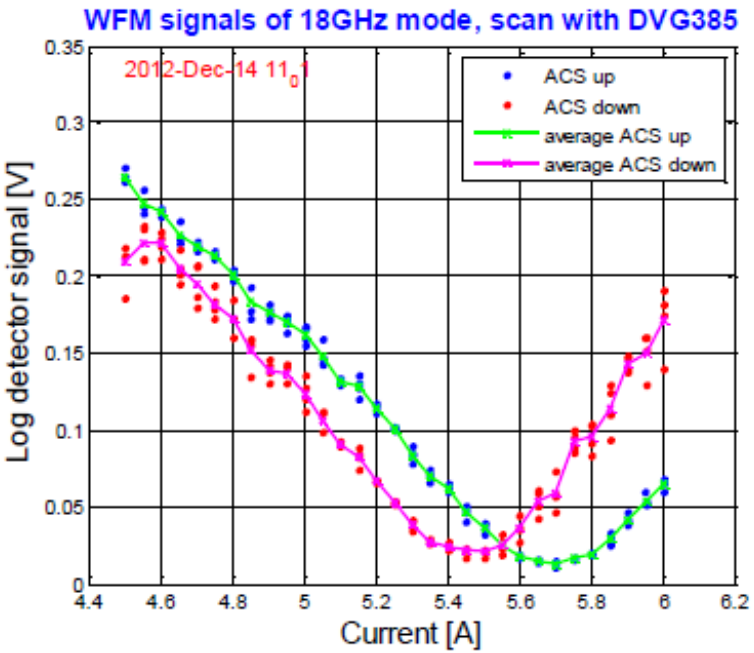


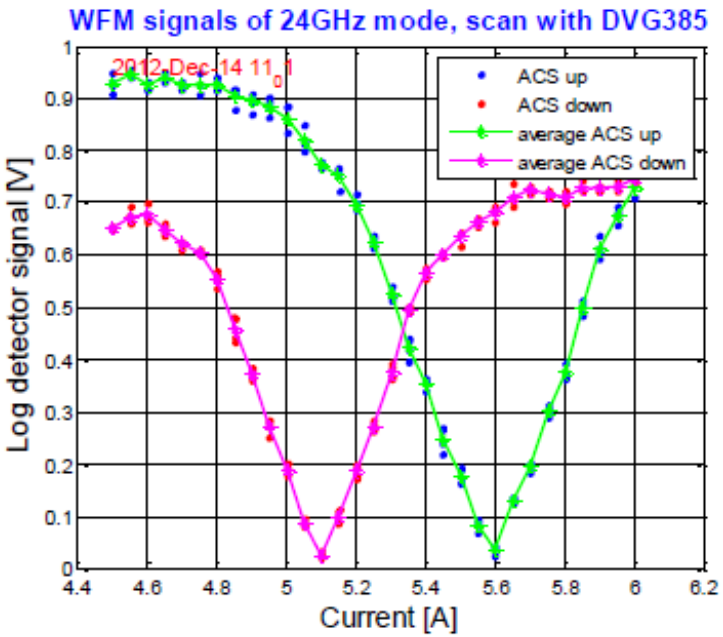


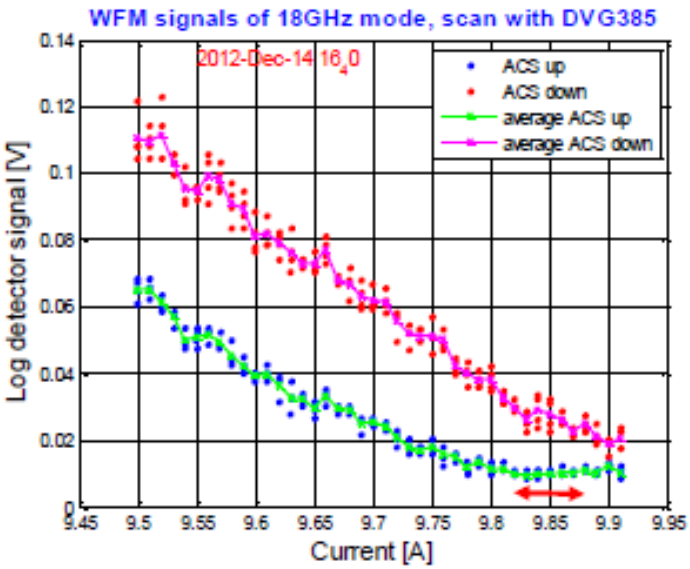
- Waveguide cross section: 11.25 x 6.997mm, + 2 fillets R=3 mm
- SiC load: $\varepsilon_r = 13$, : $\tan\delta = 0.1$
- Antenna penetration depth = 1.2 mm
- S31 (TM mode) = -10 dB from 15 to 30 GHz
- S41 (TE mode) = -5 to -10 dB from 22 to 30 GHz
- S11 < -20 dB from 15 and 30 GHz
- 12 GHz mode total attenuation = -160 dB for TM mode before recombination

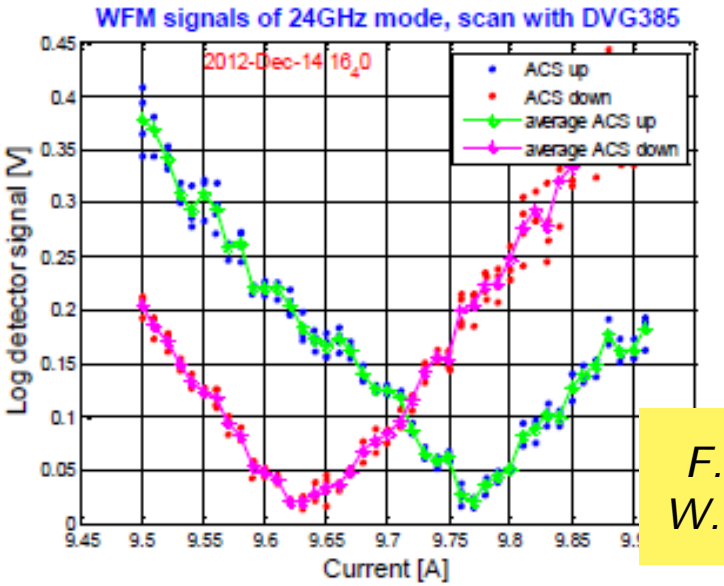
F. Peauger

First WFM scan in the TBTS





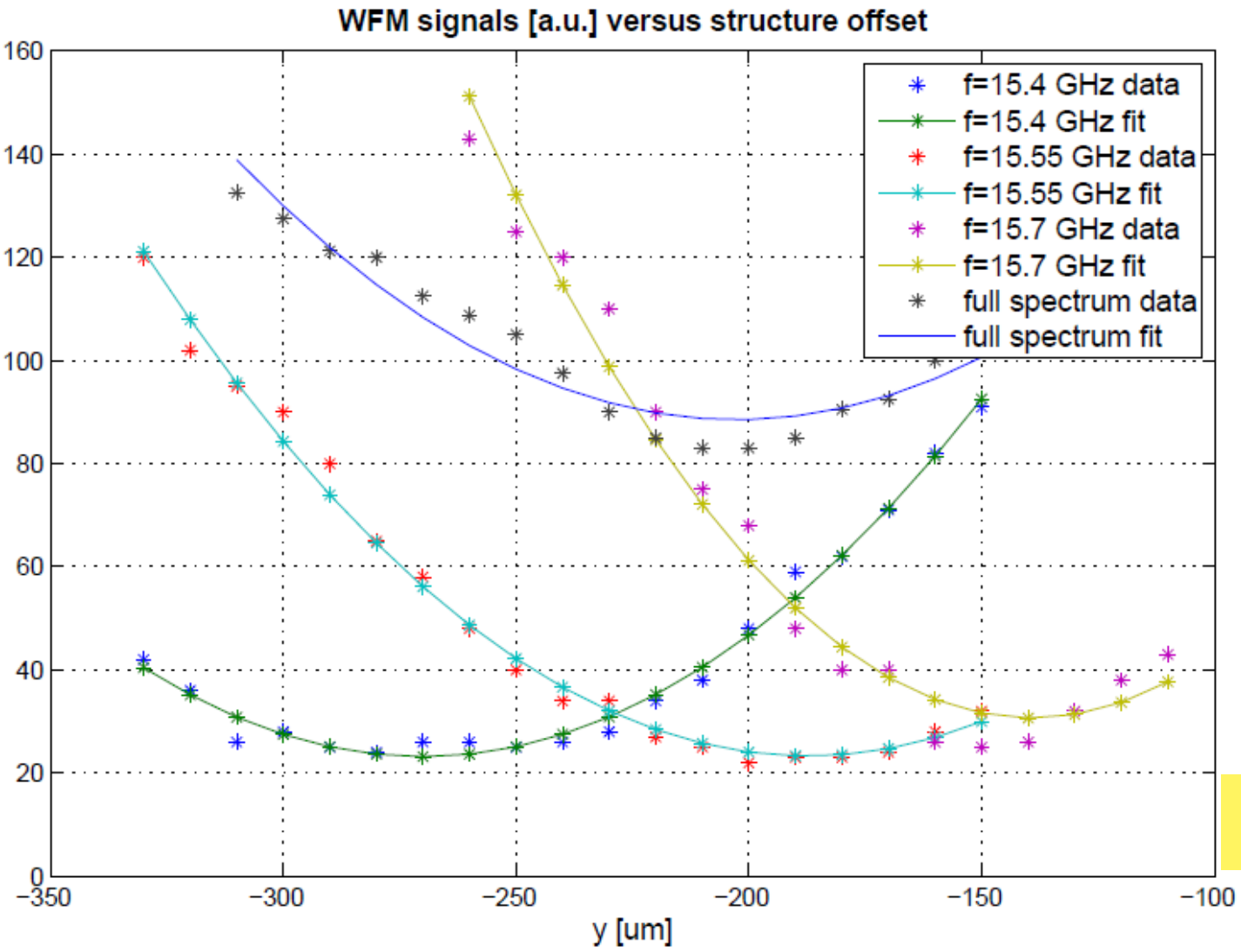




F. Peauger, W. Farabolini

Electro-optical front-end: Structure tilt

3 positions in the structure show different minima during a tilt of the structure



M. Dehler