Progress of the High Precision BPM for the TESLA Spectrometer

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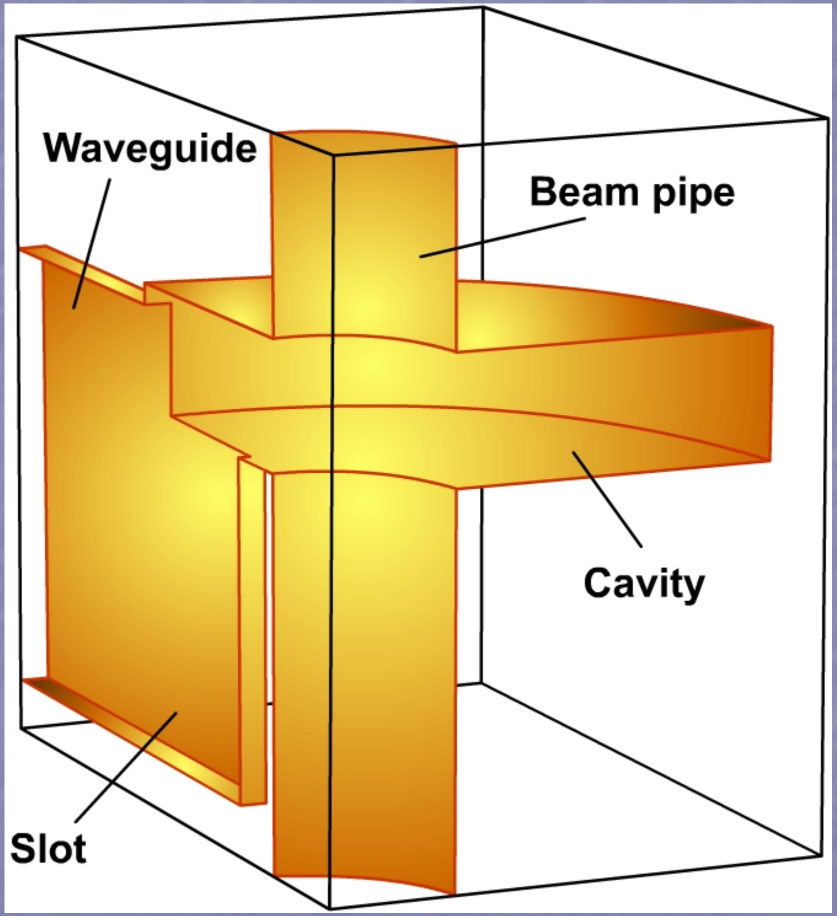
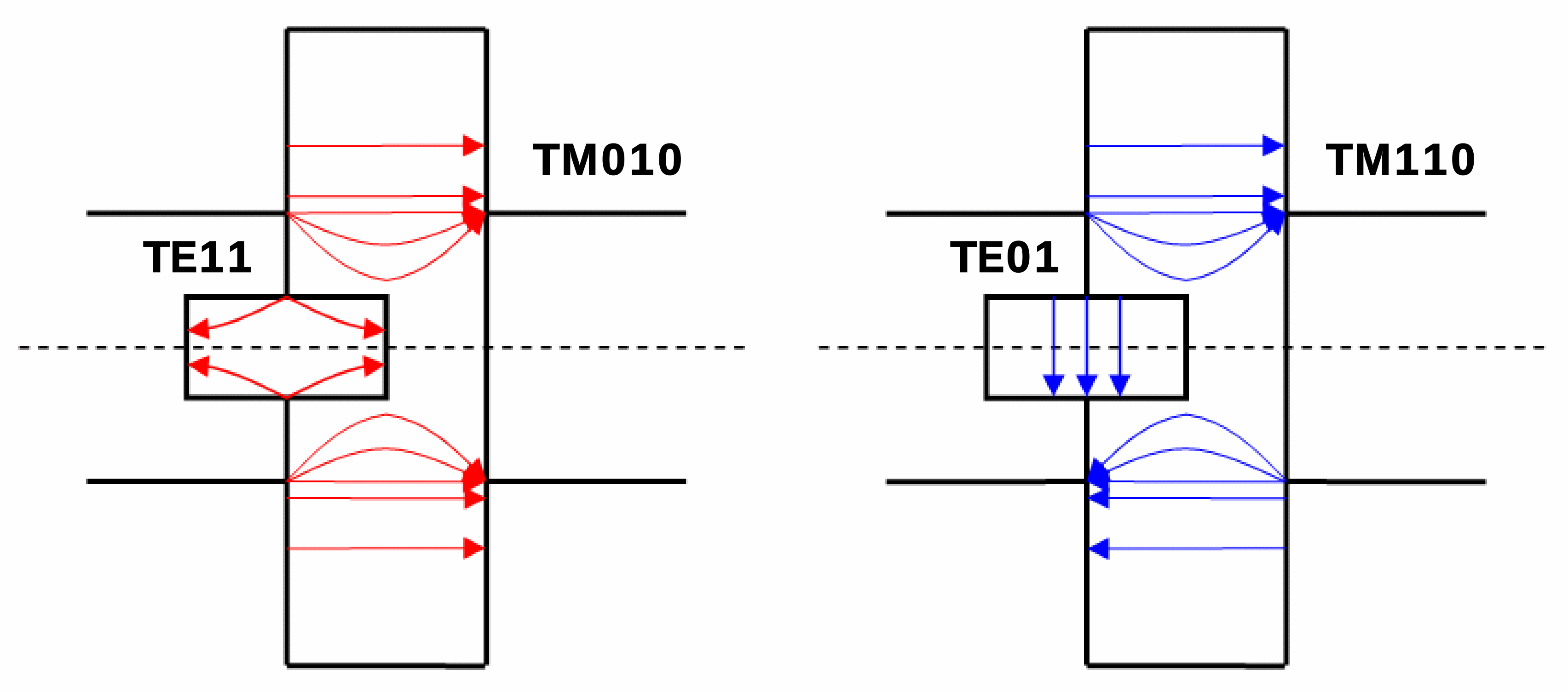
BPM Structure



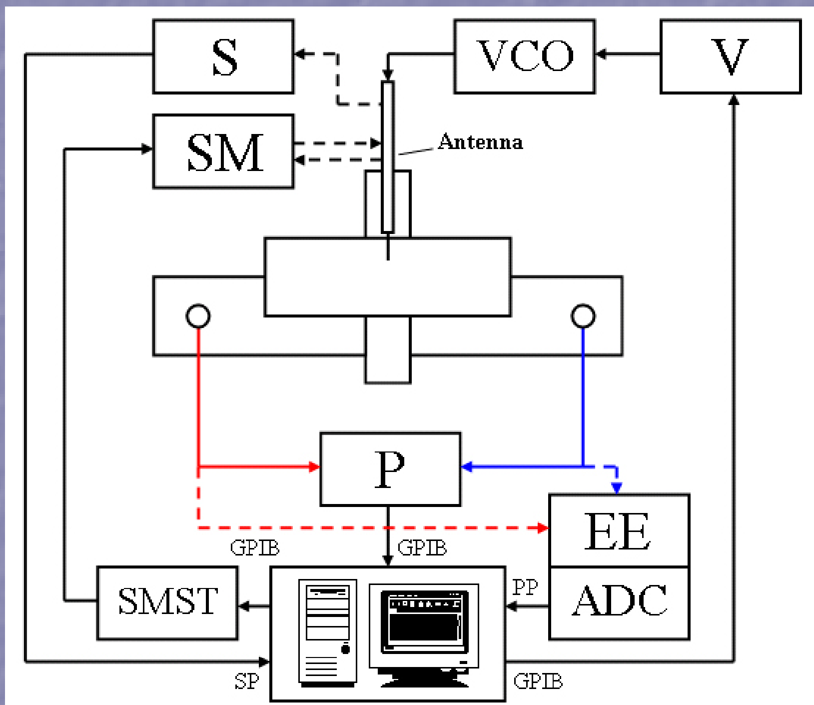
The dipole mode of the cavity, which contents the beam offset information, is coupled with a system of a slot and a rectangular waveguide.
Due to this configuration the strong monopole modes are not coupled.

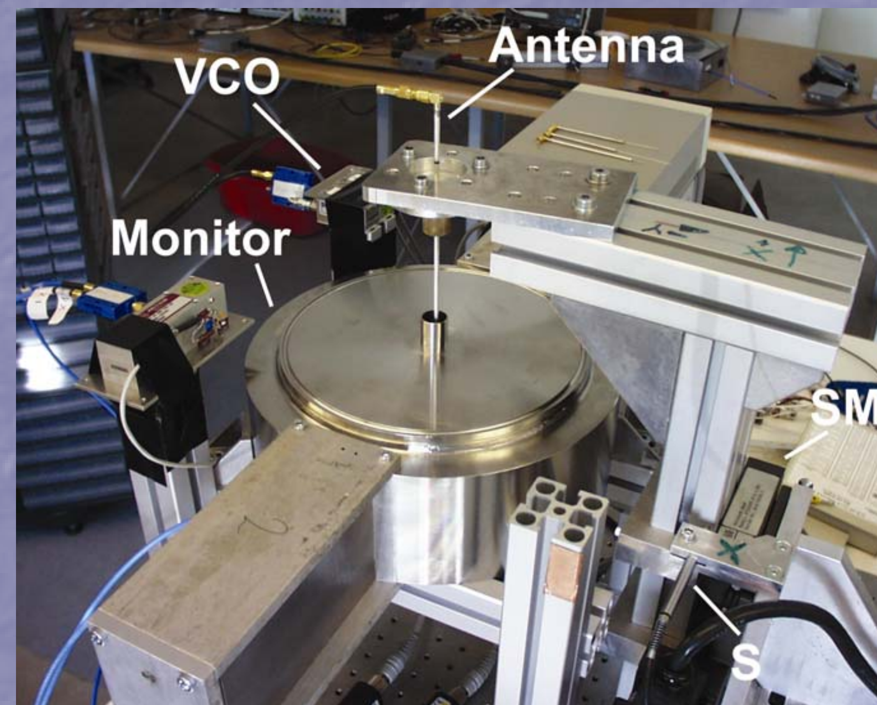
BPM Structure



The dipole mode TM110 couples to the lowest wave of the waveguide, TE01, while the monopole modes couple to the higher wave, TE11, which has a higher cut-off frequency. Therefore the monopole modes don't propagate in the waveguide.

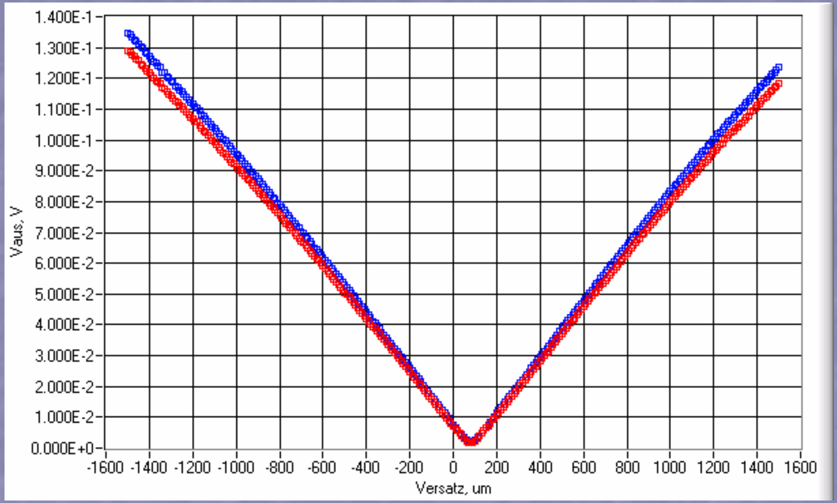
Measurement Setup

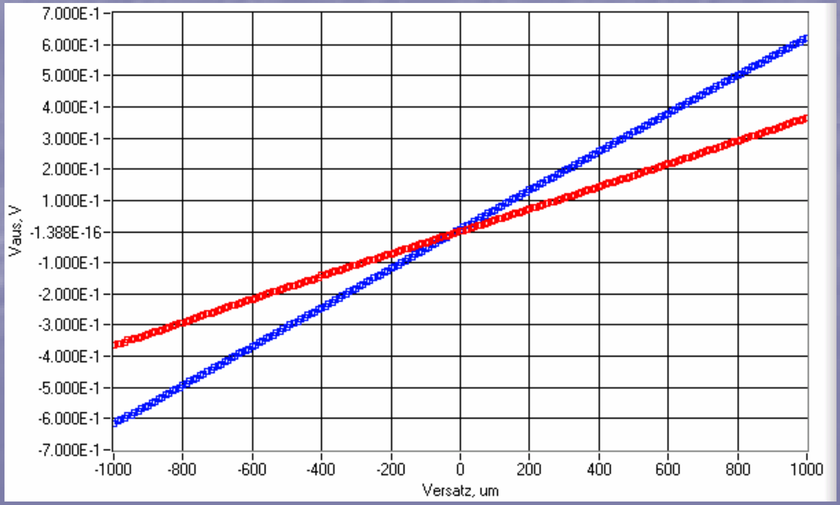




In order to test the monitor one places an antenna into the cavity and excites the dipole mode. Antenna is moved transversally to simulate the beam deflection.

Measurements with the 1.5 GHz-Prototype





The measurements show about 130 nm of resolution by 20 times smaller signals as at the 3.2 nC beam. The linear range is about ±900µm. A measurement of the common mode signal gives a precision of about 150 nm.

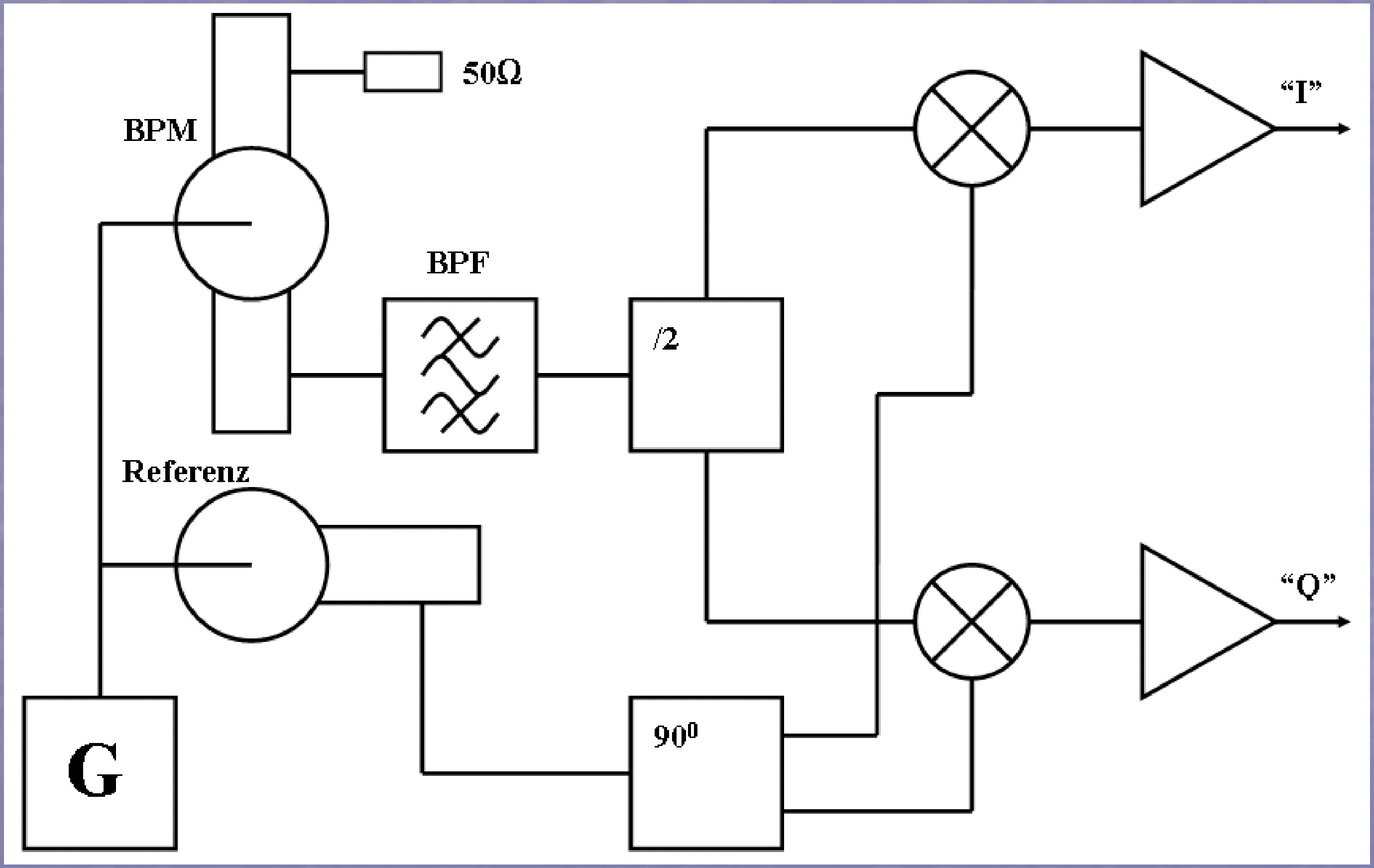
New Prototype

A new prototype of the cavity for the frequency of 5.5 GHz was designed and tested with the test setup.
Its monitor cavity is about 4 times smaller as by the 1.5 GHz-Prototype.

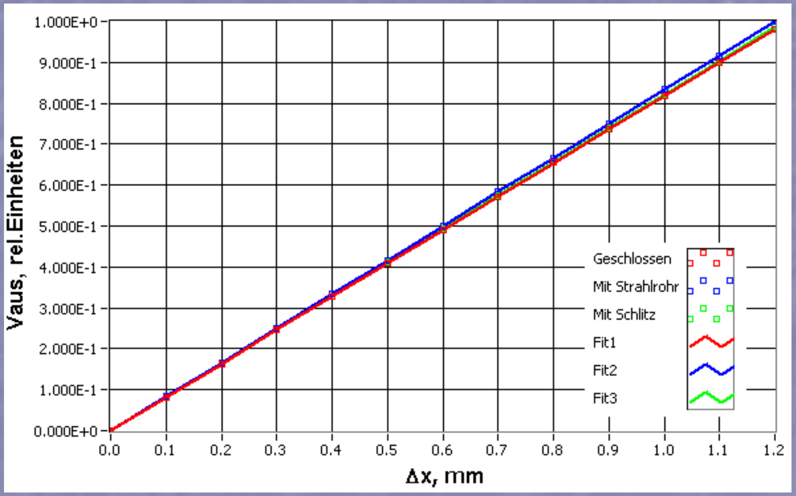
New Prototype

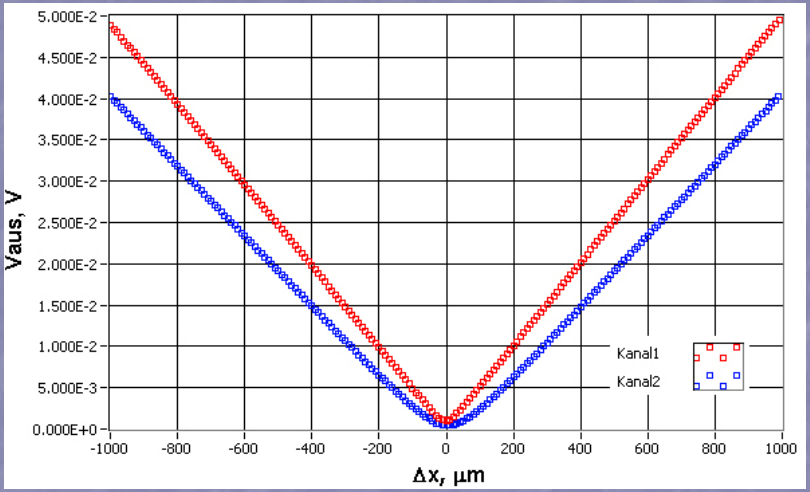
The reference cavity was also implemented in the prototype. The main block was produced out of two parts in order to simplify its production of the slots.

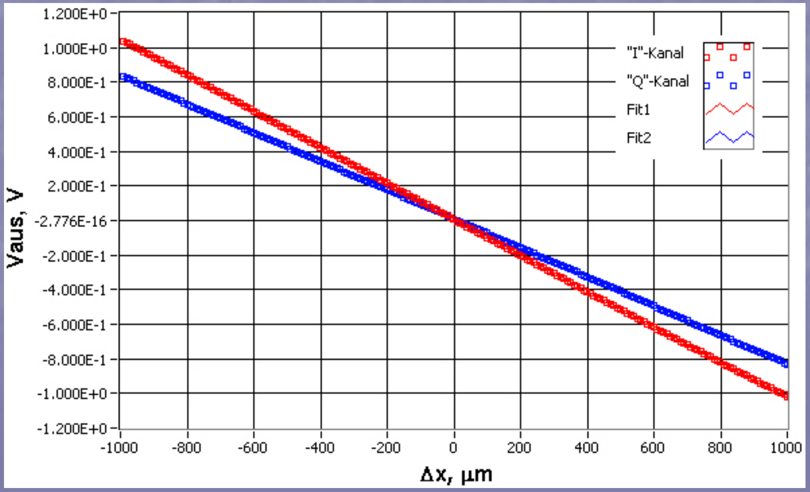
Measurements with the Reference Cavity



Measurements with the 5.5 GHz-Prototype







The 5.5 GHz-Prototype has practically the same linear range as the 1.5 GHz-Prototype. Measurements show a resolution of about 200 nm. The signal processing scheme seems to limit the resolution and also the linear range.

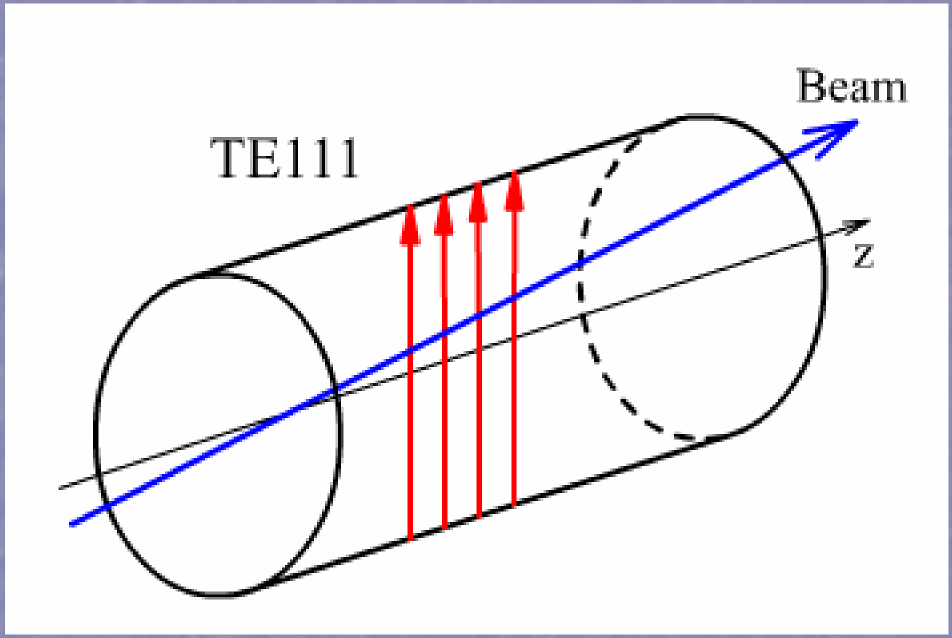
Comparison

Parameter	1.5 GHz	5.5 GHz
Signals (est.)	173µV/100nm	1.9mV/100nm
Common M. (est.)	956µV	4.3mV
Resolution (meas.)	130nm	200nm
Precision (meas.)	150nm	-
Linear range (meas.)	±900	±700
Angle dependence (est.)	34	4
Time resolution (est.)	115	16

Conclusion

Two prototypes of the monitor for frequencies of 1.5 GHz and 5.5 GHz were designed and produced for the laboratory measurements. They have similar parameters, but the 5.5 GHz-Prototype seems to be more applicative in the spectrometer because of the smaller angle sensitivity and compactness. Also the time resolution of this prototype is higher. Its spatial resolution and linear range can be improved with the modification of the electronics.

Angle Measurement



A resolution of 10^{-3} ÷ few 10^{-4} seems to be possible.
The possibility of the higher resolution has to be investigated.
This monitor can be a good possibility to control the cavity tilt.