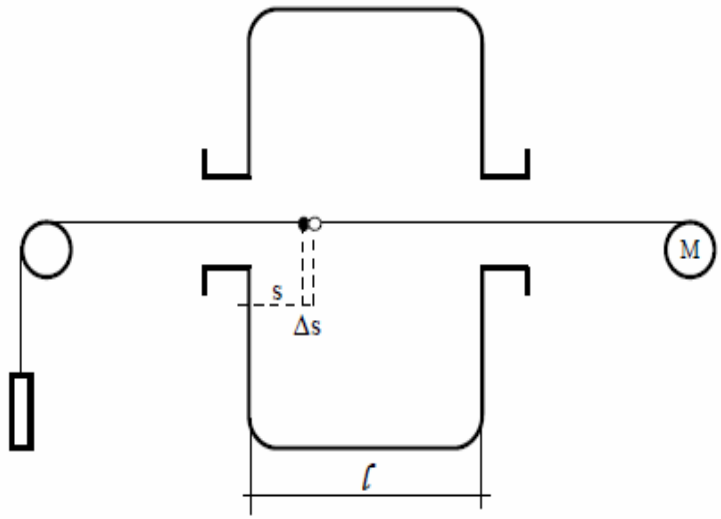
Automatic Field Balancing of the PETRA-III 7-Cell Cavities

Introduction

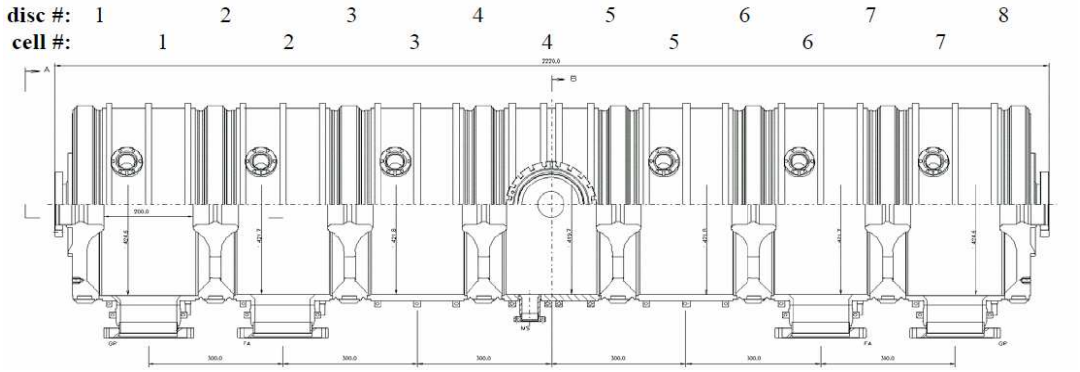
- In common the bead pull measurements are used to balance the electric fields in a multi cell cavity.
- The Frequency shift is proportional to the change in electromagnetic energy by introducing an object into a cavity.

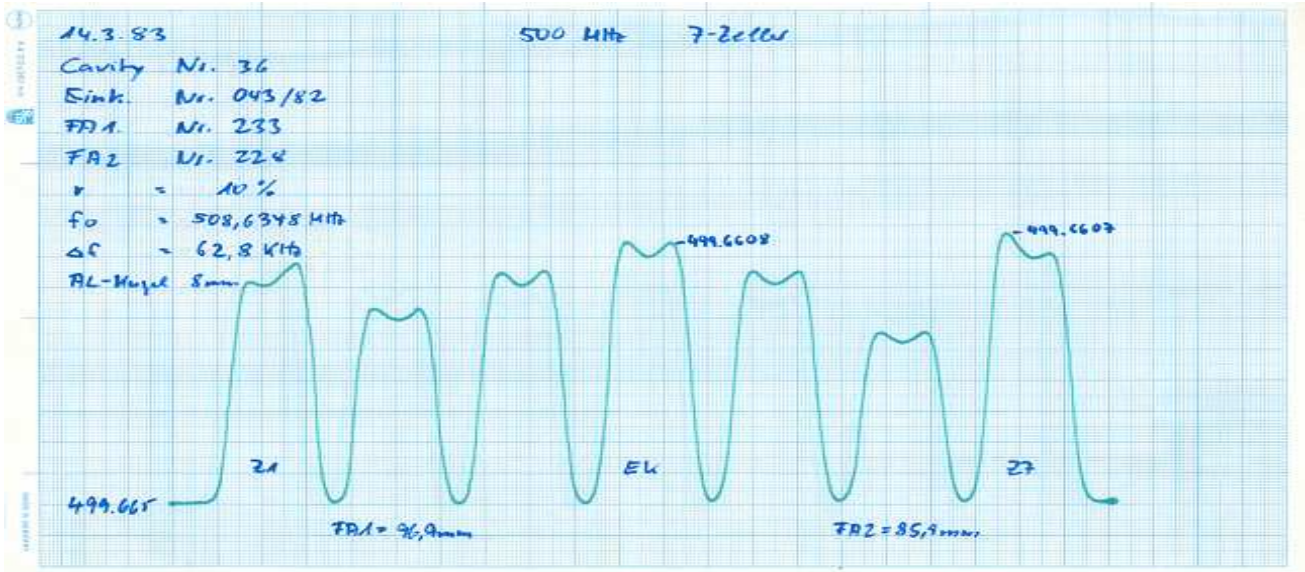


Schematic of a bead-puller apparatus

Example Measurement

PETRA Cavity





-Goal: Finding the plunger positions for a balanced electrical field.

Bead Pull Disadvantages

After the replacement of a power coupler, a pick up, or a plunger a new field balancing is necessary.

- This is not possible when the cavities are installed.

- This measurement is time consuming.

Temperature Method

Alternative:

Temperature in-situ method
by measuring the cell losses.
First we have to switch off the
water cooling of the cavities.
Then we have to balance the
temperature distribution.
But this also takes several hours.

The New Idea

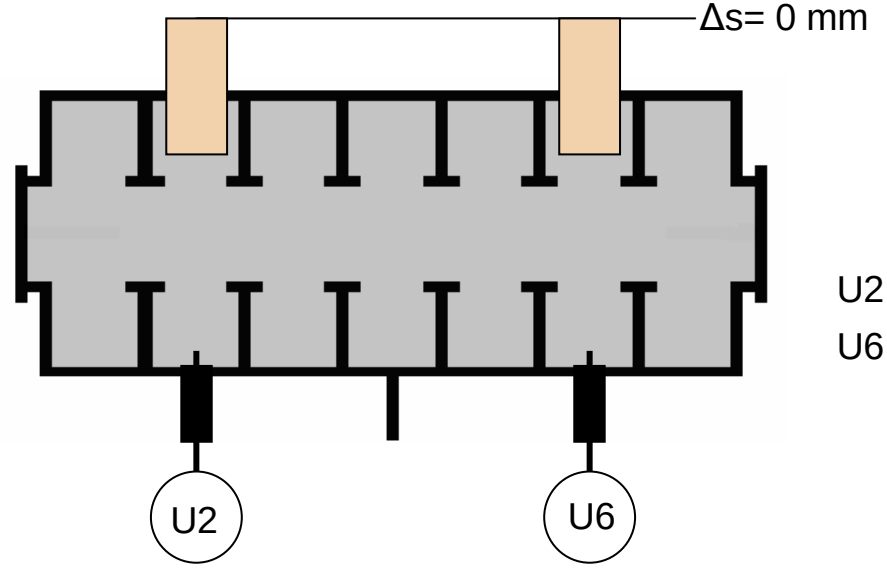
- Why not use the plungers to balance the electric field in the cavity ?

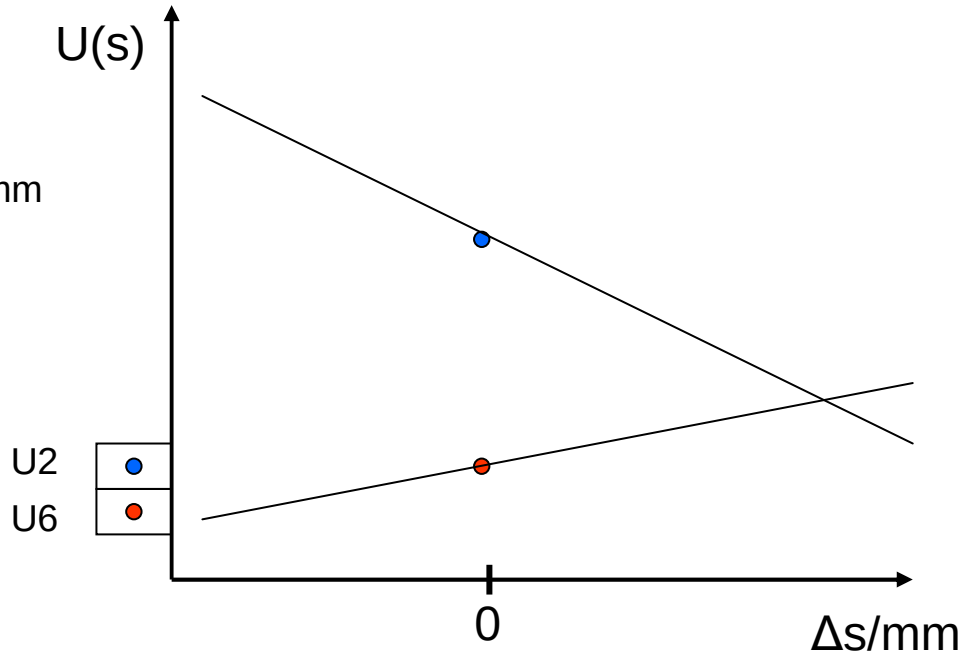
- The electric field is balanced if the same plunger movements of each plunger result in the same frequency changes.

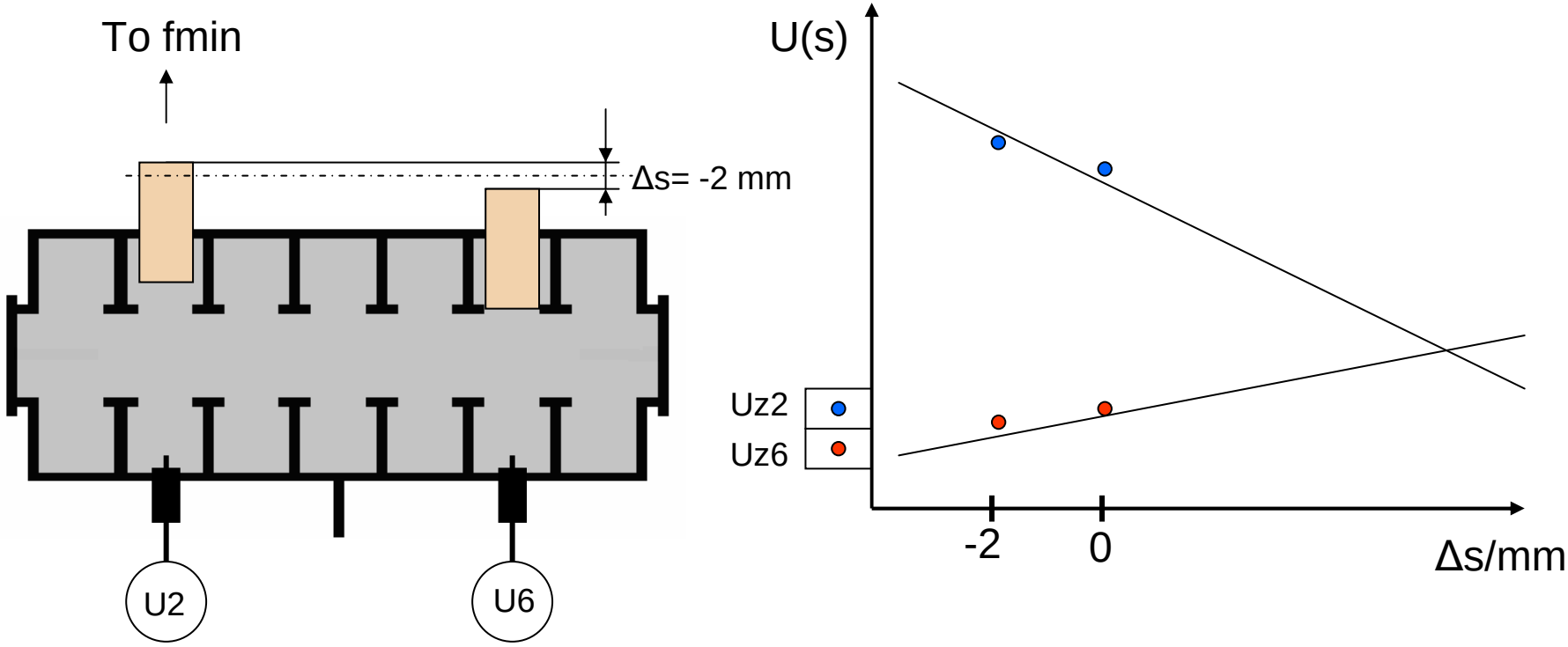
Measuring the Same E-Field

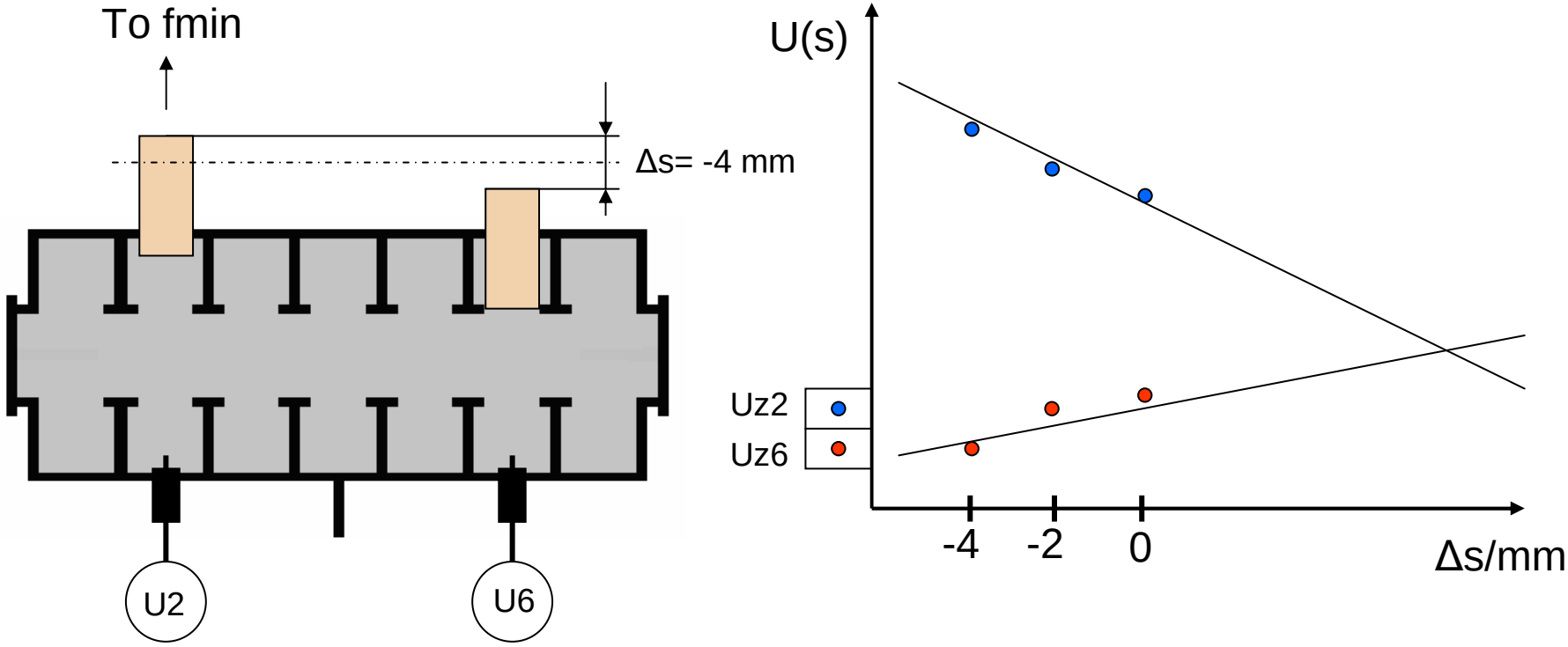
- The main issue is to develop an algorithm to determine the calibration factors of the pick ups in cell 2 and cell 6.

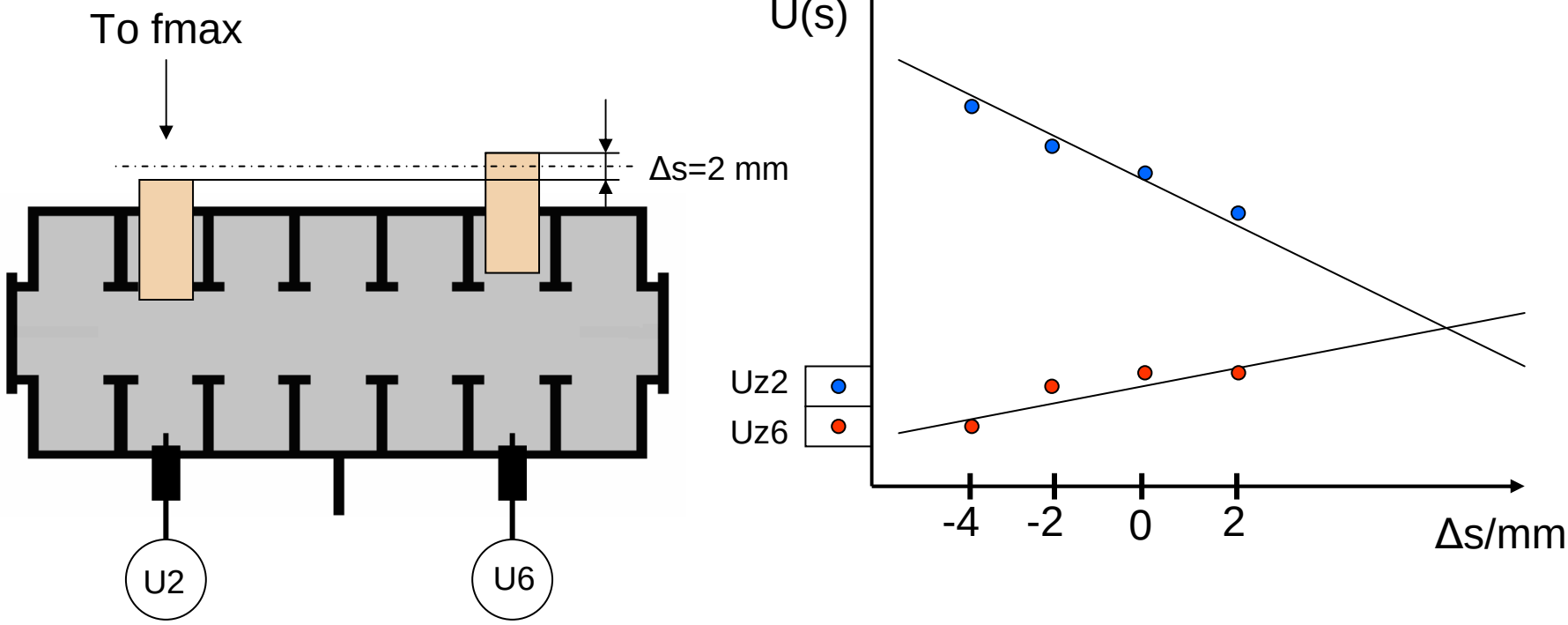
The Plunger Sequence

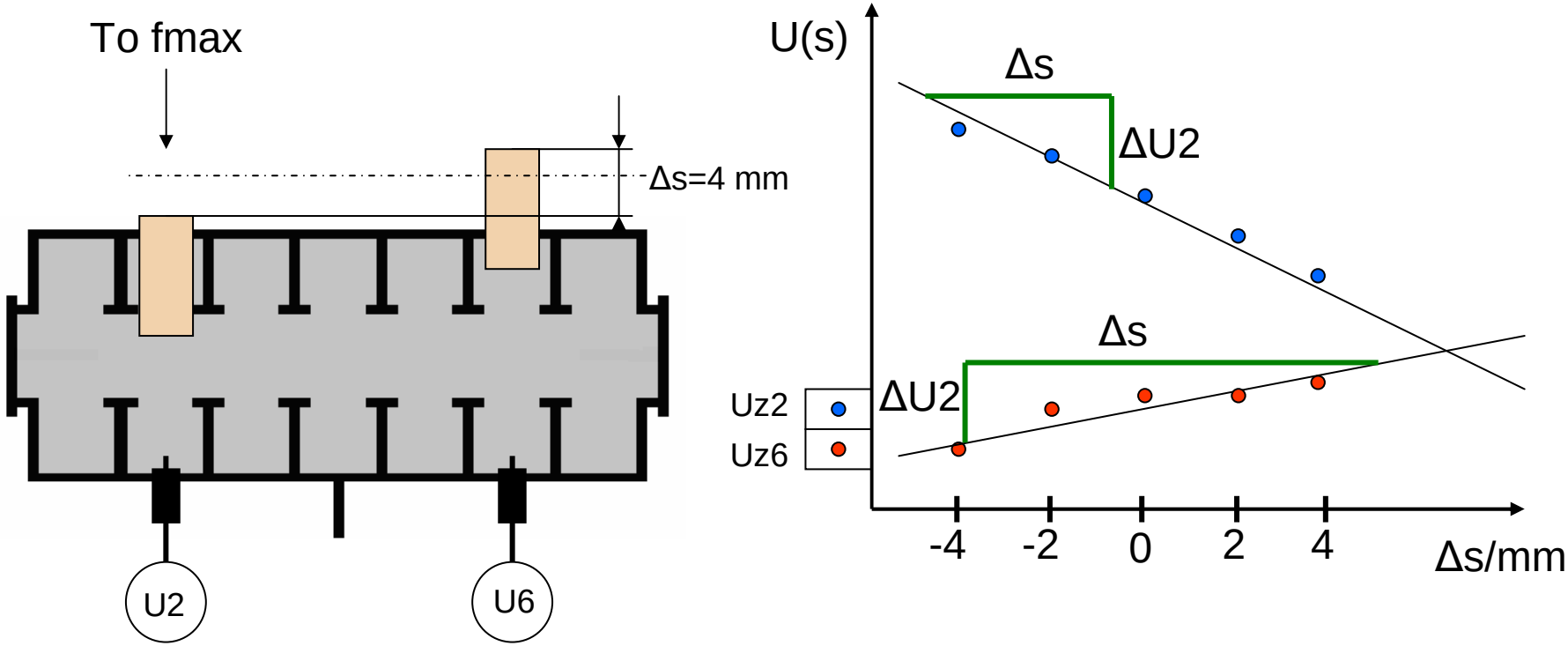





To fmin
Δs= -2 mm
U2
U6
U(s)
Uz2
Uz6
-2
0
Δs/mm


To fmin
Δs= -4 mm
U2
U6
U(s)
Uz2
Uz6
-4
-2
0
Δs/mm


To fmax
Δs=2 mm
U2
U6
U(s)
Uz2
Uz6
-4
-2
0
2
Δs/mm


To fmax
Δs=4 mm
U2
U6
U(s)
Δs
ΔU2
Δs
ΔU2
Uz2
Uz6
-4
-2
0
2
4
Δs/mm

The Calibration Factor

- The following equation is used

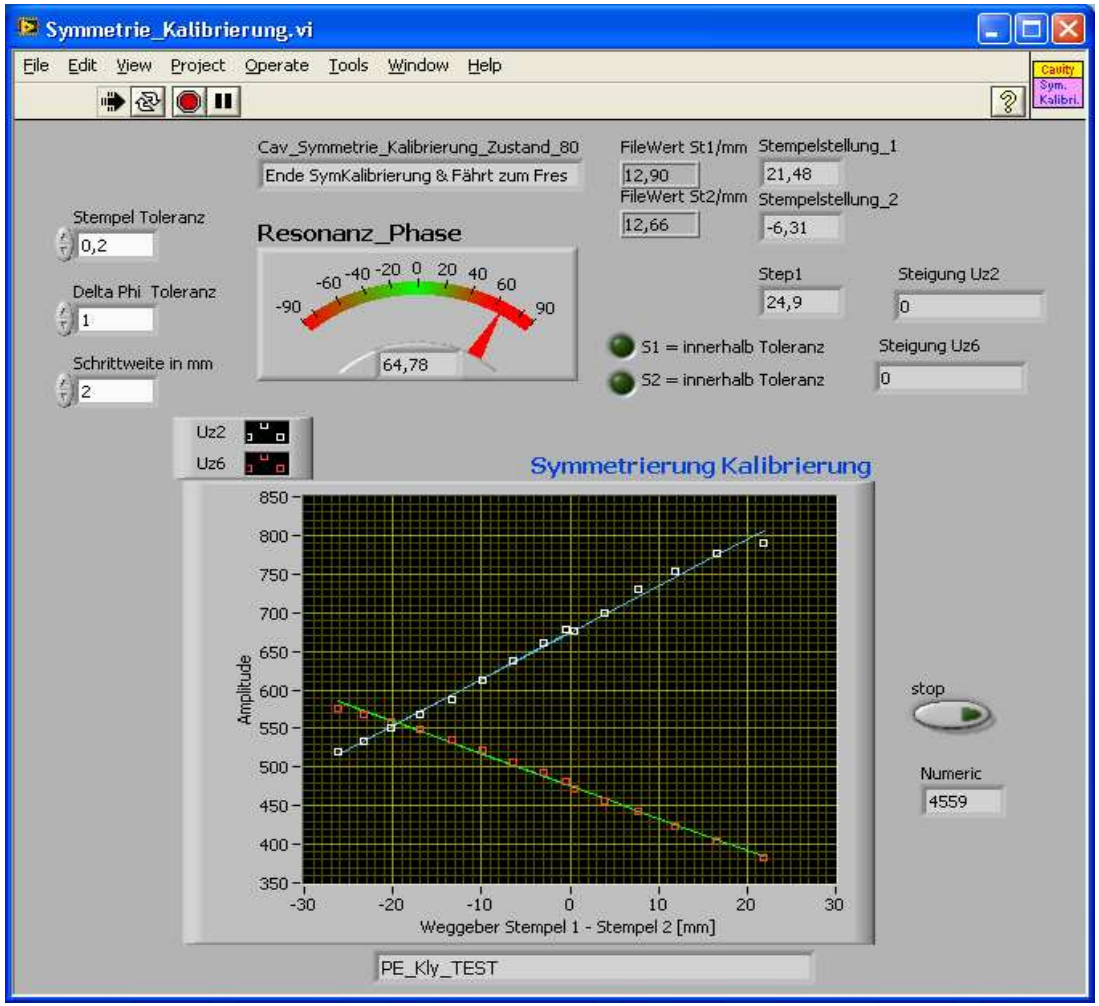
$$U_2 \frac{\Delta U_6}{\Delta s} = U_6 \frac{\Delta U_2}{\Delta s}$$

Calibration factor for pick up 2

Calibration factor for pick up 6

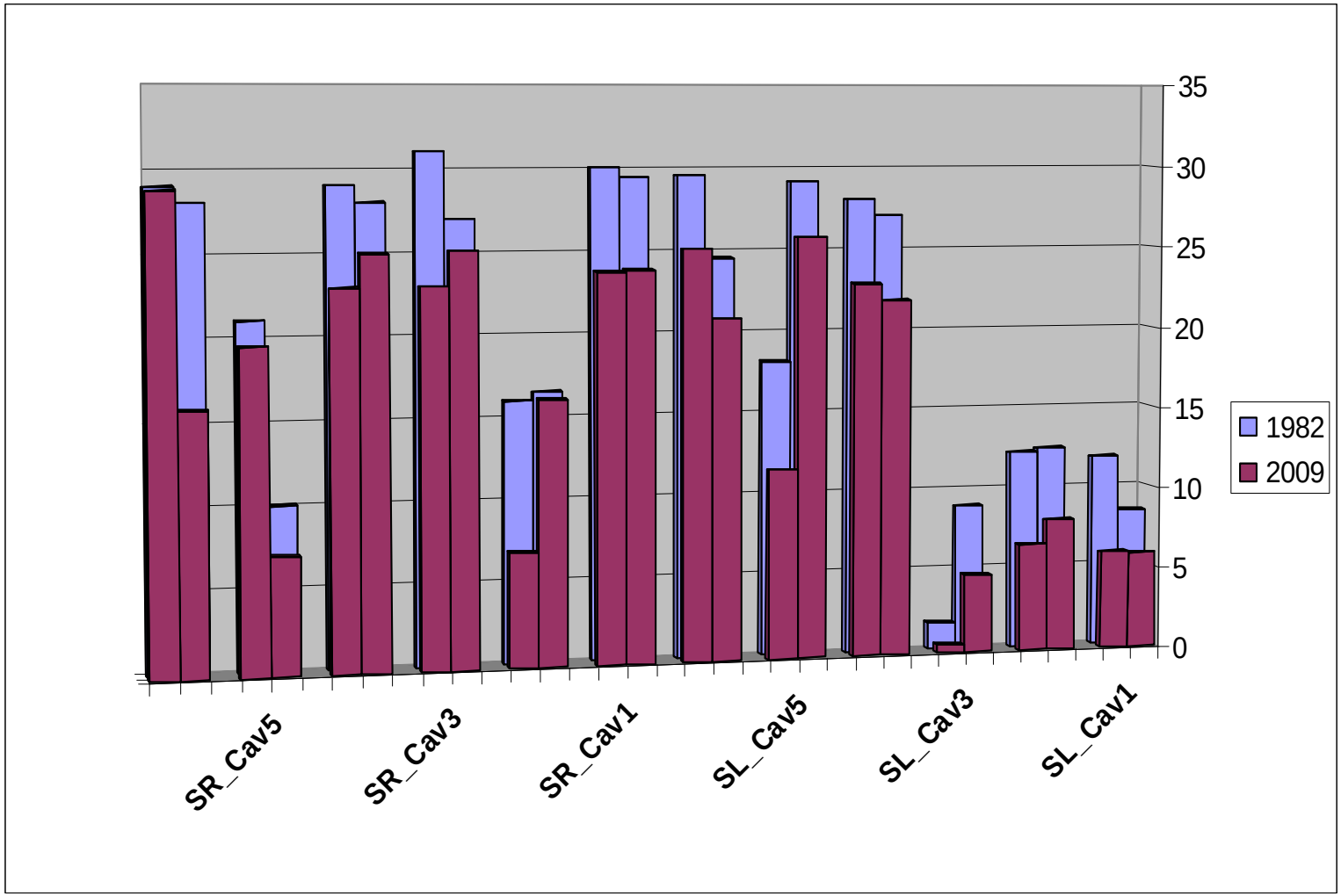
to determine the plunger positions so that the electric fields in the Cavity cells are always balanced.

Field Balancing Calibration



ELWIS field balancing calibration done at the 1 GHz test cavity.

Plunger Positions in 1982 and in 2009



Thank you for your attendance!