Running Cavities in a Vectorsum at Individual Gradients

Markus Hüning

Scenario

- The cavities of one RF station are all powered by a single klystron, i.e. the power at each cavity has the same pulse shape although the absolute levels may differ
- Let one cavity be weaker. To optimize the gradient of the whole RF station this cavity should be run at lower gradient than the others
- There is a solution…(let’s see)

General Considerations

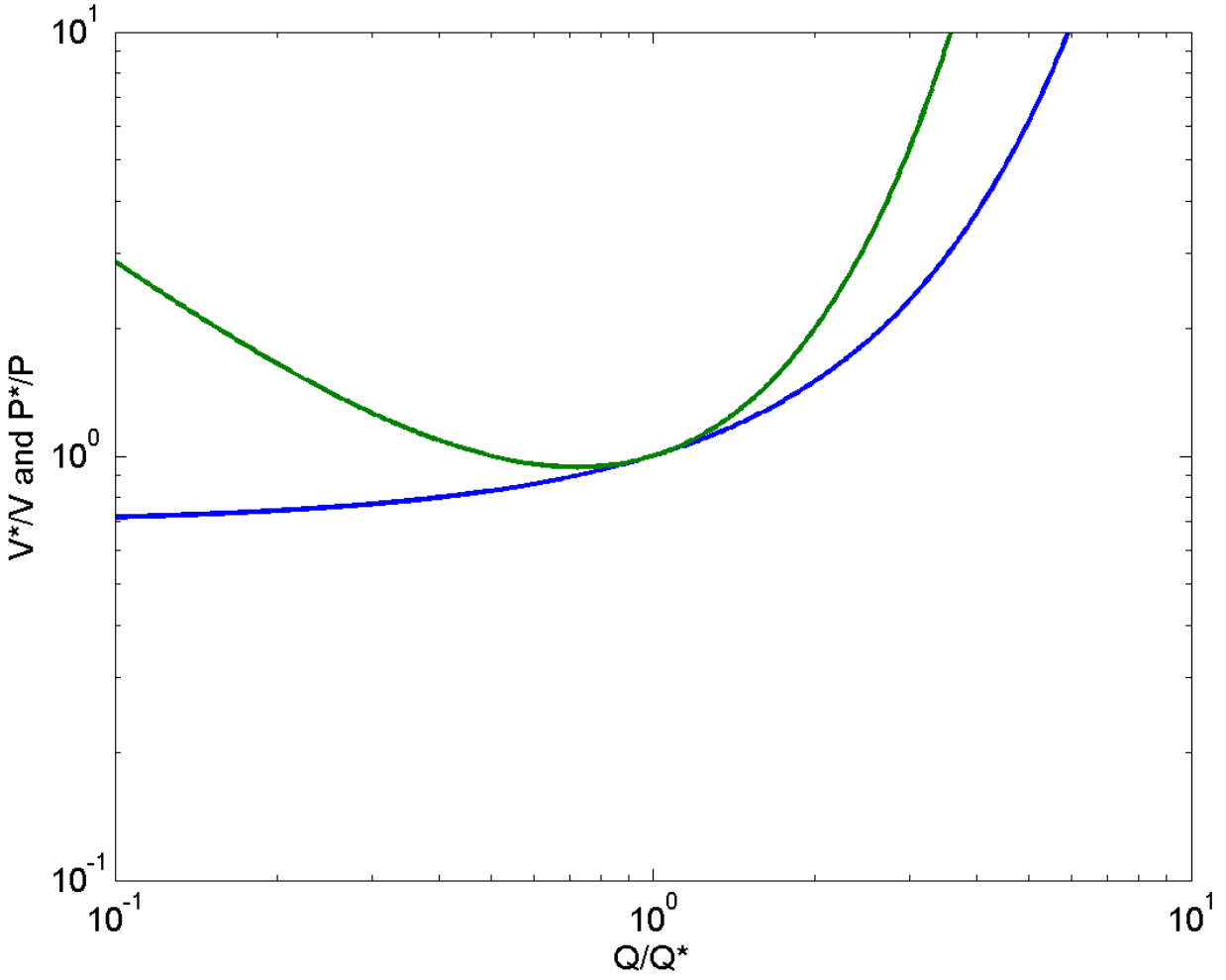
- Let V be the regular (optimized) voltage, V* the modified voltage then

$$\frac{Q_L^*}{Q_L} = \frac{\ln 2}{\ln\left(1 + \frac{V^*}{V}\frac{Q_L}{Q_L^*}\right)}$$

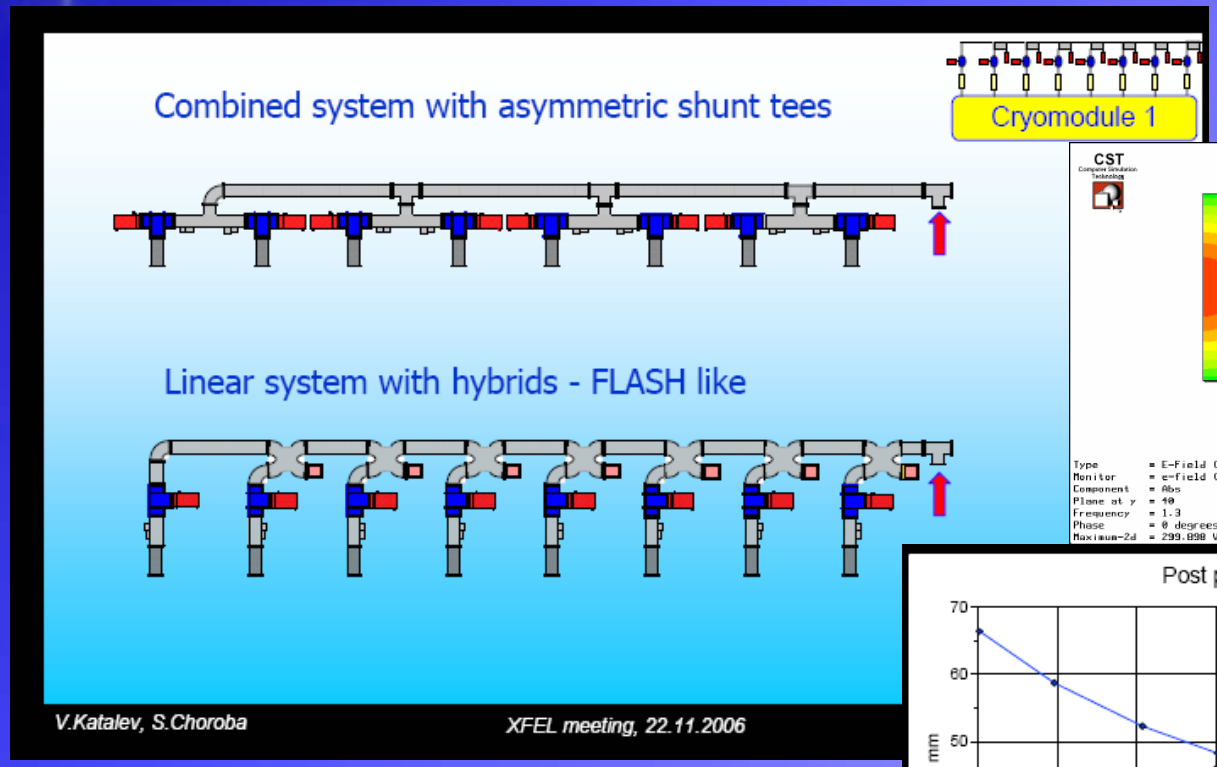
- And the power ratio

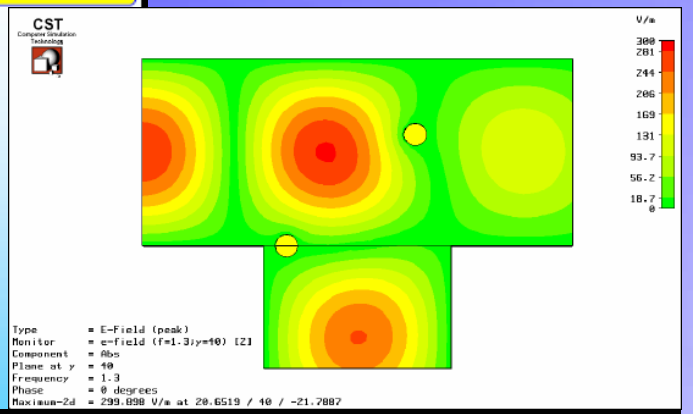
$$\frac{P^*}{P} = \frac{4^{Q_L/Q_L^*}}{4Q_L/Q_L^*}$$

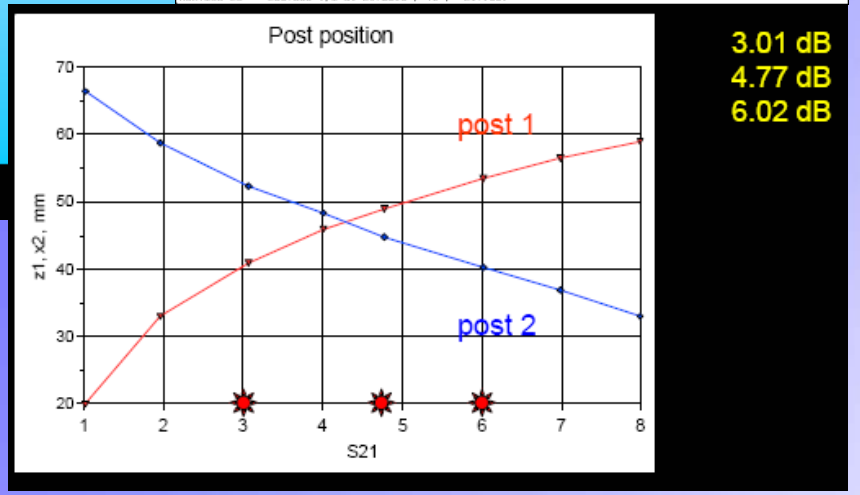
What Ratio can be achieved?



How to do this technically?



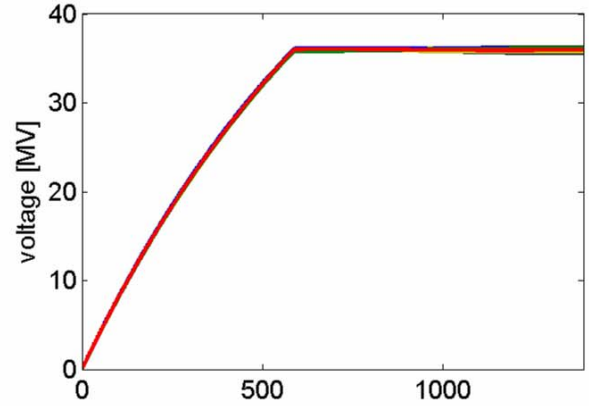


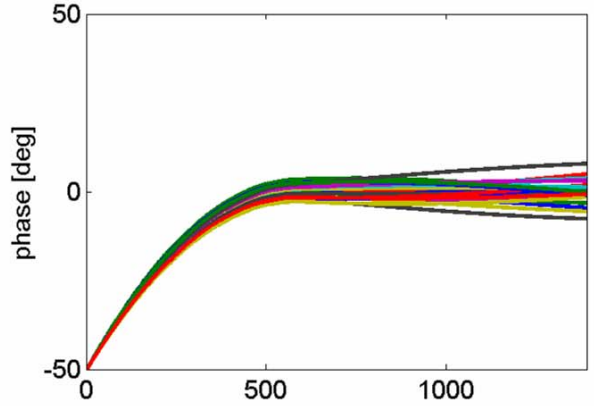


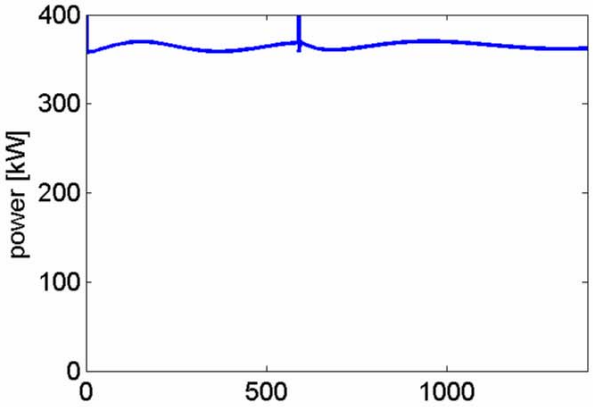
Some Example

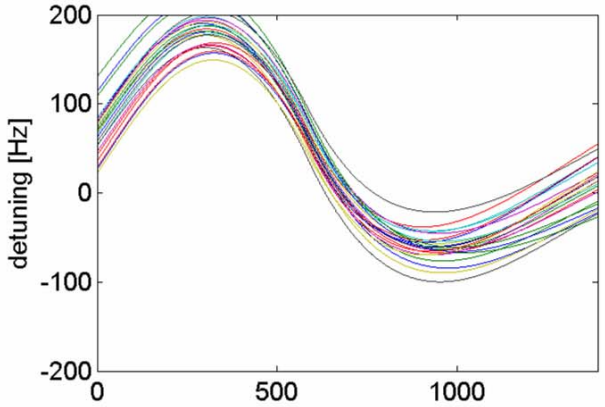
- Simulate a Vectorsum of 24 Cavities with a Gradient of 36 MV
- Include Feedback, Microphonics, Lorentz-Force Detuning, Piezotuner, Adjustment errors
- Then change one cavity to 30 MV (80%)

When all Cavities are equal

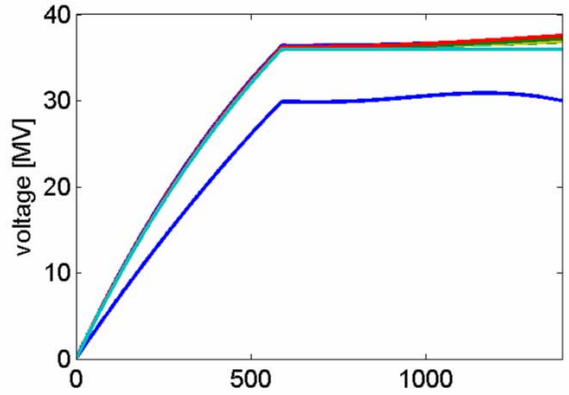


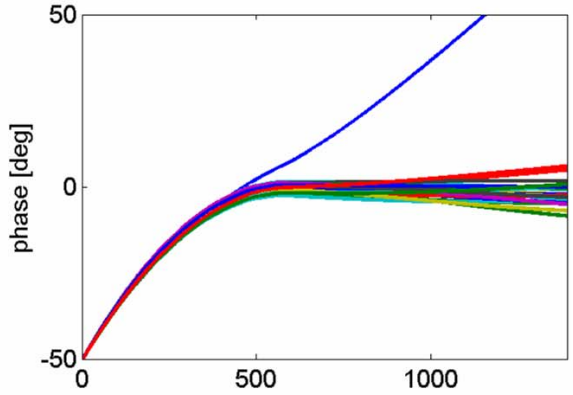


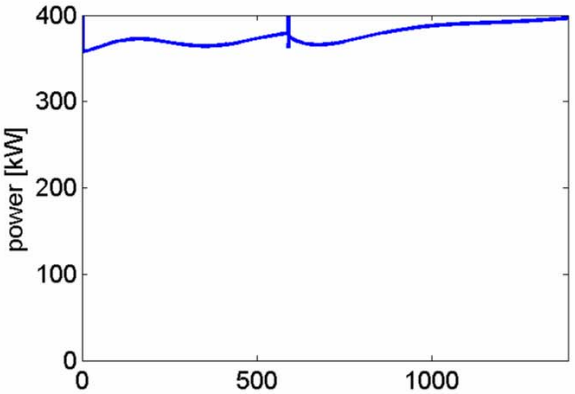


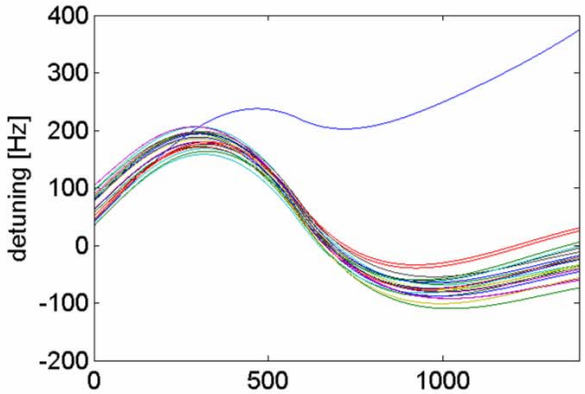


Using above Formula

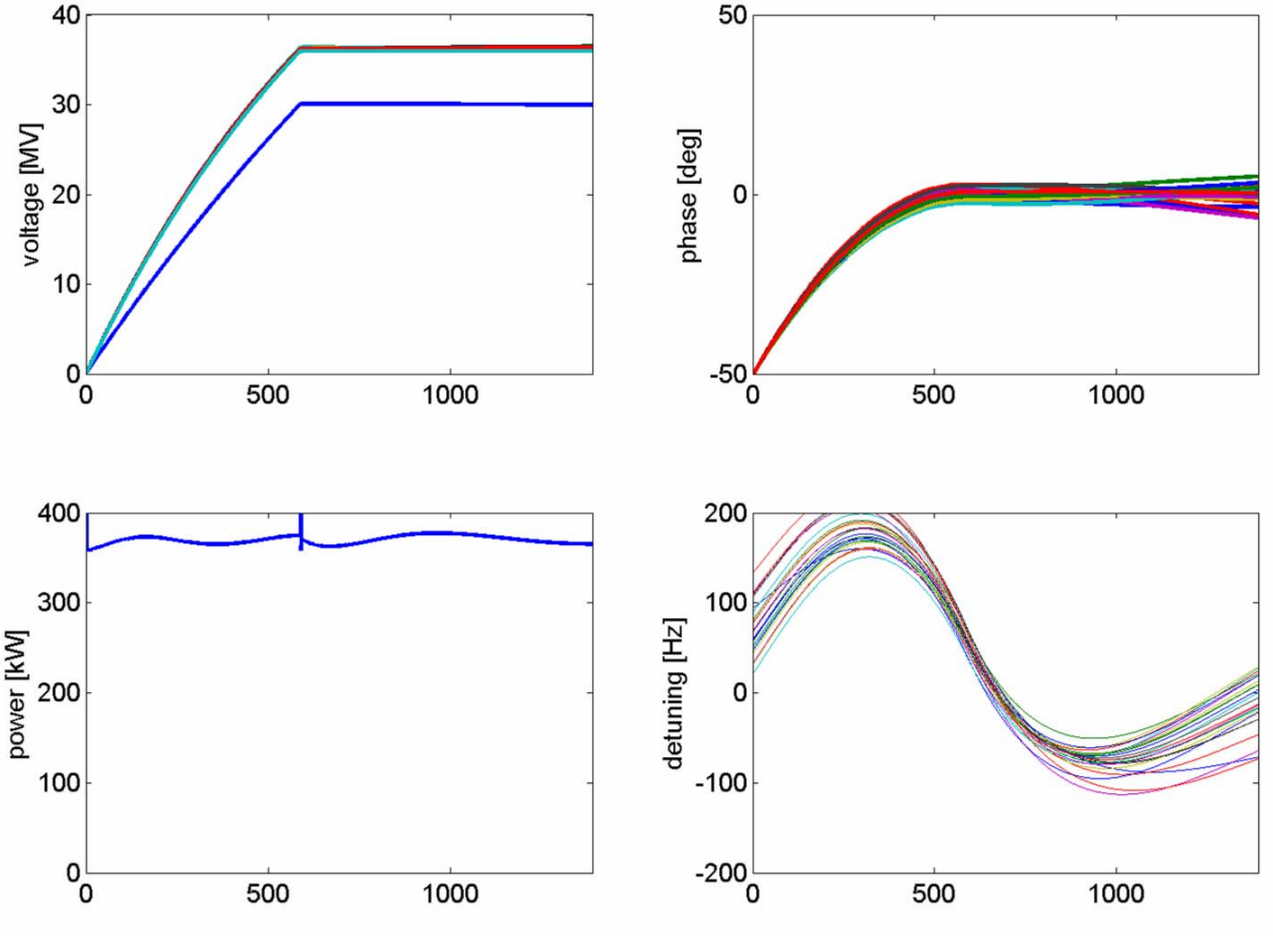








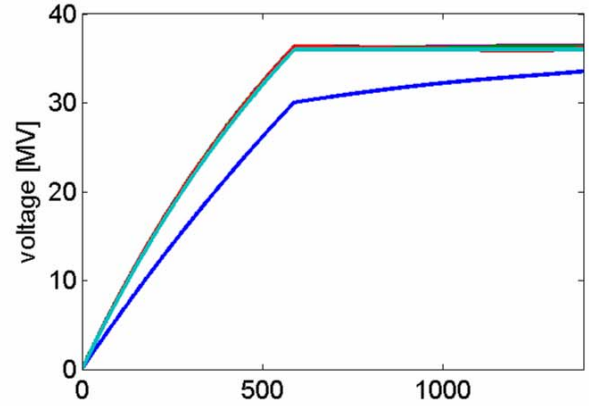
Correct the Tuning

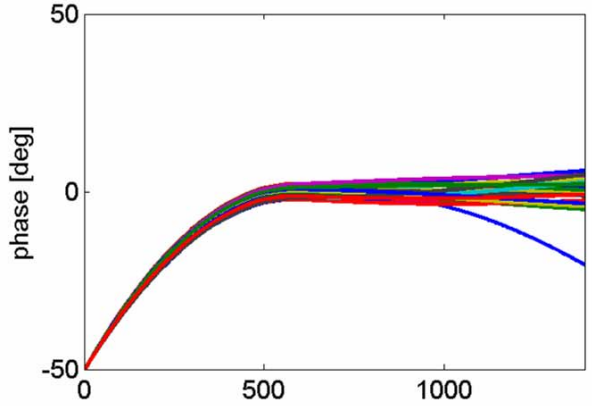


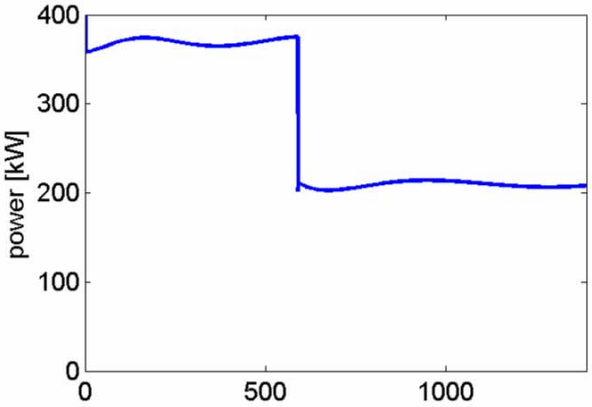
But

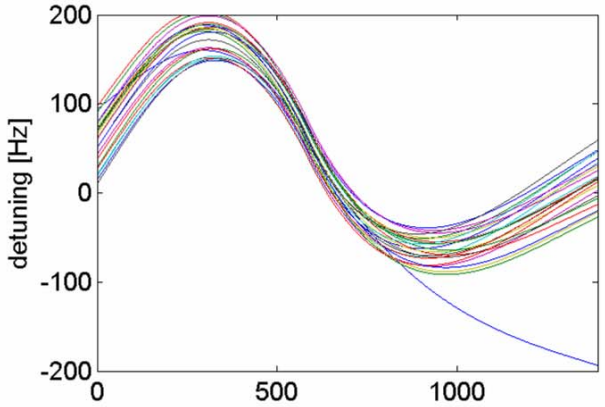
- The pictures before were made with the design current
- Without current the lower voltage rises leading to a quench, which is covered by the exception handling
- With low beam current the same happens interrupting operation!

Half the Beam Current

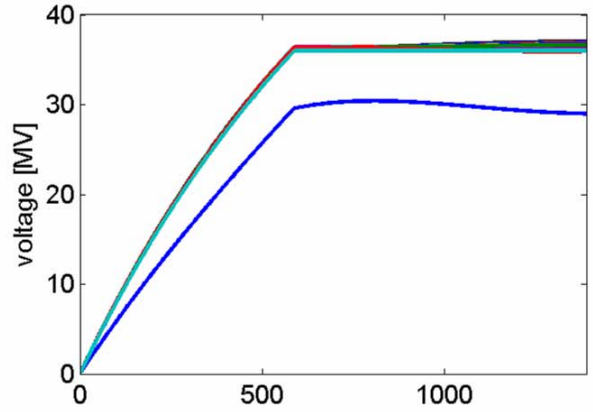


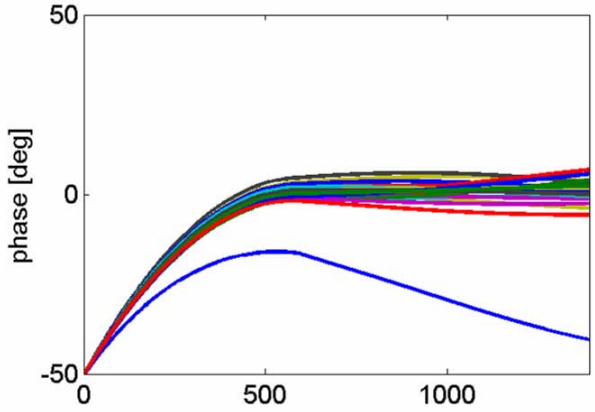


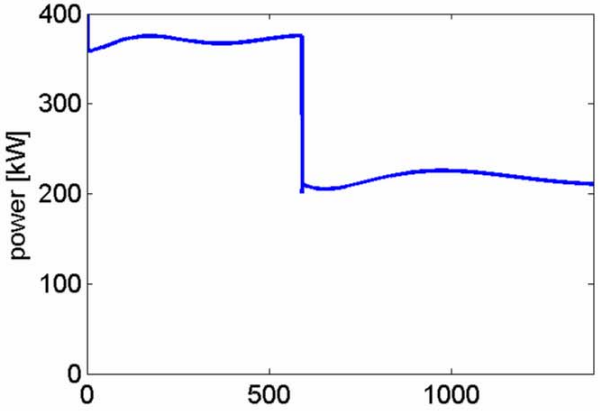


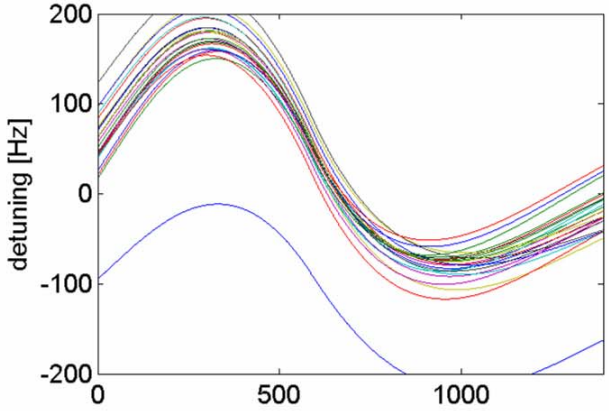


Play with the tuning and piezo









Summary

- There is a setting to allow cavities within the vectorsum to run at lower gradient
- Manual adjustment of the waveguide necessary
- Adjustment of the cavity tuning necessary each time the operation point (gradient and current) is changed
- More load on the automation system