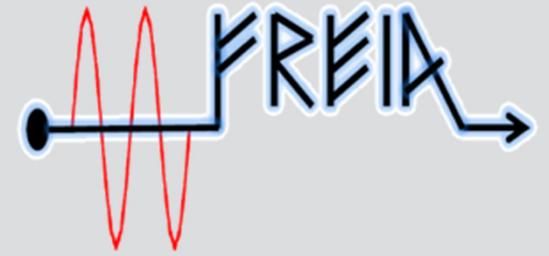




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High-precision measurements of Superconducting cavities

Anirban (Krish)na Bhattacharyya
FREIA / HIGH ENERGY PHYSICS
Uppsala University





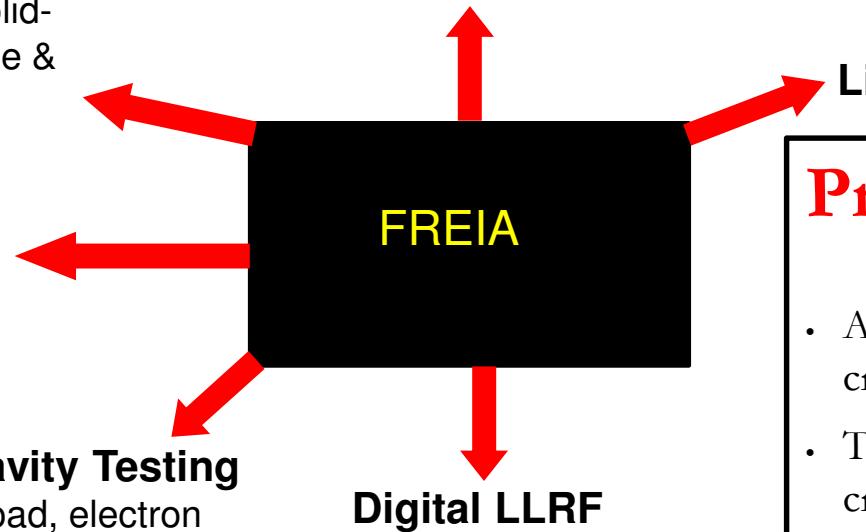
RF Source Development
(vacuum tube amplifier, solid-state amplifier, SSA module & combiner optimization)

Combined THz/X-ray source

High-power Spoke Cavity Testing
(tuning system, dynamic load, electron emission, mechanical parameters and multipacting)

UU-ESS-IPNO-CERN & Industry Collaboration

(Thales, Electrosys, DB Elettronica, Siemens, NXP, ESRF, CERN)

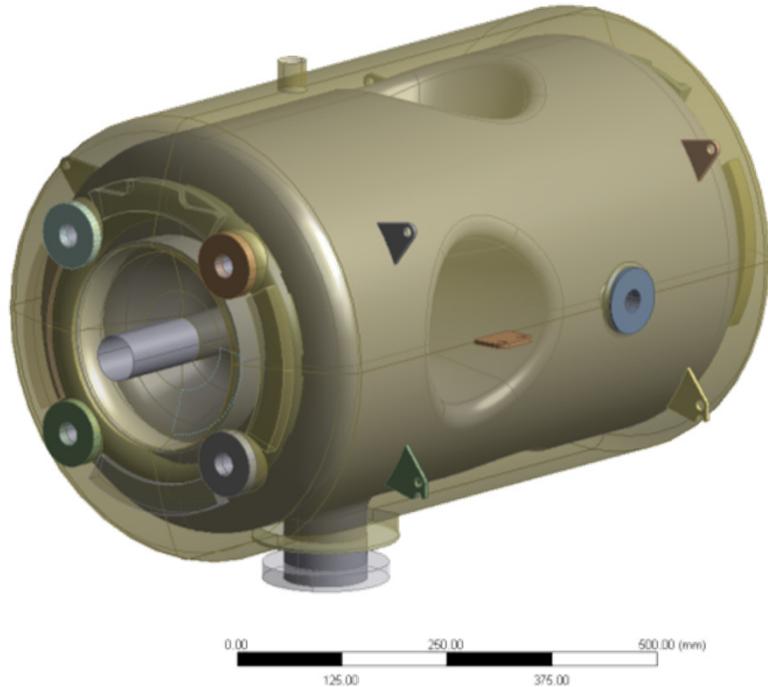


Present & Future

- Acceptance testing of spoke cryomodule ✓
- Test of prototype spoke cryomodule valve box ✓
- Test of prototype Single spoke and Double Spoke superconducting cavities ✓
- Testing of crab cavities for LHC upgrade
- ESS neutrino super beam.



Courtesy of P. Duthil

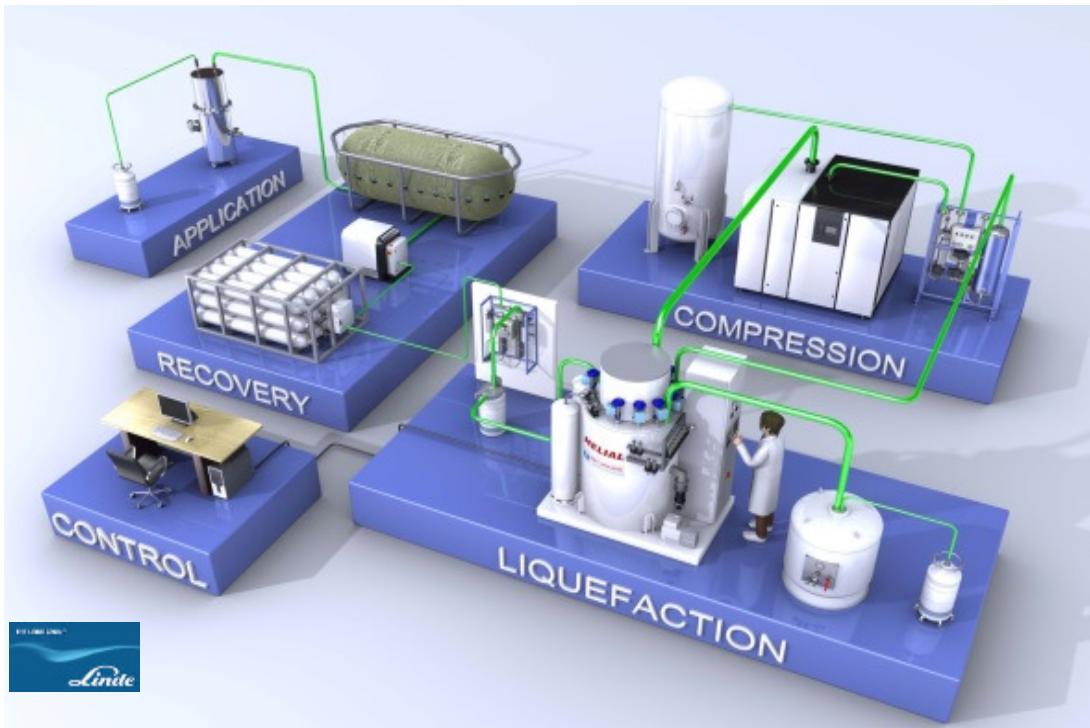


Spoke Cavity
(super - conducting)



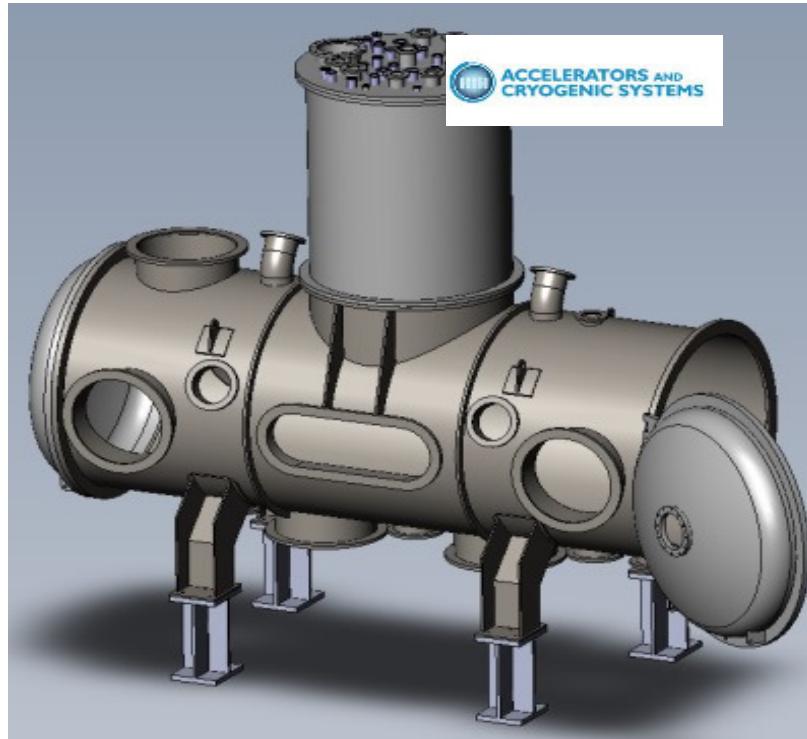
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Horizontal Cryostat

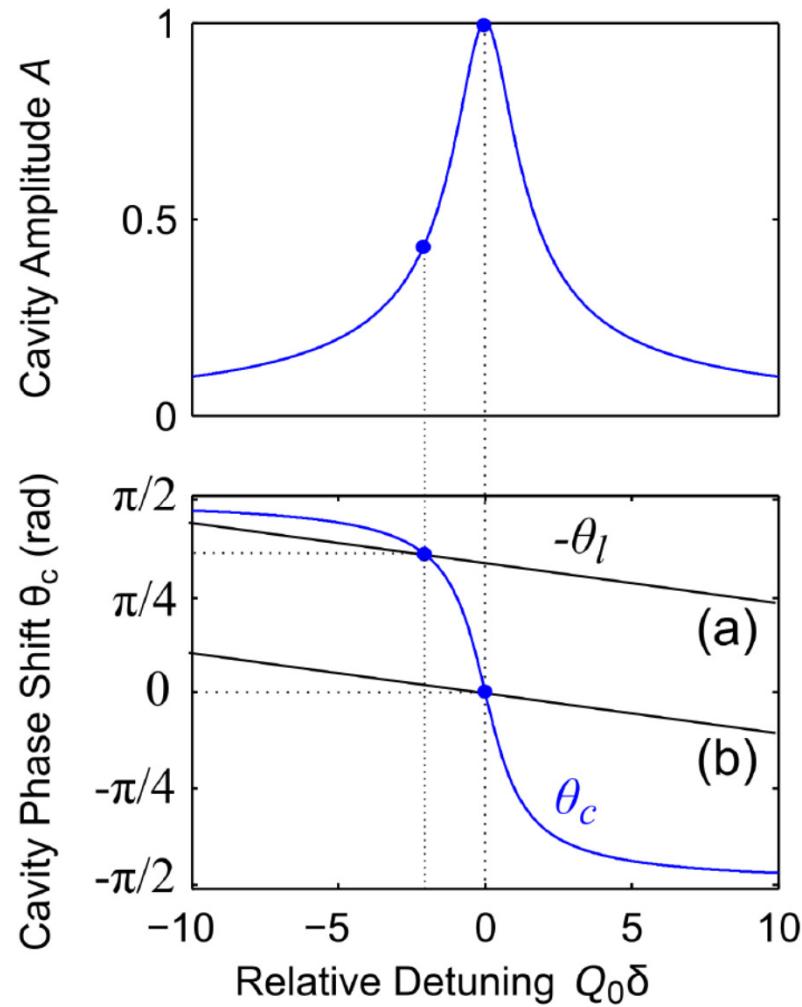


Spoke Cavity
(super - conducting)

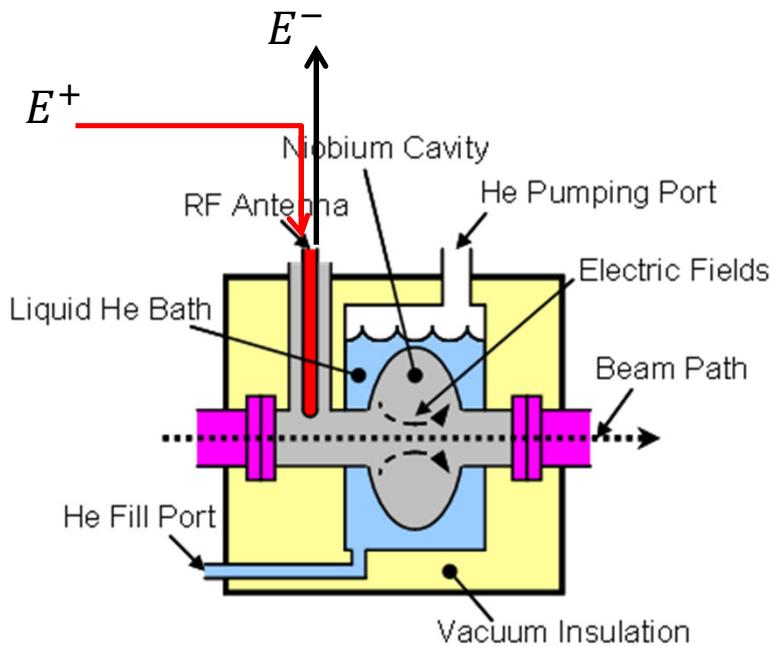
Cavity resonator



$$\ddot{V} + \frac{\omega_c}{Q_L} \dot{V} + \omega_c^2 V = 2\omega_c(R/Q)I_i \quad Q_L = (Q_0^{-1} + Q_{ext}^{-1})^{-1}$$



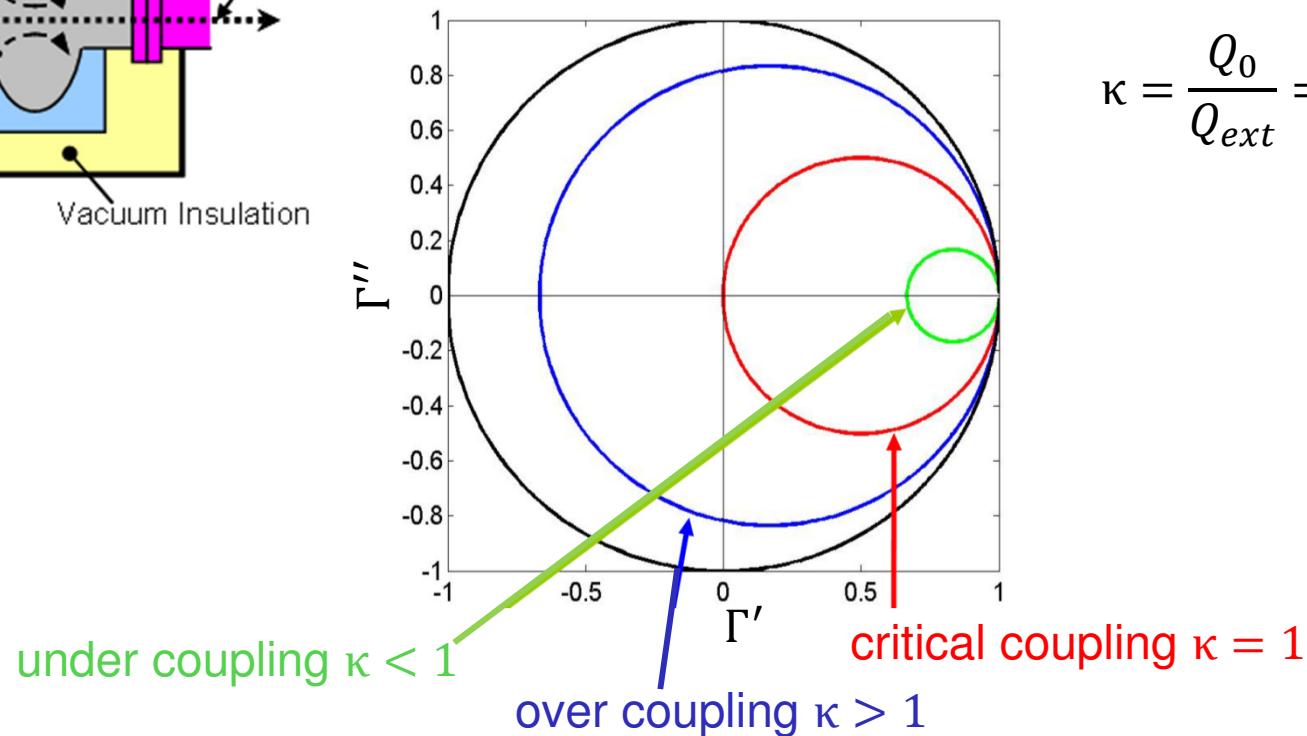
Reflection coefficient



$$\Gamma = \frac{E^-}{E^+} = \frac{\kappa - 1 + iQ_0\delta}{\kappa + 1 - iQ_0\delta}$$

$$\delta = \frac{Q_{ext} + Q_0}{Q_{ext}Q_0} \tan \theta_c$$

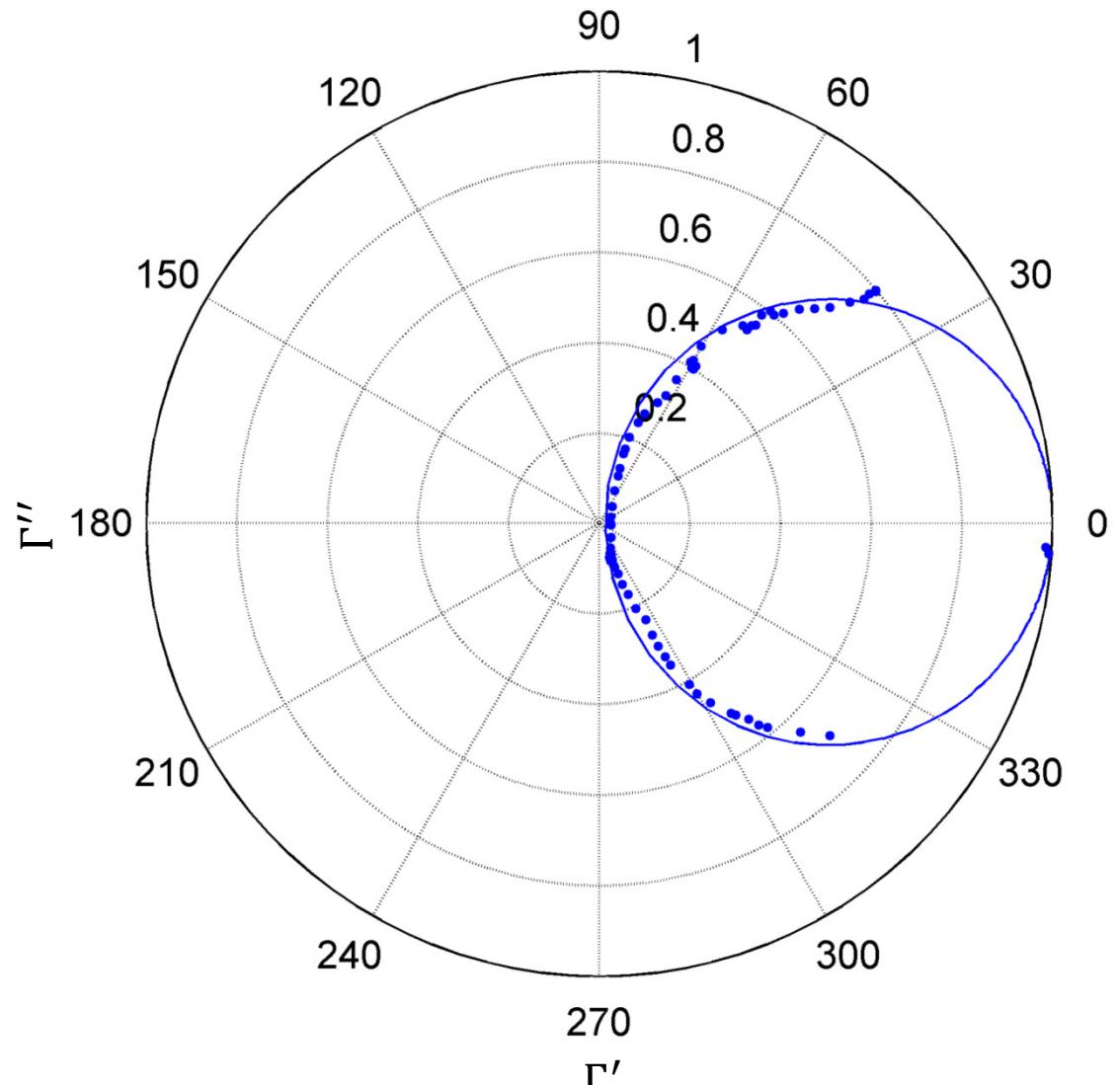
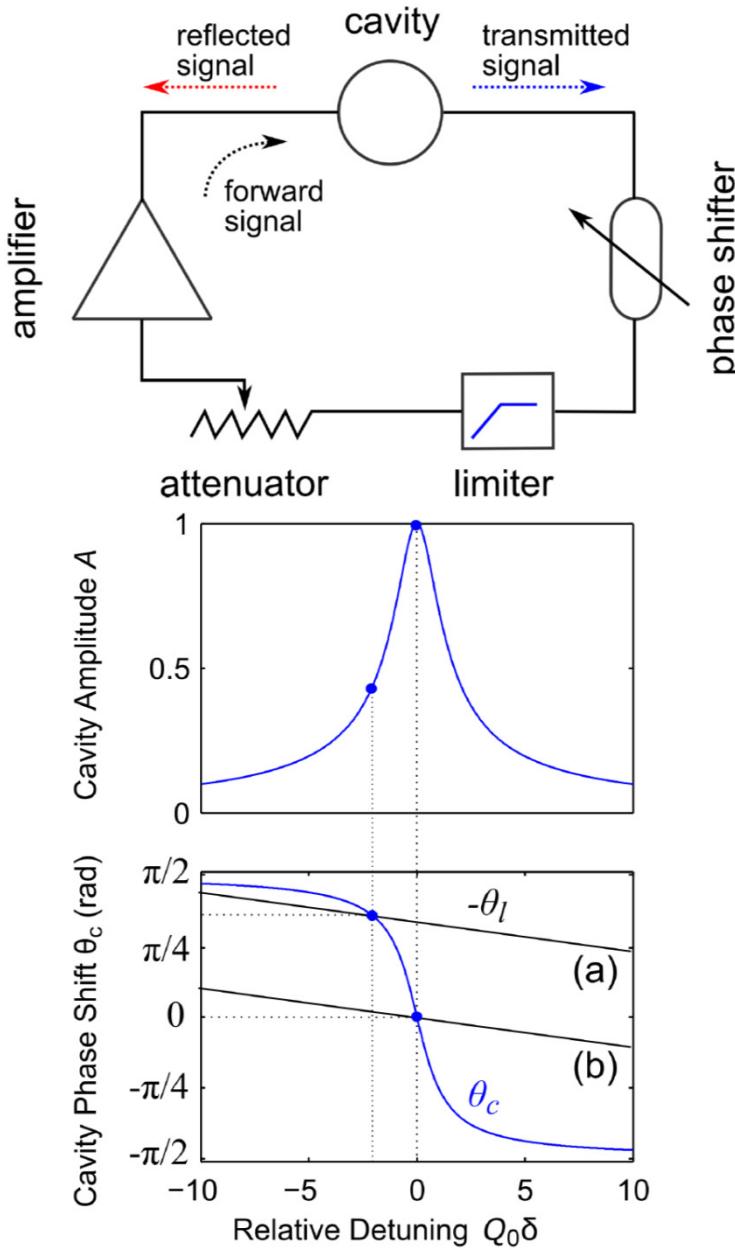
$$\left(\Gamma' + \frac{1}{1+\kappa} \right)^2 + \Gamma''^2 = \left(\frac{\kappa}{1+\kappa} \right)^2$$



$$\kappa = \frac{Q_0}{Q_{ext}} = \frac{1}{\frac{1}{r} - 1}$$



Normal conducting cavity

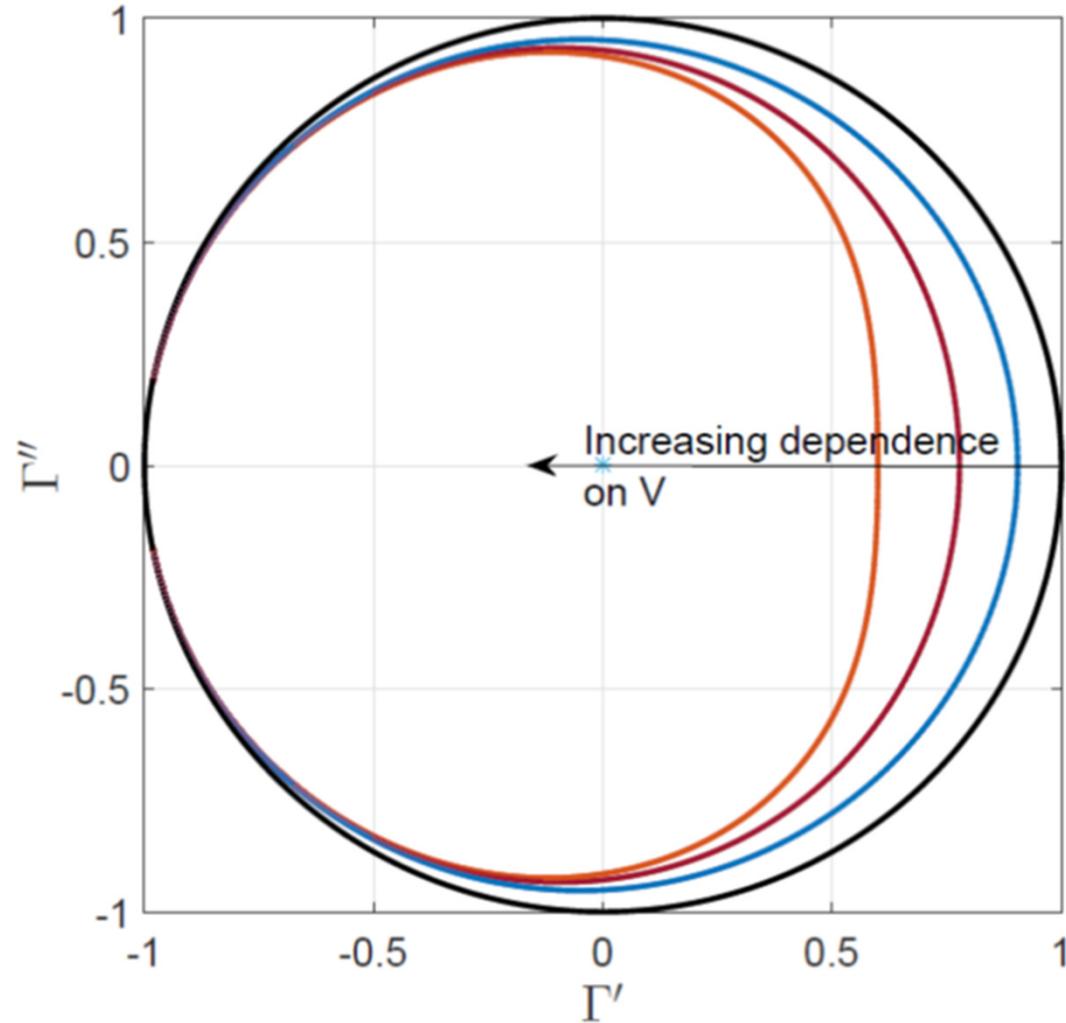


Superconducting cavity

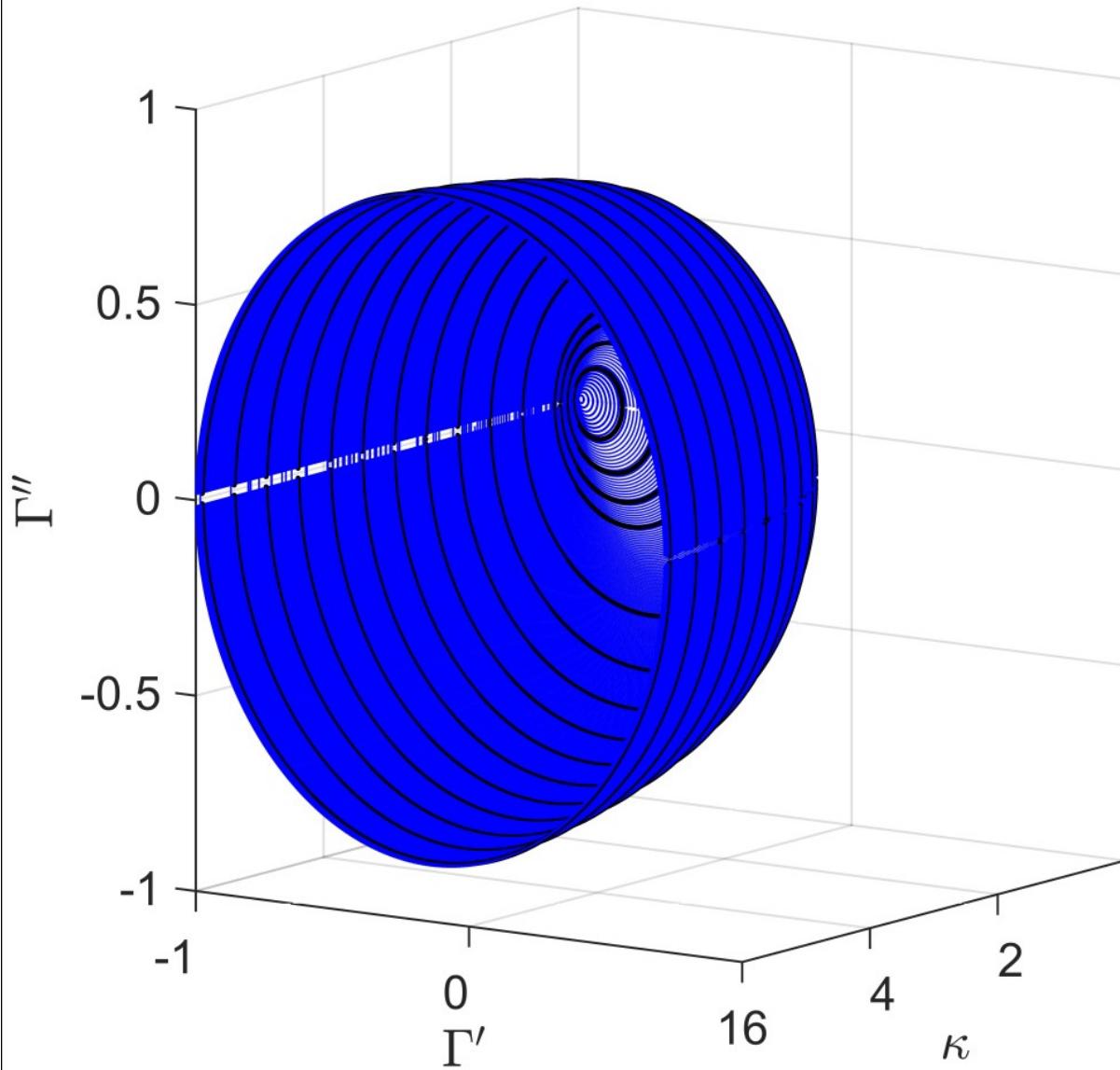


$$\left(\Gamma' + \frac{1}{1+\kappa}\right)^2 + \Gamma''^2 = \left(\frac{\kappa}{1+\kappa}\right)^2$$

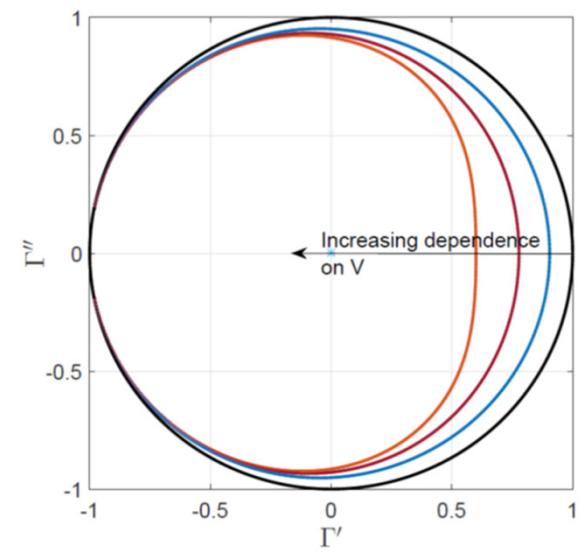
$$\kappa = \frac{Q_0(V)}{Q_{ext}}$$



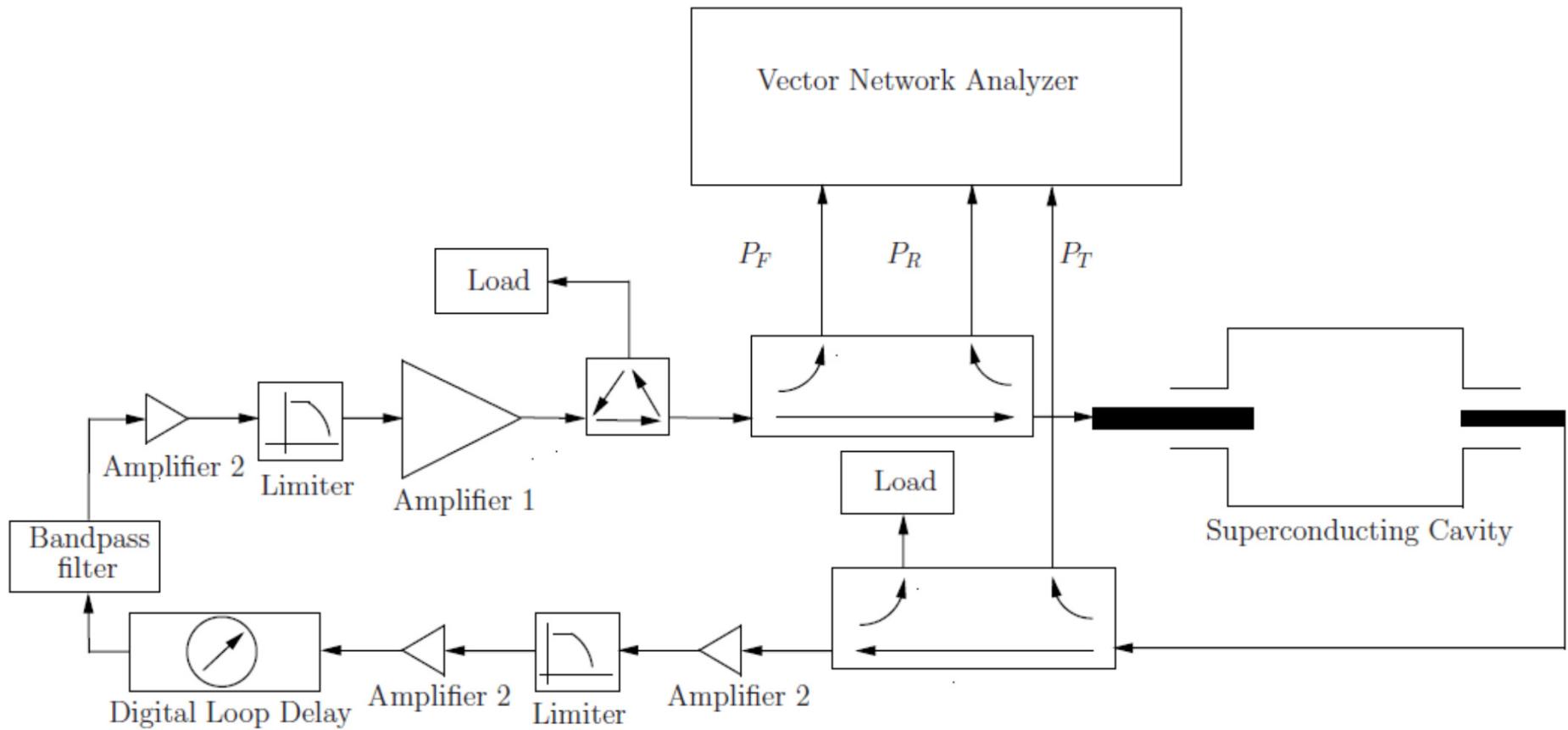
Reflection co-efficient, Q-circle and surface



$$\left(\Gamma' + \frac{1}{1+\kappa} \right)^2 + \Gamma''^2 = \left(\frac{\kappa}{1+\kappa} \right)^2$$



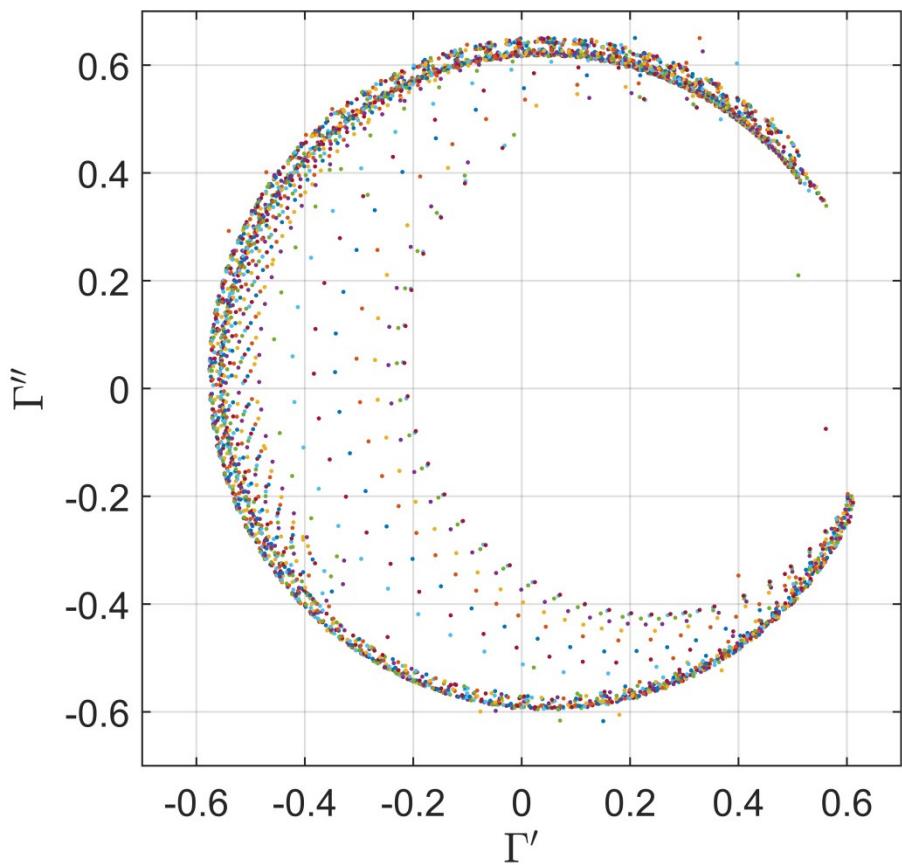
Experimental setup



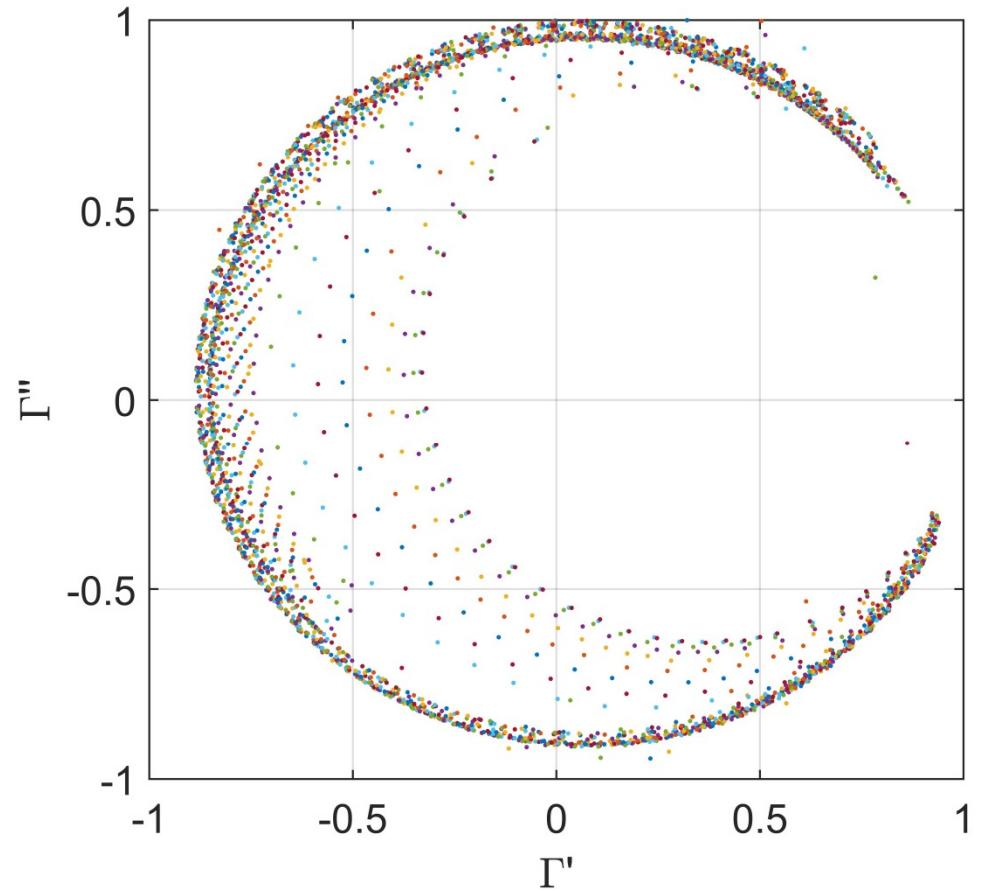
Reflection coefficient



Before cable compensation



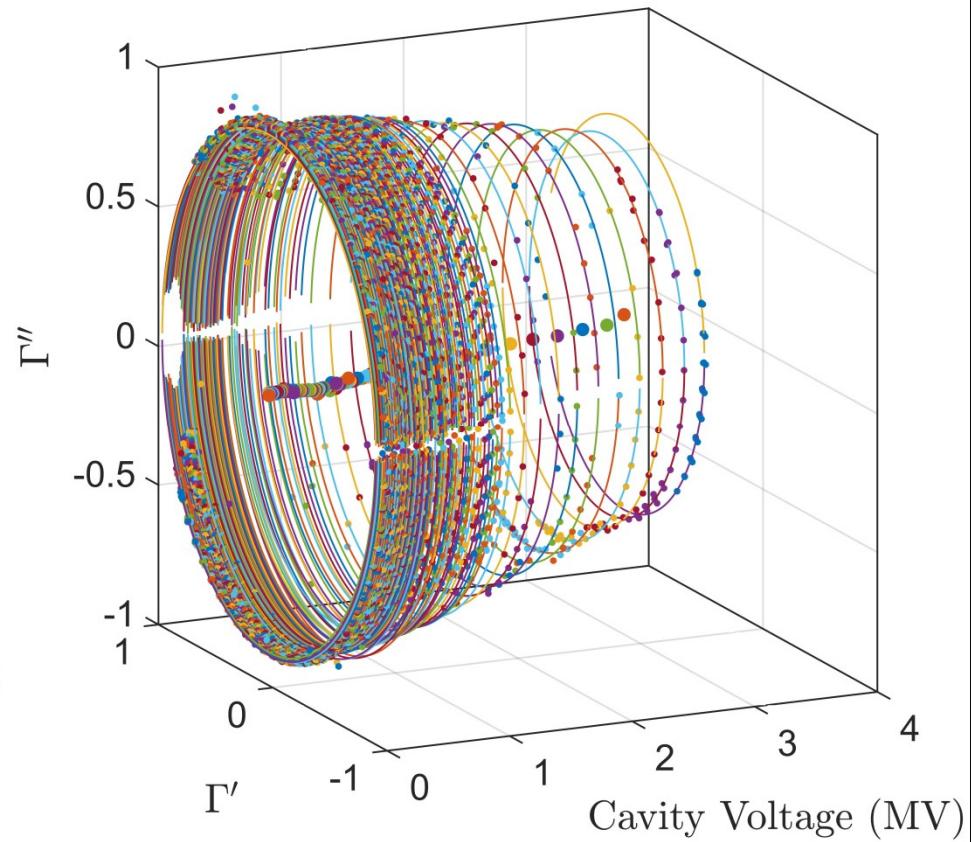
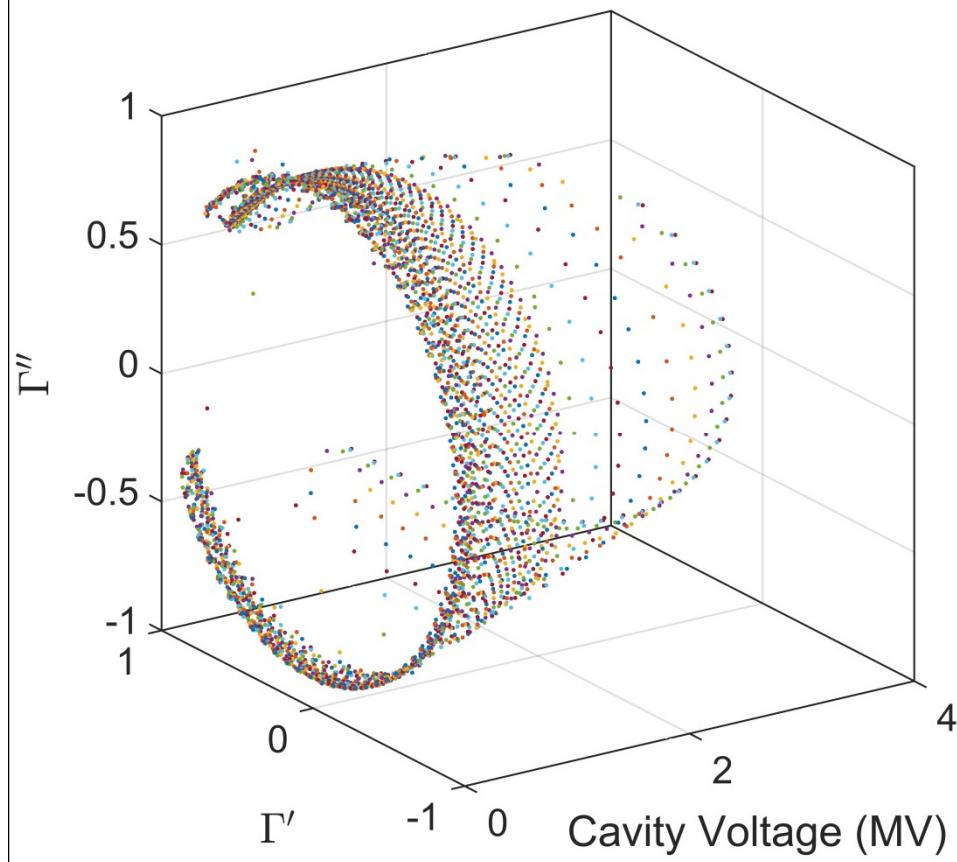
After cable compensation





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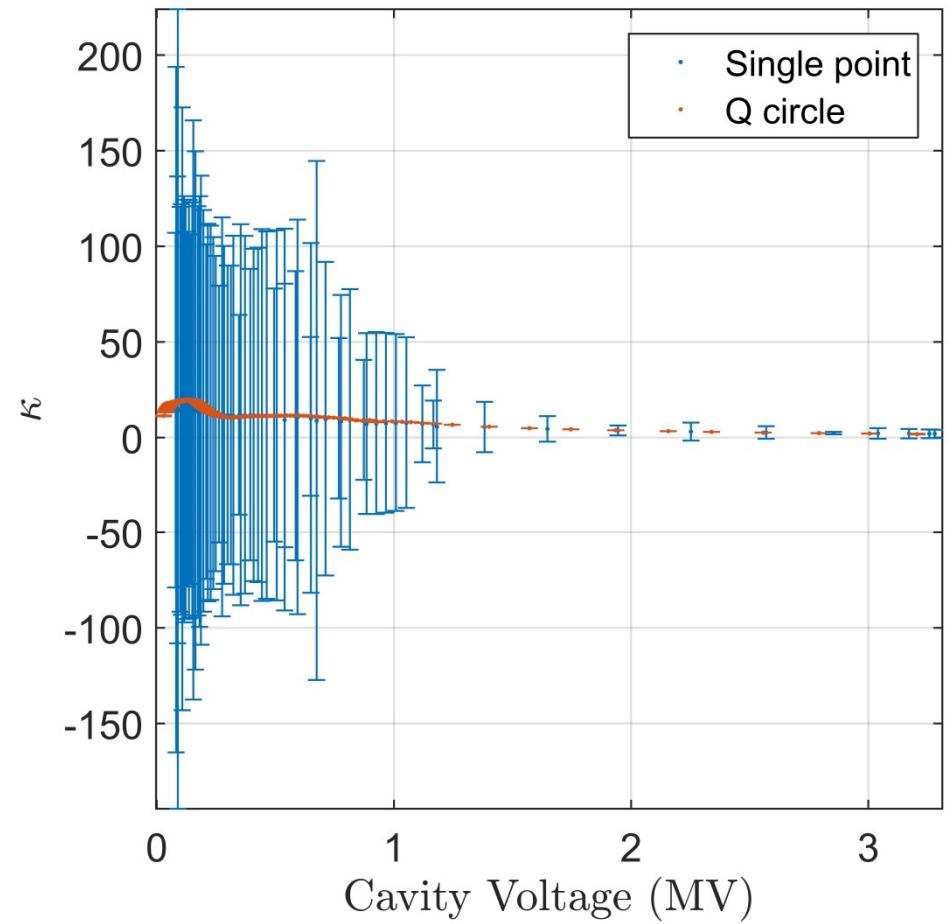
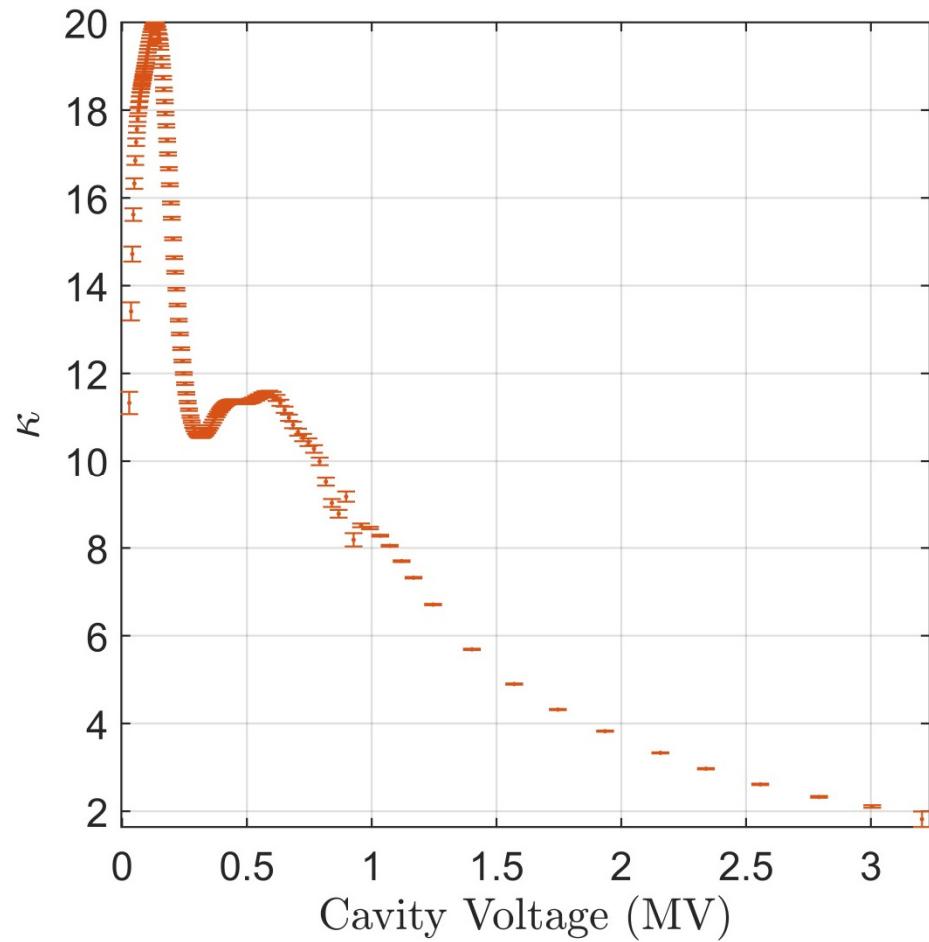
Q-surface



Q-slope



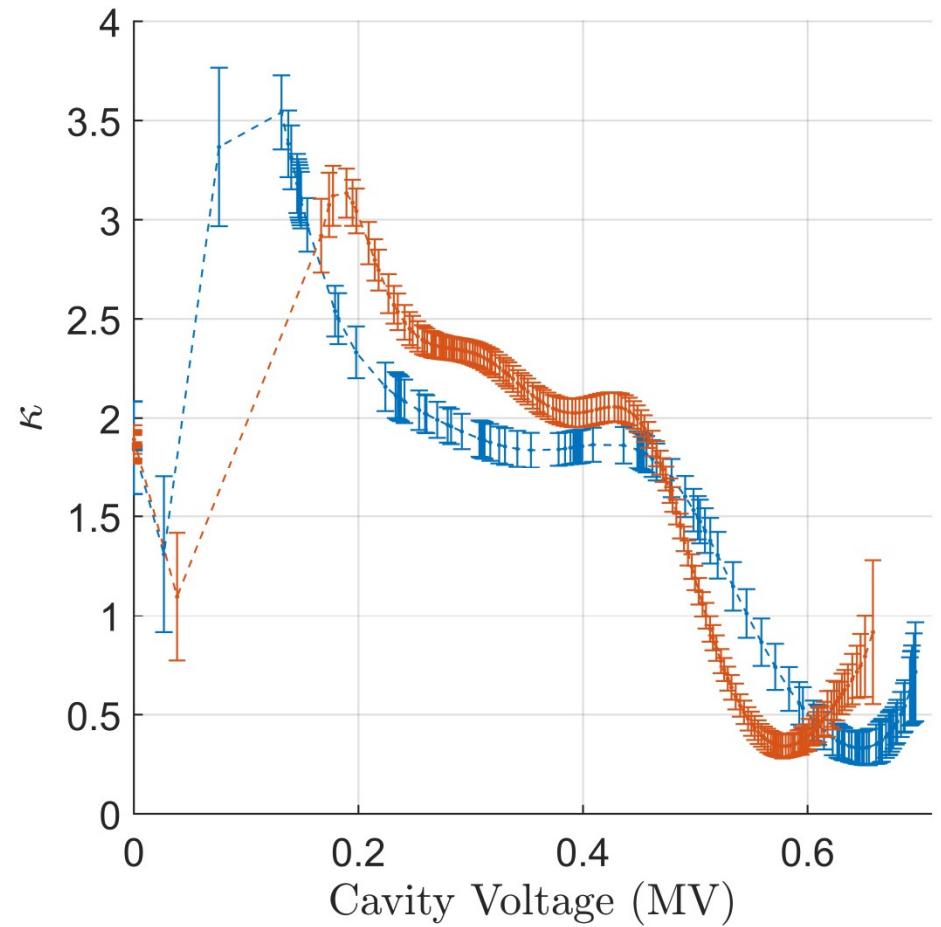
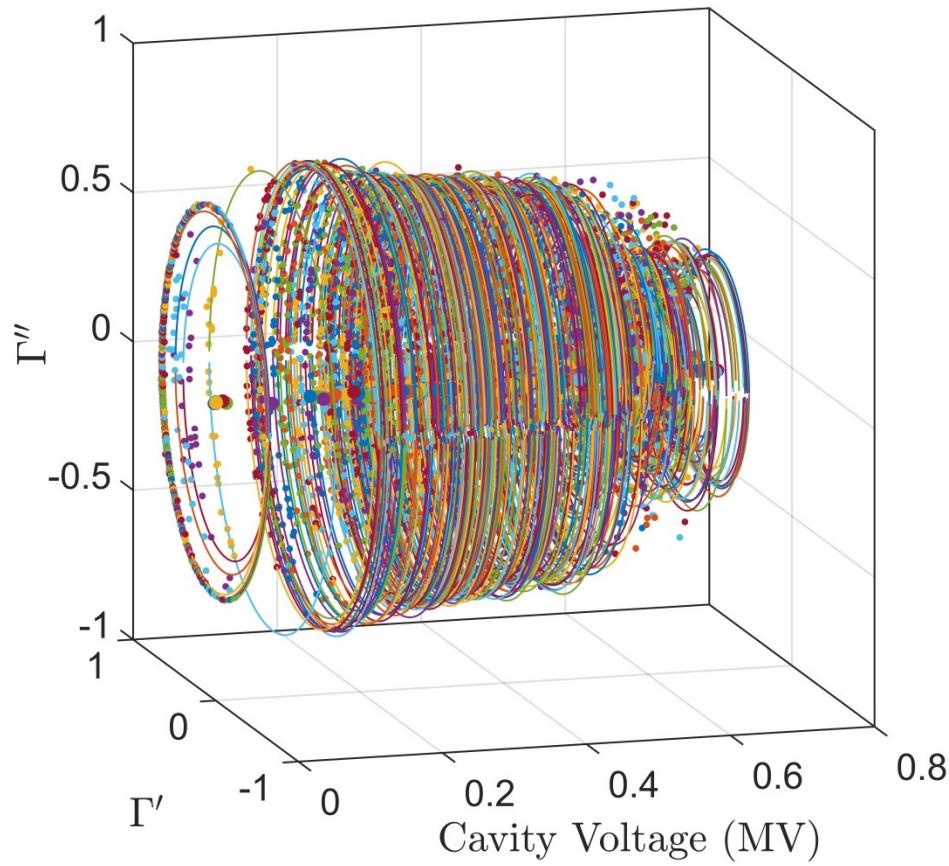
Double-spoke cavity



Q-slope



Single-spoke cavity



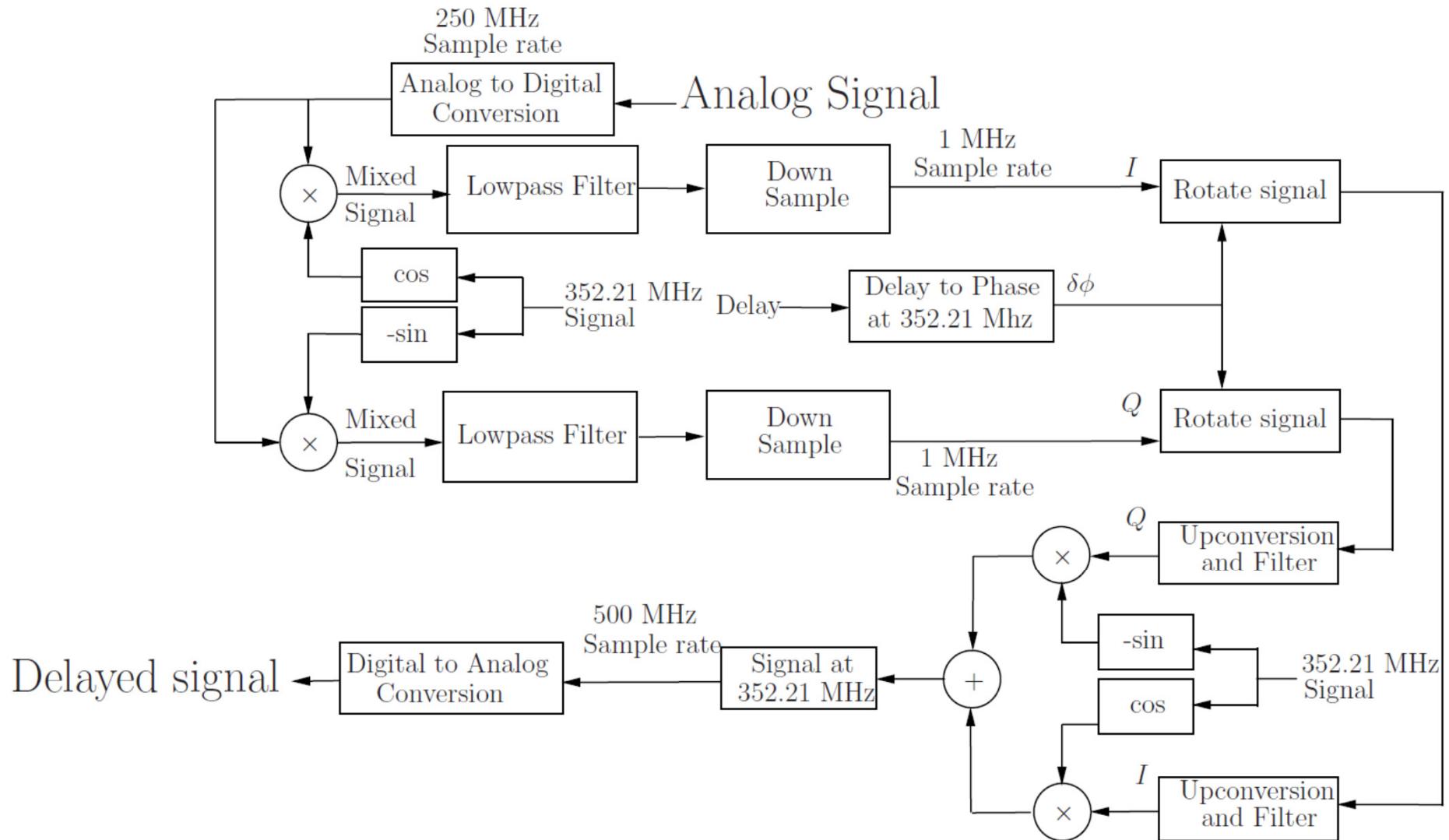


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THANK YOU

Digital loop delay



Cavity conditioning

