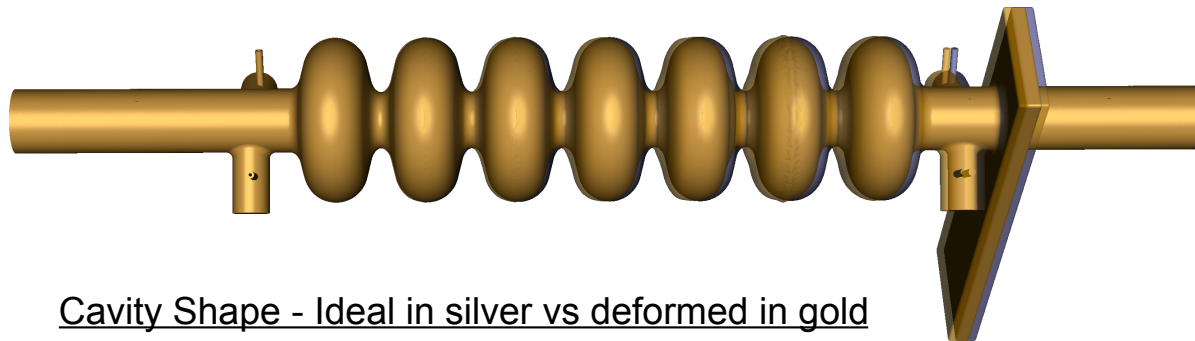
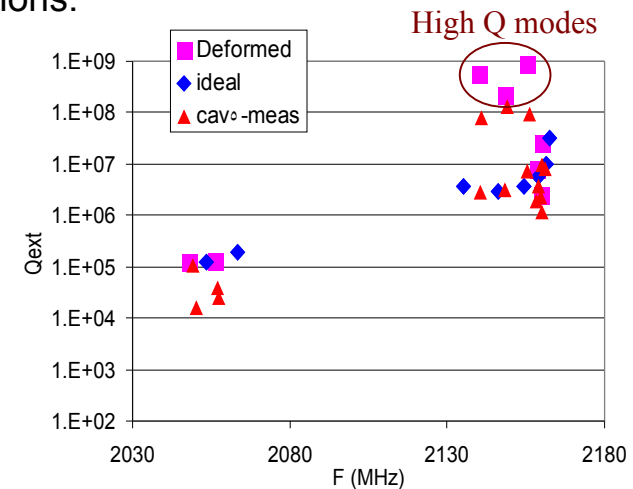


# Solving CEBAF BBU Using Shape Uncertainty Quantification Method

## SciDAC Success as a Collaboration between Accelerator Simulation, Computational Science and

**Experiment** – Beam Breakup (BBU) instabilities at well below the designed beam current were observed in the CEBAF12 GeV upgrade of the Jefferson Lab (TJNAF) in which Higher Order Modes (HOM) with exceptionally *high* quality factor (Q) were measured. Using the shape uncertainty quantification tool developed under SciDAC, the problem was found to be a deformation of the cavity shape due to fabrication errors. This discovery was achieved as a team effort between SLAC, TOPS, and JLab which underscores the importance of the SciDAC multidisciplinary approach in tackling challenging applications.

**Method of Solution** - Using the measured cavity parameters as inputs, the deformed cavity shape was recovered by solving the *inverse* problem through an optimization method. The calculations showed that the cavity was 8 mm shorter than designed, which was subsequently confirmed by measurements. The result explains why the troublesome modes have high Qs because in the deformed cavity, the fields shift away from the HOM coupler where they can be damped. This shows that quality control in cavity fabrication can play an important role in accelerator performance. .



Cavity Shape - Ideal in silver vs deformed in gold

