Recent Dielectric Loaded Gas-filled RF Experiment

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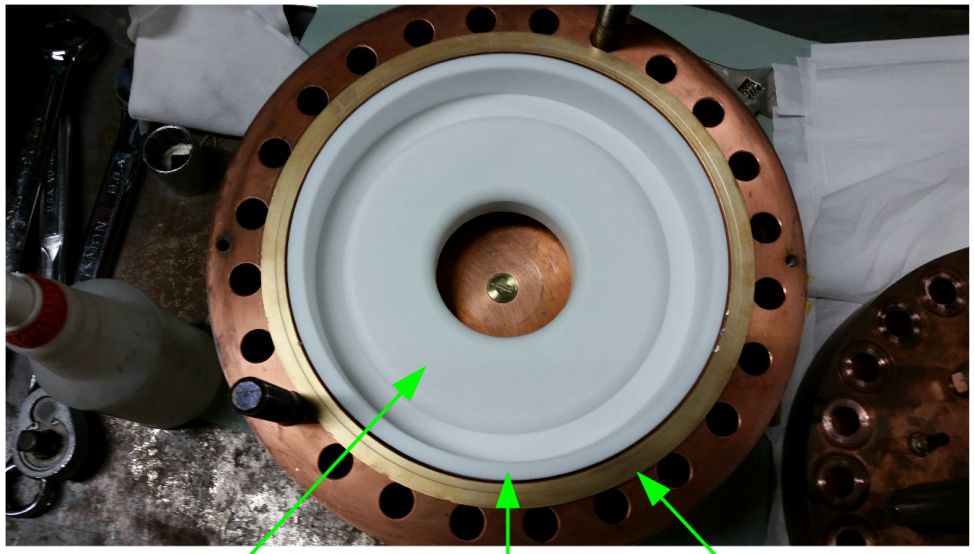
Goal of current experiment

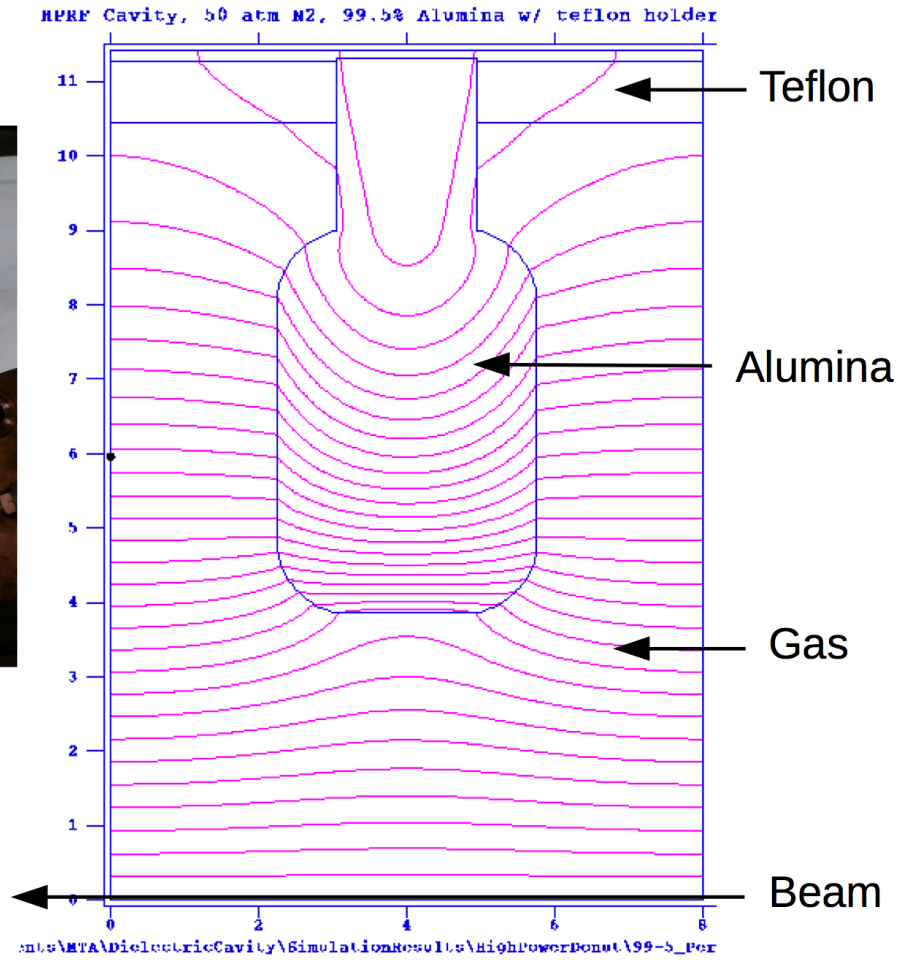
- Study AC characteristic of Alumina in high RF power with various purities
  - To design realistic RF cavities for a cooling channel
  - Dry run for MTA beam test
    - Use Nitrogen gas instead of using Hydrogen

High Powered Test Cavity

B. Freemire, MAP Collaboration Meeting 2015

- "Donut" shaped alumina inserts held in place by teflon spacers

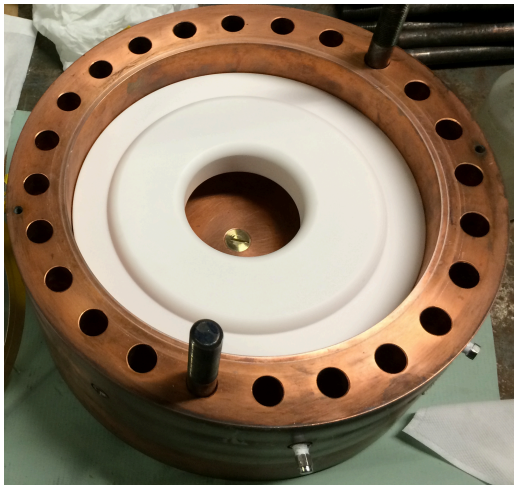




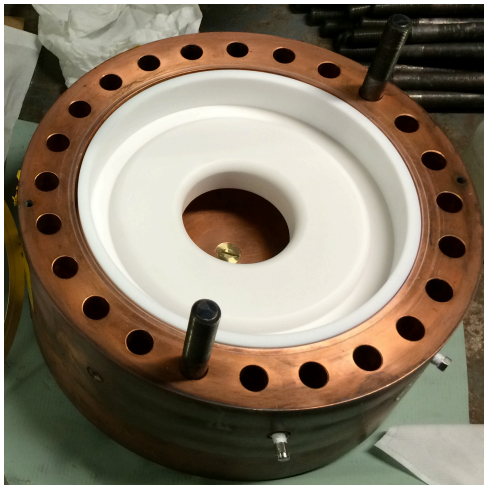
Maximum field enhancement on Alumina is 1.7 by comparing the RF gradient on axis

Assemble Alumina Donut

Bottom teflon spacer



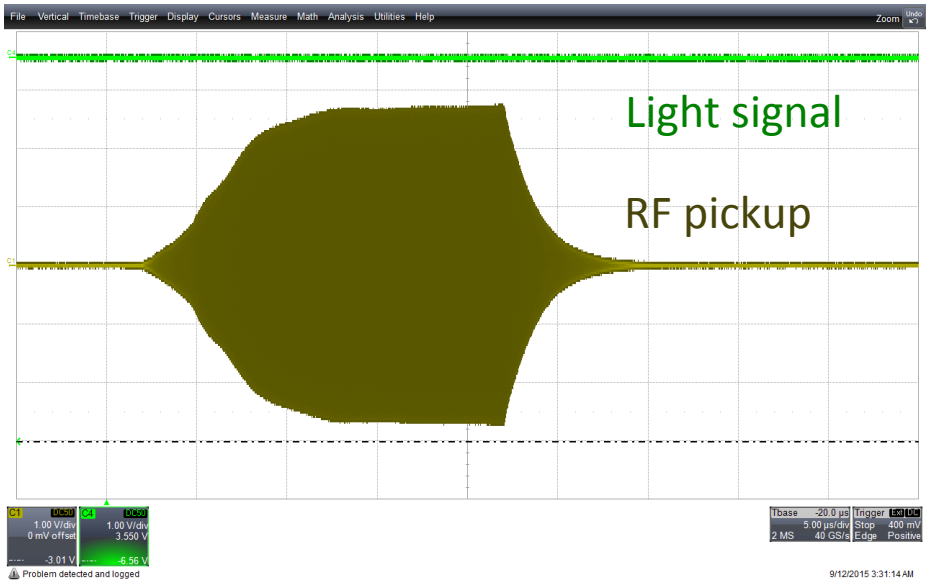
Ceramic donut



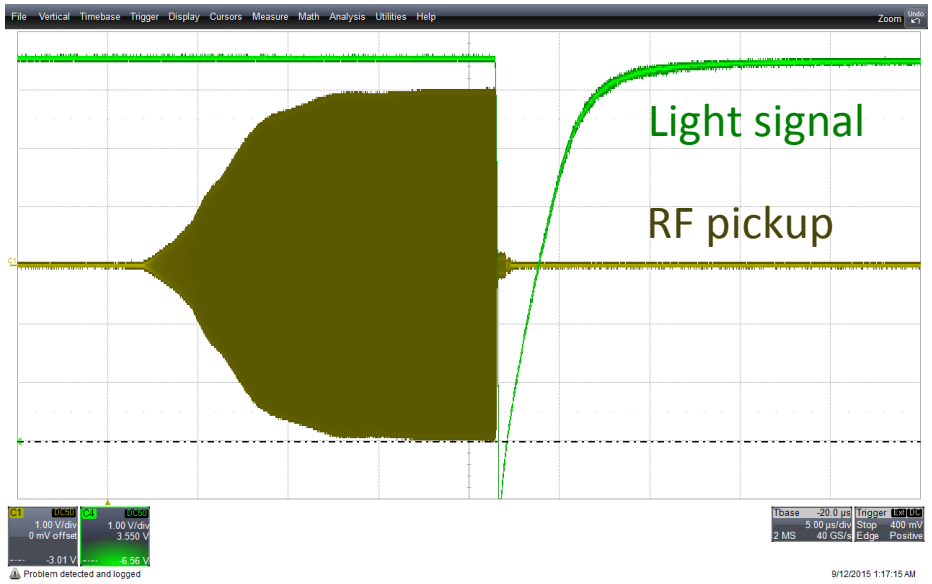
Top teflon spacer

- Dielectric constant of a ceramic donut is dependent on its purity
  - ε = 8.8@96, 9.1@98.5, 9.4@99.5 and 9.5@99.8 %
- Teflon space is used to tune the resonant frequency
- Improved pressure sealing by using a new diamond-shape Al gasket
  - This technique is more practical than an old flat-shape Al gasket

First Run (Test 99.5 % donut)

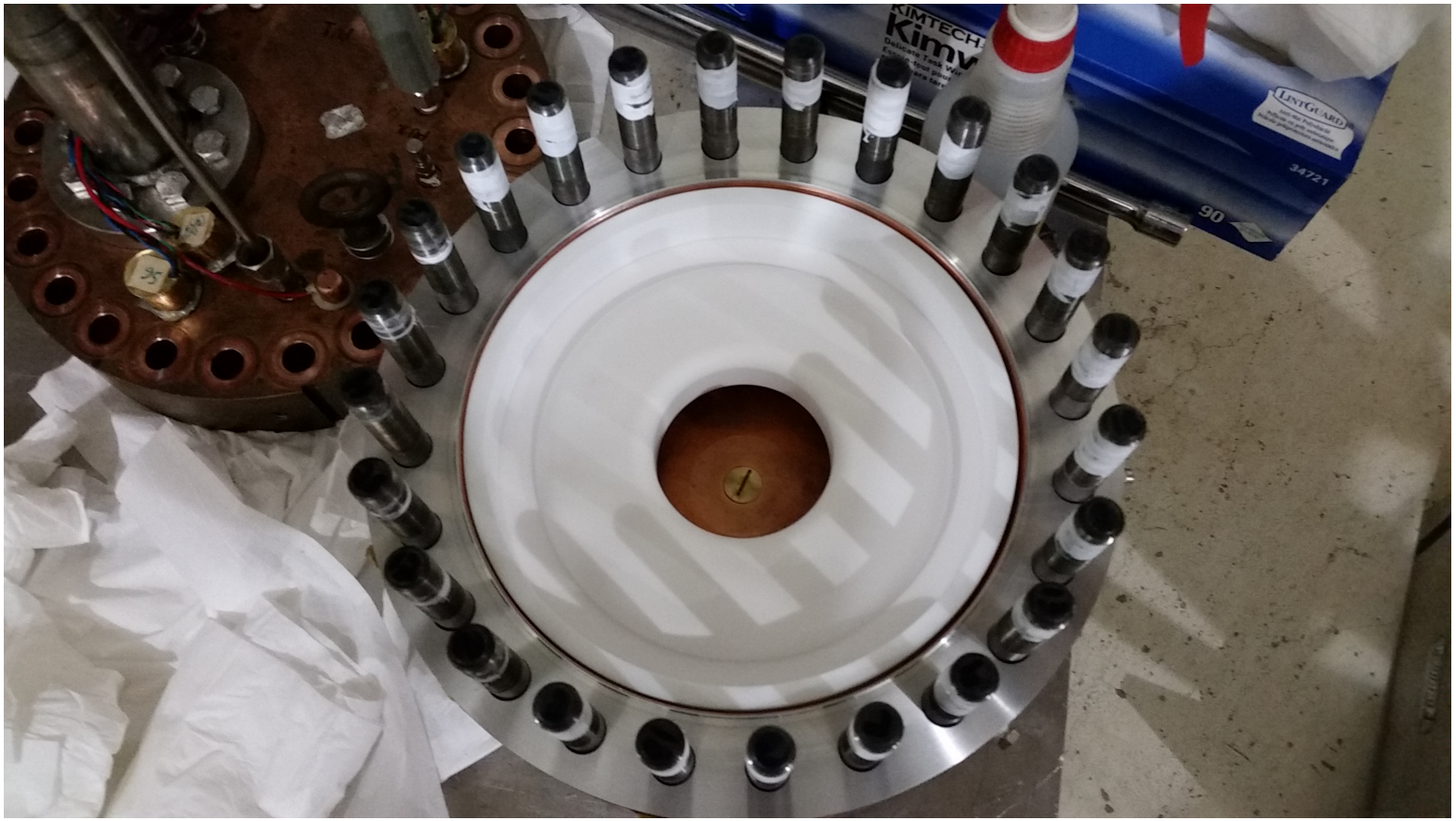


Breakdown



- Achieved maximum RF gradient on axis ~ 8 MV/m
- RF gradient on ceramic surface ~ 14 MV/m

Inspection after first run



- No damage on a ceramic donut

Observation

- First run with 99.5 % and 98.5 % Donuts and achieved 8 and 6 MV/m on axis
- Corresponding gradient on ceramic surface is 14 and 10 MV/m, respectively

CoorsTek published dielectric strengths

Purity (%)	96	98.5	99.5	99.8
Dielectric Strength (MV/m)	8.3	8.7	8.7	8.7

- Current data is similar or exceed the reference value

- Indeed, the dielectric strength is strongly dependent on a special (secret) ingredient of impurity materials (fraction of Mg, Cr, etc)

Wesgo Alumina grade (purity)	AL500 (94 %)	AL600 (96 %)	AL300 (97.6%)	AL995 (99.5%)	AL998 (99.8%)
Dielectric Strength (MV/m)	25.6	26.6	43.3	31.5	≥ 17

Observation (cont'd)

- RF repetition rate is 1 Hz
- No temperature increment w/o any active cooling even in a sequential breakdown
- No frequency shift found even in a sequential breakdown

- Successfully demonstrated feasibility of the cavity at this RF power level

- Still learning about radiation mechanism in the cavity
  - Conditioning cavity
  - Treating multipactoring
  - Breakdown mechanism

Next step

- More measurement
  - We have two more donuts (99.8 % and 96 %)
  - Need more measurements in various conditions
- Analysis
  - Full analysis of RF parameters
  - Breakdown event
- Design realistic RF cavity