Material activities towards high Q_o with HT-N @ JLab

C. Reece

TTC Mtg @ DESY, March 2014

Pursuit of High Q_0

- Stimulated by very encouraging results from FNAL, JLab and Cornell, and the need of LCLS-II to minimize the cryogenic system load,
- JLab was invited to partner with FNAL and Cornell to expedite R&D on the new high-Q phenomenon.
- The new data are very attractive for the implications for accelerators, but also present fresh challenges for the parameterization and interpretation of the field dependence of the SRF surface resistance, R_s. ($Q_0 = G/R_{s\,avg}$)
- Several potential contributions are getting fresh scrutiny:

$$R_s = R_{bcs}(T,B) + R_{flux} + R_{norm} + R_{pe}(T,B) + R_{eff\text{-}topo}(B) + R(E)_{eff\text{-}FE} + \ldots$$

BCS	ambient flux pinned	normal metal	proximity effect	roughness field enhancement	field emission

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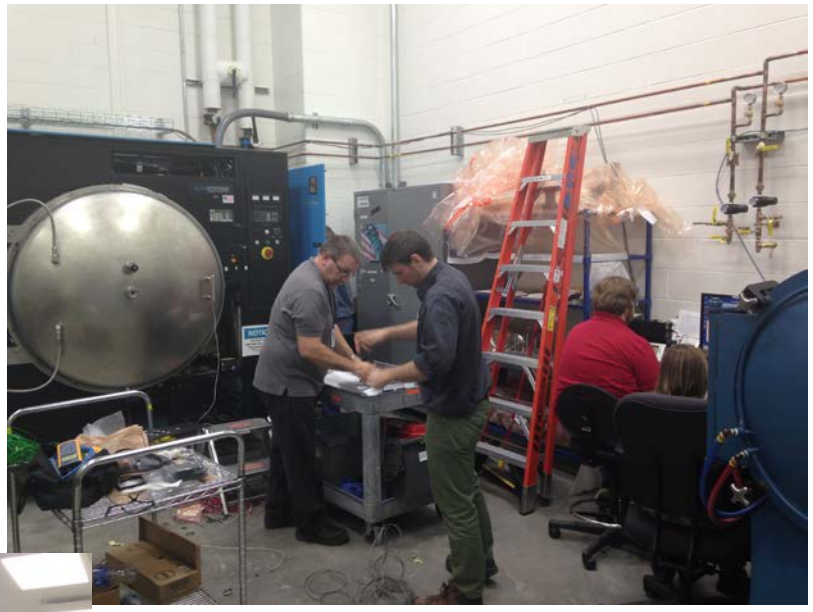
$R_{residual}$

Pursuit of High Q_0 via HT-N

- JLab has launched a program to
  - **Establish the infrastructure** to process and test high Q_0 cavities – furnace upgrade, police test stand mag field
  - Perform a **structured N doping and EP removal study** in pursuit of a robust protocol – using 12 single-cell cavities
  - Help **debug extension of protocol to 9-cell cavities**
  - **Assess "robustness"** of candidate protocol to off-normal occurrences
  - With partners establish candidate LCLS-II protocol
  - Apply candidate protocol (frozen on July 1) **"production" style** to a set of 6 new 9-cell cavities
  - Complete by October 2014 !
  - Evaluate any **FG/LG differences** in high Q_0
  - Analyze and interpret the $R_s(T,B)$ from the data set

Pursuit of High Q_0 via HT-N

Set of new test cavities ready



Upgrading furnace controls for N gas supply at HT

Dedicated qualified test stand

Pursuit of High Q_0 via HT-N

We want a protocol with weak sensitivity to details of N-doping and EP removal

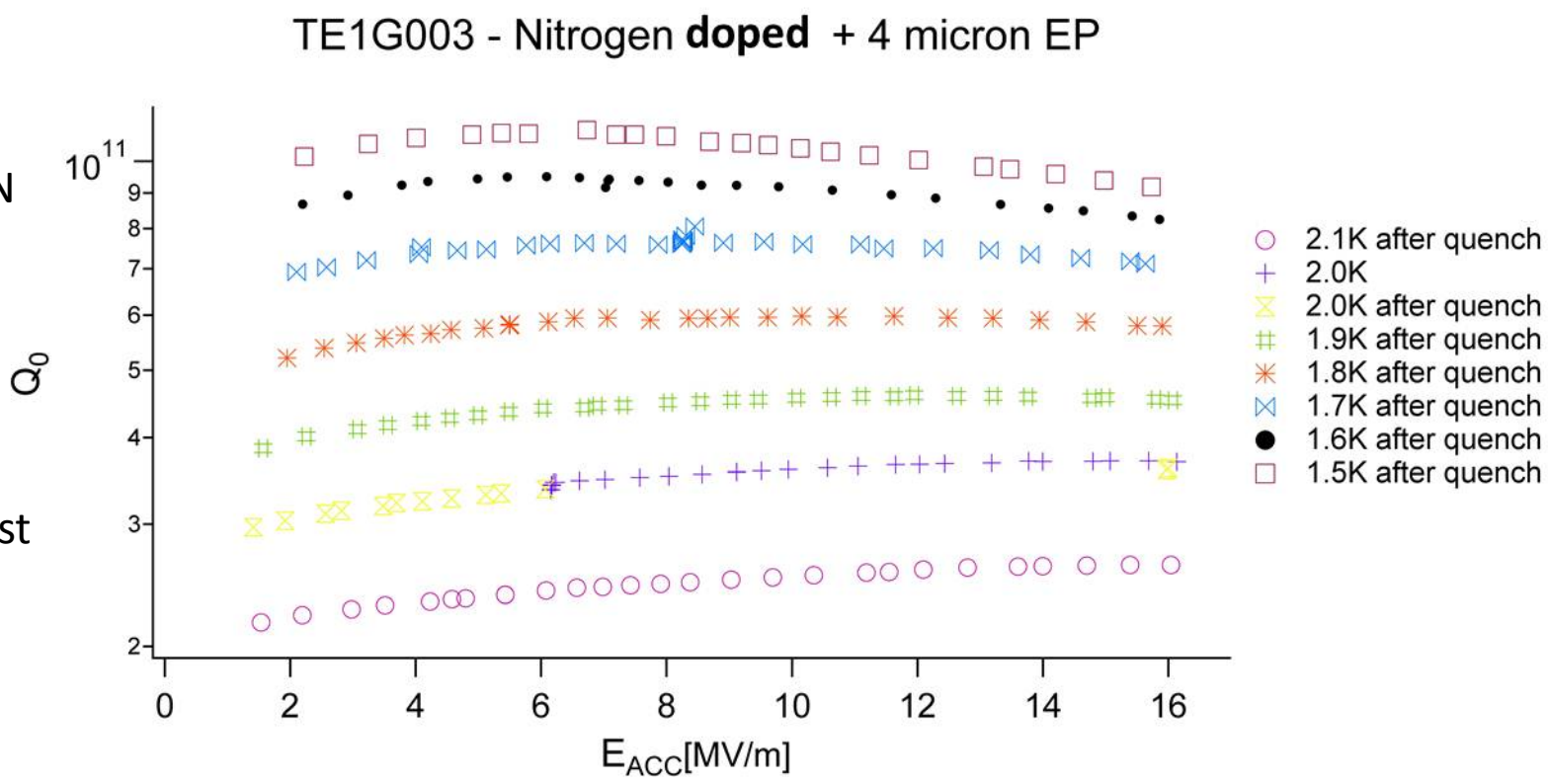
- Perform a **structured N doping and EP removal study** in pursuit of a robust protocol – using set of 12 single-cell cavities
- 6 HT-N runs each with 4 cavities at a time
  - Varied diffusion soak time
- 8 EP runs, each with 3 cavities at a time
  - Cavities from different HT-N runs EP'd simultaneously
  - Varied removal amount, e.g. 4, 8, 12 µm
- 24 systematic, extended VTA tests with $Q_0(T, B_{pk})$
- Nb samples to track HT-N and bench EP'd then analyzed
  - SIMS, topography, micro-TEM with EDS, etc.

Pursuit of High Q_0 via HT-N

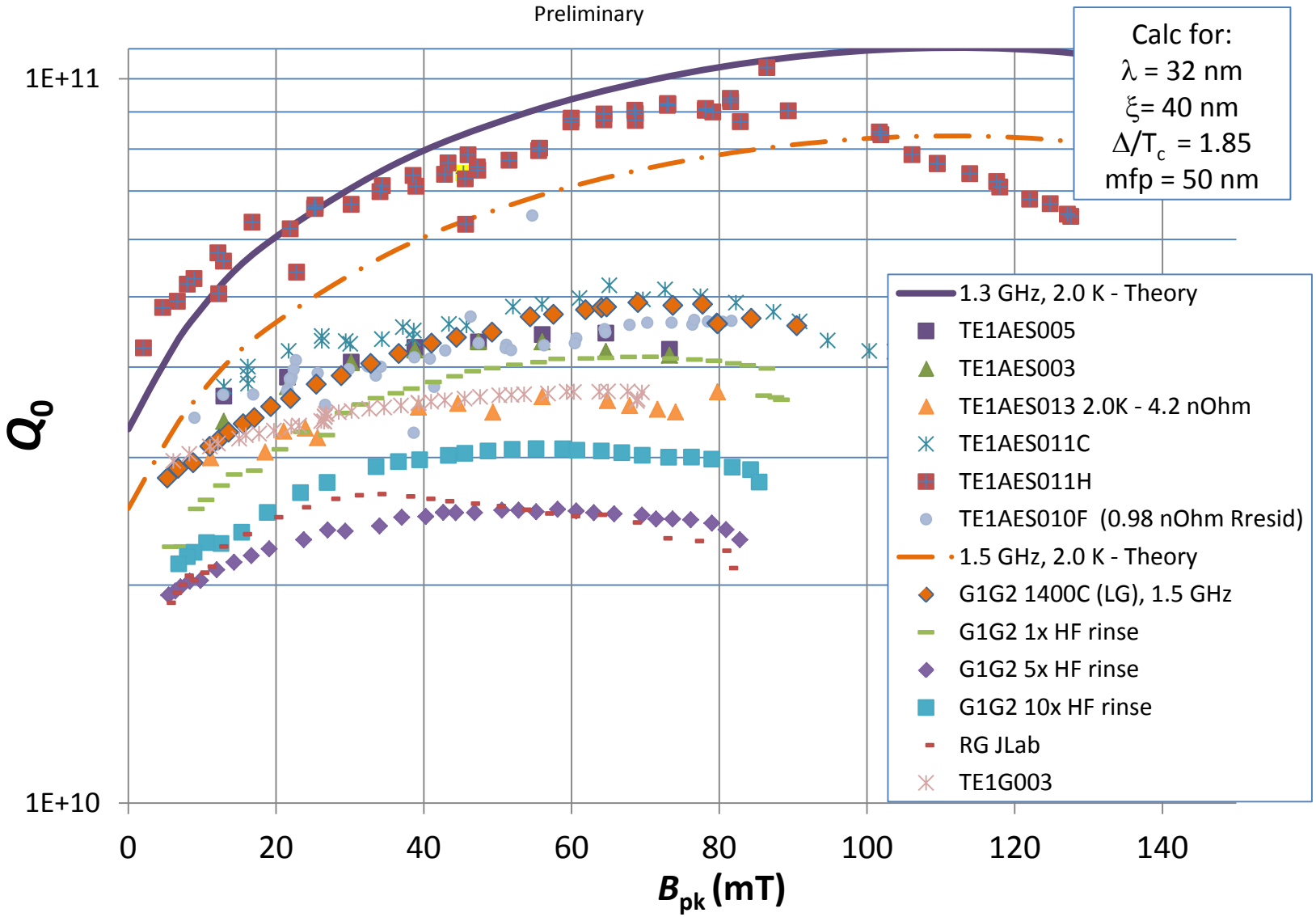
- As part of system commissioning, two of these cavities were HT-N treated in FNAL furnace and EP'd 4 µm at Jlab.
- One tested last week (FG), one to test this week (LG)
- First furnace commissioning run this week.

FG 1.3 GHz
CBP + BCP + HT-N + EP

Not bad for a "shake-down" test



Pursuit of High Q_0 via HT-N



Theoretical, Previous Standard, and Recent - Q_0 Limit @ 1.3 GHz, Tesla cell Shape