High Gradient Cryomodule Prototype for the International Linear Collider

Necessity of High Gradient/High $Q_0$ for ILC Realization

- The world is ready for a new Higgs factory for BSM physics
- ILC is a ready to go technology:
  - Uses SRF cavities; capable of very high $Q_0$ and gradients
  - Largest cost driver is the average accelerating gradient of the main SRF LINAC

Baseline cavity specs:

- $Q_0=1\times10^{10}$
- $E_{acc,avg}=31.5$ MV/m

- Increasing the baseline cavity specs allows for either:
  - **Lower Cost**
  - **Higher Luminosity**

Higher Luminosity

FNAL Workshop on HL-HG ILC:
- Proposed a high luminosity/high gradient ILC upgrade enabled by recent progress made in High G/$Q_0$ R&D:

Unprecedented Performance in Single Cells with New High Gradient Surface Treatments

- Consistently achieve very high gradients with the FNAL developed 75C/120C modified bake surface treatment

Reproducibility of High Gradients at Other Labs

- Two 1.3 GHz single cell cavities processed at FNAL with the 75C/120C treatment were sent around the world for testing
- Very high gradients of +47 MV/m confirmed by other laboratories

Material Science Studies to Uncover Mechanisms Responsible for Record High Gradients

- To better tailor surface treatments that further push the limits of record breaking performance, **material science techniques** are used to understand the microscopic mechanisms responsible for improved gradients and $Q_0$.

  - Cryo Atomic Force Microscopy (AFM) images taken of 75C/120C cavity cutouts show the growth and dissociation of nano-hydrides
  - Improved performance is linked to dissociation of these nano-hydrides

More info @: arXiv:1910.01276

Refurbishing a Cryomodule for High Gradient

- In the context of ILC cost reduction, FNAL plans to lead the assembly of a High Gradient Cryomodule (HGC)
- Partners at national and international institutions such as JLab, Cornell, KEK, CEA, DESY, and TRIUMF
- CM1 will be disassembled and upgraded with cavities processed using **new techniques developed** since the ILC Technical Design Report