C100's and the CEBAF Performance Plan: Possibilities

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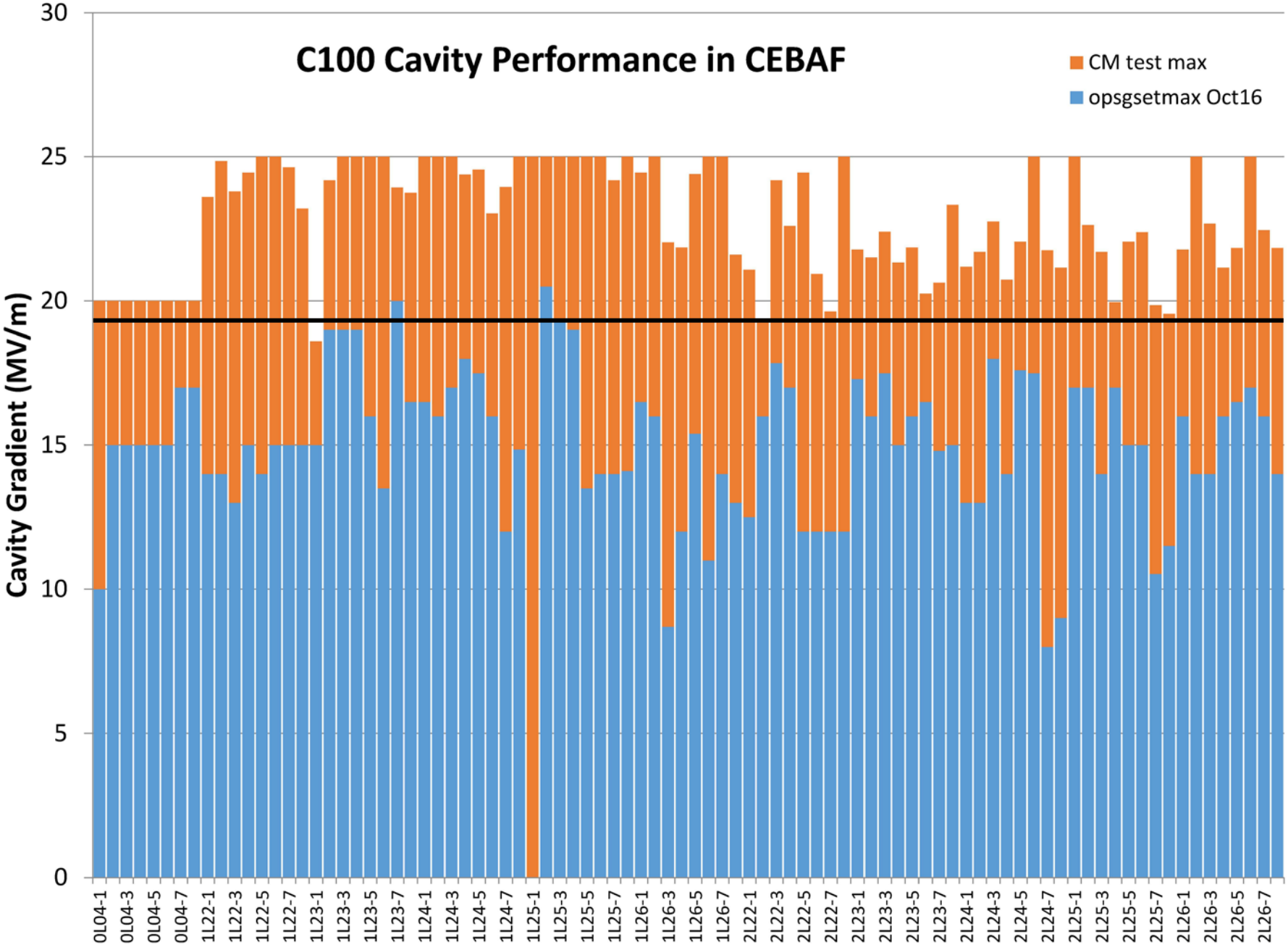
Outline

C100 CMs

- Not a problem:
  - Raw SRF cavity performance
- **Real problems:**
  - Particulate contamination
    - Field emission
      - Heat
      - Radiation
  - Vibrational stability/sensitivity
  - Conducted heat sources?
    - Extra dynamic heat – (Cu-plated WG transition, RF window)
    - Source of anomalous quenches?
- **"Why not the best?"**
  - What **could** be the standard in 2022.


C100 Cavity Performance in CEBAF
CM test max
opsgsetmax Oct16
Cavity Gradient (MV/m)
30
25
20
15
10
5
0
0L04-1
0L04-3
0L04-5
0L04-7
1L22-1
1L22-3
1L22-5
1L22-7
1L23-1
1L23-3
1L23-5
1L23-7
1L24-1
1L24-3
1L24-5
1L24-7
1L25-1
1L25-3
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1L26-1
1L26-3
1L26-5
1L26-7
2L22-1
2L22-3
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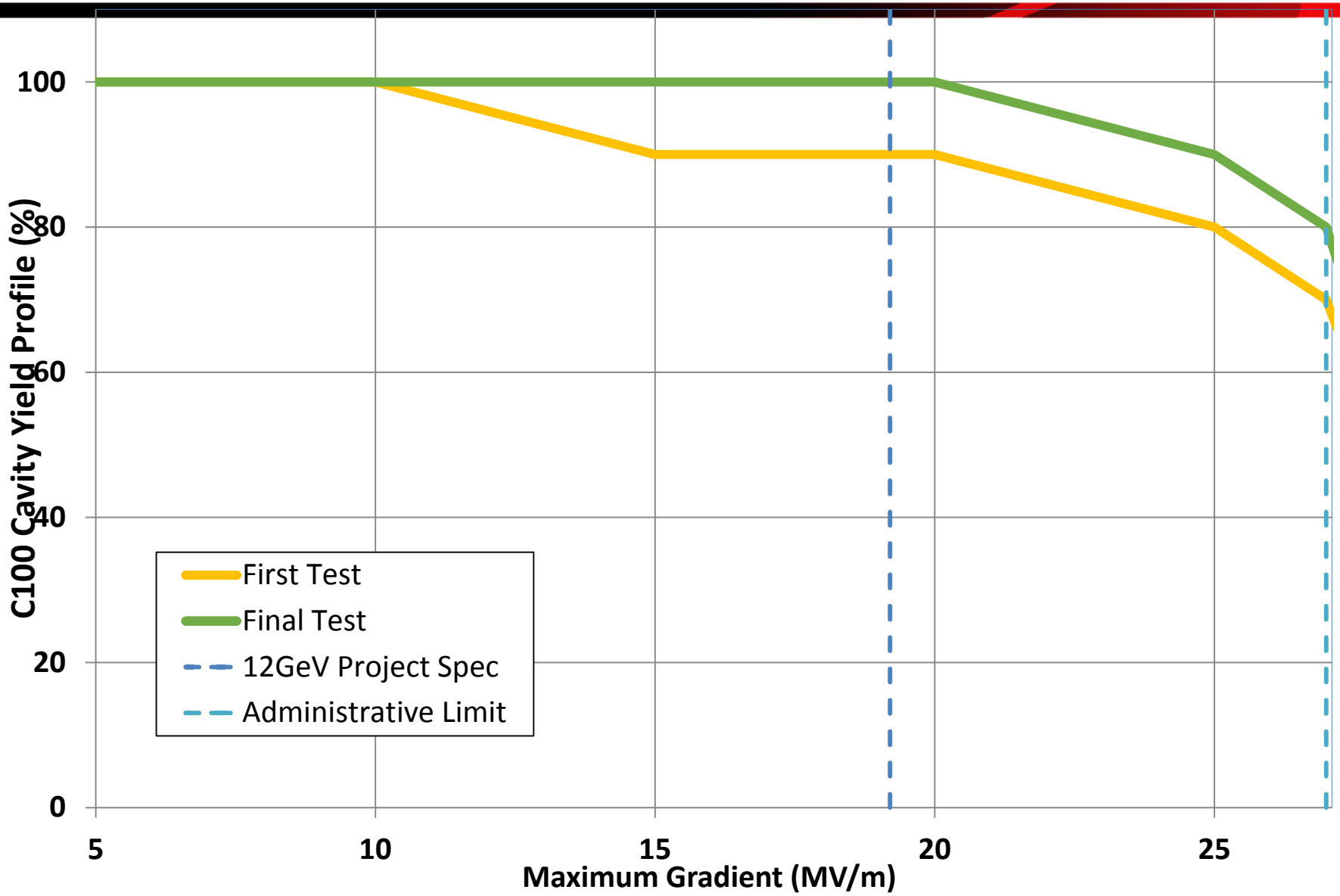
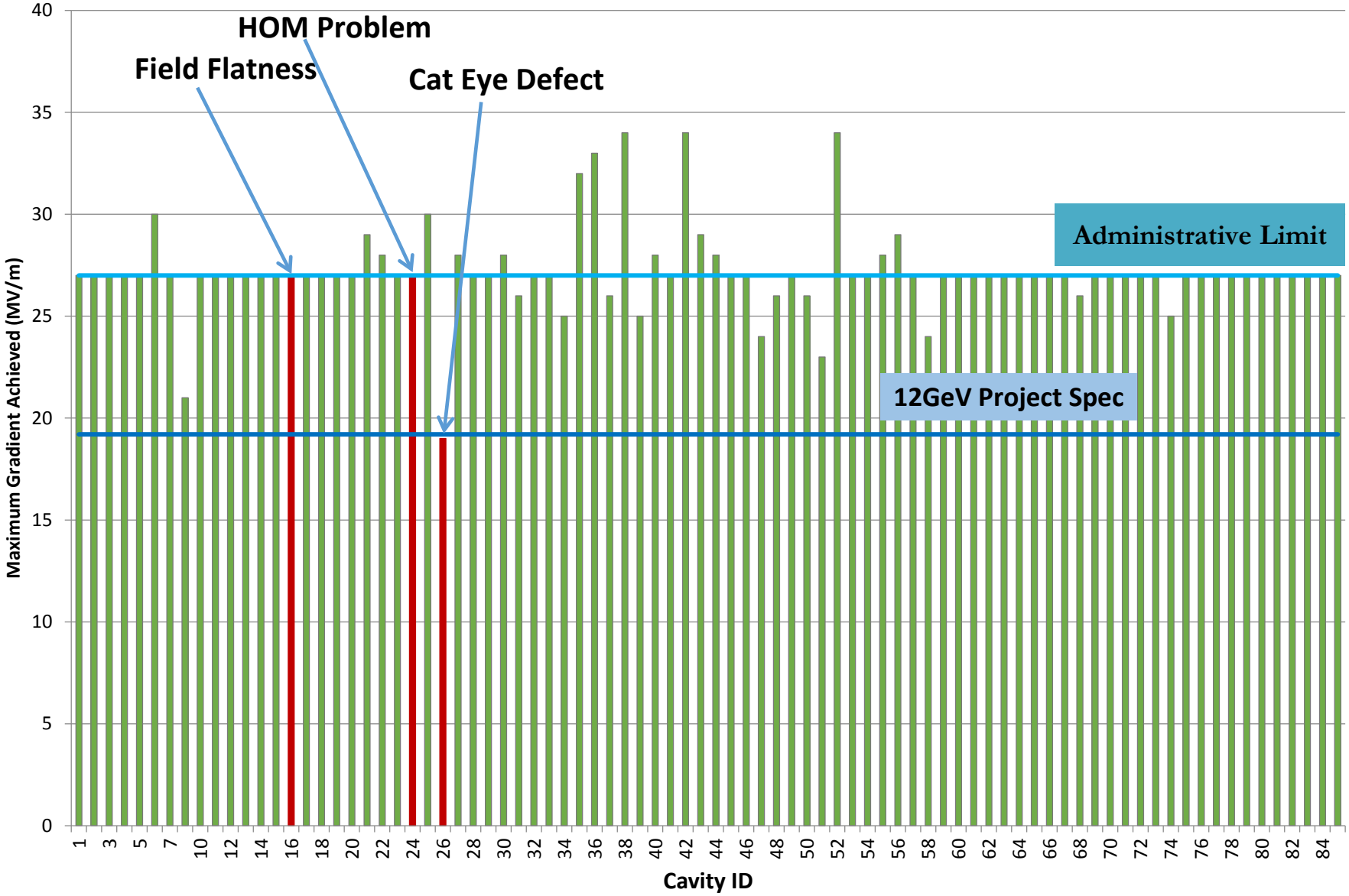
2L26-1
2L26-3
2L26-5
2L26-7

Jefferson Lab 12 GeV C100 Cavity Yield Profile



Jefferson Lab 12 GeV C100 Cavity Final Emax



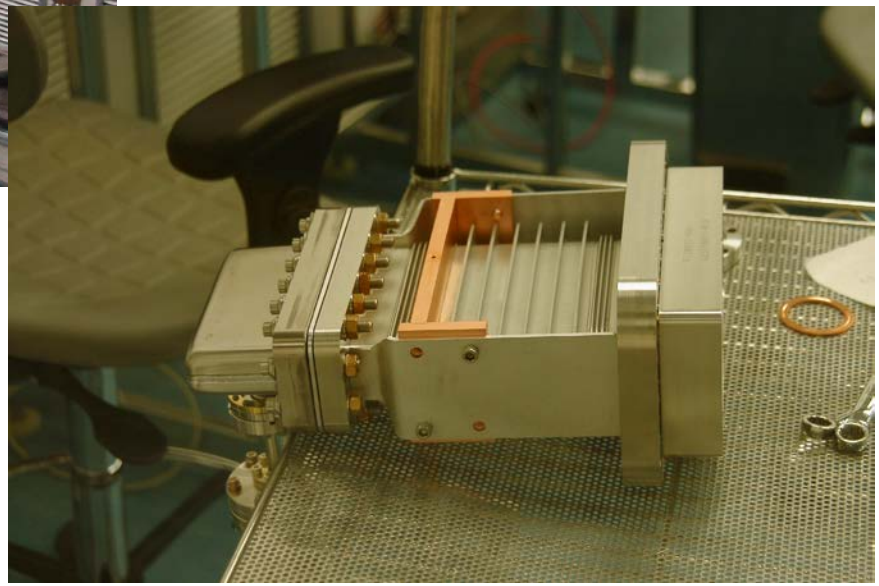
C100 CMs

- **Real problem:**
  - **Particulate contamination**
    - Field emission
      - Heat
      - Radiation
- C100 cavity design accepted higher E_{pk}/E_{acc} (greater vulnerability to field emission) to gain lower H_{pk}/E_{acc} (lower losses)
  - Judged “safe” because we had learned how to make cavities clean enough.
  - *However*, we had not (yet) learned how to keep them clean.
- Now, new TEDF facilities, new procedures refined with LCLS-II
  - “Clean” CM assembly is in hand.
- Next, “clean” installation and maintenance

C100 CMs

C100 string in old cleanroom

Waveguide transition

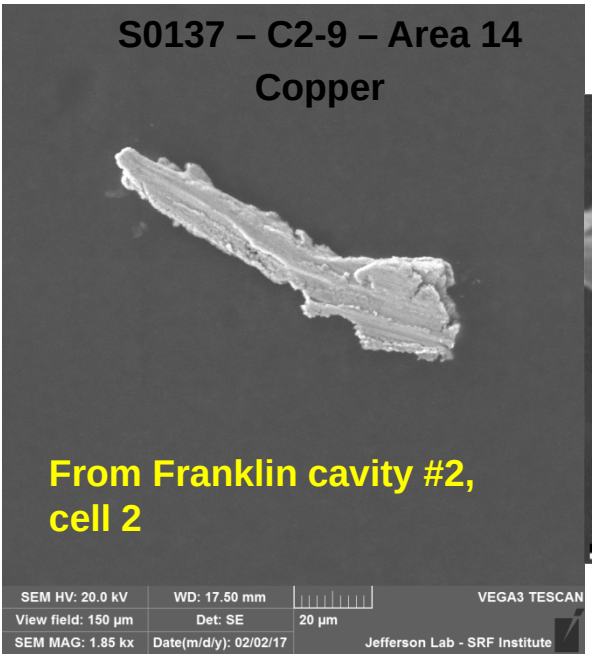


Analysis of particulates from CEBAF

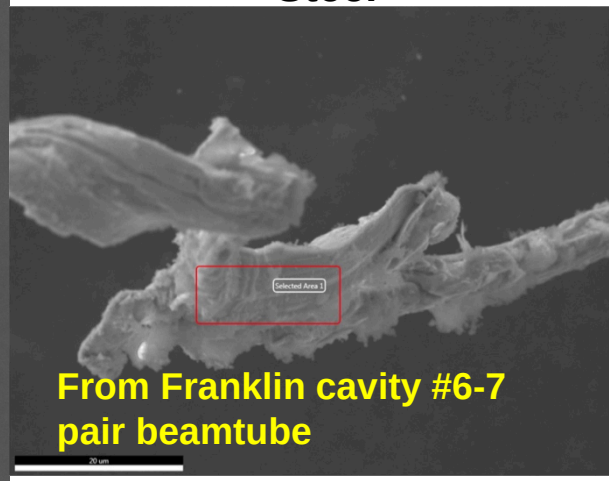
- Systematic particulate sampling (>340) from CM and girders removed from CEBAF
- Examination using new SEM with elemental analysis
- Many copper and steel particles found > 40 µm
- Large assortment of other materials found
- **Clearly inconsistent with current standards**
- Responsible for CEBAF's energy reach limitation
- Feedback for process improvement

Examples

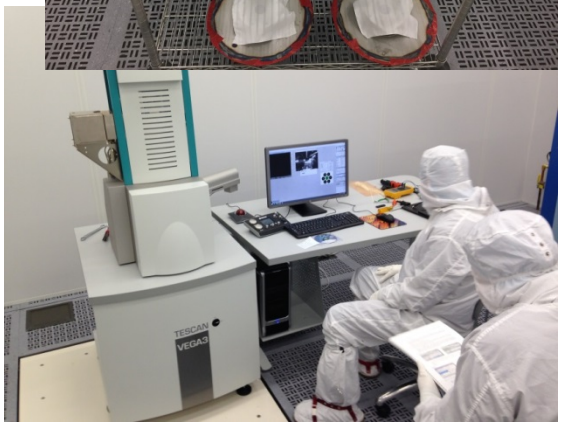
S0137 – C2-9 – Area 14
Copper



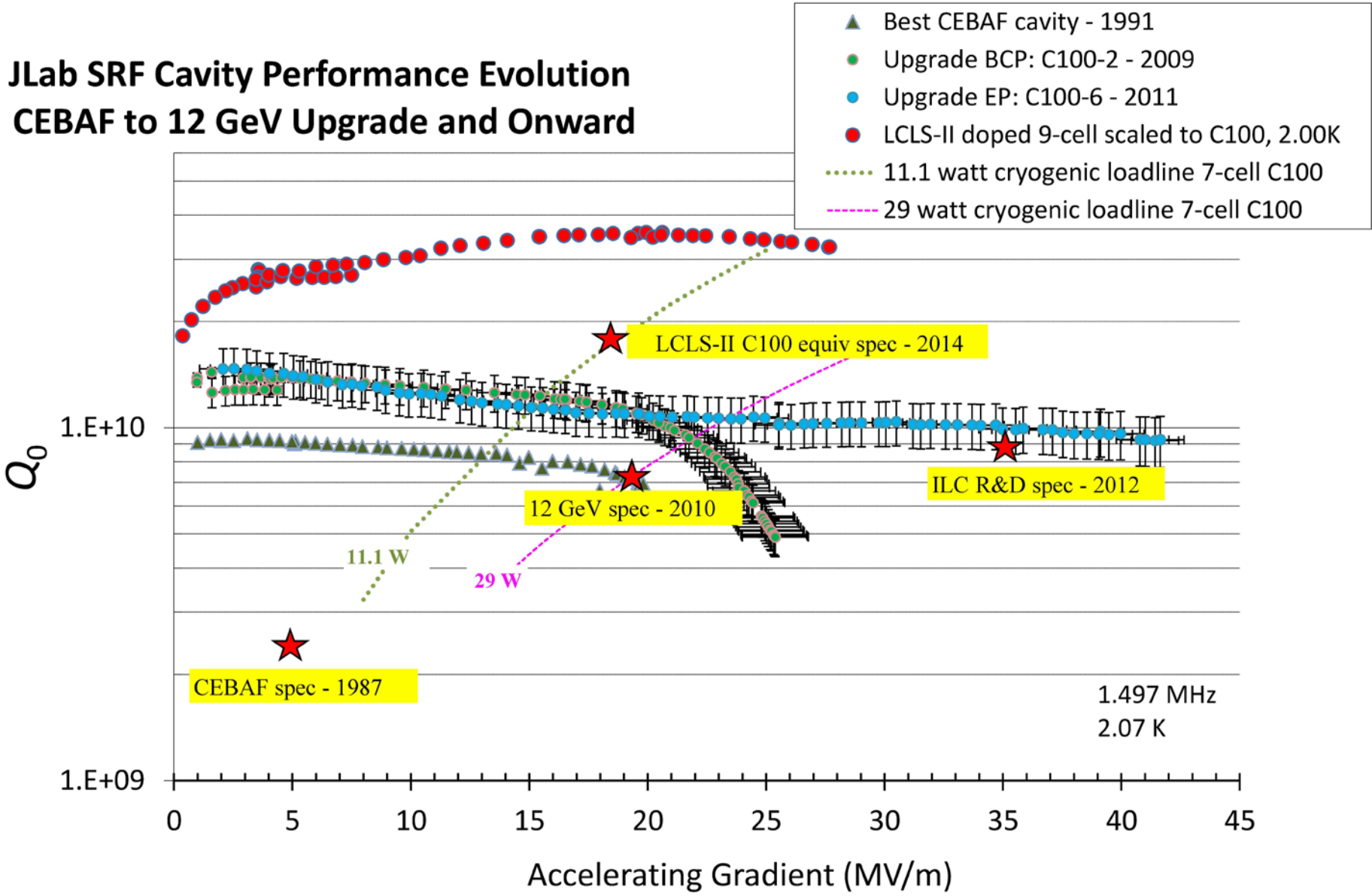
S0320 - C6-18 - Area 7
Steel



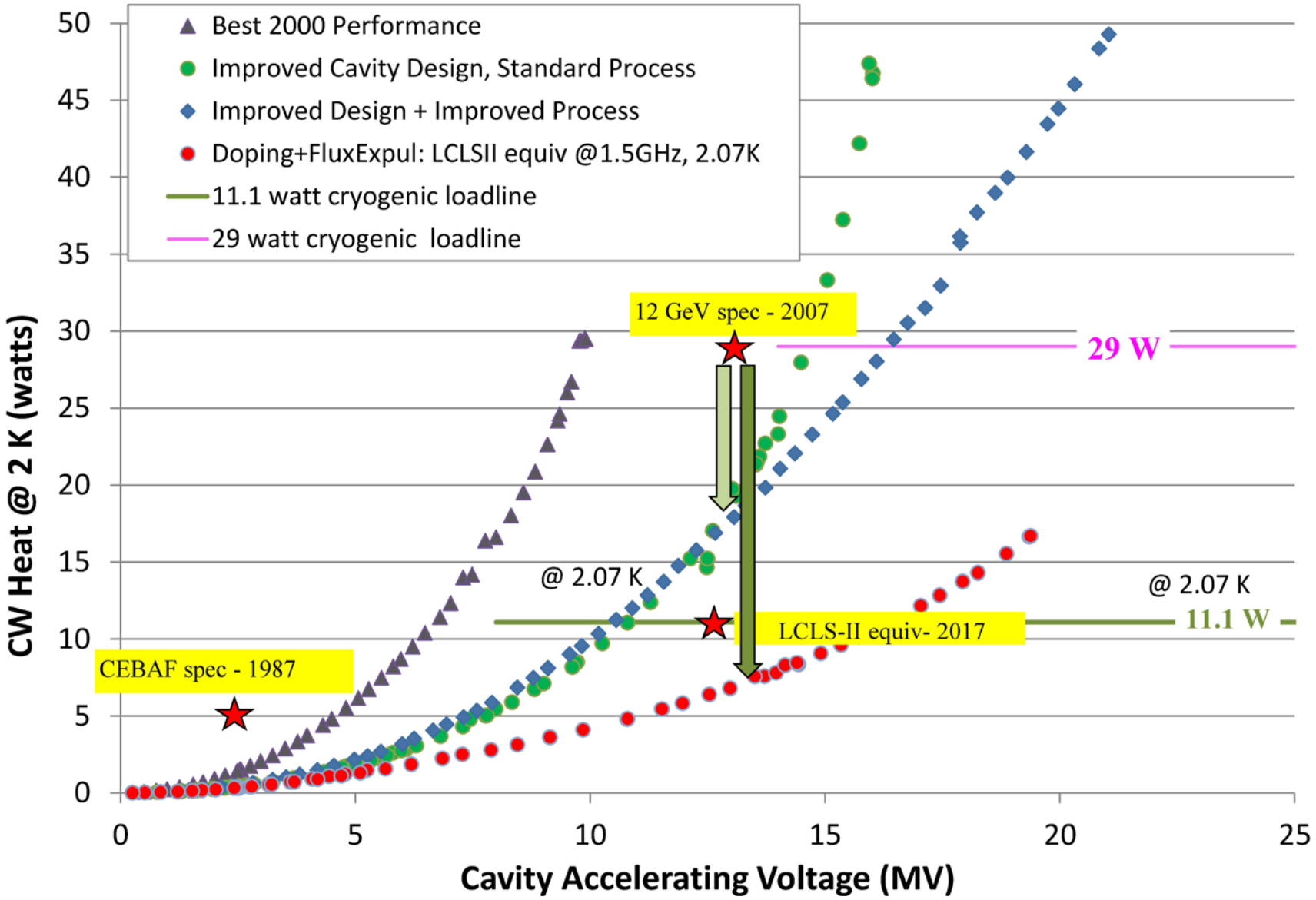
Valente-Feliciano, Spradlin, Trofimova



JLab SRF Cavity Performance Evolution
CEBAF to 12 GeV Upgrade and Onward



JLab Cryogenic Heat Load Reduction - Progress and Potential



Future of C100s

C100 CMs "Why not the best?"

- JLab will deliver clean CMs to LCLS-II
- All CEBAF CMs can henceforth be comparably clean at delivery. Must propagate clean standards to all beamline work.
- Not unreasonable to ask for **115 MV per CM**
  - (20.5 MV/m), field emission free – **now**.
- **If**, heat management and μ-phonics are controlled.
  - Required for operational stability
- By **2022**, Q_0 at 2.07 K of **2×10^{10} at 25 MV/m** will be quite reasonable. >> **140 MV CM**
  - (May need more klystron power or lower current)
- Confidence requires a CM design development platform and dedicated design mech engineering.
  - Must we wait for an installed C100 to "volunteer" for this duty?
  - Track engineers to roll off of LCLS-II onto this design refinement?

Future of C100s

C100 CMs "Why not the best?"

1. What treatment to existing C100 cavities?
   - **2×10^{10} at 25 MV/m** at 2.07 K
2. What CM design mods would eliminate μ-phonic issues?
3. What contamination control procedures will confidently avoid FE to 25 MV/m?
4. What trajectory will get the linacs clean and keep them clean?
5. What CM design mods will reduce dynamic heatload?
   - FPC waveguide and window?
   - Magnetic hygiene < 5 mG?