S0/S1 Next Steps

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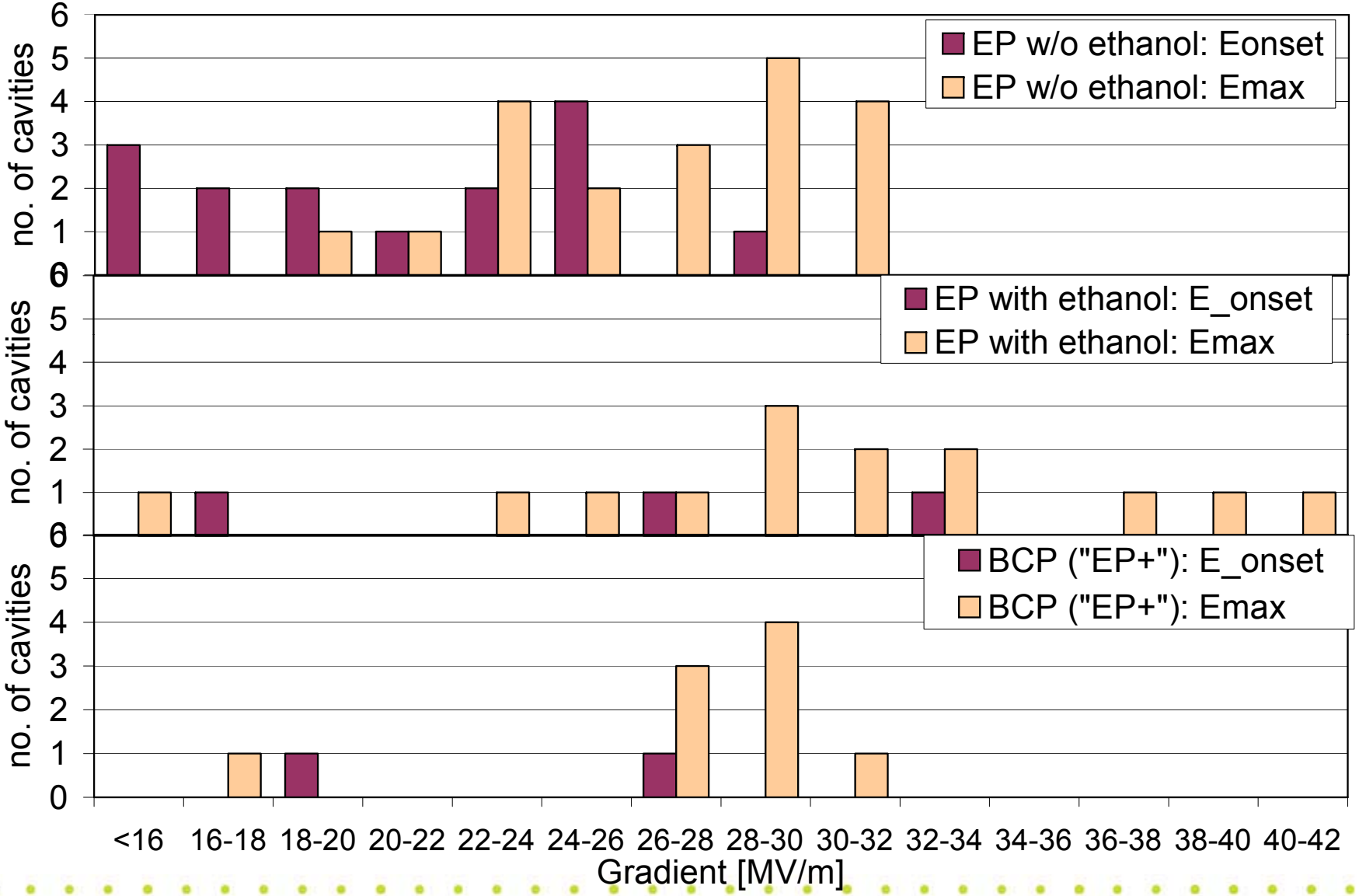
Status

- Field emission has been reduced
  - **This is good news**
  - **Monitoring the three approaches (Ethanol, Ultrasound or Fresh EP) needed**
    - Is there a significant advantage of one over the other?
    - Data set for Fresh EP on multi-cells small
- Still rather large gradient differences are observed due to thermal breakdowns
  - **Needs improved understanding of the nature of these breakdowns**
    - E.g. some of the very low gradient breakdowns have been tracked to the equator region
    - At higher gradients this is not yet obvious
    - Need improved diagnostics
      - High-resolution temperature maps and high resolution optical inspection
  - **There is a broad consensus on this in the SCRF community**
    - See recent TTC Meeting at DESY

DESY 4th: Field Emission Analysis



Field Emission Monitoring and Data Comparison for Multi-cell Data

- A systematic first study on single- and nine-cells has shown that field emission could be reduced by three different approaches:
  - **Ethanol Rinse, Degrease and Flash EP.**
- To add further credibility to the data a continuous monitoring of field emission properties for multi-cells is needed.
- This will allow establishing the superiority of the proposed rinses and eventually make a choice for a baseline process.
- This should be done in parallel to every test on nine-cells and therefore does not necessitate additional testing to first order.
- Tasks
  - **Production-like efforts in all three regions**
  - **Monitor tests esp. for field emission and compare results**

Variability due to Thermal Breakdown

- General tasks
  - **Improvement of diagnostic tools and the standard process**
  - **Initial tests to demonstrate the usefulness of these two systems on single cells should be done.**
    - This calibration should be the first step and focus on the three rinsing methods mentioned already.
  - **The single-cells will be insufficient for being the primary study tool on the standard processes, as**
    - they show a different (namely smaller) spread in quenches
    - they are fabricated not in the same place as multi-cells
    - the surface preparation is simpler e.g. they typically do not need similar processing times
- After first tests on single-cells, the diagnostics should be applied to as many multi-cell cavities as possible.
- Tasks
  - **Development and Application of high-resolution t-mapping and optical inspection systems**
  - **Use a set of single-cells cavities to 'calibrate' the systems mentioned above**
    - A detailed analysis of quench locations is needed to check e.g. whether the weld affected zone shows breakdowns more often than other areas (Cavity WP 2.3)
  - **Use the systems on as many multi-cells as possible e.g. from the 'production-like' efforts (Cavity WPs 1.2, 1.3)**

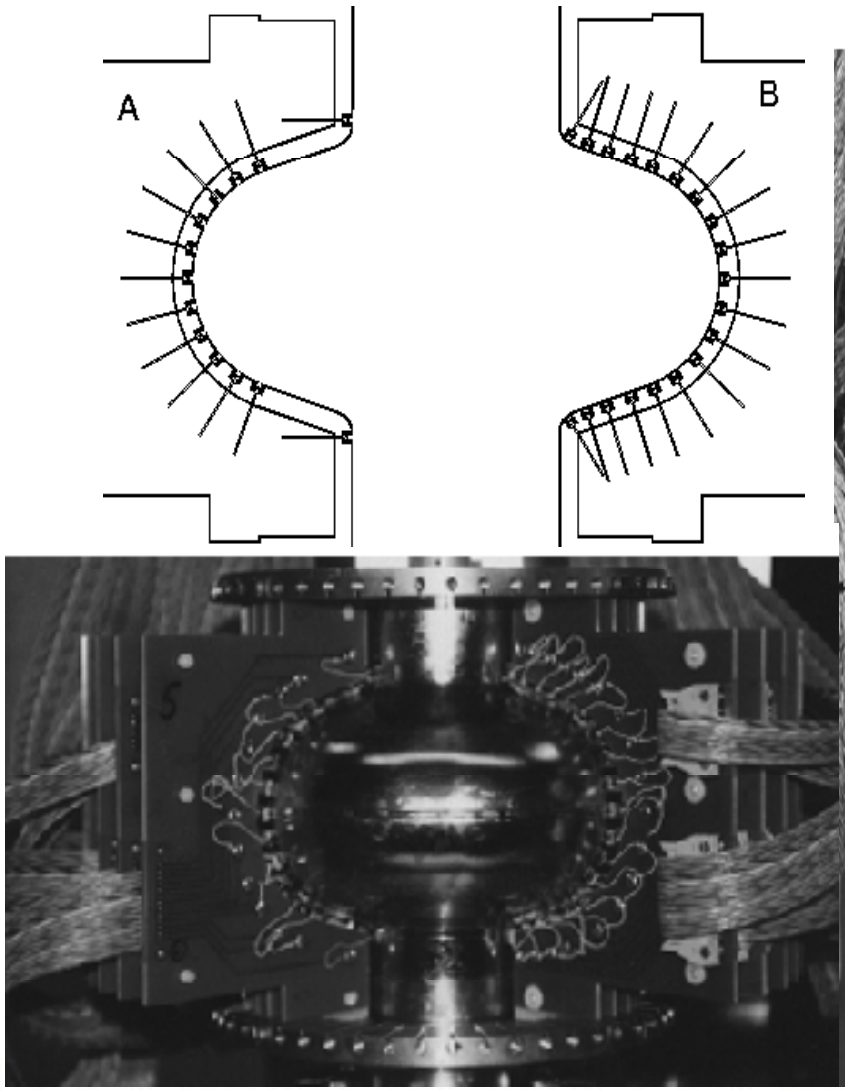
High-Resolution Temperature Mapping

Temperature mapping is a very important tool to understand the loss mechanisms in superconducting cavities.

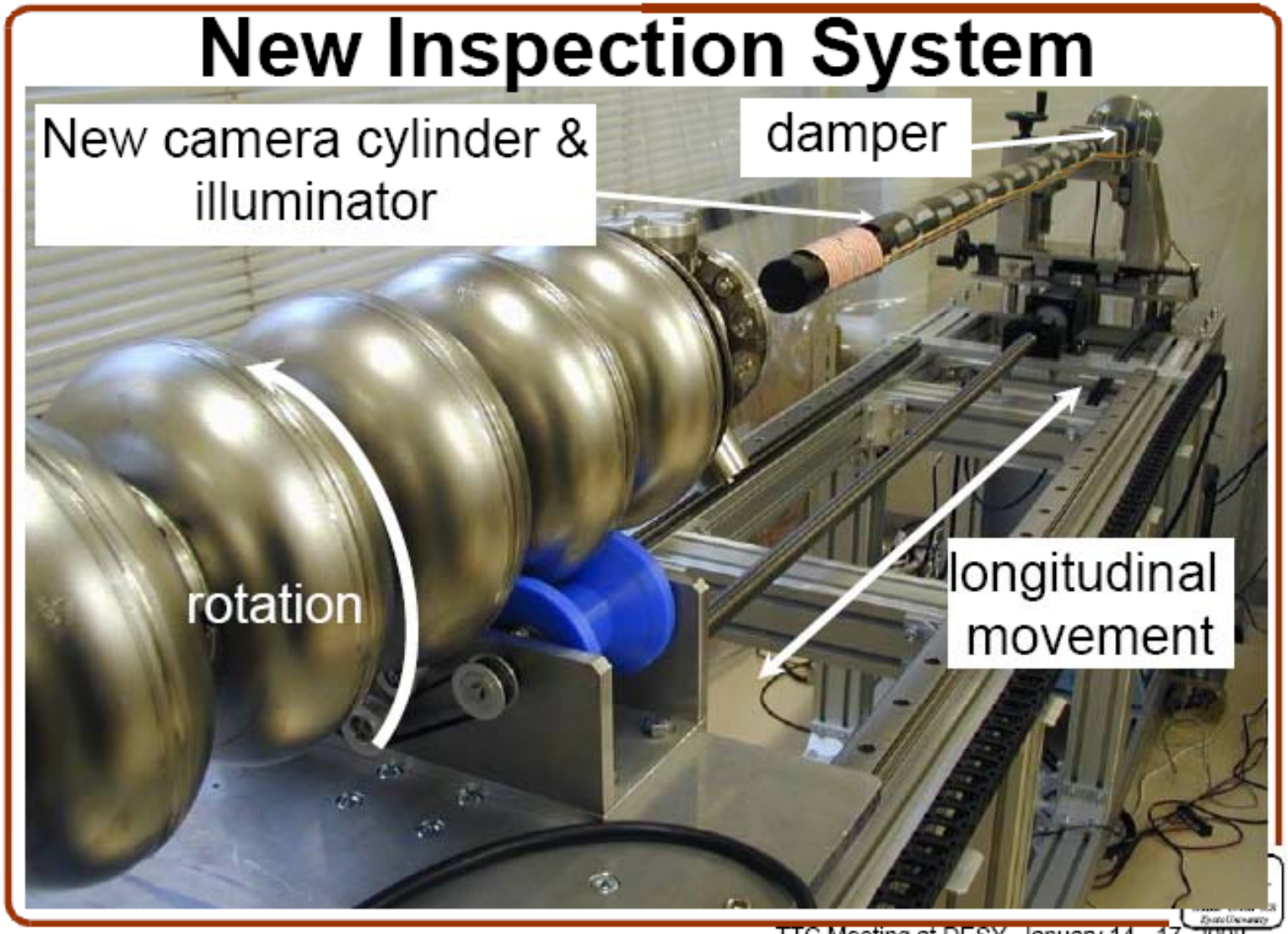
Loss mechanisms have typical signatures:

-local heating for local defects, multipacting and field emission

- global heating like in the case of high field enhanced surface resistance



High-Resolution Optical Inspection



AES001 #3 cell 169°

Larger grains

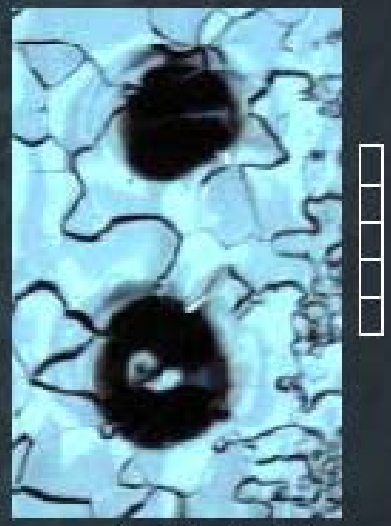
Fine grains

EBW area: Larger Grain

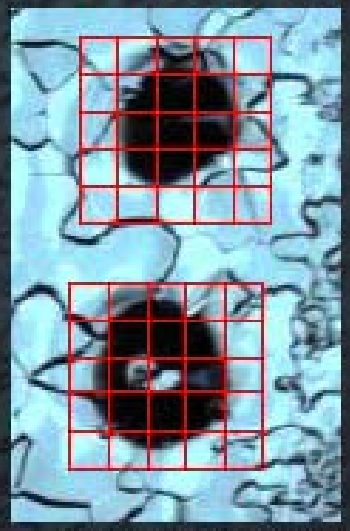
Twins

spot(a)@168°

spot(b)@169°



200μm/div

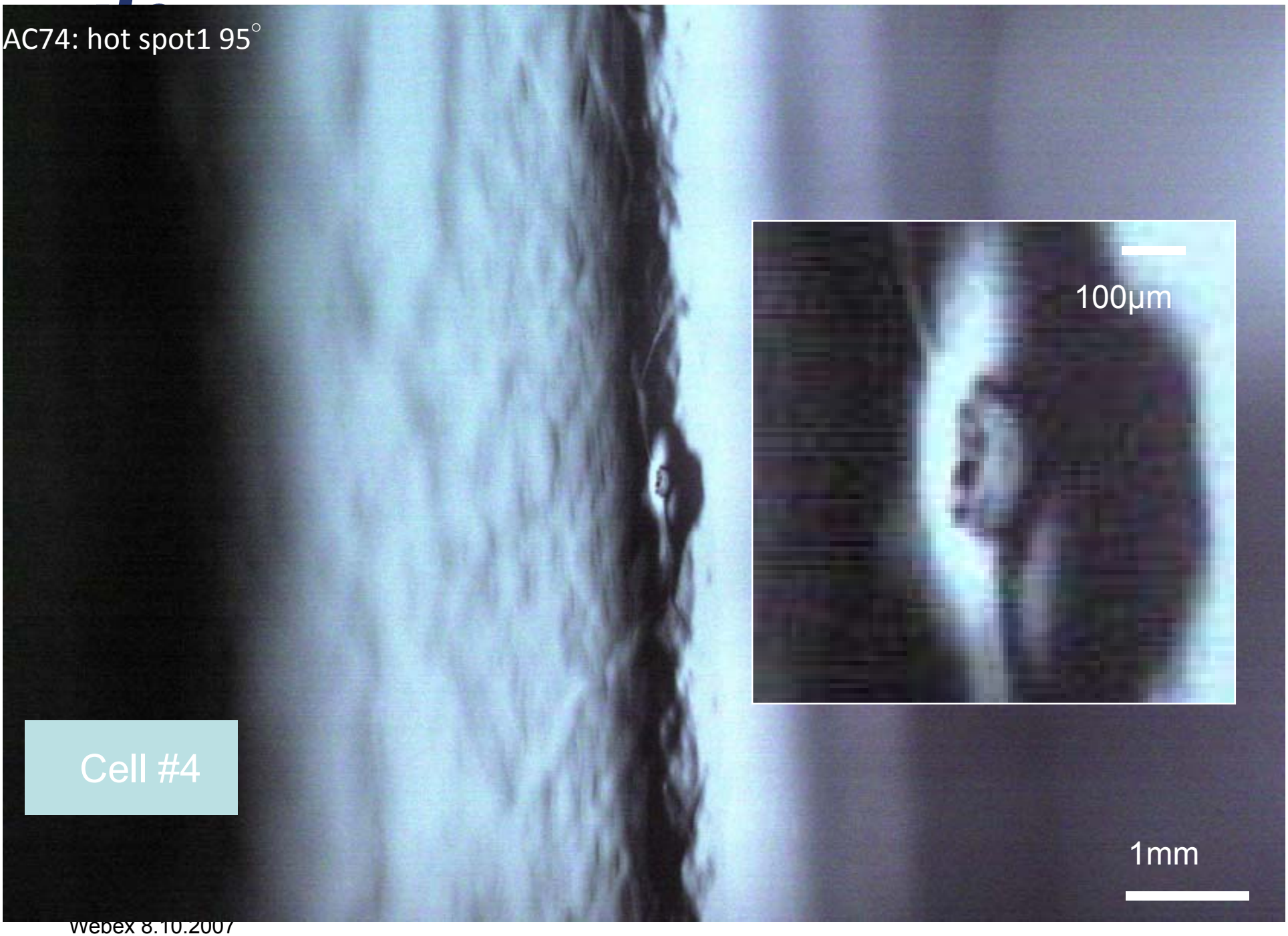


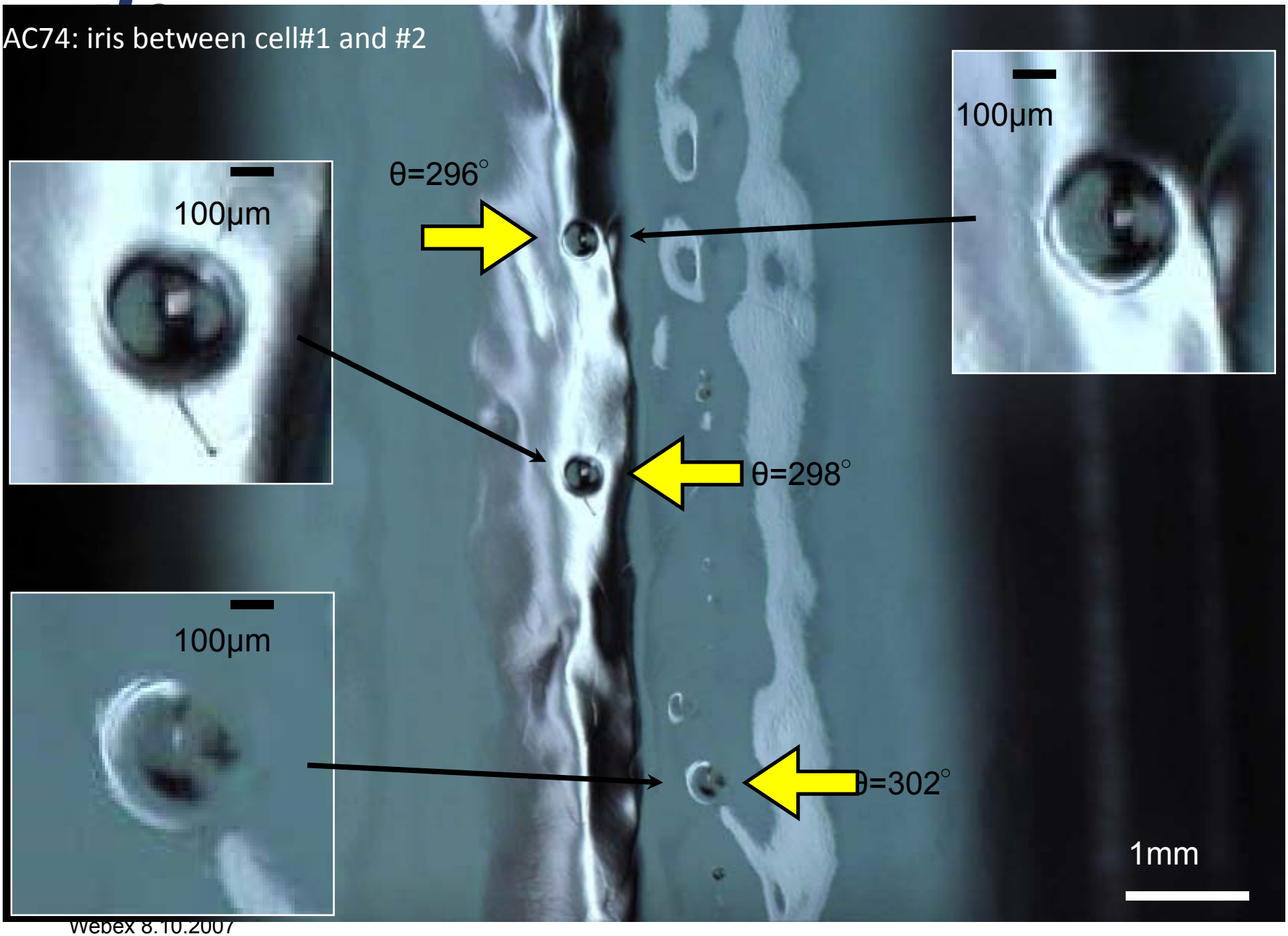
to Equator
and #2 cell

z

θ

1mm


AC74: hot spot1 95°
100µm
1mm
Cell #4


AC74: iris between cell#1 and #2
100μm
θ=296°
100μm
θ=298°
100μm
θ=302°
1mm

Understanding Variability: Use of Alternatives

- Data on alternative concepts needs to be accumulated (e.g. large grain material).
  - **Use existing cavities with improved diagnostics**
- This allows crosschecking certain theories concerning the nature of the thermal breakdowns.
  - **Residues in grain boundaries**
  - **Defects in the weld heat affected zone**
  - **etc.**
- The alternatives should concentrate on the most attractive options
  - **especially large-grain**

Variability due to Breakdown: Large-grain material

- Large grain material has been developed as a cost saving option.
  - **Further development on the optimum preparation process needs to be done. The data to date is not conclusive.**
  - **While JLab single-cell data suggests that etching is marginally sufficient to achieve ILC gradients, at DESY electropolishing shows a clear advantage over BCP in terms of gradient.**
- The surface of large-grain cavities can serve as a simpler system than the more complex fine-grain surfaces. This is certainly even more true for single-crystal cavities. Some theories claim that grain boundaries can lead to pre-mature breakdown due to either impurities or surface irregularities.
- Tasks
  - **(Demonstration of cost advantage) – not really S0**
  - **A study with t-mapping and optical inspection is needed on large-grain (or single-crystal) single-cells comparing the two surface treatments: EP and BCP**
  - **Development of large-grain multi-cells**

Variability due to Breakdown: Seamless cavities

- A comparison of seamless cavities with welded cavities needs to be done to exclude the welding area and its surrounding as being problematic.
- Tasks
  - **A study with t-mapping and optical inspection is needed on a few electropolished single-cells of standard and weldless type**

Variability due to Breakdown: Vertical EP

- Vertical EP on multi-cells can possibly straightforwardly used for the Flash EP (Fresh EP, Micro EP) a la K. Saito and be combined with temperature mapping.
  - **Increase the experience with *multi-cells***
- Task
  - **Test several multi-cells with T-map after vertical Flash EP**

Proposal for Goals/Milestones

- The basic R&D goals for S0 have not changed. The timescale has changed.
- End of 2008:
  - **need to enhance temperature map (or similar) capacity worldwide**
  - **need to enhance high-res optical inpsection capacity woorldwide**
  - **use welded single-cells to 'calibrate' these two methods for mapping and inspection**
  - **use tight-loop to set up preparation facilities (ANL, KEK)**
  - **cost advantage large grain evaluation**
  - **continue production-like effort**
    - 10 cavities Europe
    - 6+ cavities US
    - y cavities KEK
- Mid of 2009
  - **large-grain detailed study after EP and BCP**
  - **comparison seamless with welded**
  - **Flash EP on multi-cells in Cornell (and KEK?)**
- TDP1: technical feasibility by 2010
  - **Gradient (S0) in progress to reach 35 MV/m w/ yield 50 %**
- TDP2: technical credibility by 2012
  - **Gradient (S0) to reach 35 MV/m w/ yield 90 %**