# BAW1 Cavity Gradient Agenda

Rongli Geng

August 24, 2010

26th ILC Cavity Group Meeting

# BAW1 Organization and Goals

- Organized by ILC-GDE Project Managers:
  - Akira Yamamoto, Marc Ross, and Nick Walker
- Main Subjects:
  - Single-tunnel ML design and High Level RF System (Sept. 7 - 8)
  - Accelerator Field Gradient for SCRF Cavity (Sept. 9 – 10)
- Objectives and Goals:
  - Assessment of technical proposal in SB2009
  - R&D plan and goal in TDP-2
  - Impact across system interfaces, cost and schedule
  - Discussions toward consensus in GDE and Physics/Detector groups

# PM's Charge for ILC Accelerator Gradient Topics

- Gradient improvement R&D:
  - Material/fabrication, surface processing, instrumentation and repair
  - Strategies to overcome 'quench', and 'field/radiation emission' and to maintain moderate cryogenic load
  - Improvement of gradient and achievement of adequate yield
  - Long-term and alternate approach for gradient improvement and for cost-reduction in industrialization
- Strategy for the ILC accelerator gradient
  - Concept of average accelerator gradient and spread
  - Overview and scope of 'production yield' progress and expectation for TDP including acceptable spread needed to achieve the specified average gradient
  - Specification of gradient, Q0, emitted radiation in vertical test including the spread and yield
  - Specification of gradient, cryogenic-load, and radiation in cryomodule test (without beam)
  - Specification of gradient, cryogenic load in accelerator operation (with beam)
  - Strategy to define and specify 'emitted radiation' (radiation that may result in increasing cryogenic-load and usable gradient)
  - Strategy for tuning and control, including feedback, control of 'Lorentz force detuning', tolerances and availability margin
  - Impact on other accelerator systems: CFS, HLRF, LLRF, cryogenics, and overall costs

# ILC R&D Plan Release 5

***ILC Research and Development Plan for the Technical Design Phase***

**Release 5**

**August 2010**

ILC Global Design Effort

Director: Barry Barish

Prepared by the Technical Design Phase Project Management

Project Managers: Marc Ross
Nick Walker
Akira Yamamoto

The primary R&D goals for SCRF include:

- Cavity: The primary R&D goal remains the demonstration of a field gradient of ≥35 MV/m at $Q_0 = 8\times10^9$ (operation at 31.5 MV/m at $Q_0 = 10^{10}$) with a production yield of ≥90%. (Designated as S0.) High-gradient R&D with single-cell and 9-cell cavities for R&D into: materials; mechanical forming; surface-preparation process; and vertical testing.

- Cavity-integration: Plug-compatible cavity-package design and integration including tuner, input-coupler, He-vessel and magnetic shield, and the cavity string test with an average field gradient of 31.5 MV/m in one cryomodule. Designated as S1 and S1-global program. In parallel to the on-going effort on field gradient improvement,

# Gradient Goal and Timeline

Table 4-1: Milestones for the SCRF R&D Programme

| Stage | Subjects | Milestones to be achieved | Year |
|---|---|---|---|
| S0 | 9-cell cavity | 35 MV/m, max., at $Q_0 \geq 8\times10^9$, with a production yield of 50% in TD PHASE 1, and 90% in TD PHASE 2 [1), 2)] | 2010/ 2012 |
| S1 | Cavity-string | 31.5 MV/m, on average, at $Q_0 \geq 10^{10}$, in one cryomodule, including a global effort | 2010 |
| S2 | Cryomodule-string | 31.5 MV/m, on average, with full-beam loading and acceleration | 2012 |

1. The process yield of 50 % in TDP-1, in the R&D Plan (release 2), has been revised to be the production yield of 50 % in the TDP-1.

2. A quantitative evaluation of radiation emission is to be included in the milestone list in near future.

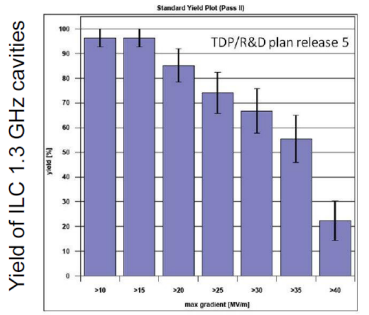
# Gradient Progress Reported by Barry at ICHEP2010 Well Received by Community

## Now the challenge is 90% yield by 2012

### 1. Beam Power Challenge

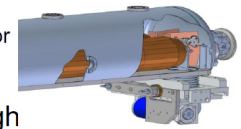
- Many critical technologies
  - Targets, collimators and dumps, materials, MPS, SCRF, …

Barry Barish, Saturday session




- LHC beam will be ~350 MJ
  - Beam collimation challenge!

Metallic collimator to reduce $Z_{\perp}$

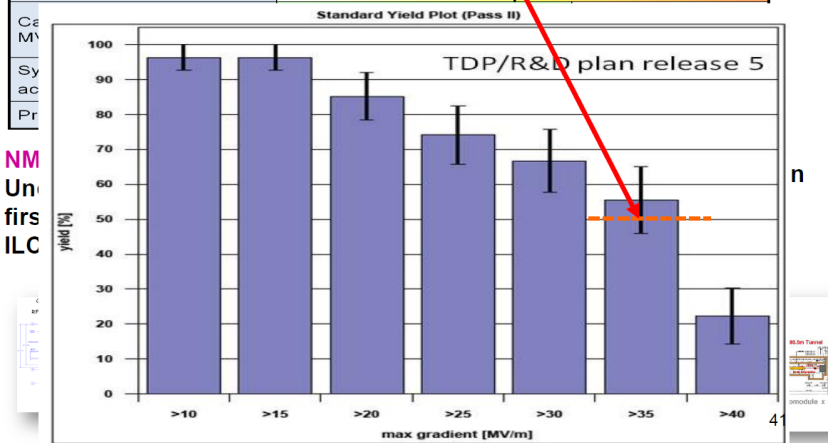


- SCRF → high power proton beams for a number of new applications:
  - Neutrino beams
  - Neutrino factory & Muon Collider
  - Accelerator Driven Systems (sub-critical reactors) and transmutation of waste

Tor Raubenheimer, ICHEP2010

***Successful ILC Super Conducting RF developments in global collaboration***

| Year | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|
| Phase | TDP-1 | | TDP-2 | | |
| Cavity Gradient in v. test to reach 35 MV/m | → Yield 50% | | → Yield 90% | | |



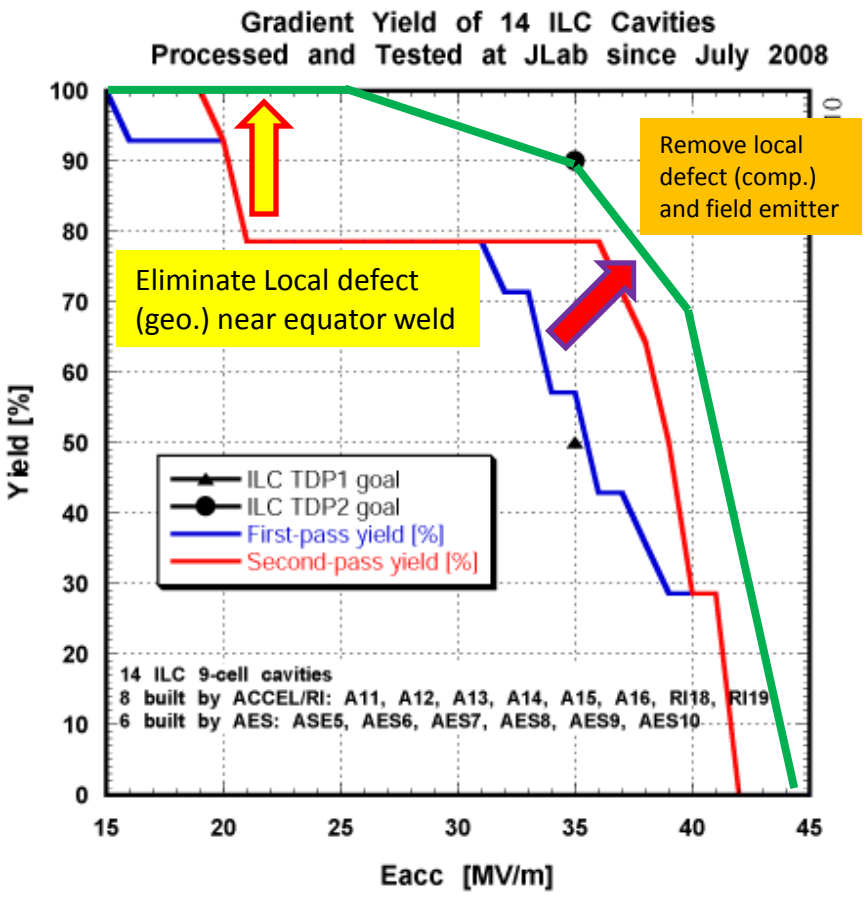

J.P.Delahaye, ICHEP2010

# Questions

- Is 90% yield by 2012 a defendable goal given the limited available resources?
- By now, it is fairly established that yield drop near 20 MV/m is due to quench at highly localized sub-mm sized defect from fabrication and/or material, is it possible to realize early defect detection by optical or other means prior to "damage layer" chemistry – followed by effective defect removal?
- Are there any planned immediate changes in cavity fabrication behaviors of near future cavity procurements that may lead to improved results in the next two years?
- PM's list of discussion items cover broad topics – but the time for discussion is rather limited. What should we be focused on so as to reach agreement?

# Gradient Improvement Plan

Based on Recent Understanding due to Globally Coordinated S0 Program




- Highest priority is to push yield up near 20 MV/m – the yield drop due to local (geometrical) defects near equator weld.
  - Fab. QA/QC
  - Mechanical polish prior to heavy EP
  - Post-VT local targeted repair
  - Seamless cavity
  - Large-grain mat. From ingot slicing
  - Fine grain mat. Optimization
- Also high priority is to suppress field emission at high gradient (up to 42 MV/m) – and quantify its effect on cryogenic loss and dark current.

# BAW1 Cavity Gradient Agenda Sept. 9

- Cavity Gradient R&D-1 (Convener: Hitoshi Hayano, KEK)
  - Technical address (Akira)
  - Overview of gradient R&D progress (Rongli)
  - ILC Cavity database progress (Camille)
- Cavity Gradient R&D-2 (Convener: Eiji Kako)
  - Regional R&D status & future plan: Europe (Sebastian)
  - Regional R&D status & future plan: Americas (Mark)
  - Regional R&D status & future plan: Asia (Hitoshi)

# BAW1 Cavity Gradient Agenda Sept. 9 (cont.)

- Strategy for Cavity Gradient Improvement (Convener: Echard Elsen)
  - Near term R&D and improvement program in TDP-2
    - XFEL/HiGrade. Speaker:
    - Mechanical polishing. Speaker:
    - Repair methods. Speakers:
    - “destructible” R&D cavities. Speaker:
    - New vendor developments. Speakers:
  - Long term R&D and improvement scoping TeV collider
    - ACD shape cavities. Speakers:
    - Seamless cavities and Nb-Cu clad material cavities. Speakers:
    - Thin film coated cavities. Speakers:
  - R&D for lowering cost per MV/m
    - Large grain cavities, vertical EP, Bulk removal by BCP etc.
- R&D Plan and Discussion (Convener: Rongli Geng)
  - General discussions
    - Field emission induced radiation quantification
  - Summary and recommendations