ILC Energy Upgrade Paths to 3 TeV

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Where does the ILC stand today?

Japanese inches forward with plans to host next big particle collider

ILC Readiness

- ILC remains the most technologically mature of all possible options for Higgs Factory at 0.15 TeV
- With EXFEL operating: 800 cavities, 100 CM
- ILC is ready for an expedient start
- World-wide SRF infrastructure and capability exists
- Baseline cost has been reduced from 8 B to < 5.0 B by starting at 0.25 TeV instead of 0.15 TeV
  - Plus manpower + detector
  - 40% Cost reduction from TDR
  - 35 MV/m gradients for cavities and 33.5 MV/m for cryomodules can be expected from the current state of the technology.

ILC 1 TeV: Paths for 45 MV/m, Q = 2 x 10^10

A. Two step final baking (75C/120C)/ with Cold Electropolishing
   40 – 50 MV/m

B. Nitrogen Infusion 40 – 45 MV/m

1. From nitrogen doping for high Q
2. BUT Very sensitive to furnace quality, hard to implement

ILC Luminosity and Energy Upgrades Potential

- Q advances in SRF will allow the ILC baseline luminosity to be upgraded by 6 for Higgs Factory, to be competitive with the proposed FCCee, but at substantially lower cost.
- A strong physics attraction of ILC is the inherent energy upgradeability of ILC
- 0.5 TeV, 1 TeV, 2 TeV & 3 TeV...
- And clean e+ e- physics to the next century
- With expected SRF cavity performance upgrades to 45, 55, and 70 MV/m
- Over the next decades, to the next century!
- After-burner, plasma-wakefield accelerator (PWFA) with gradients of many GeV/m would open the door to
  - 10 – 30 TeV
- The competition for Higgs Factories: FCCee and CepC – top out at about 380 GeV energy due to synchrotron radiation limits

ILC 2 TeV Option 1 – 55 MV/m

55 MV/m with

- Advanced cavity shapes (e.g. low-loss) with lower Hpk/Eacc=> 50 – 52 MV/m, demonstrated in 1-cell
- + Best surface treatment, e.g. Two-Step Baking (75/120C) => 50 x 1.2 => 60 MV/m

ILC 2 TeV - Option 2 – 70 MV/m

70 MV/m with Travelling Wave Structures

- Epk/Eacc = 1.73, Bpk/Eacc = 2.88 m/Tev/MV/m, R/Q = 2126 W/m TESLA cav. 2.0 – 4.26 => 1037
- 48% higher gradient than best TESLA => 74 MV/m

- Many Challenges => Long development (2 – 3 decades?)
- High circulating power in return waveguide
- Cavity fabrication, processing must deal with (roughly) double the number of cells per meter of structure.
- Careful tuning to achieve TW operation
- HDM studies
- Effort started

Conclusions

- Several options explored for ILC energy upgrade to 2 TeV and 3 TeV
- Attractive possibilities open up with TW structure
- 70 MV/m!
- Hpk/Eacc 48% lower than for TESA structure
- R/Q is 2 X higher
- => lower cryo cost, lower RF power, lower AC power
- Can continue to use Nb technology
- ILC 3 TeV comparable in cost to CLIC 3 TeV
- But substantially lower AC power e.g. 400 vs 600 MW
- ILC decision makers in Japan should be encouraged by these possibilities of HEP in Japan.

ILC 3 TeV

Option 1

70 MV/m with Travelling wave
Continue to use Nb

Option 2

80 MV/m with Nb3Sn (4.2 K)
Extrapolated result for High Power Pulsed measurements at high T
or Overlayers

3 TeV Parameters, High Level
(Detail parameters available in paper)

Compared to CLIC 3 TeV

Note: ILC 0.25 TeV = 5 B ILCU, ILC 0.5 TeV = 7.8 B ILCU