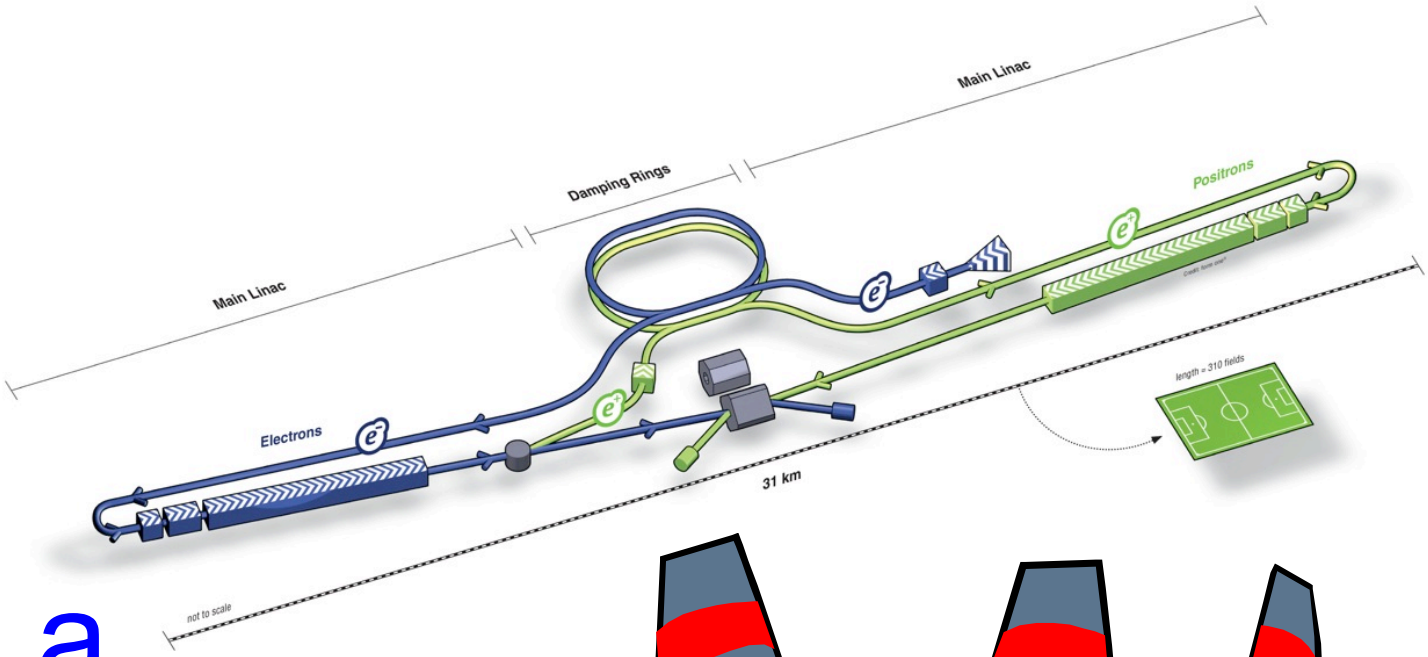


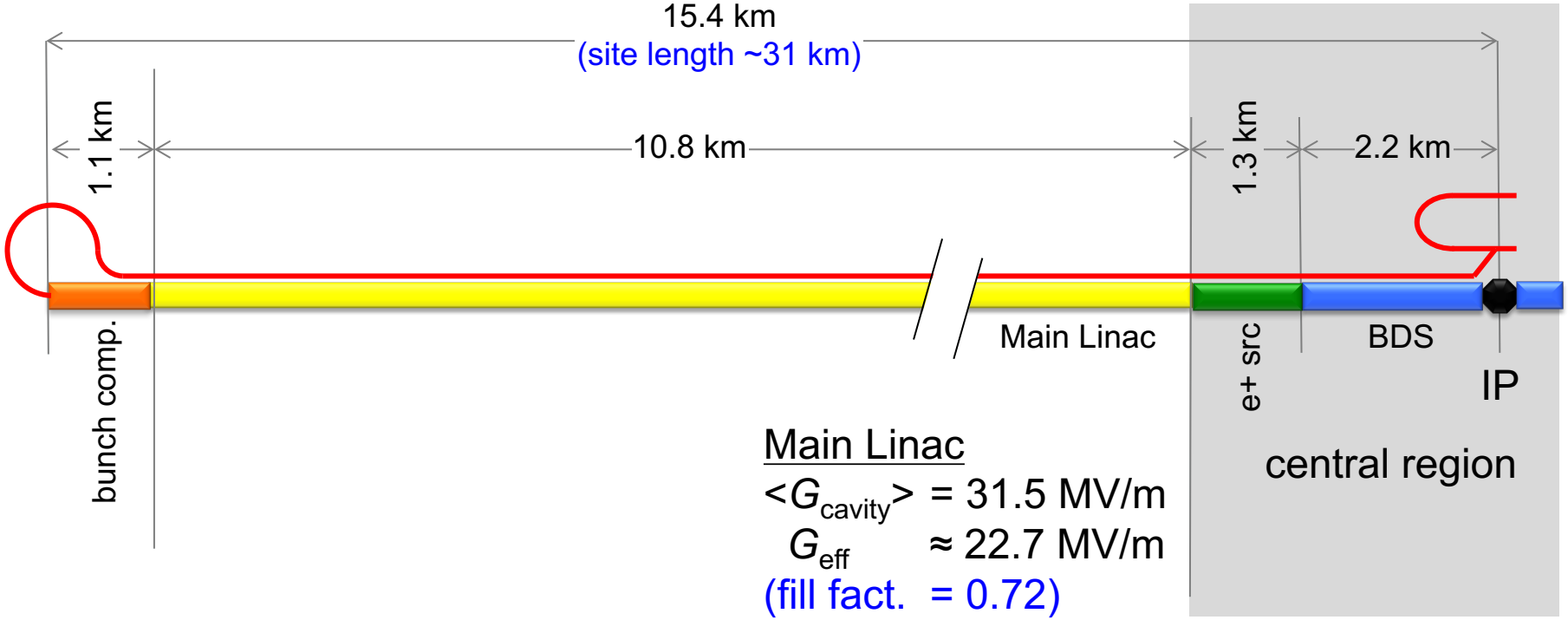
ILC as a Higgs Factory

Nick Walker (DESY)

What's in store

- **Halving the energy of the TDR machine**
- **Benchmark cryomodule cost (XFEL)**

TDR 500 GeV Baseline



Main Linac

$\langle G_{cavity} \rangle$ = 31.5 MV/m

G_{eff} ≈ 22.7 MV/m

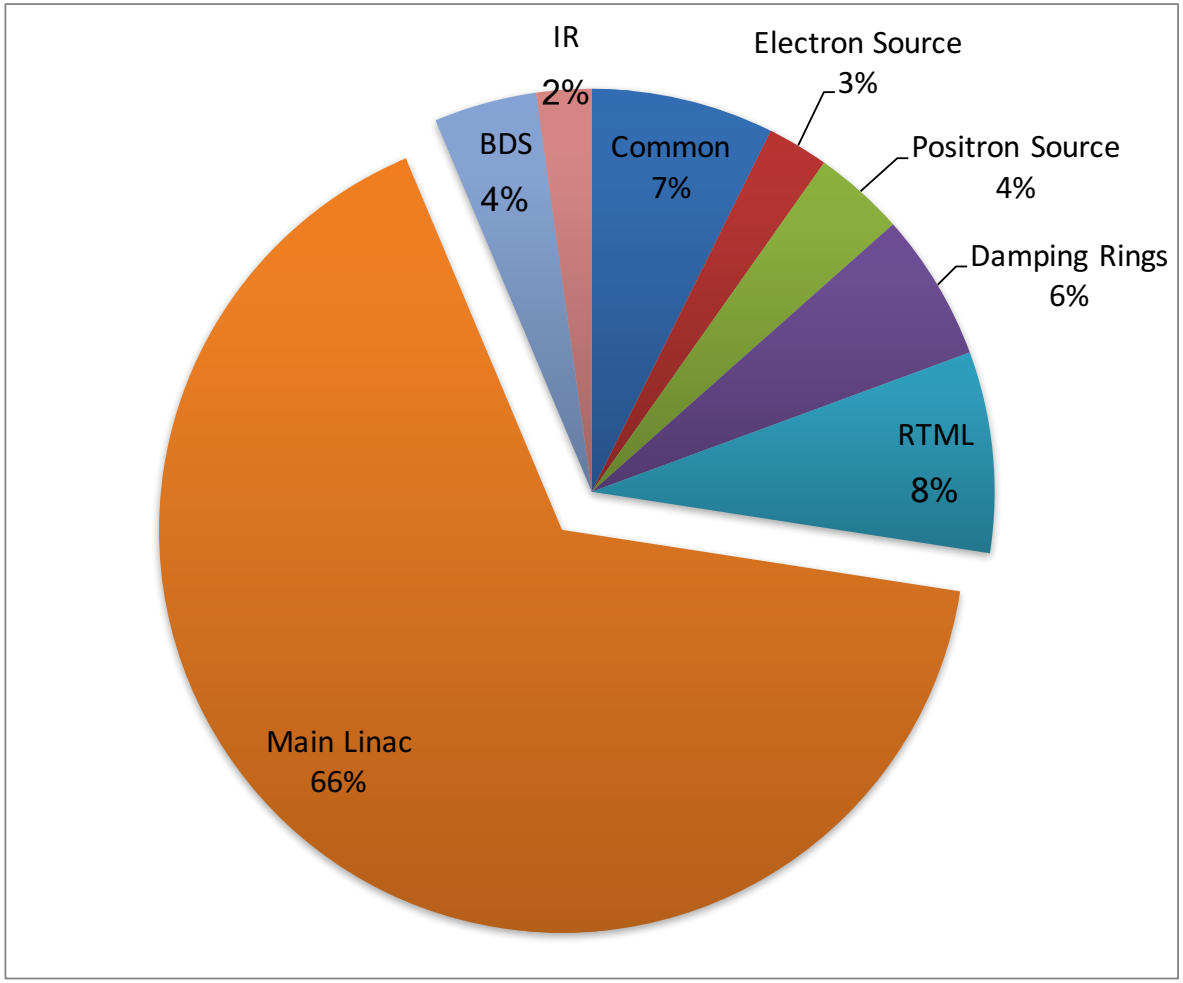
(fill fact. = 0.72)

Cost: 100%

P_{AC}: 161 MW

TDR Baseline Relative Costs

By accelerator sub-system



TDR Baseline Relative Costs

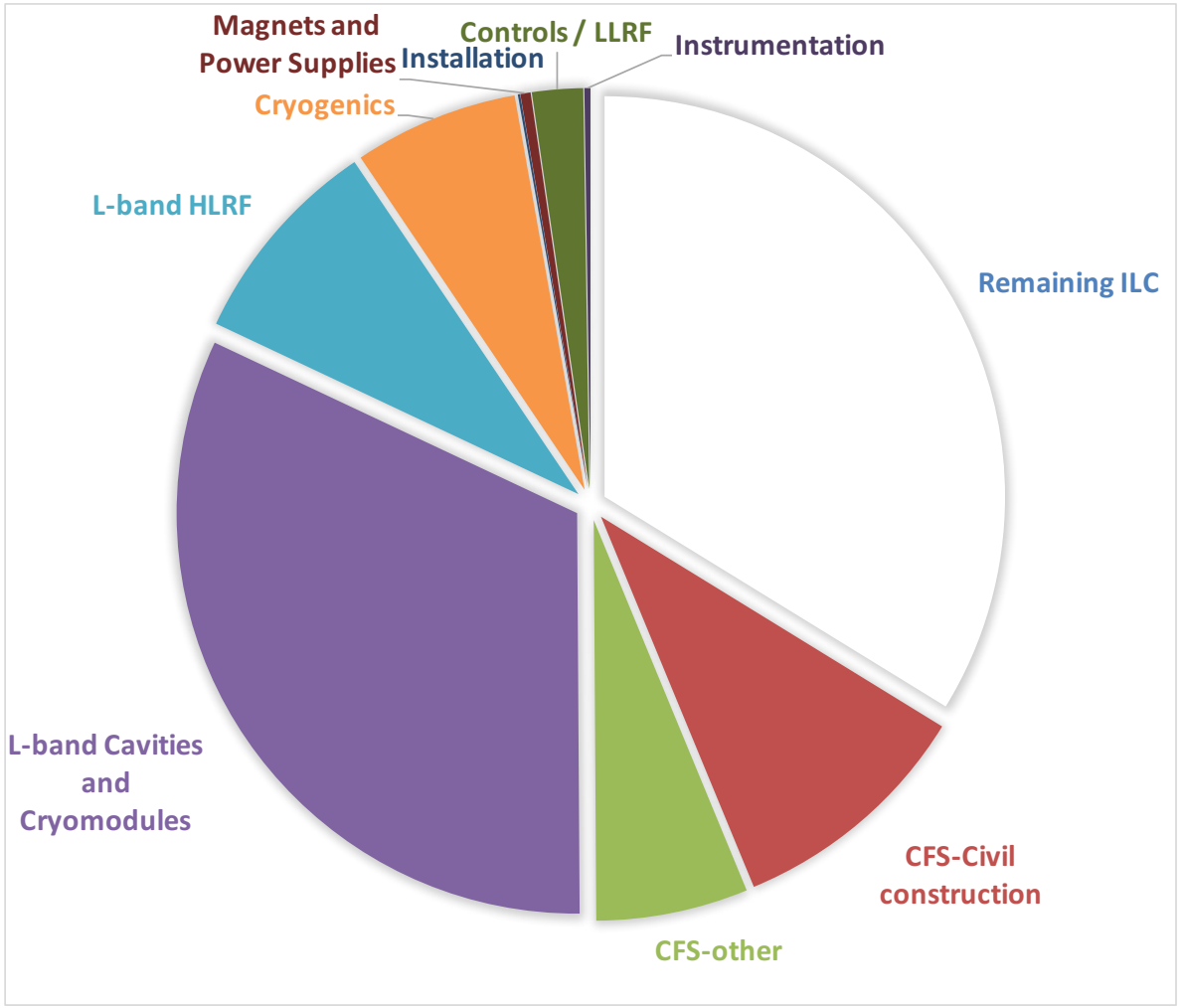
Main linac breakdown (Tech. sub-systems)

Main linac ~50% cost of ILC (not including CFS)

Simple Cost Scaling:

Assuming 500 GeV infrastructure maintained (CFS)

➜ 250 GeV ~25%
➜ 350 GeV ~15%

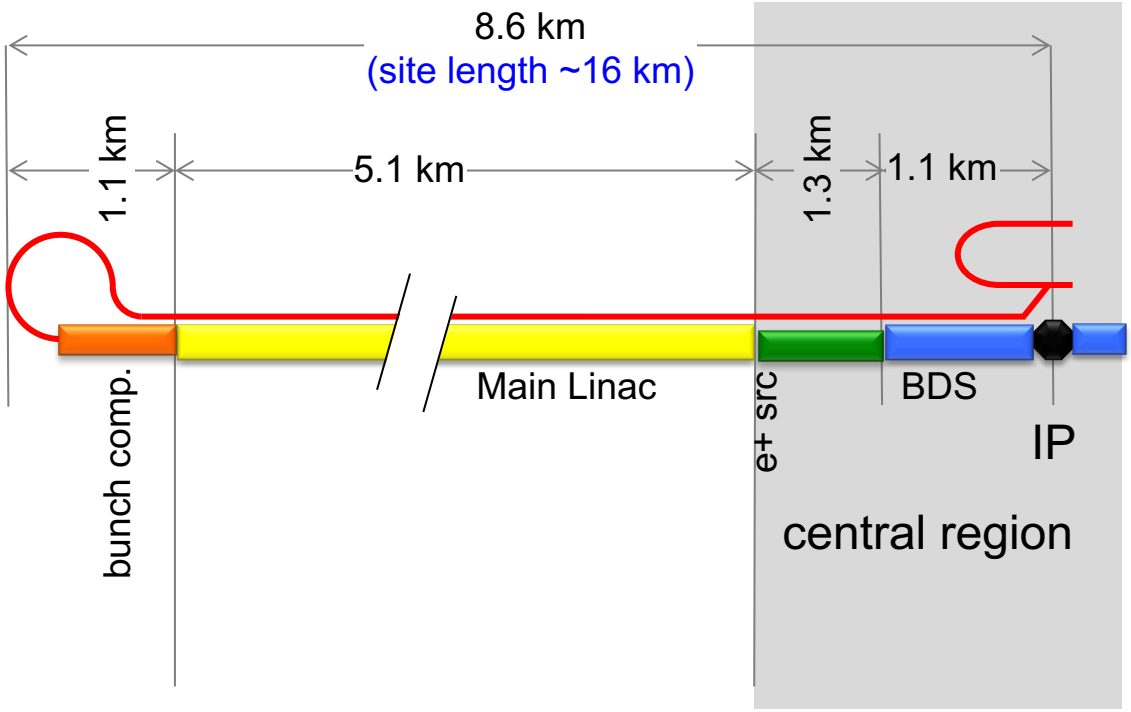


250 GeV Only

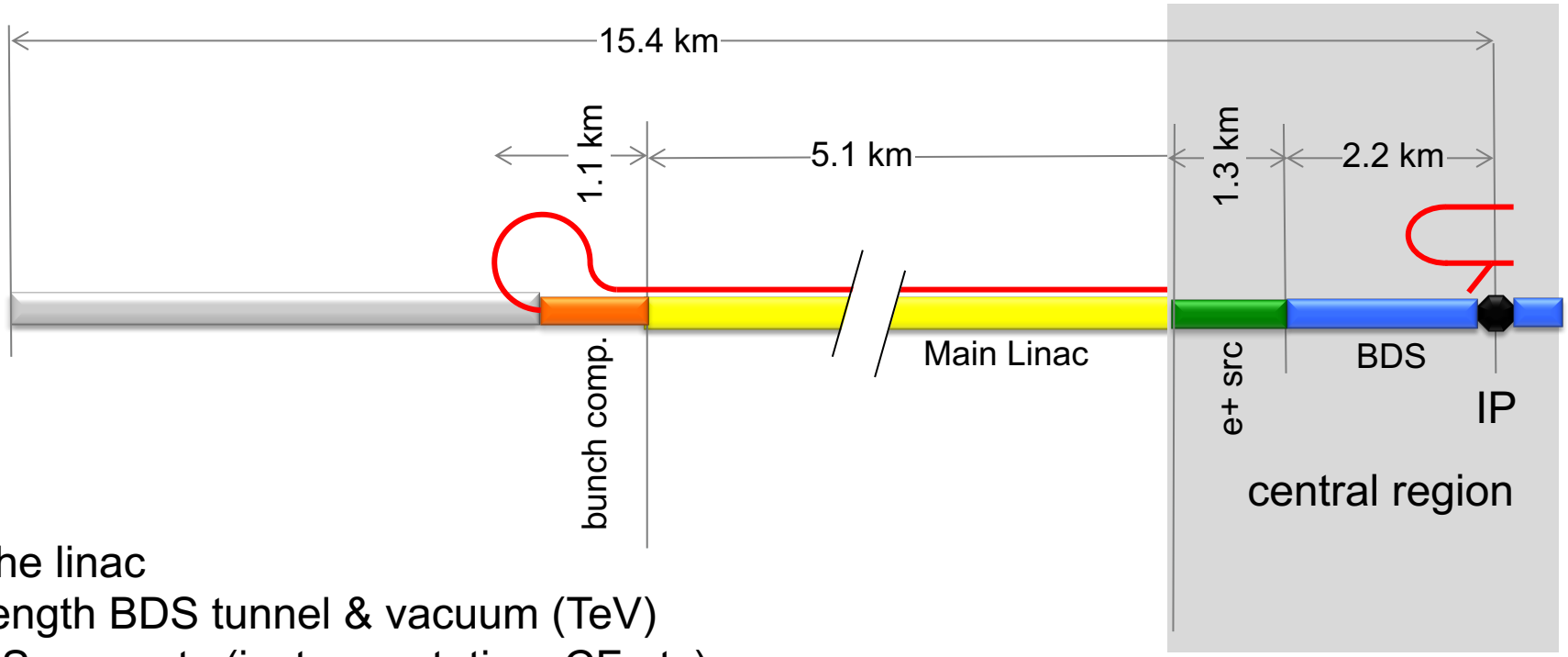
Half the linac
Shorter BDS ½

RTML LRL ½

10Hz mode e- linac
for pol. e+ production



250 GeV staged (scenario 1)

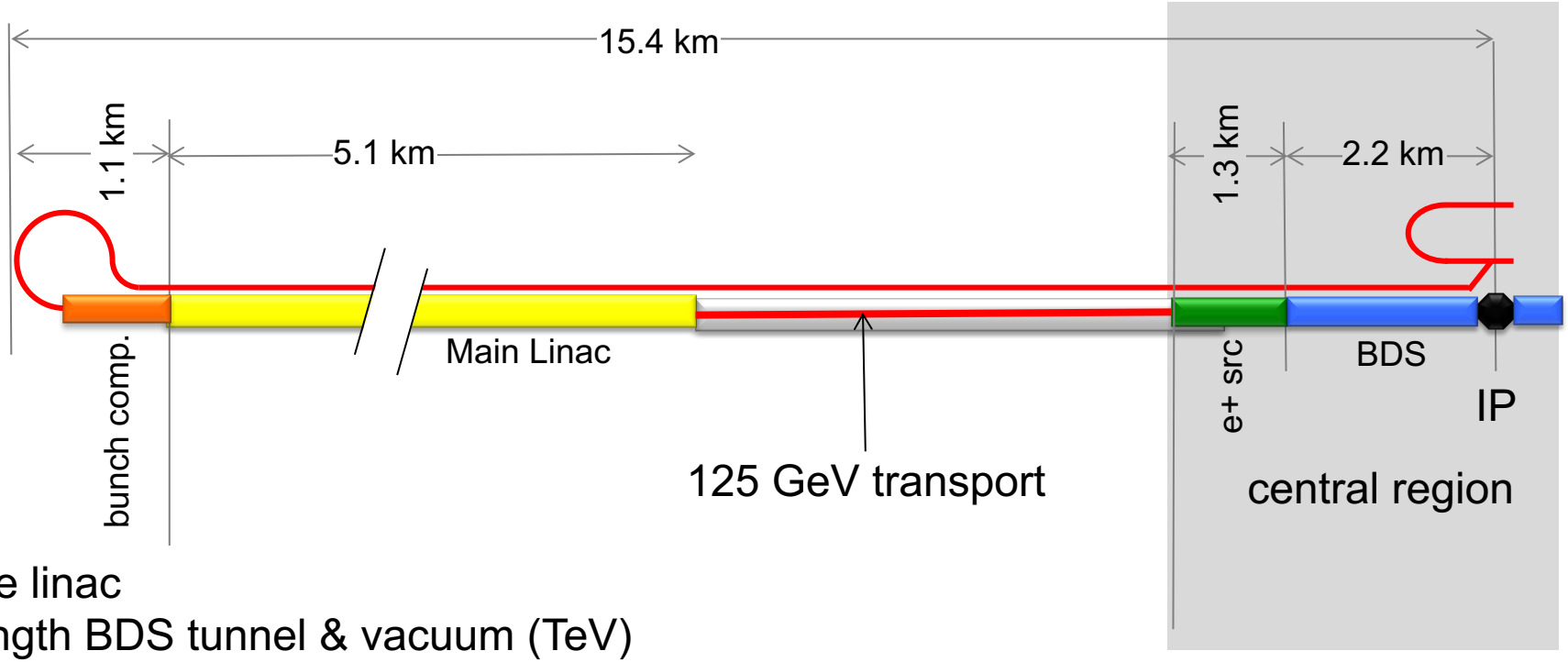


Half the linac
Full-length BDS tunnel & vacuum (TeV)
½ BDS magnets (instrumentation, CF etc)
½ RTML LTL

Extended tunnel/CFS already 500 GeV stage

10Hz mode e- linac

250 GeV staged (scenario 2)



Half the linac
Full-length BDS tunnel & vacuum (TeV)
½ BDS magnets (instrumentation, CF etc)
1 RTML LTL
5km 125 GeV transport line

quasi-adiabatic energy upgrade?

Extended tunnel/CFS already 500 GeV stage

10Hz mode e- linac

Summary

	TPC	MW
Minimal Higgs Machine	67%	120
Full tunnel scenario 1	73%	120
Full tunnel scenario 2	75%	125
Remove 10-Hz op.	-3%	-25

Warning!
Approximate Scaling Only!
Highly likely to change

Cryomodule cost: from XFEL to ILC

- **XFEL final costs are now completely known**
  - Small tweaking still on-going, mostly institutional labour costs
- **XFEL cost breakdown available for**
  - Cryomodule
    - Niobium
    - Cavity fabrication
    - HP coupler
    - Tuner
    - Quad package
  - Testing (cavity, cryomodule, HPC processing)
    - Infrastructure
    - Labour cost
    - Operations cost (kW)

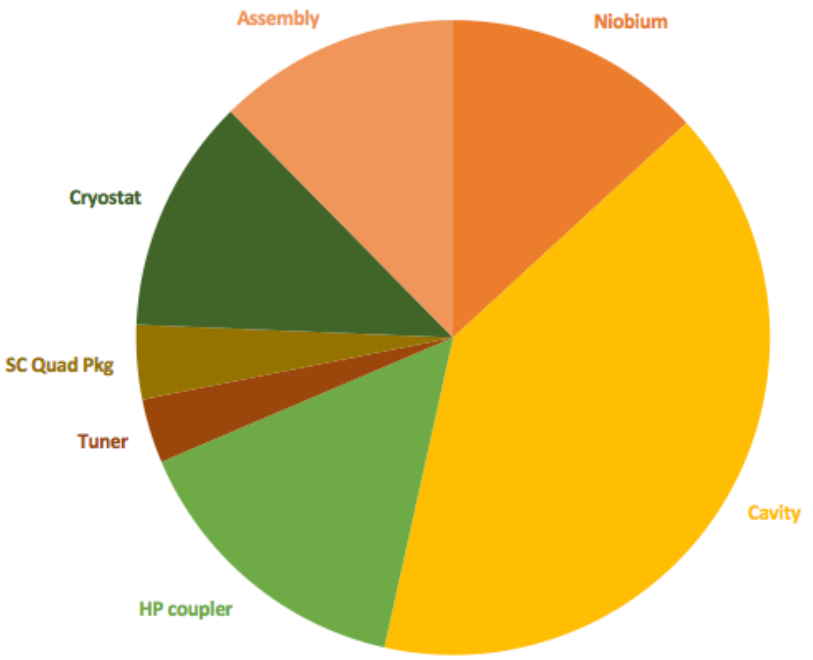
Cryomodule cost: from XFEL to ILC

- **ILC estimate (TDR) has very detailed breakdown**
  - More depth than I have for XFEL
- **Institution labour reported as hours**
  - Cavity and cryomodule testing
  - HP coupler processing
- **Despite difficulties, will attempt a comparison**
  - XFEL module cost can be taken as “state of affairs” as of today.

Cryomodule Cost

Module costs without testing

XFEL: 100 modules



~1.7 M$ (2012)

ILC: 1850 modules

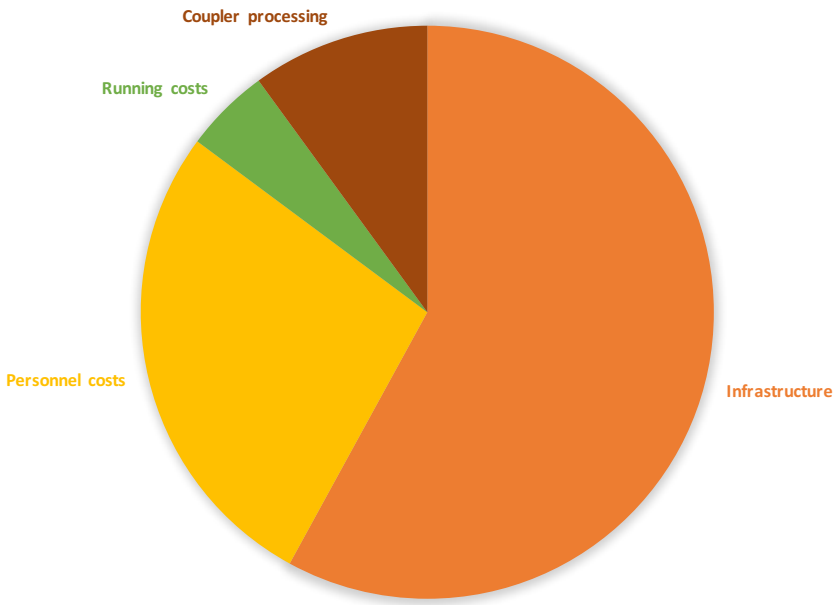
~1.2 M$ (2012)

Comments (cavity cost)

- **ILC module costs predominantly based on XFEL costs**
- **Application of 95% slope learning curve applied**
  - Assumed two-vendor model ➜ ~15% reduction
- **Exception: cavity**
  - Bottoms-up cost study (by RI)
  - Assumed 3 year production of 50% of cavities (~8000)
  - Investment in high capacity infrastructure (reduction of manpower per cavity)
  - Currently looking at 3x2=6 vendors for 5-6 year production
- **50% cost reduction over XFEL to achieve TDR possible but will require work**
  - Industrialisation, design for manufacture, R&D…

Cryomodule costs (testing)

XFEL
1 test per module
1.4 tests per cavity



~0.76 M$ (2012)

Includes 100% of infrastructure cost

ILC (TDR)
0.33 tests per module
1.2 tests per cavity

~0.21 M$ (2012)

Includes 50% of infrastructure cost

Comments (on testing)

- **Largest cost reduction is 1-in-3 testing rate**
  - Also ‘rent’ mode of infrastructure (50% cost)
  - Amortisation of infrastructure cost over larger production volume
- **For XFEL, cost of testing is second biggest cost driver**
  - Next to cavities
- **1-in-3 testing model would not have worked for XFEL**

Final comments

- **Based on current TDR cost estimate, halving the energy reduces the total cost by 25%**
  - Main Linac is 50% of TPC (not including tunnel)
- **'Minimum' 250 GeV machine could achieve ~33-36%**
  - But not as easy to upgrade later
- **Plenty of scope for further cost reduction**
  - Many many 1-2% effects (not just SRF R&D!)
  - Requires good Value Engineering (i.e. resources!)
- **Also Plenty of Scope for cost increase!**
  - Cost of XFEL module still 50% higher than ILC goal
  - 31.5 MV/m average operation still requires some work

Backup

250 GeV CM (as first stage)

Relative to TDR 500 GeV baseline (1312 bunches)

Two stage compressor (5-15 GeV)

Half linacs solution

G = 31.5 MV/m

250 GeV CM (as first stage)

Relative to TDR 500 GeV baseline (1312 bunches)

Two stage compressor (5-15 GeV)

Half linacs solution

G = 31.5 MV/m

POSITRON linac straightforward

~50% ML linac cost (cryomodules, klystrons, cryo etc.)

~50% ML AC power

250 GeV CM (as first stage)

Relative to TDR 500 GeV baseline (1312 bunches)

Two stage compressor (5-15 GeV)

Half linacs solution
G = 31.5 MV/m

POSITRON linac straightforward

~50% ML linac cost (cryomodules, klystrons, cryo etc.)

~50% ML AC power

ELECTRON linac needs 10Hz mode for e+ production

ΔE = 135 GeV instead of 110 GeV (+25 GeV)

~57% ML linac cost (cryomodules, klystrons etc)

10Hz needs (1/2 linac × 10Hz/5Hz):

100% ML AC power (1/2 linac × 10Hz/5Hz)

80% cryo cost (50% static + 100% dynamic)

250 GeV CM (as first stage)

Relative to TDR 500 GeV baseline (1312 bunches)

Two stage compressor (5-15 GeV)

Half linacs solution
G = 31.5 MV/m

POSITRON linac straightforward

~50% ML linac cost (cryomodules, klystrons, cryo etc.)
~50% ML AC power

ELECTRON linac needs 10Hz mode for e+ production

ΔE = 135 GeV instead of 110 GeV (+25 GeV)
~57% ML linac cost (cryomodules, klystrons etc)

10Hz needs (1/2 linac × 10Hz/5Hz):
100% ML AC power (1/2 linac × 10Hz/5Hz)
80% cryo cost (50% static + 100% dynamic)

Total Main Linac infrastructure	
Linac components:	50%
Cryogenics:	65%
RF AC power	75%