ILC Cryomodule WBS

1 Level 1

This is an example of the type of information I think would be useful to concisely document.

Note that it is heavily centred on the choice of baseline.

1.1 Component

1.1.1 requirements

The basic requiremens / specifications for the component. If we cannot specifcy them exactly because it depends on some other choices (outside the scope of this breakdown), then those dependencies should be stated.

1.1.2 baseline

the suggested baseline choice.

Note that for the Baseline Configuration Document (BCD), we want to attempt to identify a single baseline solution, even if we believe this will get superceeded later by 'an option'.

1.1.3 baseline justification

The justification for why we believe this should be the (current) baseline.

1.1.4

1.1.5

1.1.6 baseline status

The current status of the baseline choice, including known limitations that required further R&D. We might consider putting information about cost here.

1.1.7 foreseen/required baseline R&D

List of on-going R&D on the baseline (including industrialisation studies). We might want to indicate R&D that's known to be needed but is currently not happening (lack of resources?)

1.1.8 options

Options should be effectively parallel R&D paths that may possible lead reduced cost, increased performance (or both). The GDE will probably only directly support a limited number of such options.

opt 1

For each option some brief text about the pros and cons for the option would be useful.

opt 2….

2 General Parameters

2.1 Gradient

2.1.1 requirements

2.1.2 baseline

35 MV/m (for 1TeV)

Defines maximum length of tunnel.

2.1.3 baseline justification

(1) **Proof-of existence**

2.1.4 baseline status

(1) **Reliability of preparation process is not yet sufficient**

(a) **Field emission is the major source**

(b) **Thermal conductivity needed is unclear**

2.1.5 foreseen/required baseline R&D

(1) **Improved preparation needed**

(a) **Reduction of field emission**

(b) **Improved understanding of the (electro-)chemical process**

(2) **Understanding the Q-slope/bakeout effects**

(a) **Basic research on superconducting properties of Nb needed**

(b) **Improving process to be easily applicable**

(3) **XFEL cavity preparation**

(4) **Operability a gradients close to limit**

2.1.6 Options

25-45 MV/m

The choice of baseline gradient is (to some extent) linked with the cavity design. I assume that "very high gradients" (i.e. >35MV/m) would probably mean a new cavity shape.

2.2 Cryogenics

2.2.1 requirements

2.2.2 baseline

2 Kelvin

2.3 Dark current

Again, as with Cryogenics, this is a place holder to state the requirements (limits) on the dark current. This is an important parameter that needs to appear here (in my opinion).

3 Cavity Package

3.1 1 cavity

3.1.1 requirements

3.1.2 baseline

TESLA 9-cell

3.1.3 baseline justification

(1) Experience with operation in TTF

(2) Fabrication experience with ~100 cavities

(3) HOM experiments with beam

3.1.4 baseline status

3.1.5 foreseen/required baseline R&D

(1) 1000 will be built for XFEL

(2) Cost reduction

(a) Large-crystal Nb material

3.1.6 options

low-loss

3.2 1 High-Powered Coupler

3.2.1 requirements

3.2.2 baseline

TTF III

3.2.3 baseline justification

- **(1) Operating experience**
  - **(a) Linac (38000 h)**
  - **(b) Endurance test in high power test stand (1100 h)**

3.2.4 baseline status

- **(1) Specific Infrastructure for testing exists**
- **(2) Industrialisation underway**

3.2.5 foreseen/required baseline R&D

- **(1) Conditioning time**
  - **(a) Improving handling to reduce and preserve pre-conditioning**
  - **(b) Conditioning procedure (e.g. interlock thresholds)**
- **(2) Cost reduction**
  - **(a) Reduce number of sensors (interlocks)**
  - **(b) Mass-production issues**

3.2.6 options

disk-shape windowscold window position change ?

3.3 2 HOM coupler

How final is the current proposed solution? Are there still questions over the HOMs? Are there cost/manufacturing issues here that need to be dealt with? Presumably the orientation of the HOM couplers has some impact on the cryomodule design?

3.3.1 requirements

3.3.2 baseline

current TTF + broadband absorber

3.3.3 baseline justification

(1) **Beam measurements**

(2) **Fabrication experience (RF mode measurements)**

3.3.4 baseline status

(1) **Broadband absorber under development**

3.3.5 foreseen/required baseline R&D

(1) **Mirrored coupler needs test**

(2) **Coupling improvement (tunability)**

(3) **Test of broadband absorber needed**

3.3.6 options

Simplication of the output line (elimination of the capacitor)

3.4 Pickup

3.4.1 requirements

3.4.2 baseline

current TTF

3.4.3 baseline justification

3.4.4 baseline status

3.4.5 foreseen/required baseline R&D

3.4.6 options

3.5 1 Tuner (including fast piezo)

3.5.1 requirements

3.5.2 baseline

lateral tuner (Saclay) or

coaxial tuner (INFN)

3.5.3 baseline justification

(1) **Tests without Piezo have been done**

(a) **Motor and gearbox have been working**

(2) **Prototypes underway**

3.5.4 baseline status

(1) **Piezo integration needs test**

3.5.5 foreseen/required baseline R&D

(1) **Test until end of 2005**

(2) **Industrialisation**

(3) **Selection of active elements**

(a) **Life-time testing**

(b) **Qualification of suppliers**

3.5.6 options

Magnetostrictive

3.6 Magnetic shield

3.6.1 requirements

3.6.2 baseline

TTF type (material), no de-magnetization of cryo vessel

3.6.3 baseline justification

3.6.4 baseline status

3.6.5 foreseen/required baseline R&D

3.6.6 options

3.7 Helium tank

3.7.1 Requirements

Depends on tuner choice

3.7.2 baseline

TTF-3 type

3.7.3 baseline justification

3.7.4 baseline status

3.7.5 foreseen/required baseline R&D

3.7.6 options

4 Quadrupole Package

4.1 SC quadrupole

4.1.1 requirements

4.1.2 baseline

TESLA TDR (CIEMAT prototype, incl. corrector windings)

4.1.3 baseline justification

4.1.4 baseline status

Prototype under test

4.1.5 foreseen/required baseline R&D

Fiducialization of quad to BPM

Cleanroom compatibility

4.1.6 options

Separate steering coils

4.2 BPM

4.2.1 requirements

4.2.2 baseline

TBD

4.2.3 baseline justification

4.2.4 baseline status

4.2.5 foreseen/required baseline R&D

4.2.6 options

reentrant cavity

4.3 Current leads

4.3.1 Requirements

needs 2K option

4.3.2 baseline

CERN LHC design (2K)

4.3.3 baseline justification

4.3.4 baseline status

4.3.5 foreseen/required baseline R&D

4.3.6 options

HTC cables?

5 Layout

5.1 number of cavities

5.1.1 baseline

8

5.1.2 baseline justification

5.1.3 baseline status

5.1.4 foreseen/required baseline R&D

5.1.5 options

any number less than or equal to 12

5.2 cavity spacing

5.2.1 requirements

5.2.2 baseline

not n*lambda/2)

5.2.3 baseline justification

5.2.4 baseline status

5.2.5 foreseen/required baseline R&D

5.2.6 options

as short as possible

TDR

5.3 quadrupole location

5.3.1 requirements

5.3.2 baseline

TDR

5.3.3 baseline justification

5.3.4 baseline status

5.3.5 foreseen/required baseline R&D

5.3.6 options

at end

5.4 Cryo tubing

5.4.1 requirements

5.4.2 baseline

TDR

5.4.3 baseline justification

5.4.4 baseline status

5.4.5 foreseen/required baseline R&D

(1) 50-80K needs review

5.4.6 options

5.5 Main supports

5.5.1 requirements

5.5.2 baseline

TTF (3 supports)

5.5.3 baseline justification

5.5.4 baseline status

5.5.5 foreseen/required baseline R&D

(1) Transport issues / Safety fixtures

5.5.6 options

(optimised position)

5.6 Thermal shieldings

5.6.1 requirements

5.6.2 baseline

TDR

5.6.3 baseline justification

5.6.4 baseline status

5.6.5 foreseen/required baseline R&D

5.6.6 options

MLI blankets

5.7 Vacuum interconnections

5.7.1 requirements

5.7.2 baseline

5.7.3 baseline justification

5.7.4 baseline status

5.7.5 foreseen/required baseline R&D

5.7.6 options

no o-rings, welded interconnections

5.8 Module Interconnection

5.8.1 requirements

5.8.2 baseline

5.8.3 baseline justification

5.8.4 baseline status

5.8.5 foreseen/required baseline R&D

(1) optimising weldibility

5.8.6 options