CLIC Re-baselining

Project Meeting, December 2012

D. Schulte for the CLIC team

Strategy

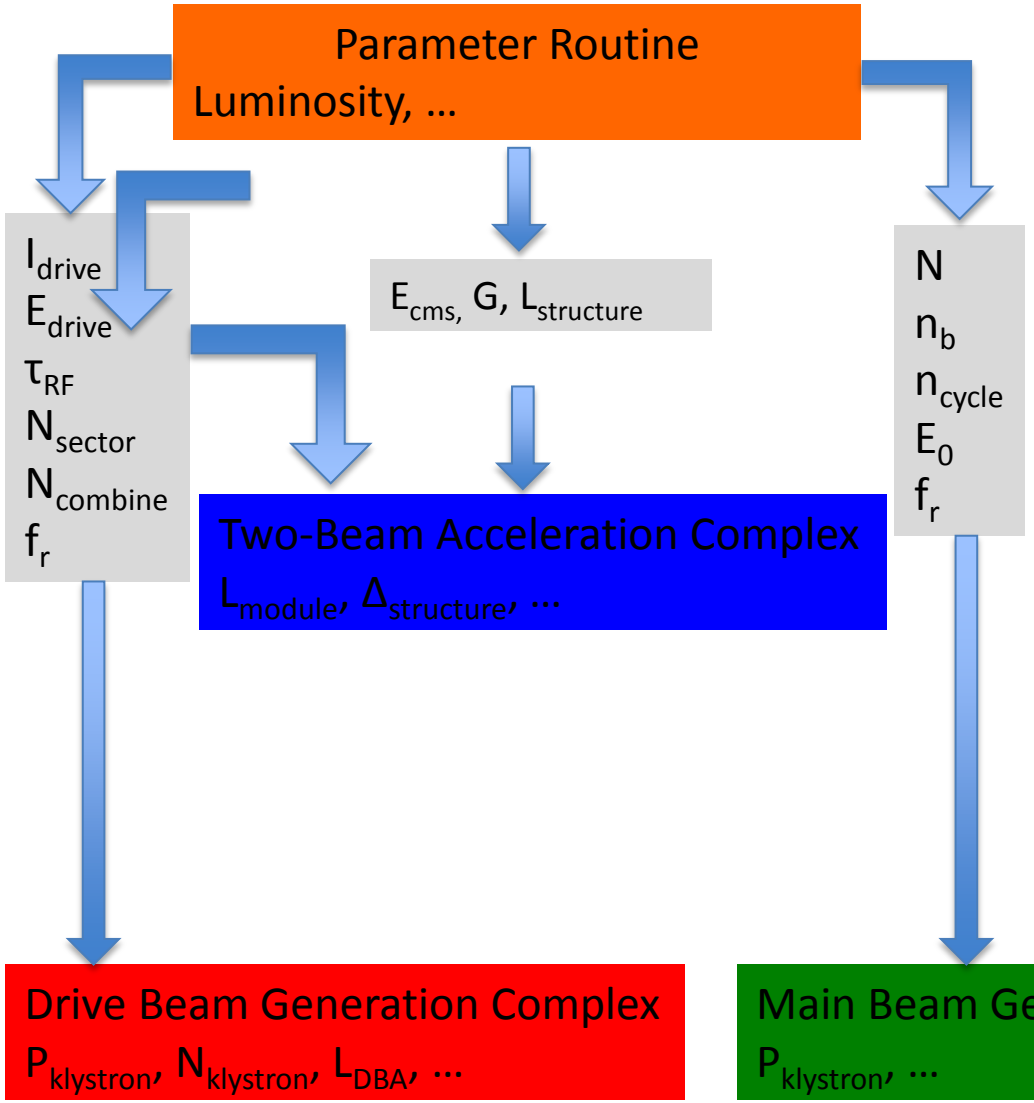
- Optimise the first energy stage
  - Focus has been on 3TeV
  - Alternative options should also be studied, most importantly a klystron-drive first stage
  - Include upgrade considerations

- Split design into relatively independent pieces
  - Including all cost, in particular also civil engineering
  - Make a simple cost model for each area for overall optimisation
  - Identify internal cost saving potential in each area and associated R&D, e.g. main linac module length
  - Study the cost saving and required R&D

- Form a discussion group for each area
  - Main beam sources: Yannis Papaphilippou
  - Drive beam generation: Roberto Corsini
  - Two-beam acceleration: Alexej Grudiev
  - Klystron-based first stage: Igor Syratchev
  - Please contact them with any good idea

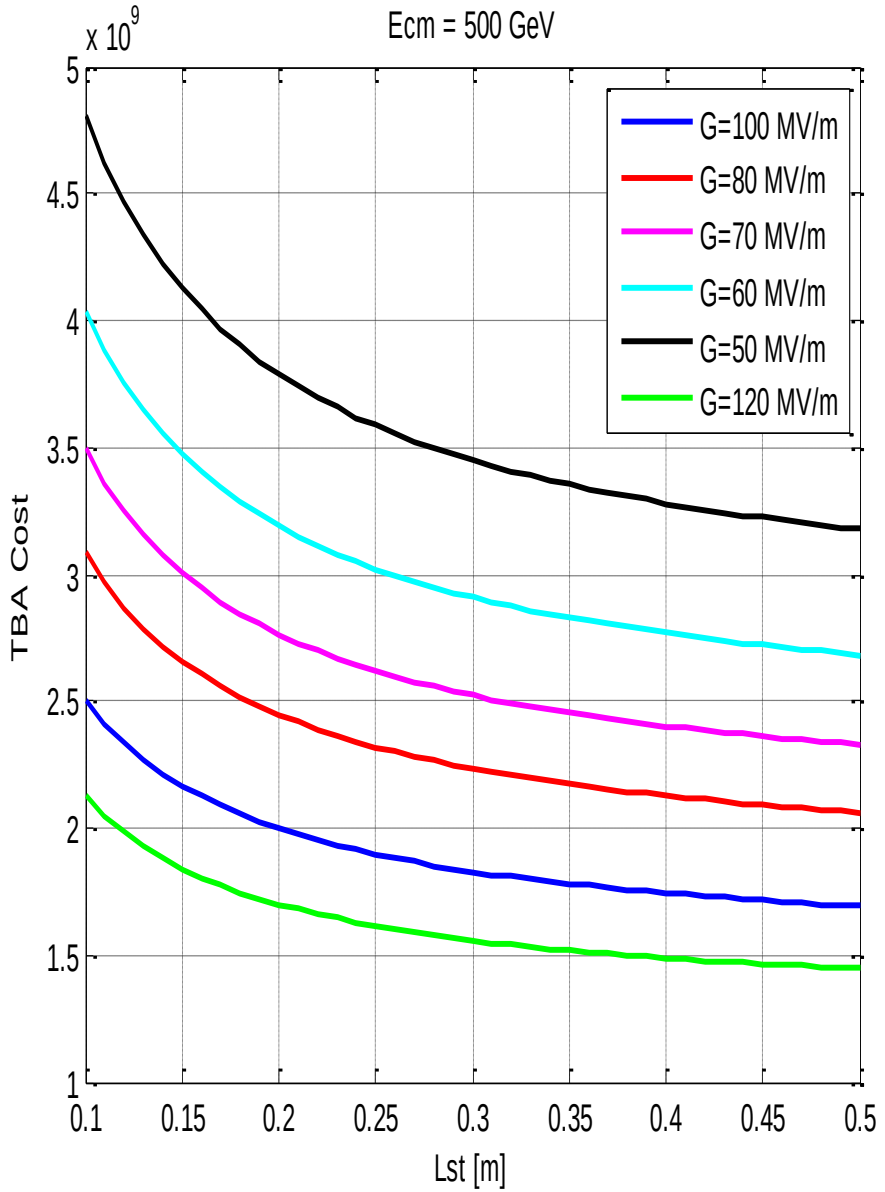
- Full optimisation in common working group
  - A number of studies can directly report to this group, e.g. klystrons and modulators

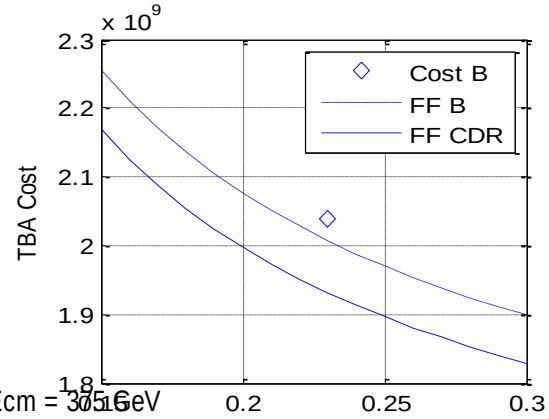
Simplified Diagram

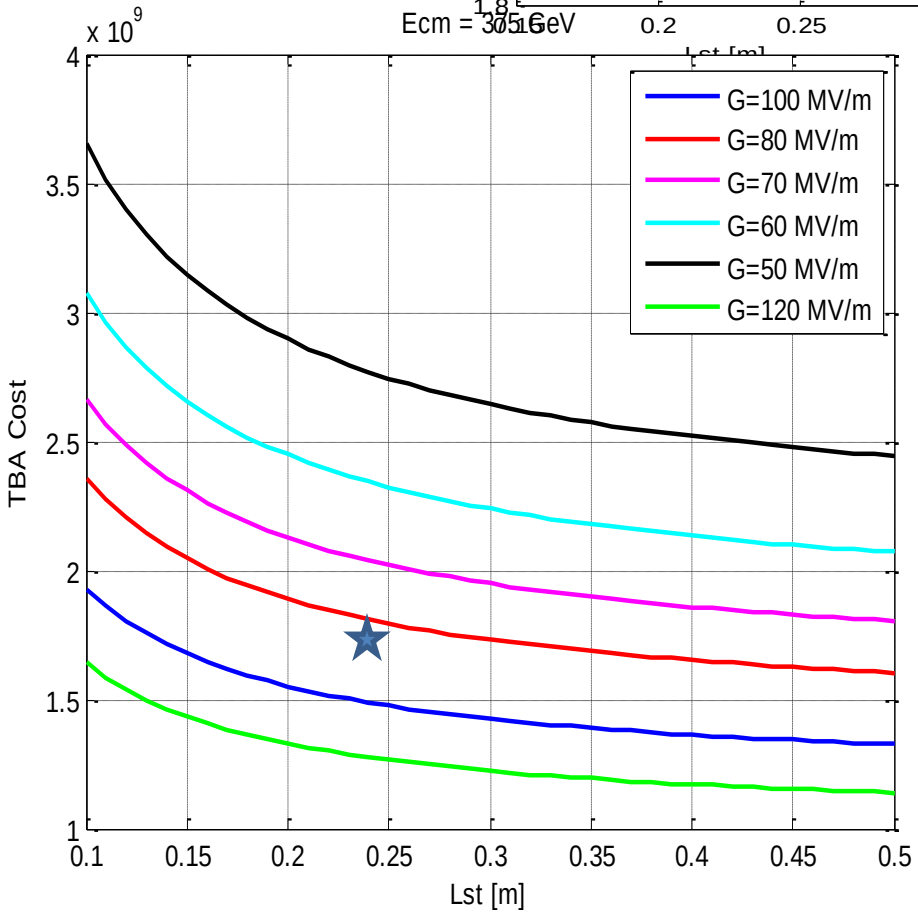


Variable	Meaning	Current value
I_{drive}	Drive beam current	101A
E_{drive}	Drive beam energy	2.37GeV
τ_{RF}	Main lianc RF pulse length	244ns
N_{sector}	Number of drive beam sectors per linac	4
$N_{combine}$	Combination number	24
f_r	Repetition rate	50Hz
N	Main beam bunch charge in linac	3.72e9
n_b	MB bunches per pulse	312
n_{cycle}	Spacing between MB bunches	6 cycles
E_0	MB energy at linac entrance	9GeV
E_{cms}	Centre-of-mass energy	500GeV
G	Main linac gradient	100MV/m

Cost vs. Structure Length

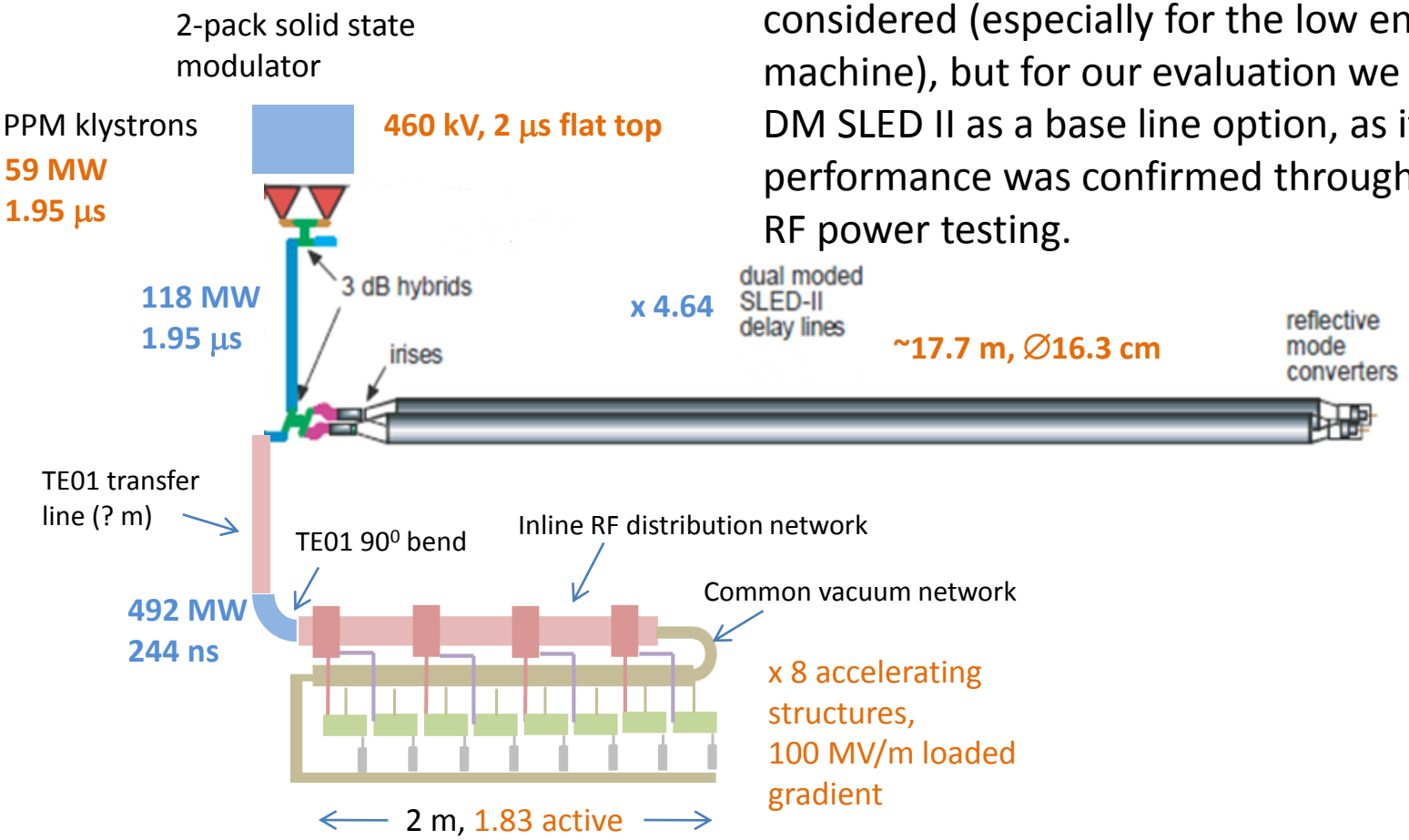






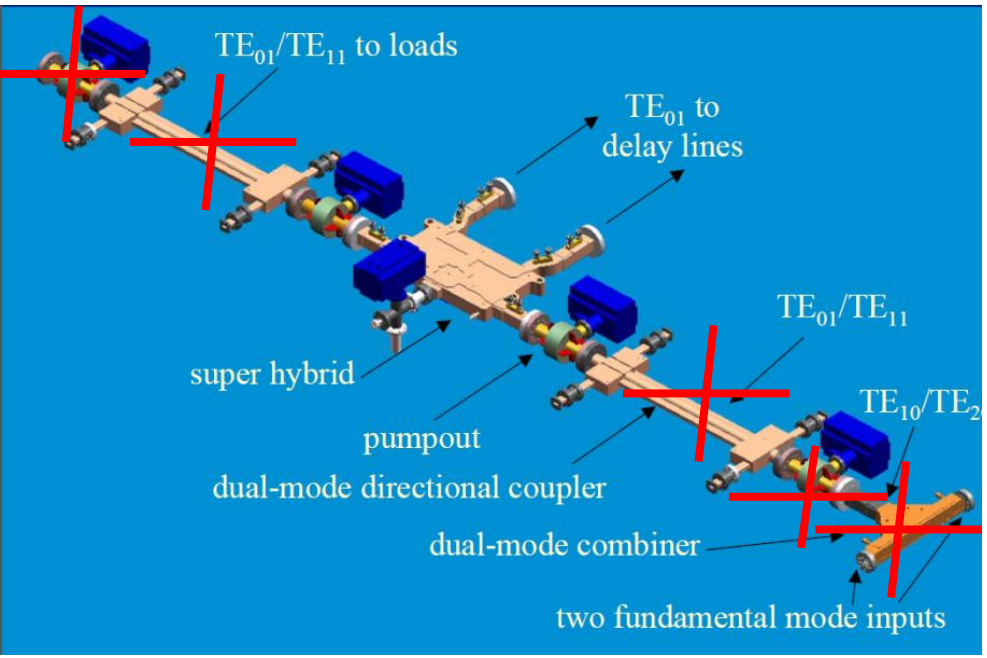
Klystron-driven First Stage: RF Unit Layout

The alternative PC schemes certainly must be considered (especially for the low energy machine), but for our evaluation we will keep DM SLED II as a base line option, as its performance was confirmed through the high RF power testing.

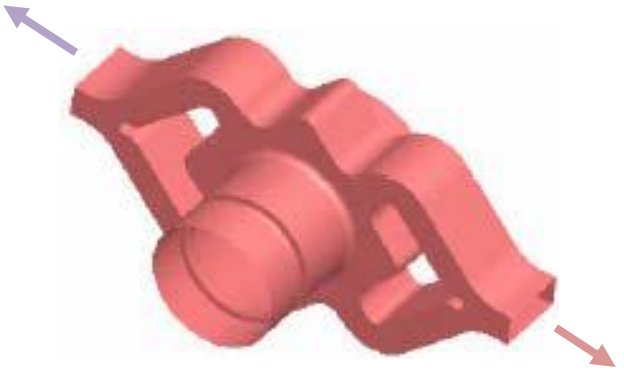


Compared to NLC, the energy gain per unit in CLIC'k case is 26% lower (need more klystrons per meter), but the unit length is ~ 3 time shorter.

RF Pulse Compressor and Distribution System

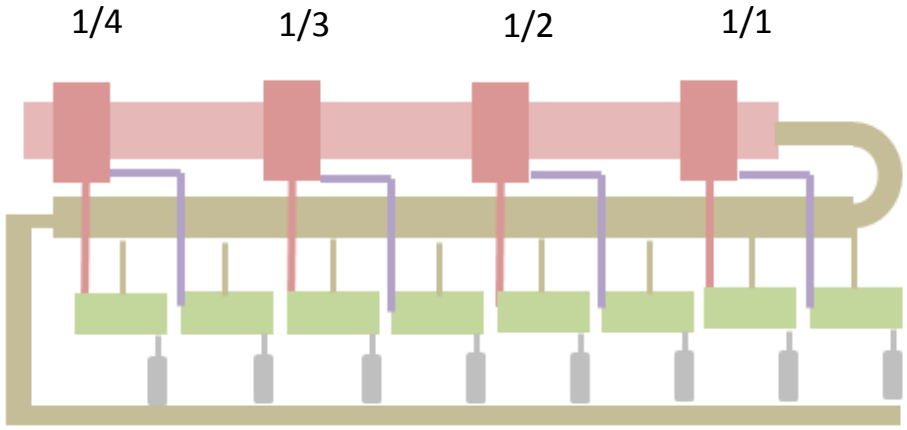


Distribution system will be new design

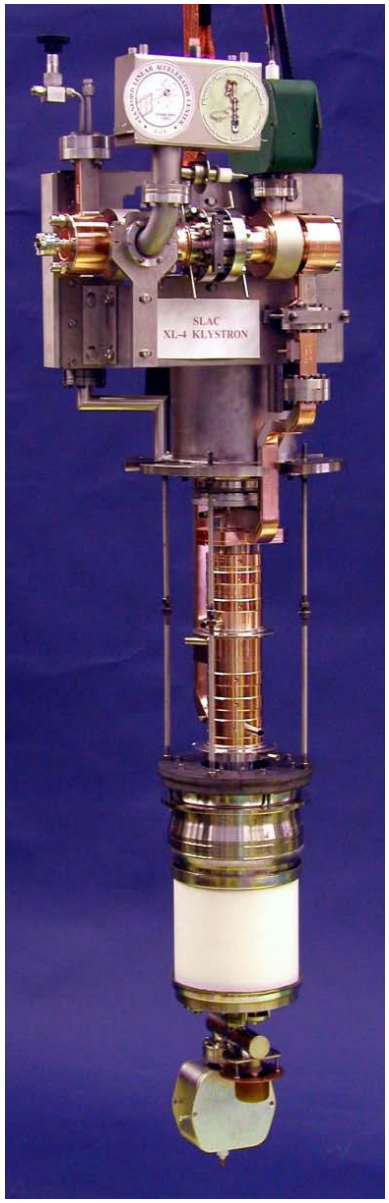


Pulse compressor will be based on SLED-II design, removing parts that were needed for the tests only

Other options appear possible and remain to be studied

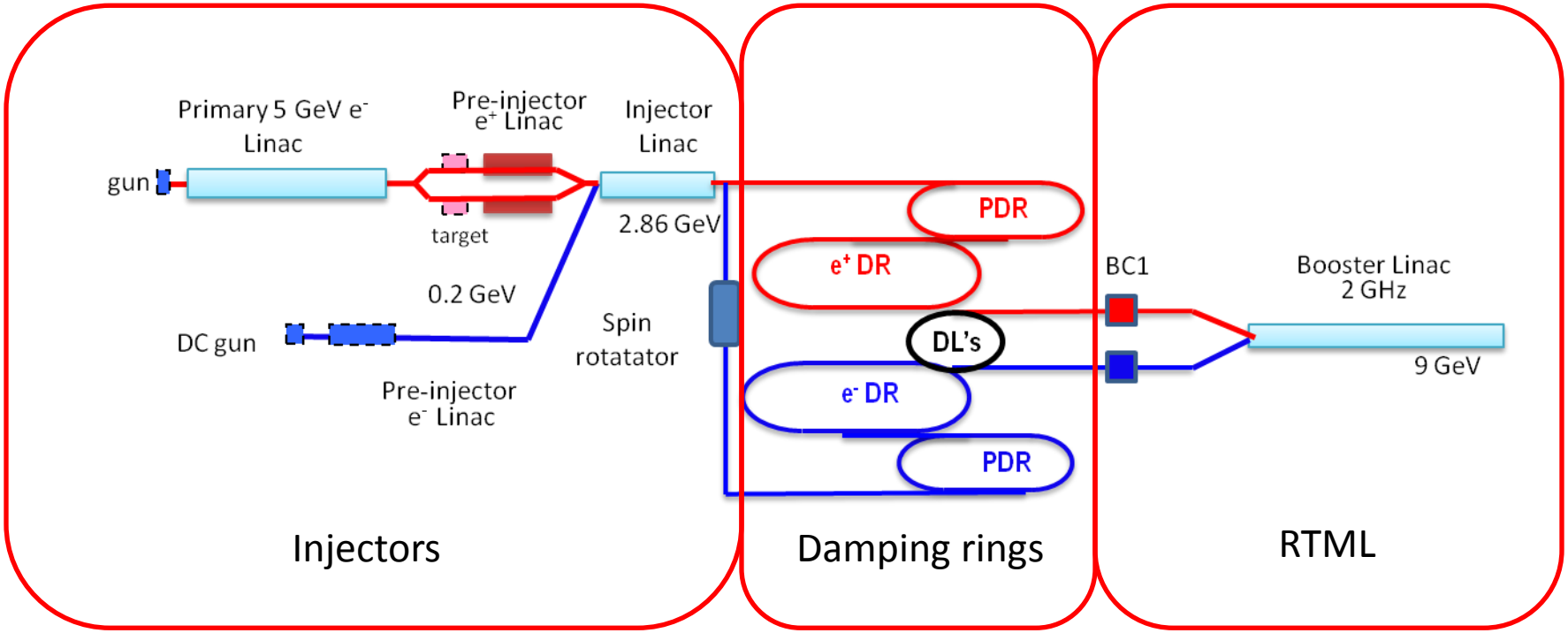


Klystrons



- Klystrons are an important challenge
  - Using less ambitious parameters (60MW, 2µs pulses, 50Hz)
  - Focusing is critical
    - Can use permanent magnet focusing for highest efficiency
    - Or use superconducting solenoid, which is easier but slightly less efficient and more costly
- Klystrons are a large part of the cost
  - Started cost estimate based on the components of the klystron: Gun, body, collector, RF window/ RF network, assembly/ brazing, solenoid, vendor profit
  - In reasonable agreement with price of klystrons
    - Assuming reasonable higher profit to cover risk of prototype
  - Relevant is cost reduction as function of number of klystrons, i.e. learning factor

Main Beam Generation

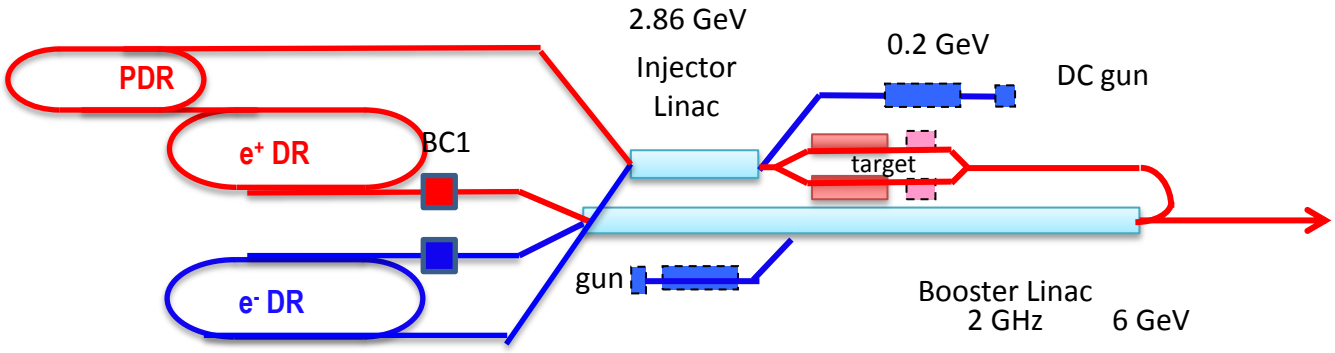


Significant cost is in the different linacs

- cost optimisation for each linac, respecting RF and beam dynamics limits
  - note: scenario A uses about 100% more RF than scenario B but needs only 40%
- review choice of RF frequency for each linac
- review of 1 vs. 2GHz in the damping ring and impact on cost
- review cost of long pulses for low energy operation

Can we remove the electron pre-damping ring?

Main Beam Generation (cont.)



Could re-use a linac for other beam

- e.g. booster linac to produce electron beam for positron production
- the drive beam accelerator could be used for the same purpose
- …

Could power the booster linac with the drive beam

Need to carefully evaluate the consequences

Drive Beam Generation

Scope

375

CLIC overall layout – ~~500~~ GeV

819 klystrons
15 MW, 58 μs

Delay loops
DL 2

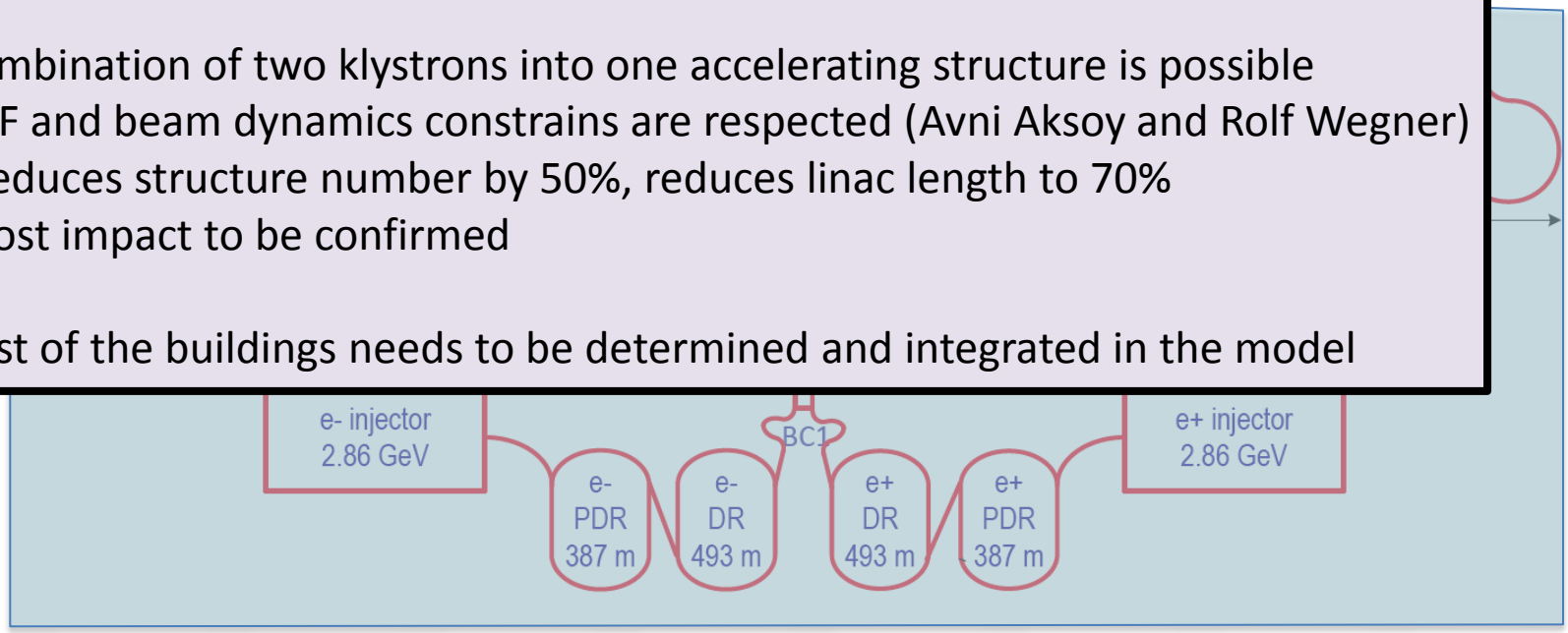
Line length	[m]
DL1 (delay loop 1)	215
DL2 (delay loop 2)	339
DLS (delay loop S)	193

Have a good understanding of the functional dependence of the cost

Most important are drive beam accelerator klystrons and modulators
- Need to verify the optimisation of these systems, e.g. klystron peak power
- strong dependence on learning factor

Combination of two klystrons into one accelerating structure is possible
- RF and beam dynamics constrains are respected (Avni Aksoy and Rolf Wegner)
- reduces structure number by 50%, reduces linac length to 70%
- cost impact to be confirmed

Cost of the buildings needs to be determined and integrated in the model



Conclusion

- The work has started
  - Impressive progress on a klystron-based alternative
  - Technical results on drive beam accelerator
  - Important questions raised for klystrons and modulators
  - Cost models are progressing
  - But much more work

- More results at the CLIC workshop

Reserve

Some Examples of Saving Options for Current Design

- Cost
  - Alternative main linac structure fabrication
  - Longer main linac modules
  - Maybe do not need electron pre-damping ring
  - CVS overdesigned for 500GeV
  - Main beam sources RF power quite high
  - Shorter drive beam pulses in first stage can reduce cost of modulator (modular design)
  - Combining pairs of drive beam accelerator klystrons
  - Using cheaper copper type in drive beam accelerator structure
  - Cost impact of 1GHz damping ring RF
  - Cost impact of long main beam pulses for low energy operation
  - …
- Power
  - Permanent drive beam turn-around magnets
  - …
- For many items need R&D since choices were made for a reason