



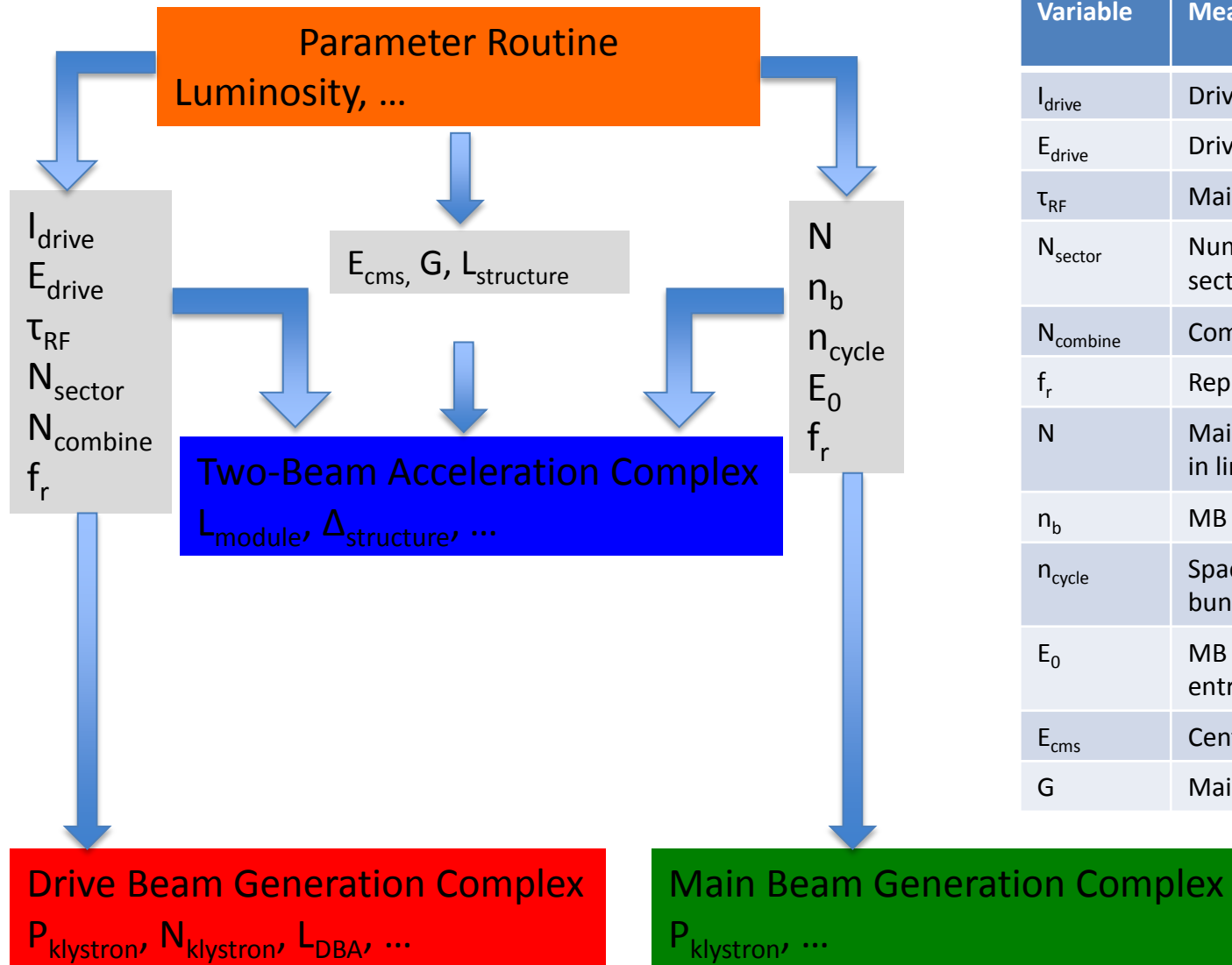
# CLIC Re-baselining

Project Meeting, December 2012

D. Schulte for the CLIC team

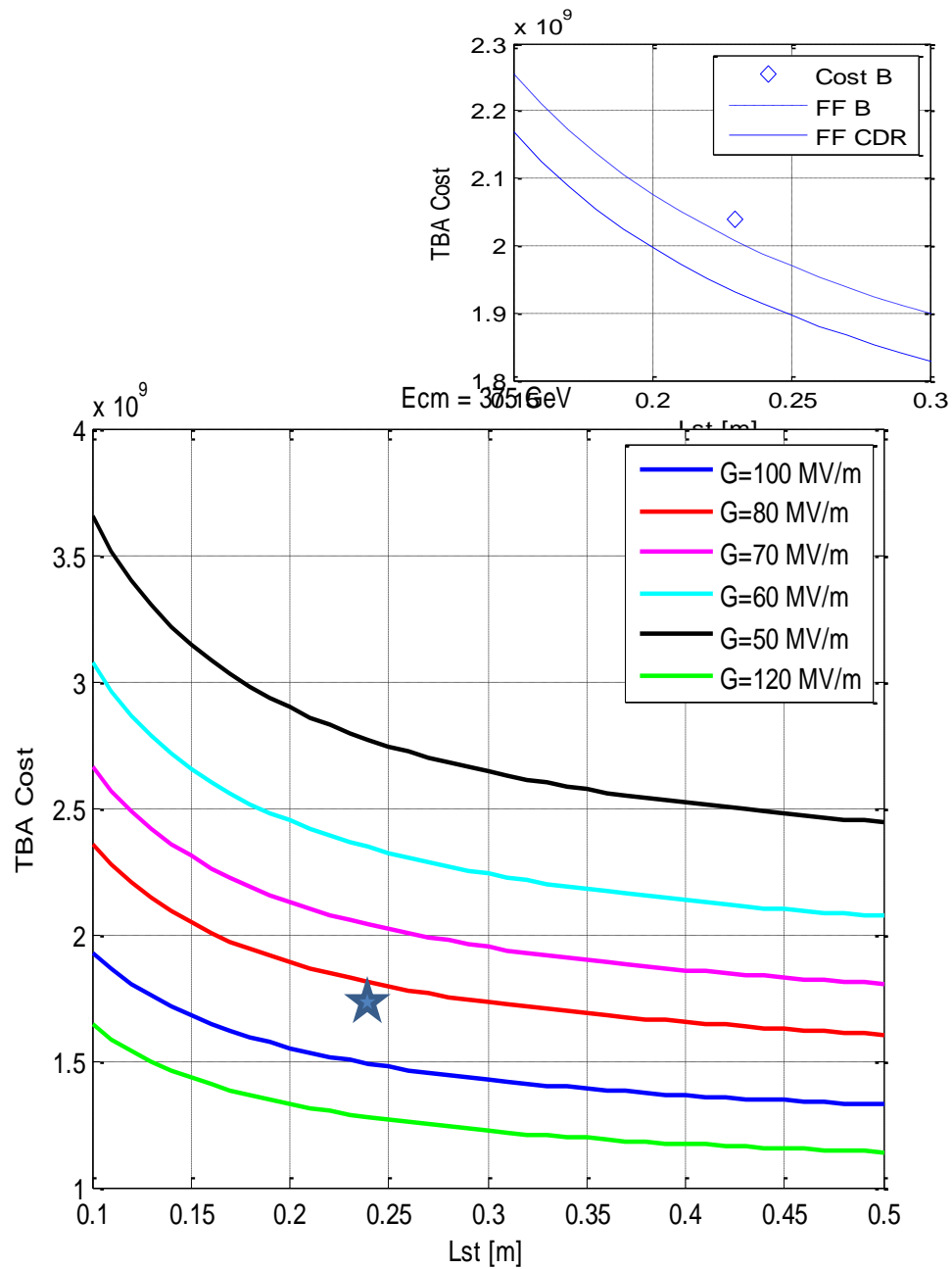
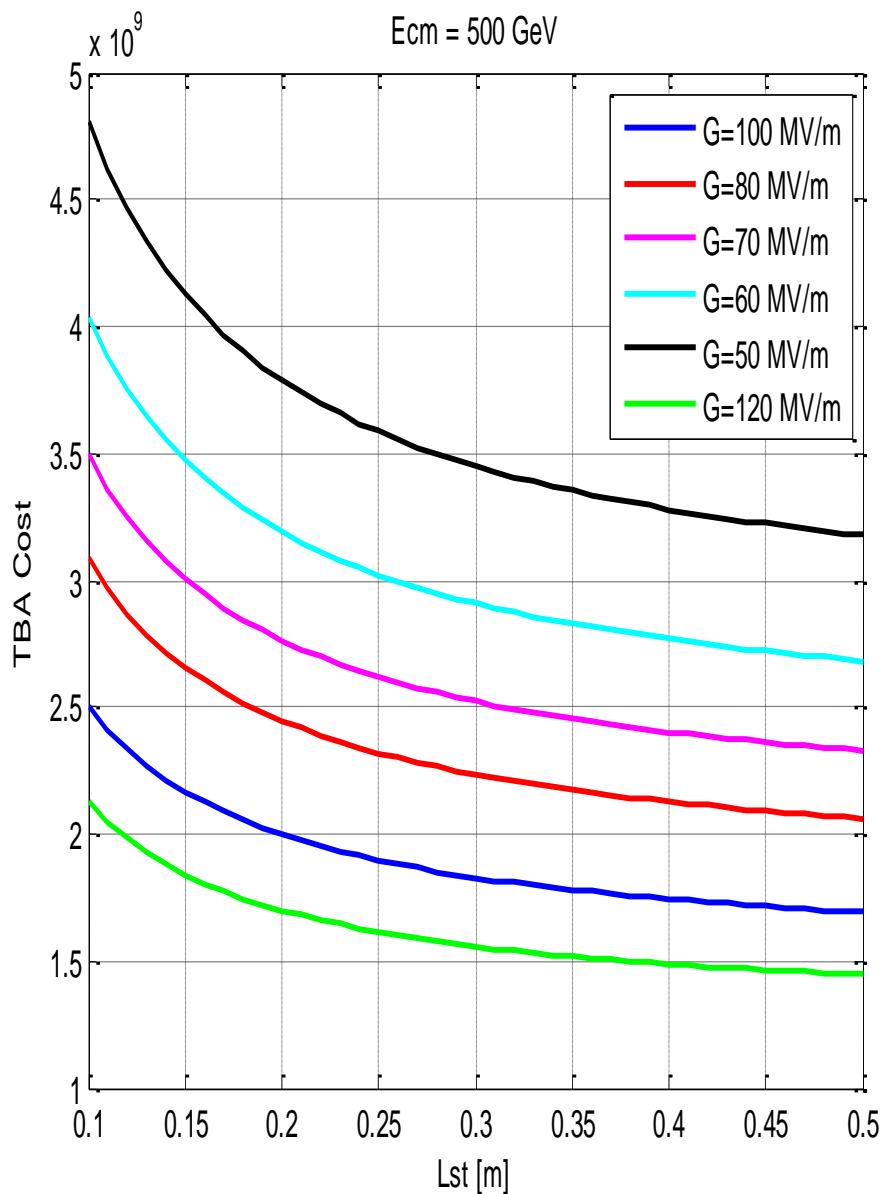
- Optimise the first energy stage
  - Focus has been on 3TeV
  - Alternative options should also be studied, most importantly a klystron-drive first stage
  - Include upgrade considerations
- Split design into relatively independent pieces
  - Including all cost, in particular also civil engineering
  - 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 Syrathev
  - 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

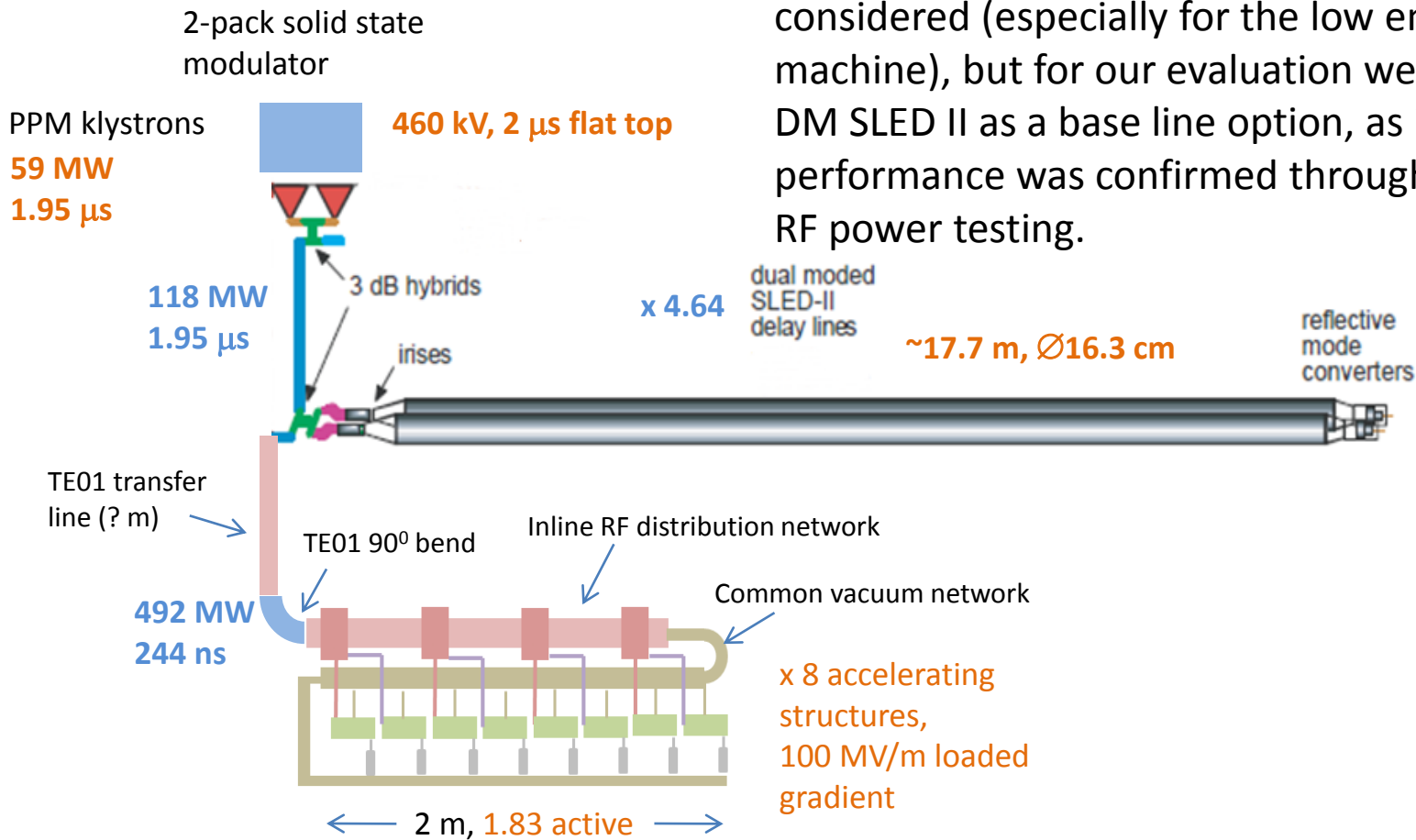


Variable	Meaning	Current value
$I_{drive}$	Drive beam current	101A
$E_{drive}$	Drive beam energy	2.37GeV
$\tau_{RF}$	Main lianc RF pulse length	244ns
$N_{sector}$	Number of drive beam sectors per linac	4
$N_{combine}$	Combination number	24
$f_r$	Repetition rate	50Hz
$N$	Main beam bunch charge in linac	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

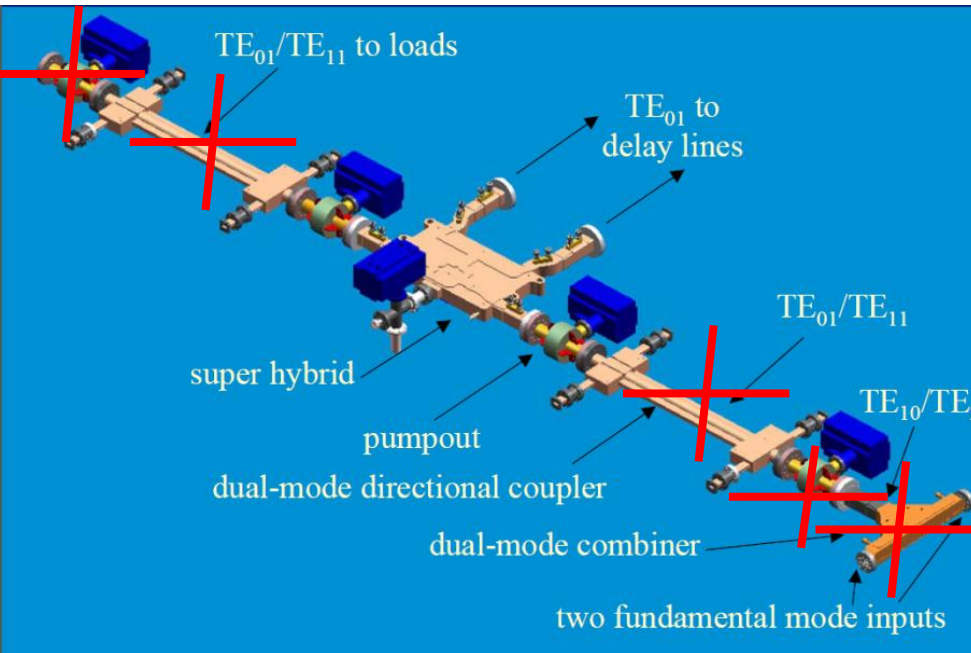
# Cost vs. Structure Length



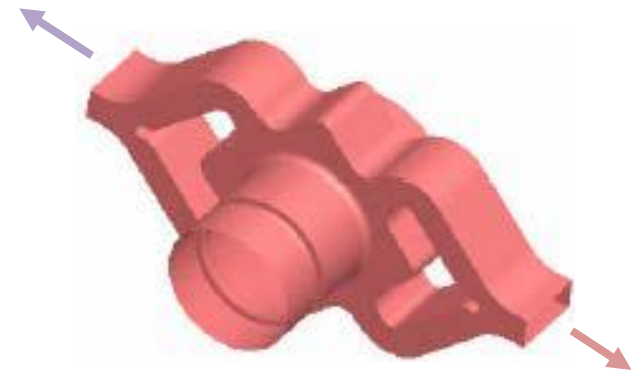
The alternative PC schemes certainly must be considered (especially for the low energy machine), but for our evaluation we will keep DM SLED II as a base line option, as its performance was confirmed through the high RF power testing.



Compared to NLC, the energy gain per unit in CLIC's case is 26% lower (need more klystrons per meter), but the unit length is  $\sim$  3 times shorter.

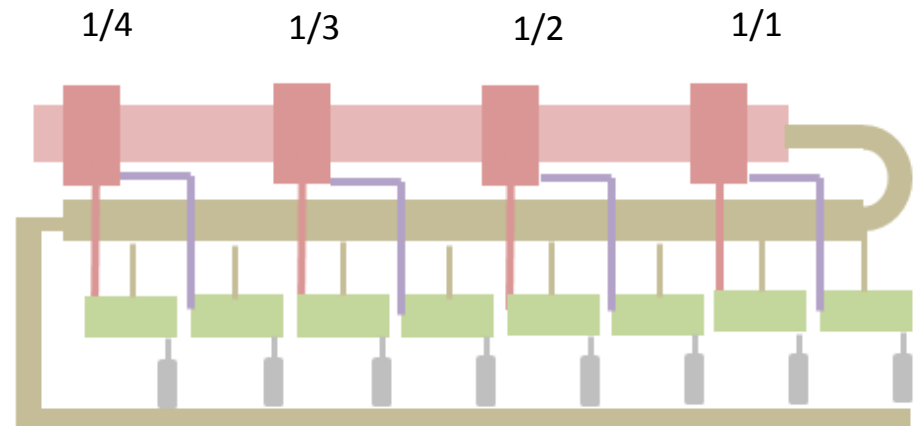


Distribution system will be new design



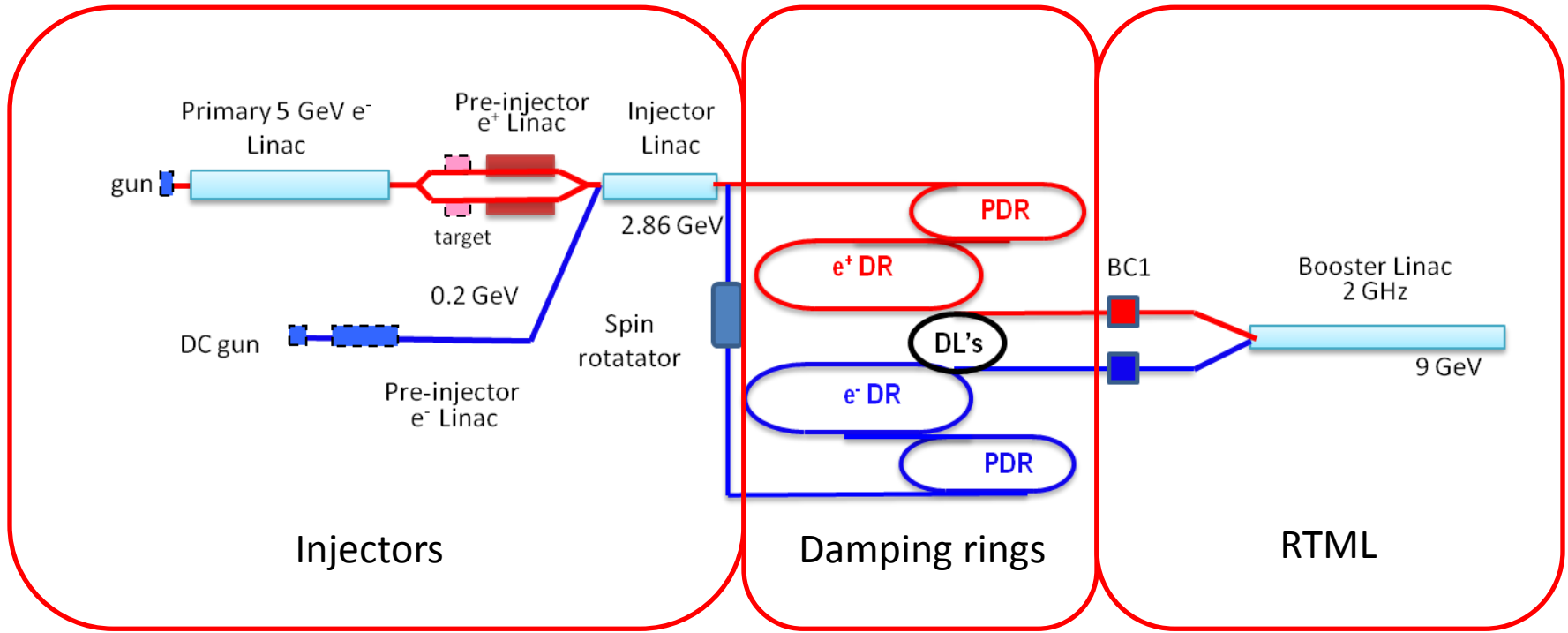
Pulse compressor will be based on SLED-II design, removing parts that were needed for the tests only

Other options appear possible and remain to be studied





- Klystrons are an important challenge
  - Using less ambitious parameters (60MW, 2 $\mu$ s 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

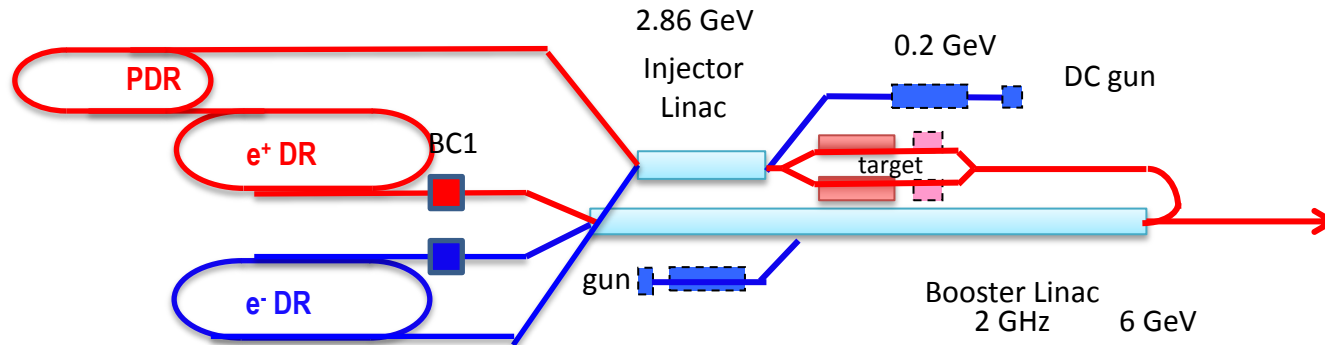


Significant cost is in the different linacs

- 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?





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

## Scope

~~CLIC overall layout – 500 GeV~~ 375

819 klystrons  
15 MW 58  $\mu$ s



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



- 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