CR1: Insert Dogleg

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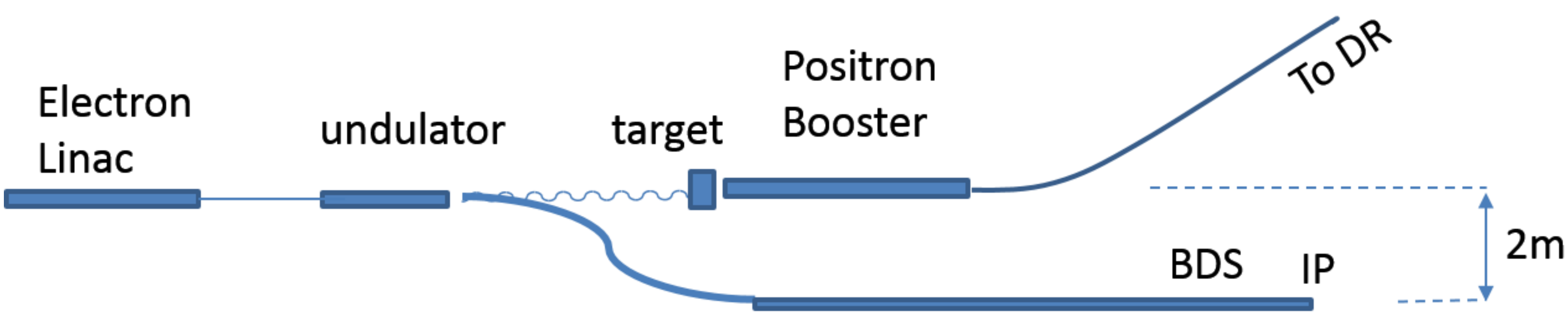
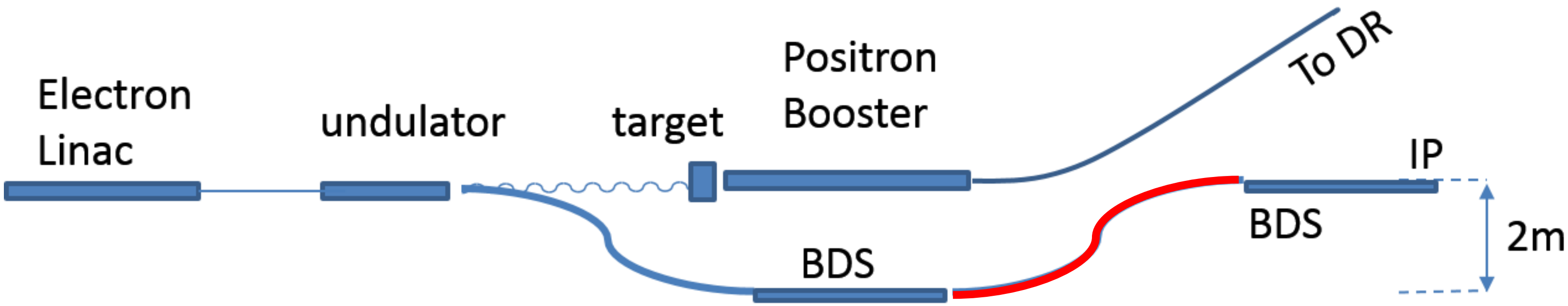
Insertion of Dogleg : Motivation

- In TDR, after passing the undulator, the electron beam is separated from the photons by a dogleg and goes to the IP
- Hence, the BDS line is horizontally shifted from the extension of the linac line by 2m.
- This dogleg causes 8% increase of the horizontal normalized emittance (w.r.t. the DR emittance) at E_e = 0.5TeV（CM 1TeV）(estimated by K.Kubo)
- Emittance increase is proportional E_e^6 .
→ About 90% at E_e = 0.75TeV
- This dogleg can be a bottle neck for going to >1TeV CM in the far future by whatever technology.
- It can be fatal, in particular, if we aim at smaller horizontal emittance.



1st Solution

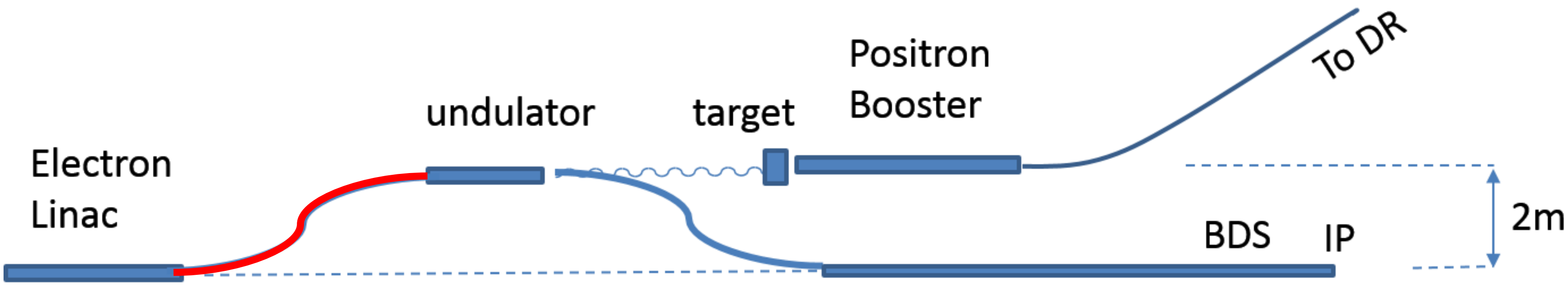
- Insert a backward dogleg of ~400m long in or before BDS such that BDS comes on the linac line



- For ECM > 1TeV in the far future the beam goes straight from the linac to BDS, by moving the positron system somewhere.
- This change does not affect the path length issue
- Cost:
  - tunnel ~10M$
  - beamline ~20M$ (magnet, power supply, vacuum)

2nd Solution

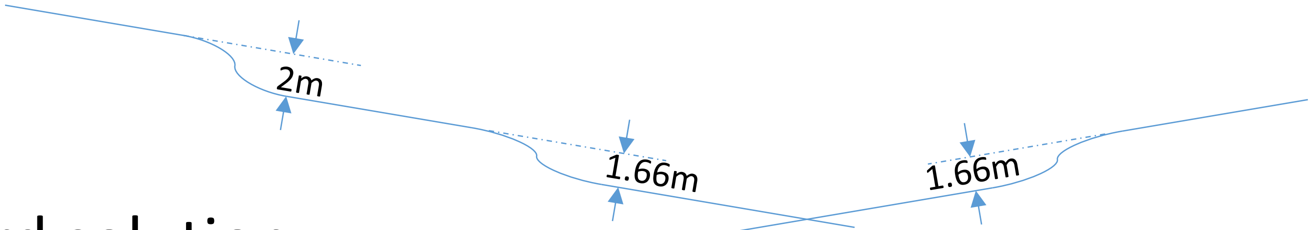
- Insert a dogleg of ~400m long before the undulator
- An extra beamline, depicted by the dashed line, is needed for 10Hz (5+5), together with a 5Hz pulsed magnet



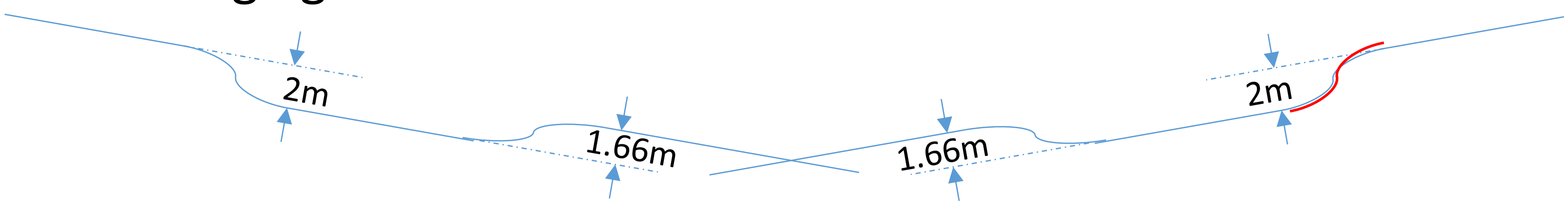
- Simple if we have to start with e-driven positron source
- This change does not affect the path length issue
- Cost: a bit more expensive due to the dashed line

3rd Solution

- BDS in TDR has another dogleg (1.66m) to create dispersion
  - Do not know if the tunnel from e-linac to IP is straight or not, to cover 2+1.66=3.66m



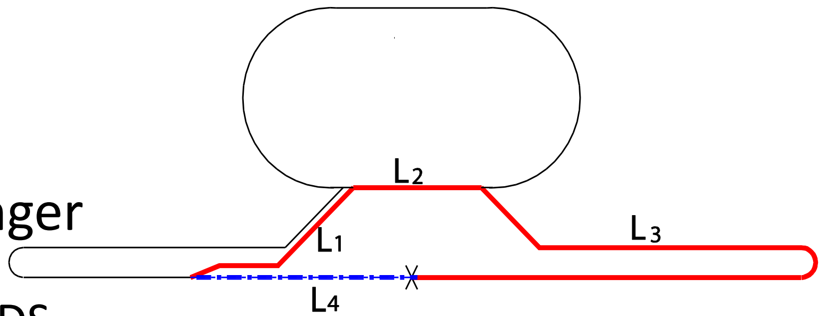
- 3rd solution:
  1. Invert the sign of bend in BDS dogleg for both e+ & e-
     - This will cause sign change of dispersion. Is this OK?
  2. Insert ~400m dogleg in positron side, symmetrically with the dogleg after the undulator in electron side



- This will make the IP only 0.34m off the extension line of each linac.
- Presumably the tunnel can be straight from the linac all the way down to IP.
- 1.66m might be smaller in >1TeV design but this will change the IP only a small amount transversely.

However, ...

- The 3rd solution clearly violates the path length constraint with n=9
  L1+L2+L3-L4 = n x C
  - In the present design L.H.S. is longer by ~300m if n=9
    - There is a possibility to shorten BDS by 100~200m ?
  - The discrepancy would be ~ 1100m (300+2*400) if the 3rd solution is adopted



On the other hand

- There are some reasons for longer linacs
  - Many physicists would like 550GeV rather than 500GeV
    - 4x higher crosssection at ttbarH
  - Gradient margin to guarantee the maximum energy by 100%
  - Maximum energy in the present design can be, e.g., 475GeV if 5% gradient loss → completely kill ttbarH

Advantage of the 3rd solution when …….

- If it be decided to adopt longer linacs (or at least longer tunnels with empty space) in LCC/LCB level, n=10 would be inevitable.
- Then, how about doing this? (This not a part of this Change Request)
  - Adopt n=10 → Lengthen positron arm by (3.2km – 0.3km)/2 = 1.45km (but no change in DR circumference and BDS length)
  - from which use 0.4km for the new dogleg.
  - Use remaining 1.05km as the empty space for positron linac extension
  - Lengthen electron arm by 1.05km as the empty space for electron linac extension
  - 1.05+1.05=2.1 km (corresponds to ~50GeV) can later be filled with linac modules in case the maximum energy not sufficient (due to either of the two reasons)
- In this case the cost of the new dogleg is ~20M$ (tunnel must anyway be lengthened)

- This CR does not contain complex technical issues.
- It is a policy issue.
- Do you pay for 20-30M$ as totally-uncertain, far-future investment?