Proposal for Correcting Both PAR-To-Booster and LEUTL Beam Trajectories for Interleaving Operations

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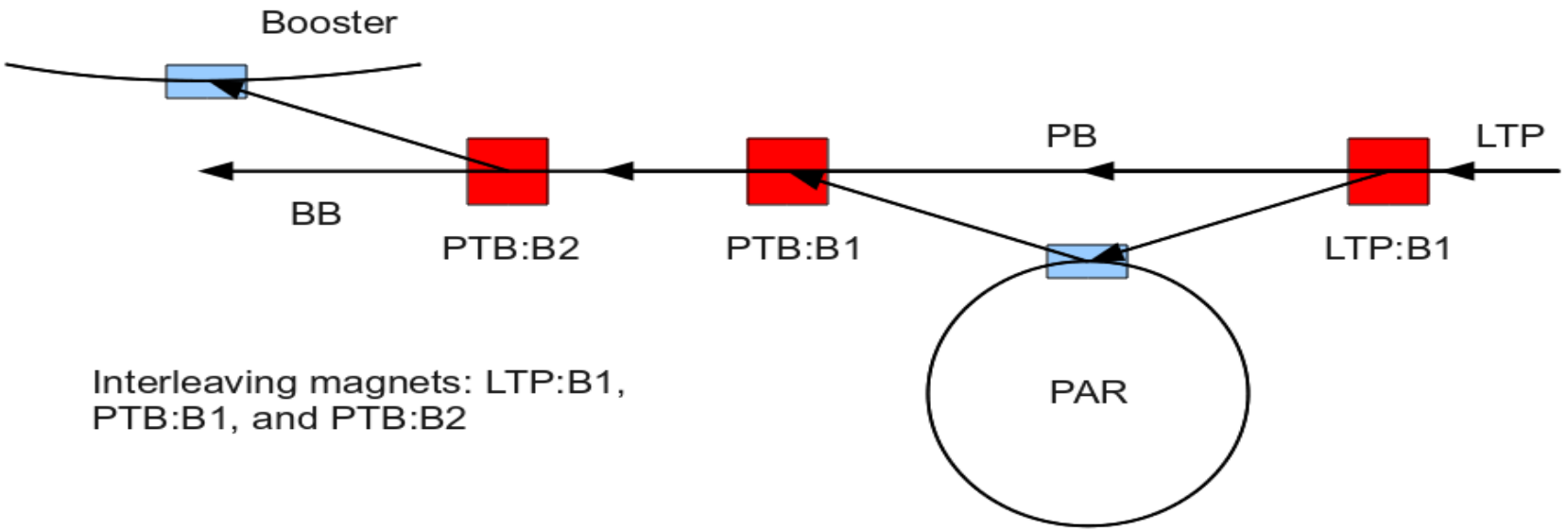
Outline

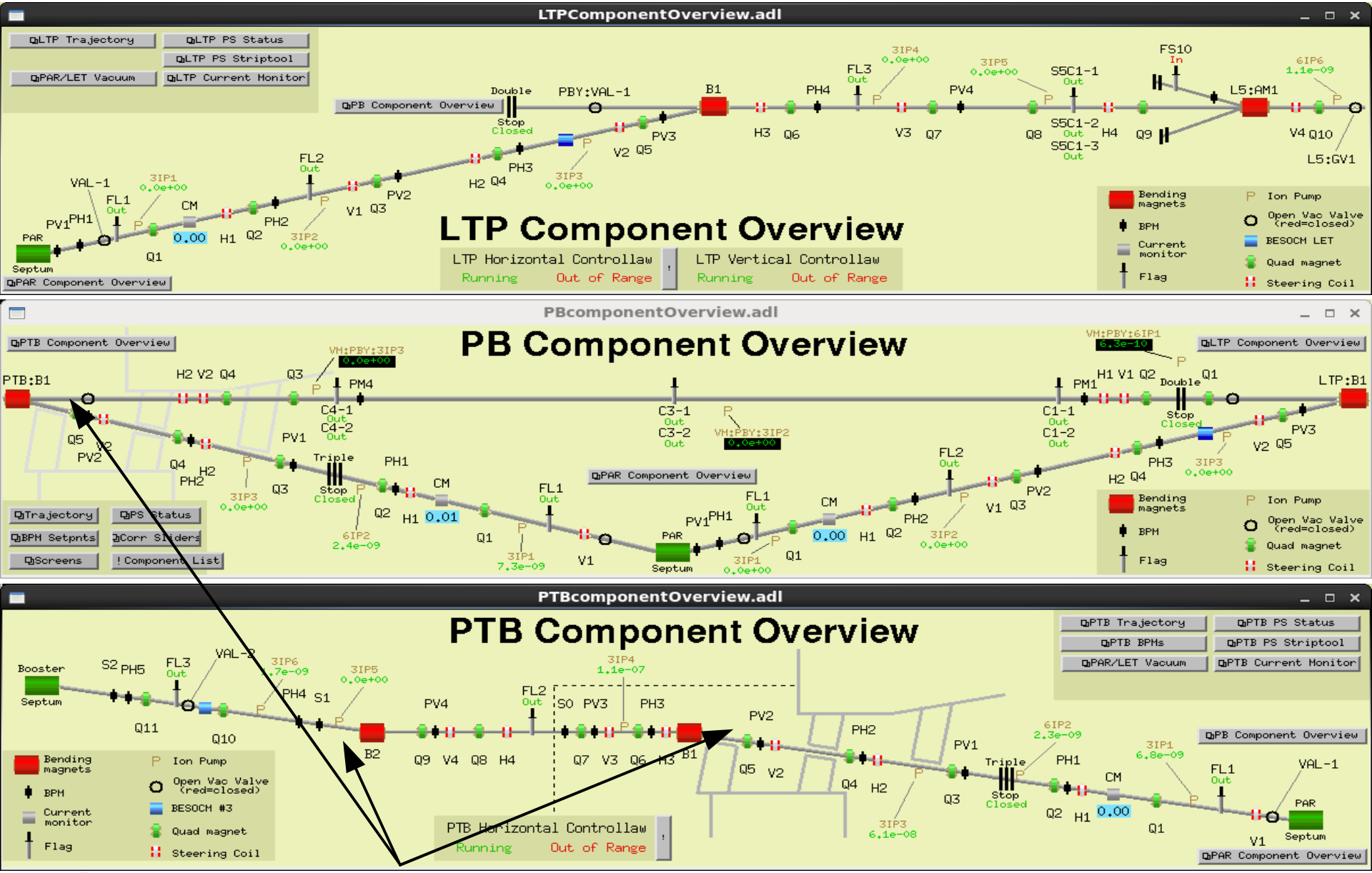
- Interleaving dipole beamline layout
- Interleaving dipole geometry
- Interleaving dipole bucking coil field calculation
- Requirements for interleaving dipoles used as correctors
- Additional correctors to correct PCGun beam trajectory through PTB to LEUTL

Beamline Layout

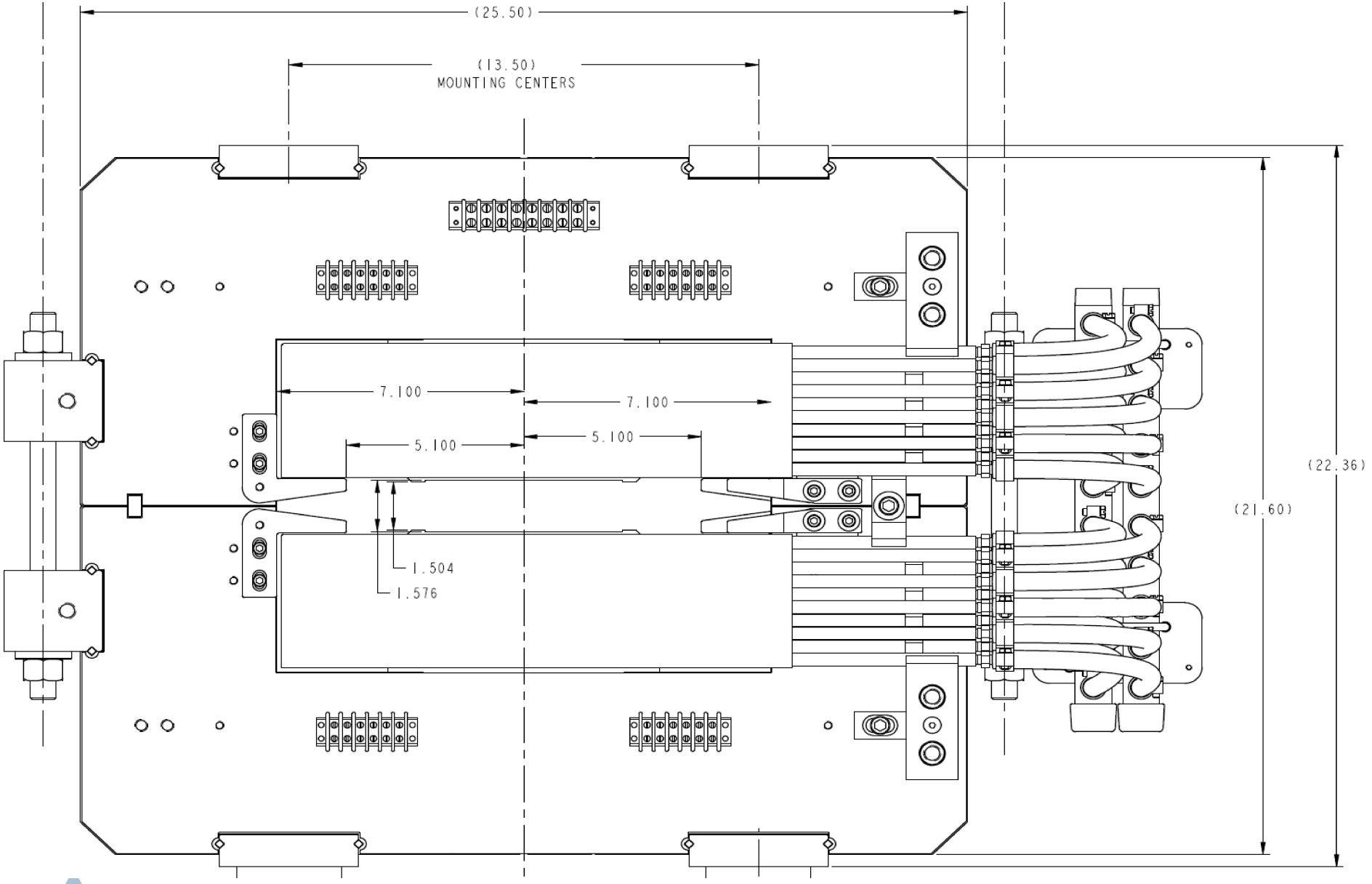


- Up to LTP:B1, both beams need to be corrected well using linac/LTP correctors/bpms (cancel remnant field and no new correctors needed)
- Main problem is correcting both beams through the common PTB transport line (cancel remnant field and new correctors added)

Beamline layout cont.



Interleaving Dipole Geometry

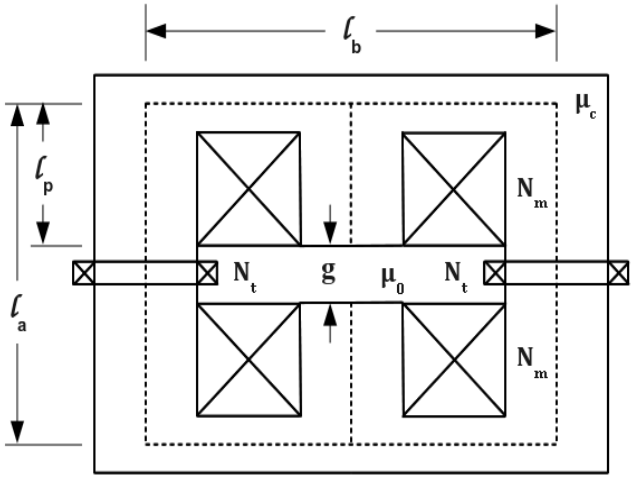


Bucking Coil and EMF Calculation

$$B_g = \frac{\mu_0 N_t I_t}{g}$$

$$V_{EMF} = \frac{2\mu_0 w\, d\, N_m N_t}{g}\frac{dI_m}{dt}$$

$$\mu_0 \ll \mu_c$$



Interleaving Dipole Parameters	
μ_c	~100-1000 μ_0
W (pole width)	0.198 m
d (pole length)	0.4 m
N_m (Magnet coil turns)	70
N_t (Bucking coil turns)	10
g (Magnet gap)	0.04 m
Δt (rise/fall time)	50 ms

- Interleaving dipole magnet field calculation (AOP TN by Dooling, Sereno)
- Windings can also be installed around the pole piece

Bucking Coil and EMF Calculation cont.

Interleaving Dipole Bucking Field Calculation / Measurement		
I_t (A)	B_g (G) Calculated	B_g (G) Measured
4	12.6	15

Interleaving Dipole Bucking Coil EMF Calculation	
I_m (A)	V_{EMF} (Volts)
139 (375 MeV)	9.7
350 (Max Current)	24.4

- Test in PS cage indicates:
  - The 8 G remnant field can be canceled using N_t = 10 turns and I_t = 4 A
  - Probably would want to go to N_t = 20 turns and I_t = 2 A to cancel remnant field
  - However, induced EMF (assuming 50 ms rise/fall time) doubles for N_t = 20 turns
- How much EMF can a realistic 2 A supply survive?
- Next look at what it would take to make the bucking coil a corrector similar to the PTB

Interleaving Dipoles Used as Correctors

- May want to simply buck the remnant field of the dipoles and add H/V correctors upstream of PTB:B1 and downstream of PTB:B2
- Or, add only vertical correctors upstream of PTB:B1 and downstream of PTB:B2 and use bucking coil as a corrector
  - Saves one power supply
  - One would like to use controllaw for LEUTL trajectory control – may affect PAR to Booster transport if bucking coil current is updated frequently
- LTP/PTB correctors:
  - Have [1]2.018 x 10^{-3} T-m / A integrated field per Amp
  - Are typically run at +/- 0.5 A during operations
- For operation margin, how much field do the interleaving dipole bucking coils need to produce to have the same field integral as the LTP/PTB correctors at +/- 1 A?
  - Bucking coil field would need to be 5 x 10^{-3} T = 50 G (for d = 0.4 m)
  - Requires 16 A for N_t = 10 turns
  - Requires 5.3 A for N_t = 30 turns (V_{EMF} = 29 V for 139 A – 375 MeV operation)
- So, once again the question becomes what performance can one expect from a realistic power supply?

[1]AOP-TN-2013-009