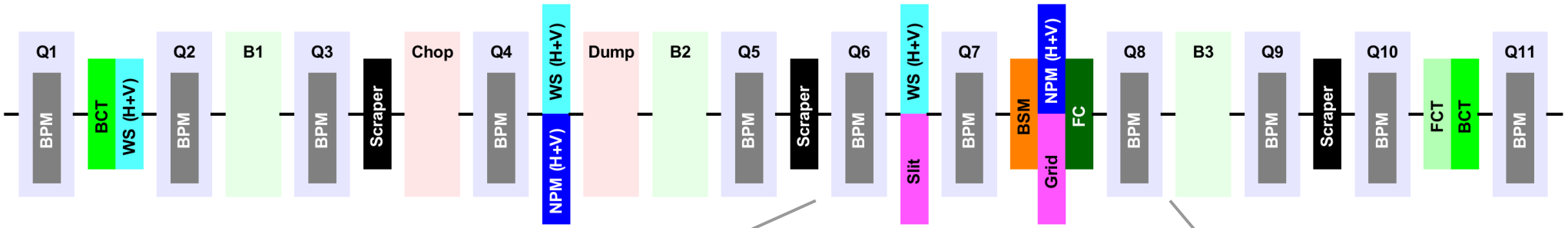
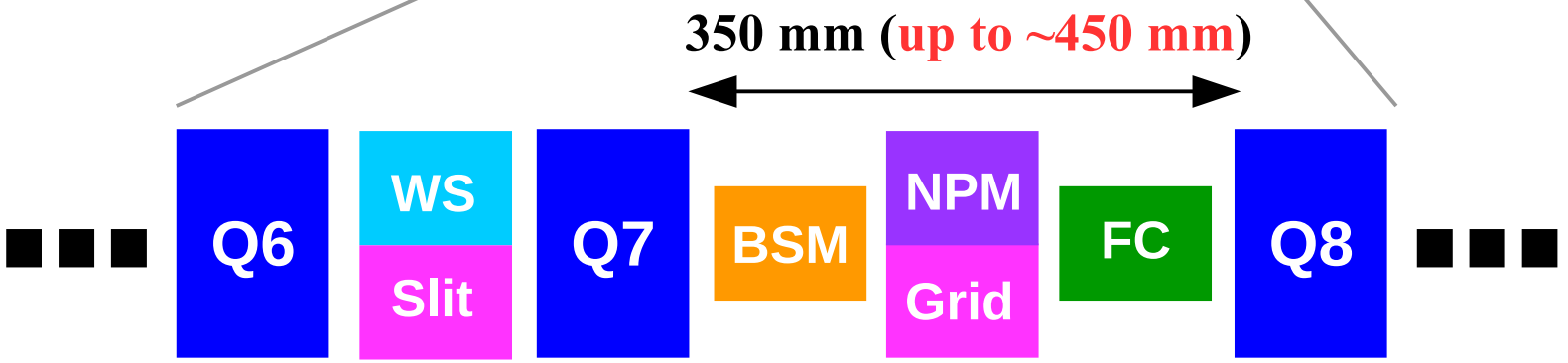
My Recent Activities Related to BI

Ryoichi Miyamoto (ESS/AD/BPG)

June 9th, 2015
BI Group Meeting

MEBT lattice related issues

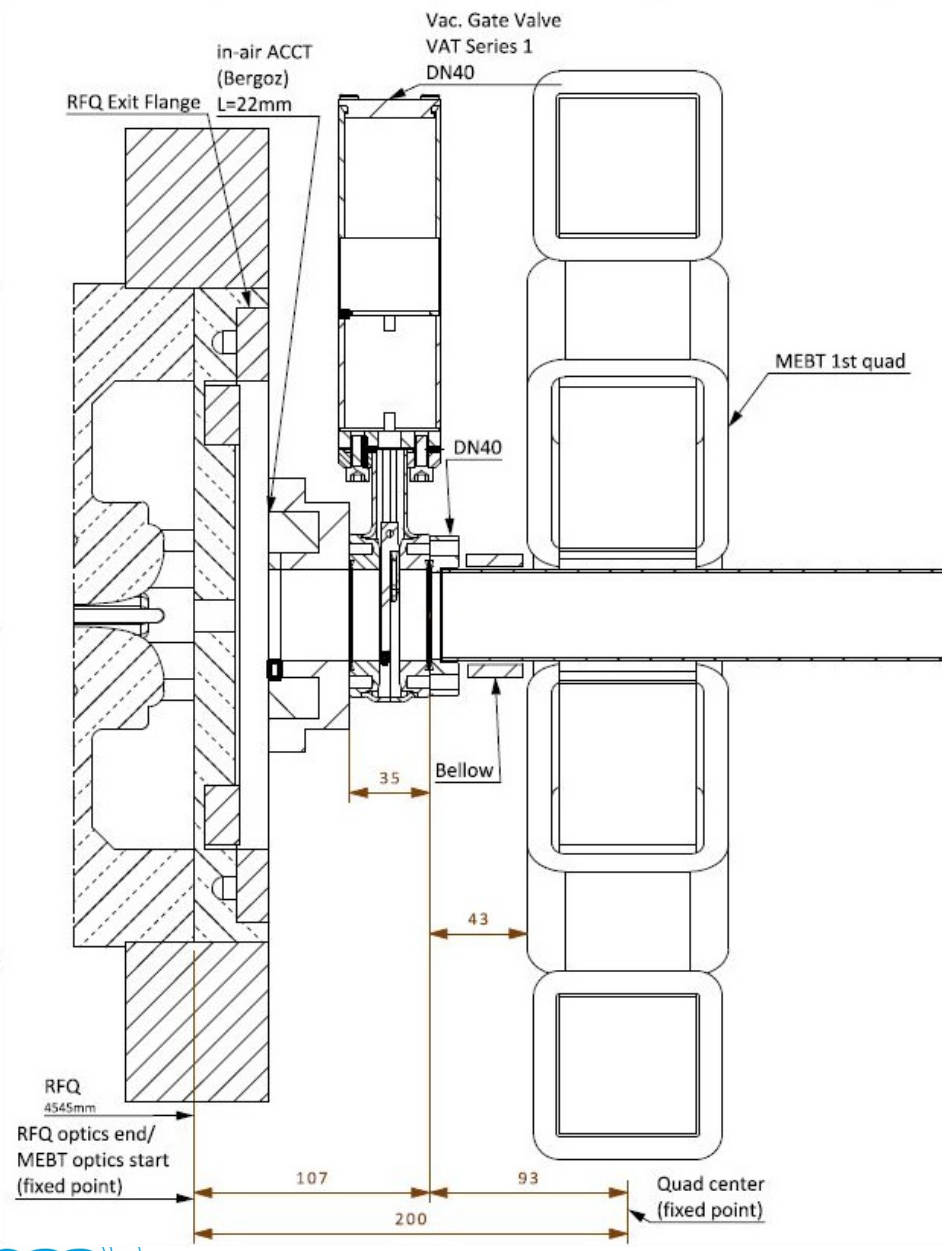




This MEBT layout was agreed among the all stakeholders. The remaining issues related to BI are

- What's the needed space for BSM + diagnostics box? (**HW for BI**)
- Can we have the slit and WS in the same space? (**HW for BI**)
- Is it OK to have the Fast BCM (to check the chopper efficiency) after FC? (HW for the commissioning planning.)
- **Do we need an additional BCM toward the beginning?**

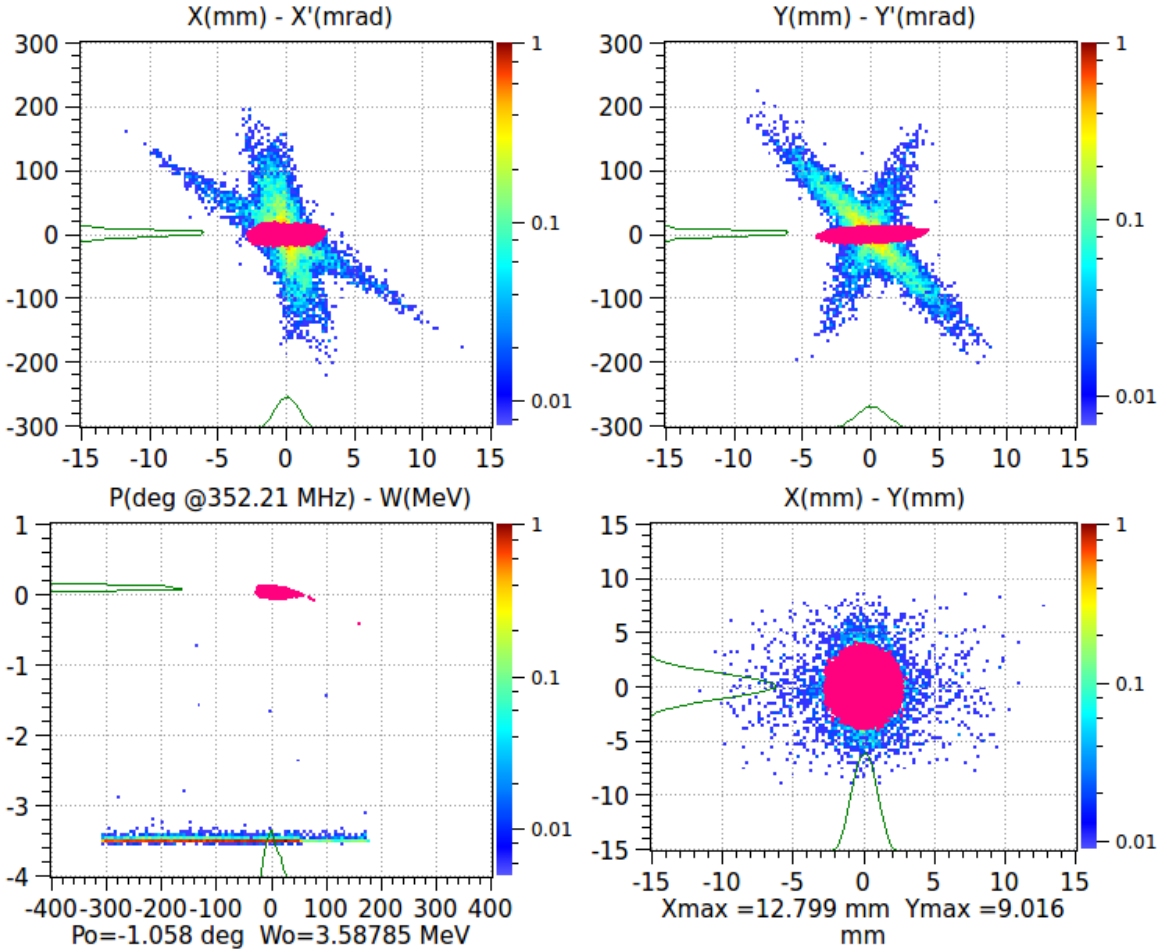
An issue with the 1st BCM location

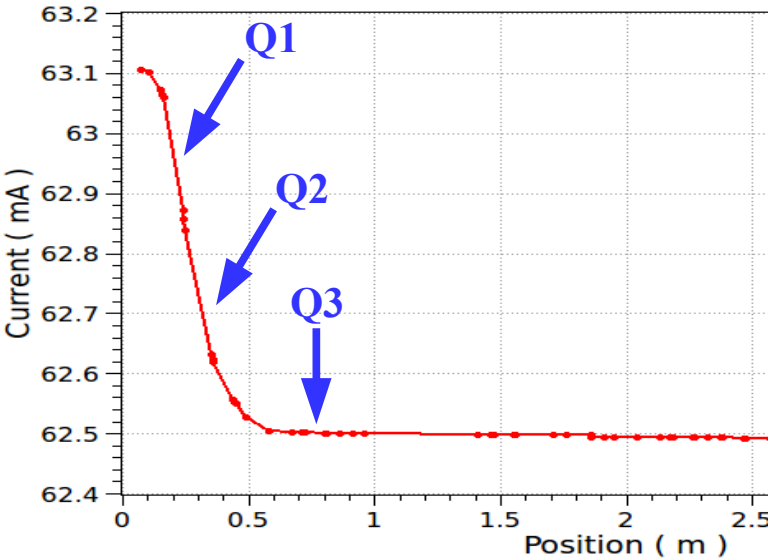


- The 1st BCM is moved from Q1-Q2 to the 1st drift (attached to the RFQ flange). At this location, the BCM signal includes the DC part of the beam.
- But, the current/transmission of the bunched part of the beam is an important figure of merit (practically only one once everything is installed in the tunnel?) for IS+LEBT+RFQ.
- The DC part survives until around Q3. (see the next slide.)
- Aurélien wants to keep one attached to the RFQ (or in Q1-Q2) to see the difference between the input and output for machine protection.
- Is it possible to squeeze another one somewhere?

When the DC part is gone?

Input to MEBT

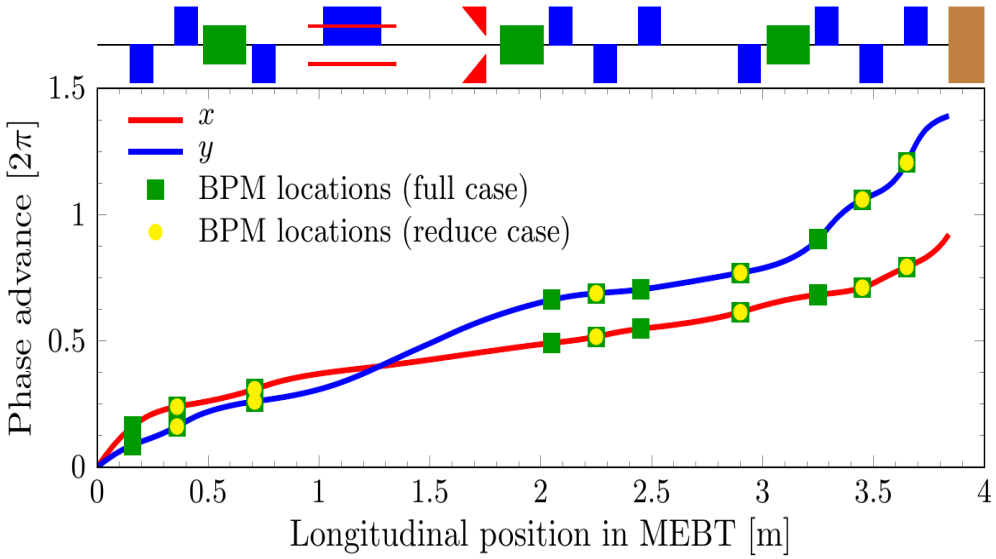


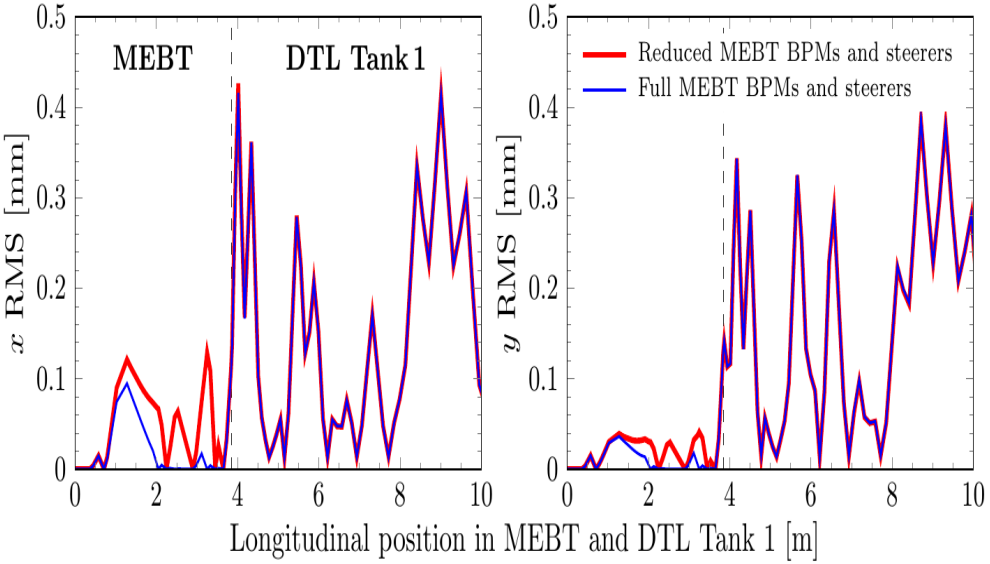


- The input to MEBT looks like this. This is generated by assuming a Gaussian distribution at the RFQ entrance. I have another one starting from the source output, which has more DC component.
- Nonetheless, I vs s plot indicates that we have to place a BCM after Q3 to avoid the effect of the DC part.

- Tried (1) increasing Q1 strength to the max (default ~16.5 T/m → ~31 T/m) (2) a 3 bump with Q1-Q3 steerers, but either didnt' make a major difference.
- One possibility is to swap the 1st WS and 1st scraper and have a WS and BCM in the Q3-chopper space. The other possibility may be to have the Q4-dump space. **Any other idea?**

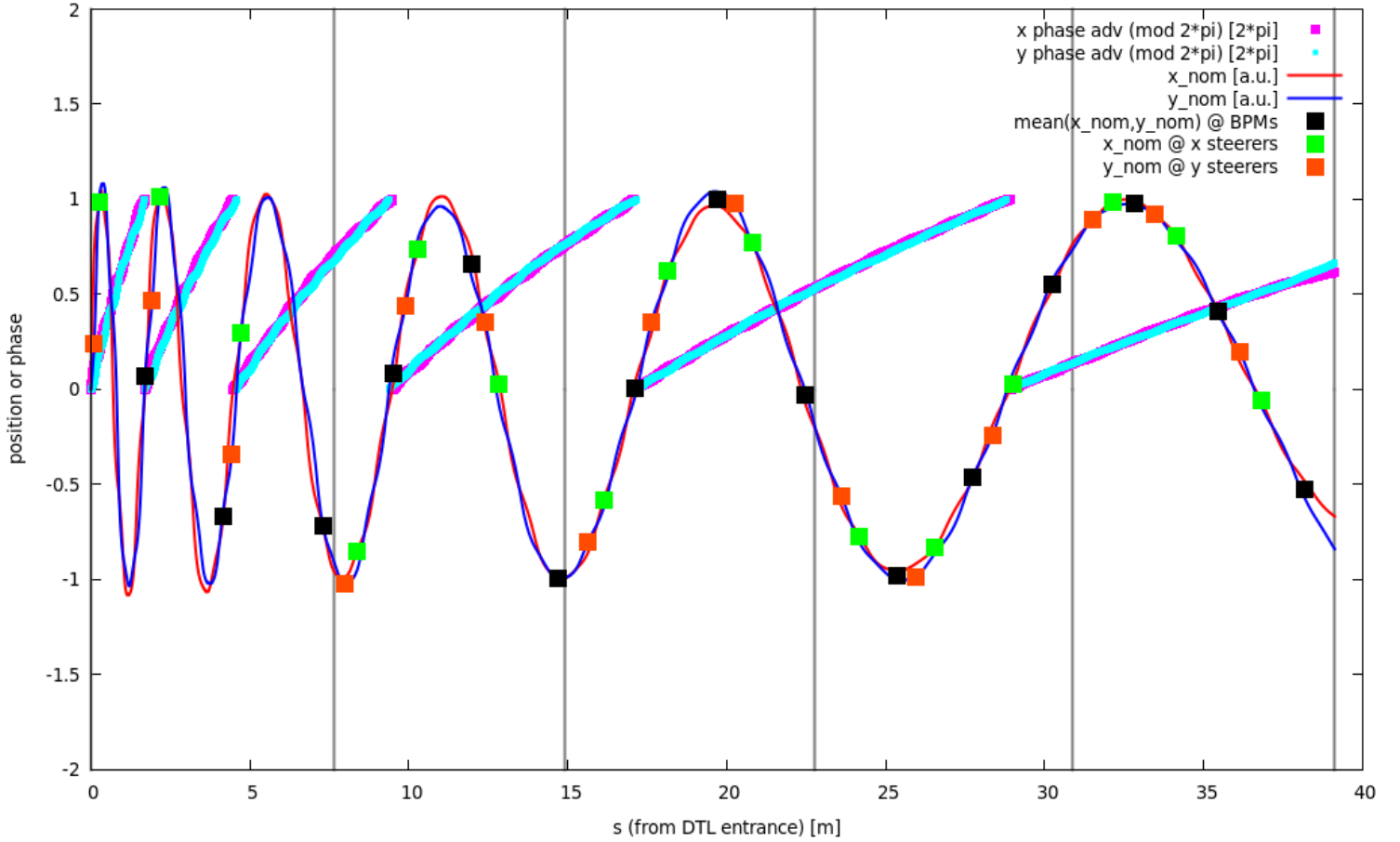
MEBT trajectory correction





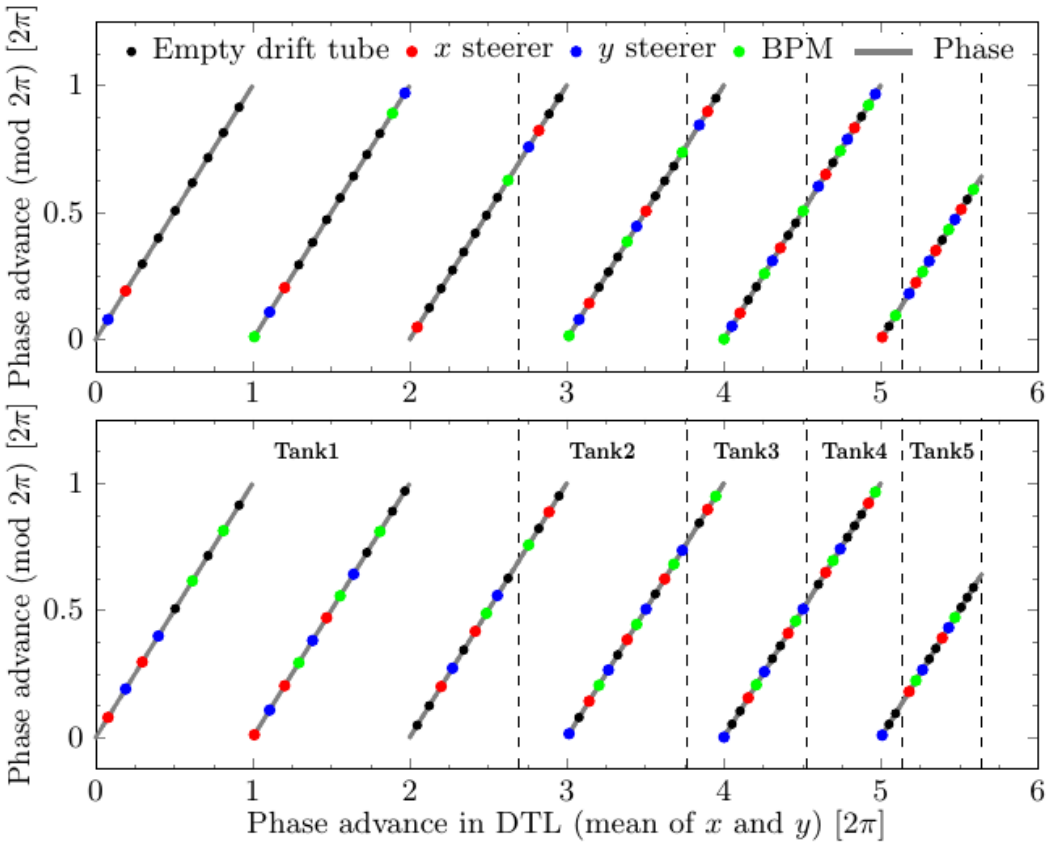
- We haven't done so much for the tuning, in general. I recently studied trajectory correction in MEBT and DTL.
- Trajectory correction with a reduced number (6) of BPMs was studied for the last year's baseline MEBT.
- 6 seems fine but to be checked with this year's lattice.
- The above selection is optimized only for trajectory and amp/phase scan isn't taken into account.

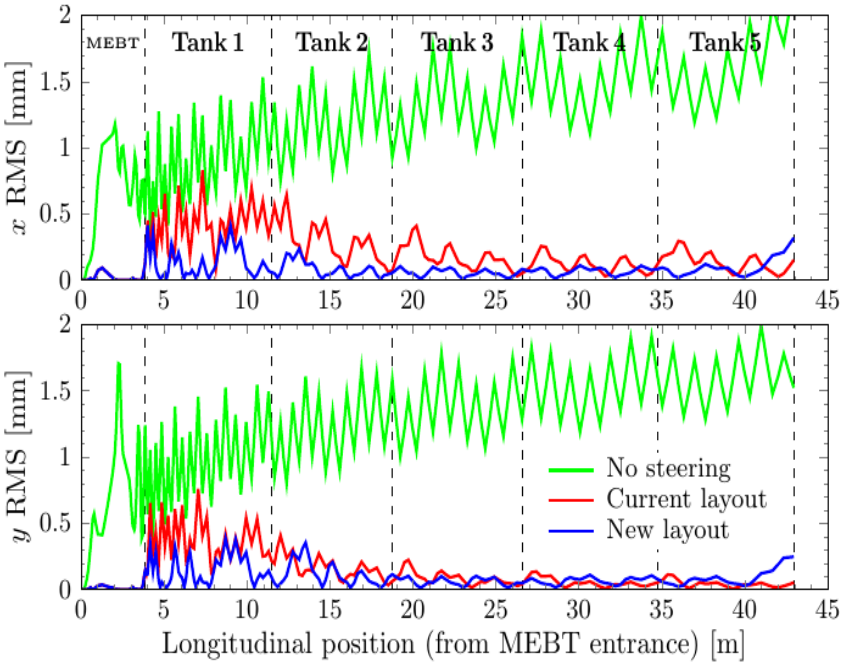
Current locations of DTL BPMs and steerers



- The layout is based on the idea of 3 BPMs and steerers per plane. But, as a result, Tank1 is utterly under-sampled.
- The correction is done by artificially applying an empirically known limit (~6 Gm) to steerers. This also means that we can't do a correction with linear methods and requires a generic minimization algorithm which can take into account constraints.
- A large blind spot is not ideal in case we have a problem there.

So, can I do better?





- By following "90-degree rule" as much as possible, the best solution I could found so far uses 6, 4, 3, 2, 2 (17 in total) BPMs and 7, 4, 3, 2, 2 (18 in total) steerers. But, this isn't at all a unite solution and I can propose a compromised solution with less numbers. So, the input from the "up" is needed.
- No impact on the loss until we increase the PMQ alignment error x2.
- The real advantage of the robust layout is that it allows simpler algorithms such as SVD or even one-to-one and has less blind spot.
- This layout hasn't taken into account the amp/phase scan, yet...

Not much has be done for the phase scan...

	A	B	C	D
1		s	phs(n,n+1) int [2*pi]	phs(n,n+1) frac [deg]
2	BPM.MEBT.3	0.7100	10	166.6
3	BPM.MEBT.4	1.4900	8	355.4
4	BPM.MEBT.5	2.1600	2	245.8
5	BPM.MEBT.6	2.3600	2	245.8
6	BPM.MEBT.7	2.5600	6	13.0
7	BPM.MEBT.8	3.0100	4	250.1
8	BPM.MEBT.9	3.3600	2	245.8
9	BPM.MEBT.10	3.5600	2	245.8
10	BPM.MEBT.11	3.7600		
11				
12	beta	0.08759		
13	lambda	0.8512		
14	beta*lambda	0.07455		

- The MEBT buncher is like a thin gap and we set the phase to 90 deg, so amp/phase scan MAY not be too difficult. The superconducting cavities are a bit more complex, but at SNS they only adjust the phases and don't touch the amplitudes.
- The DTL tanks are by far the most complex and important for the phase scan.
- We need to carefully study individual cases.

Thoughts/plans on the tuning

- Trajectory
  - Trajectory corrections in MEBT and SC sections shouldn't be too difficult. My only (personal) concern is on the DTL.
  - Amp/phase scan may have a bigger impact to finalize the BPM layout rather than the trajectory correction.
- Amp/phase scan
  - This should have a high priority for us in the last half of this year. Since the conditions are different, each case should be studied carefully.
- Transverse matching
  - The crucial part is the matching to the DTL where the space-charge is strong and the linear space charge model doesn't work well. (Can we do a tracking based matching in a real machine?)
  - We have only one WS in some section so we should study how well we can reconstruct the phase space with one device.
- Longitudinal matching
  - We have only one BSM in a section so we should study how well we can reconstruct the phase space with one device.