Summary of RFQ input studies
by

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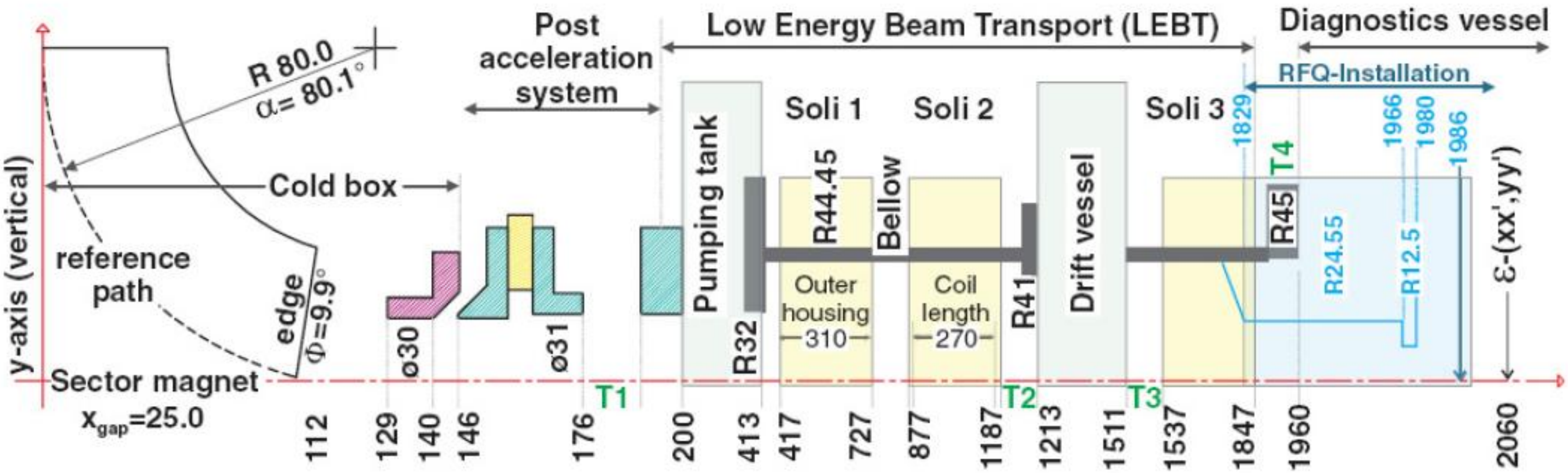
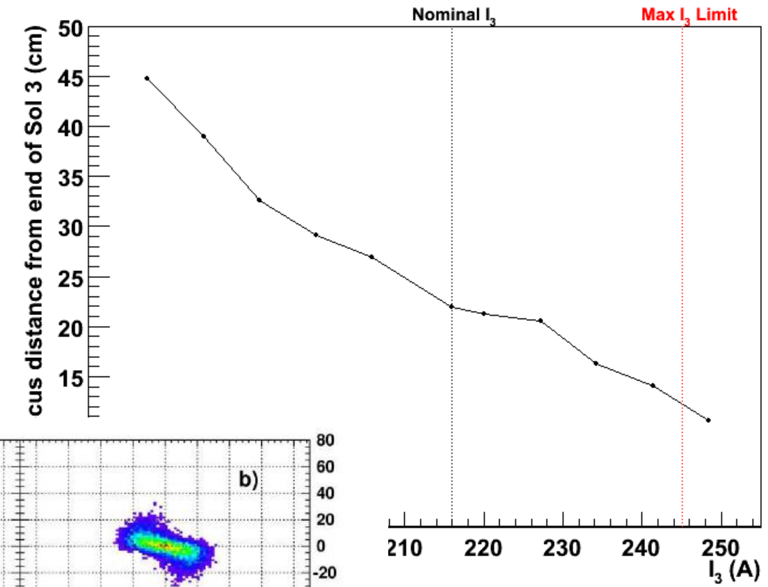
FETS meeting 22[th] August 2012

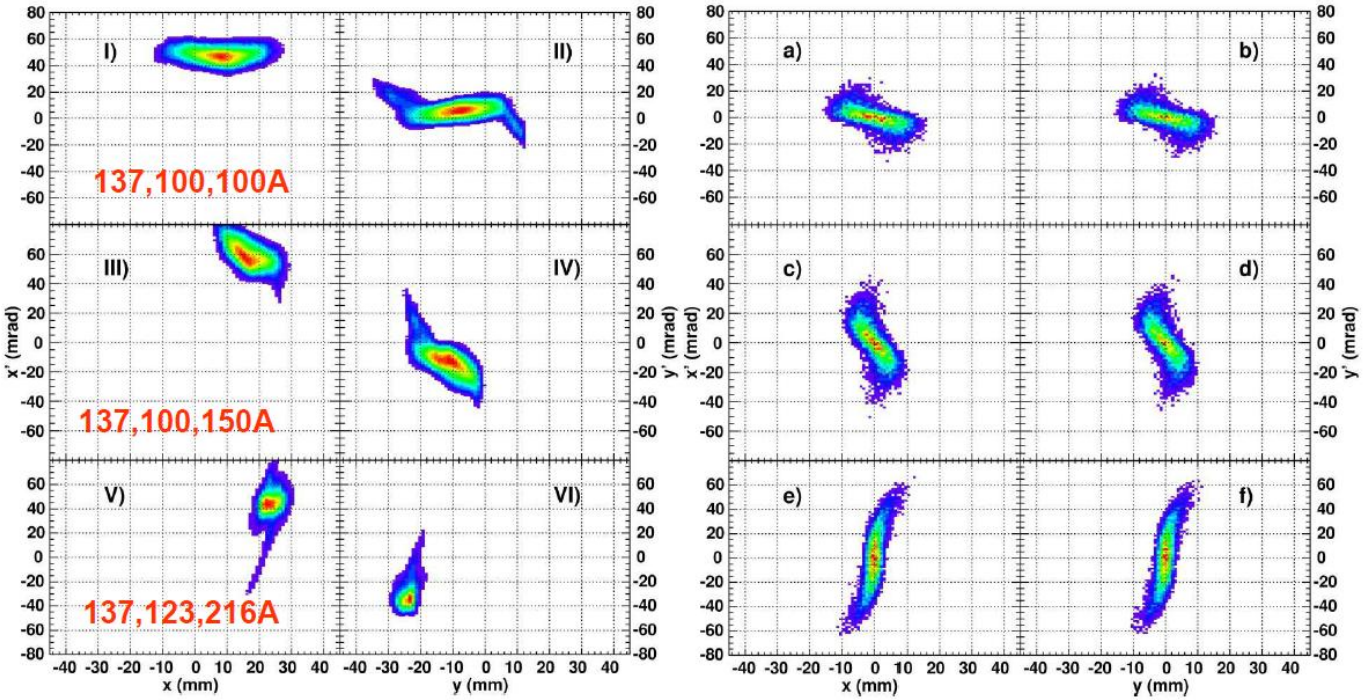
- Problem : Matching of beam from LEBT to RFQ – design of last LEBT drift.



LEBT – delivery so far

- Measured z=2060 mm
- Relation to RFQ entrance ?
- Sol3 end = 1847 + 120 ....
- + 250 mm – but only 50 mm variation ion design

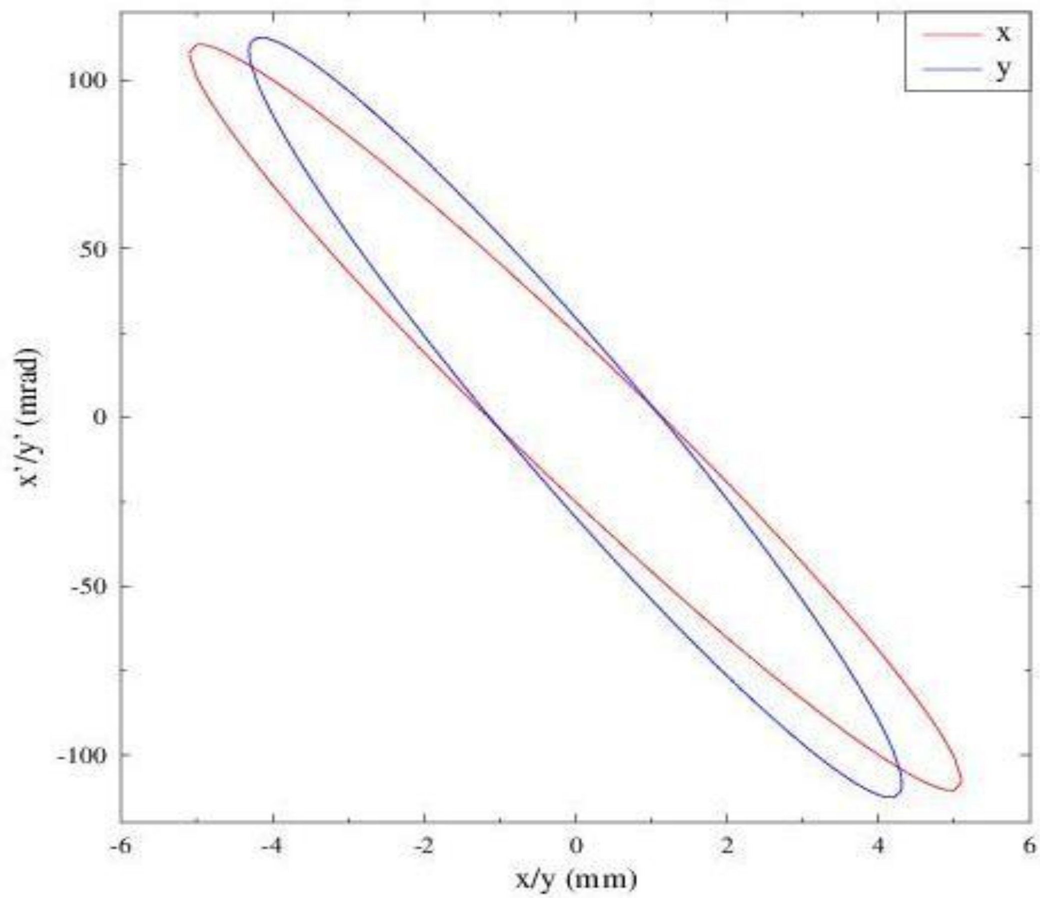




Starting point RFQ

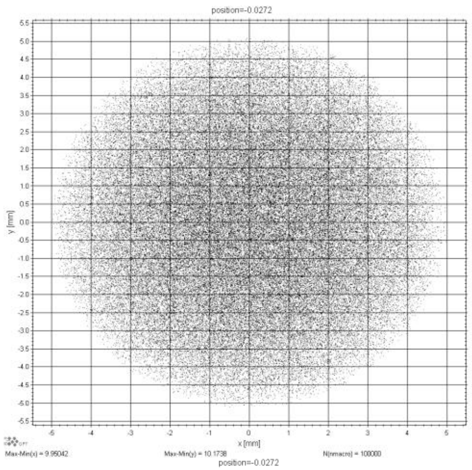
- Acceptance at z_{alan}=-27.2 mm, at z_{pete} = -2.7 mm
- for “reference particle”
- With space charge
- and end fields
- Z_{simon} = -21 mm,

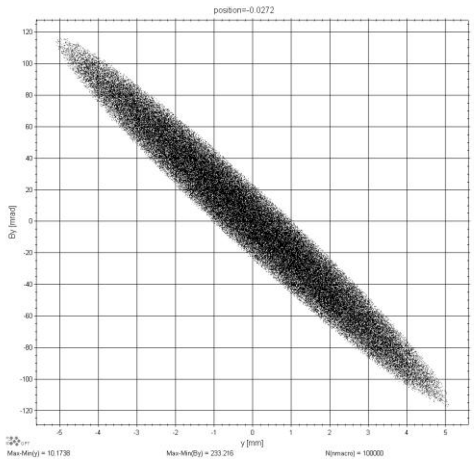
+3.5mm after Z_{pete}

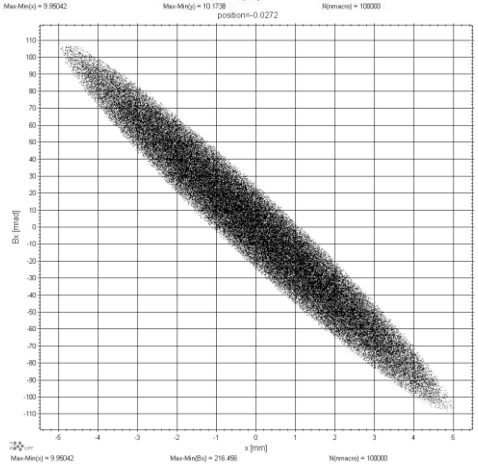


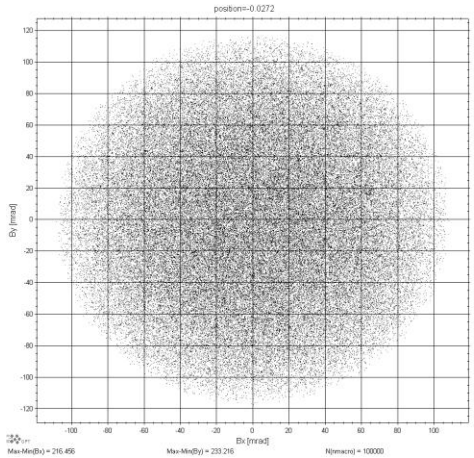
Initial particle distribution

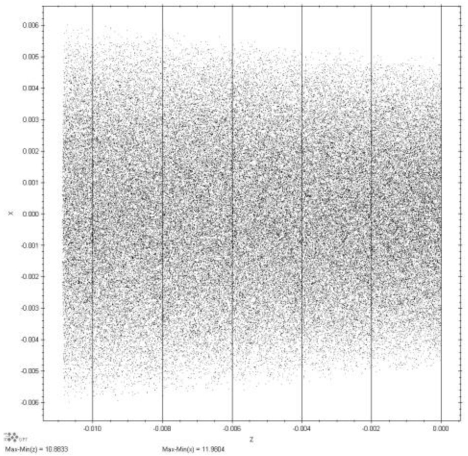
- Particle distributions for matched twiss parameters.

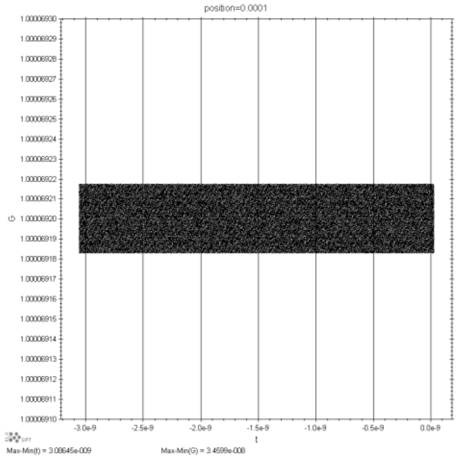




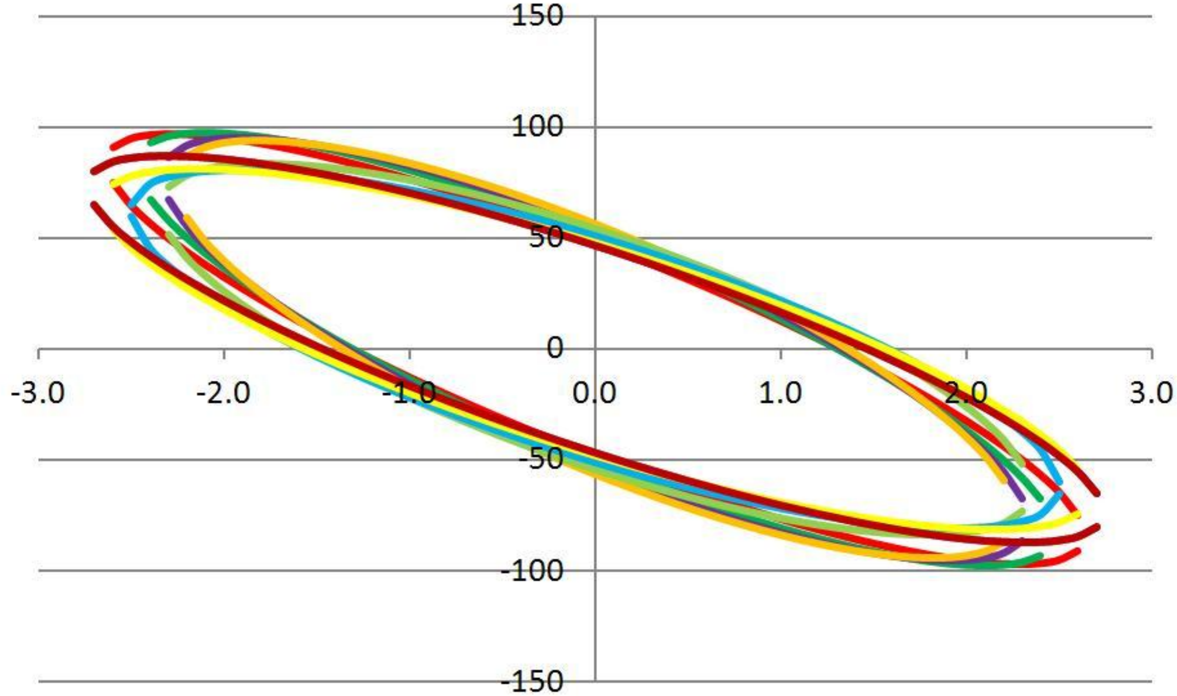








- Phase / time dependence of acceptance
- Time varying external forces at the RFQ entrance lead to a “rotation” of acceptance.



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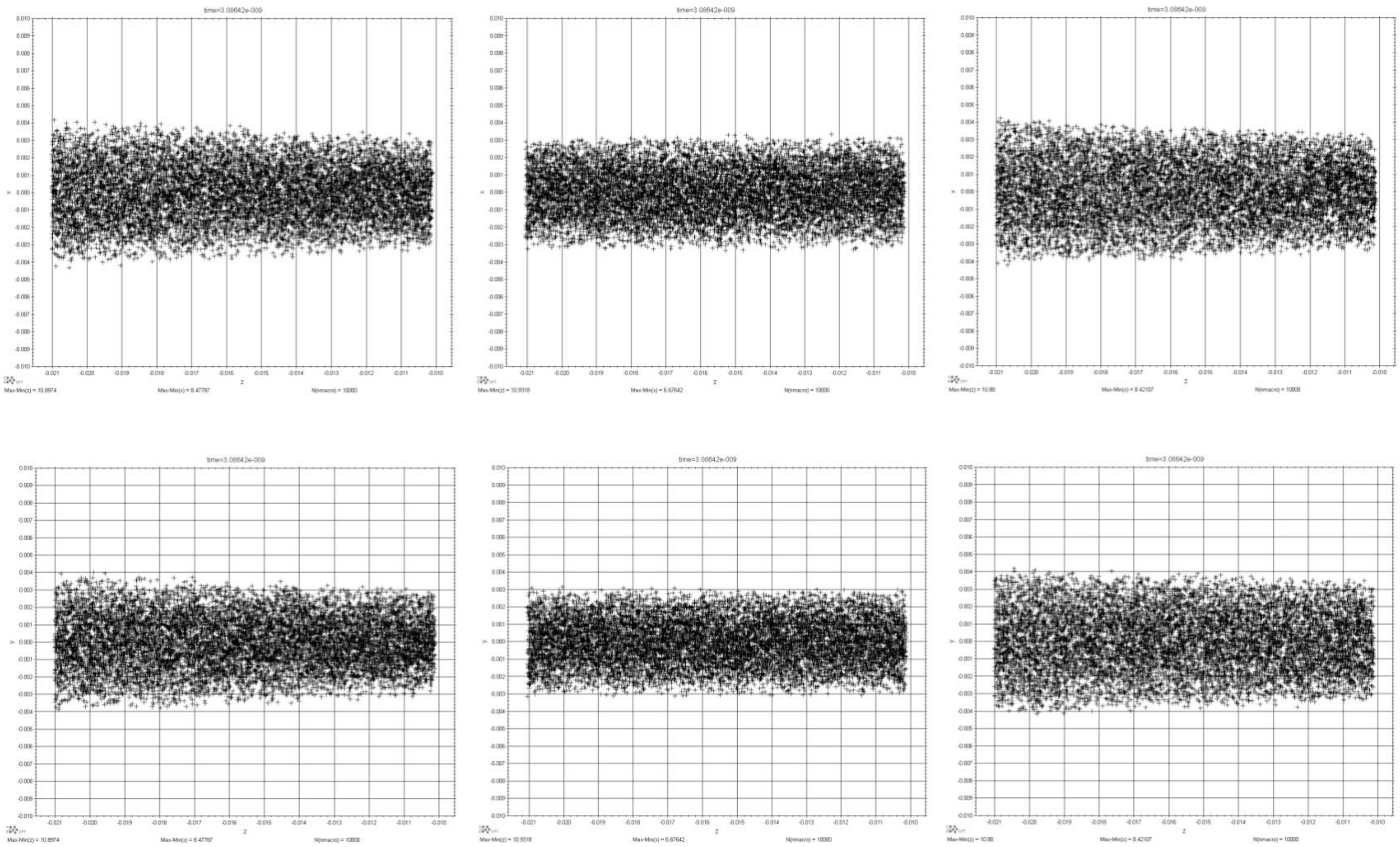
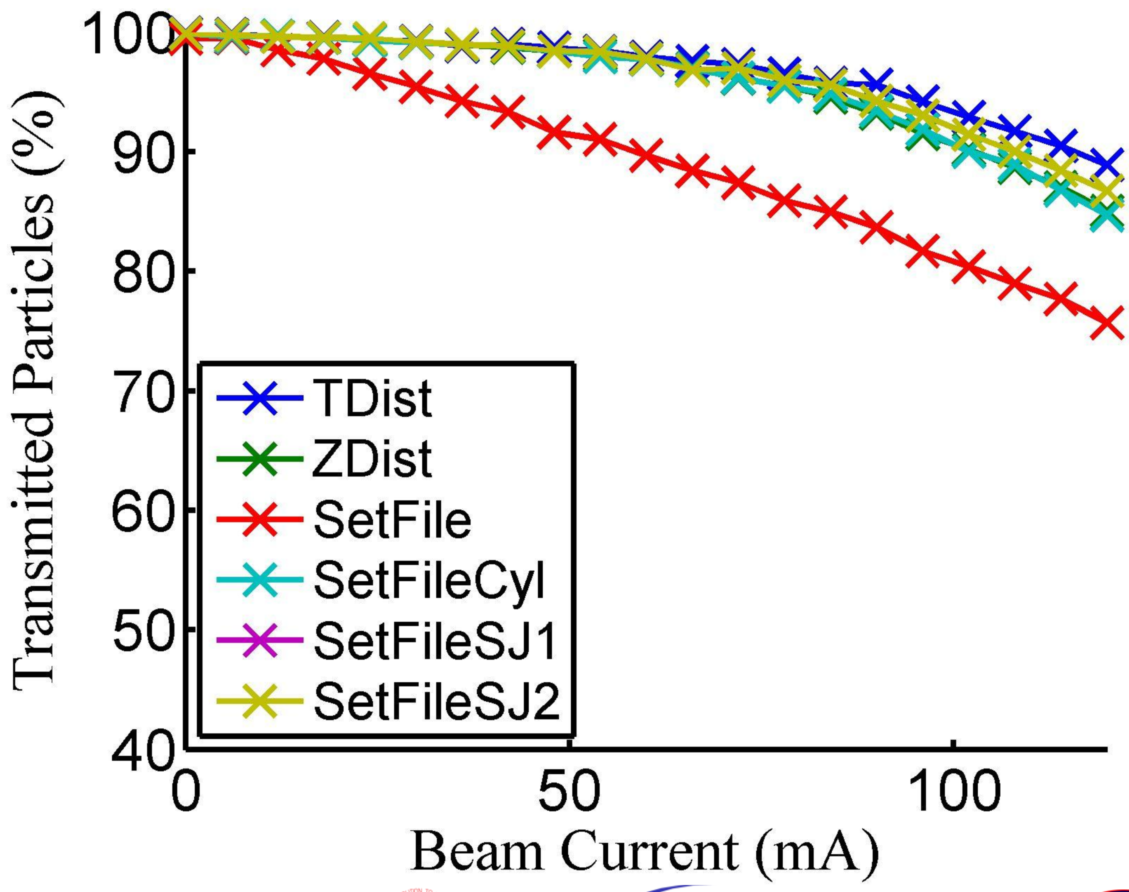
• Tdist, Zdist or setfile

- What is the “correct” way to define the beam start



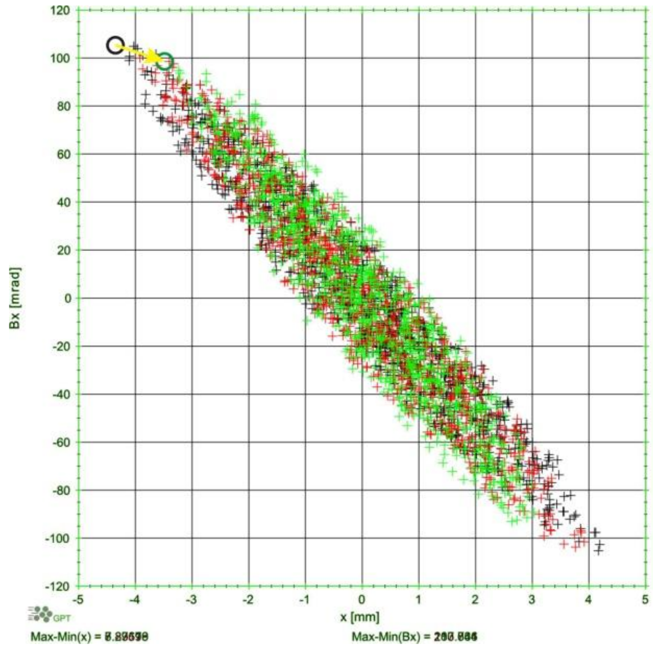
Initial results with GPT

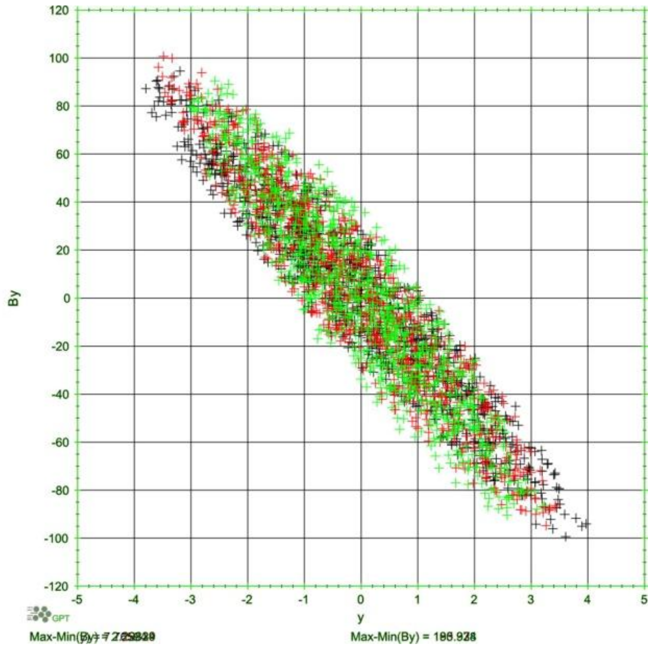
- Particle run with GPT by Simon showed surprising results on the first glance.



Zdist details

- Twiss parameters vary along the beam pulse





	α_x	α_y	β_x	β_y
nominal	3.8200	3.4000	0.1599	0.1415
front	3.61	3.19	0.1496	0.1340
middle	3.29	2.87	0.1273	0.1107
end	2.68	2.41	0.0976	0.0882

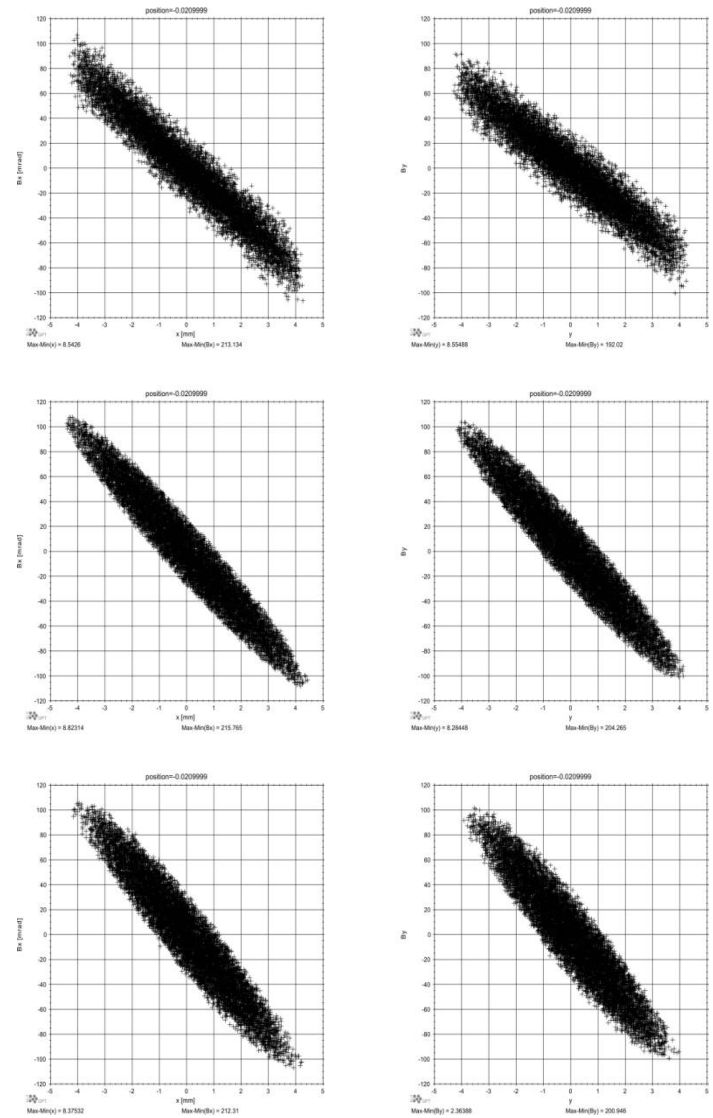
Summary 1

- The use of the Zdist distribution is not correct but delivers good results in terms of transmission.
- While the Zdist mismatched beam shows good transmission the setfile distribution is performing much worse – what is the reason ?

Transversal phase space comparison

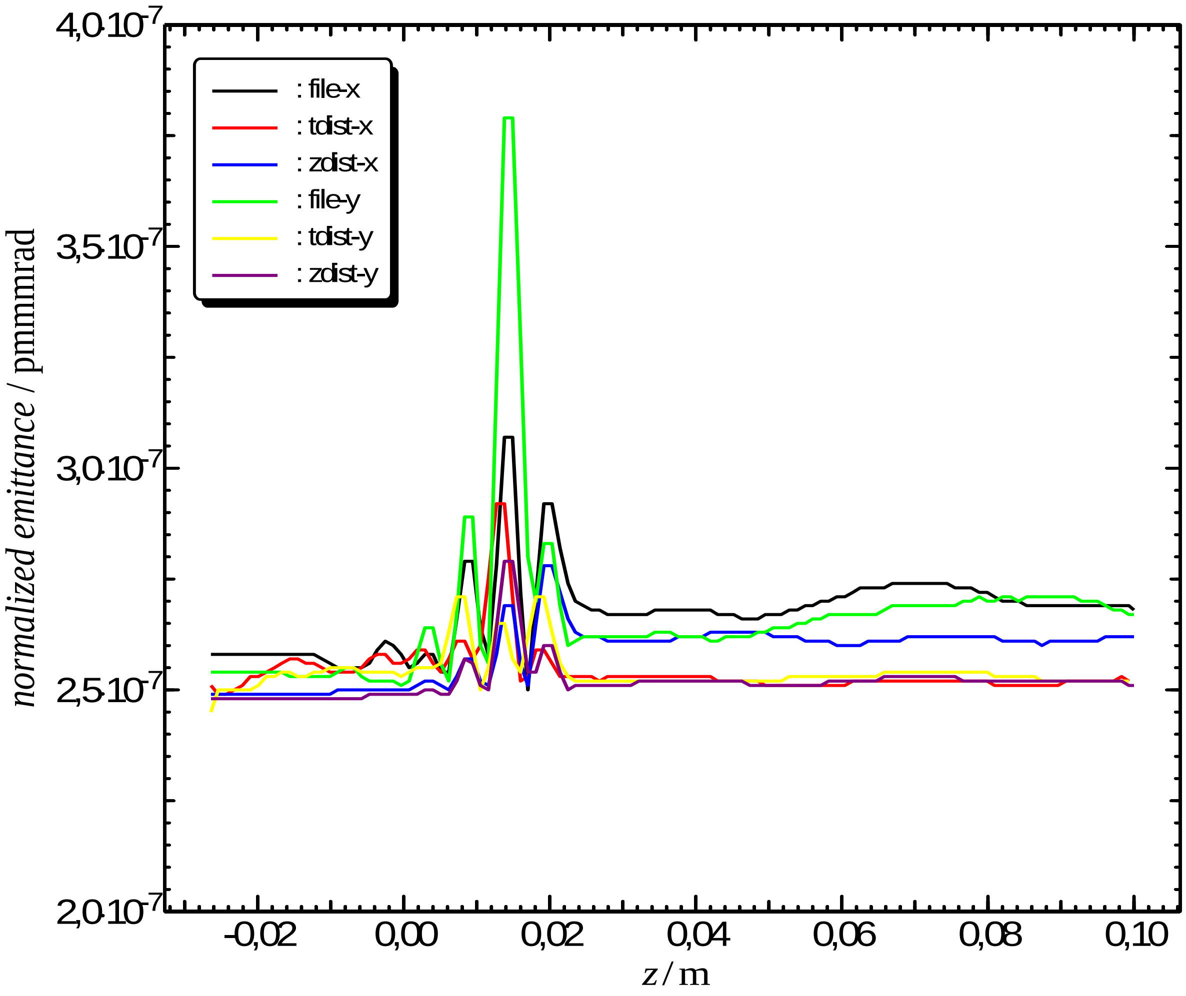
- Further comparison of the transversal phase space showed very similar distribution with some minor variation except for a clear difference of the setfile distribution generated by Juergen....

Reconstruction of file generation showed that the twiss α from Simon (-21 mm) was used together with the twiss β from Alan (-27.2mm). This explains the results....



Emittance growth

- Further analyses showed that the mismatch is clearly visible in an emittance growth for the setfile and Zdist cases.



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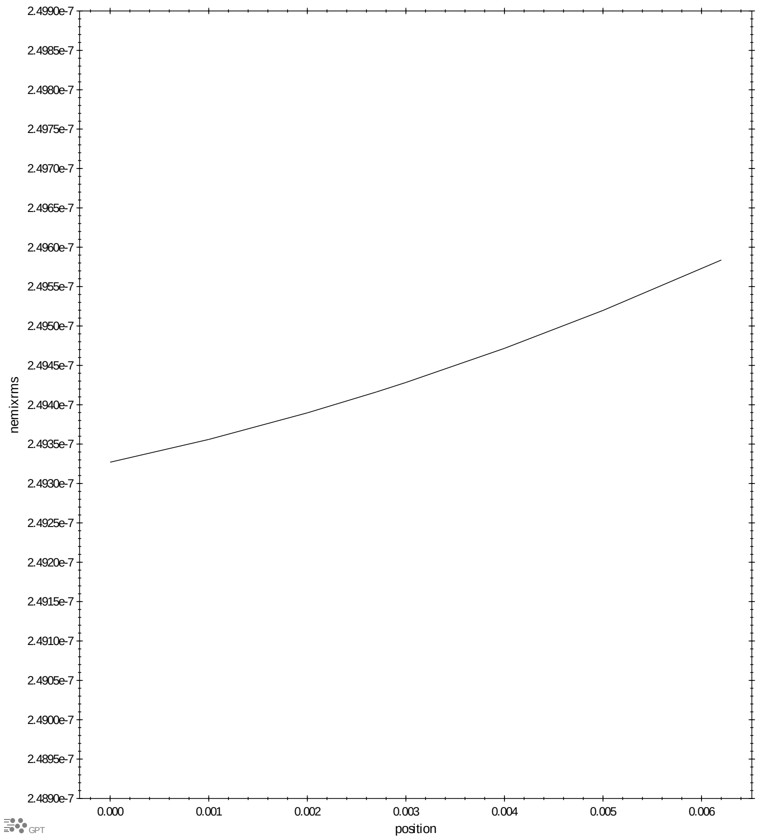
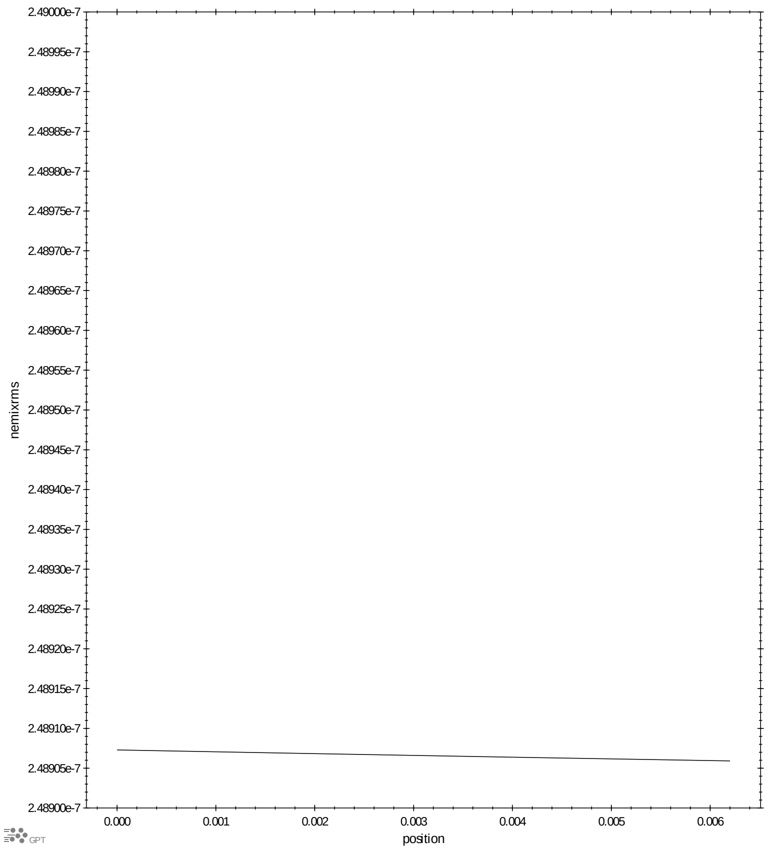
Emittance growth in drift

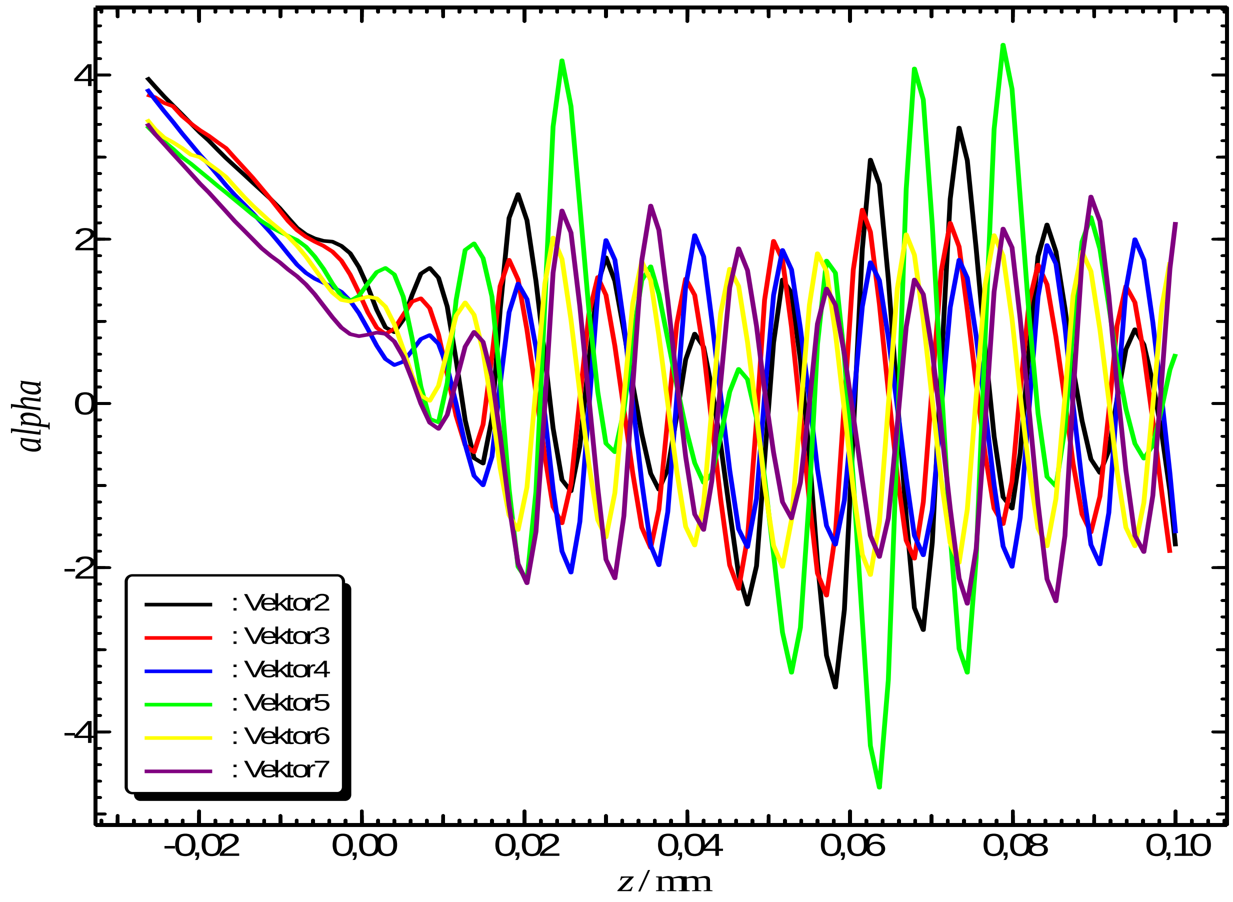
- Increase of emittance due to SC is 20 times smaller than due to mismatch, numerical influence ~ 10 times smaller again





Development of twiss α

- The mismatched beams show also increased oscillation amplitude in α



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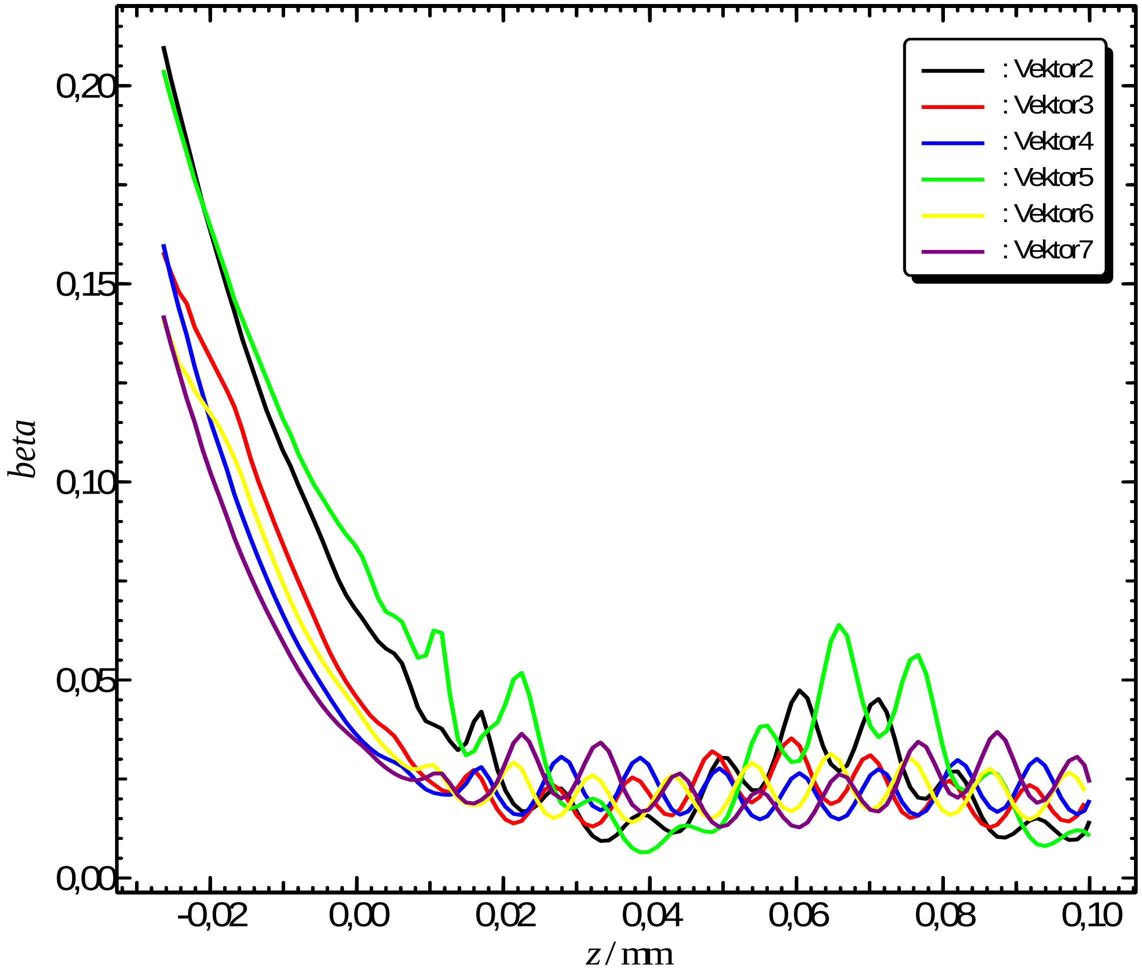
Development of twiss β

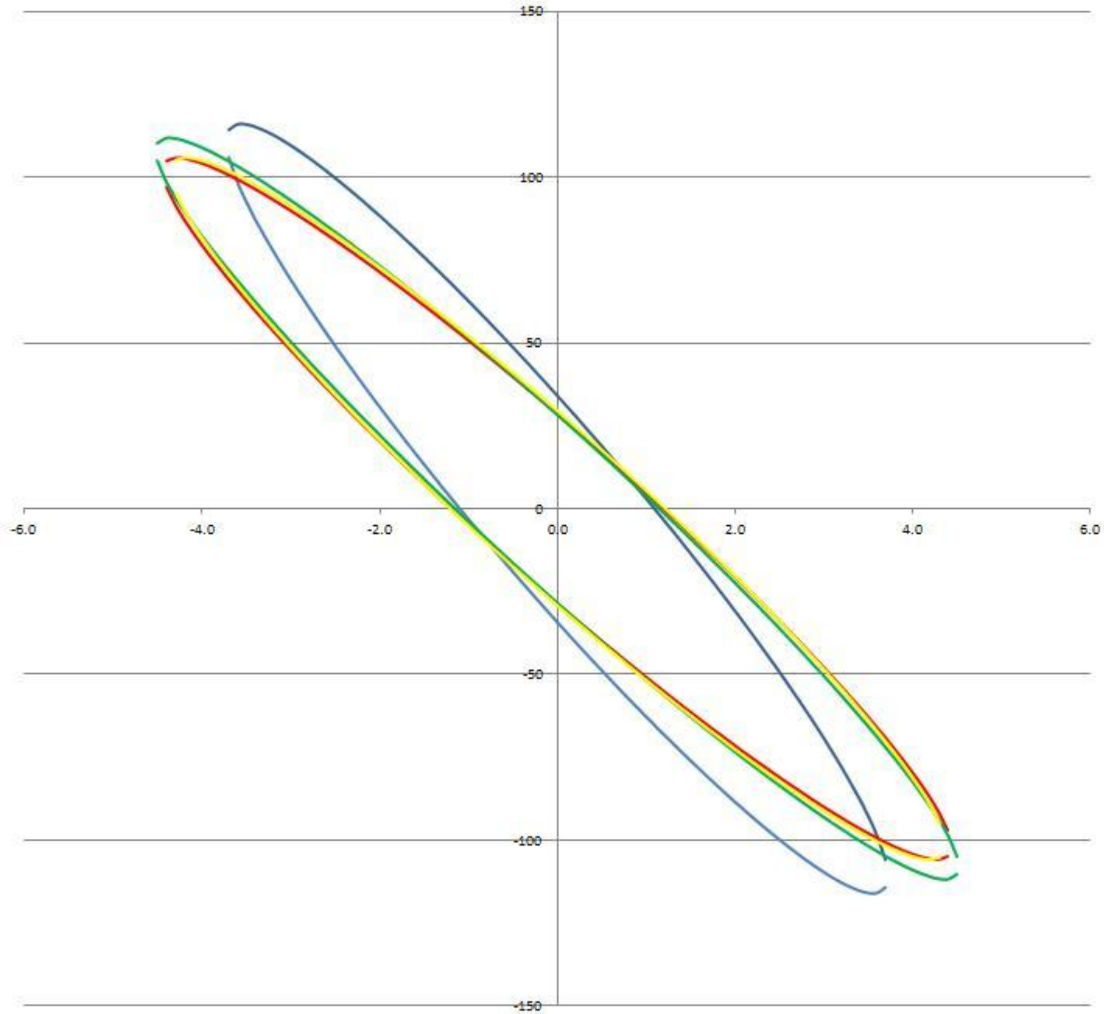
- The missmatched beams show also increased oscillation amplitude in β due to an additional lower frequency component.



Comparison of time variation of

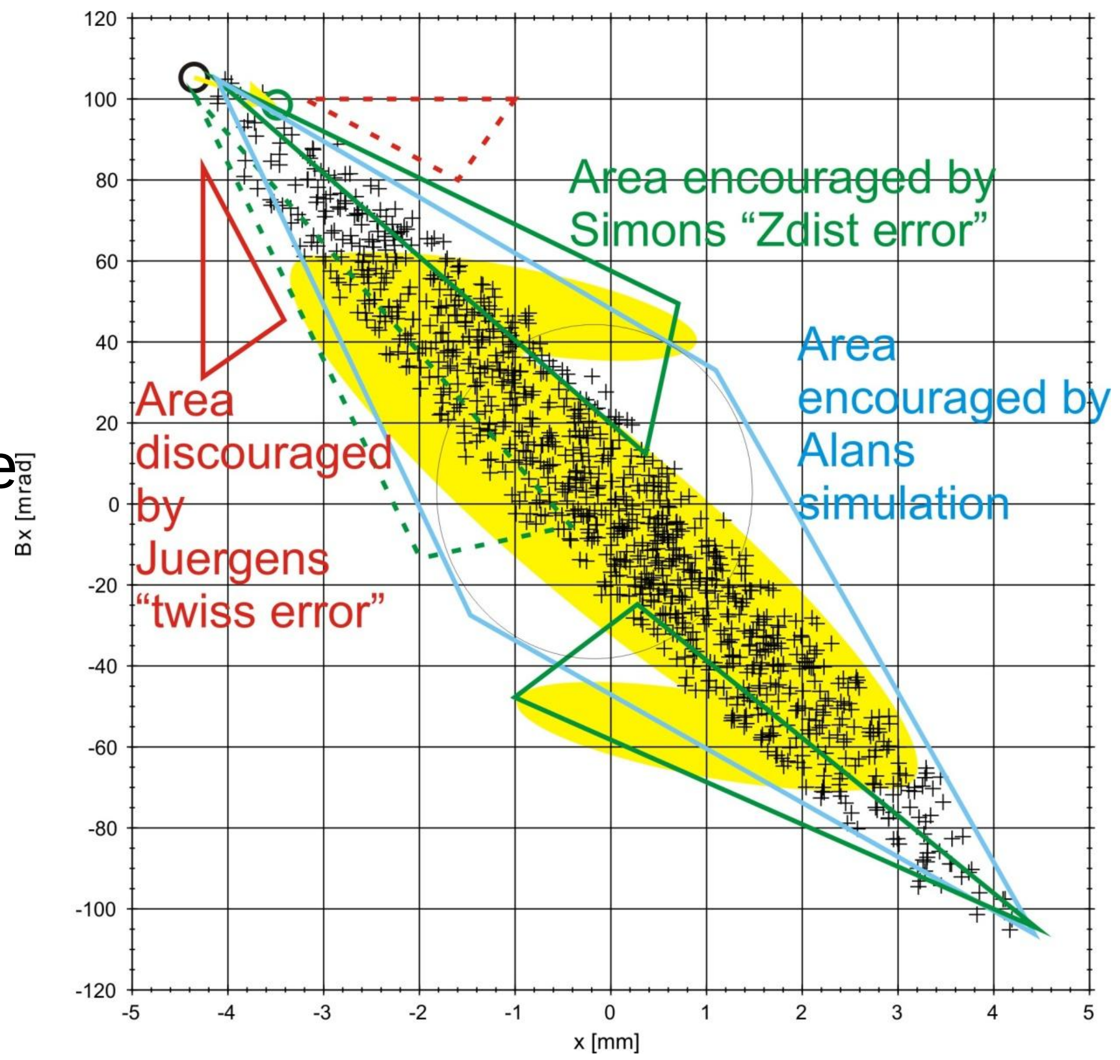
- Blue different position (datum), Green reference, others averaged. Variation between the last three is negligible.

The time variation of the acceptance is not relevant for transmission.



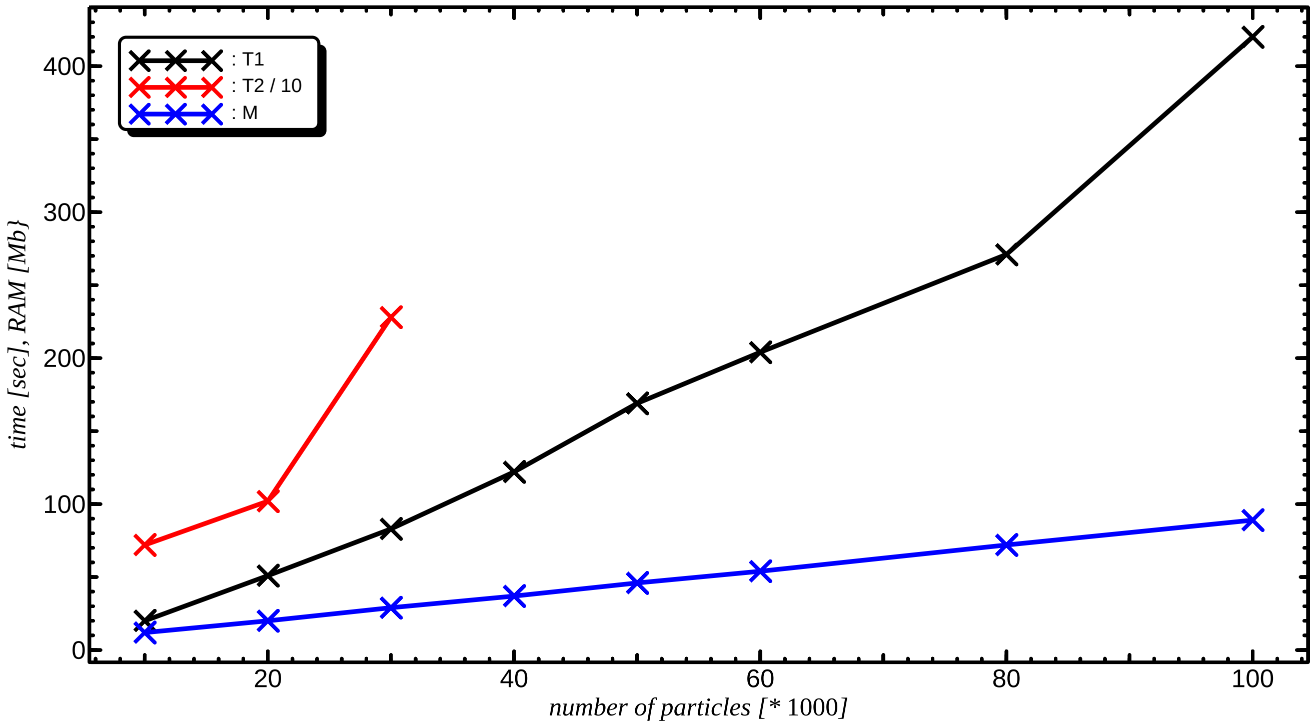
Second summary

- Investigations so far showed that a certain miss match can be tolerated while a different missmatch lead to sever loss of transmission. From the errors and Alans first simulations certain areas of the phase space should be considered for further investigations. More particles for sampling.



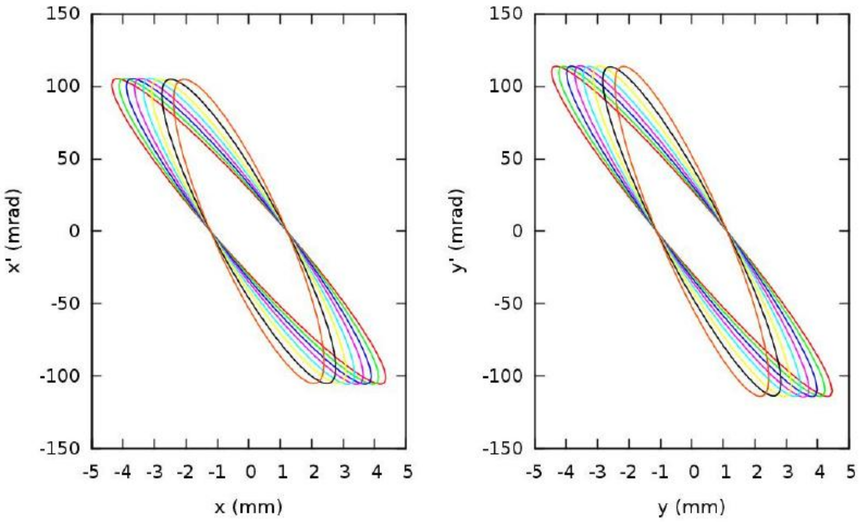
Resources consumption – 100 k runs

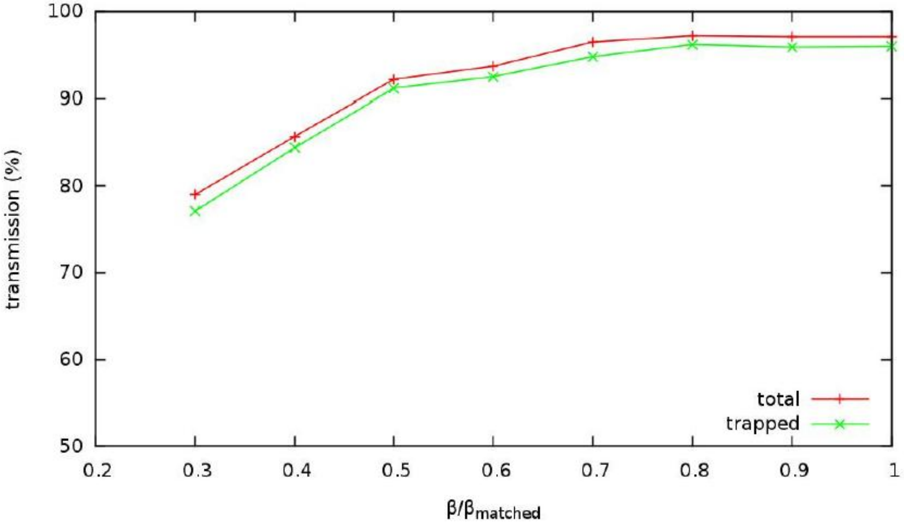
- 2000 tout + 5 screens / Win 7 / i7 3770 / 12 Gb
- => with space charge time is an issue (1/2 day), memory not, if 29 Gb output file on disk is no problem.
- Unhandy file for transport – reduce tout number



Variation twiss β

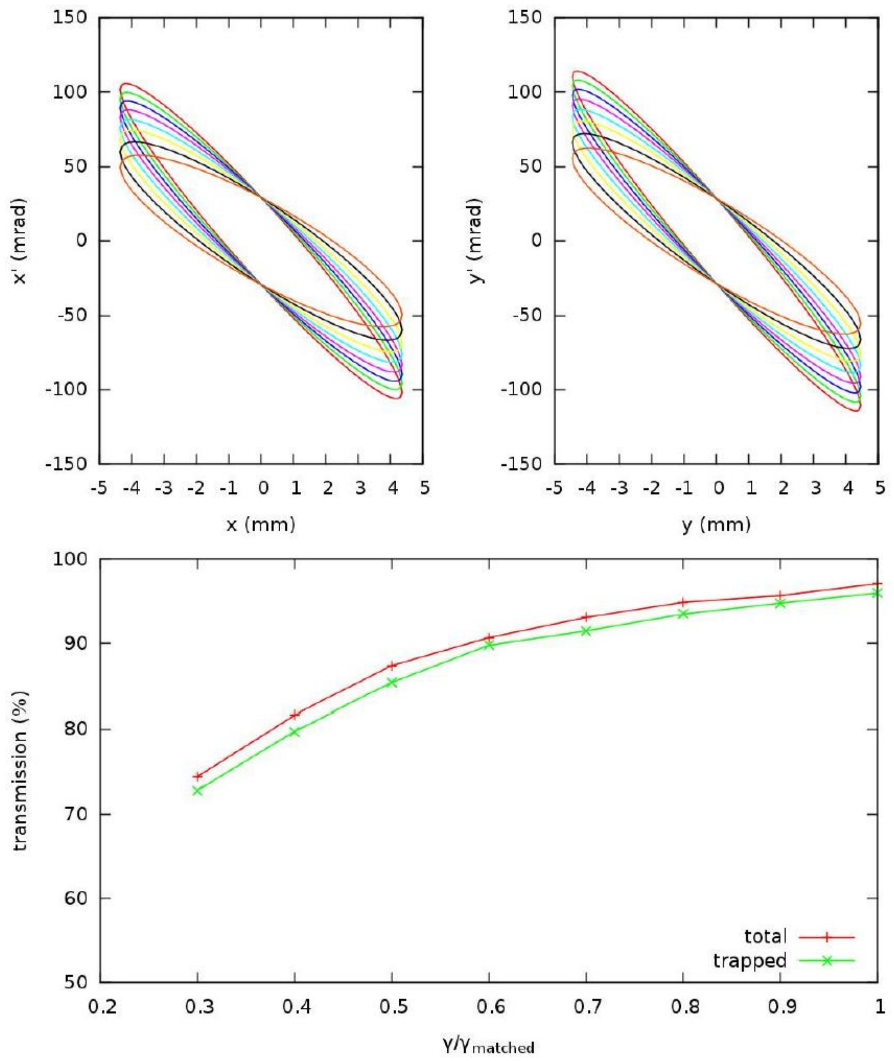
- A more detailed investigation of the expected variation of the beam transmission as a function of a variation of the twiss β parameter showed that the transmission is not severely decreased (90%) up to a factor of 0.5. This is consistent with the finding from the Zdist results.





Variation twiss γ

- A variation in twiss γ shows a much stronger, continous decrease in transmission with the 90% limit at 0.6. This is consistent with the previously found excluded area.



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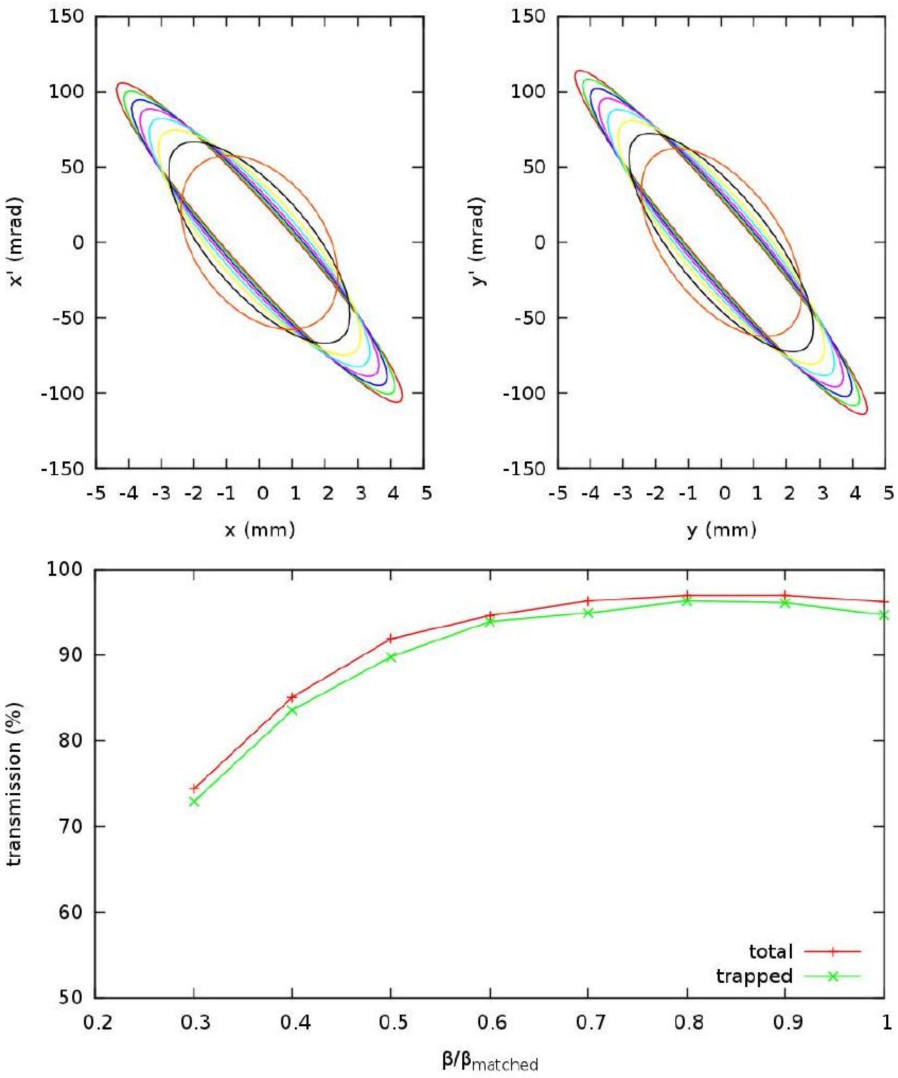
• Variation aspect ratio

- The influence of the aspect ratio on the emittance is again relatively moderate up to a ration of 0.5 of the match case (90%). This confirms the area identified by previous results.



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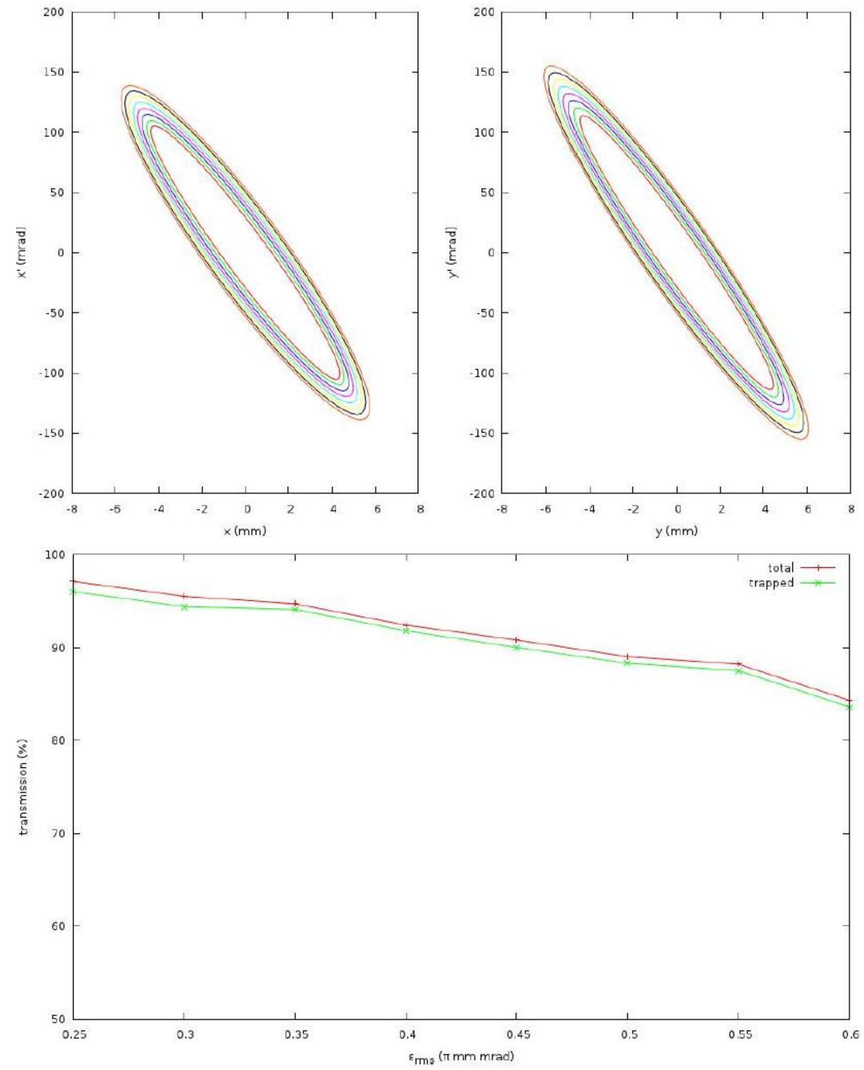
• Variation emittance matched

- Again a quite moderate slope with increasing emittance falling below 90% for emittances exceeding 0.45. As the measured emittance is lower this on its own would be very encouraging.

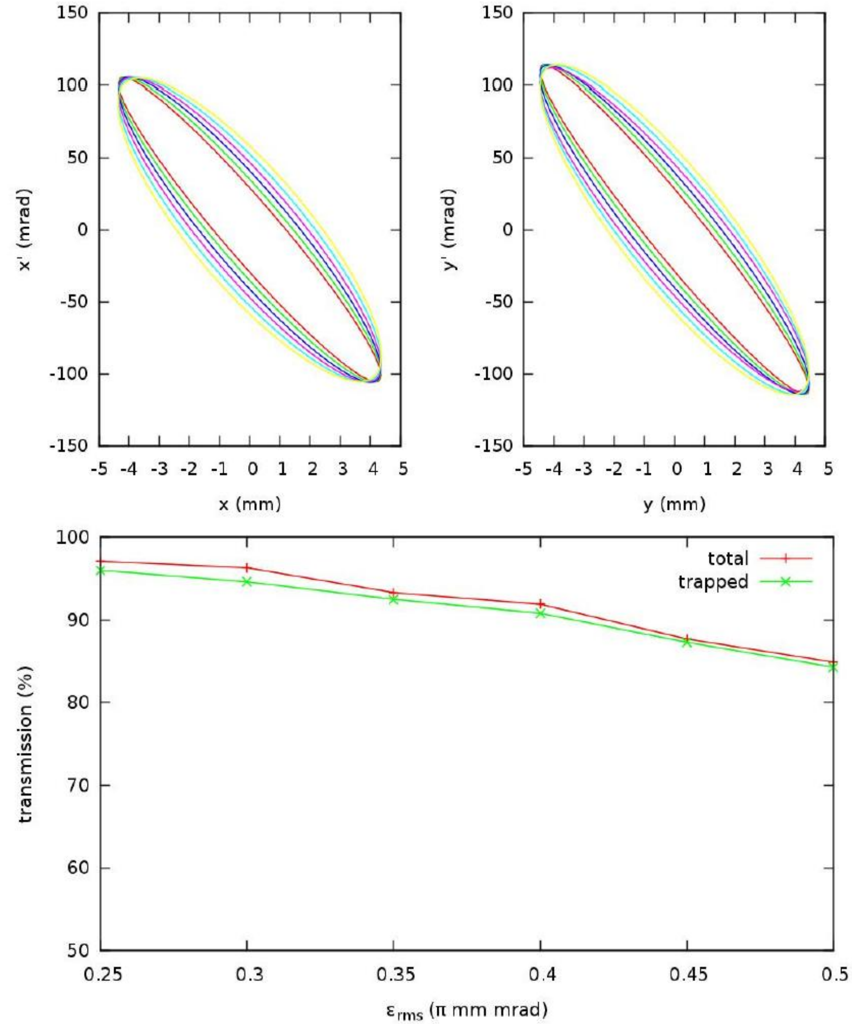


Variation emittance unmatched

- Even for an unmatched beam an emittance of 0.4 could be tolerated.

⇒ The emittance and twiss parameters can be varied by quite a large amount in certain cases and still allow for a reasonable transmission.

⇒ **The focus must now shift back to the LEBT to deliver the beam to one of the identified phase spaces.**



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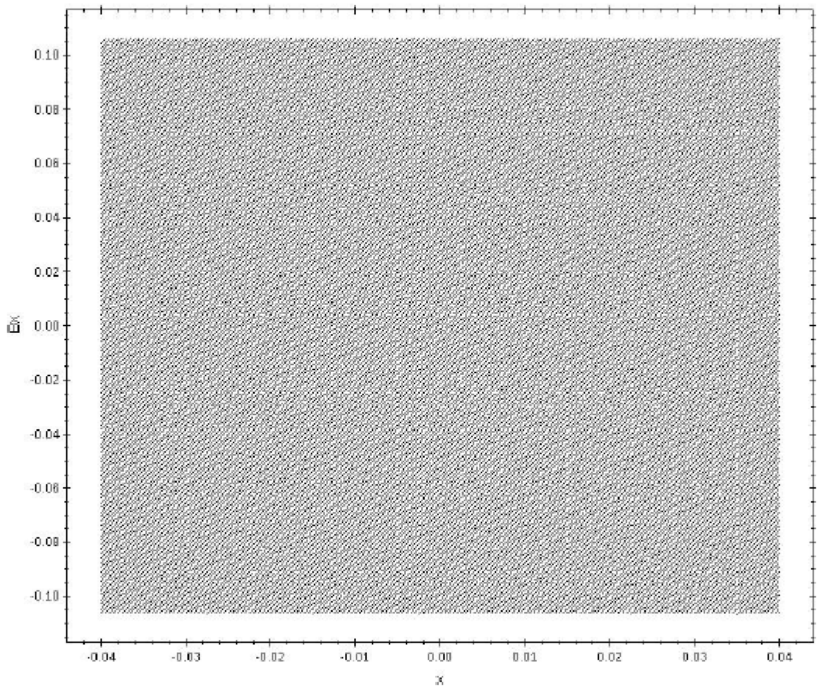
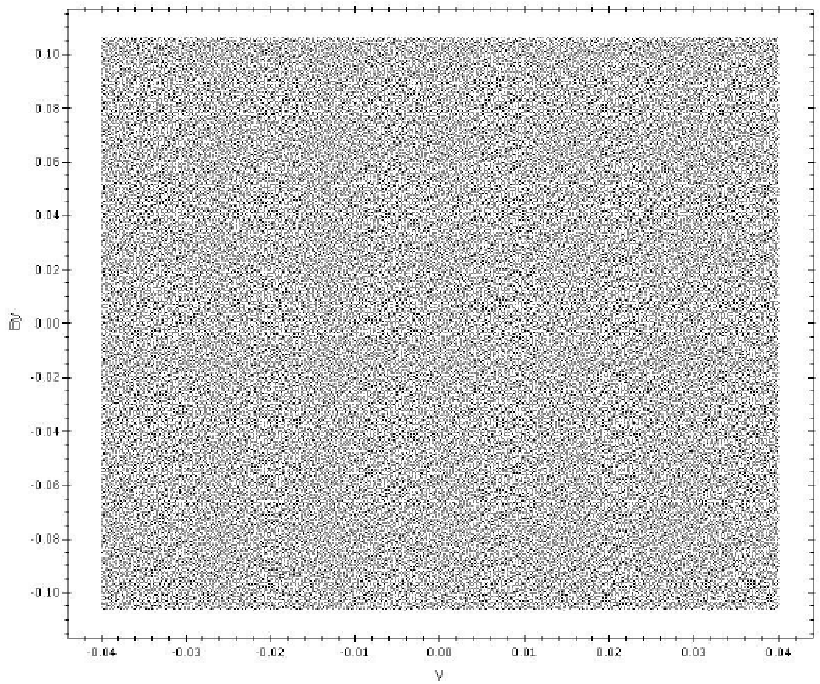
LEBT simulations with huge phase space

- An GPT input file was produced with a huge transversal phase space to identify the acceptance of the LEBT, and to identify the cause of the miss match in the LEBT.





First solenoid

- The results for the first solenoid operated only seem to indicate that the beam origin is in the upper boundary of the acceptance.

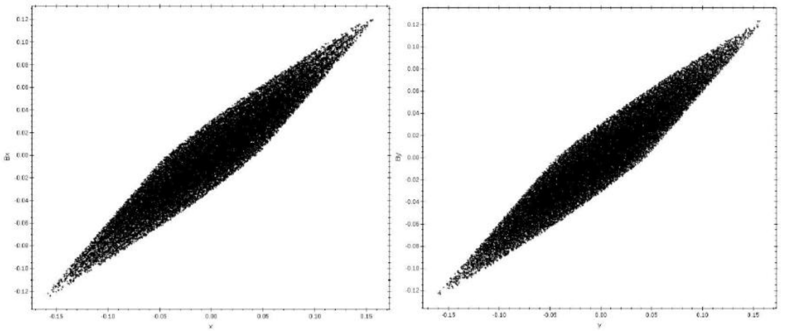


Figure 3 Surviving particles for 137A, 0A, 0A.

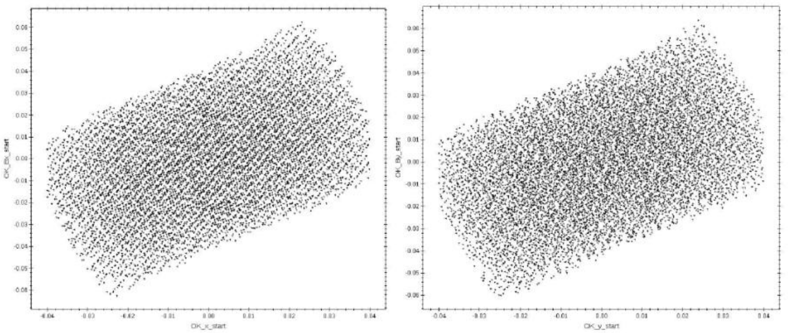


Figure 4 Acceptance for 137A, 0A, 0A.

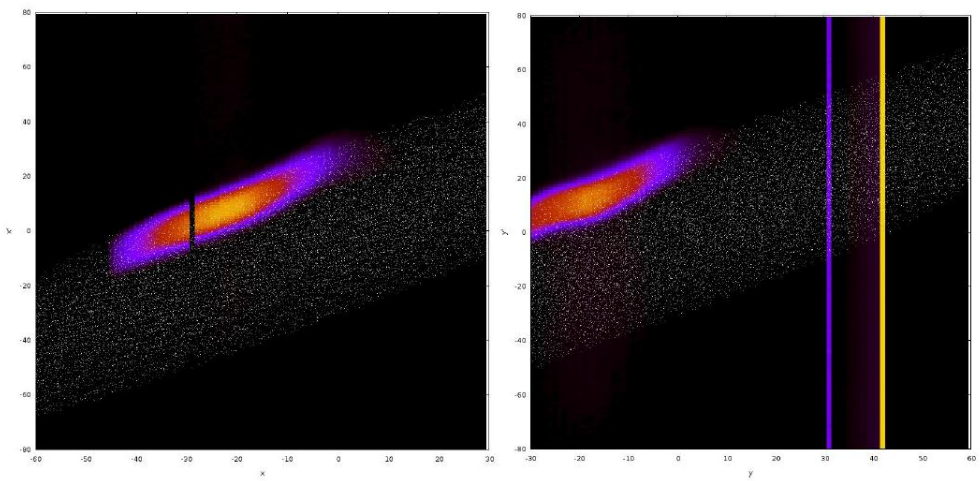


Figure 5 Simulated particle distribution overlaid on measurement for 137A, 0A, 0A.

First and last solenoid

- The results for the first and last solenoid operated seem to confirm that the beam origin is in the upper boundary of the acceptance. But outside of the previously allowed phase space.

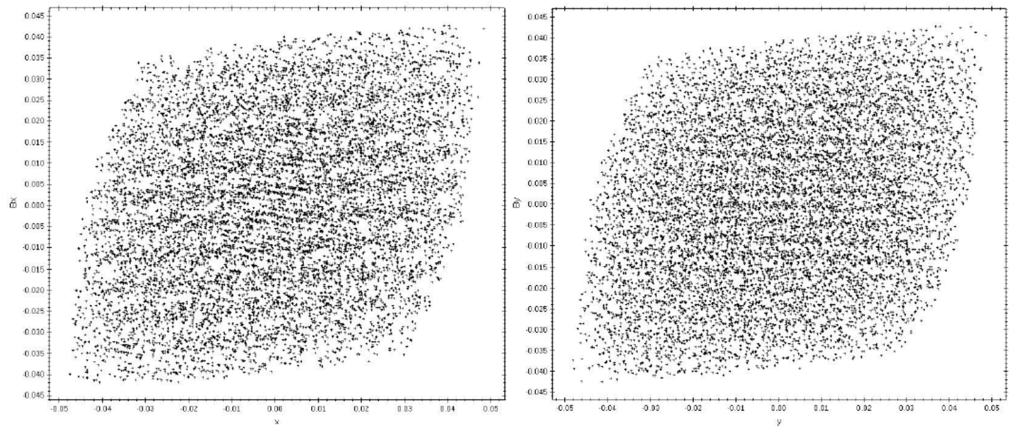


Figure 6 Surviving particles for 137A, 0A, 100A.

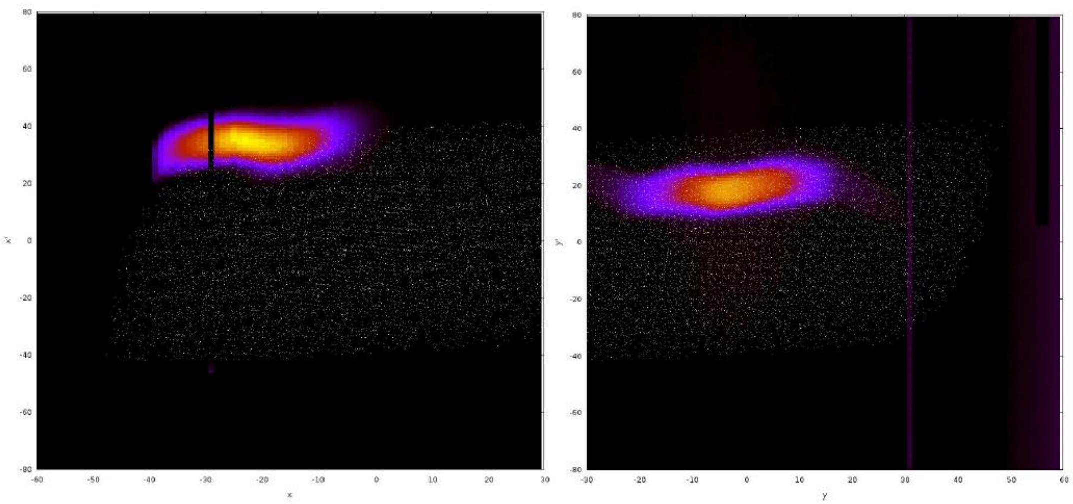


Figure 8 Simulated particle distribution overlaid on measurement for 137A, 0A, 100A.

Three solenoids

- The results for three solenoid confirm that the beam origin is in the upper boundary of the acceptance, but again outside the previously indicated space (in x, x')

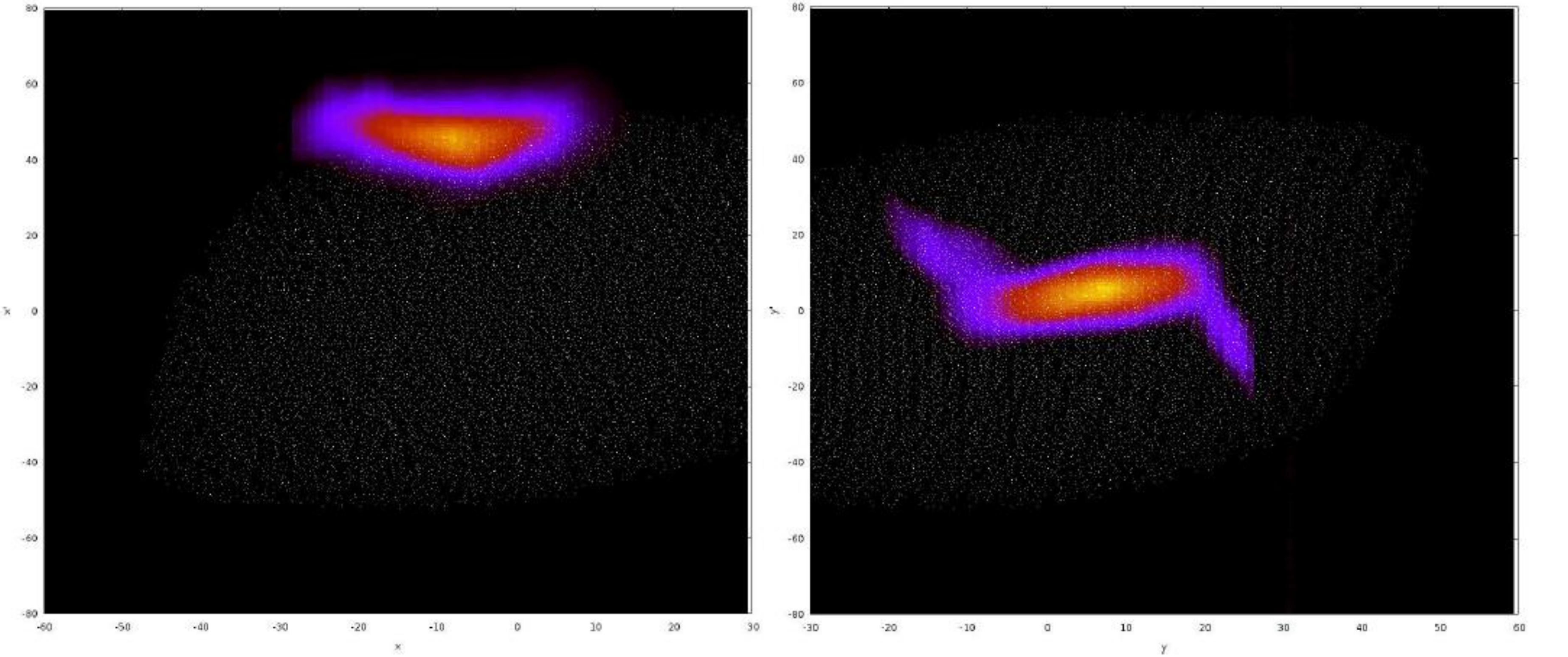


Figure 11 Simulated particle distribution overlaid on measurement for 137A, 100A, 100A.

- Further (latest) investigations on the LEBT miss match in next presentation.