Three versus **four** Quads for the round-to-flat beam transformer

P^2, April 19th, 2004

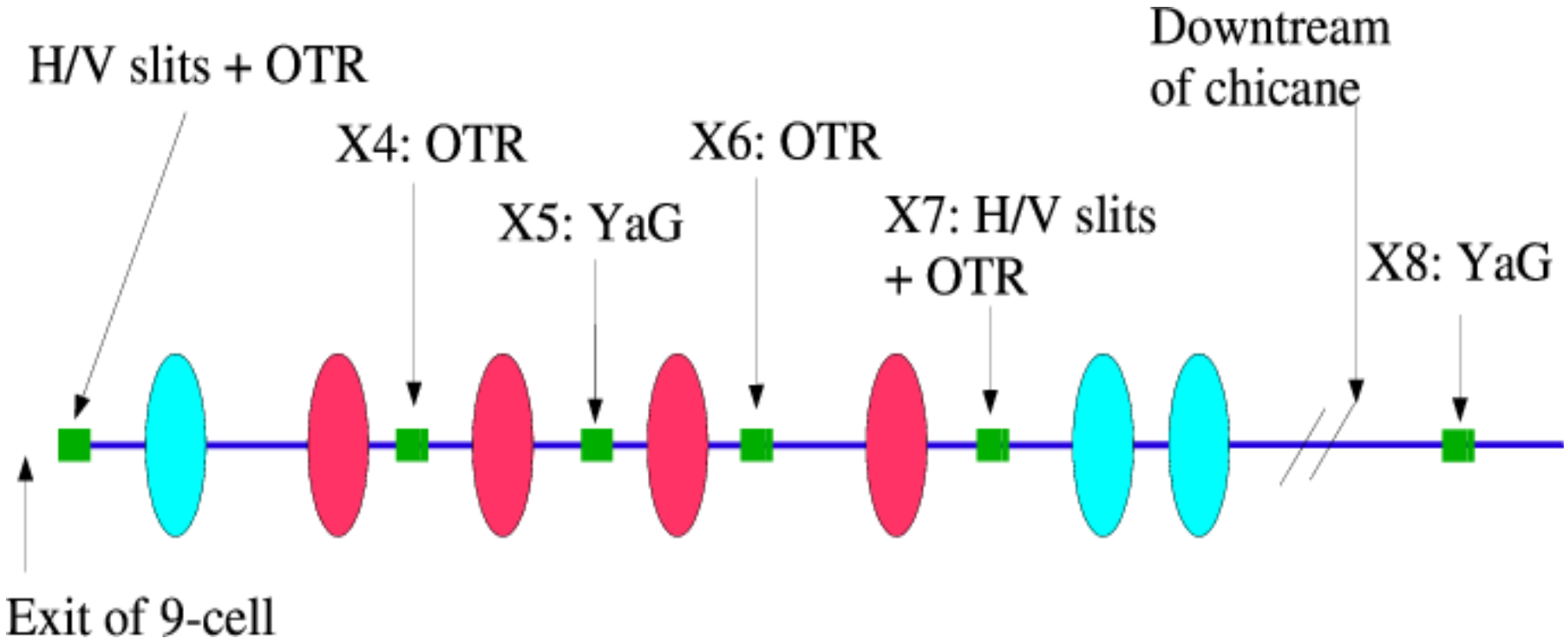
- Initial experiment done with three quads,
- four quads set-up suggested from Astra simulations by Klaus Floettman
- A0 upgraded setup incorporates four quads
- however due space constraint there is a problem with emittance measurements [comment from Kai Desler] (still some need to do checks+
  document what is the problem and the dynamical range of the emittance measurement... maybe this Thusday morning).
- In principal for an incoming cylindrical symmetric beam there are only three equations to zero all the correlation matrix elements

Nota: These are old results but need to be shown to clarify some "sayings"

The problems/limitations

.In A0 setup we have a problem due to space constraint and have two choices (somebody a better IDEA?):

1. four quads transformer: slits at X7 and YaG at X8: this means the distance X7 to X8 is ~2 m (chicane between)
2. three quads transformer: slits at X6 and YaG at X7 this is identical to other screen/slits distances



Nota: there is still a normal emittance measurement station at X11,X13

Performance of 3 versus 4 quads R2FB transformer

To compare the performance of three and four quads-based round-to-flat beam transformer, I studied emittance + emittance ratio evolution versus incoming relative momentum spread

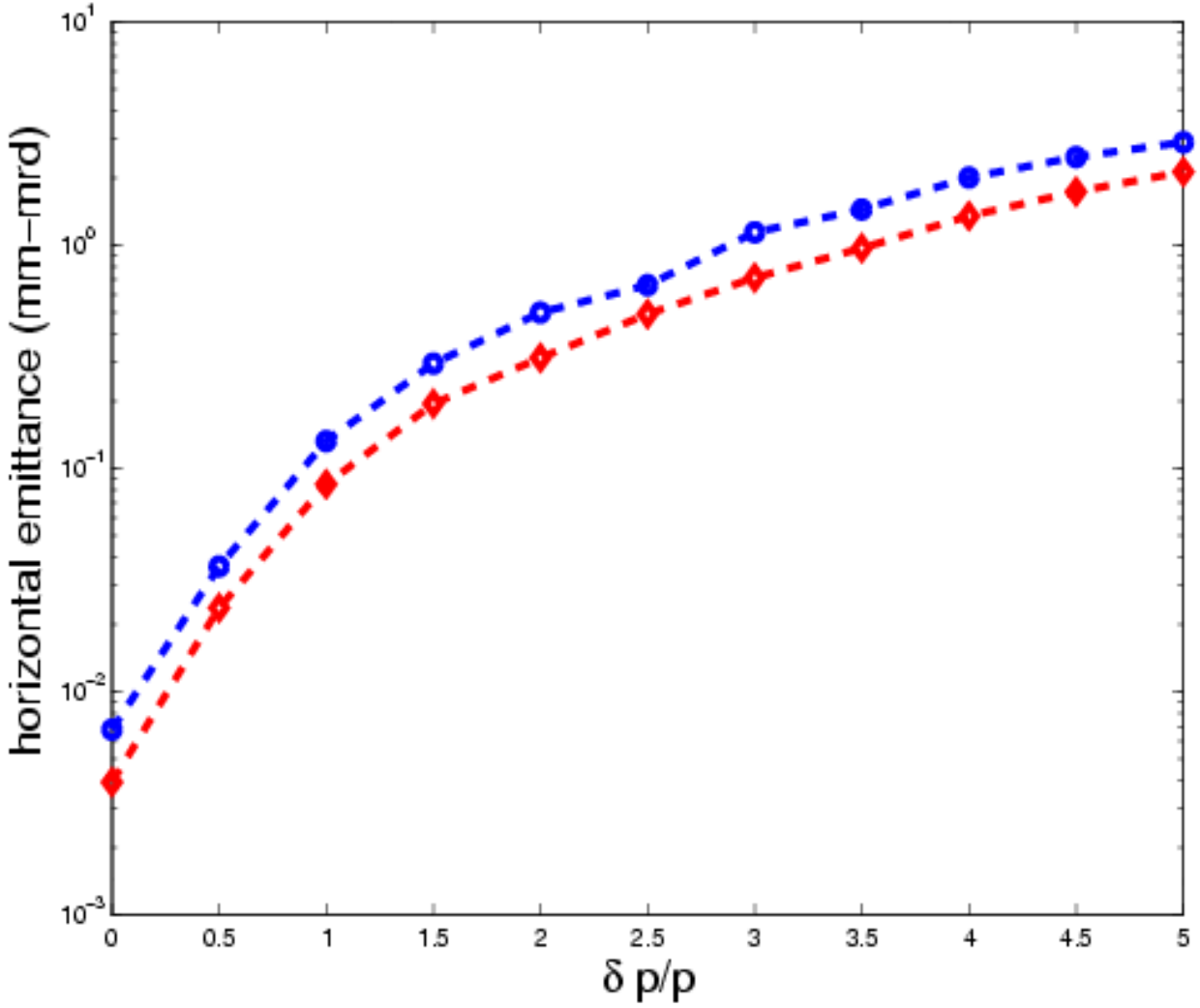
The incoming correlation matrix is computed and canceled using the quads to minimize a Chi square that is defined as the quadratic sum of the correlation matrix elements. Such a definition allows the use of the SAME algorithm for both the 3 and 4 quads set-up

For the three cases set-up the algorithm gives results in agreement with analytical calculation based on this lens approximation (E. Thrane et al paper)

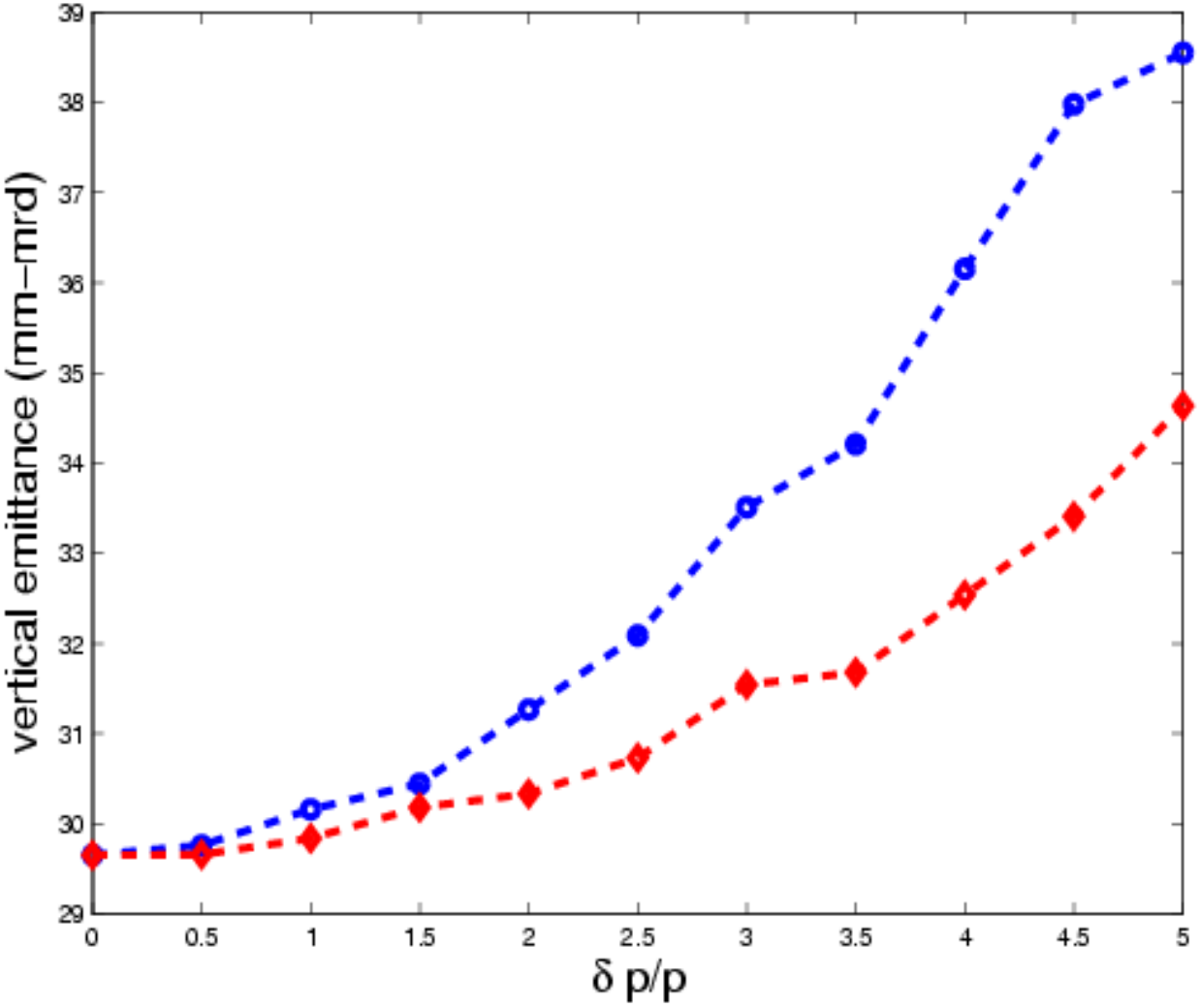
Conclusion: from a beam dynamics point-of-view four quads have a very small advantage with respect to the three quads set-up

FYI: I remember Steve Lidia coming to a similar conclusion for the LUX injector (?)

Comparison of performance between 3 and 4 quad R2FT



Comparison of performance between 3 and 4 quad R2FT



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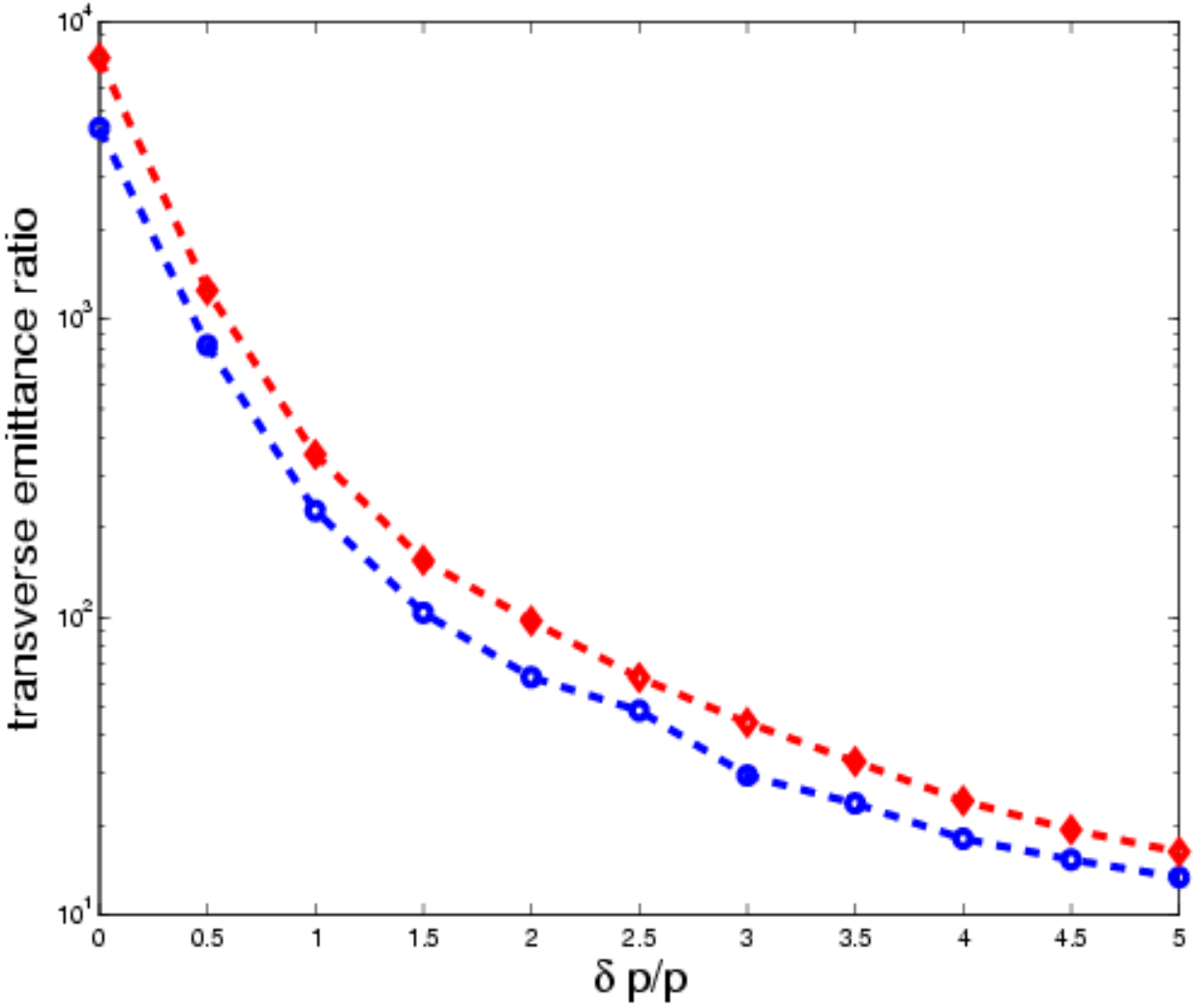

Conclusions

Four quads have no big advantage compared to three quads setup in the R2FB transformer,

Maybe we could keep the four quad set-up and see what the emittance measurement gives, we could also take data on angular momentum versus **B** on cathode for three and four quads (it would be interesting to see how the compensation differers) we can now measure beam spot between ALL the skew quads so this should be fast measurements

If the {X7,X8} emittance measurement is okay we can stick with the present setup, if we really have trouble we should go back to the {X6, X7}

Also we should really investigate the old idea of using a quads between the slit and the screen to increase the dynamical range of emittance measurements based on slit + screen technique.

Finally quad scans? Should try. I have written a set of program to analyze data from quad scan (with error propagation), but we need to have a small `python` script to take data fast which I have started but never finished