Beam optics issues for PBS

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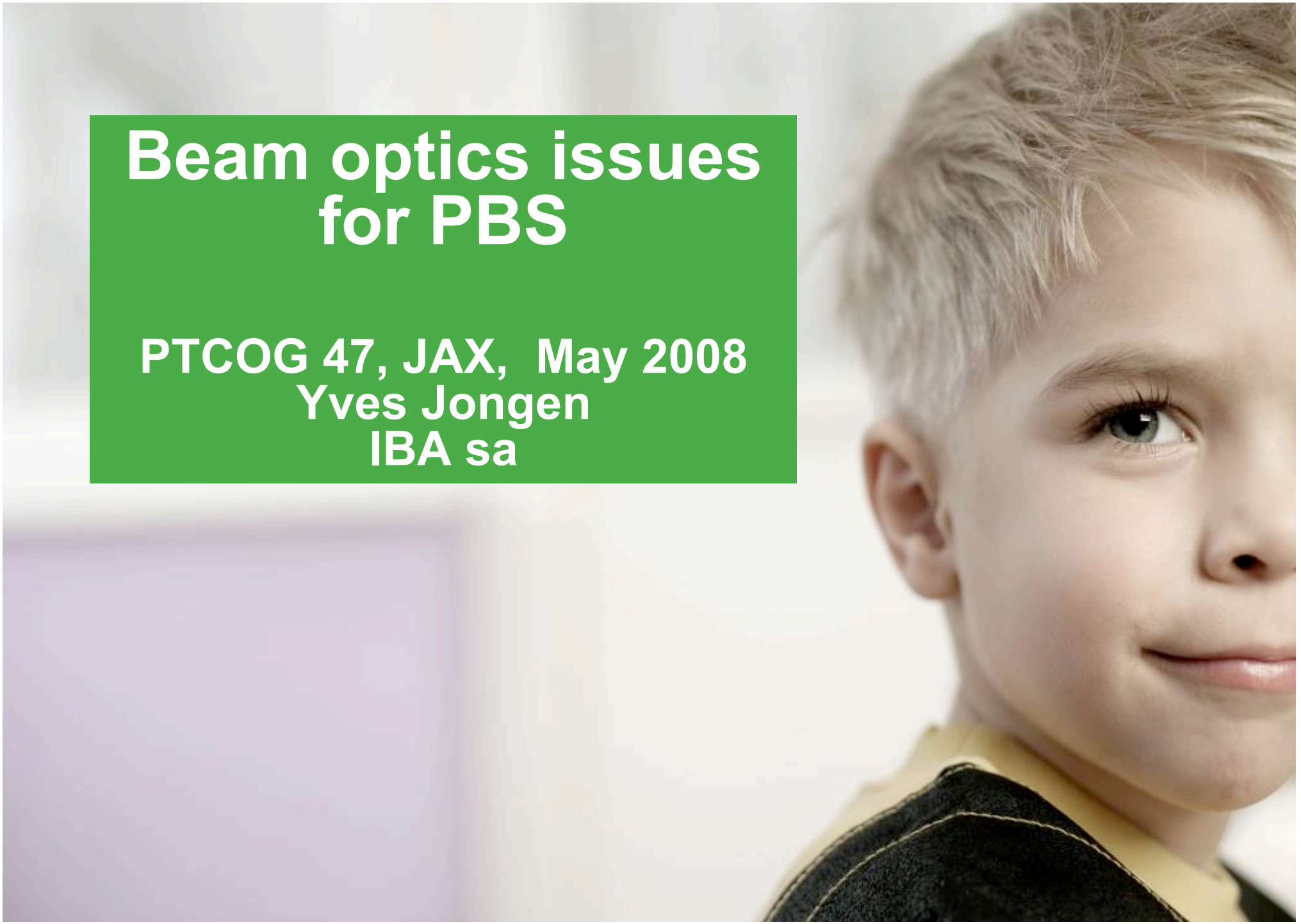
IBA sa



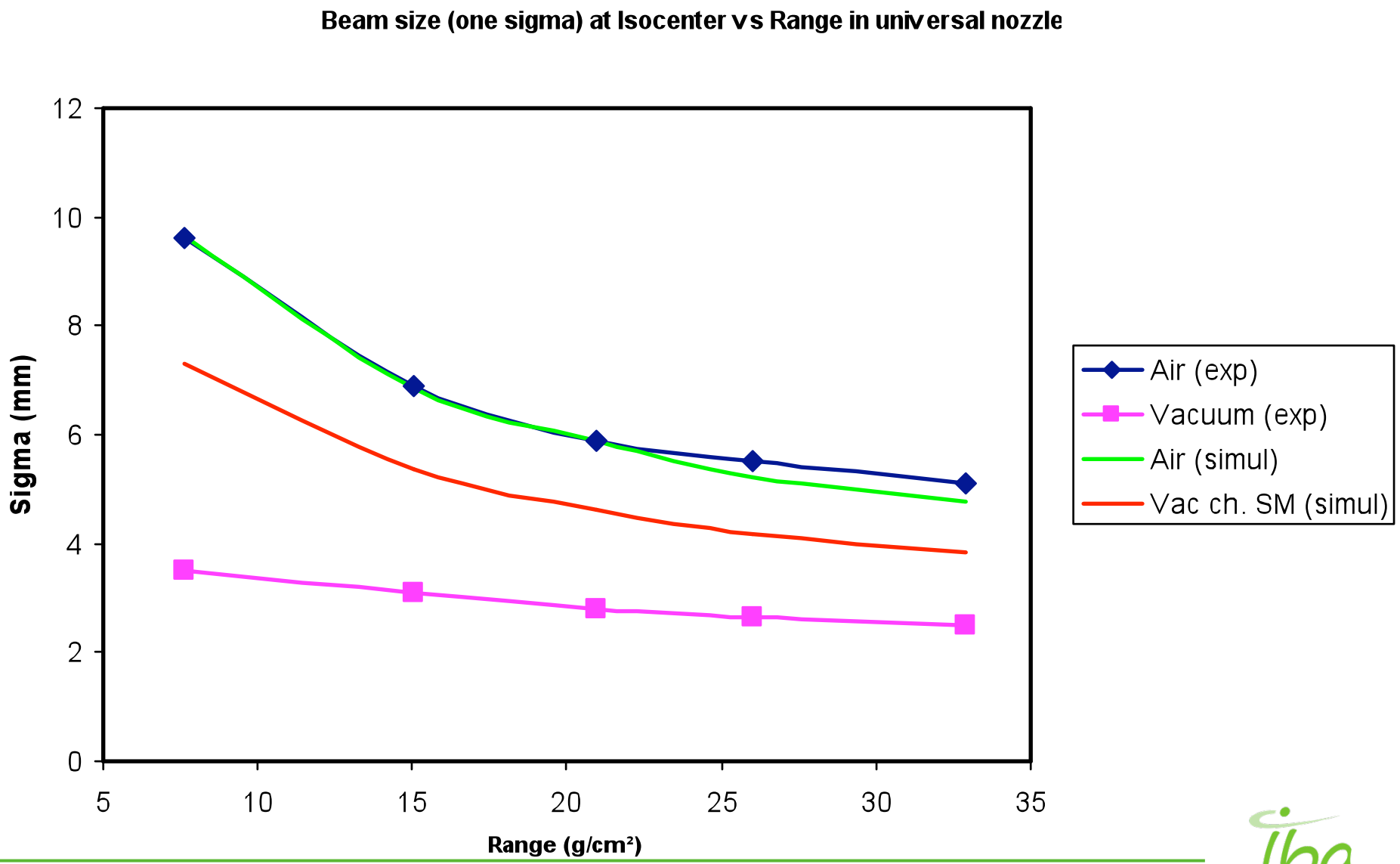
Beam optics questions for PBS

- What is the beam size at isocenter? In vacuum? In air?
- How fast can we change range?
- How reproducible are beam line settings?
- How do we adjust the slits to have the same emittance in X and Y?
- Is the beam spot at isocenter changing with gantry rotation?
- Is the beam spot at isocenter moving when the cyclotron is detuned?

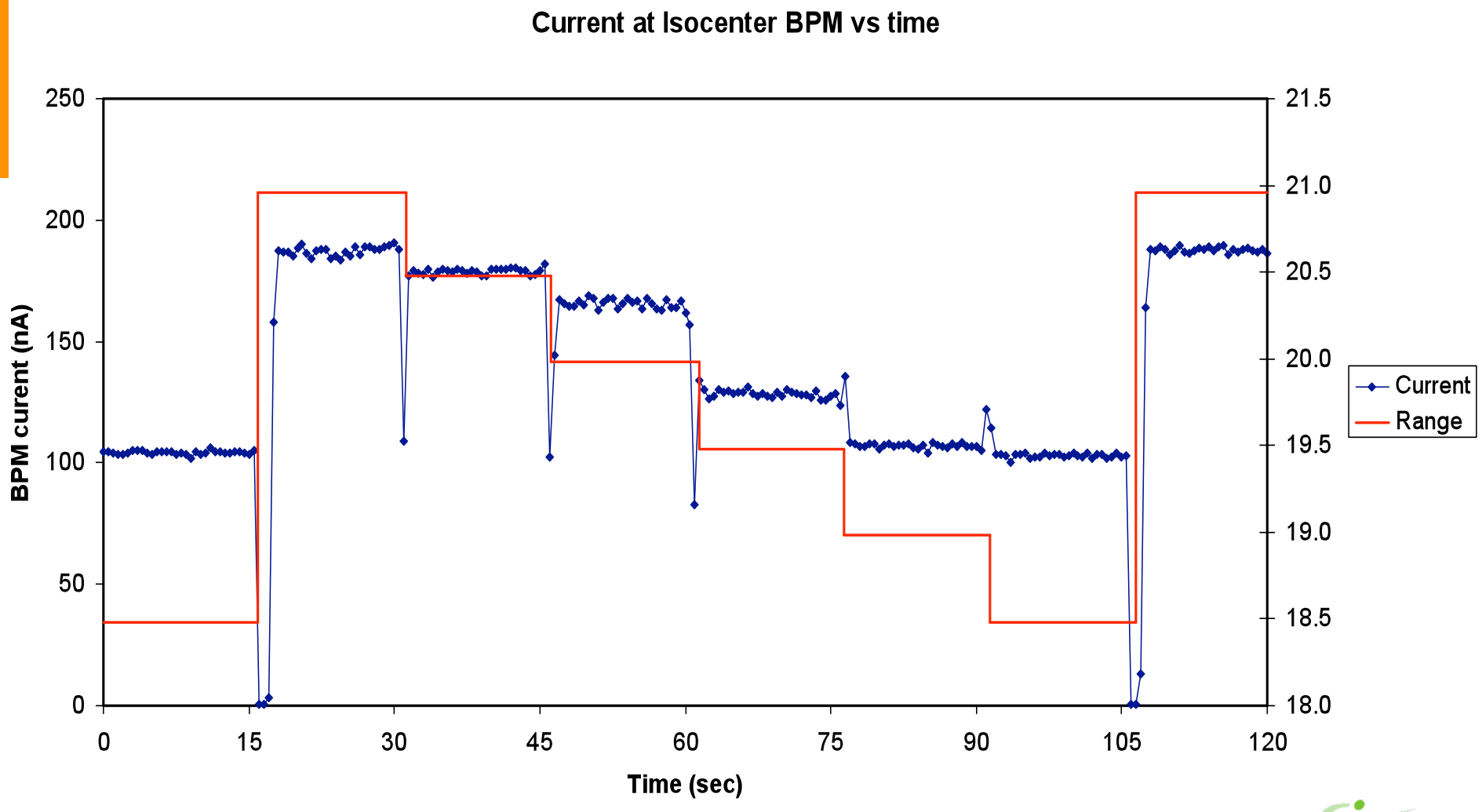
Experimental conditions

- Experiments made at night time (after patient treatments and QA), here in Jacksonville
- October to December 2007, in Gantry 2
- PBS quadrupoles installed each night for measurements, removed after for patient treatments in scattering mode
- Beam positions and sizes measured by BPM at isocenter
- Emittance limiting slits adjusted to have the same emittance in X and Y
- Optics adjusted for symmetrical beam at gantry entrance, and small, circular spot at isocenter
- True telescopes between TR's
- Very good agreement between theory and experiments in beam optics

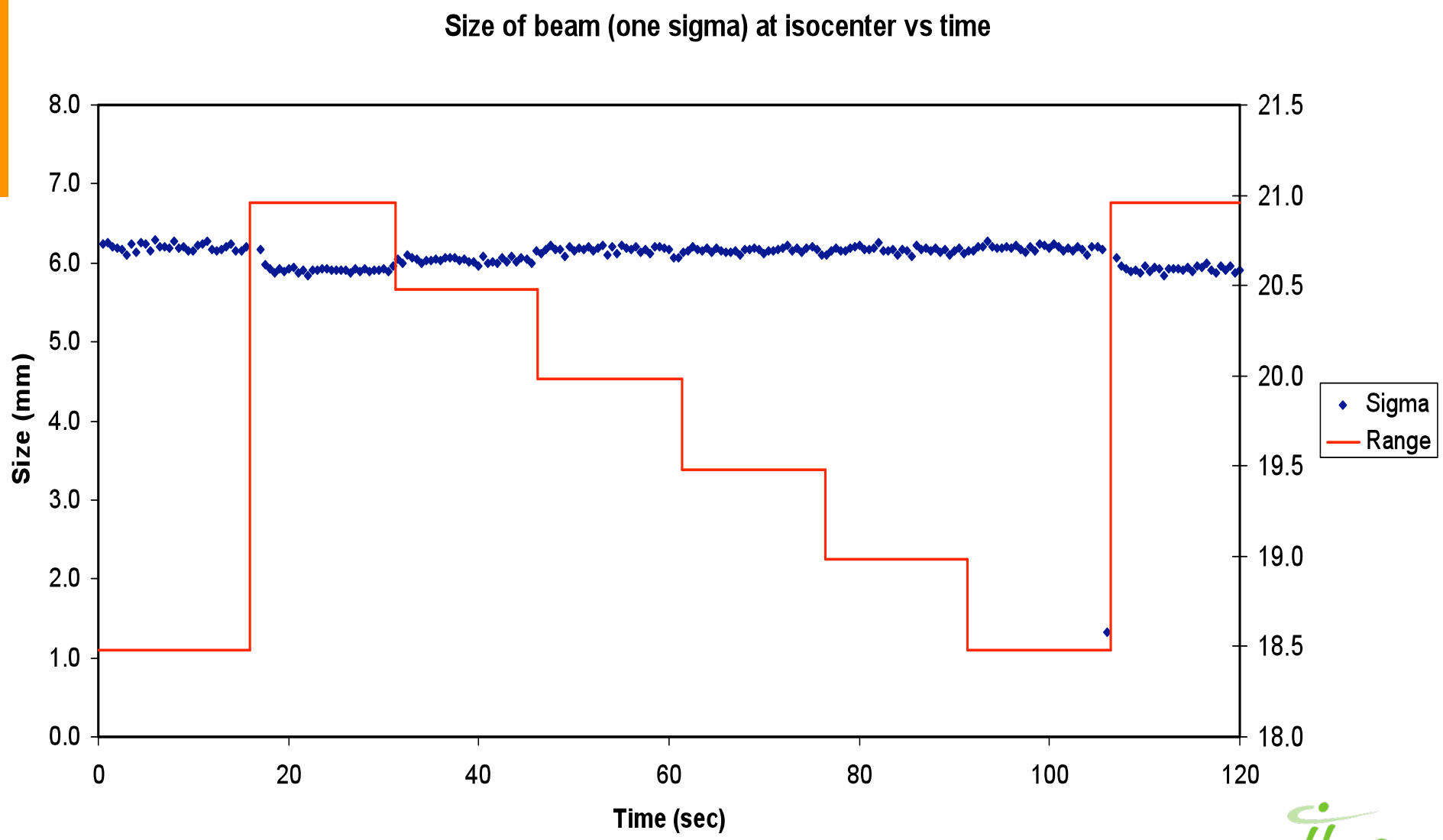
Beam size at isocenter vs. range



Beam current at isocenter



Beam size at isocenter



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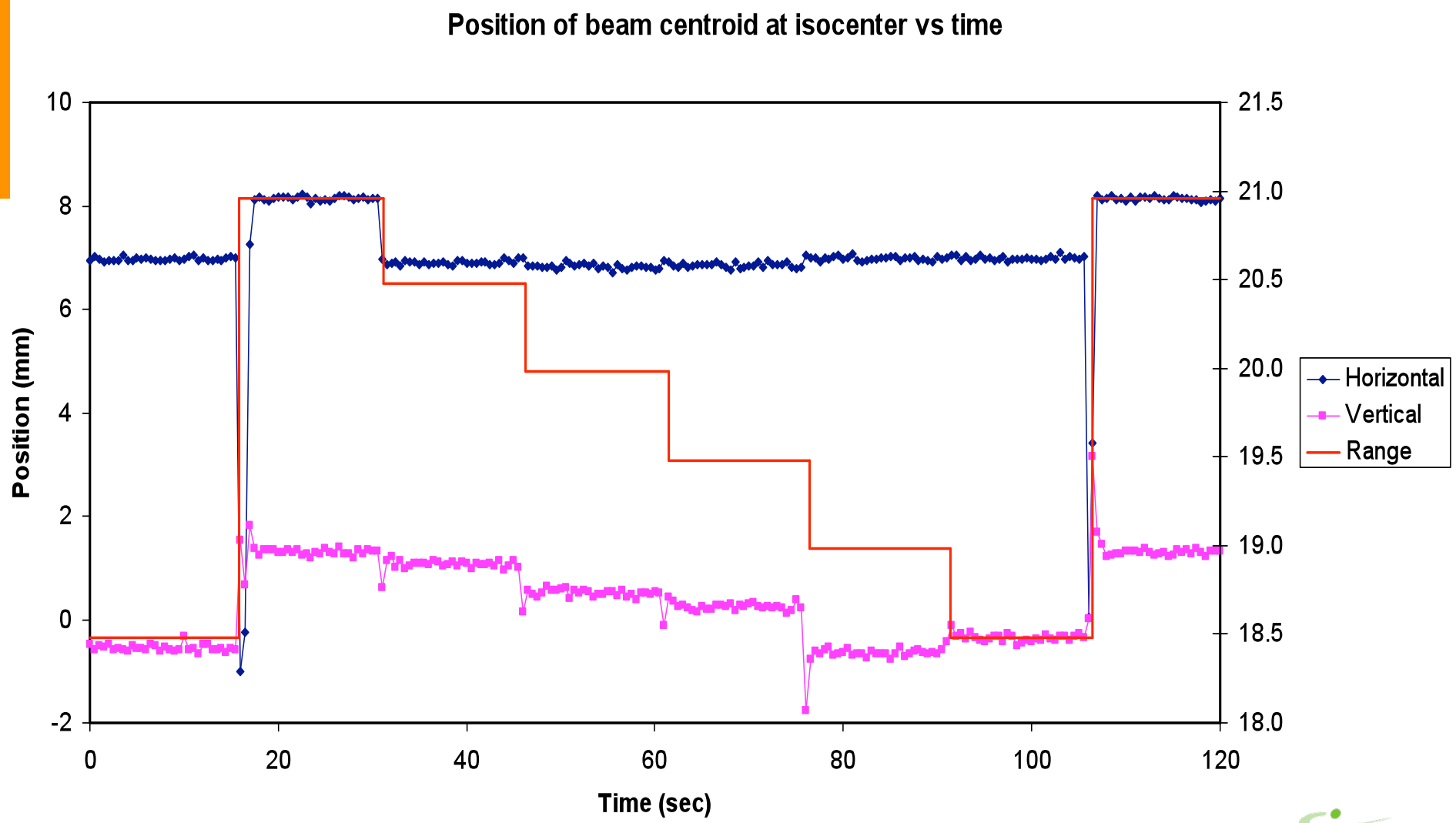
Beam position at isocenter



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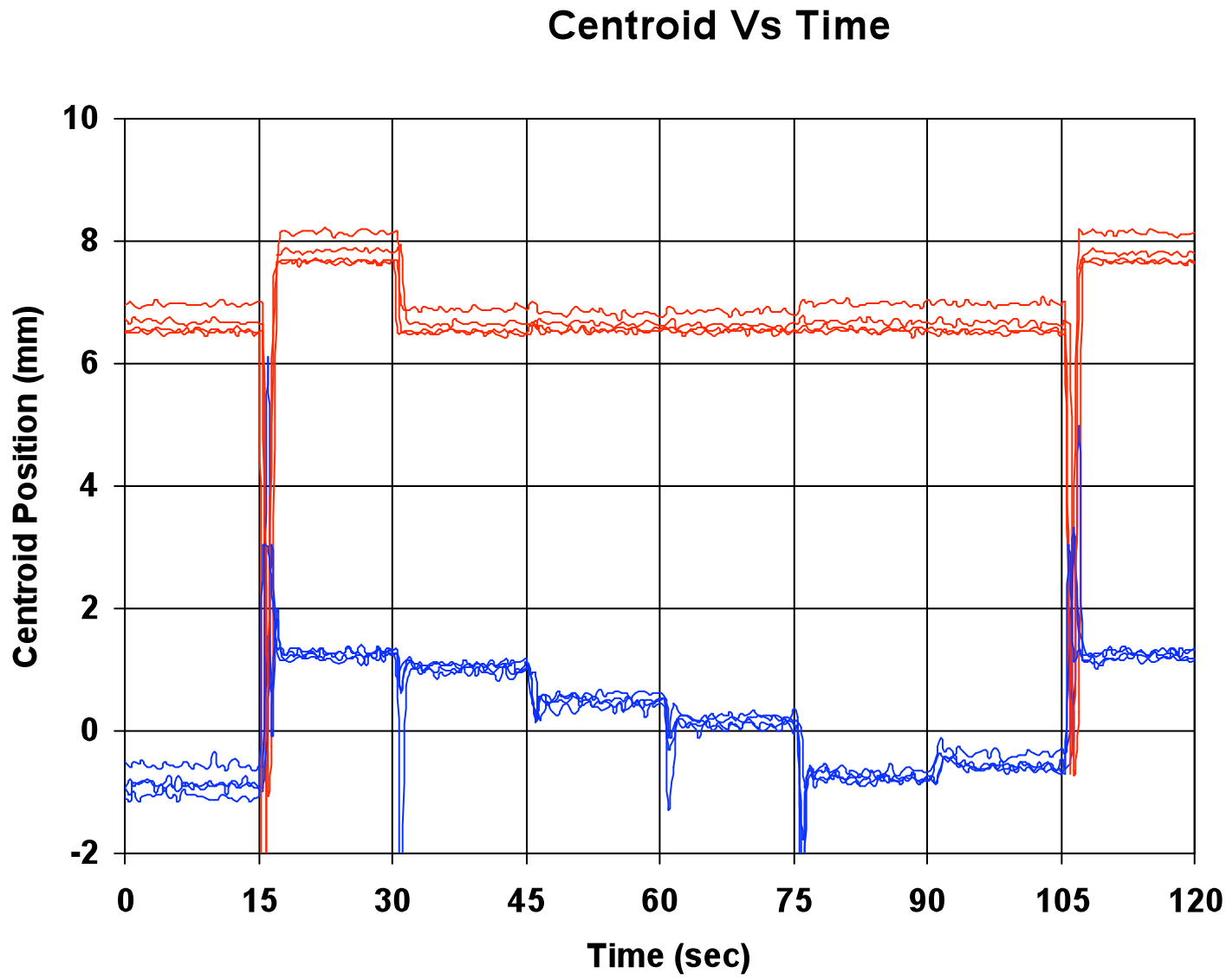
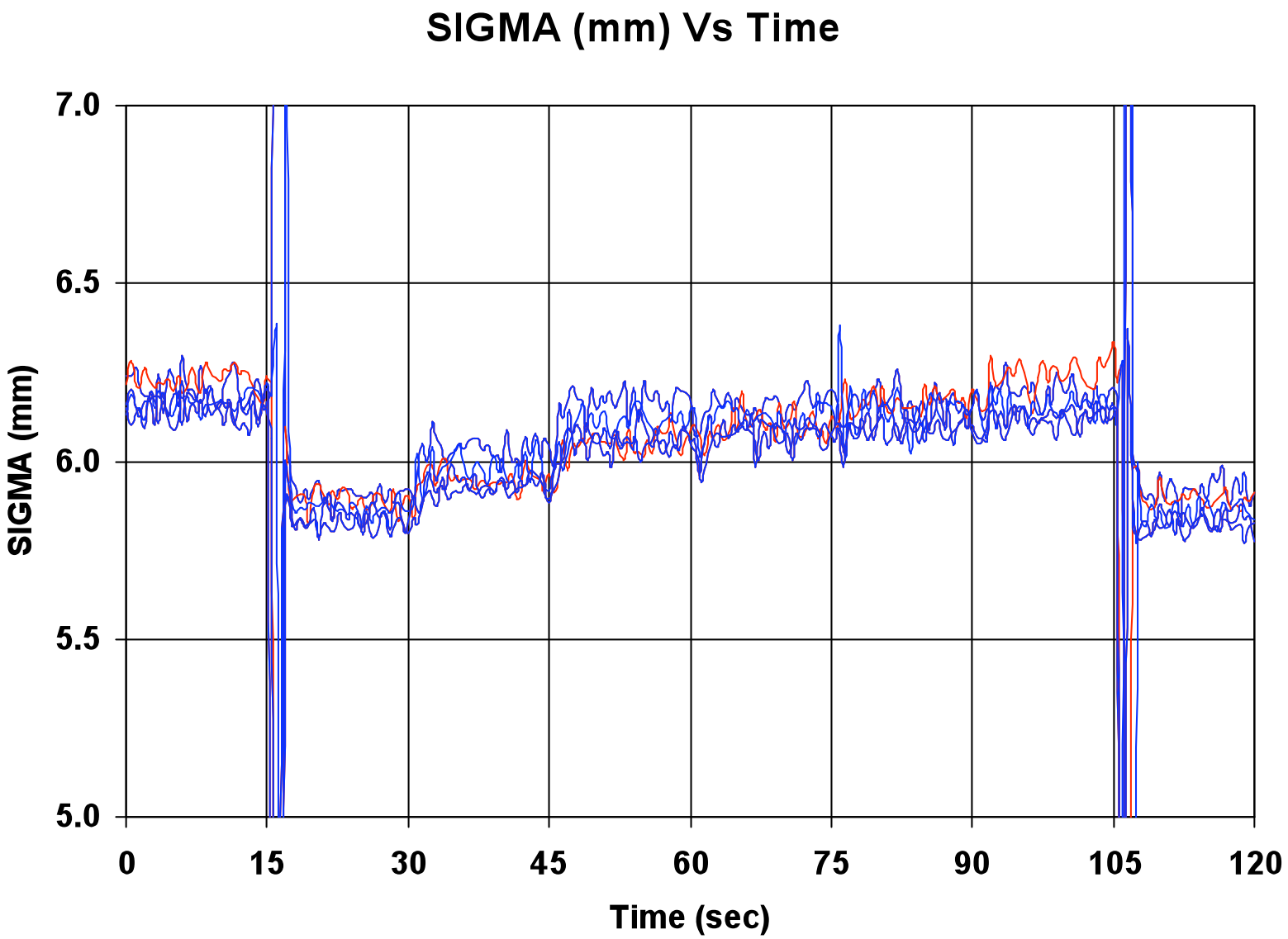
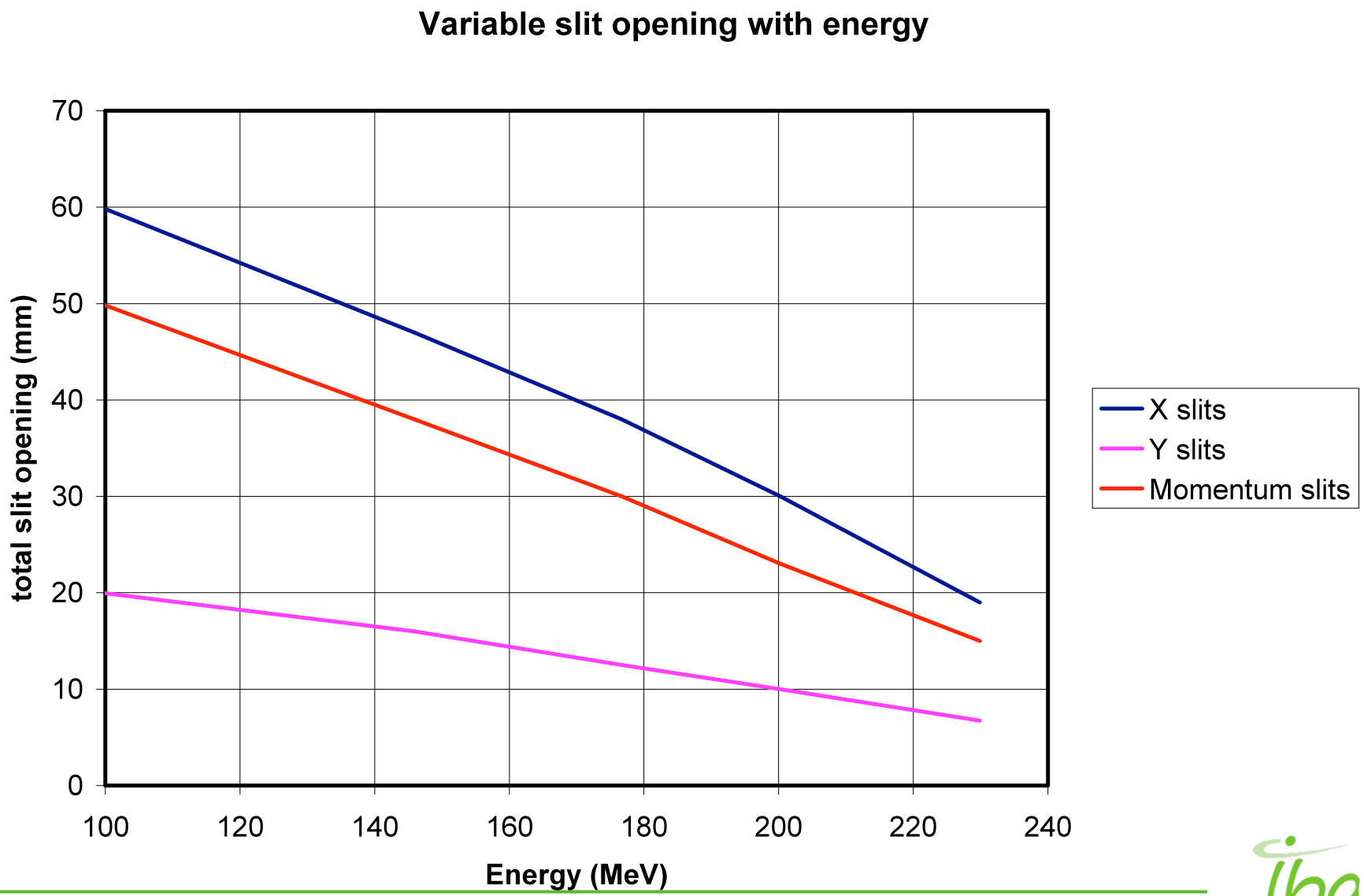
Beam position reproducibility



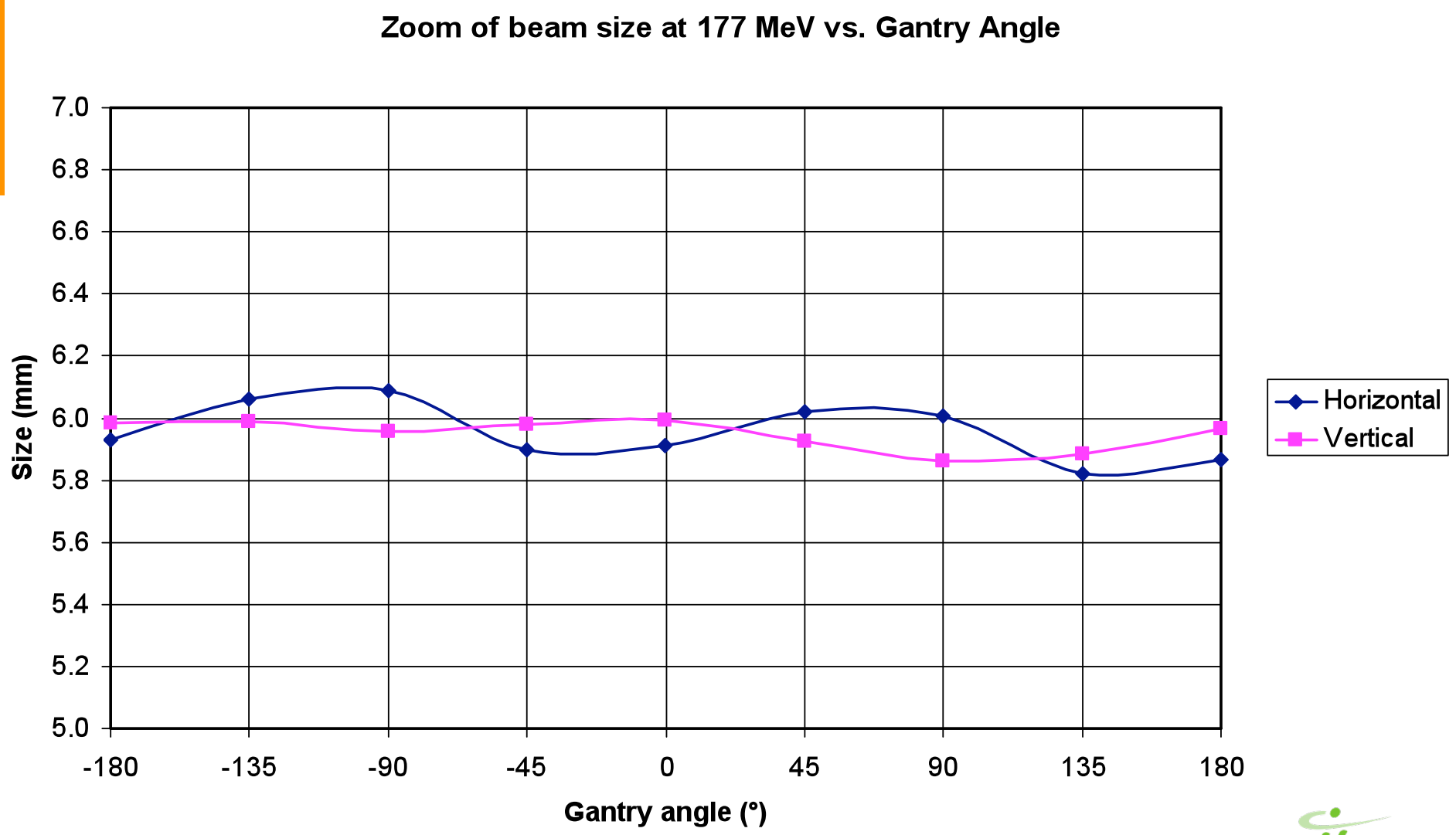
Beam size reproducibility



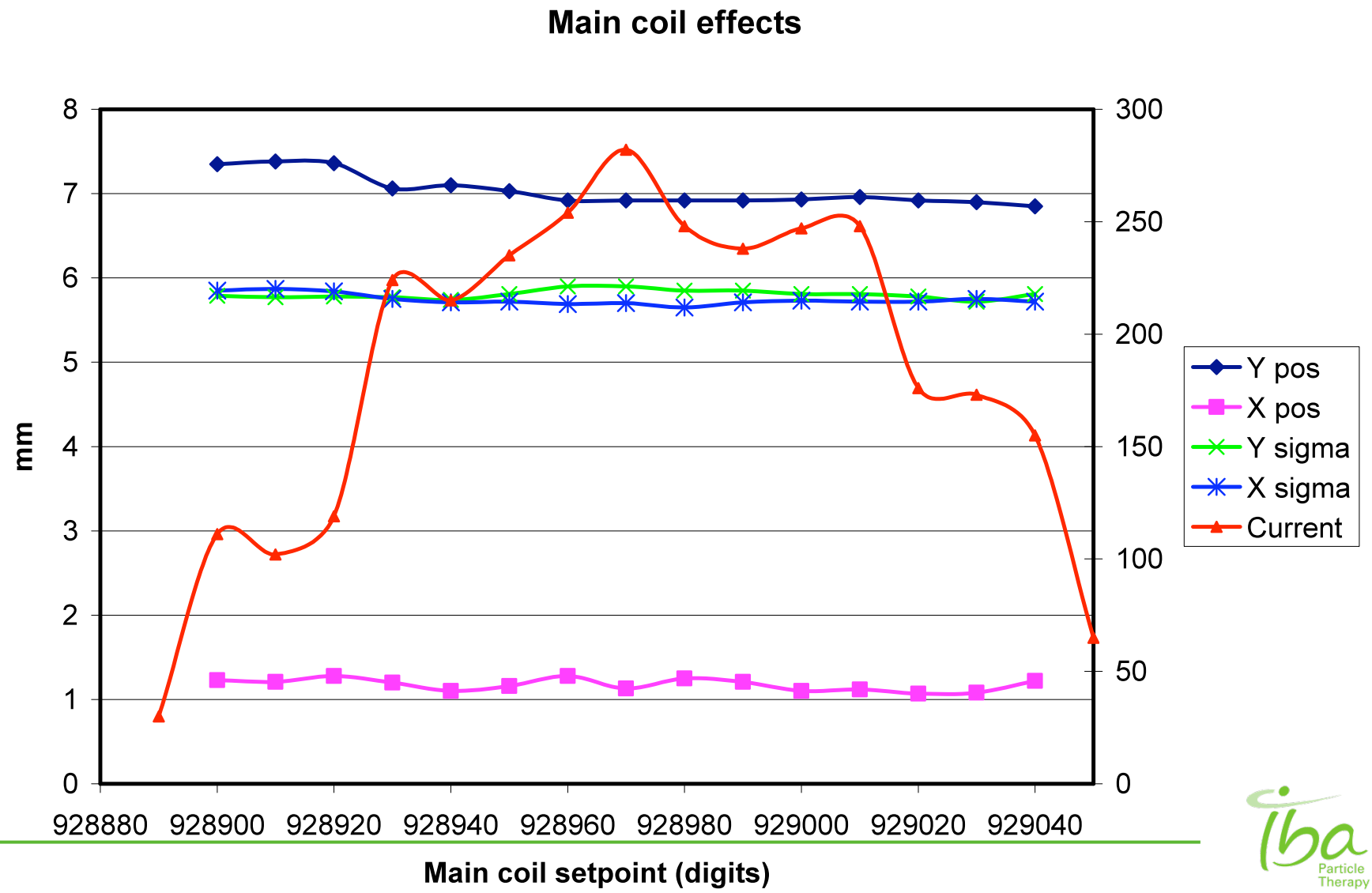
Variable slit setting with energy



Beam size vs. gantry angle (zoom)



Beam size and position at isocenter when detuning the cyclotron



Conclusion

- Beam size at isocenter from 2.5 to 3.5 mm (one sigma) under vacuum. From 3.8 to 7.3 mm calculated for universal nozzle
- Changes of range in 1.5 second. Beam size and position stable after that time
- Beam lines setting are very reproducible from day to day
- The beam spot size remains circular and constant to +- 3% with gantry rotation
- The beam at isocenter does not changes in size and position when the cyclotron is grossly detuned

Thank you…