

Permanent Magnets for Beam Delivery

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Motivating Questions

What are the *benefits of Permanent Magnets* over electromagnets?

What *magnet configuration* works best?

Will it work?

Using Permanent Magnets

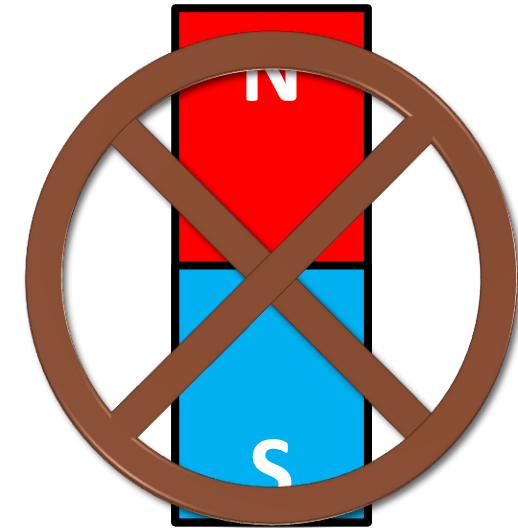
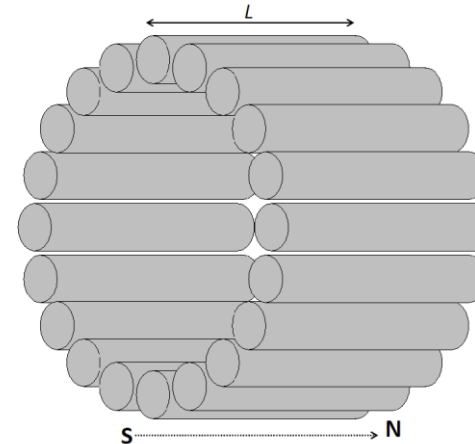
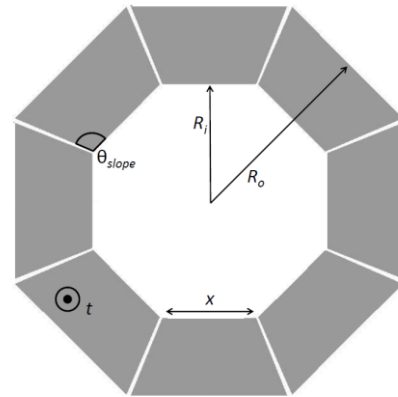
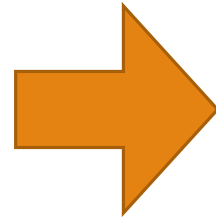
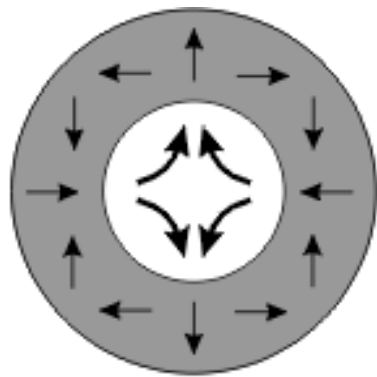
- Don't consume power
- No water cooling requirement
- No maintenance required

But...

- Permanent Magnets alone aren't enough

What Type of Magnet

- Focusing: Quadrupoles or solenoids

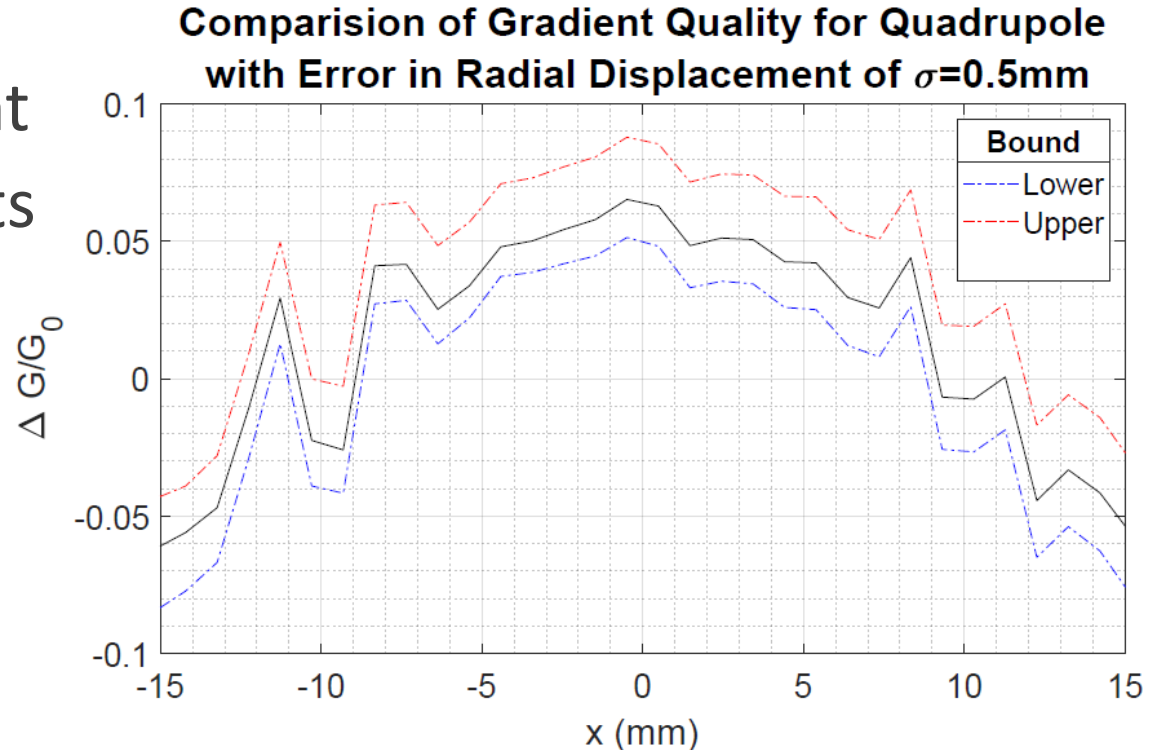


- Different Magnet Structure
- Different Particle Behaviour

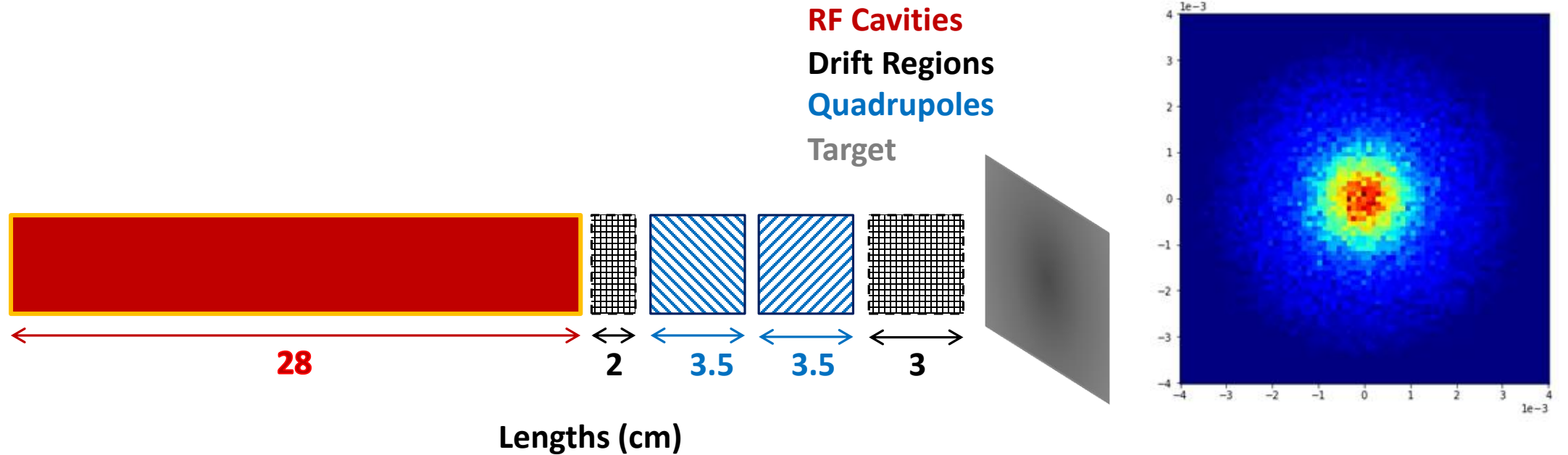
Will It Work?

- Multiple things that could go wrong
 - Magnet Wedge Misalignments
 - Quadrupole Angle Misalignment
 - Transverse / Longitudinal Offsets
 - External Temperature Changes

One of these things is not like the others...

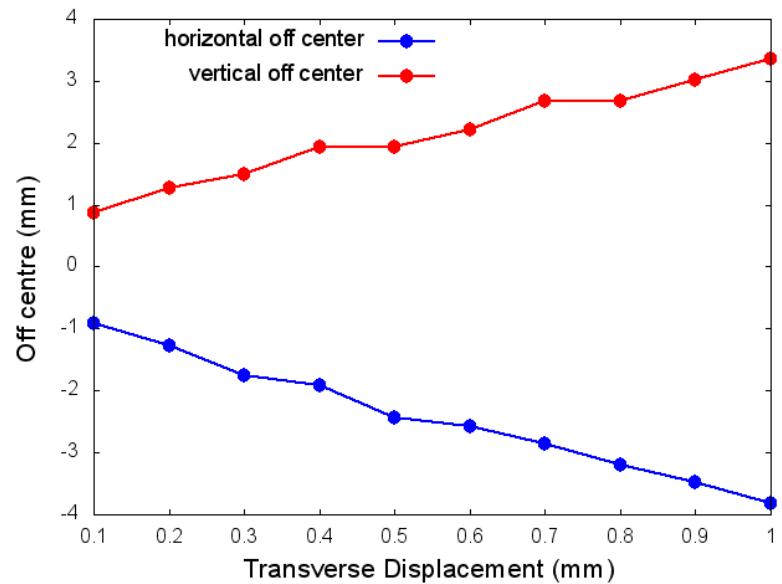
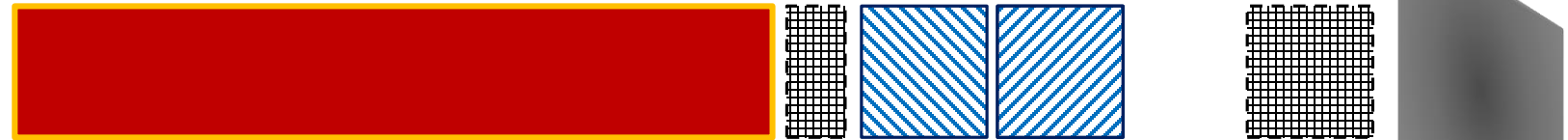


Model Accelerator

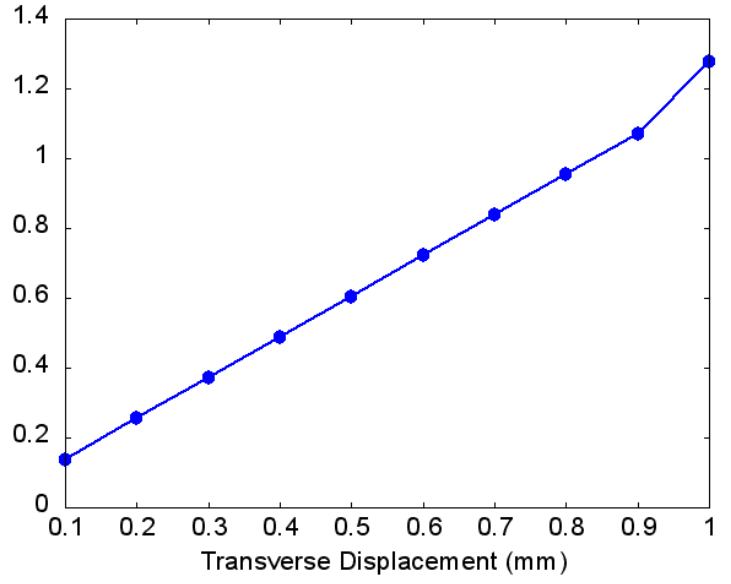


RF radius 3mm Quad Gradients: 15, 18.9 T/m
Rest radius 3cm Electron Energy 6MeV

Angles and Offsets



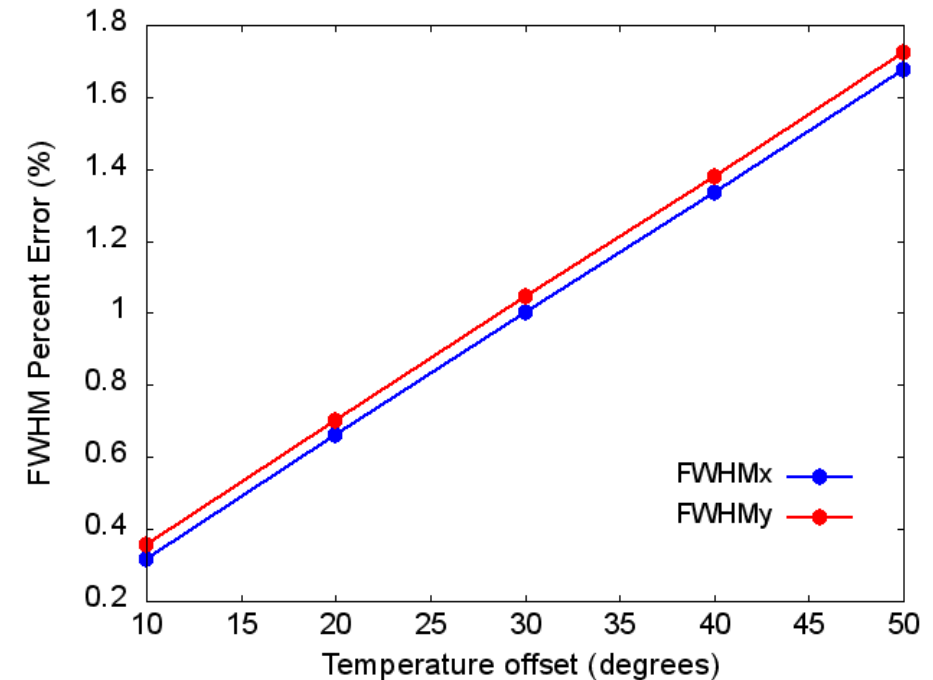
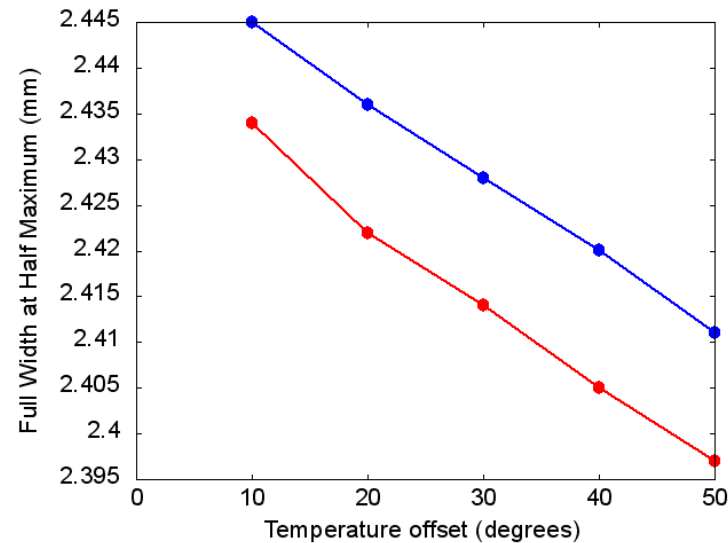
QUADRUPOLE



SOLENOID

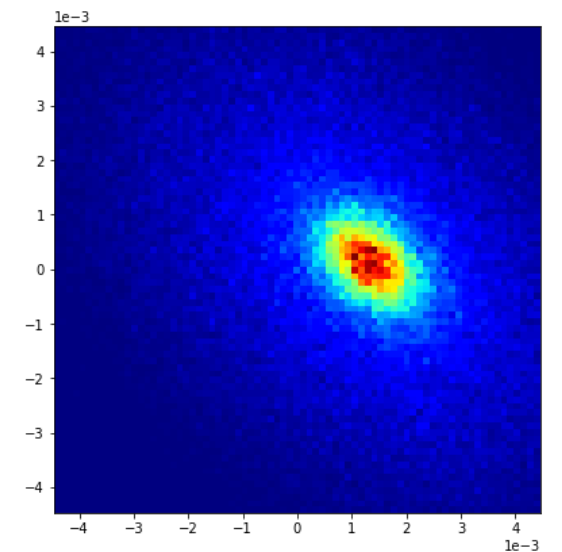
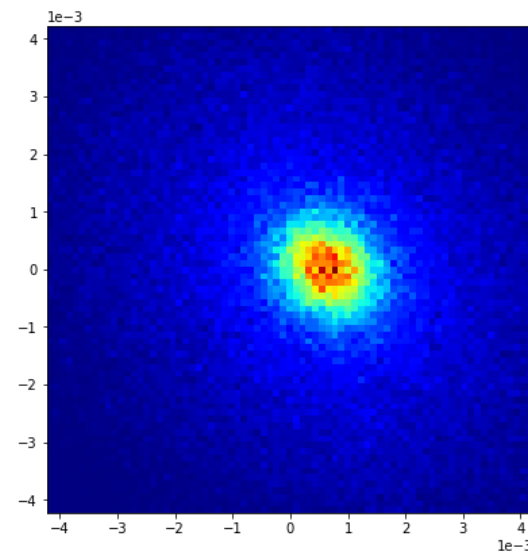
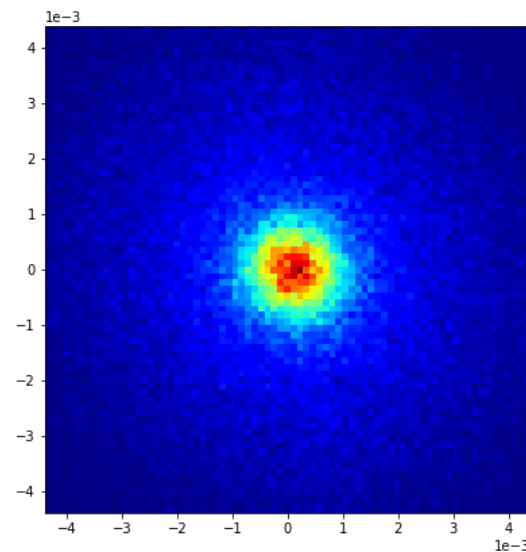
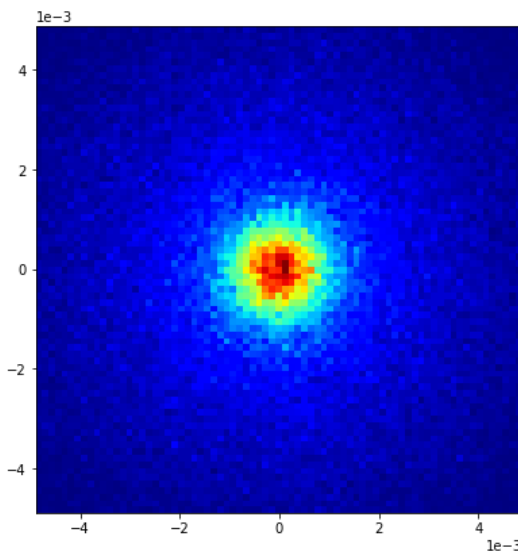
Temperature Dependence

- When Permanent Magnets get warm, their field strength falls
- Is temperature dependence significant
 - At different times of day?
 - At different locations?



Combined Errors

- What if lots of things go wrong at once?



Conclusions

Clear advantage of Permanent Magnets over electromagnets

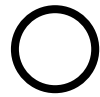
Quadrupole magnets give good treatment despite internal or external error sources

Next step:

perform a detailed study once parameters are decided

An Unexpected Extra: Magnetic Field of the Earth

Head-on
view



B_{Earth}



Worst case

25-65 μT

50 μT

