

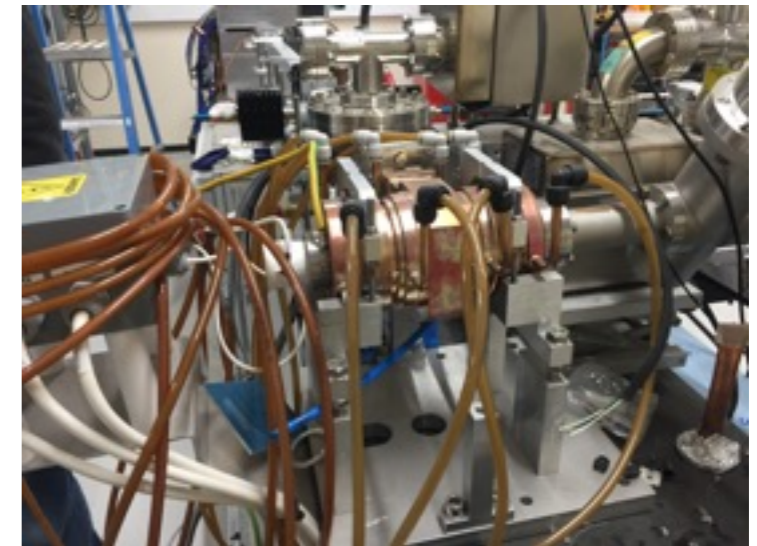
BEAM DELIVERY SYSTEM - OVERVIEW

➤ WHAT FOCUSING DOES THE ROBUST MEDICAL LINAC NEED?

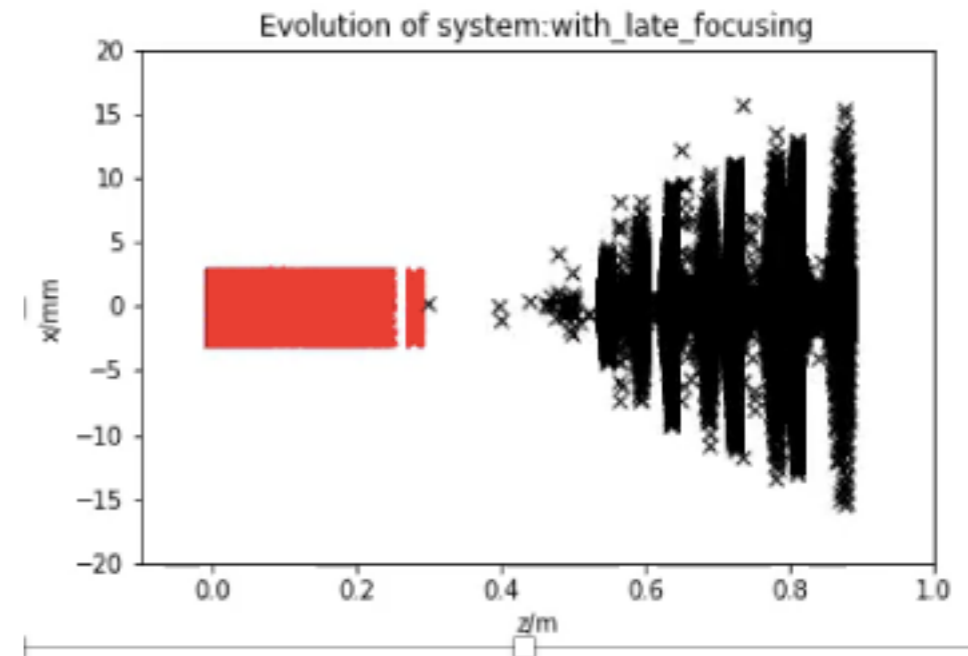
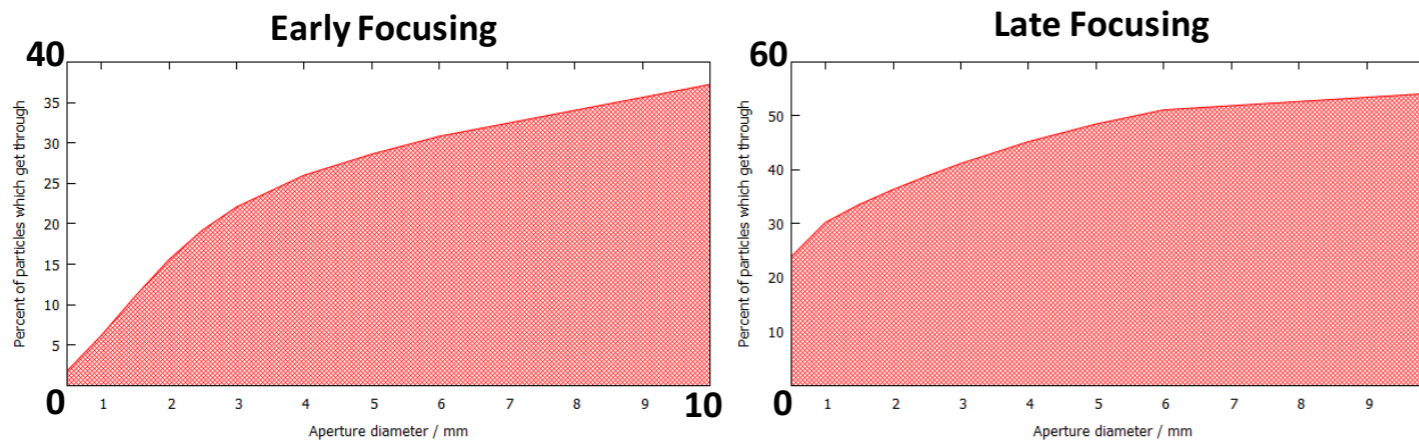
- What is the emittance at the source? (**Depends on source**)
- Set up method of simulation/modelling to determine required focusing and beam quality.

Need to study beam dynamics of proposed linac structures to see losses

STATUS: ASTRA model and new post-processor (A. Steinberg) created to model beam dynamics including space charge.



4MV industrial setup at DL



BEAM DELIVERY SYSTEM - OVERVIEW

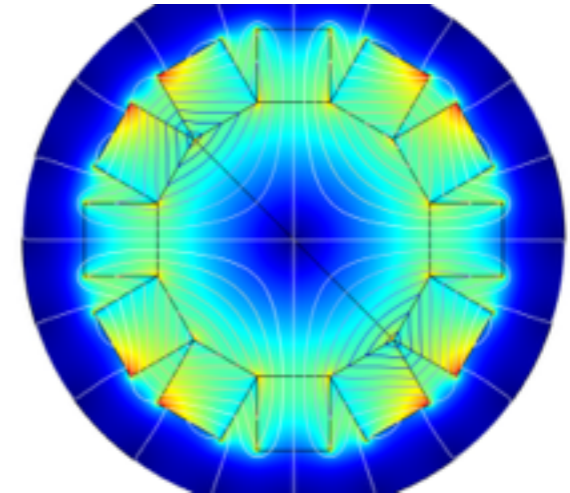
⊙ ARE PERMANENT MAGNETS SUITABLE FOR THIS APPLICATION?

Permanent magnets may offer another option (cheap, easy to maintain, no power required),

Fields are *temperature dependent* and the fields have *less flexibility* compared to electromagnets

However these effects can (in principle) be overcome)

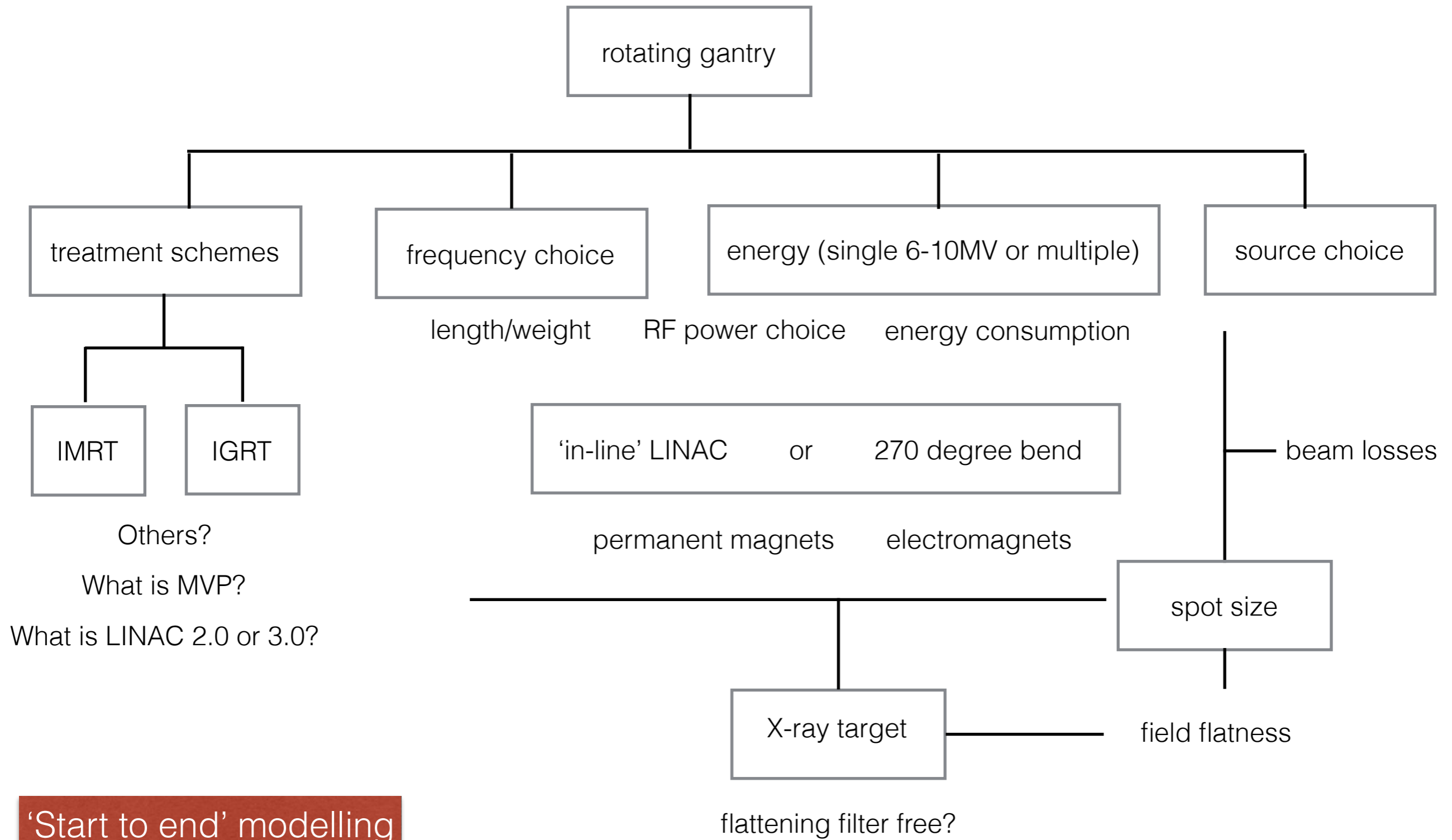
- PROGRESS: Set up tools to design and study the error tolerances of fields in permanent magnets in potentially large temperature fluctuations - OPERA 3D (Paul Coe)



Additional aspects to study in future (potentially out of scope):

- **incorporating focusing using elliptical cavity shape**
- **Effect of 'impact' forces on permanent magnets**

DECISION TREE - BEAM DELIVERY SYSTEM



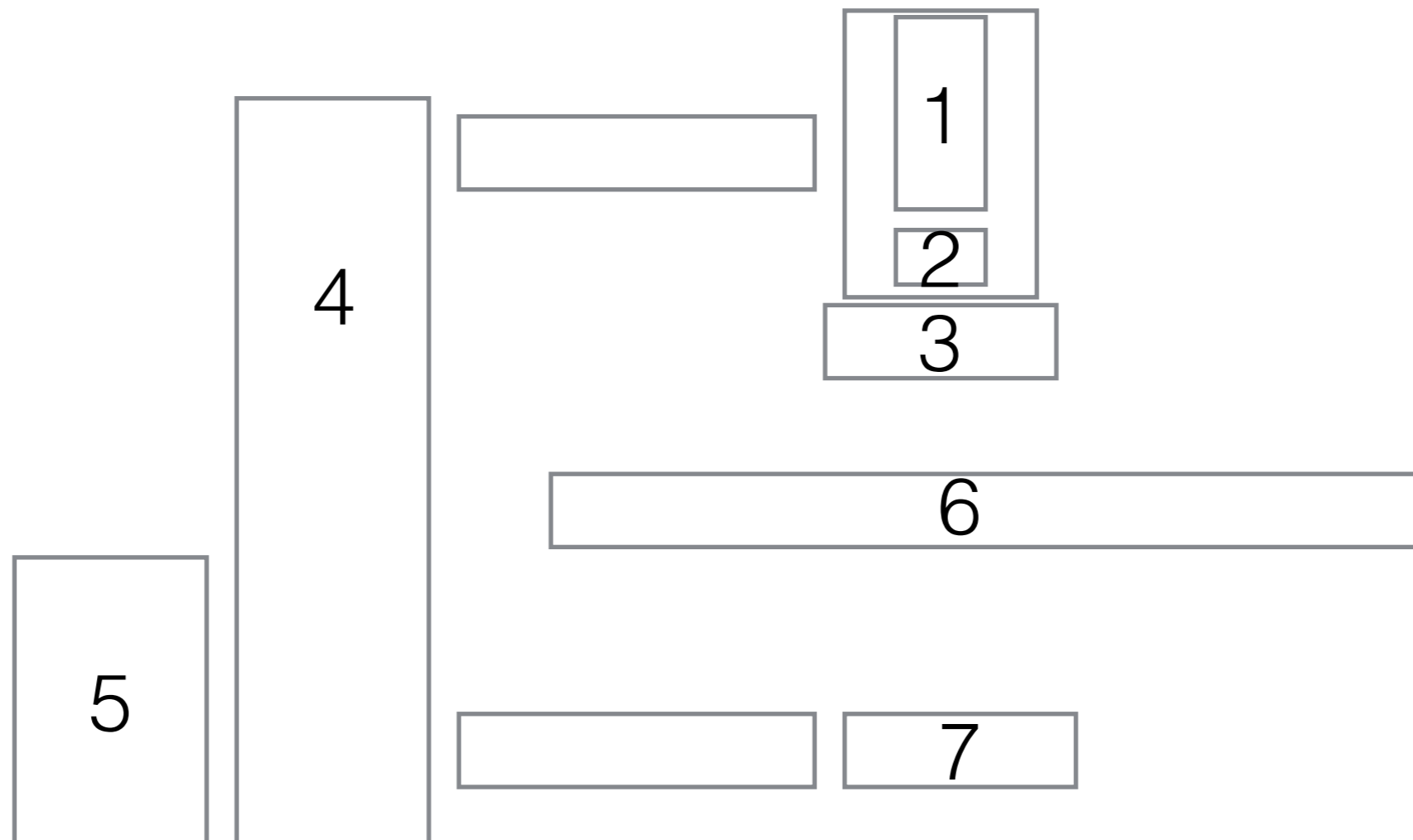
'Start to end' modelling

MVP

- 1- source and RF module
- 2 - beam delivery (magnets)
- 3 - square LC
- 4 - rotating gantry (move & stay)
- 5- rf power source
- 5- treatment couch

Upgrade/Linac2.0

- Higher gradient - replace module
- Multi-energy version
- Robust MLC
- Move constantly during treatment
- Upgrade for multi-energy
- Moving during treatment



Why do medical LINACs fail? A comparative analysis of radiotherapy provision in the UK and Africa

- Laurence Wroe, MPhys, University of Oxford
- Laidlaw Scholarship, summer 2018
 - Collect log data from individual LINACs
 - Initially, analysis will be carried out on a sample of UK-based LINACs to establish the methodology and main failure modes.
 - This will then be compared to comparative data obtained from LINACs in LMICs in Africa
 - Also qualitative analysis to capture factors not possible in statistical analysis



Your input, engineering reports and offers to host Laurence's travel (in LMICs) is most welcome!

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ALTERNATIVE SOLUTION?

“Fixed field alternating gradient” optics

Able to have MULTIPLE energies stable in FIXED FIELD magnets.

Demonstrated for first time at Daresbury Laboratory (EMMA experiment)

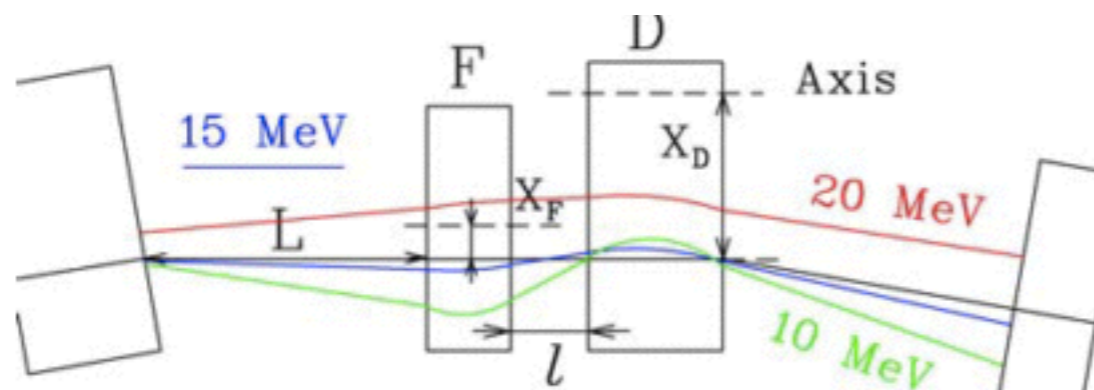
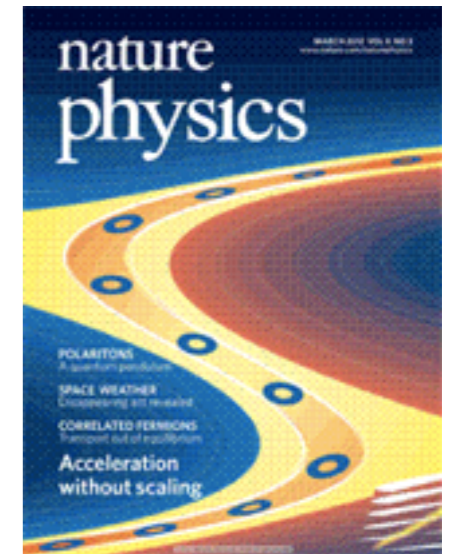
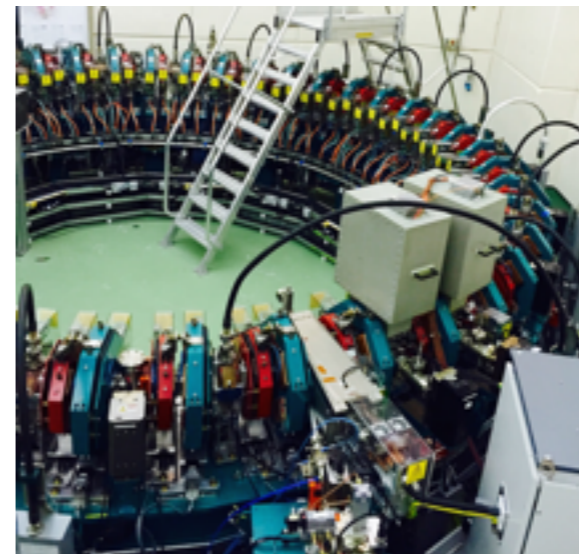
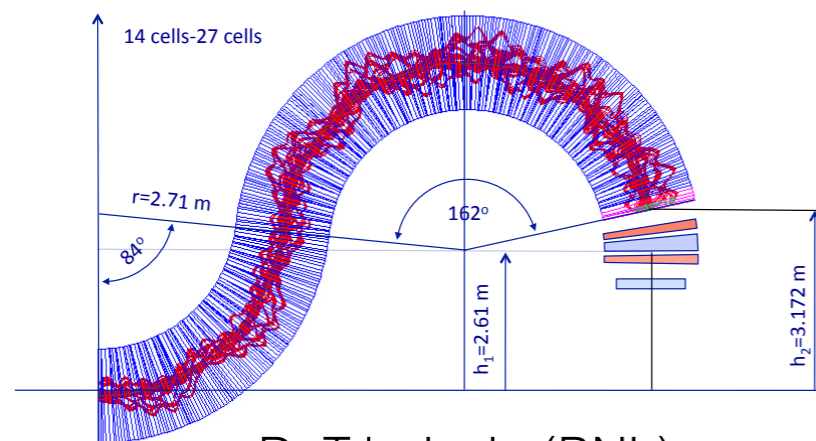


Figure 2: Orbits in a quadrupole doublet cell.

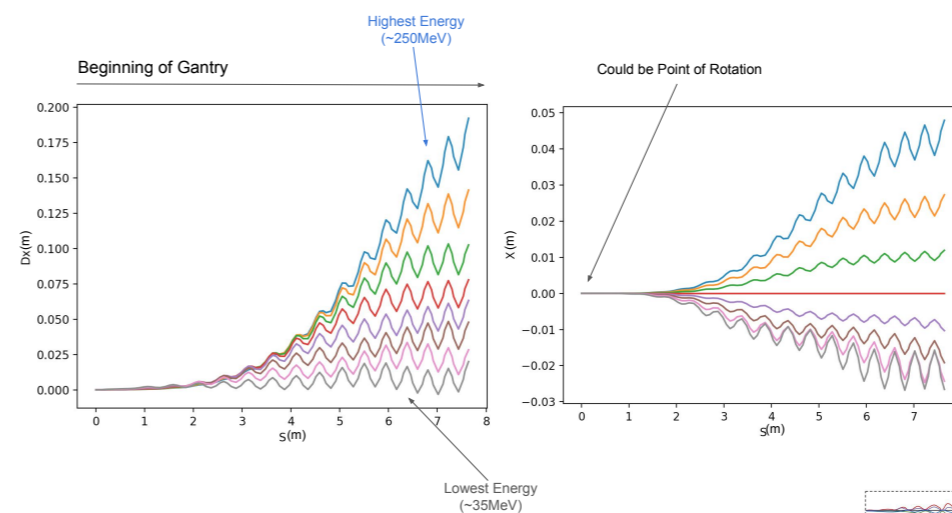


Is this useful? Honestly, I have no idea!

But we know how to design multi-energy stable optics with fixed magnets...



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