FFAG Designs for a Muon Collider

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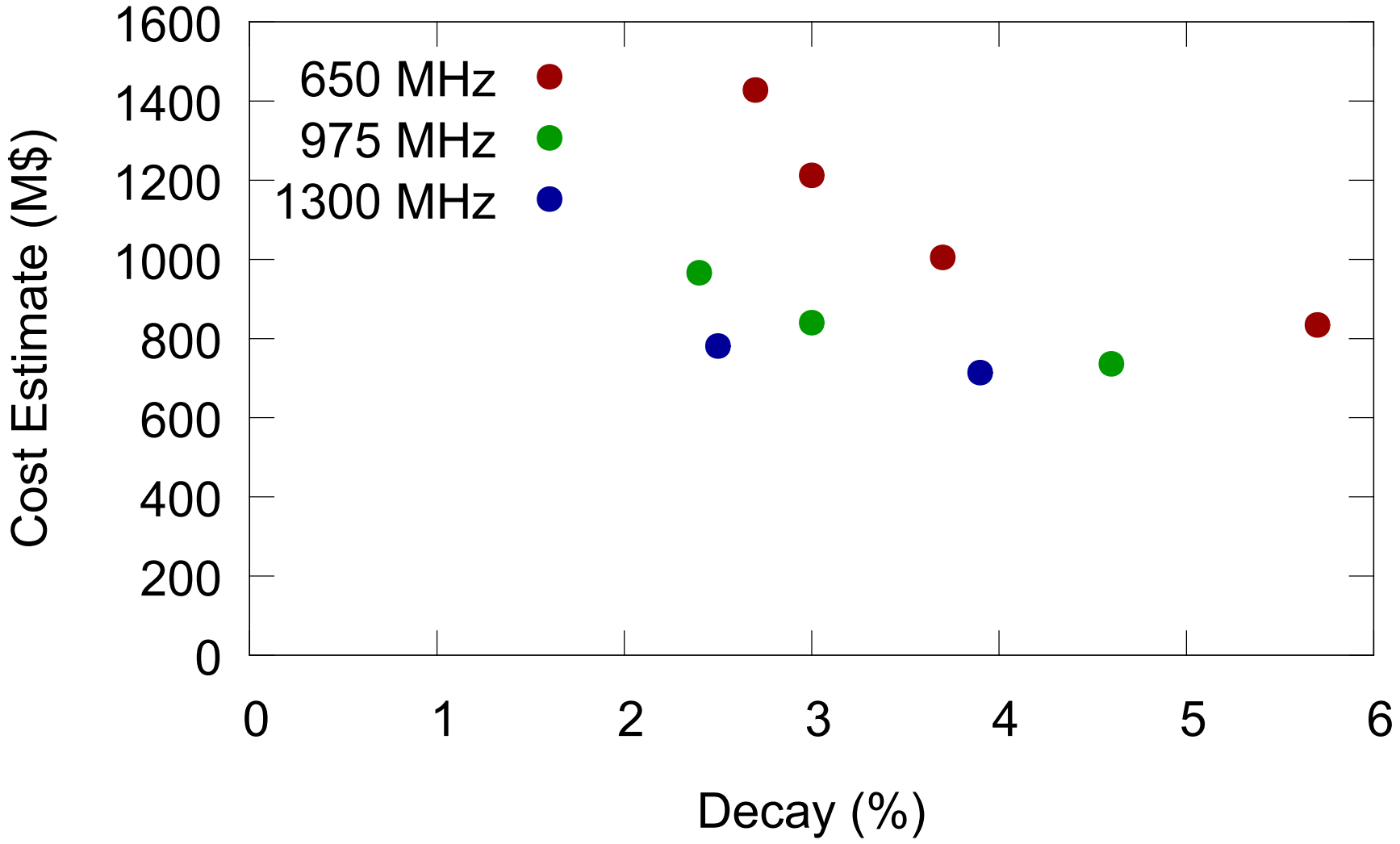
Acceleration Scenario

Initial Energy (GeV)	Final Energy (GeV)	Type
0.75	2.5	RLA
2.5	10	RLA
10	25	FFAG
25	63	FFAG
63	173	FFAG
173	375	FFAG
375	750	Hybrid Synchrotron

Choice of FFAGs

- Will FFAGs have an advantage?
- Initial estimate by scaling from neutrino factory
  - Very few turns: maximum 8.5, and that requires 325 MHz
  - Best scenario is 173–375 GeV
  - Design 173–375 GeV FFAG to test this
  - Also look at 63–173 GeV for scenario comparison
- Secondary question: longitudinal emittance growth
  - Use emittance growth, or
  - Ellipse distortion, allowing distribution to become more parabolic
  - Choose the latter, 3% based energy acceptance from Yuri

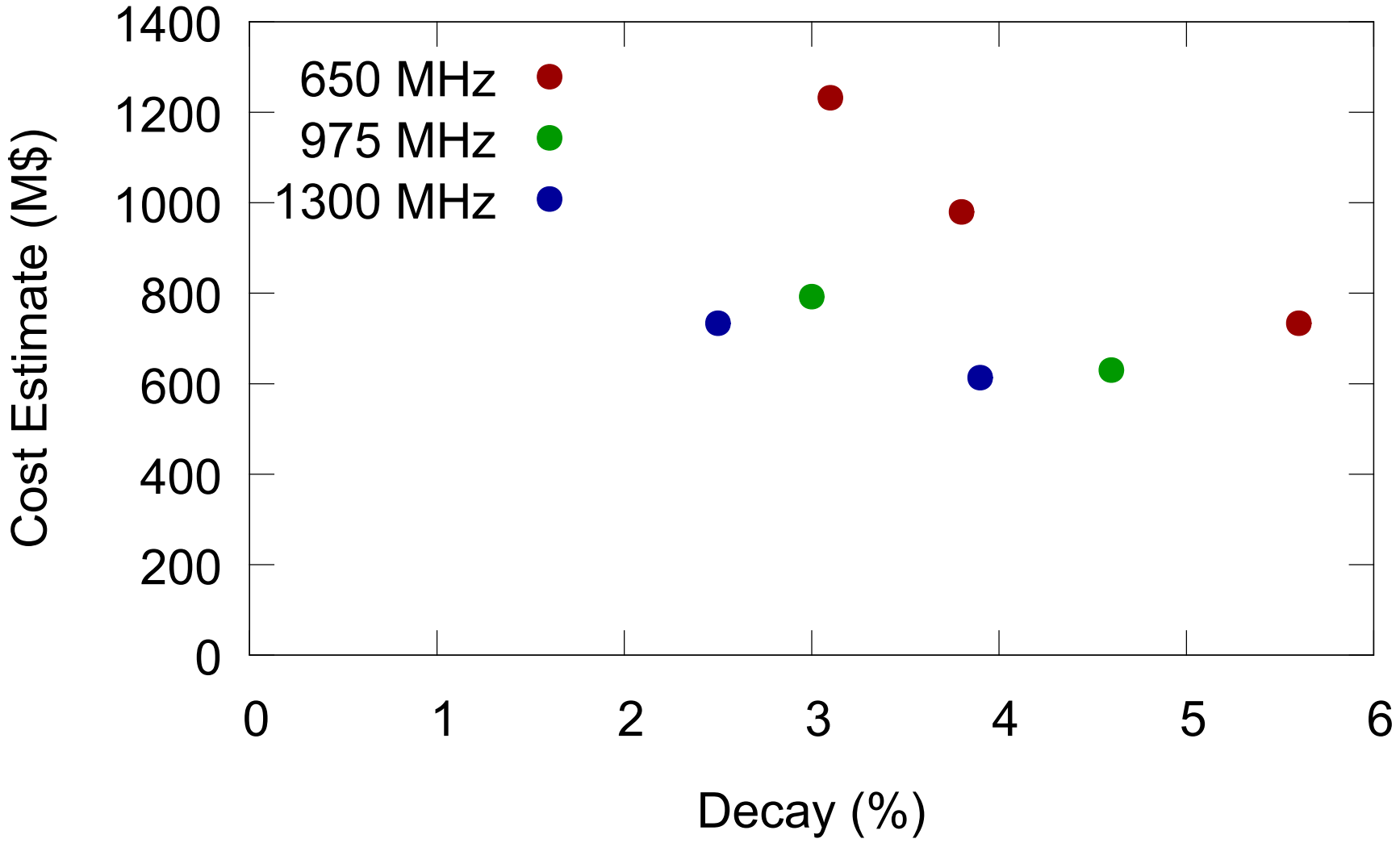
FFAG Cost vs. Decay: 173–375



FFAG Results: Comments

- 2.5% decay required to meet decay standard
- I only get 6.7 turns at the lower decay, cost optiumu
- Cost dominated by linear cost:
  - Magnets: 155 M$
  - RF: 210 M$
  - Linear: 416 M$
  - RLA may not win on cost!
- Cost basis
  - Based on 2004 EPAC cost algorithm paper
  - RF scales as inverse square of frequency
  - Multiplication factor based on IDS-NF cost estimate

FFAG Cost vs. Decay: 63–173



Other Solutions

- All assume 1300 MHz RF
- Only include RF and linear costs
  - Magnets only a modest correction
- RLA 63–375 GeV: 697 M$
  - Magnet costs possibly more important
  - Assumes switchyard for 7 passes possible
- Non-hybrid synchrotron 63–375 GeV: 826 M$ for 5 MV/m, 717 M$ for 2.5 MV/m
  - Cost reduction from shared tunnel with next stage?
- Hybrid synchrotrons, 63–173 GeV, 173–375 GeV: 490 M$ for 5 MV/m
  - Pulse times 73 μs at 5 MV/m for 63–173, 130 μs at 5 MV/m for 173–375 GeV (doubled for 2.5 MV/m)

Conclusions: Scenario

Initial Energy (GeV)	Final Energy (GeV)	Type
0.75	3	RLA
3	13	RLA
13	63	RLA
63	375	Synchrotron/RLA
375	750	Hybrid Synchrotron

Conclusions: Scenario

- FFAGs look expensive
- Preference for synchrotron
  - Cost qualifications above push toward this
  - Beam dynamics nicer
- Unclear if short pulse times workable for lower energy hybrid synchrotrons
  - Measurements of magnetic materials essential
- Need to specify decay requirements
- Rethink FFAGs if
  - 1300 MHz won't work for other options
  - Cost scaling of RF too favorable to high frequency
  - Longitudinal emittance is significantly lower