BROOKHAVEN NATIONAL LABORATORY

fact Muon Collaboration

FFAG Optimization with Cost per Muon

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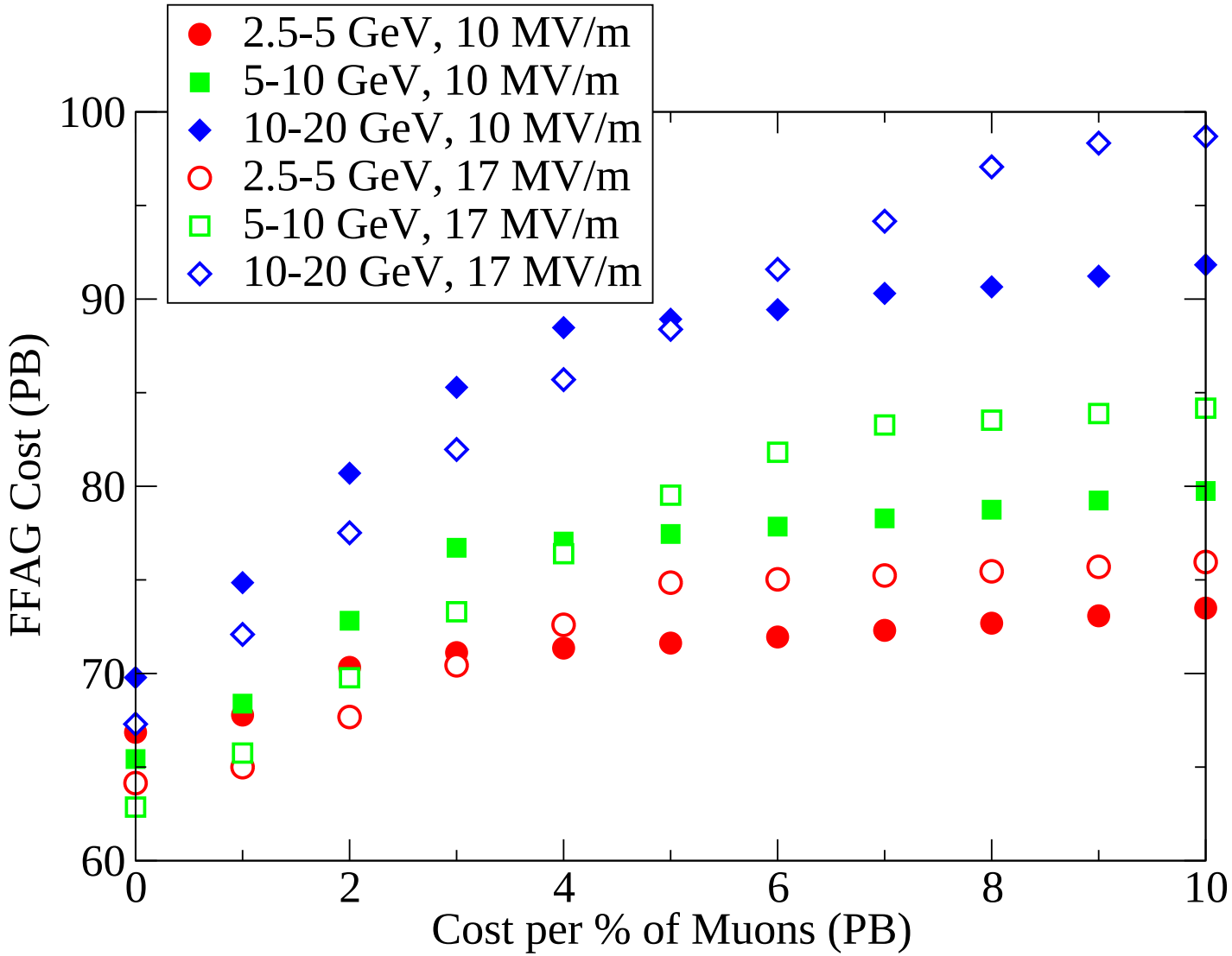
Advanced Accelerator Group Meeting

7 October 2004

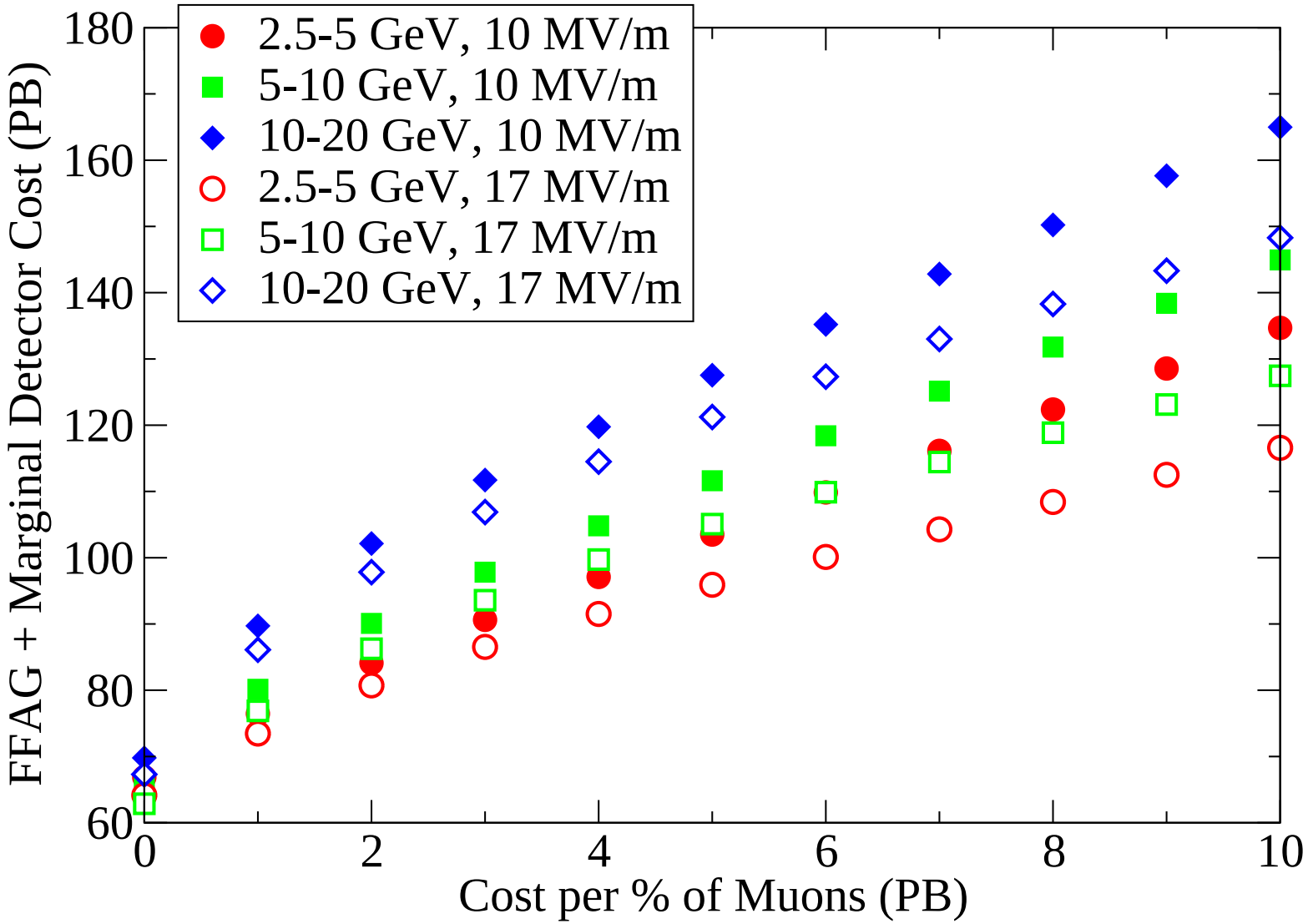
Need for Cost per Muon in Optimization

- If FFAGs are optimized merely for cost, they are very long
  - Longer ring has smaller dispersion, smaller aperture
  - Smaller aperture gives smaller magnet cost
  - Cost goes down faster than linearly in number of magnets
    - ⋆ Until number of cells is large (200 in some cases)
- Longer rings also have lower RF voltages
  - Smaller time-of-flight variation per turn
  - Partially filled with cavities
- Need to include cost of decays in long ring
  - Simple algorithm: multiply detector cost by fractional decay loss: "marginal detector cost"

FFAG Cost vs. Cost per Decay



Total Cost vs. Cost per Decay



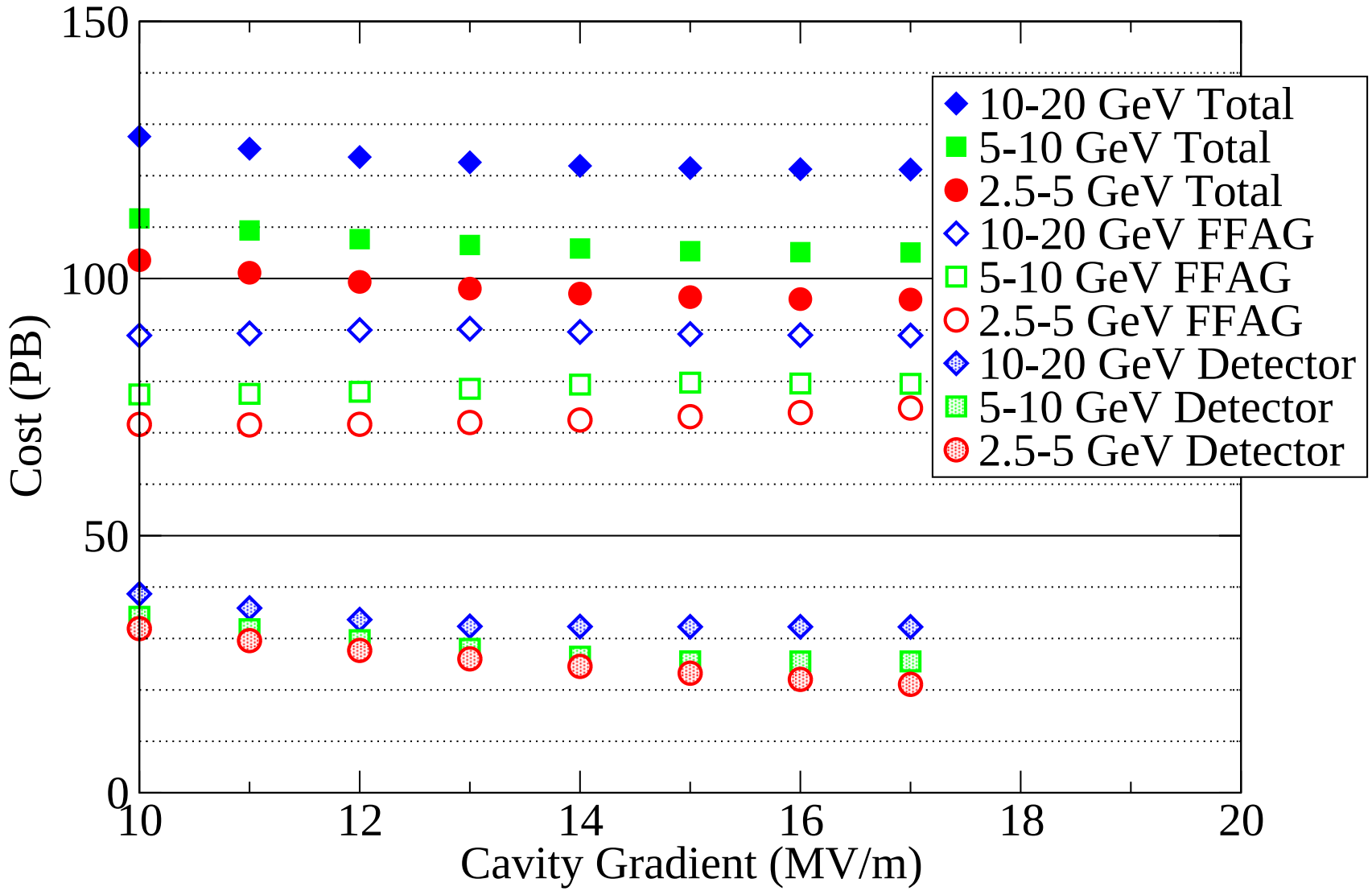
Analysis

- If the muons cost nothing, we choose the cost-optimum FFAG
  - RF only in some cells
  - Ring is very long, lots of decay
- Once muons cost something, shorten ring and add more RF
  - Ring cost increases rapidly at first
    - ⋆ Filling a larger fraction of the ring with RF
    - ⋆ Shortening the ring
  - Later, ring cost levels off
    - ⋆ Ring is filled with RF
    - ⋆ Performance improvements come by shortening magnets and increasing fields
      - ➢ Very expensive for little gain
      - ➢ Cheaper to instead increase detector size

Parametric Dependencies

- Cost vs. Gradient
  - Use 5 PB/% for the muon cost
  - Relatively weak dependency
  - FFAG cost increases with increasing gradient for low gradients
    - Total cost decreases since detector cost decreases
    - Ring is filled
      - Total voltage increases faster than cost per voltage
      - Ring circumference decresases, increasing ring cost
  - Higher gradients, can partially fill ring
    - Roughly same voltage and circumference
    - Fewer cavities
- Cost vs. Aperture
  - Strong dependence of cost on aperture
  - 10 MV/m: ring filled at these parameters (independent of aperture)

Cost vs. Gradient



Cost vs. Aperture