
# Superconducting Magnet R&D Cost Estimate

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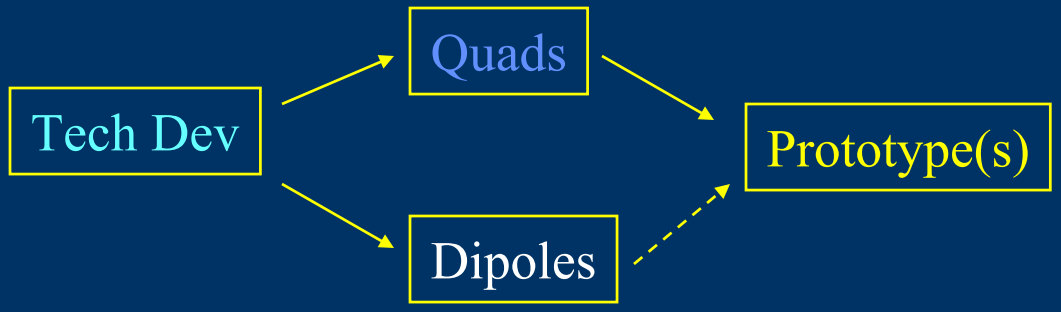
# Cost Estimate Considerations

- New Technological Territory
  - How difficult will it be?
  - What form will upgrade take?
  - What are technological limits?
- Cost model illustrates scope of R&D program that is possible with available funding – NOT a detailed plan
- Simultaneously, develop technology and define application

# Basic Program

## Start with model based on what we know now

- Combine
  - Technology Development
  - Quadrupoles
  - Dipoles
- Divisions arbitrary
- More for quads
  - Primary focus
  - Include 4m models



# Magnet Program Profile

| | | FY04 | FY05 | FY06 | FY07 | FY08 | FY09 | FY10 |
|---|---|---|---|---|---|---|---|---|
| Subscale Tests | | 1 | 3 | 6 | 5 | 4 | 3 | 2 |
| Simplified 1m Q | | | | 1 | 1 | | | |
| 1m Q | | | | | 1 | 2 | 2 | 2 |
| 1m D | | | | | 1 | 1 | 1 | 1 |
| 4m D or Q models | | | | | | | 0.25 | 1 |

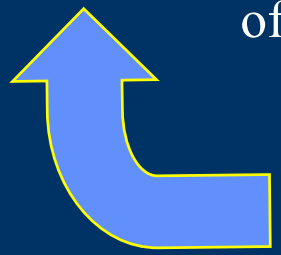
24 Sub-Scale tests

2 Simplified models

7 Quad models

4 Dipole models

1 4 m model



Solid technology development base complemented by a series of models of varying complexity

Slow start is a problem

Can Base Programs help?

# Cost Estimate Basis

- Start with costs from . . .
  - LHC Quad Program
  - High Field magnet programs at the labs

Relative cost scale
Costs of design and tooling amortized

- Apply to . . .
  - 4-layer, large aperture quad (Dipole same as quad)
- Scale for . . .
  - Material
  - Length

| | FTE | Labor | M&S | Total |
|---|---|---|---|---|
| Technology Development | 0.75 | 124 | 44 | 168 |
| Simplified Models | 4.5 | 804 | 377 | 1181 |
| 1 m Dipole/Quad | 8 | 1211 | 855 | 2066 |

# M&S Cost Detail

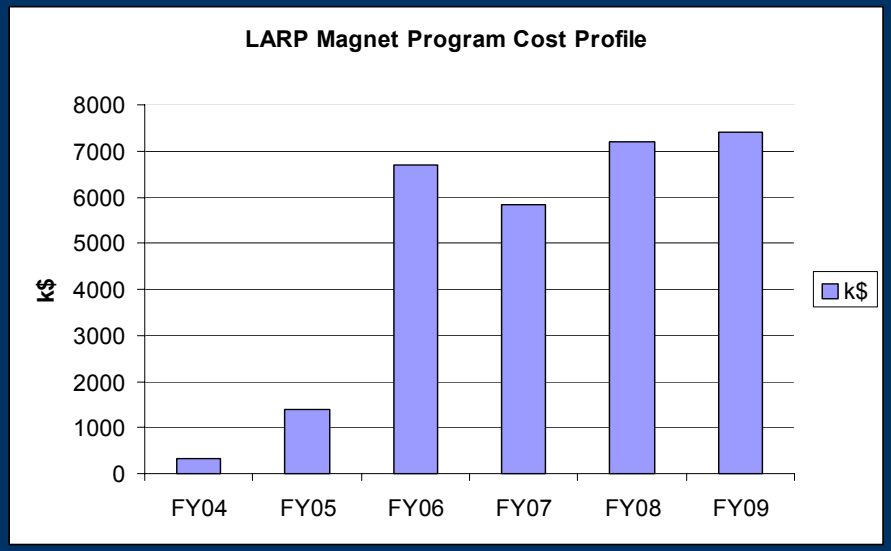
| Parts | 1 m | 4 m |
|---|---|---|
| Cable | $163k | $650k |
| Coil Assembly | $180k | $525k |
| Cold Mass | $56k | $134k |
| Test | $46k | $46k |
| Total | $444k | $1355k |
| | | |
| Tooling | | |
| Coil | $733k | $2240k |
| Cold Mass | $188k | |
| Total | $921k | $2240k |

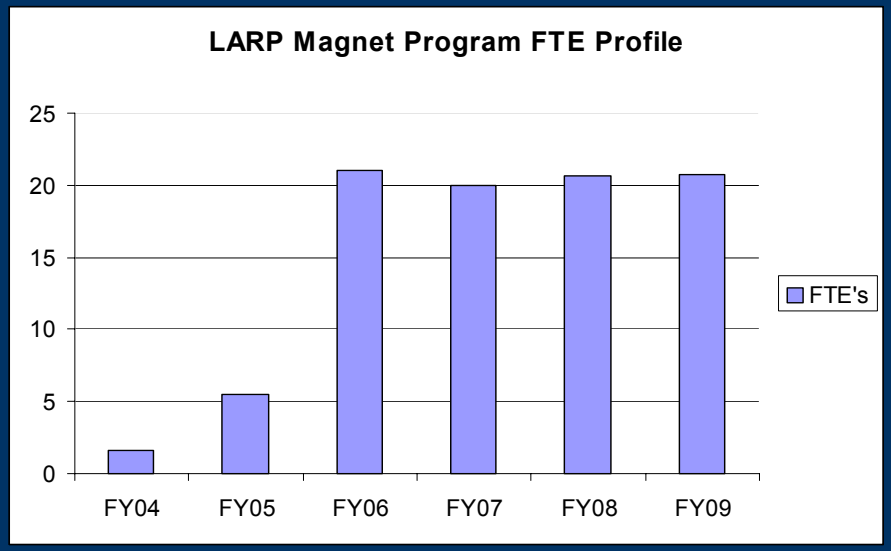
# Magnet R&D Cost Overview

| | FY04 | FY05 | FY06 | FY07 | FY08 | FY09 |
|---|---|---|---|---|---|---|
| **LABOR COUNT** | 1.6 | 5.5 | 21.0 | 20.0 | 20.6 | 20.7 |
| **LABOR COST** | 288 | 940 | 3168 | 3064 | 3152 | 3148 |
| **TRAVEL** | 6 | 18 | 41 | 42 | 43 | 42 |
| **MATERIAL & SERVICES** | 20 | 358 | 2920 | 2091 | 3010 | 3021 |
| **TOTAL COSTS** | **314** | **1315** | **6128** | **5196** | **6205** | **6210** |
| **Escalated** | **323** | **1395** | **6697** | **5849** | **7193** | **7415** |
| Guideline | 325 | 1400 | 6695 | 5845 | 7185 | 7425 |

Travel budget allows $5k/yr per scientist and engineer

# Cost and FTE Profiles




Program profiles based on budget guidance

# Enhanced Magnet R&D Program

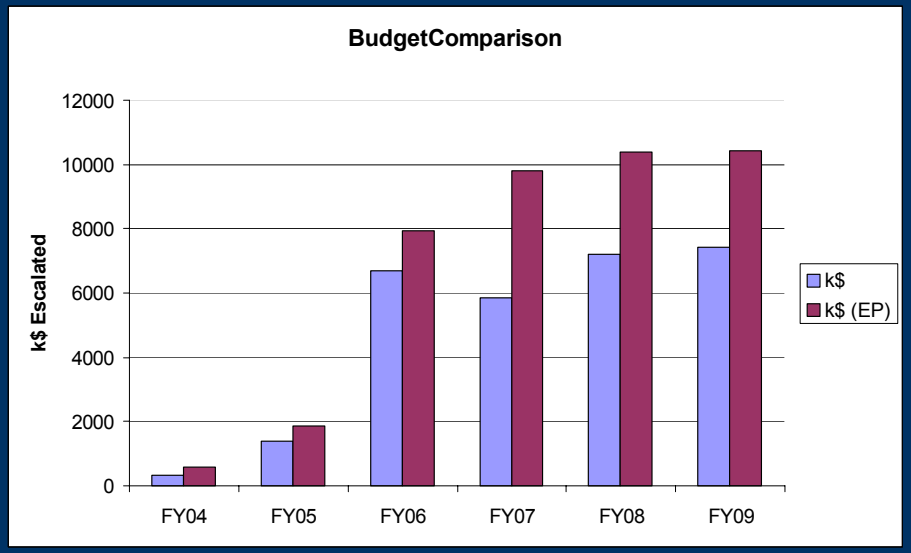
- Greater assurance of success of the R&D for high-performance magnets for luminosity upgrade
  - More vigorous start
  - Robust program – risk mitigation
  - Ensures R&D on both dipoles and quads
- Compare to Program based on budget guidelines
  - Additional sub-scale tests early in program
  - Healthier technology development component to support main program
  - 1 additional simplified model
  - 5 models/yr compared to 3/yr
  - Earlier start of 4m program
  - Commensurate increase in management and budget

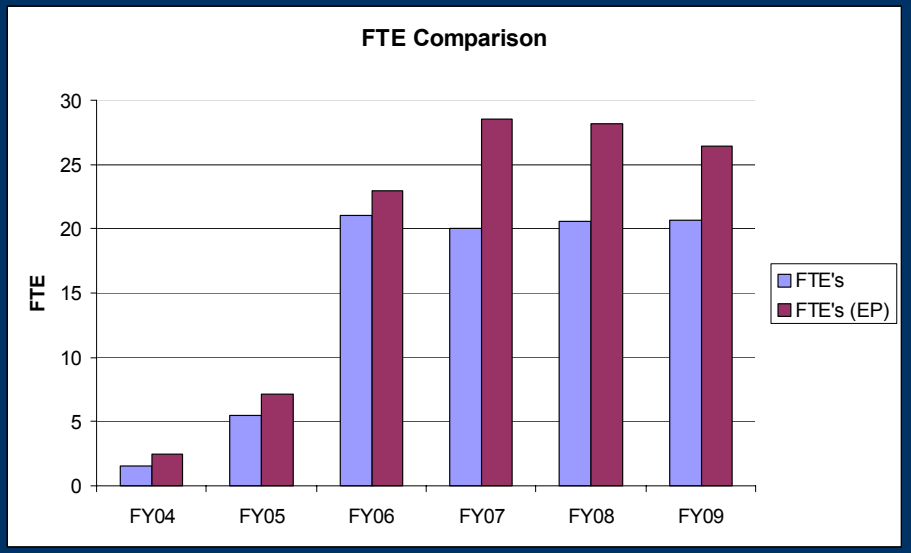
# Enhanced Magnet R&D Program

| | | FY04 | FY05 | FY06 | FY07 | FY08 | FY09 | FY10 |
|---|---|---|---|---|---|---|---|---|
| Subscale Tests | | 1 | 3 | 6 | 5 | 4 | 3 | 2 |
| Simplified 1m Q | | | | 1 | 1 | | | |
| 1m Q | | | | | 1 | 2 | 2 | 2 |
| 1m D | | | | | 1 | 1 | 1 | 1 |
| 4m D or Q models | | | | | | | 0.25 | 1 |

| | | FY04 | FY05 | FY06 | FY07 | FY08 | FY09 | FY10 |
|---|---|---|---|---|---|---|---|---|
| Subscale Tests | | 2 | 4 | 6 | 6 | 5 | 4 | 3 |
| Simplified 1m Q | | | | 1 | 2 | | | |
| 1m Q | | | | | 1 | 3 | 3 | 3 |
| 1m D | | | | | 2 | 2 | 2 | 2 |
| 4m D or Q models | | | | | | 0.25 | 1 | 2 |

# Base and Enhanced Program Comparison




# Summary

- Significant program of $Nb_3Sn$ magnet development
  - Makes extensive use of existing programs and infrastructure
    - Cost efficient
- Need an early start to assess scope and refine the program
- Baseline program is committed to complete development of at least one magnet type
  - A modestly enhanced program will . . .
    - Mitigate technical risk
    - Add assurance that we can successfully develop two types of magnet