"5-Year Plan"
Goals and Resources

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(on behalf of the Muon Collider Coordinating Committee)

Context: Strategic Vision

- In 2008 we presented to P5 a Muon Collider strategy to bring the high energy frontier back to the U.S.
  - study to demonstrate MC feasibility by 2013
  - post-study experiments and component test for 7-10 years
  - Start MC construction early to mid 2020's
- In parallel with MC R&D, the medium term Neutrino Factory development plan presented in 2008 to P5:
  - Complete MICE experiment & participate in IDS to deliver a NF-RDR by 2012
  - If community wishes to proceed, preconstruction R&D for a few years beyond 2012, with an option to start construction in the late 2010's
- Given this vision, in 2008, MCOG and MUTAC encouraged the NFMCC & MCTF leadership to develop a joint 5 year plan that proposes the way forward for the next step

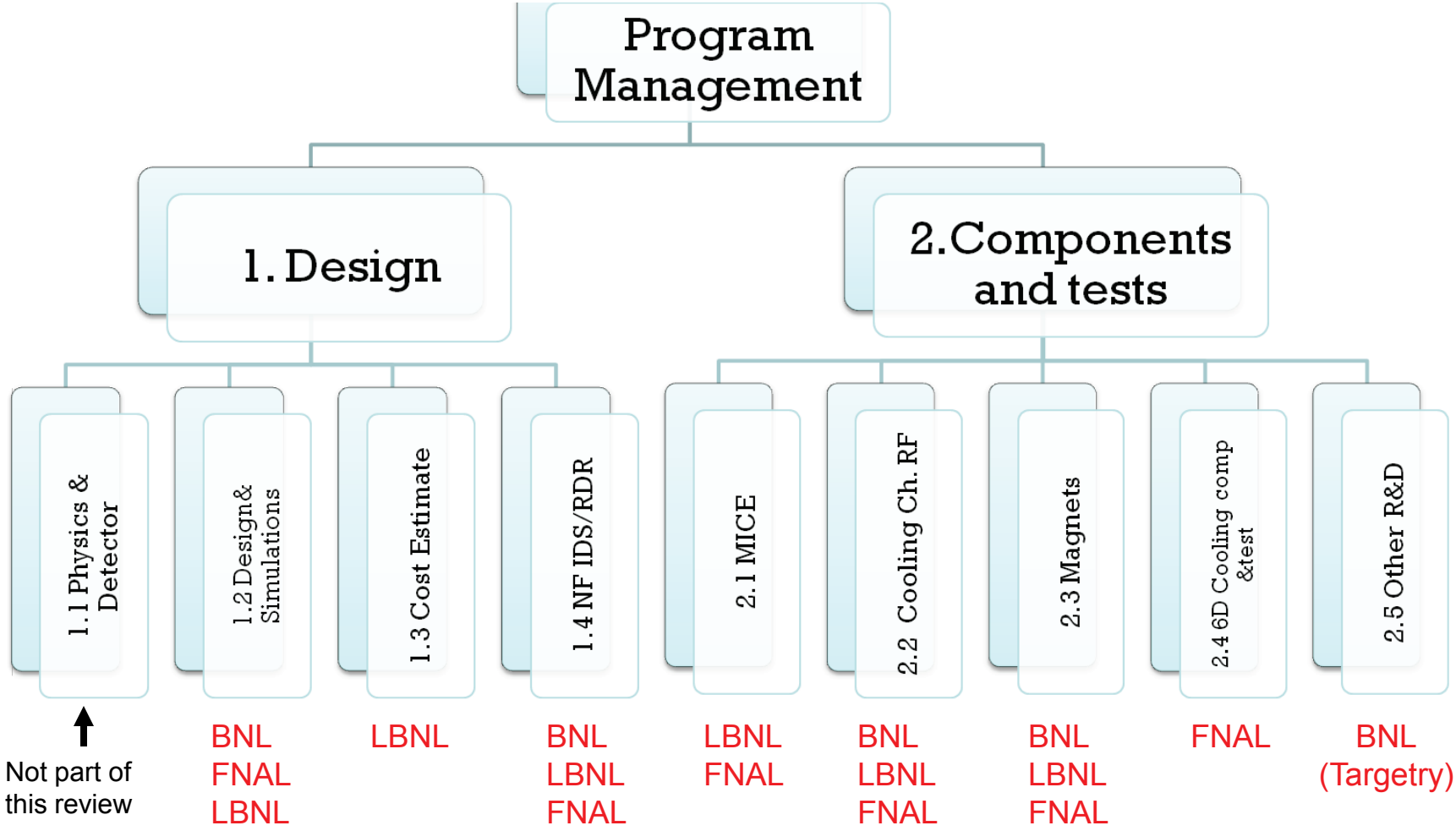
Plan History & Status

- April 2008 MUTAC Review: NFMCC & MCTF asked to complete a joint 5-year R&D plan within a few months.
- Special MUTAC meeting in August 2008 provided a critique of an initial version of the "5 year plan → invaluable input for the proponents.
- The final version of the document was sent to MCOG & the MUTAC chair for final comment in November.
- The plan was presented at the OHEP Laboratory Accelerator Science Review (December 2008) as a heads-up (not as a subject of that review).
- The document (5 year proposal) was also formally submitted to DOE in December
  - Receipt acknowledged. We anticipate the plan will be formally reviewed by DOE, but when is not yet determined.

The 5 Year Plan

- A joint NFMCC-MCTF Plan
  - A measured program based on the solid muon accelerator R&D achievements of the last decade
  - Sufficiently ambitious to make substantial progress before the next round of long-term decisions by the particle physics community (~2013 ?)
  - The proposed effort-levels have been negociated with the sponsoring laboratory (BNL, LBNL, FNAL) Directorates.
  - Includes accelerator, physics & detector studies (only accelerator part seeks support from accelerator R&D funds)
- Meets our existing commitments (NF-RDR, MICE) and in addition will deliver:
  - MC performance requirements based on physics
  - A first end-to-end MC simulation
  - Critical component development & testing
  - A first MC cost estimate

Elements of the R&D Plan



Elements of the Plan - 2

- Design and Simulations
  - MC DFS
    - Physics and Detector Study (Demarteau and Eichten)
    - Accelerator Design & Simulation Study (Ankenbrandt & Fernow)
    - Cost Estimation Study (Zisman)
  - NF RDR (Bross) (under IDS-NF auspices)
    - overall system design and staging scenarios
    - siting issues
    - participation in cost estimation activity

Elements of the Plan - 3

- Component Development and Experiments
  - carry out hardware development & perform tests to "inform" MC DFS & NF RDR (Jansson)
    - facilitate down-selection of MC cooling channel options
    - complete MICE
  - includes ongoing work
    - RF testing, magnet development, absorbers, target
      - understand performance limits, engineering issues, costs
  - hardware R&D has been carefully selected
    - plan only includes activities needed to assess feasibility & make 1st defensible cost estimate.
  - defines subsequent experimental program (extends beyond 5-yr plan)

Downselection

- Crucial to the plan is a downselection of RF options (for the cooling channel design)
  - Vigorous rf R&D in MTA for years 1 & 2, to determine which options are viable
  - RF decision at end of year 2. This will determine the baseline cooling channel option.
  - Design, build and test a short cooling section with this rf technology in years 3-5.

ACTIVITIES: YEARS 1 - 2

- **MC-DFS Physics & Detector**
  - Establish physics reach vs E & L
  - **Define performance goals (E, L, …)**
  - Set up background & detector simulations
  - Define detector requirements & plan detector R&D to inform ZDR
- **MC-DFS Design & Simulations**
  - **Study alternatives for the accelerator subsystems** using defensible parameters
  - Cross-check promising subsystems with 2 simulation codes
- **NF-RDR Studies**
  - Determine relevant underground conditions at FNAL
  - Detector magnetization design & procurement for test
  - Interim NF-RDR report in 2010
- **Components & Experiments**
  - MICE: Complete Steps III – V (1 RF section + 2 absorbers)
  - **RF in magnetic field studies: Determine viable options & performance**
  - HCC: 4-coil models (2009) & conceptual design + short demo HCC magnet (2010)
  - Other magnets (ring, fast-ramping): Study options, define parameters

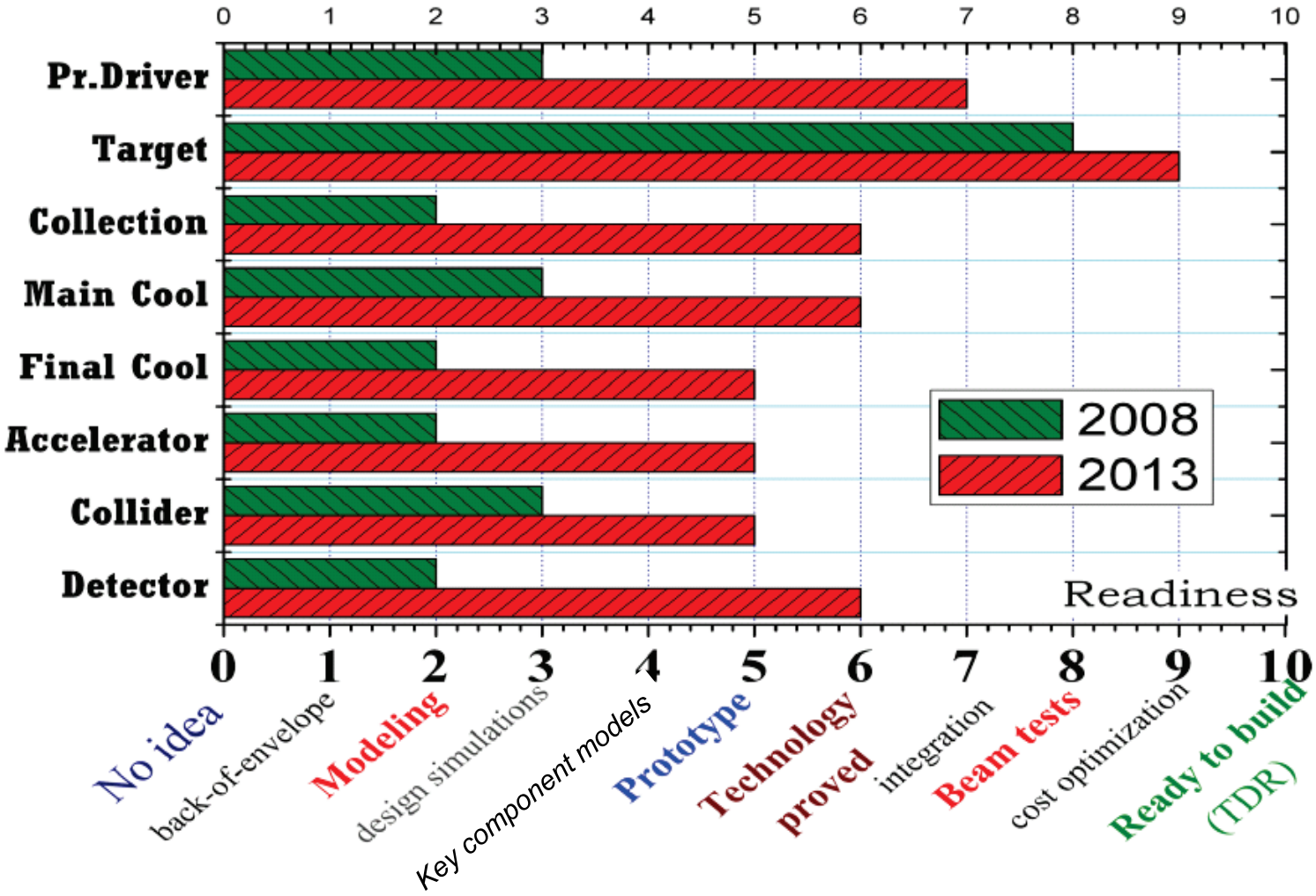
ACTIVITIES: YEAR 3

- **MC-DFS Physics & Detector**
  - Detector R&D, simulation & physics studies
  - **Establish likely MC detector performance**
- **MC-DFS Design & Simulations**
  - Specify baseline accelerator design & study optimization (minimize work on alternatives)
  - Simulate representative matching sections
  - Carry out representative tolerance studies
  - **Freeze accelerator design**
- **NF-RDR Studies**
  - Underground engineering: begin cost, schedule, risk analysis
  - Build detector test magnet
- **Components & Experiments**
  - **MICE: Complete Last steps III – V (2 RF sections + 3 absorbers)**
  - Study 6D cooling experiment options
  - **HCC-Section: Engineering design & procurement (magnet+RF)**
  - **Guggenheim-Section: RF Cavity and magnet conceptual design**
  - Other magnets (ring, fast-ramping): Define technology tests to inform DFS

ACTIVITIES: YEAR 4 & 5

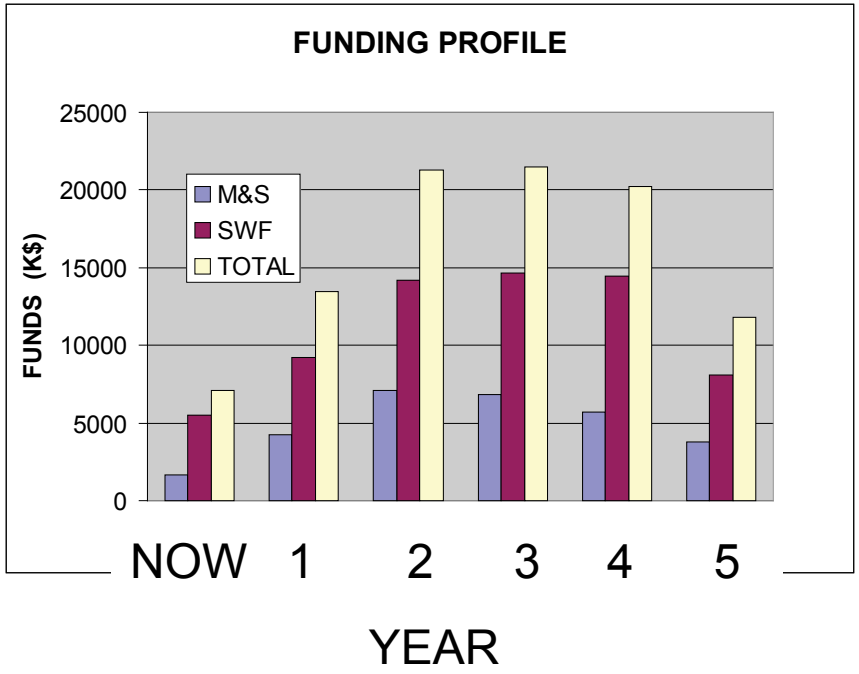
- **MC-DFS Physics & Detector**
  - Continue detector R&D
  - **Compare simulated physics reach with other machines (e.g. CLIC)**
- **MC-DFS Design & Simulations (& cost)**
  - Complete design of all matching sections
  - **End-to-end simulation of accelerator complex**
  - Detailed tolerance studies
  - **Cost estimate**
- **NF-RDR Studies**
  - **Complete RDR report**
- **Components & Experiments**
  - MICE: Simple 6D cooling experiment (LiH wedge ?)
  - 6D Cooling experiment design studies to inform decision about what to propose
  - **HCC Section: Magnet test & RF integration & test**
  - **Guggenheim-Section: Engineering design & procurement (magnet+RF) … build & test in year 5-6**
  - Other magnets (ring, fast-ramping): Technology tests to inform ZDR & post-ZDR R&D needs

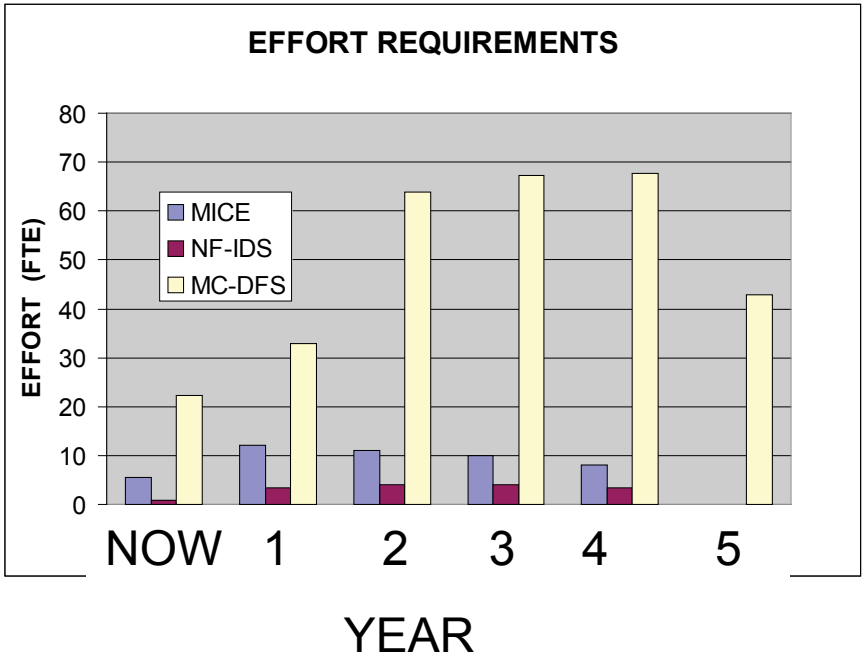
Expected MC Status after Plan



Resources

Resources needed to execute the 5 year plan





NOTE: Roll-over in years 4-5 provides an opportunity to initiate post-DFS activities, should the community wish us to proceed to the next step

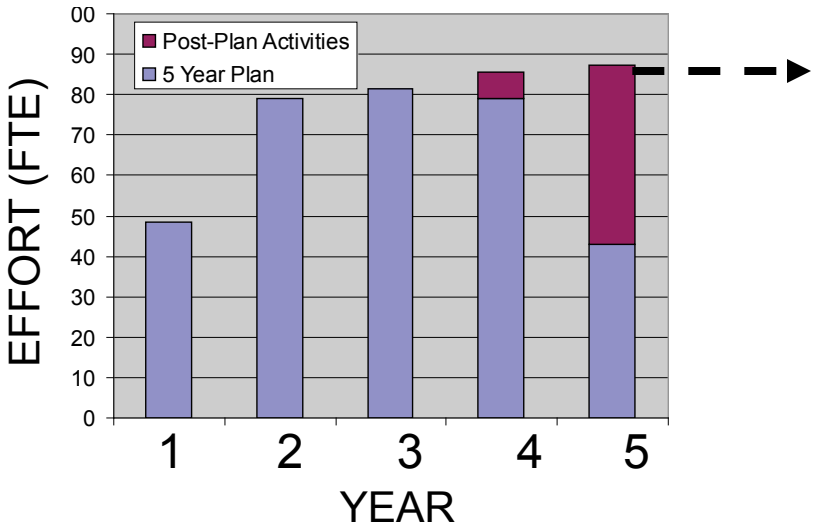
Contributions (FTE)

- Proposed effort profile (FTEs) for muon accelerator R&D:

	Now	Year 1	Year 2	Year 3	Year 4	Year 5
BNL	6.5	7	8	11	11	11
FNAL	20.8	23	28	30	33	33
LBNL	2.5	5	8	9	11	13
Other	7 a)	13 b)	35 b)	31 b)	31 b)	31 b)
TOTAL	36.8	48	79	81	86 c)	88 c)

a) Universities ~ 5FTE, Other Labs ~ 2FTE. NOTE: In addition there are ~ 10FTE SBIR.
b) Includes SBIR, Universities, Other Labs, & additional engineering effort from BNL+FNAL+LBNL or external contracts (with M&S vs SWF adjustment)
c) Includes post-5-year plan activities

- Utilization of Effort
  - -5-year plan activities dominate years 1-4
  - -Start post-plan R&D in years 4-5 if community wishes to proceed to next step



M&S

	YEAR 1	2	3	4	5	TOTAL
Design & Simulations	**3012**	**6027**	**6802**	**7379**	**3105**	**26325**
M&S	90	320	95	110	25	640
SWF	2922	5707	6707	7269	3080	25685
Components & Tests	**7528**	**10500.5**	**9225.5**	**8201.5**	**4962.5**	**40418**
M&S	2070	2906	2291	2136	1135	10538
SWF	5458	7594.5	6934.5	6065.5	3827.5	29880
Program Management	**1324**	**1584**	**1794**	**1899**	**1534**	**8135**
M&S	494	694	769	749	384	3090
SWF	830	890	1025	1150	1150	5045
Total M&S	**2654**	**3920**	**3155**	**2995**	**1544**	**14268**
Total SWF	**9210**	**14191.5**	**14666.5**	**14484.5**	**8057.5**	**60610**
M&S Overhead	**398.1**	**588**	**473.25**	**449.25**	**231.6**	**2140.2**
Contingency	**789.75**	**1501.25**	**1600**	**481**	**481**	**4853**
Escalation	**385.67**	**1108.597**	**1575.721**	**1797.358**	**1511.696**	**6379.042**
TOTALS	**13437.52**	**21309.35**	**21470.47**	**20207.11**	**11825.8**	**88250.24**

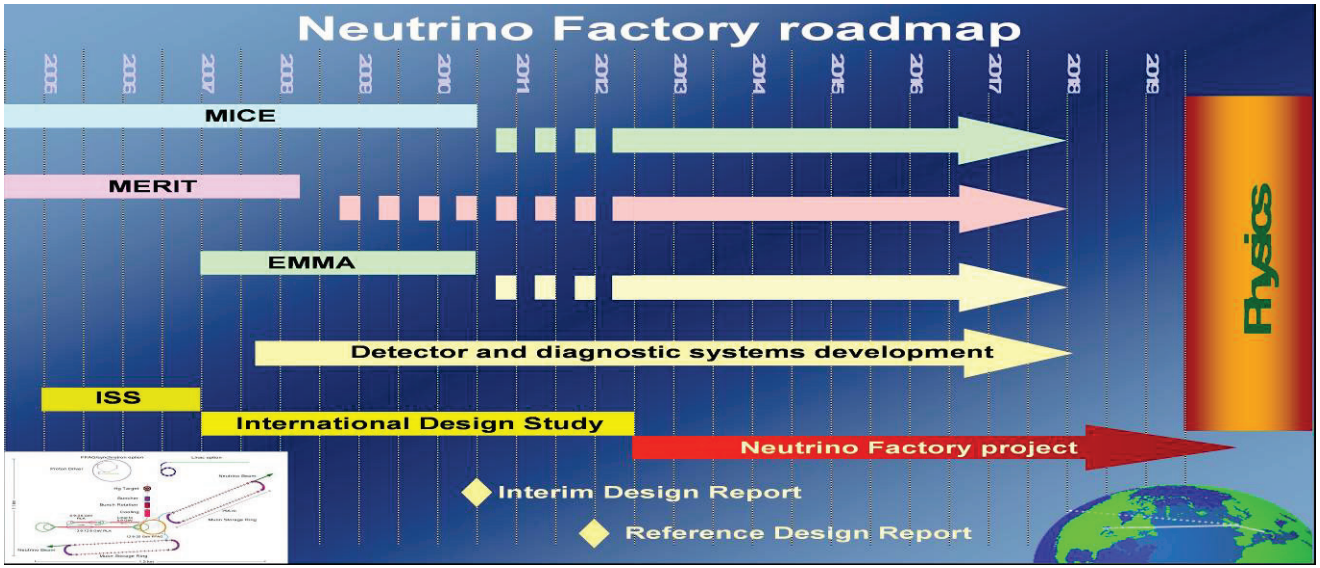
Effort

YEAR	M&S K$	SWF K$	ENGS FTE	TECHS FTE	PDOCS FTE	SCIENTS FTE	TOTAL	Total FTE
FY08	1633	5479.5	6.8	9.5	3.3	11.902	**7112.5**	**31.502**
1	3317.5	9210	13.5	8.3	8	20.6	**12527.5**	**50.4**
2	4900	14191.5	21.05	14.4	16.75	29.15	**19091.5**	**81.35**
3	3943.75	14666.5	16.55	14.5	21.25	32.45	**18610.25**	**84.75**
4	3743.75	14484.5	20.4	10.25	21.5	30.55	**18228.25**	**82.7**
5	1930	8057.5	10.25	9.75	9	17.35	**9987.5**	**46.35**

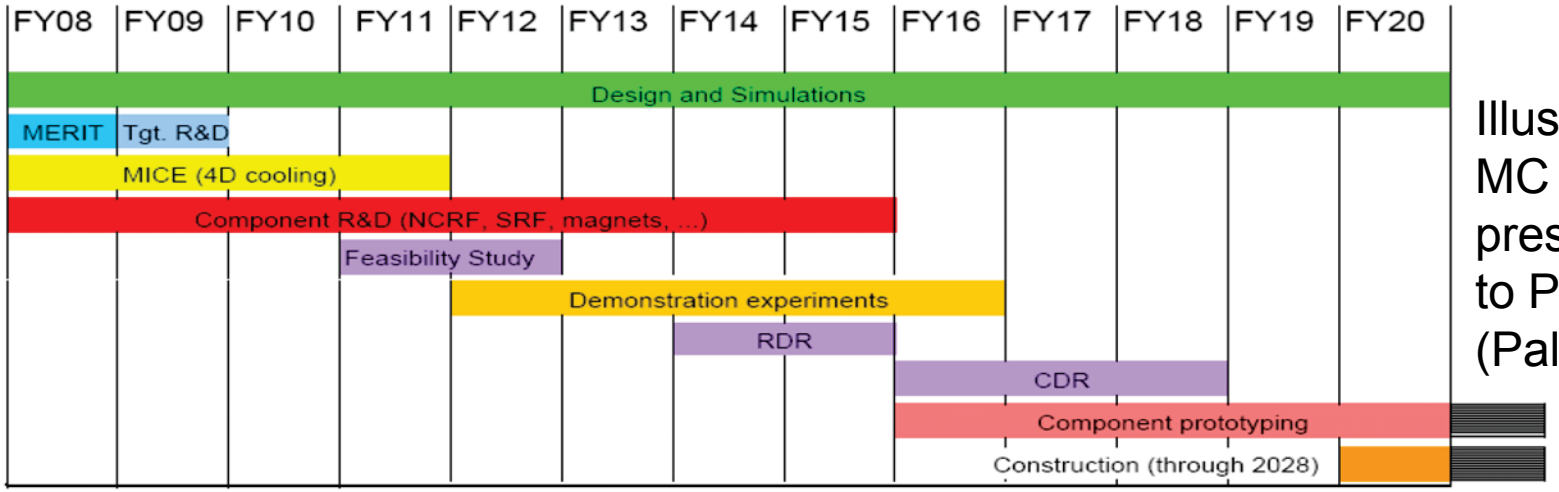
Effort Distribution

	YEAR 1	2	3	4	5	
1.1 Physics & Detector	2	2.5	3.5	3.5	3.5	**NOT INCL**
1.2 Design, Simulations, Report	9	23	29	27	13	
1.3 MC-DFS Costing	0.4	0.4	0.4	6.8	0	
1.4 NF-RDR	3.5	4	4	3.5	0	
2.1 MICE	12	11	10	8	0	
2.2 RF R&D	7.5	11.5	8	5.5	4.25	
2.3 Magnet Studies	12.2	12.45	14.25	12.2	9.4	
2.4 6D Cooling Sections & Tests	0	12.1	10.6	10.7	10.7	
2.5 Other R&D	0	0	0	0	0	
3 Management	3.8	4.4	5	5.5	5.5	
TOTAL	**48.4**	**78.85**	**81.25**	**79.2**	**42.85**	

Timelines - NF



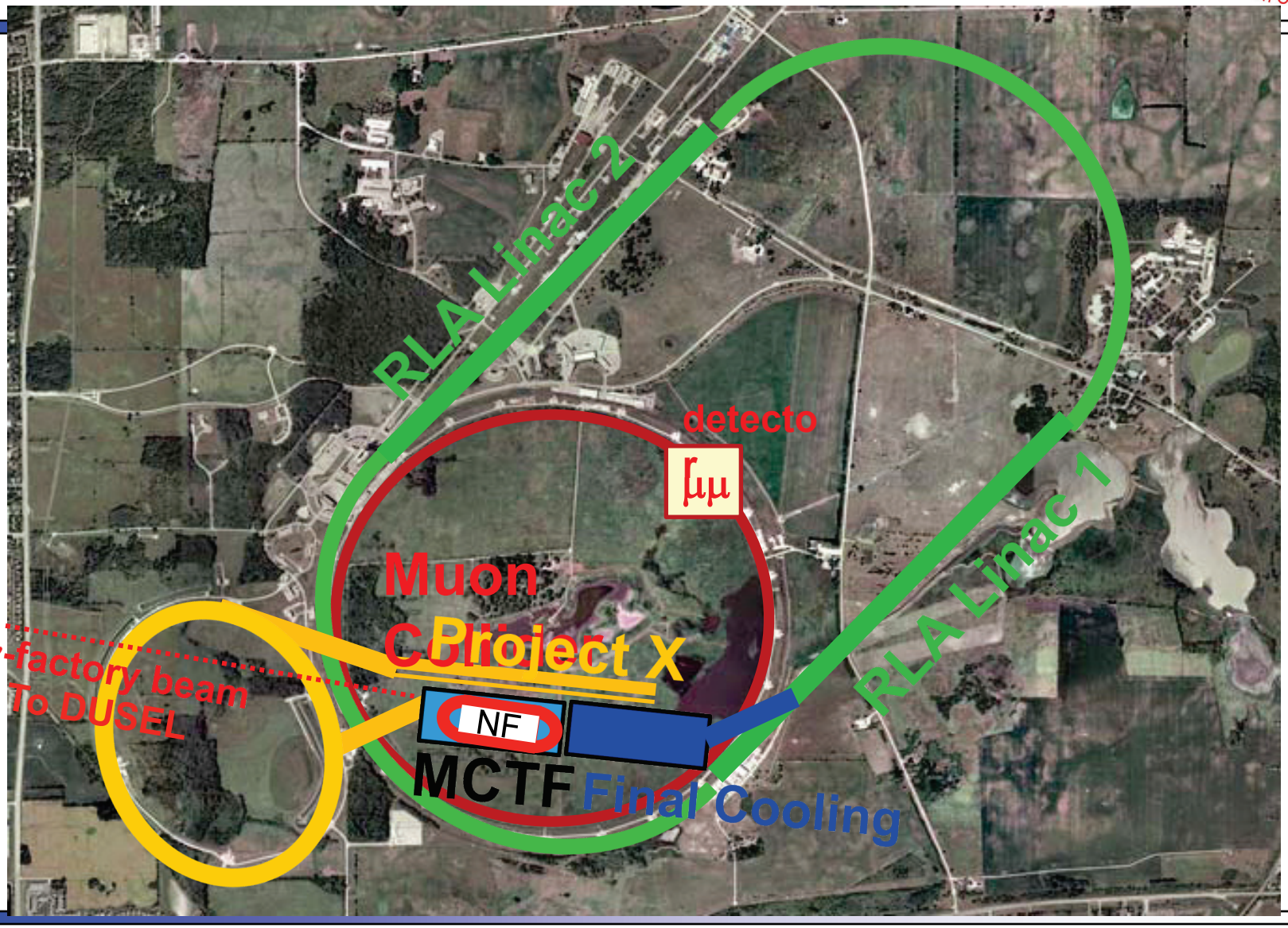
Aspirational NF timeline presented in ISS report



Illustrative MC timeline presented to P5 (Palmer)

MCTF

A Muon-Based Vision



MUTAC 2008 Recommendations

- Develop a detailed plan to reach the goal of a MC feasibility study by 2012 for presentation to the MUTAC in 2009
  - DONE (2012 → 2013)
- A detailed costing breakdown of the 5 year plan & its activities is requested before the next MUTAC review, to ensure that task priorities are effectively matched to meet both international commitments and feasibility study deliverables by 2012.
  - DONE with effort levels agreed upon with lab managements
- The committee recommends that the 5 year plan be a fully-integrated, joint effort, to capture & enumerate the full scope of R&D pland for both NFMCC & MCTF activities.
  - IT IS A FULLY INTEGRATED JOINT PLAN
- The committee recommends that the 5 year plan include the initiation of planning for a 6-D cooling demonstration experiment.
  - IT DOES
- Consider in the 5-year plan the evaluation of the various physics scenarios, circa 2012, to establish requirements for energy and luminosity of a MC and to help narrow the range of parameters.
  - PLAN INCLUDES THIS

Final Remarks

- In the last 12 months we have:
  - Formulated and documented our "5 year plan"
  - Given a heads-up presentation of the plan to the DOE
  - Submitted the 5-year plan proposal to the DOE
- The NFMCC + MCTF community is eager to pursue the plan:
  - Contribute to IDS: NF RDR in 2012
  - Deliver a MC-DFS report in 2013
- To succeed in our goals we need:
  - DOE support for the 5 year plan
  - A sense of urgency for the next big MC R&D step
- If we continue with the present scale of support:
  - Our ability to make progress will be limited
  - We will not be able to deliver to the community on an apropriate timescale enough information to judge the viability & cost of a MC

5 Year Plan Talks

• IDS/NF contributions	Bross
• Physics & Detector	Demarteau
• Design & Simulations	Fernow
• Experiments & Tests	Jansson
• RF R&D	Li
• Magnets	Kashikin