SRF Infrastructure at FNAL
Planning, Organization, Cost & Schedule

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Outline

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- Planning & Organization
- Budget & Tracking
- Control of the Program
- Cost Estimate
- Schedule with Milestones
- Labor Resources
- Summary

Goals for SRF Infrastructure

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- To perfect U.S. fabrication & processing of SRF cavities and modules and to demonstrate performance with a full range of testing (including beam)
  - Deploy ILC design / processing / assembly techniques
  - Establish process controls to reliably achieve high gradient cavity operation and module performance
  - Test cavities and modules at the component level and in a systems test to demonstrate yield, reproducibility and beam performance
- To facilitate commercial production of SRF components and modules
  - Train and transfer SRF technology to the US industry
  - Allow industrial participation and input to the process
    - Similar to SC cable and magnet technology transfer
- To participate in SRF Research and Development
  - Develop expertise in SRF technology and provide training base for construction and operation of future accelerators
  - Our attempt to fit into the world's SRF community

  All of this work will be carried out with US/international collaboration
- To achieve these goals (within the realities of limited budgets) we need to have strong planning, control and execution of SRF Infrastructure Program

Program Planning & Schedule

- Planning starts with the DOE/OHEP and the Fermilab Director setting priorities and then gets implemented by the ILC Program Management Office (PMO) through the Task Leaders
- ILC Program Manager receives guidance/direction from ILC GDE, Americas Regional Team Director and our collaboration partners to establish priorities for the infrastructure build up
- Given Program priorities => task schedules & budgetary estimates are then developed (by Task Leaders) but held centrally (PMO)
  - Individual facility leaders keep much more detailed schedules
- Infrastructure schedule => affected by budget levels
  - ⇒ No explicit contingency (or escalation) in the cost estimate
  - ⇒ Plan needs to be flexible (ability to change as R&D progresses and yields new results) and must be able to be prioritized
  - ⇒ SCOPE & TIME are contingency

Organization & Collaboration

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- Scope of work associated with SRF Infrastructure at FNAL is such that it requires a lab-wide effort
  - Organization chart reflects this
- More than that it requires a full collaborative effort with our colleagues worldwide (DESY, INFN, KEK, India…)
- Critical to the success of this work is the help, cooperation and input of other US national labs (SLAC, JLAB, ANL…) and our university colleagues (Cornell, Penn, NIU, MSU…)
- => MOU established with partners (deliverables, time scale, cost…)
  - Examples of MOU posted on Indico site (~10 already in place/more to come)
- Just beginning the ramp up in infrastructure with an eye towards pushing the state of the art and improving QC and throughput
  - Utilize the SRF experience already in place (both nationally and internationally) to build the right type of facilities
    - e.g. HPR Design Study by Niowave (MSU)

Fermilab ILC Program Organization Chart

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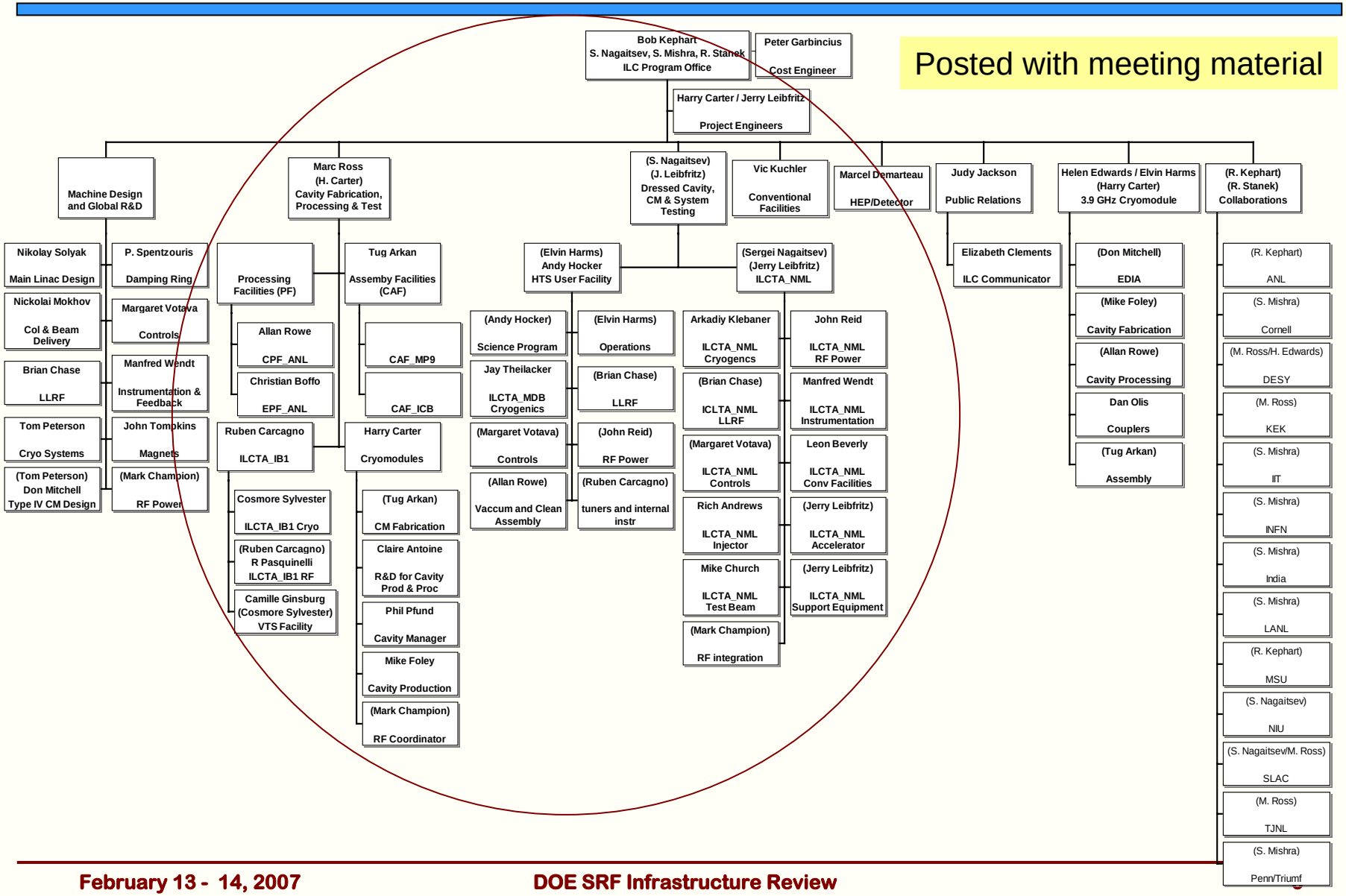
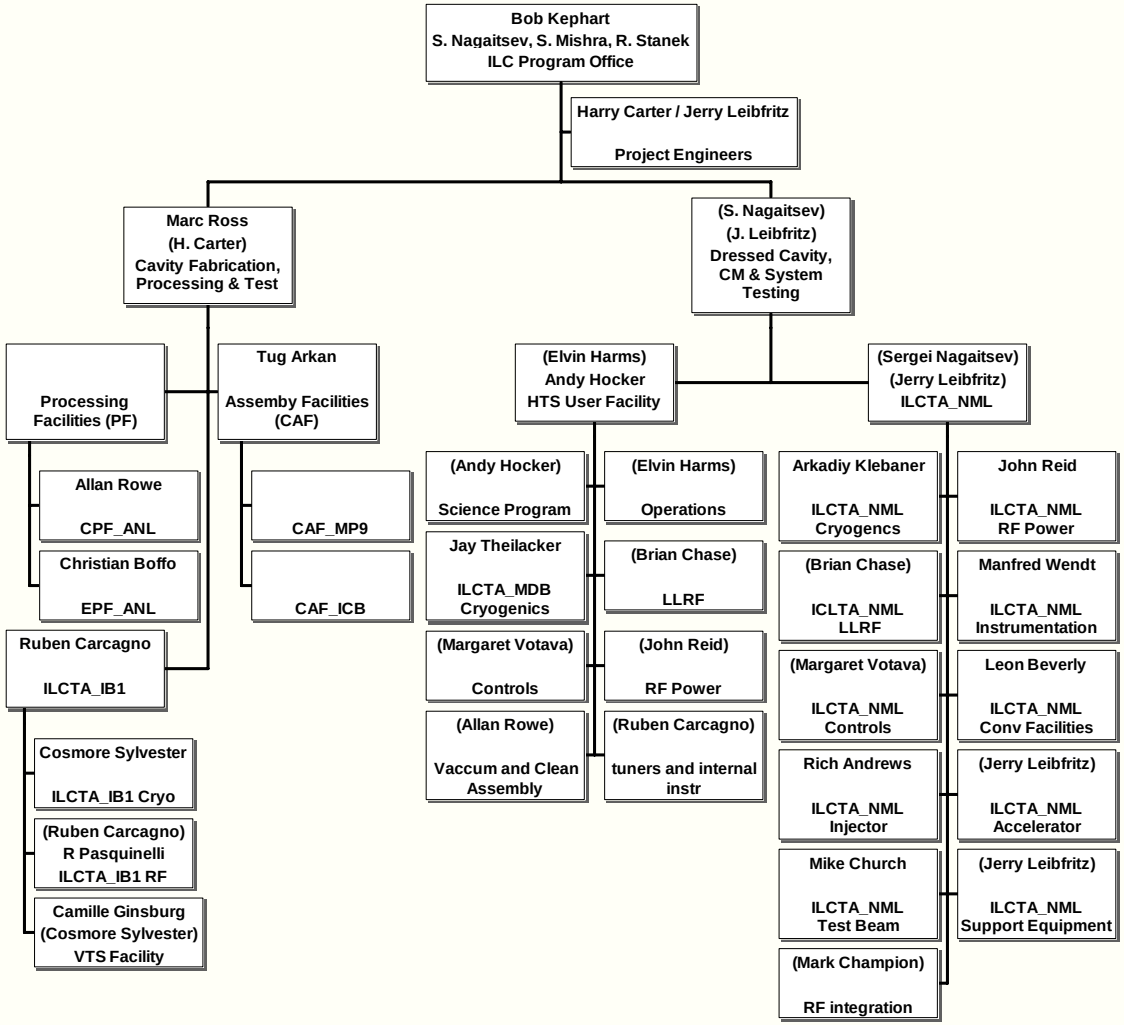
Posted with meeting material



SRF Infrastructure Organization



Comments on Organization

- Organization utilizes resources from across the Lab
- SRF Infrastructure organized around facilities
  - Test Areas, Assembly Facilities, Processing Facilities…
- Organization is very functional
  - Chain of Command well established
  - Getting help from Division Leadership
- Task Leaders in place
  - Expect additional leadership personnel to be integrated as Tevatron Ops winds down or other projects are completed
  - Task Leaders have taken ownership for the work
- Number of FTE is ~ 150 for Total ILC Program
- Working specifically on Infrastructure ~ 70 FTE

SRF Infrastructure WBS

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18.2.7.4	SRF Infrastructure
18.2.7.4.1	Test Areas (ILCTA)
18.2.7.4.2	Assembly Facilities (CAF)
18.2.7.4.3	Processing Facilities (PF)

18.2.7.4	SRF Infrastructure
18.2.7.4.1	Test Areas (ILCTA)
18.2.7.4.1.1	ILCTA _NML
18.2.7.4.1.2	ILCTA_MDB
18.2.7.4.1.3	ILCTA_IB1
18.2.7.4.2	Assembly Facilities (CAF)
18.2.7.4.2.1	CAF_MP9
18.2.7.4.2.2	CAF_ICB
18.2.7.4.3	Processing Facilities (PF)
18.2.7.4.3.1	CPF_ANL
18.2.7.4.3.2	EPF_ANL

WBS Details for NML

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18.2.7.4.1.1	ILCTA _NML
18.2.7.4.1.1.1	ILCTA_NML Conventional Facilities
18.2.7.4.1.1.2	ILCTA_NML Cryogenic System
18.2.7.4.1.1.3	ILCTA_NML Tooling & Test Enclosure
18.2.7.4.1.1.4	ILCTA_NML RF Power System
18.2.7.4.1.1.5	ILCTA_NML Auxilliary Systems
18.2.7.4.1.1.6	ILCTA_NML Operations
18.2.7.4.1.1.7	ILCTA_NML LLRF
18.2.7.4.1.1.8	ILCTA_NML Controls
18.2.7.4.1.1.9	ILCTA_NML Instrumentation
18.2.7.4.1.1.10	ILCTA_NML Injector
18.2.7.4.1.1.11	ILCTA_NML Accelerator
18.2.7.4.1.1.12	ILCTA_NML Test Beamline
18.2.7.4.1.1.13	ILCTA_NML Support Equipment/Systems
18.2.7.4.1.1.14	ILCTA_NML Building Extension

Detailed WBS/cost tracking allows Task Leaders to monitor & control work

Nomenclature

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- **Infrastructure is organized in specific types of facilities**
  - **Processing Facilities**
    - **CPF_ANL => BCP facility**
    - **EPF_ANL => EP facility**
    - **Eventually CPF_MW9 => Cavity processing & dressing (1 CM/mo)**
  - **Assembly Facilities**
    - **CAF_MP9 => Cavity String assembly**
    - **CAF_ICB => Cryomodule assembly***
    - **Requires assembled string be stabilized & transported**
  - **Test Areas**
    - **ILCTA_IB1 => VTS1 and eventually VTS 2 & 3**
    - **ILCTA_MDB => HTS1 and eventually HTS2**
    - **ILCTA_NML => RF Unit Test eventually with beam @ ILC parameters**
    - **ILCTA_CTS => exact location still being discussed (several possibilities)**
- **FNAL has buildings, equipment, human resources and expertise in many required technical areas that make it an excellent location to site these facilities**

Facilities utilize existing buildings

Program Controls

- "An R&D Program NOT A Project"
  - Still a large amount of money => therefore need controls
- Our "controls/management tools" include:
  - Single Program Management Office
    - With strong support from existing Division Management
    - Approves scope of work and gives clear direction on priorities
      - Imposes a level of "change control" consistent with an R&D Program
  - Centralized budget and cost tracking system (monthly reports)
    - Includes detailed labor summary (who is working on the project)
  - Internal ILC & HINS PMG (Program Management Group)
  - Formal reports to Americas Regional Director (for ILC $)
  - Formal reviews (DOE ART, AAC, PAC, DOE Annual Program Review)
  - Status reports & presentations (given by Task Leaders to Program Management Team + Collaborators) every week => very interactive
  - Program Schedule (will eventually be resource loaded)
    - List of milestones & M&S costs => used to respond to budget levels

Investment in SRF Infrastructure (Program to Date)

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	Cost to Date* (K$)
Test Areas	
ILCTA_NML	**$4,325**
ILCTA_MDB	**$4,161**
ILCTA_IB1	**$1,685**
Assembly Facilities	
CAF_MP9	**$1,617**
CAF_ICB	**$25**
Processing Facilities	
CPF_ANL	**$297**
EPF_ANL	**$446**

*Direct cost only
FY06 + FY07 (to date)

Substantial investment (~$12.5 M) already made in SRF Facilities and we have made substantial progress in preparing the systems

Extreme Makeover (FNAL Edition)

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NML

MDB

Spending in FY06

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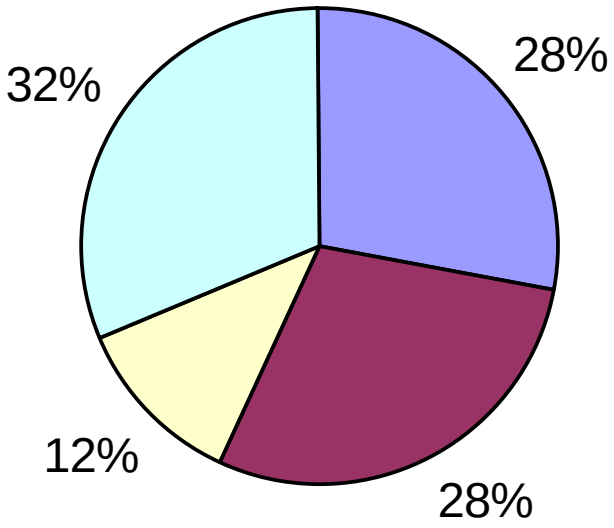
Total Direct Spending FY06 = 25.5M$



- ILC/GDE (Global Systems and R&D)
- SRF (generic R&D - incl. 3.9 GHz & Detector)
- ILC/GDE (Infrastructure related)
- SRF (Infrastructure related)

Spending on Infrastructure accounted for ~ 44% of Total Spending in FY06

Cost Estimates

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- Cost Estimates were done by Task Leaders and reflect the cost to set up the infrastructure
- Cost in this estimate DOES NOT INCLUDE
  - Future operating costs for these facilities
  - Component costs associated with fabricating the cavities and cryomodules (manufacturing cost for each unit) => captured by specific project
- Used real data from FY06, vendor quotes, engineering estimates and scaling from similar tasks
  - Most cost estimates have additional back up information (see Task Leader)
  - Some cost estimates (IARC infrastructure) are only best approximations
- Loaded the SRF Infrastructure Program Plan with M&S Cost (including Indirects) into a project schedule to better understand funding profiles

SRF Infrastructure Cost Estimate

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Infrastructure	M&S	SWF	Total with Indirect
Cavity Fabrication Infrastructure (ECS, RFT, EBW)	$ 3,000	$ 675	$ 4,380
Cavity Processing Facilities (BCP, EP, HPR)	$ 11,100	$ 4,590	$ 18,945
Vertical Test Stand (Cryo + VTS 2 & 3)	$ 2,625	$ 1,845	$ 5,475
Horizontal Test Stand (HTS 2)	$ 1,220	$ 1,057	$ 2,805
Cavity/Cryomodule Assembly Facilties (CAF ~ 1CM/mo)	$ 690	$ 270	$ 1,158
NML Facility (ILCTA_NML - cryo test & beam)	$ 18,270	$ 23,220	$ 51,700
Cryogenics for Test Facilities (New Cryo Plant)	$ 10,690	$ 950	$ 13,692
Cryomodule Test Stand (Single CM)	$ 5,400	$ 2,970	$ 10,180
Material R&D (1 Cell, Mate Test, Advanced R&D)	$ 870	$ 722	$ 1,960
Illinois Accelerator Research Center	$ 20,000	$ 4,050	$ 28,605
Grand Total ($k)	**$ 73,865**	**$ 40,349**	**$ 138,900**

Already have a WBS structure and an accounting system in place that captures the elements of the SRF Infrastructure

=> Example of this for FY06 posted on Indico

Can easily handle different funding sources

Infrastructure Schedule

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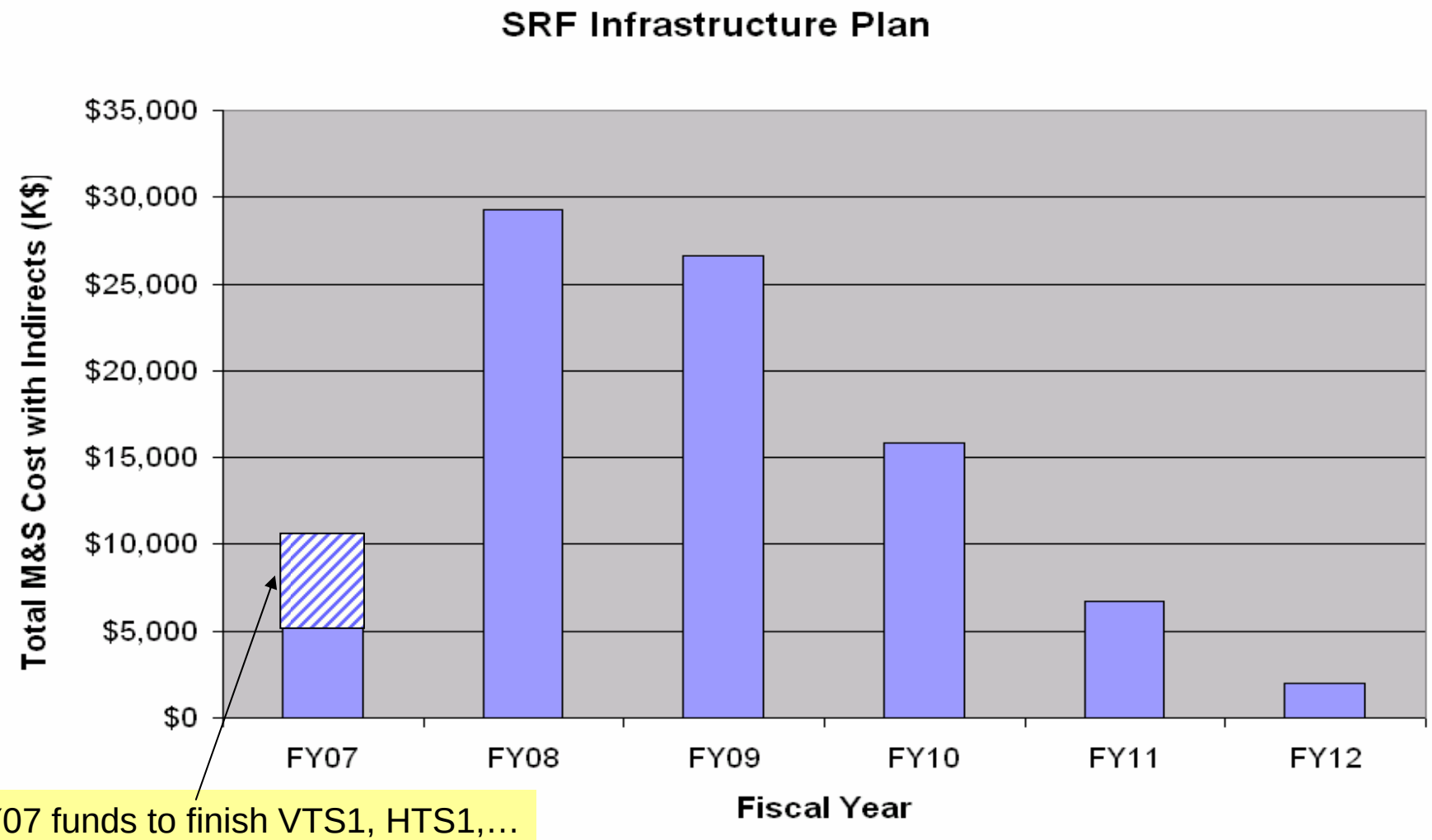
- MS Project schedule for Infrastructure build up
  - Tool to plan, prioritize, and track the Infrastructure Program
  - Also used to respond to various budget scenario
- Technically Limited schedule
  - How fast could we go if budget was not a limitation
- Funding Profile schedule
  - Best estimate of a real schedule when budget limitations are imposed
- Elements of the Infrastructure Program have different priorities based on level of need => whether they provide a missing capability or just add to throughput
- Some infrastructure tied to outside sources of funds (IARC Building) => creates dependency on another funding source

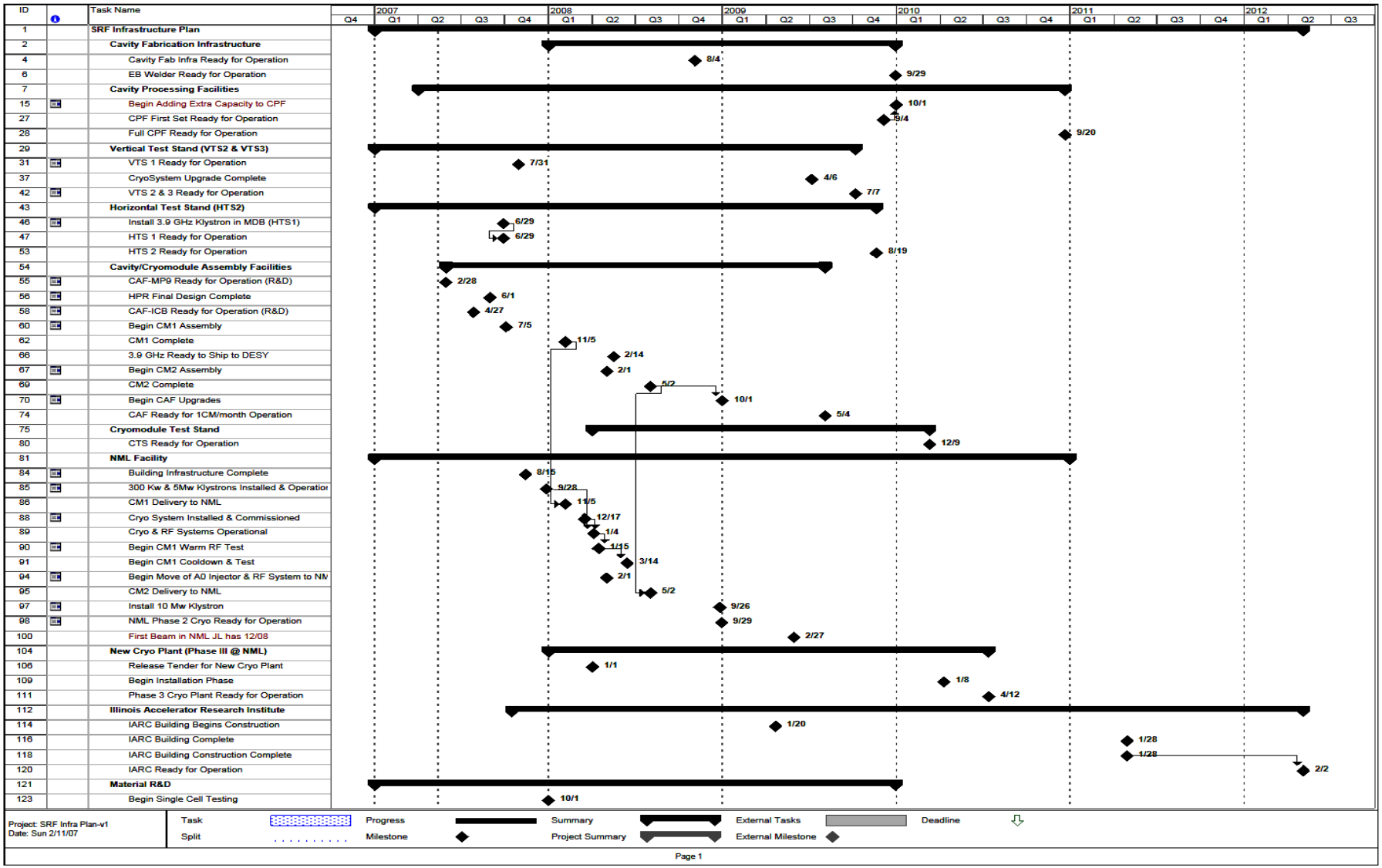
Funding Profile – Technically Limited



FY07 funds to finish VTS1, HTS1,…
Not included in White Paper request

Total M&S Cost with Indirects = $89,300

Milestones for Technically Limited Schedule



M&S Funding Profile (Infrastructure Only)

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	M&S Budget Direct (K$)	M&S Budget with Indirect (K$)
FY07	10,000	11,650
FY08	10,000	11,650
FY09	20,000	23,300
FY10	25,000	29,125
FY11	25,000	29,125
FY12	25,000	29,125

•This is just one possible budget scenario

- To see the "full picture" add in all the FY07 SRF Infrastructure costs (VTS1, HTS1, CAF (MP9 and ICB), BCP & EP @ANL…)
- Assume a budget profile based on
  - Latest information on the FY07 budget
  - President's Budget for FY08
  - Best guess of ramp up in FY09 and beyond

Establishing Priorities

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- Starting point => every part of the Infrastructure Plan will eventually be needed to meet the demands of the projects (matter of timing)
- Separate out highest priority items
  - e.g. VTS Cryo Upgrades => increase operating efficiency of VTS 1

  from ones that can be slightly delayed
  - e.g. VTS 2 & 3 which add testing capacity and are needed only when number of cavities in the system increases dramatically
- Break high level tasks and costs down to a lower level
  - More segmentation might allow shifting of some costs
- Identify tasks that cannot move forward (immediately) and are awaiting additional engineering or R&D
- Categorize tasks that have long lead times and high costs
  - Look at phased funding options
- Find tasks where other institutions (JLAB, ANL, Cornell) can help fill the void, at least temporarily
  - Each collaborating institution is under its own limitations
- Identify tasks that have additional funding constraints (IARC) and allow for schedule slippage in that funding source

Priorities

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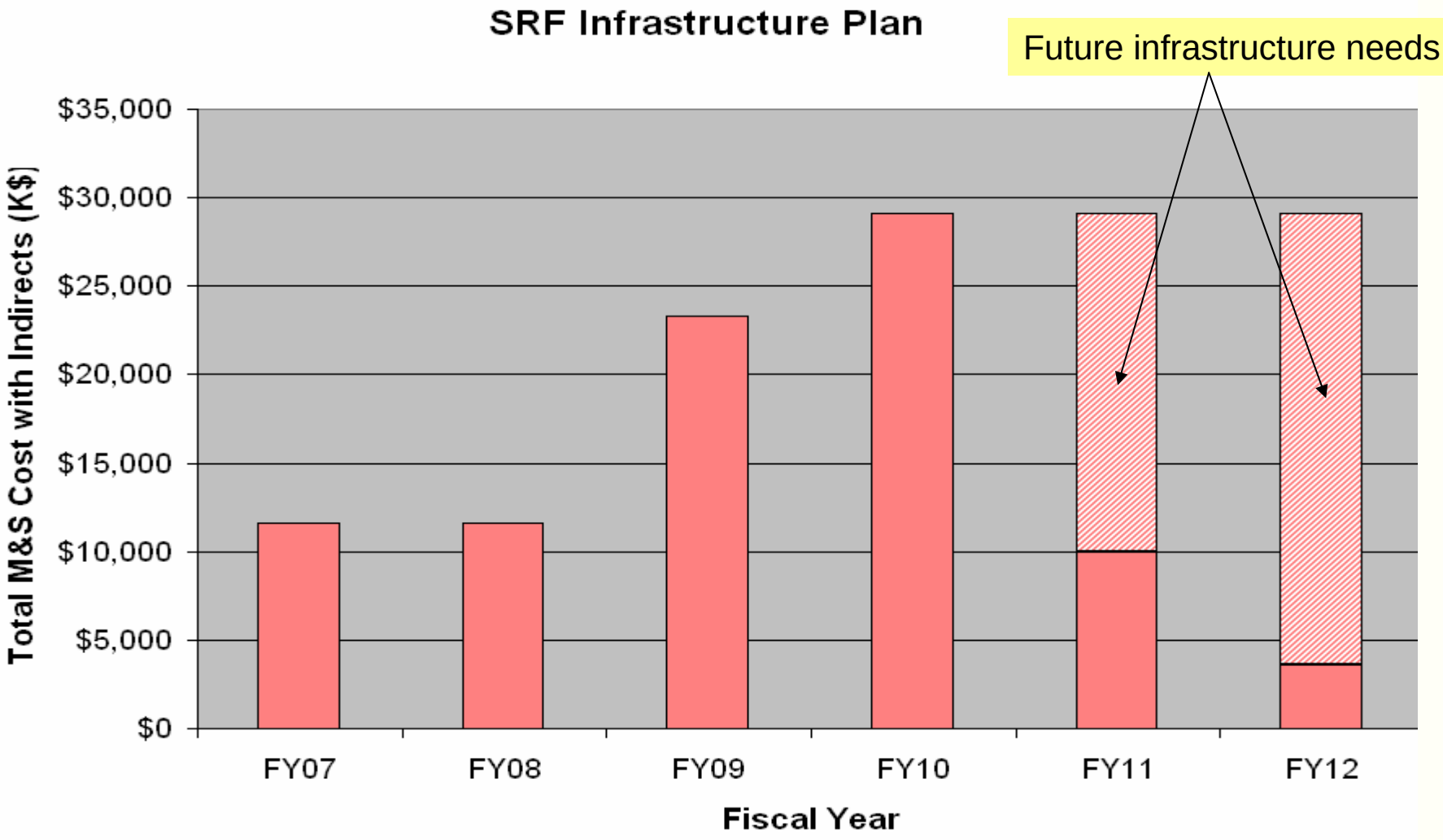
- **Basic SRF capability**
  - Finish VTS1, HTS1, CAF (CM ass'y) and NML(CM Test) @ FNAL
  - Dress & process cavities at collaborating institutions
  - Perform material R&D and testing
- **Capability to test cryomodules with beam**
  - Fabricate & install injector and beamline in NML
- **Increase processing, testing, & assembly throughput**
  - Procure & commission Cavity Processing Facility (CPF)
  - VTS 2 & 3 and HTS 2
  - CAF Upgrades
- **Full rf unit test capability (ILC rep rate)**
  - NML building extension
  - Procure & commission new cryogenic refrigerator in NML
- **Preproduction ILC cavity & cryomodule test infrastructure**
  - Single Cryomodule Test Stand (CTS)
  - IARC

Priorities are not absolute, must fund long lead time items

Funding Profile – Budget Reality



Total M&S Cost with Indirects = $89,300 + $44,670

Milestones for Funding Profile Schedule

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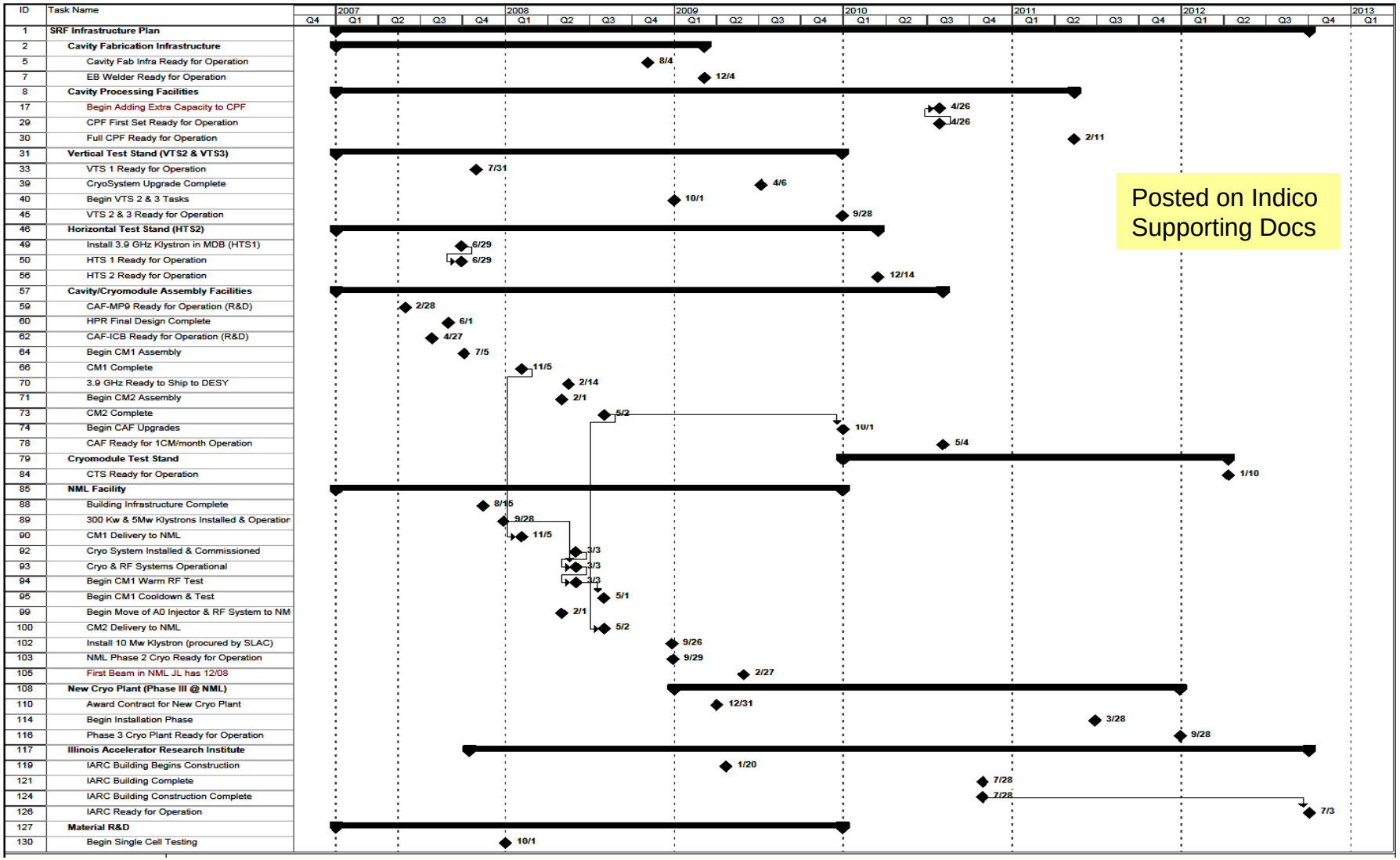

Posted on Indico Supporting Docs

Comparison of Milestones

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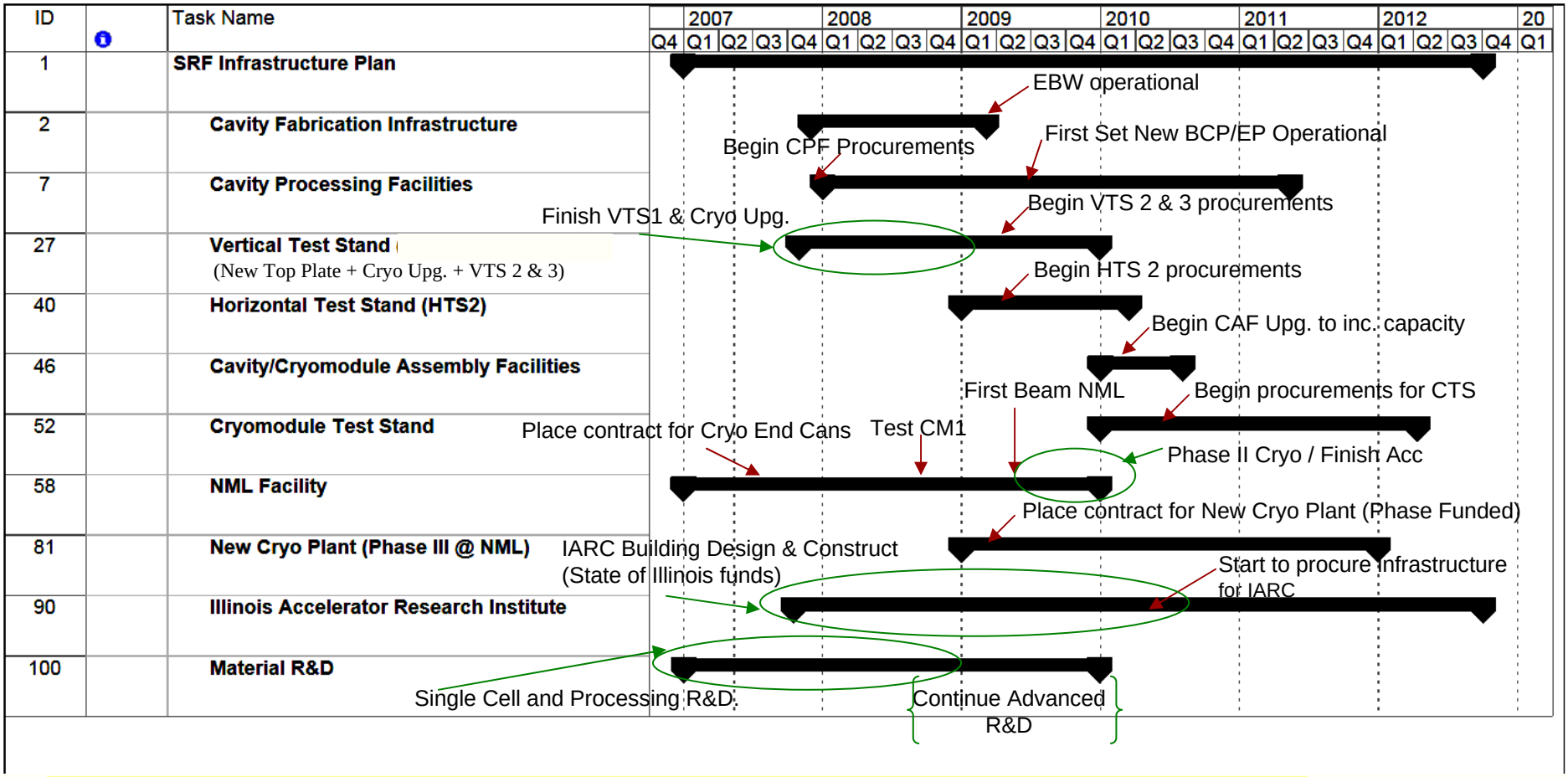
Milestone	Finish (Technically Limited)	Finish (Budget Reality)
EB Welder Ready for Operation	12/04/08	12/04/08
CPF First Set Ready for Operation	09/04/09	04/26/10
Full CPF Ready for Operation	09/20/10	02/11/11
VTS 1 Ready for Operation	07/31/07	07/31/07
IB1 Cryo System Upgrade Complete	04/06/09	04/06/09
VTS 2 & 3 Ready for Operation	07/07/09	09/28/09
HTS 1 Ready for Operation	06/29/07	06/29/07
HTS 2 Ready for Operation	08/19/09	12/14/09
CAF Ready for 1 CM/mo Operation	05/04/09	05/04/10
CTS Ready for Operation	12/09/09	01/10/12
First Beam in NML	12/15/08	02/27/09
New Cryo Plant Ready for Operation	04/12/10	09/28/11
IARC Ready for Operation	02/02/12	07/13/12

Readable Schedule



This schedule (which removes ongoing FY07 activities and some early design tasks) gives an idea of how priorities and budget profiles affect the timing of tasks

What Does This Funding Level Achieve

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- Continues to push the facilities that we need to execute a cavity & cryomodule program for an R&D level of activity
  - R&D on materials issues and cavity fabrication
  - VTS and HTS (single facilities completed in FY07 + the cryo upgrade)
  - CAF_MP9 => cavity dressing / string and cryomodule assembly
  - ILCTA_NML => rf unit test area (test cryomodules)
  - First set of “next generation” cavity processing equipment
- Slight delay in establishing beam through rf unit
- Delays facilities and capabilities to fabricate and test at higher production levels (increased throughput)
  - VTS 2 & 3 and HTS 2 (delayed several months)
  - New cryo plant (delayed 1.5 years) => affects beam test through rf unit
  - Additional cavity processing and cryomodule assembly fixtures to get to ~ 1CM/mo level (delayed a year)
  - Separate Cryomodule Test Stand (needed after one establishes beam)
  - IARC

Labor Plan

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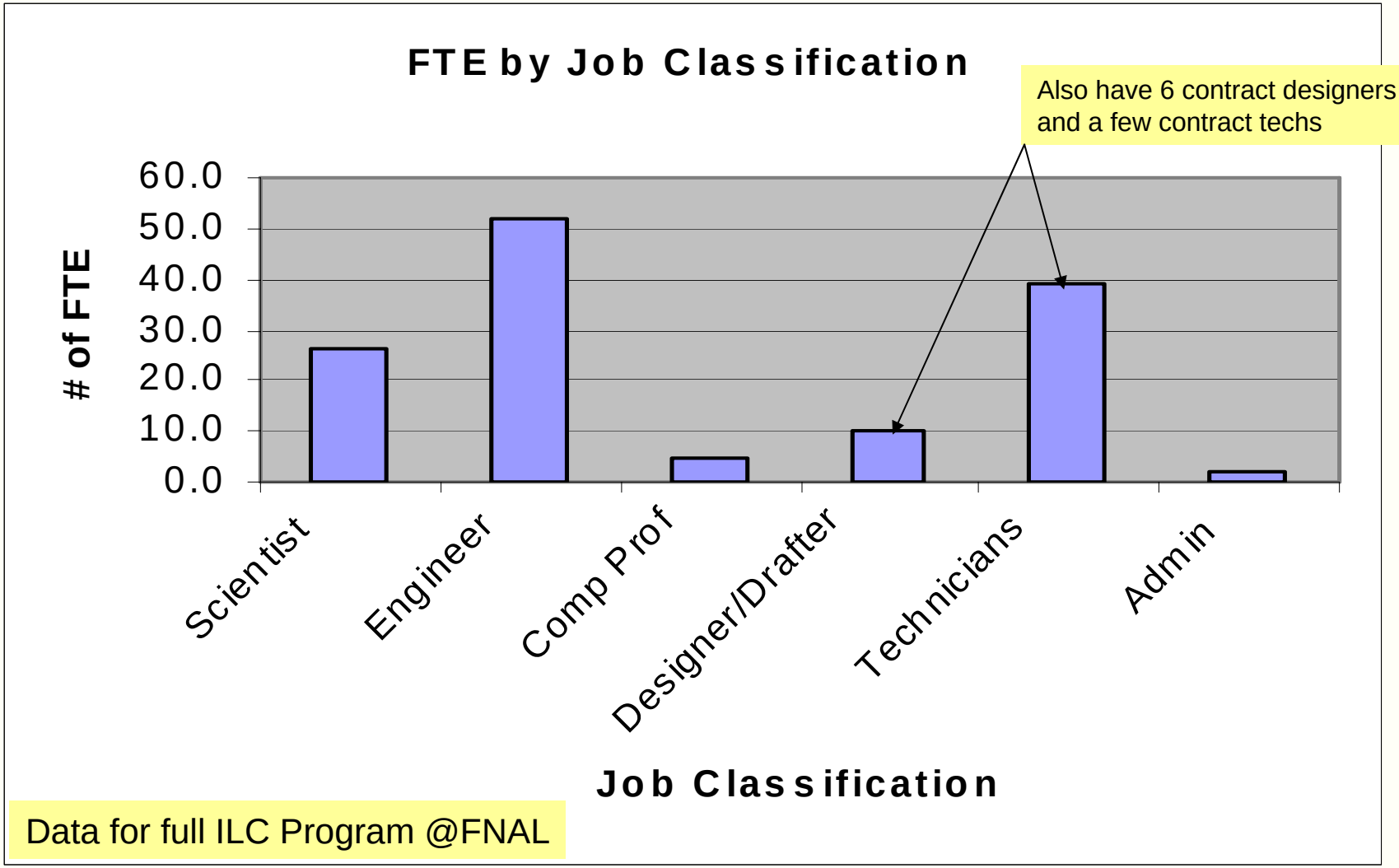
- Current Labor Force working on only the infrastructure part of the Program ~ 70 FTE/yr
- Plan calls for ~ 75 FTE/yr (on average/based on 4 yrs) with a peak of ~ 86 FTE/yr (during full funding)
- Must increase the work force (in certain disciplines) as well as redirect people to work on these tasks
  - Need to increase cryogenic and mechanical engineering
  - Need to train additional techs for clean room environment and to work with chemical processing equipment
- Utilize contract techs and designers as necessary
- Continue to integrate new people into the Program
- Monthly Labor Report allows Task Leaders to see who (by name) is working on their tasks and at what %

Example of the Labor Mix



Data for full ILC Program @FNAL

Labor Required for Plan

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Infrastructure	SWF	FTE per Yr
Cavity Fabrication Infrastructure	$ 675	2.5
Cavity Processing Facilities	$ 4,590	7.5
Vertical Test Stand (VTS 2 & 3)	$ 1,845	4.5
Horizontal Test Stand (HTS 2)	$ 1,057	2.6
Cavity/Cryomodule Assembly Facilties (CAF_MP9 & ICB)	$ 270	2
NML Facility (ILCTA_NML)	$ 23,220	57
Cryogenics for Test Facilities	$ 950	2.3
Cryomodule Test Stand	$ 2,970	11
Material R&D	$ 722	1.8
Illinois Accelerator Research Institute	$ 4,050	6
Adjustment for Tasks that do not overlap (use same people)		(11.00)
Grand Total	**$ 40,349**	**86.2**

In Jan 07 ~70 FTE worked on Infrastructure related tasks

Response to Charge Item #6

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- **Is the FNAL SCRF plan configured and prioritized in a such a way that it can be sensibly scaled back should all of the requested funds not be available? YES**
  - **Project Planning Tool => MS Project Schedule (high level)**
    - **=> Allows Program Office to adjust to various budget scenarios**
  - **Prioritized List of Tasks => based on needs/alternatives available**
    - **=> Differentiate between absolute need and adding capacity**
  - **Some large obligations do not occur for a few years**
    - **=> Allows for adjustments in schedule (budget fluctuations) or change of plans (based on R&D results)**
  - **Existing buildings and infrastructure are being reused**
    - **=> Provides flexibility in executing the plan (minimizes civil construction)**
  - **No large ramp up in workforce planned**
    - **=> Personnel can be redirected from other projects or Tevatron operations work when it winds down**

Summary

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- Technical Plan for SRF Infrastructure exists => based on "current collective wisdom" of the larger SRF community
  - Pushes the "state of the art"
  - Provides the necessary additional capacity to meet goals set out by projects such as ILC
  - Allows industrial participation in process design (and even operation) as well as technology transfer to industrial partners
  - Plan is flexible to allow for changes that come out of R&D efforts
- Strong collaborative working arrangements with our SRF colleagues (both nationally and internationally)
  - Formalized using the MOU process
- Organization that efficiently utilizes Lab resources
  - Task Leaders assigned to specific facility technical areas
  - Labor resources match the needs of the Infrastructure Plan
- Facilities reuse existing buildings & infrastructure

Summary (cont'd)

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- **With respect to Command & Control:**
  - **Established method to budget and track costs**
  - **High-level program schedule that can be used to plan the program and adjust to changing budgets**
  - **Task Leaders taking ownership for their systems**
  - **Program Management Office that controls the work flow by setting the scope and priority of the tasks**

Conclusion

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- SRF is one of the enabling technologies for future accelerator efforts
- These future efforts will require additional R&D as well as proven fabrication & testing expertise for cavities and cryomodules => Infrastructure
- Fermilab is well positioned to build up an SRF Infrastructure capable of sustaining the U.S. efforts on programs such as ILC (up until project start), HINS or ERL