



U.S. DEPARTMENT OF
ENERGY

Office of
Science

Consolidated FY17 Budget Request: Alignment, Accel Physics, Instrumentation, Linac PM, LLRF, Mech Support Systems, Power Supplies, Vacuum

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PIP-II Budget Retreat

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PIP-II Accelerator Physics - FY17 Initial Goals

- Support Conceptual Design Report (CDR) and Resource Loaded Schedule (RLS)
 - Provide any required elucidation of the goal here
- Support LEBT, RFQ, and MEBT beam analysis
 - Provide any required elucidation of the goal here
- Support resonance control studies
 - Provide any required elucidation of the goal here

PIP-II Accelerator Physics – Resources Required to Meet Initial Goals

Comparison of Initial Target vs Request for: Accel. Physics

<i>Category</i>	<i>FTE</i>	<i>(\$000)</i>		
		<i>SWF Cost</i>	<i>M&S Cost</i>	<i>Tot. Directs</i>
Original Target	4.20	\$ 582.1	\$ 40.0	\$ 622.1
Current Request	4.80	\$ 737.9	\$ 14.0	\$ 751.9
(Over)/Under Target	(0.60)	\$ (155.7)	\$ 26.0	\$ (129.7)

Note: Preliminary allocated cost per FTE is an average of \$138.6K/FTE

- Describe FTE resource needs to reach goals
 - Resonance Control 2.1 FTE
 - CDR/RLS: 1 FTE
 - Beam Analysis/Simulation: 1.7 FTE
- Describe M&S resource needs to reach goals
 - Software licenses
 - Instrumentation support for Resonance control

PIP-II Accelerator Physics – FTE – By Job Category and Role

FTE and SWF Cost - Job Category - Job Role			
For Work Effort - Accel. Physics			
Category	Role	Tot. FTE	SWF Before OH
Electrical Engineer	Control System Engineer	0.20	\$ 37,797
	Electrical Design Engineer	0.10	\$ 13,774
Scientist	Accelerator Physicist Experimental	0.10	\$ 18,898
	Accelerator Physicist Theory	2.30	\$ 365,232
	Particle Physicist Experimental	0.30	\$ 36,676
	RF Scientist	0.80	\$ 97,849
Postdoctoral Res Asso	Accelerator Experimental Research Associate	0.20	\$ 16,656
Other Technical	Engineering Physicist	0.80	\$ 150,973
Grand Total		4.80	\$ 737,854

- Support for the 3 jobs
 - CDR/RLS
 - LEBT/MEBT Analysis
 - Resonance Control

PIP-II Accelerator Physics – Achievable Goals at Initial Target

<u>Category</u>	<u>FTE</u>	<u>Accel. Physics</u>		
		<u>(\$000)</u>		
		<u>SWF Cost</u>	<u>M&S Cost</u>	<u>Tot. Directs</u>
Original Target	4.20	\$ 582.1	\$ 40.0	\$ 622.1

- 15% oversubscribed:
 - Lose some support for Resonance Control
 - Lose some support for Beam Analysis
 - Lose some support for CDR/RLS

PIP-II Alignment/Installation - FY17 Initial Goals

- Support Conceptual Design Report (CDR) and Resource Loaded Schedule (RLS) for alignment and installation program
 - Support CDR and RLS development as required
- Support PXIE installation and commissioning activities
 - Support installation and commissioning of MEBT-2
 - Support installation and commissioning of MEBT-3
 - Alignment support PXIE infrastructure
- Support SSR-1 assembly activities
 - Alignment of the cavity string to cold mass

PIP-II Alignment/Installation – Resources Required to Meet Initial Goals

Comparison of Initial Target vs Request for: Installation

<u>Category</u>	<u>FTE</u>	<u>(\$000)</u>		
		<u>SWF Cost</u>	<u>M&S Cost</u>	<u>Tot. Directs</u>
Original Target	0.40	\$ 55.4	\$ -	\$ 55.4
Current Request	1.53	\$ 223.5	\$ 7.4	\$ 230.9
(Over)/Under Target	(1.13)	\$ (168.0)	\$ (7.4)	\$ (175.5)

Note: Preliminary allocated cost per FTE is an average of \$138.6K/FTE

- Labor in this task includes:
 - engineering and technician work associated with PXIE installation and commissioning activities and with SSR-1 assembly activities
 - engineering work to support CDR and RLS development
- M&S includes:
 - Fiducials for PXIE components referencing and alignment
 - Fiducials for SSR1 cavities alignment
 - Infrastructure related costs to support PXIE installation and commissioning activities (epoxy, cleaning solution, tools, vacuum equipment, etc.)

PIP-II Alignment/Installation – FTE – By Job Category and Role

FTE and SWF Cost - Job Category - Job Role				
For Work Effort - Installation				
Category	Role	Tot. FTE	SWF Before OH	
Alignment	Geodesist	0.67	\$	126,416
	Metrologist	0.86	\$	97,070
Grand Total		1.53	\$	223,486

- Geodesist - design and implement geodesy/surveying and industrial alignment procedures to support PXIE installation and commissioning, SSR-1 assembly, and CDR and RLS development activities
- Metrologist - technician support to implement the PXIE and SSR-1 activities

PIP-II Alignment/Installation – Achievable Goals at Initial Target

<i>Category</i>	Installation			
	<i>FTE</i>	<i>(\$000)</i>		
		<i>SWF Cost</i>	<i>M&S Cost</i>	<i>Tot. Directs</i>
Original Target	0.40	\$ 55.4	\$ -	\$ 55.4

Milestones	FTE Geodesist	FTE Metrologist	FTE Total	\$ Geodesist	\$ Metrologist	\$ Total	\$ M&S
Support installation and commissioning of MEBT-2	0.13	0.23	0.36	24536	25975	50511	2160
Support installation and commissioning of MEBT-3 + diagnostics	0.16	0.30	0.46	30191	33825	64016	1647 + 1120
Alignment support PXIE infrastructure	0.20	0.20	0.40	37765	22592	60357	1050
Support SSR1 assembly activities	0.03	0.13	0.16	5654	14679	20333	1440
Support CDR and RLS development for PIP-II	0.15	0.00	0.15	28270	0	28270	0

- With initial target funding can be achieved:
 - Goal 1: support PXIE MEBT-2 (contingent to some M&S funding for fiducials), **or**
 - Goal 2: support PXIE MEBT-3 without diagnostics (contingent to some M&S funding for fiducials), **or**
 - Goal 3: 2/3 support PXIE infrastructure (contingent to some M&S funding), **or**
 - Goal 4: support SSR-1 assembly (contingent to some M&S funding for fiducials) **and**
 - Goal 5: support CDR and RLS development

PIP-II Instrumentation - FY17 Initial Goals

- Support Conceptual Design Report (CDR) and Resource Loaded Schedule (RLS) for Instrumentation program
- Continue development of laser based measurement system
 - Minimal support for design
- Prepare for HWR, SSR-1, and HEBT instrumentation
 - Put no requests for this goal at this time
- Support PXIE and MEBT beam commissioning
 - Request covers the instrumentation for the full MEBT (except laser wire)
 - DCCT
 - RWCM (extinction monitor)
 - Laser Wire Test Station
 - 7 BPMs, including bunch by bunch capabilities (with a scope)
 - 4 Wire Scanners
 - Readbacks for 8 scraper plates, diff pumping insert, kicker protection electrodes, ring pickup

PIP-II Instrumentation – Resources Required to Meet Initial Goals

Comparison of Initial Target vs Request for:

Instrumentation

<u>Category</u>	<u>FTE</u>	<u>(\$000)</u>		
		<u>SWF Cost</u>	<u>M&S Cost</u>	<u>Tot. Directs</u>
Original Target	1.50	\$ 207.9	\$ 50.0	\$ 257.9
Current Request	<u>2.85</u>	<u>\$ 373.9</u>	<u>\$ 217.0</u>	<u>\$ 590.9</u>
(Over)/Under Target	(1.35)	\$ (166.0)	\$ (167.0)	\$ (333.0)

Note: Preliminary allocated cost per FTE is an average of \$138.6K/FTE

- Describe FTE resource needs to reach goals
 - Build, install, commission the diagnostics on the previous page
 - Software (especially the FPGA programming) support
- Describe M&S resource needs to reach goals
 - Buy the hardware for the diagnostics listed on the previous page

PIP-II Instrumentation – FTE – By Job Category and Role

FTE and SWF Cost - Job Category - Job Role			
For Work Effort - Instrumentation			
Category	Role	Tot. FTE	SWF Before OH
Mechanical Engineer	Mechanical Design Engineer	0.50	\$ 69,562
Scientist	Accelerator Physicist Experimental	0.40	\$ 55,555
Electrical Technician	Electronics Technician	0.45	\$ 50,801
Electrical Engineer	Electronics Design Engineer	0.60	\$ 85,882
Information Technolo	Applications Development & Systems Analyst	0.40	\$ 55,634
Design	Mechanical Drafter	0.50	\$ 56,417
Grand Total		2.85	\$ 373,851

- Scientist: Vic & Jinhao
- ME & Drafter: Matt & Brian, Eric
- Electrical Tech: Bogey & Andrea for installation (cables, etc)
- EE: Niral, Peter, Brian F, Ning for design & firmware
- IT: Roger T & John D for firmware and programming

PIP-II Instrumentation – Achievable Goals at Initial Target

<u>Category</u>	<u>Instrumentation</u>			
	<u>FTE</u>	<u>(\$000)</u>		
		<u>SWF Cost</u>	<u>M&S Cost</u>	<u>Tot. Directs</u>
Original Target	1.50	\$ 207.9	\$ 50.0	\$ 257.9

- With M&S: support
 - BPMs
 - But not bunch by bunch unless could scrounge up scopes
 - Current readback devices but probably not all of them
 - Scrapers
 - Kicker electrodes
 - Differential pumping
 - Ring pickup
- Labor for installation – probably for a limited set
- labor for software/firmware – some of it, not necessarily CW operation everywhere
- Other devices would wait

PIP-II Linac Project Management - FY17 Initial Goals

- Support all high level goals of the PIP-II project
 - Provide any required elucidation of the goal here

PIP-II Linac Project Management – Resources Required to Meet Initial Goals

Comparison of Initial Target vs Request for: Linac Proj. Mgmt.

<u>Category</u>	<u>FTE</u>	<u>(\$000)</u>		
		<u>SWF Cost</u>	<u>M&S Cost</u>	<u>Tot. Directs</u>
Original Target	0.40	\$ 55.4	\$ -	\$ 55.4
Current Request	0.85	\$ 134.8	\$ -	\$ 134.8
(Over)/Under Target	(0.45)	\$ (79.3)	\$ -	\$ (79.3)

Note: Preliminary allocated cost per FTE is an average of \$138.6K/FTE

- Describe FTE resource needs to reach goals
 - Fernanda & Allan: general oversight
 - Is Allan's time accounted for somewhere else?
 - Daniel Bowring: for resonance control
 - Is time accounted for in Accel Physics?

PIP-II Linac Project Management – FTE – By Job Category and Role

FTE and SWF Cost - Job Category - Job Role				
For Work Effort - Linac Proj. Mgmt.				
Category	Role	Tot. FTE	SWF Before OH	
<input type="checkbox"/> Mechanical Engineer	Mechanical Design Engineer	0.40	\$	75,486
<input type="checkbox"/> Scientist	Accelerator Physicist Experimental	0.25	\$	34,781
	Particle Physicist Experimental	0.20	\$	24,497
Grand Total		0.85	\$	134,764

- Allan, Fernanda, Daniel

PIP-II Linac Project Management – Achievable Goals at Initial Target

Linac Proj. Mgmt.				
<u>Category</u>	<u>FTE</u>	<u>(\$000)</u>		
		<u>SWF Cost</u>	<u>M&S Cost</u>	<u>Tot. Directs</u>
Original Target	0.40	\$ 55.4	\$ -	\$ 55.4

- How much and where do we put oversight for Linac tasks

PIP-II LLRF - FY17 Initial Goals

- Assist India with IIFC deliverable
 - lead design efforts and have daily interactions
- Develop strategy for LLRF and timing control for PIP-II
 - Ongoing efforts to define timing and intercommunications between high performance electronic platforms
- Support Conceptual Design Report (CDR) and Resource Loaded Schedule (RLS) for LLRF program
 - Provide any required elucidation of the goal here
- Support PXIE commissioning
 - Buncher 3 and 4 LLRF systems, MEBT Chopper waveform generation, resonance control
- Support resonance control experiments
 - Studies on 325 MHz SSR cavities and migration of algorithms to LLRF

PIP-II LLRF – Resources Required to Meet Initial Goals

Comparison of Initial Target vs Request for:

<u>Category</u>	<u>FTE</u>	<u>LLRF</u>		
		<u>(\$000)</u>		
		<u>SWF Cost</u>	<u>M&S Cost</u>	<u>Tot. Directs</u>
Original Target	2.25	\$ 311.9	\$ 10.0	\$ 321.9
Current Request	3.25	\$ 396.6	\$ 23.7	\$ 420.3
(Over)/Under Target	(1.00)	\$ (84.7)	\$ (13.7)	\$ (98.4)

Note: Preliminary allocated cost per FTE is an average of \$138.6K/FTE

- Describe FTE resource needs to reach goals
 - 2 FTEs are IIFC colleagues and .2 FTE to manage collaboration effort. The remaining FTE is for support for PXIE and other goals. There is a large effort required to get the remaining buncher cavity systems constructed. The project has been getting J. Edelen for free but will have to pay in this year.
 - This will be the perfect time to work on the chopper systems and to develop resonance control for SRF
- Describe M&S resource needs to reach goals
 - Hardware and software tools needed for development of systems

PIP-II LLRF – FTE – By Job Category and Role

FTE and SWF Cost - Job Category - Job Role			
For Work Effort - LLRF			
Category	Role	Tot. FTE	SWF Before OH
Electrical Engineer	Electrical Design Engineer	0.10	\$ 13,774
	Electronics Design Engineer	0.15	\$ 20,662
	RF Design Engineer	0.80	\$ 134,037
Guest Engineer	Electrical Engineer Guest	1.00	\$ 122,346
	Mechanical Engineer Guest	1.00	\$ 83,184
Electrical Technician	Electronics Technician	0.20	\$ 22,592
Grand Total		3.25	\$ 396,596

- Electrical/Electronics/RF Engineer
 - All aspects of LLRF work. Beam, RF, Control, Firmware, System simulations.
 - Hardware, firmware, software design and implementation (including guests)
- Electronics technician
 - Printed circuit board layout, contracts, purchases, construction and test

PIP-II LLRF – Achievable Goals at Initial Target

<u>Category</u>	<u>LLRF</u>			
	<u>FTE</u>	<u>(\$000)</u>		
		<u>SWF Cost</u>	<u>M&S Cost</u>	<u>Tot. Directs</u>
Original Target	2.25	\$ 311.9	\$ 10.0	\$ 321.9

- Goal one that can be achieved with initial target funding
 - Fermilab staff does management only: 0.2 FTE
 - 2 FTEs are our Indian Colleagues
 - IIFC Development – hardware, firmware, software, design effort
 - Work with PXIE and continue to learn
 - Minimal (or none) progress on PXIE commissioning, Resonance Control

PIP-II Mechanical Support Systems - FY17 Initial Goals

- Support Conceptual Design Report (CDR) and Resource Loaded Schedule (RLS) for Mechanical Support Systems
 - CDR and RLS support as dictated by project timeline
 - Ongoing concept development work in collaboration with ongoing conventional facilities design

PIP-II Mechanical Support Systems – Resources Required to Meet Initial Goals

Comparison of Initial Target vs Request for:

Mech. Suprt. Sys.

<u>Category</u>	<u>FTE</u>	<u>(\$000)</u>		
		<u>SWF Cost</u>	<u>M&S Cost</u>	<u>Tot. Directs</u>
Original Target	0.20	\$ 27.7	\$ -	\$ 27.7
Current Request	0.20	\$ 33.2	\$ 6.0	\$ 39.2
(Over)/Under Target	-	\$ (5.5)	\$ (6.0)	\$ (11.5)

Note: Preliminary allocated cost per FTE is an average of \$138.6K/FTE

- Describe FTE resource needs to reach goals
 - Low-level engineering support adequate for FY17
- M&S resource needs to reach goals
 - Strictly speaking, none is required to meet goals (contractor fluids engineering not expected to be used)
 - Would like to request \$6K M&S to support educational travel to SNS (if not supported in FY16)

PIP-II Mechanical Support Systems – FTE – By Job Category and Role

FTE and SWF Cost - Job Category - Job Role				
For Work Effort - Mech. Suprt. Sys.				
Category	Role	Tot. FTE	SWF Before OH	
<input checked="" type="checkbox"/> Mechanical Engineer	Mechanical Design Engineer	0.10	\$	16,588
	Process/Controls Engineer	0.10	\$	16,588
Grand Total		0.20	\$	33,177

- Curtis and Maurice in support of CDR/RLS and interfacing with Civil Construction

PIP-II Mechanical Support Systems – Achievable Goals at Initial Target

<u>Category</u>	<u>Mech. Suprt. Sys.</u>			
	<u>FTE</u>	<u>(\$000)</u>		
		<u>SWF Cost</u>	<u>M&S Cost</u>	<u>Tot. Directs</u>
Original Target	0.20	\$ 27.7	\$ -	\$ 27.7

- CDR support
- RLS support
- Development of LCW concepts for PIP-II in coordination with conventional facilities design

PIP-II Power Supplies - FY17 Initial Goals

- Initiate procurement of HWR solenoid power supplies
 - The HWR and SSR1 magnet power supplies are of a design similar to the Booster Corrector power supplies. Procurement lead times for all the components is of the order of 6 months. Some design work may be required as requirements are modified
- Support Conceptual Design Report (CDR) and Resource Loaded Schedule (RLS) for Power Supply/Magnet program
 - Some design engineering design work may be required as the requirements for the power supplies are modified
 - recent change to understanding of quench protection requirements
 - impacts on engineering time and M&S cost still being fleshed out

PIP-II Power Supplies – Resources Required to Meet Initial Goals

Comparison of Initial Target vs Request for:

Power Supplies

<u>Category</u>	<u>FTE</u>	<u>(\$000)</u>		
		<u>SWF Cost</u>	<u>M&S Cost</u>	<u>Tot. Directs</u>
Original Target	0.10	\$ 13.9	\$ -	\$ 13.9
Current Request	2.10	\$ 242.6	\$ 232.5	\$ 475.2
(Over)/Under Target	(2.00)	\$ (228.8)	\$ (232.5)	\$ (461.3)

Note: Preliminary allocated cost per FTE is an average of \$138.6K/FTE

- Describe FTE resource needs to reach goals
 - The original FTE request included manpower to order the parts needed to build the required bulk supply, switching modules and controls. Once parts arrive, technician support is needed to assemble the units
 - Recent study has revealed two flaws; one is that we need to increase the current capabilities and two we desire a different quench protection method. These will require extra engineering time
- Describe M&S resource needs to reach goals
 - M&S consists entirely of purchasing parts
 - We may require additional M&S for “new” quench protection system

PIP-II Power Supplies – FTE – By Job Category and Role

FTE and SWF Cost - Job Category - Job Role			
For Work Effort - Power Supplies			
Category	Role	Tot. FTE	SWF Before OH
Operations	Accelerator Systems Specialist	0.10	\$ 18,898
Electrical Engineer	Electronics Design Engineer	0.30	\$ 54,385
Electrical Technician	Electrical Assembly Technician	0.20	\$ 16,691
	Electronics Technician	1.30	\$ 117,186
Information Technolo	Applications Development & Systems Analyst	0.20	\$ 35,487
Grand Total		2.10	\$ 242,647

- Manage the process to insure it is moving along and to deal with design changes and requirements
- To verify proper components are ordered, supervise component testing and to adjust the electrical design to insure specs are met.
- Order and build the bulk supply and associated modules
- Order controls hardware, build PS controller modules and provide necessary software

PIP-II Power Supplies – Achievable Goals at Initial Target

Power Supplies				
<u>Category</u>	<u>FTE</u>	<u>(\$000)</u>		
		<u>SWF Cost</u>	<u>M&S Cost</u>	<u>Tot. Directs</u>
Original Target	0.10	\$ 13.9	\$ -	\$ 13.9

- Create POs so as to be ready to purchase components
- Design work for PS modules
- Design changes for quench protection

- Order needs to be placed so available with HWR installation
 - 6 month lead time
 - Need to define when necessary

PIP-II Vacuum - FY17 Initial Goals

- Interface with booster injection development
 - Provide any required elucidation of the goal here
- Support Conceptual Design Report (CDR) and Resource Loaded Schedule (RLS) for Vacuum program
 - Provide any required elucidation of the goal here
- Should have included: support for MEBT vacuum hardware

PIP-II Vacuum – Resources Required to Meet Initial Goals

Comparison of Initial Target vs Request for:

<u>Category</u>	<u>FTE</u>	<u>Vacuum</u>		
		<u>(\$000)</u>		
		<u>SWF Cost</u>	<u>M&S Cost</u>	<u>Tot. Directs</u>
Original Target	0.10	\$ 13.9	\$ -	\$ 13.9
Current Request	0.70	\$ 110.6	\$ 244.8	\$ 355.4
(Over)/Under Target	(0.60)	\$ (96.8)	\$ (244.8)	\$ (341.6)

Note: Preliminary allocated cost per FTE is an average of \$138.6K/FTE

- Describe FTE resource needs to reach goals
 - Engineering support for MEBT installation and conceptual design for PIP-II
- Describe M&S resource needs to reach goals
 - PXIE (MEBT) vacuum system: hardware for the full length MEBT

PIP-II Vacuum – FTE – By Job Category and Role

FTE and SWF Cost - Job Category - Job Role			
For Work Effort - Vacuum			
Category	Role	Tot. FTE	SWF Before OH
Mechanical Engineer	Mechanical Design Engineer	0.60	\$ 99,437
Design	Mechanical Designer	0.10	\$ 11,211
Grand Total		0.70	\$ 110,648

- Engineer: half PXIE, half CDR
- Designer: similar

PIP-II Vacuum – Achievable Goals at Initial Target

<u>Category</u>	<u>Vacuum</u>			
	<u>FTE</u>	<u>(\$000)</u>		
		<u>SWF Cost</u>	<u>M&S Cost</u>	<u>Tot. Directs</u>
Original Target	0.10	\$ 13.9	\$ -	\$ 13.9

- Support CDR.
- No hardware or design for extending the MEBT

Total Requests

	Target	Request	Over/Under	Target	Request	Over/Under
Alignment	0.40	1.53	-1.13	-	\$7.4	\$(7.4)
Accelerator Physics	4.20	4.80	-0.60	\$40.0	\$14.0	\$26.0
Instrumentation	1.50	2.85	-1.35	\$50.0	\$217.0	\$(167.0)
LLRF	2.25	3.25	-1.00	\$10.0	\$23.7	\$(13.7)
Mech Support	0.20	0.20	0.00	-	\$6.0	\$(6.0)
Power Supplies	0.10	2.10	-2.00	-	\$232.5	\$(232.5)
Vacuum	0.10	0.70	-0.60	-	\$244.8	\$(244.8)
Linac PM	0.40	0.85	-0.45	-	-	-
Total	9.15	16.28	(7.13)	100.00	745.42	\$(645.42)