Hall Infrastructure and Integration (EC Report)

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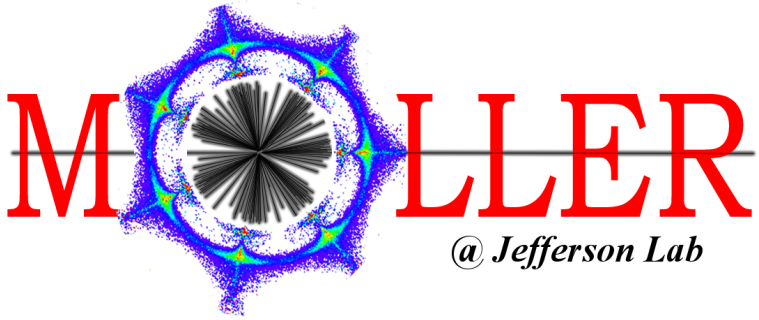

Hall Infrastructure and Integration

Outline

- Review P6 Baseline budget and present in context of experiment requirements with eye toward cost savings
- WBS has 6 subsystems:
  - **Management**
  - **Cryogenic Transfer Lines** for high power targets
  - **2MVA (Power upgrade)** for toroids
  - **Incoming Beamline Mods** to fit apparatus
  - **Particle Shielding** to lower radiation load in hall
  - **Integration**:
    - Cables, Detector Supports, and Hall Mods

Hall I & I P6 Summary (as of March 7, 2019)

WBS Path	Activity ID	Activity Name	Start	Finish	Planned Duration	Planned Labor Units	Planned Labor Cost	Planned Nonlabor Cost	Planned Material Cost	Planned Total Cost
MOLLER-1 MOLLER Schedule Dev-1			01-Mar-19	30-Sep-25	327.40	1158.05	$4,440,048	$0	$6,548,188	$10,988,237
MOLLER-1.1.06 Hall A Infrastucture and Integration			01-Mar-19	30-Sep-25	327.40	1158.05	$4,440,048	$0	$6,548,188	$10,988,237

- Planned durations are calendar-weeks and labor units are man-weeks (40 hr periods)
- Labor rates have been updated to reflect accurate planned costs (since Dec 2016 Director's Review costs used outdated rates)…
- Total Planned Cost is currently $11M for this subsystem: $6M for infrastructure and $5M for integration
- Total Cost includes 1158 weeks labor ($4.44M) plus $6.55M in materials
- Contingency rates for various activities not fully determined (or included) yet
- Several areas of potential cost reductions have already been identified

Hall I & I P6 Management

WBS Path	Activity ID	Activity Name	Start	Finish	Planned Duration	Planned Labor Units	Planned Labor Cost	Planned Nonlabor Cost	Planned Material Cost	Planned Total Cost
MOLLER-1.1.06.01		Infrastructure and Integration Management	01-Mar-19	30-Sep-25	327.40	72.50	$377,294	$0	$0	$377,294
1.06.01	10601000	Infrastructure and Integration Management (FY19)	01-Mar-19	30-Sep-19	29.80	6.50	$31,177	$0	$0	$31,177
1.06.01	10601005	Infrastructure and Integration Management (FY20)	01-Oct-19	30-Sep-20	49.60	11.00	$54,344	$0	$0	$54,344
1.06.01	10601010	Infrastructure and Integration Management (FY21)	01-Oct-20	30-Sep-21	49.60	11.00	$55,972	$0	$0	$55,972
1.06.01	10601015	Infrastructure and Integration Management (FY22)	01-Oct-21	30-Sep-22	49.80	11.00	$57,653	$0	$0	$57,653
1.06.01	10601020	Infrastructure and Integration Management (FY23)	03-Oct-22	29-Sep-23	49.40	11.00	$59,382	$0	$0	$59,382
1.06.01	10601025	Infrastructure and Integration Management (FY24)	02-Oct-23	30-Sep-24	49.80	11.00	$59,382	$0	$0	$59,382
1.06.01	10601030	Infrastructure and Integration Management (FY25)	01-Oct-24	30-Sep-25	49.40	11.00	$59,382	$0	$0	$59,382

- Total Planned Management Cost is $377k
- Broken down over the ~6.5 year project period
- Duration covers entire project period of 327 calendar weeks with 72 man-weeks of planned labor related to management

Infrastructure: 5kW Cryogenic Transfer Lines

WBS Path	Activity ID	Activity Name	Start	Finish	Planned Duration	Planned Labor Units	Planned Labor Cost	Planned Nonlabor Cost	Planned Material Cost	Planned Total Cost
MOLLER-1.1.06.02 5 kW Cryogenic Transfer Lines			02-Oct-20	01-Dec-23	157.20	320.65	$1,305,189	$0	$358,290	$1,663,480
1.06.02	10602000	Design Transfer Line and End Boxes	02-Oct-20	27-May-21	32.00	114.10	$525,496	$0	$0	$525,496
1.06.02	10602005	Procure Transfer Lines and End Boxes Materials	04-Jan-22	18-Aug-22	32.00	0.00	$0	$0	$358,290	$358,290
1.06.02	10602010	Fabrication of Transfer Lines and End Boxes	19-Aug-22	14-Apr-23	32.00	153.90	$604,014	$0	$0	$604,014
1.06.02	10602015	Installation of Transfer Lines and End Boxes	17-Apr-23	01-Dec-23	32.00	52.65	$175,680	$0	$0	$175,680
1.06.02	1060603040	5 Kw Transfer Line Complete		01-Dec-23	0.00	0.00	$0	$0	$0	$0

- Budget includes full cost needed for all new cryo lines from new ESR2 to Hall as well as new lines inside Hall.
- Present planned duration is 157 weeks with 321 weeks labor: $1.3M
- Total Planned Cost is $1.66M including $358k in materials

➢ Cryogenics group recently determined that ESR lines to Hall can be reused for ESR2 -- representing significant (1/2 to 1/3) cost reduction for this budget

Infrastructure: 2MVA and Incoming Beamline Mods

WBS Path	Activity ID	Activity Name	Start	Finish	Planned Duration	Planned Labor Units	Planned Labor Cost	Planned Nonlabor Cost	Planned Material Cost	Planned Total Cost
MOLLER-1.1.06.03 2 MVA to Hall A			04-Jan-22	16-Sep-22	36.00	0.00	$0	$0	$0	$0
1.06.03	10603000	Vendor to Install 2 MVA for Hall A (Dependency)	04-Jan-22	16-Sep-22	36.00	0.00	$0	$0	$0	$0
MOLLER-1.1.06.04 Incoming Beam Line Modifications			02-Oct-20	25-Jun-21	36.00	274.70	$993,903	$0	$349,181	$1,343,085
1.06.04	10604000	Design Incoming Beamline Modifications	02-Oct-20	01-Apr-21	24.00	95.00	$404,880	$0	$0	$404,880
1.06.04	10604005	Procure Incoming Beamline Modifications Materials (LOOK FOR requisition D.	02-Apr-21	29-Apr-21	4.00	0.00	$0	$0	$349,181	$349,181
1.06.04	10604010	Survey and Alignment (To Establish Hall NET)	02-Apr-21	02-Jun-21	8.60	10.10	$38,452	$0	$0	$38,452
1.06.04	10604015	Installation of Components and Vacuum	03-Jun-21	25-Jun-21	3.40	21.70	$69,415	$0	$0	$69,415
1.06.04	10604020	Prepare for I&C Deisnstallation	02-Oct-20	06-Jan-21	12.00	0.00	$0	$0	$0	$0
1.06.04	10604025	Relocate I&C	07-Jan-21	25-Jun-21	24.00	131.00	$425,822	$0	$0	$425,822
1.06.04	10604030	Relocate Machine Protection	28-May-21	25-Jun-21	4.00	13.90	$46,409	$0	$0	$46,409
1.06.04	10604035	Relocate DC Power	28-May-21	25-Jun-21	4.00	3.00	$8,924	$0	$0	$8,924

- Cost of 2MVA for Hall A (dependency) is absorbed by Physics Division
- Total cost of Incoming Beamline Mods is $1.34M: dominated by 275 weeks of labor costs—half from design time and half from ”brute force” moving of beam line components upstream; with $349k of materials (mostly I &C and MEG)
- Does not include new Raster system (this is also a dependency)
- Includes $50k for new BPMs (striplines and readout electronics)
- Not clear where potential cost reductions could lie here

Infrastructure: Incoming Beamline Mod Activities

*Required in order to make room for the target, spec, and detectors

WBS Path	Activity ID	Activity Name	Start	Finish	Planned Duration	Planned Labor Units	Planned Labor Cost	Planned Nonlabor Cost	Planned Material Cost	Planned Total Cost
MOLLER-1.1.06.03 2 MVA to Hall A			04-Jan-22	16-Sep-22	36.00	0.00	$0	$0	$0	$0
1.06.03	10603000	Vendor to Install 2 MVA for Hall A (Dependency)	04-Jan-22	16-Sep-22	36.00	0.00	$0	$0	$0	$0
MOLLER-1.1.06.04 Incoming Beam Line Modifications			02-Oct-20	25-Jun-21	36.00	274.70	$993,903	$0	$349,181	$1,343,085
1.06.04	10604000	Design Incoming Beamline Modifications	02-Oct-20	01-Apr-21	24.00	95.00	$404,880	$0	$0	$404,880
1.06.04	10604005	Procure Incoming Beamline Modifications Materials (LOOK FOR requisition D.	02-Apr-21	29-Apr-21	4.00	0.00	$0	$0	$349,181	$349,181
1.06.04	10604010	Survey and Alignment (To Establish Hall NET)	02-Apr-21	02-Jun-21	8.60	10.10	$38,452	$0	$0	$38,452
1.06.04	10604015	Installation of Components and Vacuum	03-Jun-21	25-Jun-21	3.40	21.70	$69,415	$0	$0	$69,415
1.06.04	10604020	Prepare for I&C Deisnstallation	02-Oct-20	06-Jan-21	12.00	0.00	$0	$0	$0	$0
1.06.04	10604025	Relocate I&C	07-Jan-21	25-Jun-21	24.00	131.00	$425,822	$0	$0	$425,822
1.06.04	10604030	Relocate Machine Protection	28-May-21	25-Jun-21	4.00	13.90	$46,409	$0	$0	$46,409
1.06.04	10604035	Relocate DC Power	28-May-21	25-Jun-21	4.00	3.00	$8,924	$0	$0	$8,924

- Several activities involved:

  --Mechanical Engineering Design

  --Survey and alignment: standard element and beamline survey work

  --Installation of vacuum components: Remove, move, install and pumpdown/leakcheck

  --Relocate Instrumentation & Control, MPS, and DC power hardware and related racks cables, electronics

Infrastructure: Particle Shielding (March 7, 2019)

WBS Path	Activity ID	Activity Name	Start	Finish	Planned Duration	Planned Labor Units	Planned Labor Cost	Planned Nonlabor Cost	Planned Material Cost	Planned Total Cost
MOLLER-1.1.06.05 Particle Shielding			02-Oct-20	25-Jun-21	36.00	36.00	$144,115	$0	$2,541,337	$2,685,452
1.06.05	10605000	Design Particle Shielding	02-Oct-20	04-Feb-21	16.00	28.00	$105,254	$0	$0	$105,254
1.06.05	10605005	Particle Shielding Procure and Installation	05-Feb-21	25-Jun-21	20.00	0.00	$0	$0	$2,541,337	$2,541,337
1.06.05	10605010	SOTR Oversight	05-Feb-21	25-Jun-21	20.00	8.00	$38,861	$0	$0	$38,861

- This budget includes more plastic and steel than the new, current plan presented by Ciprian
- The new breakdown has the following planned material costs:
  - $1.3M target enclosure (dominated by $1M in concrete)
  - $467k col 1 and 2 shielding (concrete)
  - $25k col4 shielding and Pb shadow wall
- Current Planned Material Costs are ~$1.8M (represents ~$750k cost reduction—assuming labor costs stay similar)

Integration: Cables

WBS Path	Activity ID	Activity Name	Start	Finish	Planned Duration	Planned Labor Units	Planned Labor Cost	Planned Nonlabor Cost	Planned Material Cost	Planned Total Cost
MOLLER-1.1.06.06 Integration of MOLLER Subsystems			02-Oct-20	07-Dec-23	158.00	454.20	$1,619,547	$0	$3,299,380	$4,918,926
MOLLER-1.1.06.06.01 Cables			04-Jan-22	18-Aug-22	32.00	23.20	$75,346	$0	$1,264,050	$1,339,396
1.06.06.01	1060601000	Write Specification for Signal Cabling	04-Jan-22	15-Feb-22	6.00	0.20	$1,001	$0	$0	$1,001
1.06.06.01	1060601005	Procure Signal Cables	16-Feb-22	24-May-22	14.00	0.00	$0	$0	$788,163	$788,163
1.06.06.01	1060601010	Installation of Signal Cabling	25-May-22	18-Aug-22	12.00	4.00	$11,867	$0	$0	$11,867
1.06.06.01	1060601015	Write Specification for LV Cabling	04-Jan-22	25-Jan-22	3.00	1.00	$5,003	$0	$0	$5,003
1.06.06.01	1060601020	Procure LV Cables	26-Jan-22	03-May-22	14.00	0.00	$0	$0	$57,320	$57,320
1.06.06.01	1060601025	Installation of LV Cabling	04-May-22	07-Jul-22	9.00	4.00	$11,867	$0	$0	$11,867
1.06.06.01	1060601030	Write Specification for LV Power Supplies	04-Jan-22	25-Jan-22	3.00	1.00	$5,003	$0	$0	$5,003
1.06.06.01	1060601035	Procure LV Power Supplies	26-Jan-22	03-May-22	14.00	0.00	$0	$0	$65,254	$65,254
1.06.06.01	1060601040	Installation of LV Power Supplies	04-May-22	07-Jul-22	9.00	4.00	$11,867	$0	$0	$11,867
1.06.06.01	1060601045	Write Specification for HV System and Cabling	04-Jan-22	10-Jan-22	1.00	1.00	$5,003	$0	$0	$5,003
1.06.06.01	1060601050	Procure HV System	11-Jan-22	05-Apr-22	12.00	0.00	$0	$0	$175,098	$175,098
1.06.06.01	1060601055	Procure HV Cabling	11-Jan-22	19-Apr-22	14.00	0.00	$0	$0	$178,215	$178,215
1.06.06.01	1060601060	Installation of HV System	20-Apr-22	15-Jun-22	8.00	8.00	$23,734	$0	$0	$23,734

- Total planned cost for cables is $1.34M dominated by $1.26M in materials
- Signal Cables:
  - 400 runs each of RG58 and RG108A/U 78Ω BNC Twinax: 604 requested =>196* spares (for other dets)
    - Each run consists of 4 cables: 60" to PreAmp; 600" to PatchPanel; 320ft to PatchPanel; 600" to ADC*
  - Planning for premade cables*: Total cost from web quote is $679k + $49k*(bulkhead conn.) + $7.5k (trays)
  - Total Cost is $679k (with $489k from long signal cables)
  - Recently spoke with Bogdan about reusing RG58 signal cables from SBS. He said there will be 1500 100m cables available for us (cost savings ~$225k). "short RG58 and HV cables cannot be used unless detector is decommissioned"

Integration: Cables (HV)

WBS Path	Activity ID	Activity Name	Start	Finish	Planned Duration	Planned Labor Units	Planned Labor Cost	Planned Nonlabor Cost	Planned Material Cost	Planned Total Cost
MOLLER-1.1.06.06 Integration of MOLLER Subsystems			02-Oct-20	07-Dec-23	158.00	454.20	$1,619,547	$0	$3,299,380	$4,918,926
MOLLER-1.1.06.06.01 Cables			04-Jan-22	18-Aug-22	32.00	23.20	$75,346	$0	$1,264,050	$1,339,396
1.06.06.01	1060601000	Write Specification for Signal Cabling	04-Jan-22	15-Feb-22	6.00	0.20	$1,001	$0	$0	$1,001
1.06.06.01	1060601005	Procure Signal Cables	16-Feb-22	24-May-22	14.00	0.00	$0	$0	$788,163	$788,163
1.06.06.01	1060601010	Installation of Signal Cabling	25-May-22	18-Aug-22	12.00	4.00	$11,867	$0	$0	$11,867
1.06.06.01	1060601015	Write Specification for LV Cabling	04-Jan-22	25-Jan-22	3.00	1.00	$5,003	$0	$0	$5,003
1.06.06.01	1060601020	Procure LV Cables	26-Jan-22	03-May-22	14.00	0.00	$0	$0	$57,320	$57,320
1.06.06.01	1060601025	Installation of LV Cabling	04-May-22	07-Jul-22	9.00	4.00	$11,867	$0	$0	$11,867
1.06.06.01	1060601030	Write Specification for LV Power Supplies	04-Jan-22	25-Jan-22	3.00	1.00	$5,003	$0	$0	$5,003
1.06.06.01	1060601035	Procure LV Power Supplies	26-Jan-22	03-May-22	14.00	0.00	$0	$0	$65,254	$65,254
1.06.06.01	1060601040	Installation of LV Power Supplies	04-May-22	07-Jul-22	9.00	4.00	$11,867	$0	$0	$11,867
1.06.06.01	1060601045	Write Specification for HV System and Cabling	04-Jan-22	10-Jan-22	1.00	1.00	$5,003	$0	$0	$5,003
1.06.06.01	1060601050	Procure HV System	11-Jan-22	05-Apr-22	12.00	0.00	$0	$0	$175,098	$175,098
1.06.06.01	1060601055	Procure HV Cabling	11-Jan-22	19-Apr-22	14.00	0.00	$0	$0	$178,215	$178,215
1.06.06.01	1060601060	Installation of HV System	20-Apr-22	15-Jun-22	8.00	8.00	$23,734	$0	$0	$23,734

- HV System: Total Cost is $161k + escalation + contingency?
  - Three CAEN SY4527A (2 + 1 spare): power and control mainframes -- $28k + $5k (control software)
  - Six CAEN A4533: 1200W power units (two for each mainframe + 2 spares) -- $11.8k
  - 19 CAEN A1535N: 24ch -3.5kV/3mA Common Return Board -- $115k
- HV Cables (and breakout): Total Cost is $163.5k + escalation + contingency?
  - 384 SHV to SHV 600" RG8A/U (enough for 16 cards, 24 ch each): $190/cable => $73k (standard cables)
  - HV breakout cost is $70.5k (involves a lot of expensive connectors, pins; multiconductor HV cables (16 100m), SHV connectors, breakout boxes, labor)
  - More cable trays: three at $5k each plus $5k in supports: total here is $20k + $12k labor

Integration: Detector Support Structure

WBS Path	Activity ID	Activity Name	Start	Finish	Planned Duration	Planned Labor Units	Planned Labor Cost	Planned Nonlabor Cost	Planned Material Cost	Planned Total Cost
MOLLER-1.1.06.06.02 Detector Support Structures			02-Oct-20	07-Dec-23	158.00	270.00	$919,452	$0	$1,157,410	$2,076,862
1.06.06.02	1060602000	Design/Specify Electronics Huts	04-Jan-22	15-Feb-22	6.00	6.00	$22,099	$0	$0	$22,099
1.06.06.02	1060602005	Procure Concrete	16-Feb-22	10-May-22	12.00	0.00	$0	$0	$43,660	$43,660
1.06.06.02	1060602010	Vendor Install Breaker Panels and Racks	11-May-22	01-Sep-22	16.00	0.00	$0	$0	$82,600	$82,600
1.06.06.02	1060602015	Procure Instrumentation Hardware	04-Jan-22	01-Feb-22	4.00	0.00	$0	$0	$17,700	$17,700
1.06.06.02	1060602020	Install Instrumentation into Huts	02-Feb-22	22-Jun-22	20.00	48.00	$166,872	$0	$0	$166,872
1.06.06.02	1060602025	Main Detector Integration Design	23-Mar-21	04-Nov-21	32.00	92.00	$333,108	$0	$0	$333,108
1.06.06.02	1060602030	Procure Structure Supports (100K for Installation Misc)	05-Nov-21	26-Sep-22	44.00	0.00	$0	$0	$826,000	$826,000
1.06.06.02	1060602035	Install Main Detector	27-Sep-22	27-Mar-23	24.00	63.00	$194,552	$0	$0	$194,552
1.06.06.02	1060602040	Ferris Wheel Support Design	05-Feb-21	18-Mar-21	6.00	13.00	$40,080	$0	$0	$40,080
1.06.06.02	1060602045	Procure Ferris Wheel Supports (15K for Installation Misc)	19-Mar-21	09-Aug-21	20.00	0.00	$0	$0	$143,750	$143,750
1.06.06.02	1060602050	Install Ferris Wheel	22-Jul-22	16-Sep-22	8.00	26.00	$86,961	$0	$0	$86,961
1.06.06.02	1060602055	Design Beam Monitoring Hardware	02-Oct-20	12-Nov-20	6.00	15.00	$53,640	$0	$0	$53,640
1.06.06.02	1060602060	Procure Beam Monitoring Hardware(8K for Installation Misc)	13-Nov-20	15-Apr-21	20.00	0.00	$0	$0	$43,700	$43,700
1.06.06.02	1060602065	Install Beam Monitoring Hardware	16-Apr-21	11-Jun-21	8.00	7.00	$22,140	$0	$0	$22,140
1.06.06.02	1060602070	Detector Installation Complete		07-Dec-23	0.00	0.00	$0	$0	$0	$0

- Total planned cost is ~$2.1M split ~equally among labor and materials
- Largest single line item is Structure Support Materials at $826k:
  - Main and Aux detectors support structures - they hold individual detector channels in position around beam pipe — $148k
  - Main and Aux detectors Pb shielding – $240k* (potential savings here since Pb donut absorber is much larger than planned)
  - Beam line (from tracking detectors to beam dump alcove) — $100k
  - Main and Aux detectors floor positioning systems (floor plates, jacks, Hilman rollers, mounts) — $338k

Integration: Detector Support Structure

WBS Path	Activity ID	Activity Name	Start	Finish	Planned Duration	Planned Labor Units	Planned Labor Cost	Planned Nonlabor Cost	Planned Material Cost
MOLLER-1.1.06.06.02 Detector Support Structures			02-Oct-20	07-Dec-23	158.00	270.00	$919,452	$0	$1,157,410
1.06.06.02	1060602000	Design/Specify Electronics Huts	04-Jan-22	15-Feb-22	6.00	6.00	$22,099	$0	$0
1.06.06.02	1060602005	Procure Concrete	16-Feb-22	10-May-22	12.00	0.00	$0	$0	$43,660
1.06.06.02	1060602010	Vendor Install Breaker Panels and Racks	11-May-22	01-Sep-22	16.00	0.00	$0	$0	$82,600
1.06.06.02	1060602015	Procure Instrumentation Hardware	04-Jan-22	01-Feb-22	4.00	0.00	$0	$0	$17,700
1.06.06.02	1060602020	Install Instrumentation into Huts	02-Feb-22	22-Jun-22	20.00	48.00	$166,872	$0	$0
1.06.06.02	1060602025	Main Detector Integration Design	23-Mar-21	04-Nov-21	32.00	92.00	$333,108	$0	$0
1.06.06.02	1060602030	Procure Structure Supports (100K for Installation Misc)	05-Nov-21	26-Sep-22	44.00	0.00	$0	$0	$826,000
1.06.06.02	1060602035	Install Main Detector	27-Sep-22	27-Mar-23	24.00	63.00	$194,552	$0	$0
1.06.06.02	1060602040	Ferris Wheel Support Design	05-Feb-21	18-Mar-21	6.00	13.00	$40,080	$0	$0
1.06.06.02	1060602045	Procure Ferris Wheel Supports (15K for Installation Misc)	19-Mar-21	09-Aug-21	20.00	0.00	$0	$0	$143,750
1.06.06.02	1060602050	Install Ferris Wheel	22-Jul-22	16-Sep-22	8.00	26.00	$86,961	$0	$0
1.06.06.02	1060602055	Design Beam Monitoring Hardware	02-Oct-20	12-Nov-20	6.00	15.00	$53,640	$0	$0
1.06.06.02	1060602060	Procure Beam Monitoring Hardware(8K for Installation Misc)	13-Nov-20	15-Apr-21	20.00	0.00	$0	$0	$43,700
1.06.06.02	1060602065	Install Beam Monitoring Hardware	16-Apr-21	11-Jun-21	8.00	7.00	$22,140	$0	$0
1.06.06.02	1060602070	Detector Installation Complete		07-Dec-23	0.00	0.00	$0	$0	$0

- Other major material costs include:
  - $144k for GEM ferris wheel supports
  - $144k* for two shielding bunkers: $44k in concrete, $83k in panels + racks, and $18k in hardware
  - $44k for beam monitoring hardware (Mark's request)

Integration: Detector Support Structure (Labor)

WBS Path	Activity ID	Activity Name	Start	Finish	Planned Duration	Planned Labor Units	Planned Labor Cost	Planned Nonlabor Cost	Planned Material Cost	Planned Total Cost
MOLLER-1.1.06.06.02 Detector Support Structures			02-Oct-20	07-Dec-23	158.00	270.00	$919,452	$0	$1,157,410	$2,076,862
1.06.06.02	1060602000	Design/Specify Electronics Huts	04-Jan-22	15-Feb-22	6.00	6.00	$22,099	$0	$0	$22,099
1.06.06.02	1060602005	Procure Concrete	16-Feb-22	10-May-22	12.00	0.00	$0	$0	$43,660	$43,660
1.06.06.02	1060602010	Vendor Install Breaker Panels and Racks	11-May-22	01-Sep-22	16.00	0.00	$0	$0	$82,600	$82,600
1.06.06.02	1060602015	Procure Instrumentation Hardware	04-Jan-22	01-Feb-22	4.00	0.00	$0	$0	$17,700	$17,700
1.06.06.02	1060602020	Install Instrumentation into Huts	02-Feb-22	22-Jun-22	20.00	48.00	$166,872	$0	$0	$166,872
1.06.06.02	1060602025	Main Detector Integration Design	23-Mar-21	04-Nov-21	32.00	92.00	$333,108	$0	$0	$333,108
1.06.06.02	1060602030	Procure Structure Supports (100K for Installation Misc)	05-Nov-21	26-Sep-22	44.00	0.00	$0	$0	$826,000	$826,000
1.06.06.02	1060602035	Install Main Detector	27-Sep-22	27-Mar-23	24.00	63.00	$194,552	$0	$0	$194,552
1.06.06.02	1060602040	Ferris Wheel Support Design	05-Feb-21	18-Mar-21	6.00	13.00	$40,080	$0	$0	$40,080
1.06.06.02	1060602045	Procure Ferris Wheel Supports (15K for Installation Misc)	19-Mar-21	09-Aug-21	20.00	0.00	$0	$0	$143,750	$143,750
1.06.06.02	1060602050	Install Ferris Wheel	22-Jul-22	16-Sep-22	8.00	26.00	$86,961	$0	$0	$86,961
1.06.06.02	1060602055	Design Beam Monitoring Hardware	02-Oct-20	12-Nov-20	6.00	15.00	$53,640	$0	$0	$53,640
1.06.06.02	1060602060	Procure Beam Monitoring Hardware(8K for Installation Misc)	13-Nov-20	15-Apr-21	20.00	0.00	$0	$0	$43,700	$43,700
1.06.06.02	1060602065	Install Beam Monitoring Hardware	16-Apr-21	11-Jun-21	8.00	7.00	$22,140	$0	$0	$22,140
1.06.06.02	1060602070	Detector Installation Complete		07-Dec-23	0.00	0.00	$0	$0	$0	$0

- Total planned labor costs: $900k
  - $333k for Main Detector Integration Design: 32 weeks engineering and 60 weeks of designer time
  - $195k* for installation of Main Detector
  - $167k for installation of instrumentation into shield bunkers
  - $127k for Ferris wheel support design and installation

Integration: Hall Mods and Installation

WBS Path	Activity ID	Activity Name	Start	Finish	Planned Duration	Planned Labor Units	Planned Labor Cost	Planned Nonlabor Cost	Planned Material Cost	Planned Total Cost
MOLLER-1.1.06.06.03 Hall Modifications and Installation			04-Jan-22	18-Jul-23	77.00	161.00	$624,748	$0	$877,920	$1,502,668
1.06.06.03	1060603000	Remove resistive Q1 magnets	04-Jan-22	25-Jan-22	3.00	4.00	$13,960	$0	$0	$13,960
1.06.06.03	1060603005	Remove SC Q2 magnets	26-Jan-22	08-Mar-22	6.00	7.00	$24,897	$0	$0	$24,897
1.06.06.03	1060603010	Modify(blue) utility platform	09-Mar-22	28-Jul-22	20.00	28.00	$92,118	$0	$0	$92,118
1.06.06.03	1060603015	Restructure pivot and HRS links	29-Jul-22	24-Mar-23	32.00	74.00	$246,933	$0	$0	$246,933
1.06.06.03	1060603020	Platforms and Utilities	27-Mar-23	18-Jul-23	16.00	32.00	$115,269	$0	$0	$115,269
1.06.06.03	1060603025	Hall Modifications Materials	04-Jan-22	26-Apr-22	16.00	0.00	$0	$0	$877,920	$877,920
1.06.06.03	1060603030	Engneering Oversight	04-Jan-22	18-Jul-23	77.00	16.00	$131,571	$0	$0	$131,571

- Total planned cost is $1.5M: $625k in planned labor and $878k in materials
- Planned material costs associated with activities:
  - Remove resistive Q1 magnets — $148k
  - Remove SC Q2 magnets — $32k
  - Modify (blue) utility platform — $276k
  - Restructure pivot and HRS links — $350k (Possible saving depending what is done with old pivot area?)
  - Platforms and utilities — $210k
- Planned labor costs are itemized in table

Summary

- Hall I & I is a big piece of the pie at \$11M
- I estimate \$600k + \$750k + \$225k = \$1.6M in cost reductions from transfer lines, shielding, and coaxial signal cables
- There is still potential for cost reductions in other areas:
  - Old pivot area decision, Pb donut absorber, Main detector installation, shielding bunkers
  - More savings in cables?: Reuse possibilities, HV lengths, premade vs house-made
  - More savings in cryogenic transfer lines (given reduced target power)?
- There are already a few dependencies here (2MVA, raster, ?). Would any others make sense? Pivot area & HRS links, maybe?

Summary

- Contingencies? There seem to be areas where this make sense and others where it doesn't necessarily (at least not at full rate)
- The Detector Support Structure activity costs are the least understood at this point –collaboration must now focus on this area and work with project team to explore various options and define more clearly this activity (and costs)
- If every subsytem reduced their cost by 40%, then Hall I & I would be on hook for \$4.4M. Possible \$2M could be removed ∼easily, but it's hard to see how to remove another \$2M