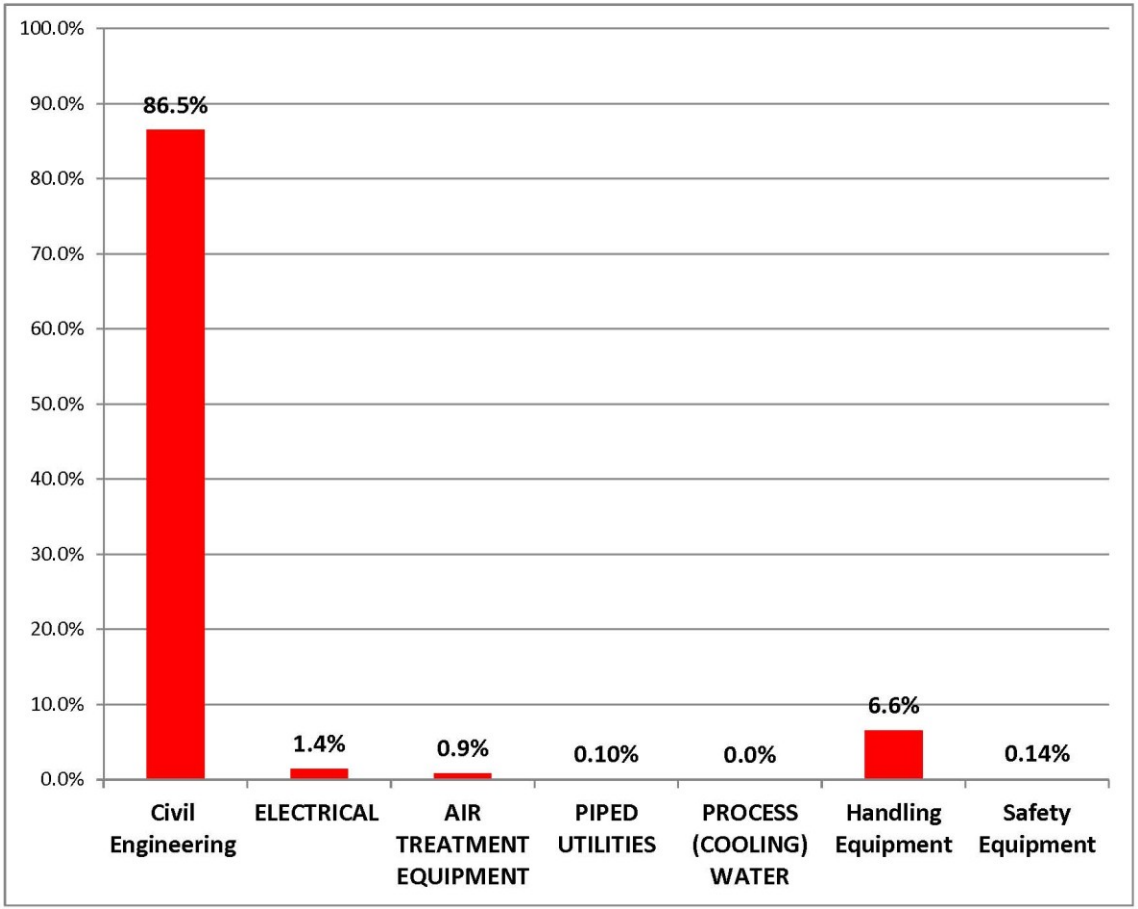
CFS Detector Hall Considerations

Tom Lackowski

- CFS must advance the IR Region and Detector Hall design for the TDR.
  - **Improved understanding of the Detector Requirements for CFS.**
  - **Regional CFS Designs that satisfy the Detector Requirements**
  - **A much more complete cost estimate**
  - **The design(s) presented and costed in the TDR must have the concurrence of each of the Detector Collaboration.**

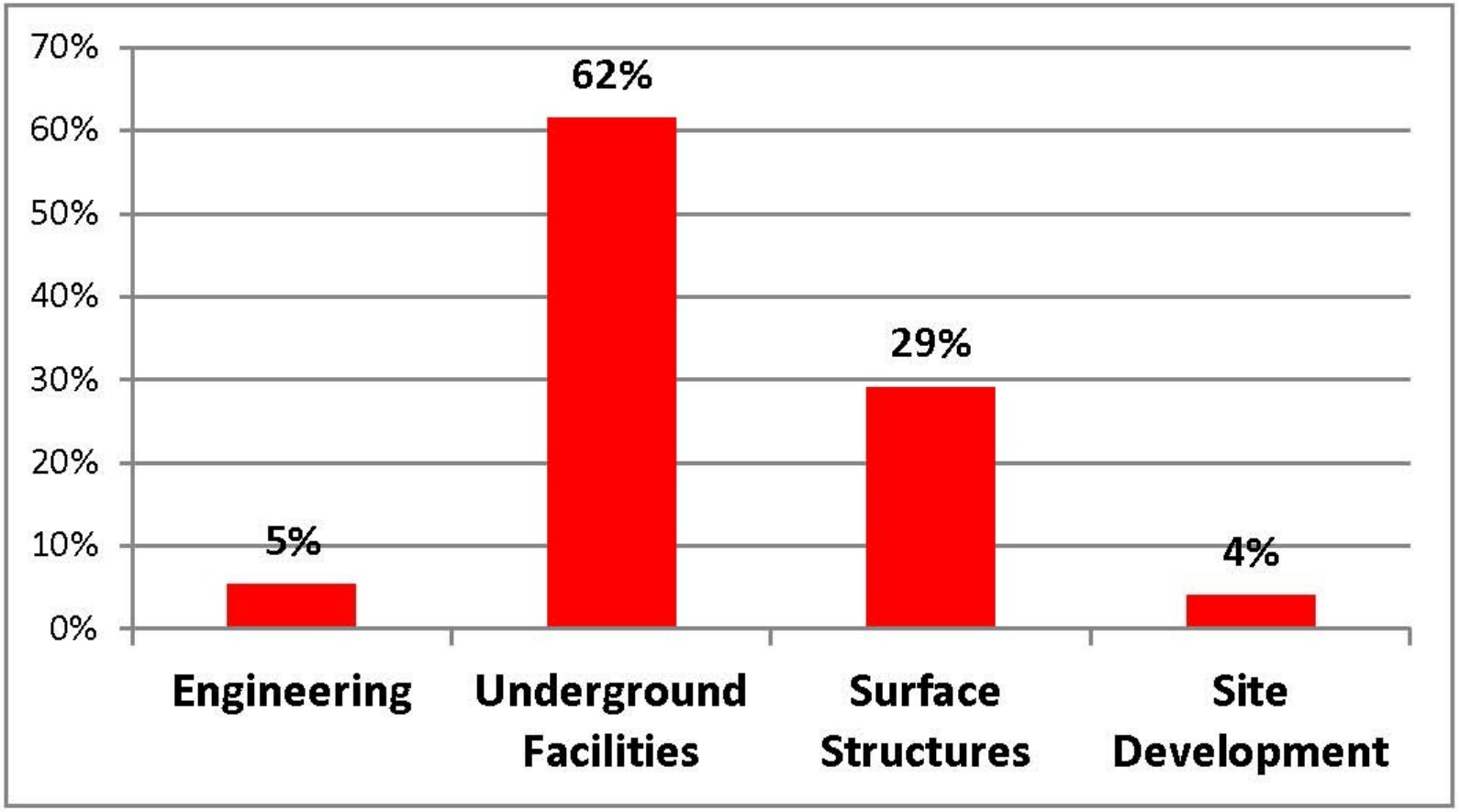
- We can move forward towards the TDR CFS goals with some direction from the Collaborations.
  - **Specific, or exact information is NOT necessary; Placeholders or Ranges will advance our efforts.**
  - **CFS would like to focus on those items that are cost drivers**
  - **We need requirements, not system designs at this point**
    - Requirements are based on detector and physics optimum performance.
    - Requirements are the same for all regions

RDR Cost



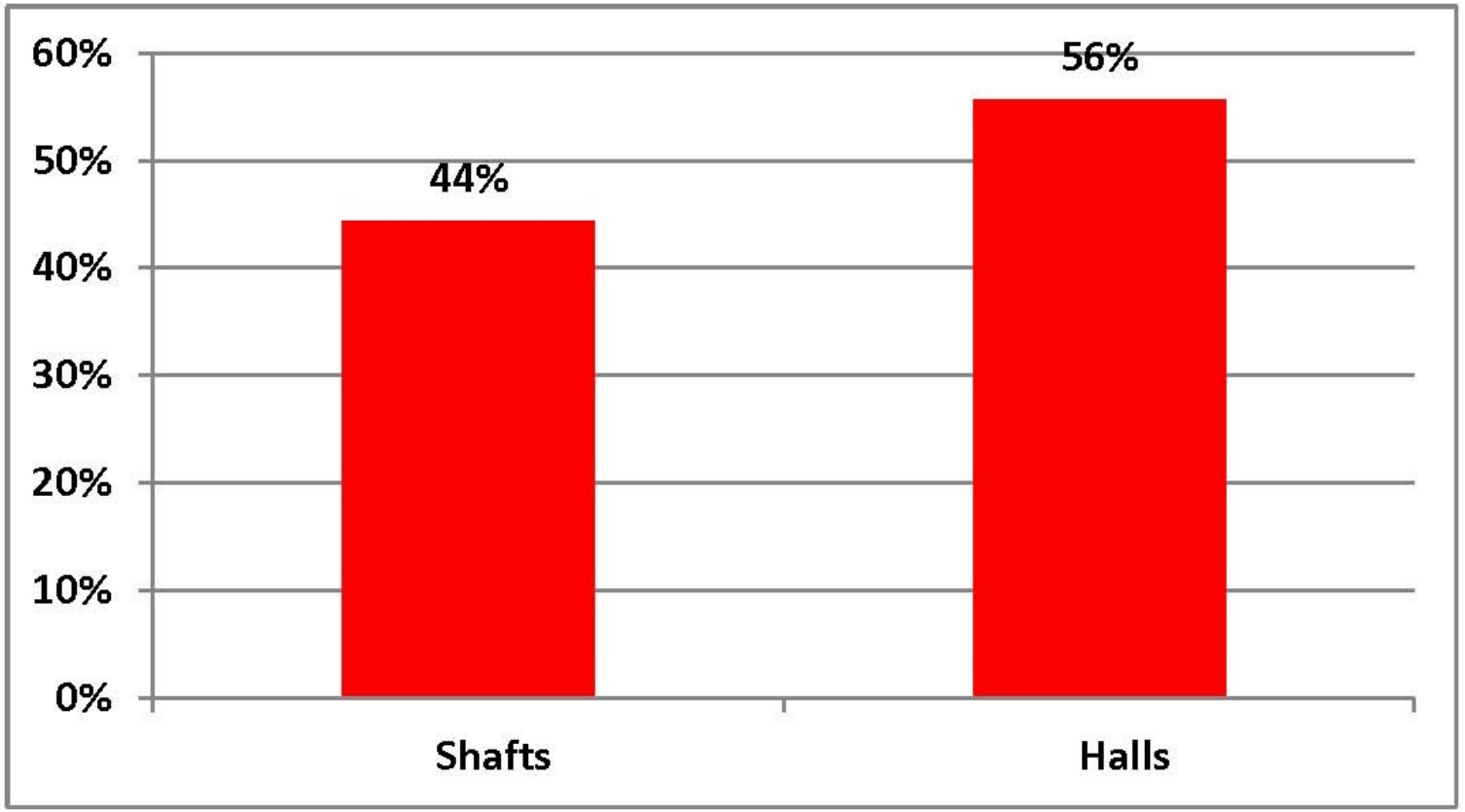
- Distribution of IR RDR Costs

RDR Cost



- Distribution of IR Civil Engineering Costs

RDR Costs



- Further Distribution of IR Underground Costs

- Some issues, such as studies to determine ground behavior with respect to settlements and vibration may be out of reach for the TDR for all regions. John's talk describes a proposed study at CERN.
  - **(Granted my geotechnical course work was done a while ago, but the geotechnical predictive models and formulas with bore hole test data are bases on empirical data and provide at best a range of potential motion)**

Requirements Outline

- Site
  - **Access Roads Weight Limits**
  - **Parking (# of people)**
  - **Storage Hardstands**
  - **Cryo and Gas Storage (Mixing)**
  - **Fire Brigade Access**
- Site Utilities
- Water
  - **Fire Protection**
  - **Primary Cooling**
  - **Potable (Drinking)**
  - **Sanitary Sewer**

- Utilities (continued)
  - **Electrical Service**
  - **Communications**
- Building(s)
  - **Detector Sub-Assembly Space**
  - **Ancillary Space**
    - Control Room
    - Office
    - Tech
    - Electronics
    - Machine Shop
    - Testing
    - Access Control

Building Requirements

- Buildings (Continued)
  - **Mechanical**
    - HVAC
      - Temperature range - Stability
      - Humidity criteria
      - ODH
      - Special Ventilation for gases, fire protection
    - Process Water loads
      - Water Temperature
      - Water Type – LCW / Chilled LCW / Chilled
  - **Electrical**
    - Power distribution
    - Lighting
    - Fire Detection

Detector Hall Access

- Shafts or Horizontal Access
  - **Governing Load dimensions and weights**
  - **Services routed in shafts**
  - **Shaft environmental criteria (Ground Water Infiltration)**

Detector Hall Requirements

- Detector Hall
  - **Footprint required to construct Detector**
  - **Detector Footprint in beam**
  - **Detector Footprint in Parked Area(Gross footprint including access platforms, servies, and detector opened for maintenance)**
  - **Platform dimensions and travel**
  - **Cranes, lifts and hoists**
  - **Ancillery Space**
    - Control Room

Detector Hall Requirements

- **# of people**
  - During Construction
  - During Running
  - Maintenance Periods
  - Sub, sub point

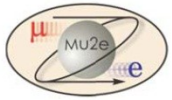
- So how do we get to our common TDR goals.
  - **Write down (CFS) the goals and deliverables**
  - **Focus on what we know or can scale from existing detectors**
  - **Set a schedule (During THIS MEETING for the near future deliverables)**
    - Requirements Document
      - Outline complete; 30%; 60%; Final TDR Requirements w/ collaboration concurrance
    - Design Development Drawings
  - **Write the Requirements Documents**
  - **Identify points of contacts that will get the tasks done. (TODAY)**

Let's Start- Can we Concur

- Each detector will be designed to provide beam radiation shielding and no shielding external of the detector is required for unrestrictive occupancy and maintenance of the parked detector.
- Both the MDI and ILD detector will be supported and transported on independent platforms.

Conclusion

- A reasonable goal is to have a “mostly complete” requirements document done by the next meeting in September.
  - **This document should be put under some form of change control.**
- Regional CFS Conceptual Document (Drawings and Text) and much of the cost estimate must be done by a year from now.



Draft 2/27/11

This WBS includes the activities required to construct the building envelope and associated support systems for the delivery, unloading, assembly and operation of the solenoid. The requirements listed below are divided into the Assembly Phase and Operation Phase.

REQUIREMENTS

The Primary Beamline, the Mu2e Cryogenic Building and the Mu2e Service building and Hall provide the functional division for the Mu2e Conventional Construction, WBS 3.0.

1) Primary Beamline Enclosure

The purpose of the Primary Beamline is to house the beamline components to transport 8 GeV beam from the Antiproton Source to the Mu2e Detector Hall.

Housing

Minimum 10 feet wide by 8 feet high. (Width based on magnet in place with magnet in transport plus 22 inch emergency egress aisle.)

Primary Beam Shielding

21 feet of earth equivalent shielding for unlimited occupancy (beam 4' from enclosure ceiling, required shielding is 24 if 1'-6" from ceiling).

Occupancy:

No access during beam on operations
20 persons during installations / major shutdowns
10 persons during maintenance

Egress

Maximum 300 foot travel distance, 50 foot maximum single path of travel.

Equipment Access and Transport

Shielded hatch with removable weather hatch cover. 21 feet of shielding
10.17 Feet by 5.67 Feet clear opening.
Maximum element weight = XXX Pounds

Ventilation and HVAC

Heat load to air:	None (to be cooled)
Temperature:	60 Degrees F Minimum
Temp stability:	None
Humidity reqmnt:	None
Ventilation:	Five Air Changes per hour during installation and maintenance operations. Any personnel ventilation shall follow ASHRAE 62.1. Any construction /installation ventilation shall follow OSHA requirement.
ODH ventilation:	None

Fire Protection	None
Process Water	
LCW:	LCW system (heat exchanger, pumps, polishing, expansion tanks, controls) will be provided under a separate WBS 2.0. Our scope includes the primary heat rejection to the ICW (see ICW item below). The working assumption is 1.5 MW load from beam (magnets) and 200KW from power supplies. The flow basis is 14F water delta T for magnets and 10F water delta T for power supply LCW. This equate to about 870 gpm LCW or a new 8" main LCW pipe system. There is a limitation in both flow and heat exchange capacity at the existing CUB P-Bar LCW loop. New LCW loads from the beamline magnets, and solenoid power supplies in the building needs to be defined later.
RAW:	None
ICW:	Placeholder of about 870 gpm for LCW heat rejection, terminating with a flanged valve near the building floor. Continuation to the LCW system, including pipe headers, flowmeter, and strainers, shall be covered under WBS 2.0
Chilled Water:	None required in beamline.
Ground water control:	Under drains connected to a sump system
Electrical	
Power Supplies:	Supplied from2000A switchboard in Mu2e Service Building and Hall (need voltage and amps required/ treaty point) and a 2000A Switchboard in AP-30 Service Building.
AC Distribution:	120V/208V – 20 Amp. Quad outlet @ 60 ' 480V – 60 Amp Welding outlet @ 200'
Lighting:	20 foot-candles
Emergency Power:	Remote Battery (UPS) powered exit lights and emergency lighting
Fire Detection	Line type heat detection; air sampling smoke detection
Cable Tray:	2- 18" wide by 4" deep trays suspended from ceiling. (By Accelerator)

2) Mu2e Cryogenic Building

The purpose of the Cryogenic Building compressor space is to house the cryogenic refrigerator and compressors required for the cooling of the solenoids.
NFPA 101 Life Safety Code; 2009 Edition - Occupancy Classification – Industrial Special Purpose

Cryo Equipment (for reference):

Interior space	
Two TeVatron style refrigerators	26' x 25' x 12' high footprint; in room sound isolated from compressors.
Four warm compressors skids	6'-9" by 13'-0" (each) Allow 4' spacing on sides and one end Allow 8' spacing at other end Allow room for starter cabinets Allow room for necessary fire equip. Use TeVatron DA building as reference
Exterior space	
Four oil removal systems	6' x 24' (6' x 6' per compressor)
Single LN2 dewar	21' x 12'
Single gas Helium storage tank	68' x 11'

Single He tube trailer 45' x 20'

Occupancy: 5 persons
Egress Maximum 300 foot travel distance, 50 foot maximum single path of travel
Equipment Access and rigging
18' wide X 14' high over head doors for fork lift access. 1000# capacity for future hoist way over compressors.
Ventilation and HVAC
Heat load to air: **TBD**
Temperature: 68 Degrees F minimum; 10 degrees F over ambient maximum.
Humidity: No control
Controls: Air flow controlled by thermostat to maintain space temperature shall be part of this WBS. ODH condition controls (alarm, actuation of fans at full cfm) shall be other WBS.
ODH Ventilation: 45,000 cfm
Fire Protection Normal Hazard Fire Sprinklers
Process Water
LCW: None
Chilled Water: None
ICW: 600 GPM (based on 3 warm compressor running at 200 gpm each), return to Casey pond via bubbler ditch, Kidney Pond, Swan Lake, Swan lake pump station (requires upgrading) to N-1 ditch. Supply and return pipe terminating with a flanged valve near the building floor. Continuation to the cryo equipment, including headers and strainers, shall be covered by Cryo group.

Mu2E Cryo Equipment	Total Qty	Total Qty Running	HP Each	Power,kW	Total Running in KW
Warm Cryo Compressor	3	2	400	298	596
Re-circulating compressor	1	1	100	75	75
Miscellanies	1	1	30	25	25
				696	696

Electrical
Primary Power: 1500KVA Substation, 13.8 kV – 480Y/277 V
480V Distribution: Supplied from2000A switchboard in compressor room, 600 Amp breaker for each compressor, DHP Panel board
AC Distribution: 120V/208V – 20 Amp. Quad outlet @ 25 '
480V – 60 Amp Welding outlet in Refrigerator and compressor Rooms
Lighting 85 foot-candles
Emergency Power: Battery powered exit lights and emergency lighting
Fire Detection Heat/smoke detection
Cable Tray: TBD

3) Mu2e Detector Service Building and Hall

The purpose of the Mu2e Service Building and Hall is to assemble, house and maintain the experimental equipment to support the Mu2e Experiment. The major spaces are described as follows:

3a) Receiving/Staging (High Bay) Area: Access and space for receiving the scientific equipment including the cryostats of the solenoids in one piece. The upper staging area may be used for storage and a machine shop during installation. During operations the beamline power supplies will be housed along the south wall. This space will also be used for storing shield blocks during maintenance periods.

Occupancy: 5 (placeholder)

Egress: Maximum 300 foot travel distance, 50 foot maximum single path of travel

Equipment Access and Rigging: Two 30-ton overhead building cranes–, radio controlled, motion control individually or two cranes controlled together

Each 30 ton capacity

Bridge speeds of 80 feet per minute

Trolley speeds of 65 feet per minute

Hoist speeds of 40 feet per minute

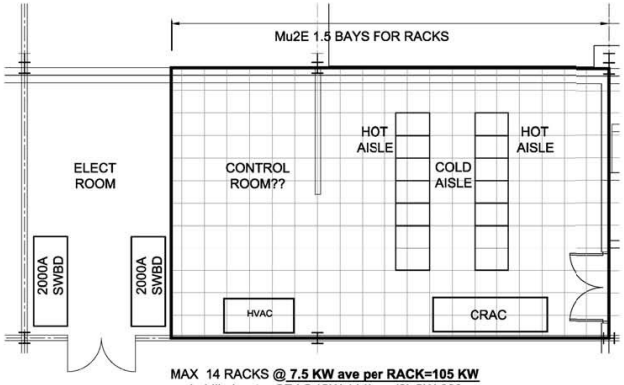
Ventilation and HVAC

Heat load to air:	No major heat load to air from equipment
Temperature:	68 Degrees F minimum; **80F** maximum.
Temp Stability:	none required
Humidity:	No minimum requirement. 55%RH maximum
HVAC controls:	to be connected to Site Metasys
ODH Ventilation:	None
Other ventilation:	None
Fire Protection	Normal Hazard Fire Sprinklers
Process Water	
LCW:	None
Chilled Water:	Building HVAC (see mech room)
ICW:	None
Electrical	
Primary Power:	1500KVA Substation, 13.8 kV – 480Y/277 V
480V Distribution:	DHP Panel board supplied from 2000A switchboard
AC Distribution:	120V/208V – 20 Amp. Quad outlet @ 25 ‘ 480V – 60 Amp Welding outlet
Lighting	85 foot-candles – Florescent High Bay
Emergency Power:	Battery powered exit lights and emergency lighting
Fire Detection	TBD
Cable Tray:	2- 18” wide by 4” deep trays suspended from ceiling.

Fire Detection: Addressable fire detection and alarm system should be provided for the Detector Support Building. The system should consist of Manual pull stations located at all exits, duct type smoke detectors on the supply and return sides of all air handling units having a capacity greater than 2000 cfm, and in ducts penetrating a 2 hr. fire/smoke barriers, sprinkler system waterflow detectors and valve supervisory switches, and combination horn/strobe devices located throughout the facility

3b) **Electronic Rack Space & Control room space:** The electronics space is divided into two locations. A space at the level of the Detector Solenoid near the downstream end. Space for 14racks

(24" x 30") is provided. Chilled water is provided for cooling. At grade, El 746'-6", there is space for 14 rack in 24' x 75'. This area will have a raised computer floor for cooling and cabling distribution.



MAX 14 RACKS @ 7.5 KW ave per RACK=105 KW
1 chilled water CRAC (CW-114) or (2) CW-060

FOR COMPARISON , BTeV was 281 KW mostly from Trigger

Occupancy: none
Egress Maximum 300 foot travel distance, 50 foot maximum single path of travel
Equipment Access and rigging: none
Ventilation and HVAC

Heat load to air:	14 Racks at 7.5 KW per rack (placeholder)
Temperature:	68 Degrees F minimum; 77F maximum.
Temp Stability:	none required
Humidity:	29% RH minimum. 55%RH maximum
HVAC controls:	to be connected to Site Metasys
ODH Ventilation:	None
Other ventilation:	None

Fire Protection Normal Hazard Fire Sprinklers
Process Water

LCW:	None
Chilled Water:	For CRAC (computer room air conditioner)
ICW:	None
DWS:	for CRAC humidification

Electrical

Primary Power:	1500KVA Substation, 13.8 kV – 480Y/277 V
480V Distribution:	DHP Panel board supplied from 2000A switchboard
AC Distribution:	120V/208V – 20 Amp. Quad outlet @ 25 ' 480V – 60 Amp Welding outlet
Lighting	50 foot-candles - Fluorescent
Emergency Power:	Battery powered exit lights and emergency lighting
Fire Detection	TBD

Cable Tray: 2- 18" wide by 4" deep trays suspended from ceiling.

3c) Solenoid Support Room & Power Supply Room: Space provided for five feed cans, 3 feet in diameter by 6 feet high, Power Supplies, Fast Switches, Resister banks and Control Racks. 20 smaller vacuum pumps are also located in this space. Current estimates require more than three 24' x 24' bays.

	Power Supplies, Qty + Size	Switch Qty + Size	Resister Qty + Size	Racks Qty	Total KW	Total LCW gpm / KW	Heat Load to Air (KW)
Production Solenoid					400		
Transport Solenoids					3@ 100		
Detector Solenoid					200		
Vac Pumps	Total Qty. = 20					200 gpm	

Occupancy: 5 persons
Egress Maximum 300 foot travel distance, 50 foot maximum single path of travel
Equipment Access and rigging: none
Ventilation

Heat load to air:	(TBD) Working assumption is 'No Major heat load to air'
Temperature:	68 Degrees F minimum; 10F above ambient maximum
Temp Stability:	none required
Humidity:	None
HVAC controls:	none
ODH Ventilation:	TBD
Other ventilation:	None

Fire Protection Normal Hazard Fire Sprinklers
Process Water

LCW:	(TBD KW)Power supplies are cooled by LCW (under WBS 2.0)
Chilled Water:	none
ICW:	**200 GPM** (based on 20 vacuum pumps at 10 gpm each), return to Casey pond via bubbler ditch, Kidney Pond, Swan Lake, Swan lake pump station (requires upgrading) to N-1 ditch. Supply and return pipe terminating with a flanged valve near the building floor. Continuation to the cryo equipment, including headers and strainers, shall be covered under WBS ???(by Cryo group)
	None

Electrical

Primary Power:	1500KVA Substation, 13.8 kV – 480Y/277 V
480V Distribution:	DHP Panel board supplied from 2000A switchboard
AC Distribution:	120V/208V – 20 Amp. Quad outlet @ 25 ' 480V – 60 Amp Welding outlet
Lighting	50 foot-candles
Emergency Power:	Battery powered exit lights and emergency lighting
Fire Detection	TBD

Cable Tray:	TBD.

3d) Mechanical & Electrical Room: Space for building power such as 2000 A switchboard, smaller transformer, and building mechanical system such as chilled water HVAC unit, chilled water heat exchanger/pump and accessories, as well as LCW heat exchanger and pumps system.

Occupancy: none

Egress Maximum 300 foot travel distance, 50 foot maximum single path of travel

Equipment Access and rigging: none

Ventilation

Heat load to air:	No Major heat load to air
Temperature:	68 Degrees F minimum; 10F above ambient maximum
Temp Stability:	none required
Humidity:	None
HVAC controls:	none
ODH Ventilation:	None
Other ventilation:	None

Fire Protection Normal Hazard Fire Sprinklers

Process Water

LCW:	None (This space will house the LCW system)
Chilled Water:	For Air Handler (serving the high bay space)
ICW:	200 gpm placeholder to the LCW system

Electrical

Primary Power:	1500KVA Substation, 13.8 kV – 480Y/277 V
480V Distribution:	DHP Panel board supplied from 2000A switchboard
AC Distribution:	120V/208V – 20 Amp. Quad outlet @ 25 ‘ 480V – 60 Amp Welding outlet
Lighting	50 foot-candles - Florescent
Emergency Power:	Battery powered exit lights and emergency lighting
Fire Detection:	TBD
Cable Tray:	TBD

3e) Gas Room (10x10)

Other Equipment located in the Mu2e Cryogenic Building are the Gas Room contained TBD equipment for support of solenoids.

NFPA 101 Life Safety Code; 2009 Edition - Occupancy Classification – Industrial Special Purpose

Occupancy: none

Egress TBD

Equipment Access and rigging: TBD

Ventilation and HVAC

Heat load to air:	None
Temperature:	68 Degrees F minimum; 10 degrees F over ambient maximum.
Humidity:	No control
Controls:	TBD
ODH Ventilation:	TBD

Fire Protection Normal Hazard Fire Sprinklers

Process Water

LCW:	None

Chilled Water:	None
ICW:	None

Electrical

Primary Power:	1500KVA Substation, 13.8 kV – 480Y/277 V
480V Distribution:	277 V lighting fed from LP panel board
AC Distribution:	120V – 20 Amp. outlet @ 12'
Lighting	85 foot-candles
Emergency Power:	Battery powered exit lights and emergency lighting
Fire Detection:	TBD
Cable Tray:	TBD

3f) Lower Space (Detector Hall): The lower level of the building contain the Production Solenoid,Detector Solenoid, Transport Solenoid, as well as staging area for the detector and solenoid and space for the primary beam absorber (dump).

Occupancy: none

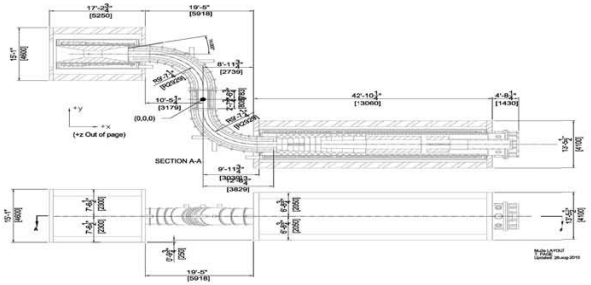
Egress Maximum 300 foot travel distance, 50 foot maximum single path of travel

Equipment Access and rigging: Two-3o ton overhead crane (from High Bay?)

Ventilation

Heat load to air:	Working assumption is 'No Major heat load to air'
Temperature:	68 Degrees F minimum; 85F maximum
Temper Stability:	none required
Humidity:	No minimum. (placeholder of chilled water fancoils to help with max humidity)
HVAC controls:	none
ODH Ventilation:	None
Other ventilation:	None

Fire Protection Normal Hazard Fire Sprinklers



Process Water

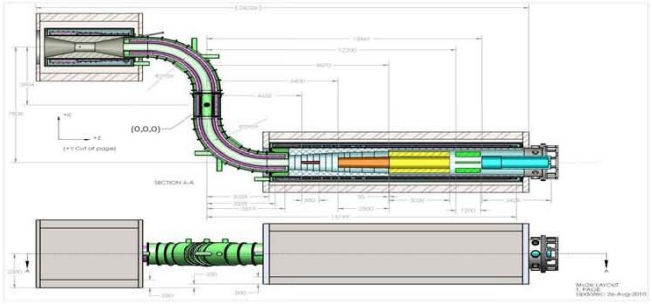
LCW:	TBD (This WBS will handle the primary heat rejection of the LCW system. The LCW system, including heat exchangers, pumps, piping located in the mechanical room, will be included in WBS 2.0)
RAW:	TBD (This WBS will handle the primary heat rejection of the RAW system. The RAW system, including heat exchangers, pumps, piping located in the lower level, will be included in WBS 2.0)
Chilled Water:	For RAW system heat rejection.

ICW: none
Cable Tray: BY Others Sub Project

Equipment in Lower Level	KW	FLOW	Direct water cooling	Primary Heat rejection (this WBS)	KW (heat load to air)
Target Cooling	2.2	1 GPM	RAW	chilled water	
Heat Shield Cooling	11	18 GPM	RAW	chilled water	
Collimator			LCW		
Primary Beam Absorber (Dump)	20	8 GPM	RAW	chilled water	
Abort			RAW	chilled water	
Diagnostic Absorber/Dump			RAW	chilled water	
Dump Resistor			None		
Calorimeter Trackers					
Power Supplies			LCW	ICW	

Electrical

Primary Power: 1500KVA Substation
480V Distribution: Supplied from2000A switchboard in compressor room, 400 Amp breaker for each compressor,
AC Distribution: 120V/208V – 20 Amp. Quad outlet @ 60 '
480V – 60 Amp Welding outlet in Refrigerator and compressor Rooms
Lighting 85 foot-candles
Emergency Power: Battery powered exit lights and emergency lighting
Fire Detection Heat/smoke detection



4) MI-52 Service Building Upgrade

The purpose of the MI-52 Service Building Upgrade is to provide space for additional kicker power supplies.

Construct a twenty five foot (25') by thirty foot (30') addition to the Main Injector MI-52 Service Building. The addition is to expand the existing kicker room to the north. The upgrade will extend power, lighting, fire detection and fire protection from the existing service building. The upgrade will double the kicker room HVAC.

5) PBAR Upgrade

The purpose of the PBAR Upgrade is to revise the shielding and shielding controls to acceptable levels. Additionally to augment the electrical power.

Radiation shielding between PBAR enclosure and PBAR Service Building to be increased from the current earth equivalent of ten feet (10') to a minimum of 13 feet (13').

Construct personnel protection radiation fencing and gates around the PBAR Rings and each side of the PBAR beamline between the Rings and the AP-0 Building.

Upgrade the electrical power at AP-30 Service Building with a 1500KVA substation and 2000Amp switchboard for new RF Power Supplies (approx. 650kva) and Mu2e beamline power supplies.

Provide additional exhaust ventilation for the Septa system. A placeholder of 180 cfm Decay exhaust P-BAR.

Abbreviations used:
LCW= Low conductivity Water
ICW= Industrial cooling water from Caseys Pond or Pond water
Kva= Kilo Volt Ampers