STRAIGHT 30 SECTION IN-TUNNEL SHIELDING FINAL DESIGN

February 28, 2014 C. Crowley







EXTRACTION LINE SHIELDING

- It was identified by the experiment that significant dose rate reduction would be needed during and after beam-on operation.
- Iterative MARS runs by Tony Leveling arrived at an appropriate amount of shielding for the straight 30 section for the problematic areas.



- These dose rate studies showed that approximately 3 feet of vertical steel shielding, with horizontal shielding consisting of 18 inches of concrete + 4" of marble gives sufficient protection for Mu2e operation. This shielding address 2 main issues:
 - Sky shine to Wilson Hall and surrounding areas
 - Residual dose rate in tunnel for workers

EXTRACTION LINE SHIELDING

Items to be shielded were identified as:

1.	C – Magnet
2.	D2Q5 Quad
3.	ELAM
4.	D2Q4 Quad
5.	D2Q3 Quad
6.	Extraction Septum (X 2)

- A need for an adaptable structure that can accommodate different magnet configurations was desired from a design and cost standpoint due to different heights and lengths associated with each device.
- Needed to allow for relatively quick magnet change outs due to dose rate concerns & ease of beam pipe welding or assembly





 $v_{v,v;z} = 1:5.243e+00$

FINAL SUPPORT COLUMN / SHELF DESIGN



- Columns are modular and can be used in all shielding areas where space allows
- Support shelves consist of 4" thick steel with a max span of 96" (8ft).
- Shielding depth is 48".
- Max steel height is 36" for full depth, or 45,000 lbs, whichever is greater.

SUPPORT COLUMN / SHELF DESIGN

 89% of load is taken by columns. Remaining 11% is on wall brackets. Column mounting brackets and front end supports are redundant & included for unknown seismic movement and settling. Also included to account for wall bracket slippage or poor fastener preloading.



SUPPORT COLUMN / SHELF DESIGN

- Columns must be placed first. Their placement needs to be correct and well thought out for proper load distribution and to avoid interference.
- Shielding shelf length can be measured after placement, with fabrication and installation occurring as a separate activity.
- Support rods can be installed afterwards, as wall brackets and support blocks will take nearly all the load.



INSTALLATION STEPS

- Columns have many mounting points. Shackles can easily be attached and strapped to fork truck tines. Column position can be manipulated with come-a-long or screw jack attached to fork truck mast.
- This will only be needed if we have to position behind an existing magnet
- Column assemblies will weigh approximately 700
 - 800 lbs. Will need to be well controlled during placement.



- Stainless LCW lines do not need to be relocated.
- 2" Dia. Copper headers will need to be relocated in some places.
- It might be easier to raise or lower entire header length instead of select spots? – Need input on this.



- Shielding stacks can share adjacent columns.
- Access to front of beam line & associated components is retained.



• Shielding can be positioned at any height on the columns after field measurements are taken.



- Enough clearance remains between columns, main LCW lines, and magnets.
- Some columns will need to be placed around large quads due to interference.
- Key issue to resolve is placement of magnet stands relative to column bases in model. These will be imported to check for interferences (WIP).
- Column placement is not set in stone; they can work around existing structures if necessary.
 - 8' shelf length limitation must be considered.- Must meet distance requirements from wall.
- Water lines, cabling, and instrumentation should work around the columns however.



ADDITIONAL CONSIDERATIONS

- Efforts to design water line, electrical bus and instrumentation connections to the front (open tunnel side) of experimental devices would make maintenance and replacement many times easier do to inability to easily access the back side of devices.
- Worst case scenario, shielding can be removed. It will take time however to unstack shielding steel.
- Steel will become activated and work activities in the tunnel could involve significant dose over lengthy repair activities.
- After column and steel placement, there will be a significant load on the floor which will most likely create some settling / displacement.
- Additional surveying might be needed after floor is allowed to adjust to shielding load.

EXTERNAL SHIELDING

- D-Blocks (18" Thick Concrete) + 4" of marble shielding will be placed outside.
- Will remain on sliding trays / rails for removal into walkway when accessing components.
- Current concept uses movable baseplates, but possible design could use parallel support rails to beam line for side to side movement instead.
- These are a minor design task and will be finished up after main shielding is approved & drawings generated.



EXTERNAL SHIELDING

- Multiple blocks will extend to end of shielding
- There will be a hand-stacked steel shield 6" thick, consisting of ½" plate at the ends of the devices which is built around the beam pipe.
- The side shield, in conjunction with the steel above and concrete / marble in front should mostly encapsulate the problematic devices.



CABLE TRAY LOCATION ON WALL

• Sufficient clearance on wall to accept a 12" W x 12 H cable tray.





• Space behind columns can be utilized for cabling & instrumentation runs if routed from top of the ceiling.

CABLE TRAY PLACEMENT IN TUNNEL



Proposed Installation Steps

M4 Line magnets, kickers, septa, etc... installed.

- Decreases chances of misplaced support column.
- Beam tube / connections cannot be installed at this point. Ideally they wait for support columns.
- Support columns placed.
 - Final device placement is known.
- Beam tube installed / welded.
- All cable trays installed.
- All water / electrical bus / instrumentation installed.
- Shielding shelves installed.
- Shielding steel put in place.
 - Will work around existing installations.
- Concrete / marble side shielding installed.

Proposed Installation Schedule

Gantt Char	hart - No OBG 11x17 24/Feb/2014 05:2														
Planned	d FY2013 FY2014 FY2015 FY2016 FY2017 FY2018 FY2019 FY2020	021													
Duration		FF													
	▼ 16/Sep/2016 05:00 PM, In Tunnel Shielding Over Loss Points														
159	9 Make MARS calculations to determine steel shielding impact on TLM response FY13 (ACWP)														
42	2 Make MARS calculations to determine steel shielding impact on TLM response FY14														
15	5 Per Extraction location change to inside of ring; iMake MARS calc. determine steel shield. impact on TLM response														
148	General Shielding Design & Review: Fixture Engineering FY13 (ACWP)														
100	General Shielding Design & Review: Fixture Engineering FY14														
69	9 Develop ESH Radiation Limit and understand MARS skyshine calculation (ACWP)														
10	0 Find possible sources of shielding steel on site (ACWP)														
74	Adjust cost estimate from preliminary design FY13 (ACWP)														
48	Adjust cost estimate from preliminary design FY14														
20	0 General Shielding Design & Review: Procurment Labor														
20	General Shielding Design & Review: Produment M&S														
1	I General Shielding Design & Review: Procurment M&S (Obligation)														
10	0 D Quadrapole / C-Magnet In Tunnel Shielding Support Structure														
125	5 Quadrapole / C-Magnet In Tunnel Shielding M&S														
1	1 Quadrapole / C-Magnet In Tunnel Shielding M&S (obligation)														
20	0 Quadrapole / C-Magnet In Tunnel Shielding														
10	0 Lambertson In Tunnel Shielding Support Structure														
126	6 Lambertson In Tunnel Shielding M&S														
1	1 Lambertson In Tunnel Shielding M&S (obligation)														
20	0 Lambertson In: Tunnel Shielding														
10	0 D2Q4 Quad In Tunnel Shielding Support Structure														
125	5 D2Q4 Quad In Tunnel Shielding M&S														
1	1 D2Q4 Quad In Tunnel Shielding M&S (obligation)														
20	0 D2Q4 Quad In Tunnel Shielding	D2Q4 Quad In Tunnel Shielding													
250	0 Develop Links to Extraction Septa installation link to installation activity in VN/MC's schedule														
20	0 Extraction Septa / D2Q3 Quad In Tunnel Shielding Support Structure														
140	0 Extraction Septa In Tunnel Shielding M&S														
1	1 Extraction Septa In Tunnel Shielding M&S (obligation)														
20	0 Extraction Septa / D2Q3 In Tunnel Shielding														
15	5 As Built conditions documented for in-tunnel shielding														

Shielding Walls For M4 / M5 Line Reconfiguration Work

- Will need to build multiple shield walls for the M4 and M5 beam line reconfigurations.
- Will involve heavy use of rigging equipment an fork truck to build wall.
- Wall depth is up to 14', stretching the width of the tunnel.



Shield Wall For M4 / M5 Reconfiguration Work

- Existing shielding from CDF will have to be dismantled and reconfigured for new installation.
- There are two walls that can be dismantled, with additional sand bags available for upper shielding.
- An interlocked gate will have to be installed at these locations.
- This wall will then be moved and reconfigured again, at a location down stream of the existing installation.



Shield Wall For M4 / M5 Reconfiguration Work

Planned	FY2	2013			FY20		FY2015					FY2016				FY2017				FY2	018			FY2	019		FY2020				021	
Duration	F	F	F	F	F	F F	Q4	F	F	F	F	FQ1	F	F	F	FQ1	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
13	H			De	sign sl	ield v	vall o	lown	strea	m/	diagn	ostic	abso	rber (in M	4 line)FY	13 (A	CWI	P)												
1	8			8/2	8/20/13 Muon Department decision to leave in place temporary shielding downstream of diagnostic absorber																											
9	9 Preliminary design shield wall downstream / diagnostic absorber (until wall taken appart) (in M4 line) FY14																															
20					Dismantle Wall at CDF																											
20														Final	plan	ning (of CE)F wa	al rel	ocatio	in, st	age n	nateri	al pri	or to	instal	lation	in M	4 line			
20														Bui	ld an	d Insi	tal te	mpor	arys	hieldi	ng w	all at	Junc	ion o	f M4 (M5	ines					
1													1	Build	and	Insta	l tem	pora	ry sh	ieldin	g wal	at Ju	inctio	n of I	M4 / N	M5 lin	es M	&S				
30																								Reco	nfig. a	and re	e-loca	ite ex	isting	shiel	d wa	ID:
1												11											Re	confi	g. and	d re-l	ocate	exist	ing s	nield (wal C)S/