Horn Alignment Cross-hair System

NuMI Horn Alignment Cross-hairs

Target Hall Instrumentation Review
November 18, 2002

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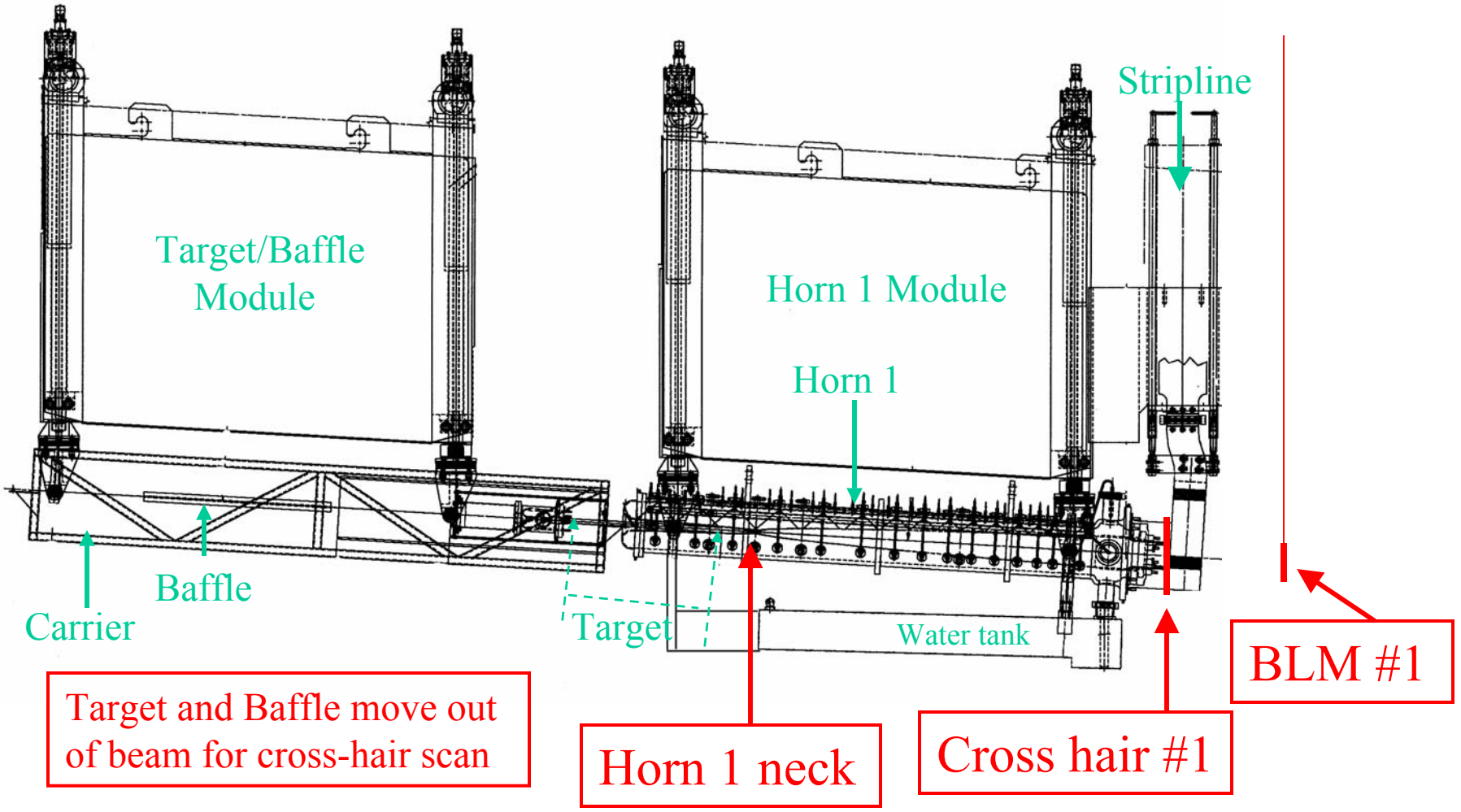
Outline

- Description, specifications
- Status and remaining work
- Summary

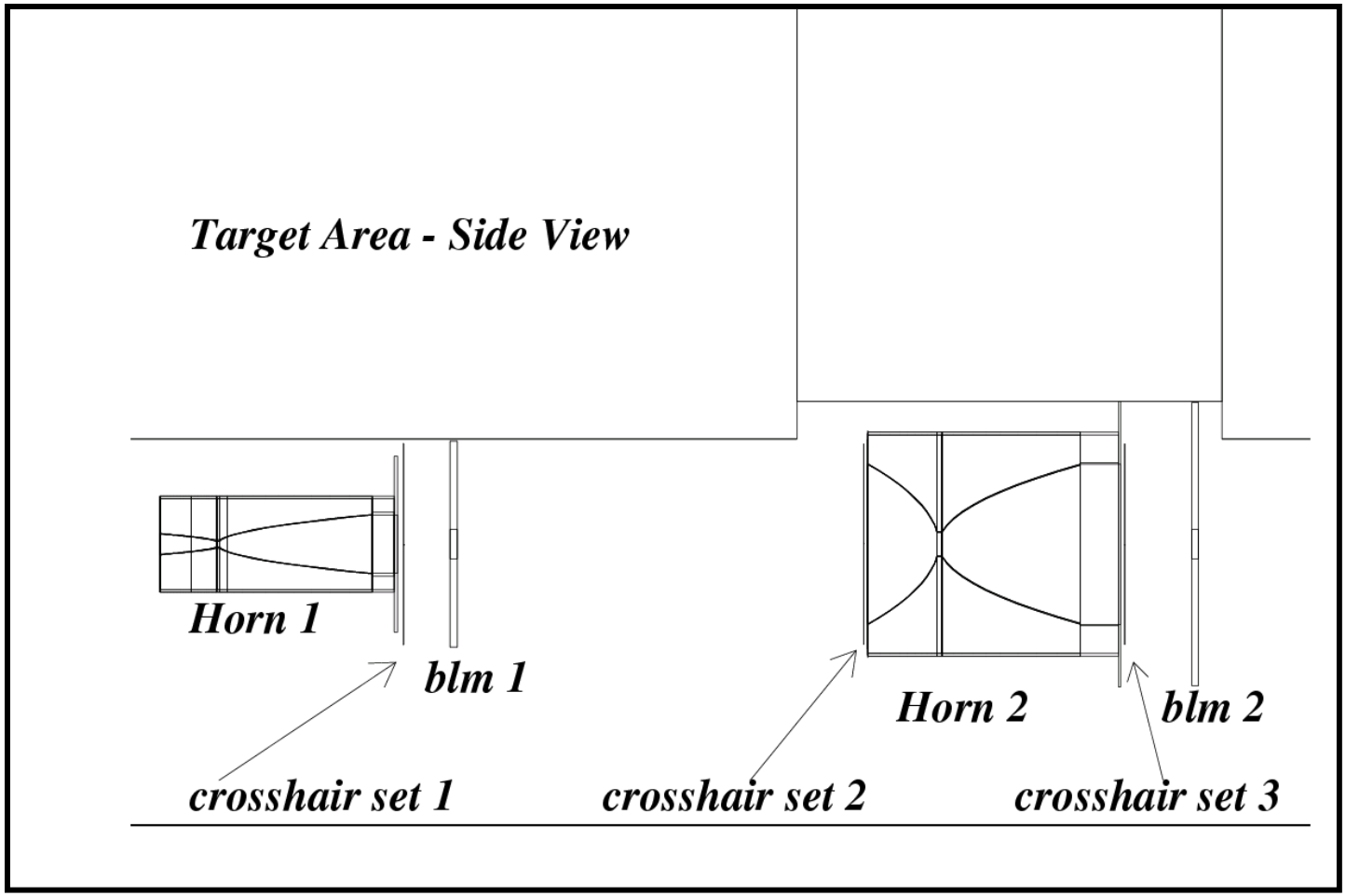
Cross-hair Alignment System

- The cross hairs are three sets of horizontal and vertical strips of aluminum attached to the ends of Horn 1 and Horn 2
- Horizontal and vertical scans are performed with the low intensity proton beam across each set of cross hairs (target/baffle out)
- Protons scattered by cross hairs are detected by Beam Loss Monitors (BLMs) downstream of Horns 1 and 2
  - « BLMs read out through ACNET
  - « BLMs offset from beam centerline by 30 cm to avoid damage during high intensity running
- Each set of cross hairs is offset from beam centerline by +2.5 mm or –2.5 mm, both horizontally and vertically
  - « To distinguish the signals from different sets during scans
  - « To avoid damage by high intensity beam
- The upstream end of Horn 1 cannot have cross hairs but its location will be determined by scanning the neck of the horn inner conductor

Target/Baffle/Horn-1 Cross-hair Geometry



Cross-hair Geometry for Horns 1 and 2



Cross-hair System Simulations

- MARS beam heating calculations determined that cross hairs made of 1-mm wide aluminum strips would not overheat during full intensity running
  - NuMI-882, Byron Lundberg
- GEANT simulations determined the thicknesses of cross hairs needed to give good scan signal-to-noise (0.6-0.8) in BLMs: #1 and #3 are 12 mm thick, #2 is 36 mm thick
  - NuMI-864, Debbie Harris
- The NuMI-864 GEANT simulation also showed that
  - A scan of the Horn 1 neck gives exellent signal-to-noise (>10)
  - During normal running, cross hair scattering causes less than 0.2% changes in neutrino flux and in the ratio of near/far detector event rates

Cross-hair System Specifications

- Proton beam instrumentation and control should permit scans at low intensity (10^{12} protons/pulse), ±3.5 mm at cross hairs, ±12 mm at Horn 1 neck.
- Beam scans should determine Horn 1 and Horn 2 transverse locations to at least ±0.5 mm and ±1.0 mm respectively.
- BLM response should be stable and sensitive to rate changes of ~5% at intensities expected during scans (10^{7} particles/cm^2/10^{12} protons/spill).
- Additional material in the beam (beyond that assumed in NuMI-864) will degrade signal-to-noise ratio in scans.
- Cross-hair material should not effect neutrino flux significantly (<1%).
- Cross-hair and BLM locations, materials are chosen to ensure survival during full intensity beam running.
- BLMs should be able to measure beam-pulse timing and targeting efficiency as a backup for target Budal monitor (after initial calibration against Budal monitor).

Cost and Schedule

- The cross-hair task is approximately on schedule
- The cost estimate (CR #156, Feb. 2002) still seems OK

Horn Alignment Cross-hair Cost and Schedule (from Oct. 02 Status)

UID	Activity	Start	Finish	Burd. Cost	Type	Notes
75157	Mechanical design	3-Oct-02	27-Nov-02	$10,458	SWF	
75158	Drafting	2-Dec-02	30-Jan-03	$11,155	SWF	
75159	Materials purchase req. prep.	31-Jan-03	6-Feb-03	$588	SWF	
75164	Materials delivery	27-Mar-03	27-Mar-03	$18,791	M&S	
75161	Fabrication oversight	31-Jan-03	3-Apr-03	$3,567	SWF	
75162	Fabrication, assembly	28-Mar-03	7-Apr-03	$4,679	SWF	
75163	Installation	26-Aug-04	9-Sep-04	$8,123	SWF	15.5 months float!
	Total burdened cost			**$57,361**		

Status and Remaining Work

- Complete engineering of cross-hair mechanical structures
  - « Complete engineering design and drawings
  - « Repeat simulations with final cross-hair and BLM configurations and locations
  - « Recheck calculation of beam heating with final geometry
- Build and test prototype cross hair sets
  - « Check mechanical stability during pulsing on Horn 2 in MI-8 during Spring 2003
  - « Test Horn 1 cross hairs in MI-8 during Summer 2003
- Build and install three production sets of cross hairs

Summary

- Cross-hair and BLM designs are advanced enough to ensure that specifications are easily met
- We have a practical plan for completing the engineering, prototyping, testing and construction of the cross-hair system on time and on budget
- BLMs may provide partial backup for Budal monitor functions after beam commissioning