

# NOvA Medium Energy Target Assembly



Zac Espinosa

# Big Questions for NOvA Neutrino Experiment

1. Neutrinos oscillate between three flavors: muon neutrinos, electron neutrinos, and tau neutrinos. By what process do muon neutrinos oscillate into electron neutrinos?
2. What is the neutrino mass hierarchy and by what process do neutrinos get their mass?
3. Do muon neutrinos and muon antineutrinos break charge-parity symmetry?

Source: <http://www-nova.fnal.gov/research-goals.html>

# How it works?

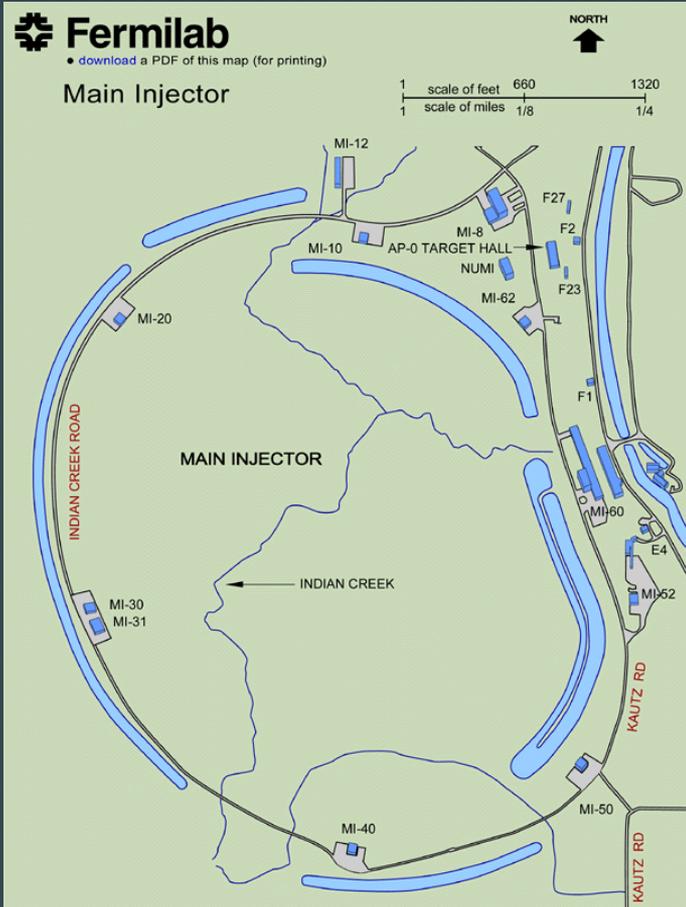


Photo: Fermilab

Main injector accelerates a proton beam

700 kilowatts of power sent to NuMI [Neutrinos at the Main Injector]

Beam pulses in 1.33 second cycles with  $4.9E13$  protons per pulse

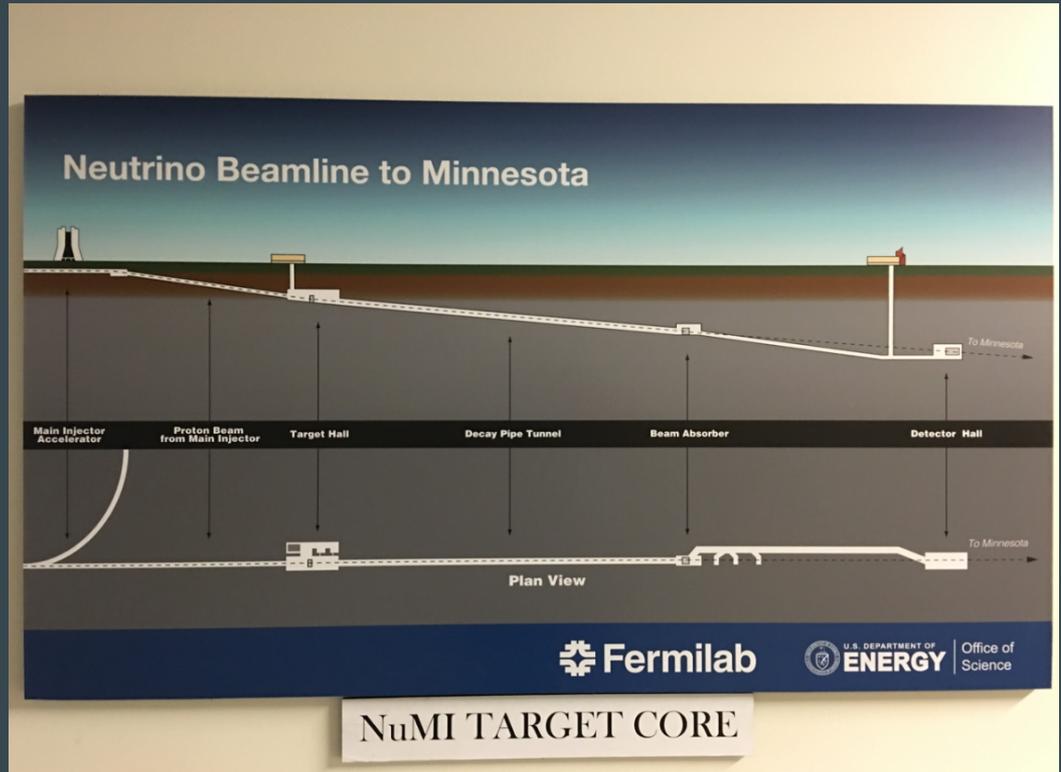
Proton beam converted into neutrino beam through Target & Horn system

Travels 500-miles to Minnesota in three milliseconds

# NOvA detector and NuMI beam



Photo Credit: Fermilab



# Horn and Target System

Entire System

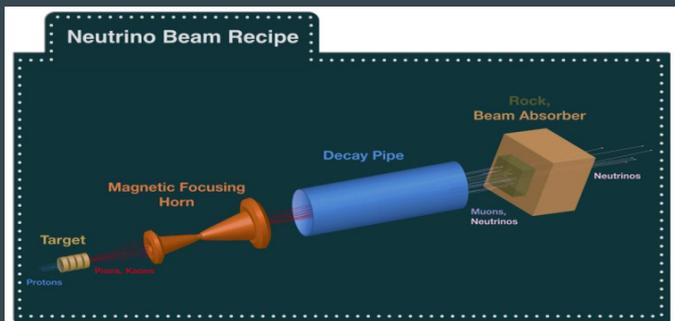


Photo Credit: Fermilab

Target



Horn Upstream

Horn Downstream

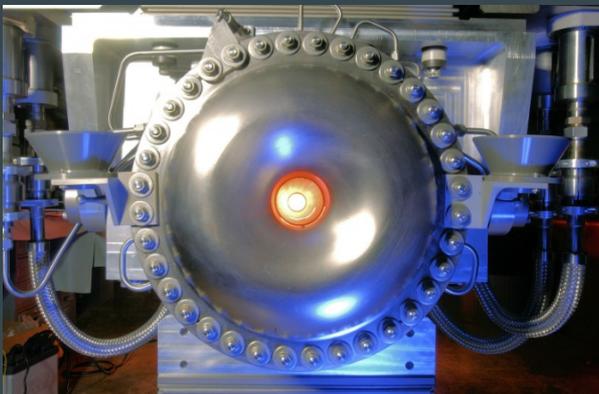


Photo Credit: Fermilab

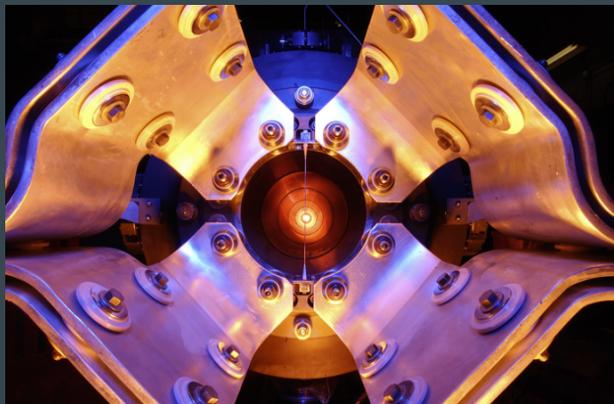
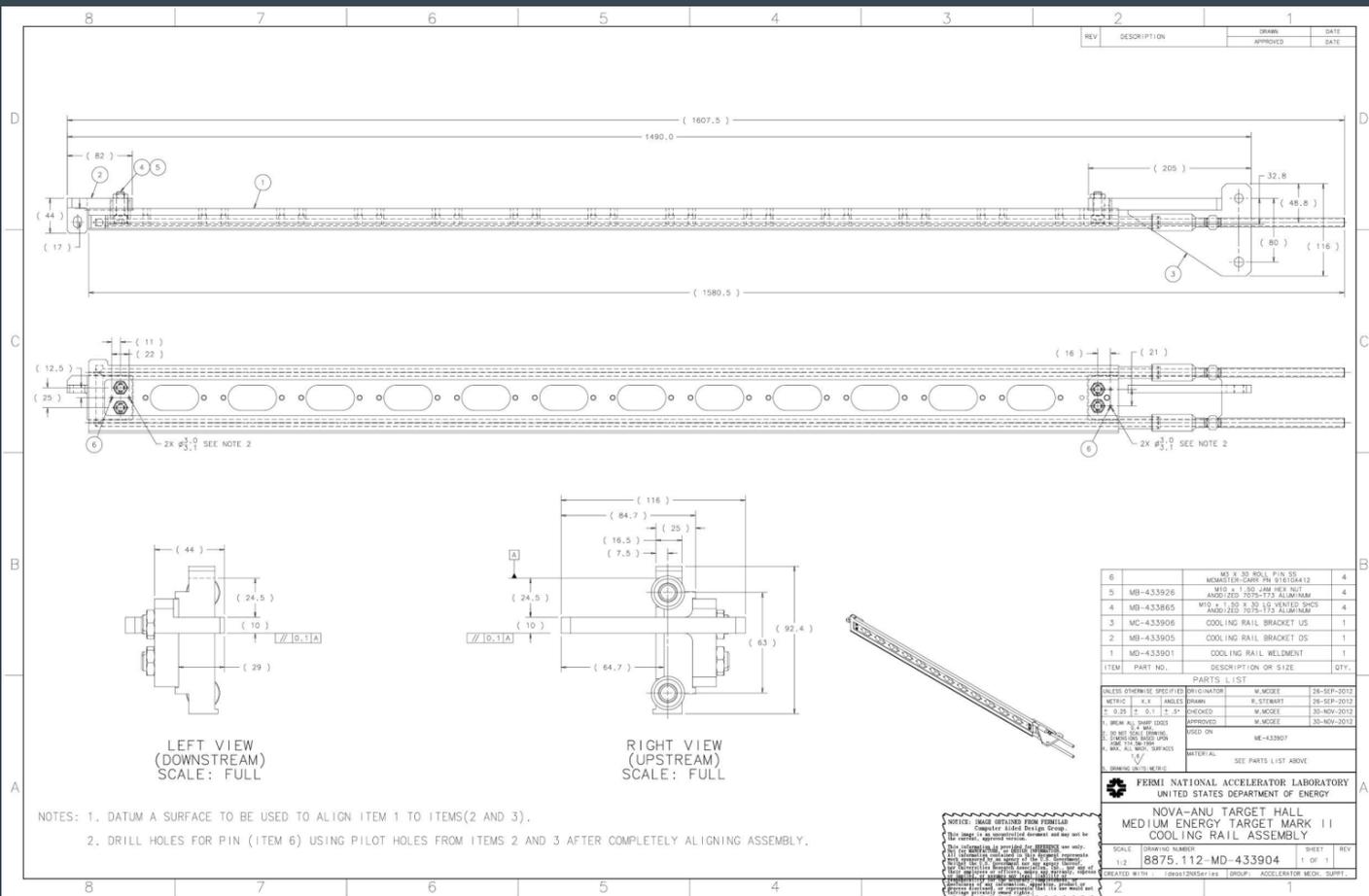


Photo Credit: Fermilab, photograph by Reidar Hahn



ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.
6	MB-433926	MID X 30 ADJ. PIN SS	4
5	MB-433926	MID X 1.50 DIA W/4 NUT	4
4	MB-433865	MID X 1.50 X 30 1/2 VENTED SHCS	4
3	MC-433906	COOLING RAIL BRACKET US	1
2	MB-433905	COOLING RAIL BRACKET DS	1
1	MD-433901	COOLING RAIL WELDMENT	1

PARTS LIST			
UNLESS OTHERWISE SPECIFIED	FINISH/TOLERANCE	DATE	BY
METRIC	R.F. ANGLES	26-SEP-2012	M. WEGE
1: 0.25 I.D. 1: 0.1 I.D.	CHECKED	26-SEP-2012	M. STEWART
0.50 I.D. 0.25 I.D.	CHECKED	30-NOV-2012	M. WEGE
0.50 I.D. 0.25 I.D.	APPROVED	30-NOV-2012	M. WEGE
0.50 I.D. 0.25 I.D.	ISSUED ON	06-433907	
0.50 I.D. 0.25 I.D.	MATERIAL	SEE PARTS LIST ABOVE	

**FERMILAB NATIONAL ACCELERATOR LABORATORY**  
 UNITED STATES DEPARTMENT OF ENERGY

**NOVA-ANU TARGET HALL**  
**MEDIUM ENERGY TARGET MARK II**  
**COOLING RAIL ASSEMBLY**

SCALE: 1:12 DRAWING NUMBER: 8875.112-MD-433904 SHEET REV: 1 OF 1  
 CREATED BY: 088512808/104 GROUP: ACCELERATOR MECH. SUPPLY

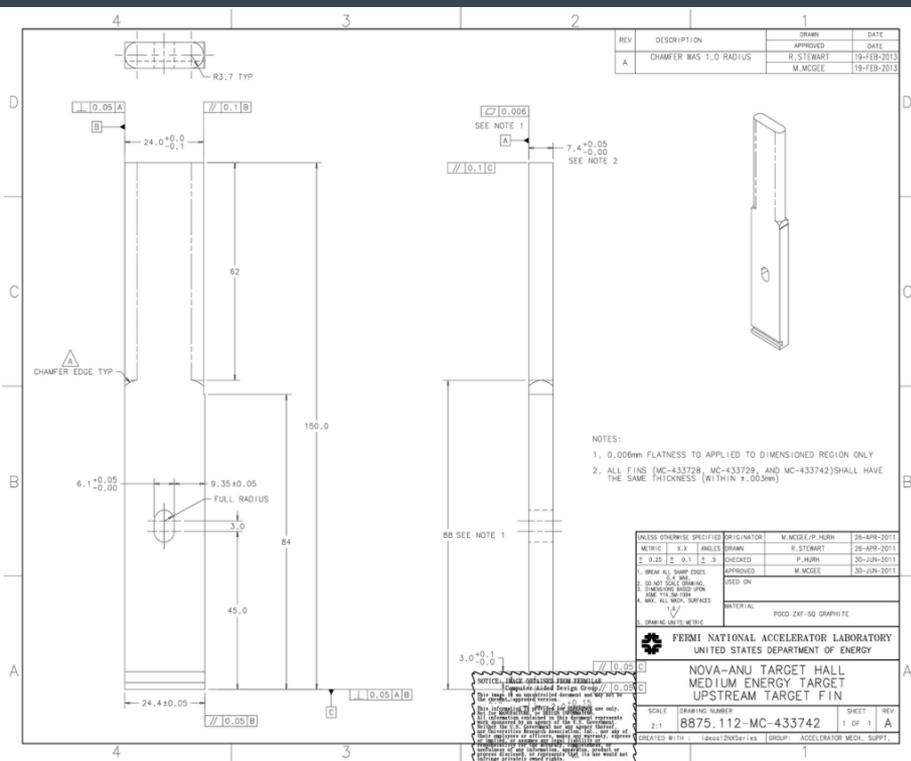
- NOTES: 1. DATUM A SURFACE TO BE USED TO ALIGN ITEM 1 TO ITEMS(2 AND 3).
2. DRILL HOLES FOR PIN (ITEM 6) USING PILOT HOLES FROM ITEMS 2 AND 3 AFTER COMPLETELY ALIGNING ASSEMBLY.

# NoVA Target Cooling Rail

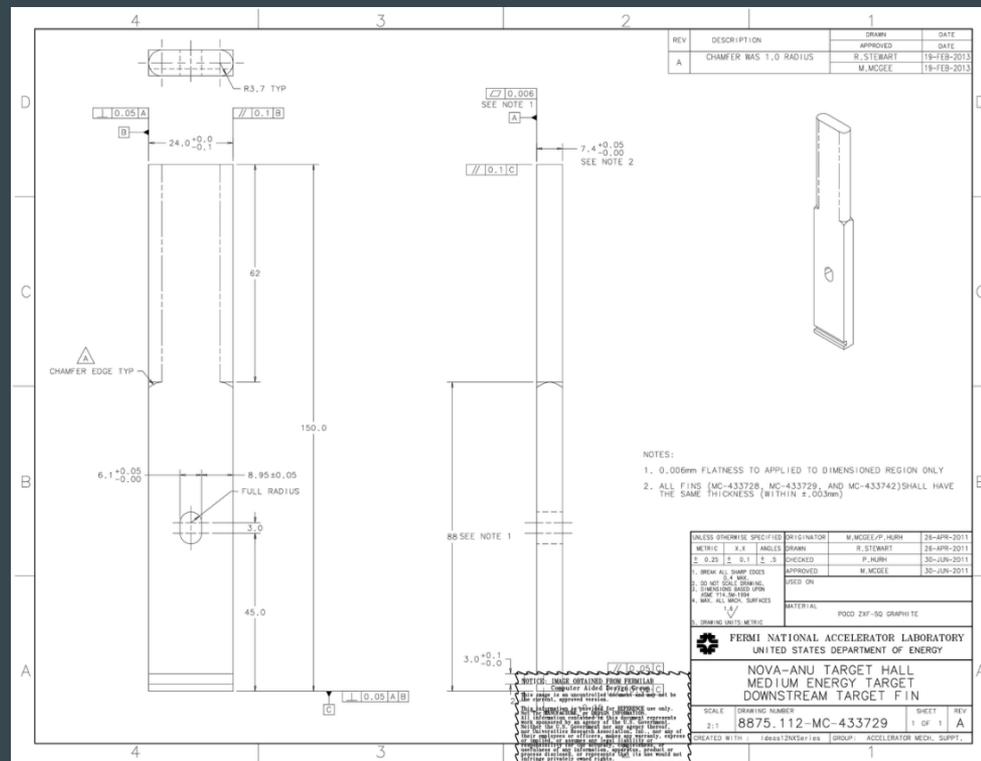


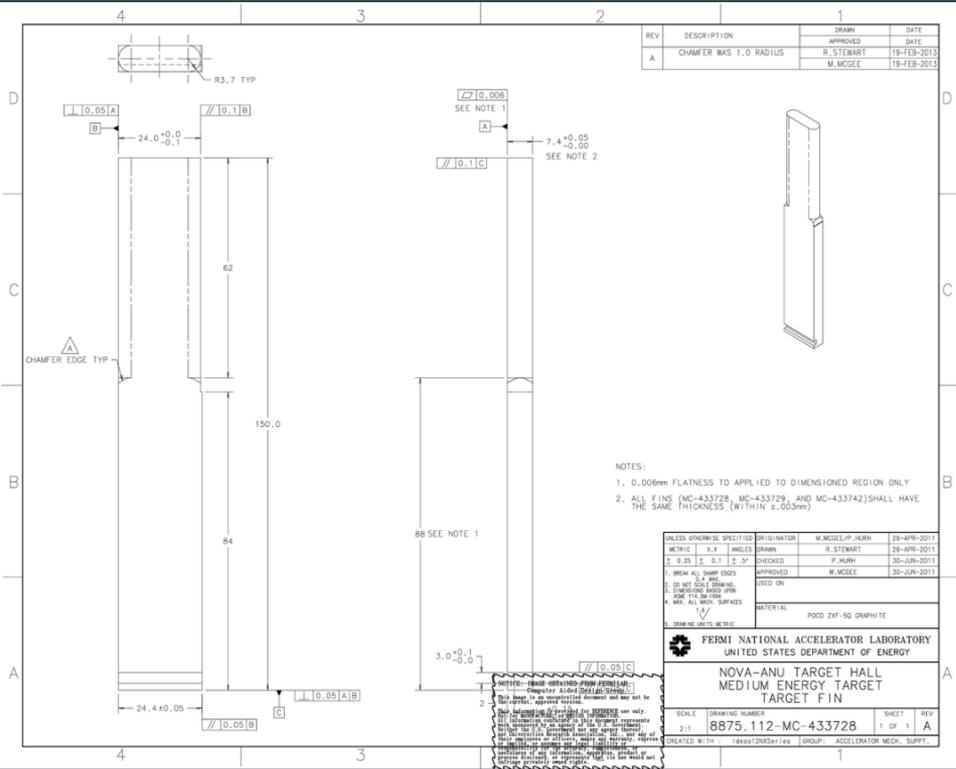
# Graphite Fins & Assembly Process

## Upstream Fin



## Downstream Fin





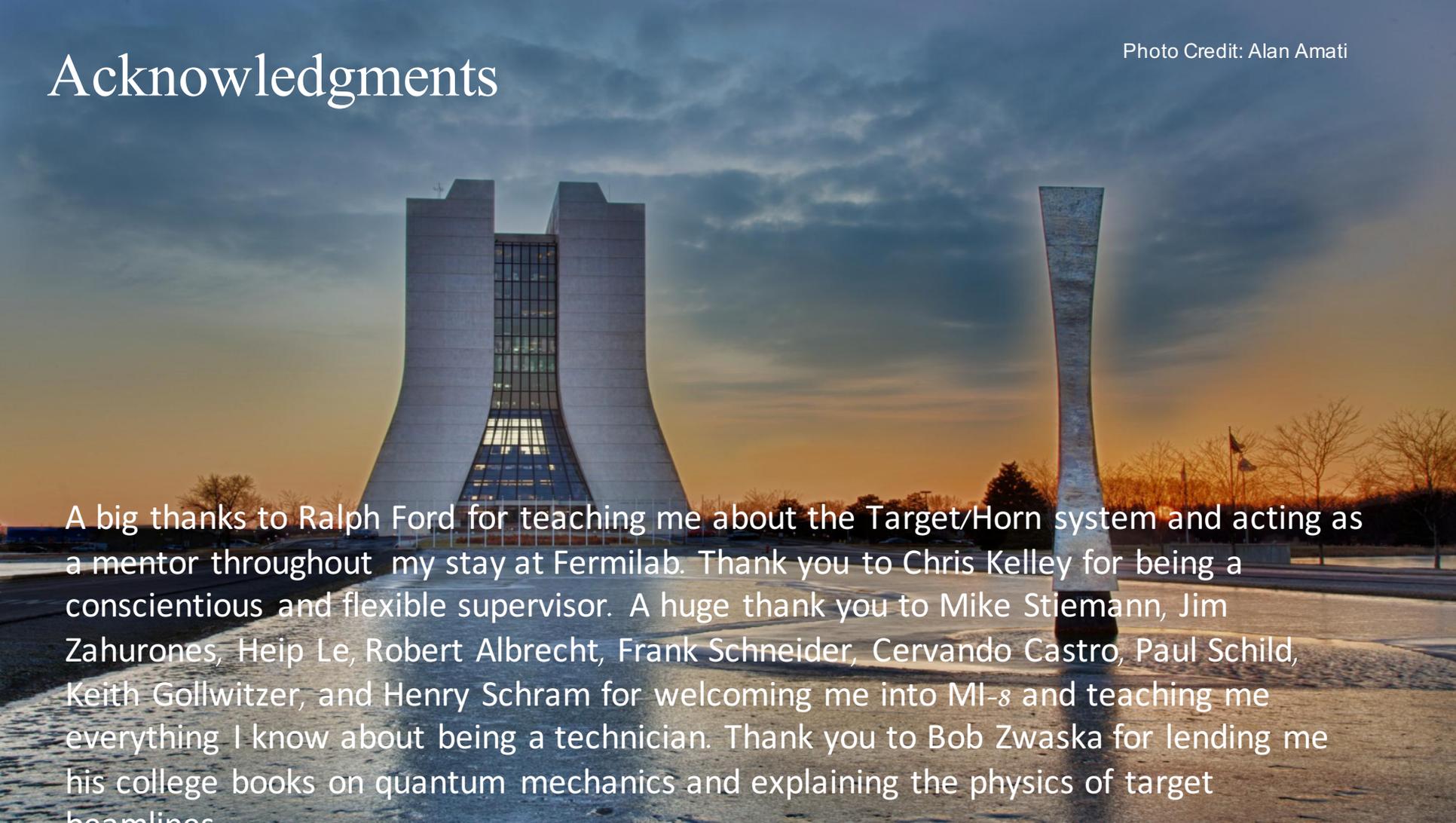
# Sources

Amati, Alan. *Shades of Winter*. 2016. Fermilab, Batavia. *Fermilab Today*. Web. 11 Aug. 2016.

"NOvA." *Fermilab*. Fermi National Accelerator Laboratory, 30 July 2015. Web. 11 Aug. 2016.

# Acknowledgments

Photo Credit: Alan Amati



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