Neutrinos from Stored Muons

νSTORM Target Station Conceptual Design

15-April-2013

Kris Anderson
Fermilab/Accelerator Division/Mechanical Support Department
Target Facilities Group Leader

νSTORM Target Station Conceptual Design

- Goal is to utilize prior and existing target station designs and components from successfully operated FNAL target stations (NuMI/NOvA, APO Antiproton Source, MiniBoone)
- Existing design costs and operational characteristics are well understood
- SWF is a significant cost driver for new projects and impact is minimized by utilizing or slightly modifying existing design concepts

Key Elements of vStorm Target Station

- Target station beamline chase with adequate shielding

- Active beamline elements include:
  - Production target
  - Focusing horn, stripline bus, and power supply
  - Pair of quadrupole magnets and related power supplies/utilities
  - Water cooled collimators for quad protection

- Support modules for beamline alignment of the above devices
- Air handling and radioactive water (RAW) systems
- Work cell for hot handling and failed component repair/replacement
- Remote handling fixtures and camera system
- Hot component storage morgue for device cool-down
- Functional civil construction enclosure consistent with providing the means of maintaining Target Station equipment and facilitating adequate operational up-time

νSTORM Target Station Beamline Elements

Utilize NuMI /NOvA style horn 1 for focusing pions produced in a NuMI low energy style graphite fin target

- *NuMI LE style graphite fin target (95cm length x 6.4mm wide) has been successfully operated at beam power of 350kW to 400kW*

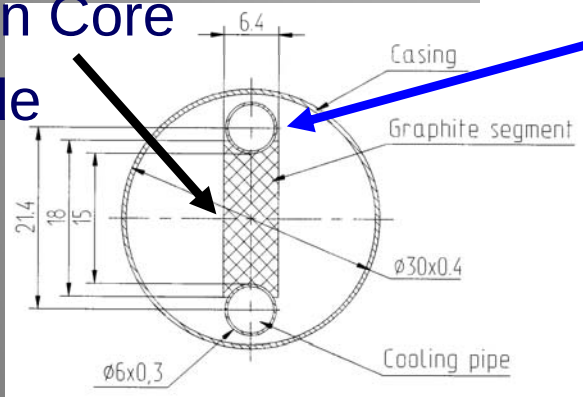
- *NuMI horn 1 baseline design for 200kA peak current pulse, 400kW incident beam, and 10M pulse fatigue life (plus an additinal fatigue life safety factor)*

- *Work ongoing to define quadrupole magnet design and requirements*

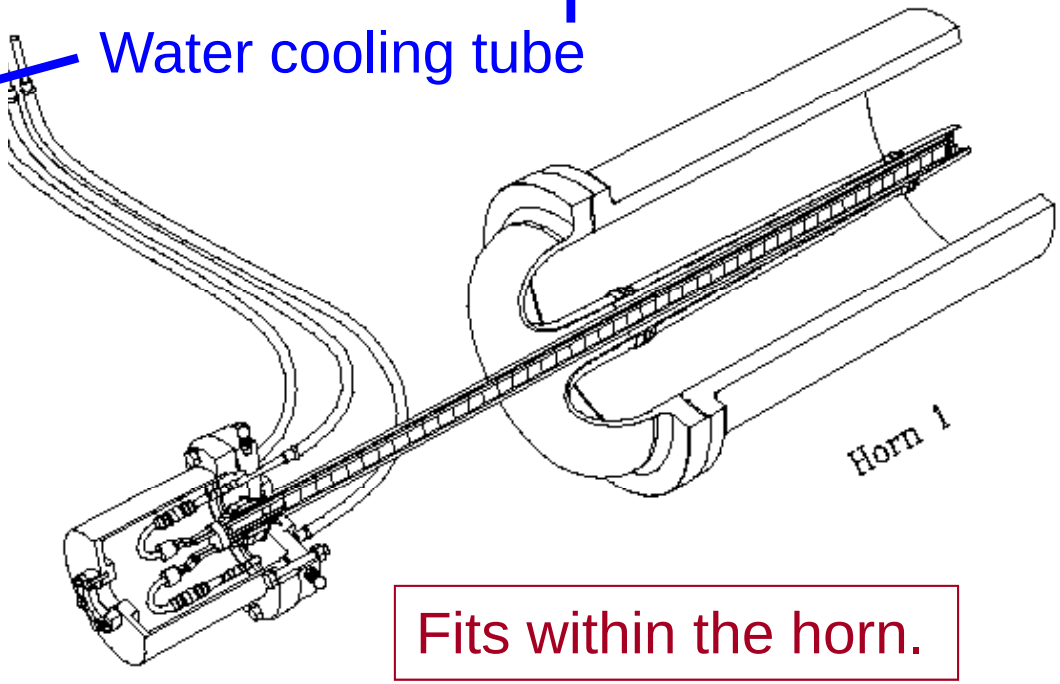
Target for Low Energy Neutrino Spectrum

Graphite Fin Core

6.4 mm wide



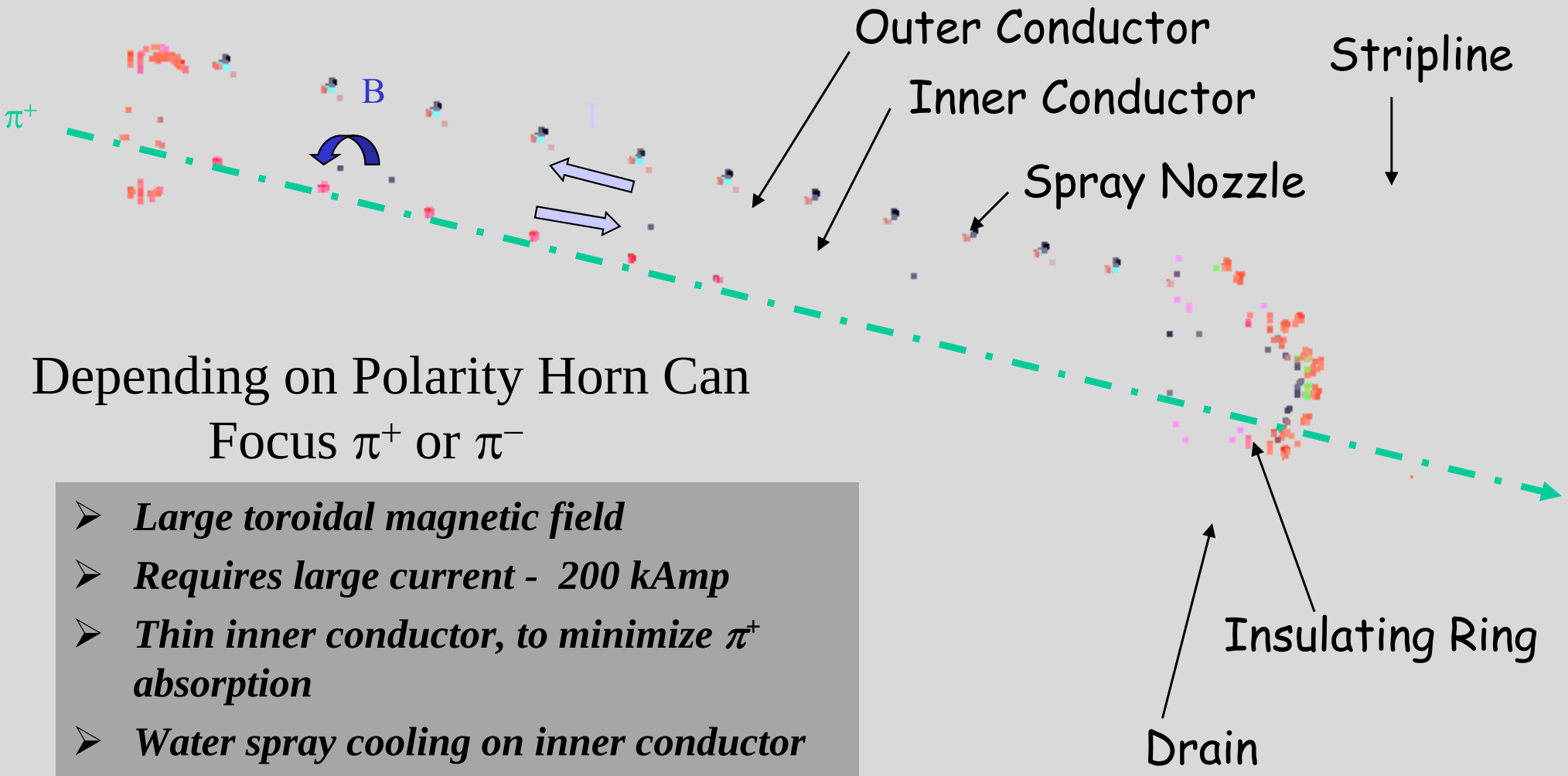
Water cooling tube



Backing target out of horn produces neutrinos at higher energies

Fits within the horn.

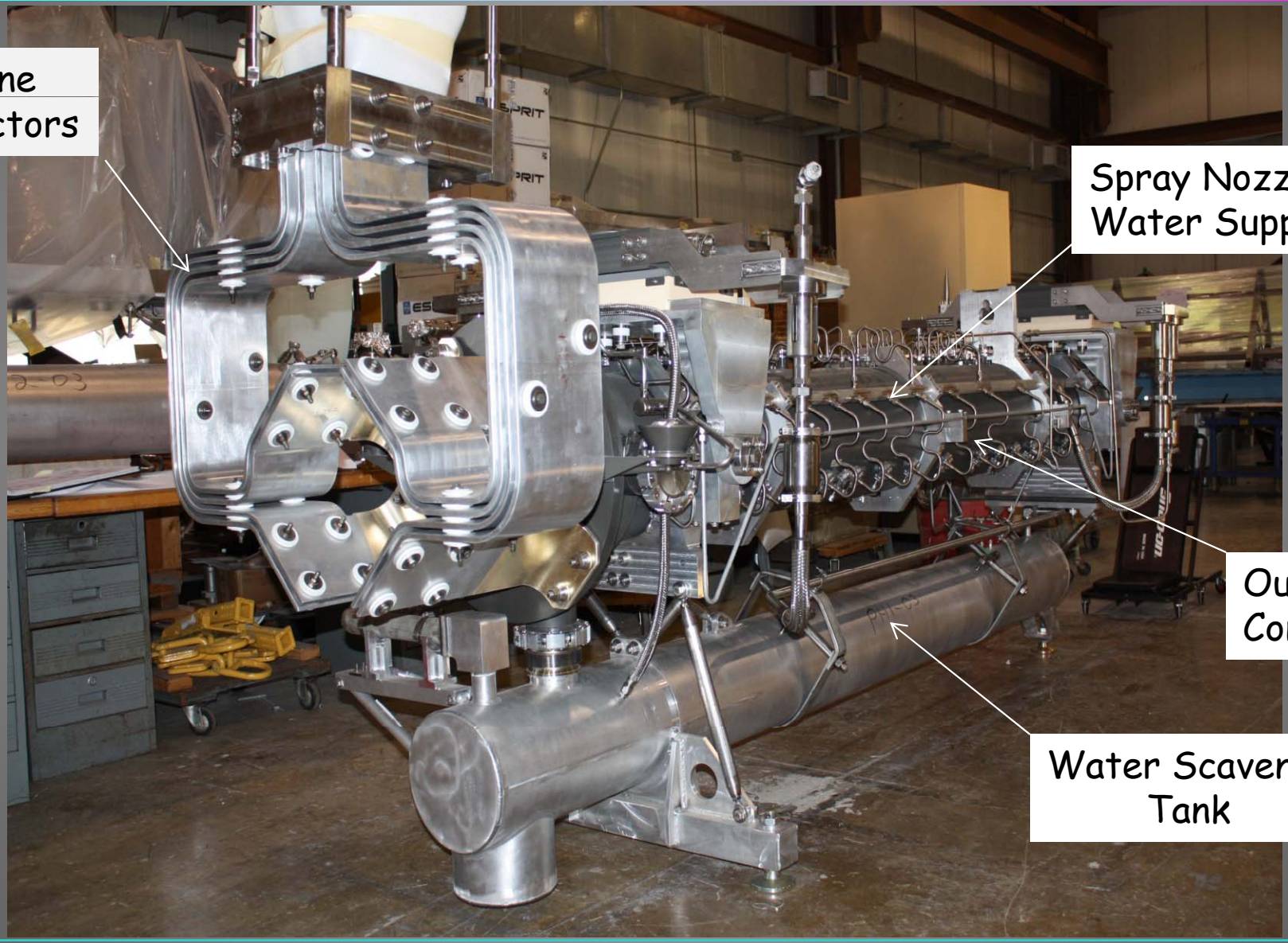
Magnetic Horn
General Design Features



Depending on Polarity Horn Can Focus π^+ or π^-

- ***Large toroidal magnetic field***
- ***Requires large current - 200 kAmp***
- ***Thin inner conductor, to minimize π^+ absorption***
- ***Water spray cooling on inner conductor***

vSTORM Target Station Beamline Elements: NuMI Horn 1



Fermilab

νSTORM Target Station Conceptual Design Approach

- Utilize NuMI style target chase and positioning modules
- Utilize NuMI style hot handling techniques
- Target chase shielding steel would be mostly comprise of relatively inexpensive "Duratek" shielding blocks
- Target station facility would likely be a variation between NuMI and the APO Antiproton Source Target Hall
- Need to have an effective plan for handling airborne activation products and tritium control

Target Chase Configuration- Proposal to Use NuMI Style

Concrete Lined Beamline Chase Walls and Base Provided by Civil Construction

Beamline Chase Steel Constructed Using Duratek Steel Blocks

Target Chase Configuration- Proposal to Use NuMI Style Components

NuMI Low Energy Target and Associated Beamline Positioning Module

New NuMI Horn 1 and Beamline Positioning Module Chase Installation

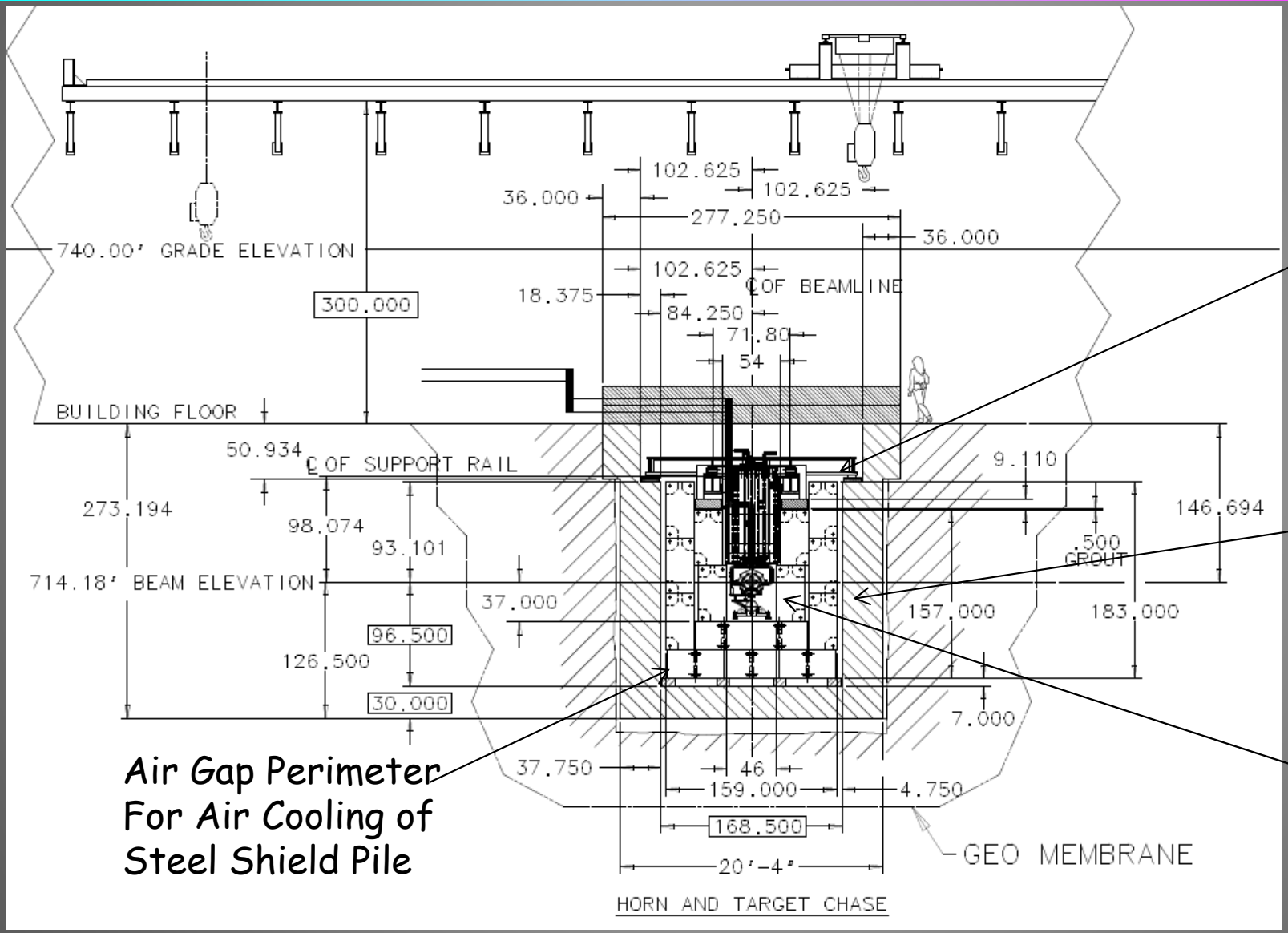
Target Chase Configuration- Proposal to Use NuMI Style Components

Downstream end of horn 1 suspended in NuMI target chase by module showing stripline conductors and water scavenge tank surrounded by Duratek steel shield block pile

Target Chase Configuration- Proposal to Use NuMI Style Components

NuMI Workcell for Failed Component Replacement
(Image shown is that of new components during installation)

vStorm Beamline Chase Conceptual Design Cross-Section: Horn, Module, and Shielding



Horn Module Support Carriage Cross-Beam

Poured Concrete 3ft. Nominal Thickness

Duratek Steel Shielding Blocks

Air Gap Perimeter For Air Cooling of Steel Shield Pile

vStorm Beamline Target Station Plan View

Work is ongoing to provide cost estimates associated with this proposed facility