



# Modification of LBNF Beam, Concept

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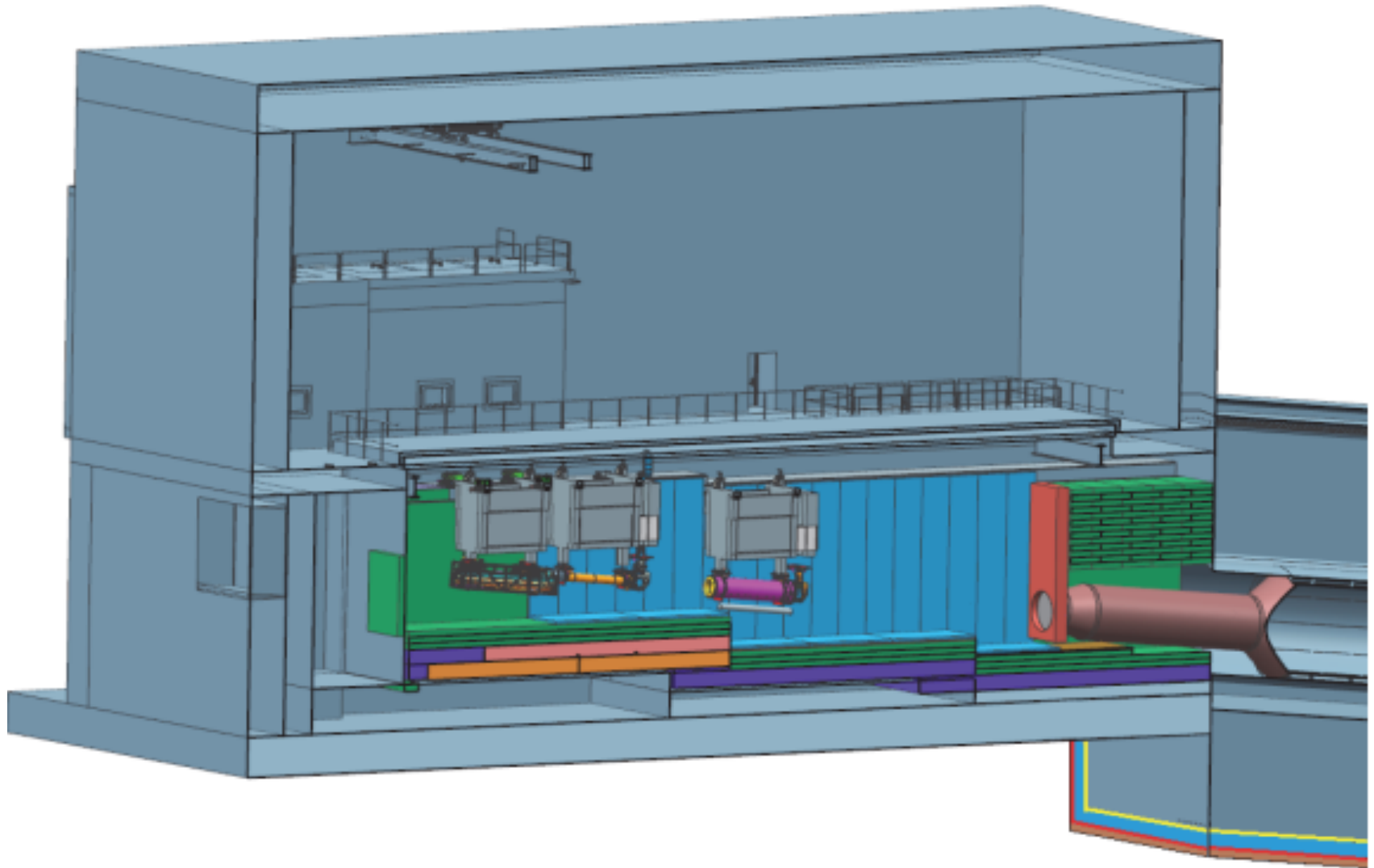
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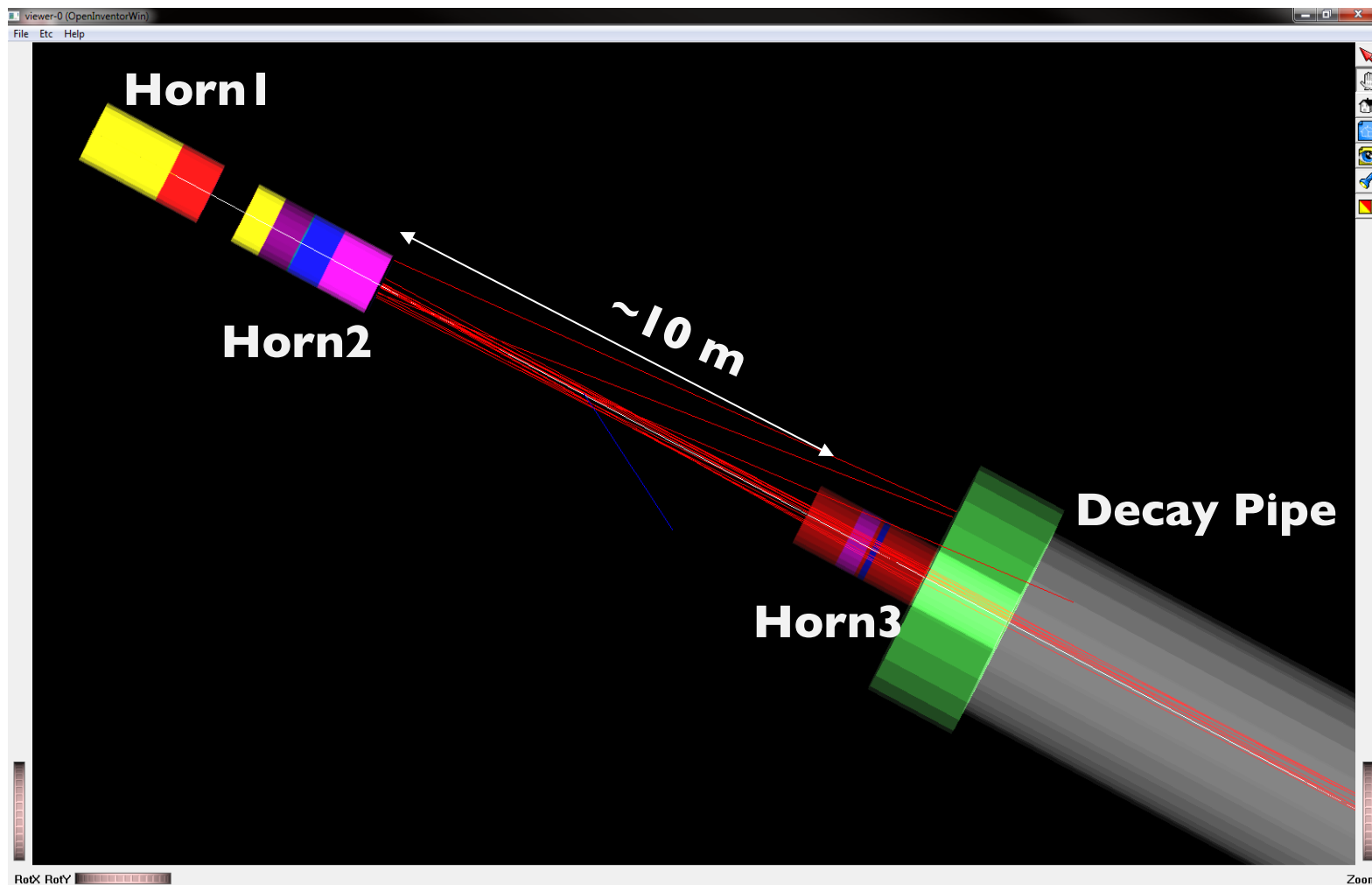


**There is about 25 meters from start of Target to the entrance to Decay Pipe inside of Target Hall**



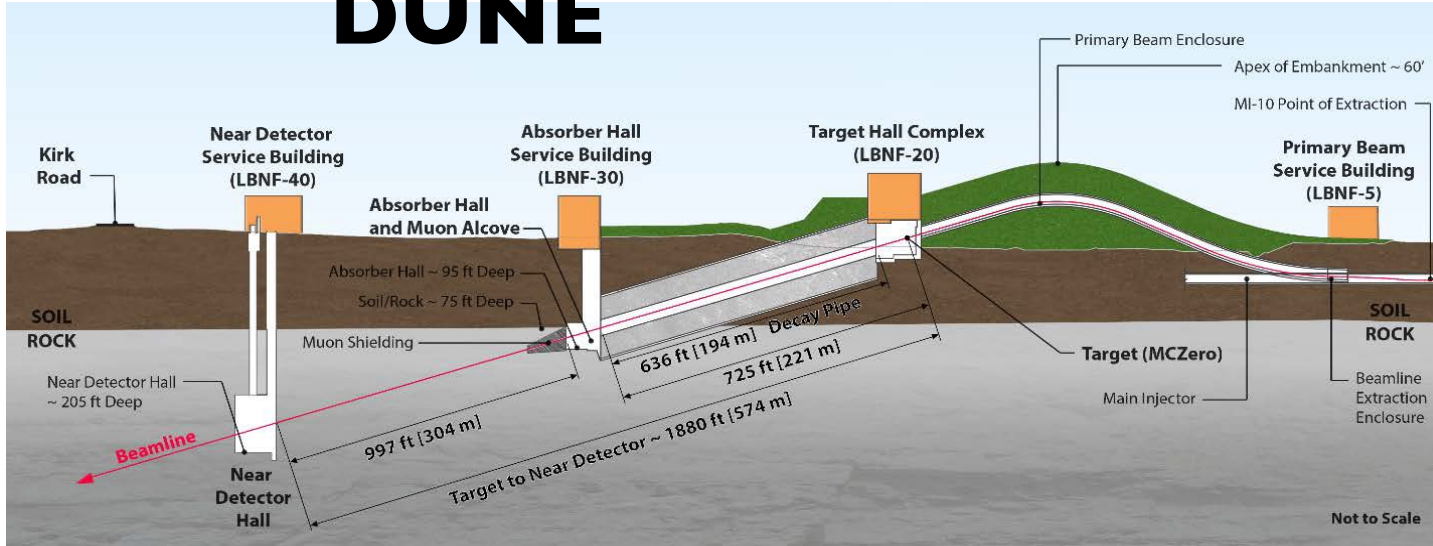


# Laura's 3 Horns Beam Optimized Configuration



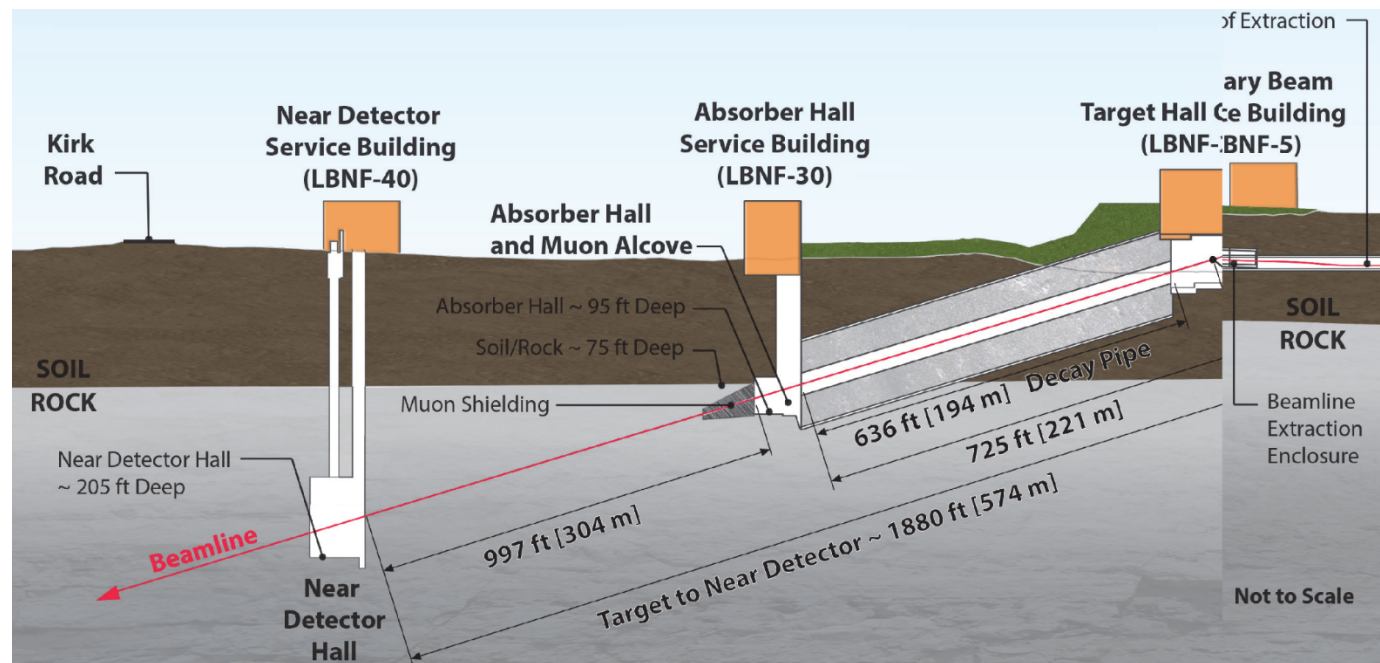


# CDR & Modified DUNE



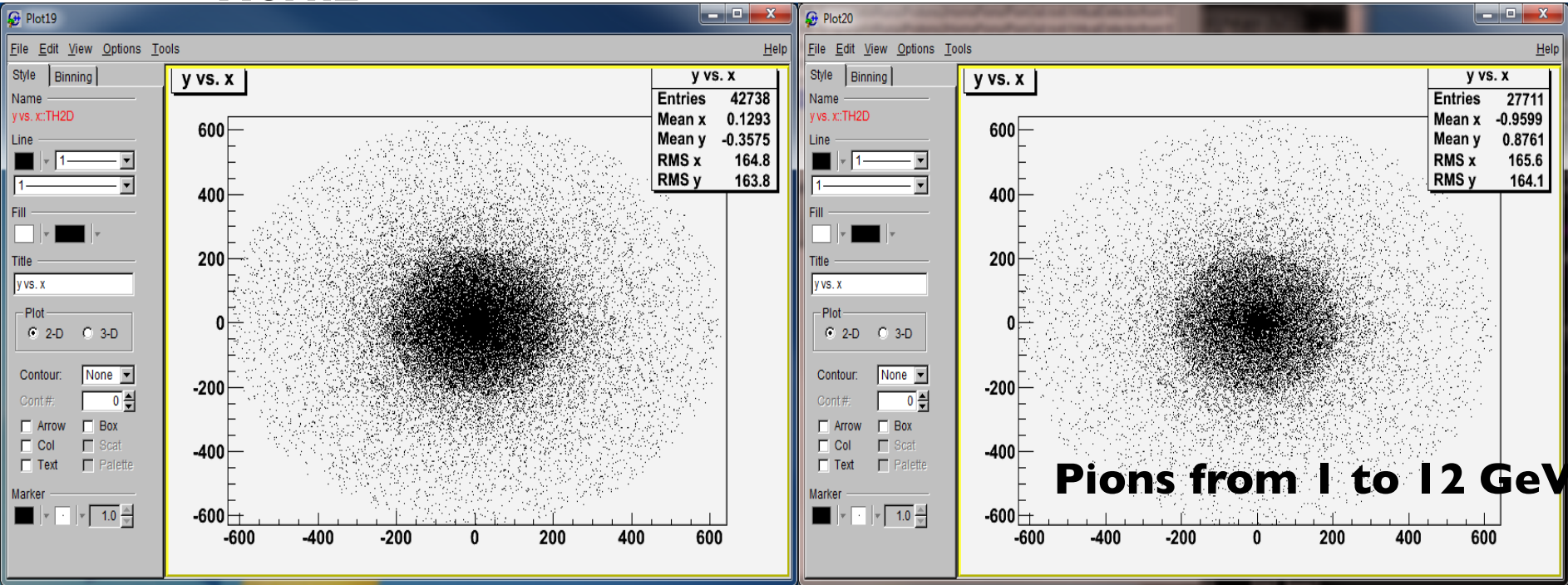
## 120 GeV protons are bended on Target

**Suggestion is to consider 120 GeV protons on Target and then bend and collect "useful" Pions**

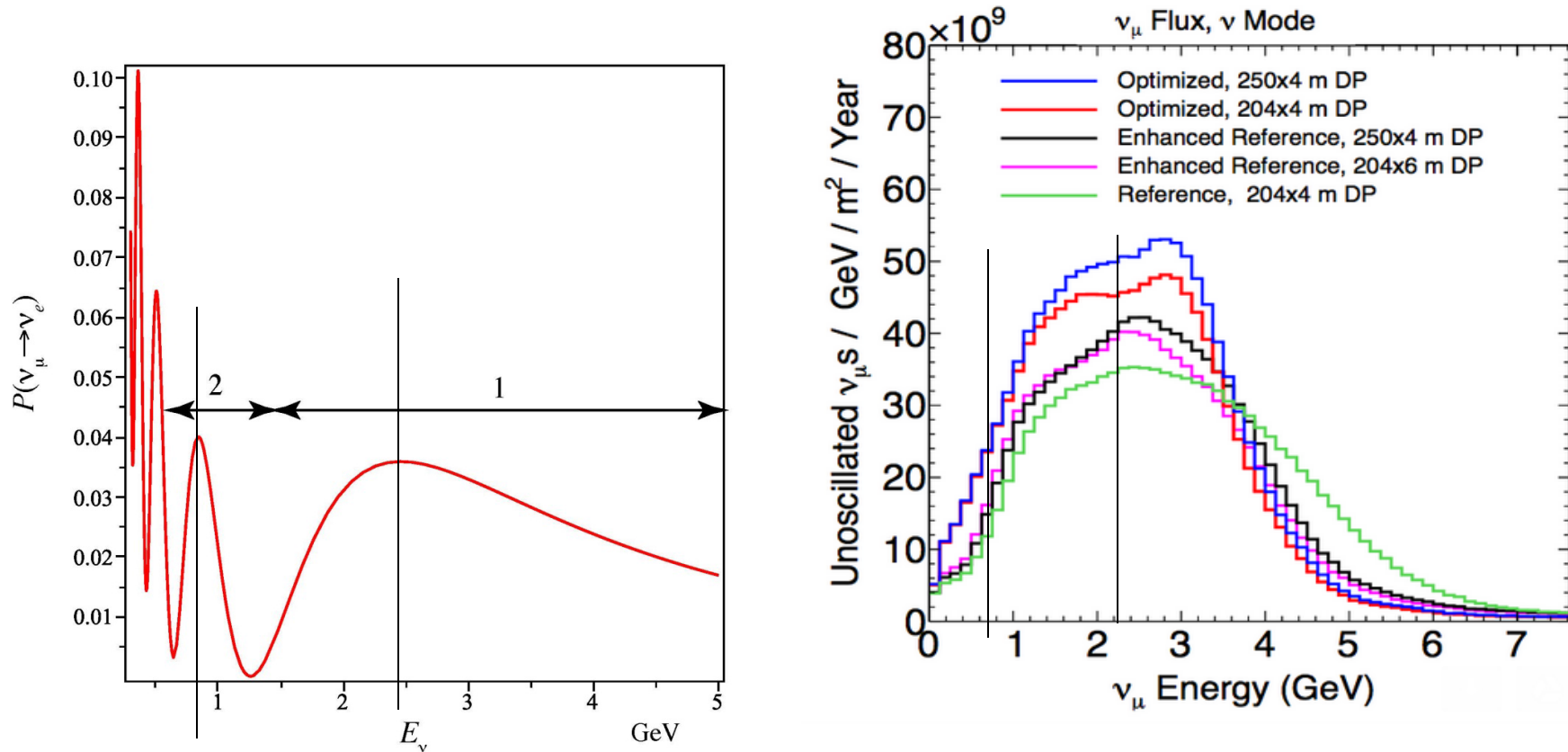




# $\pi$ 's from 10k protons on 2m C-target at exit of Horn2



**This looks like 'beam' and most of pions can fit in a pipe with radius of,  $R \sim 25\text{cm}$**



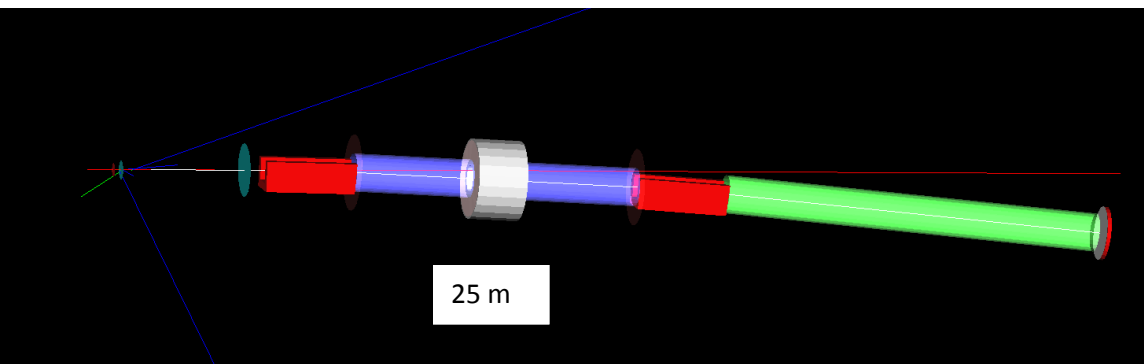
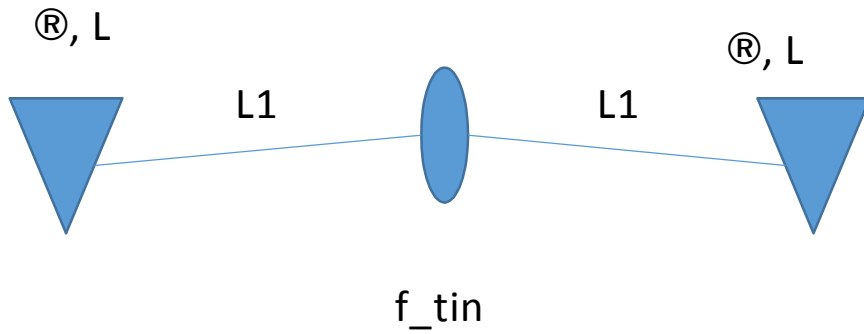
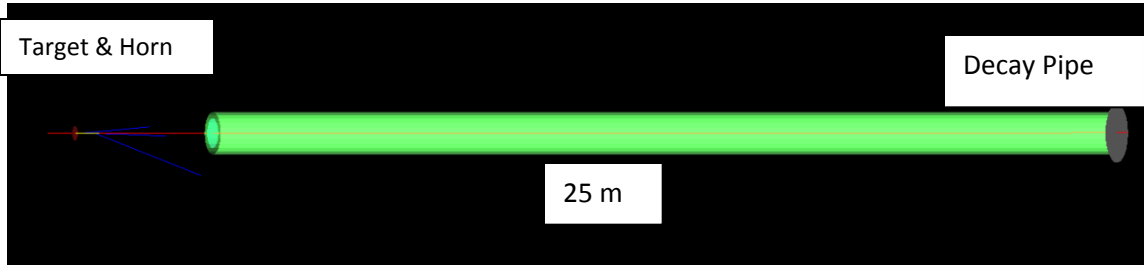
**Figure 1-2: Energy Range of the Oscillation Peaks.** The energy range of the first and second oscillation peaks are denoted by the respective numerals. The beam design is optimized to produce neutrinos within this range. The true probability depends on a parameter,  $\theta_{13}$ .



# Double Bend Achromat

## $E_{kin} = 4\text{GeV pion}(+)$

100k, GeV | 20 POT

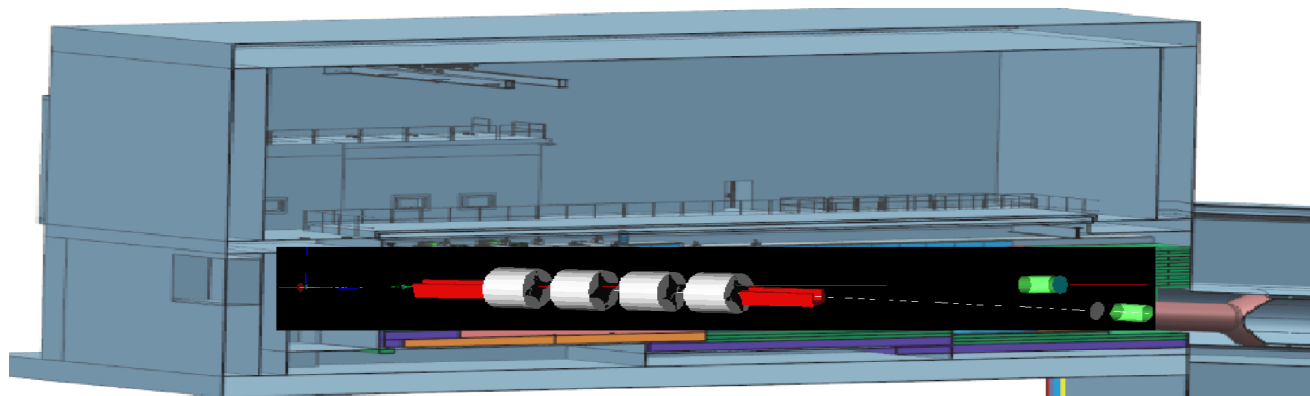
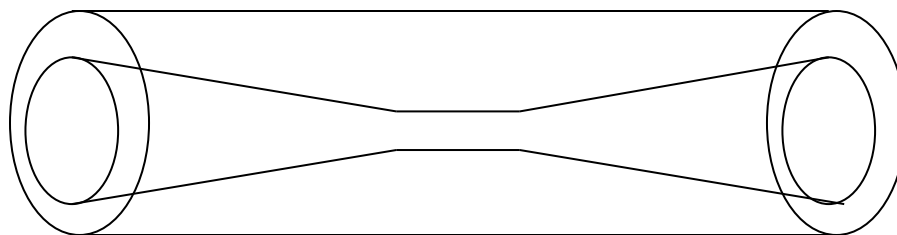
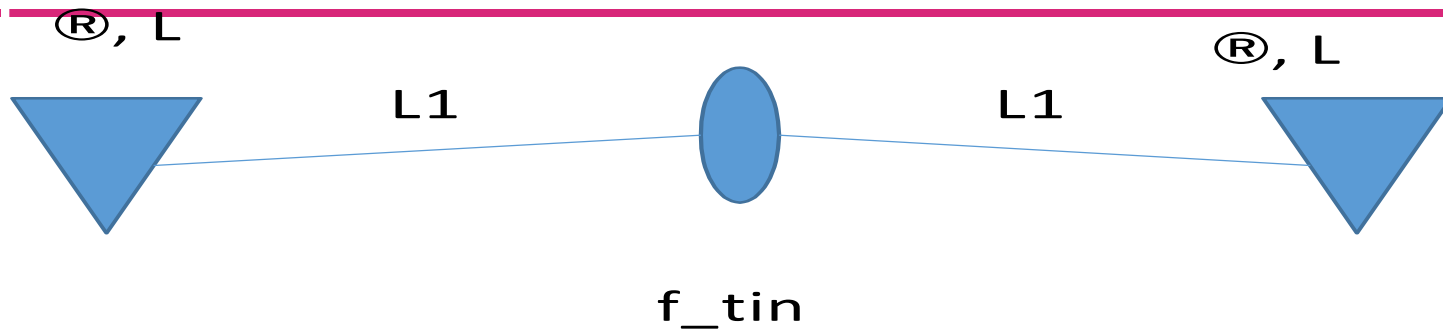


**Single quad does not work very well!**



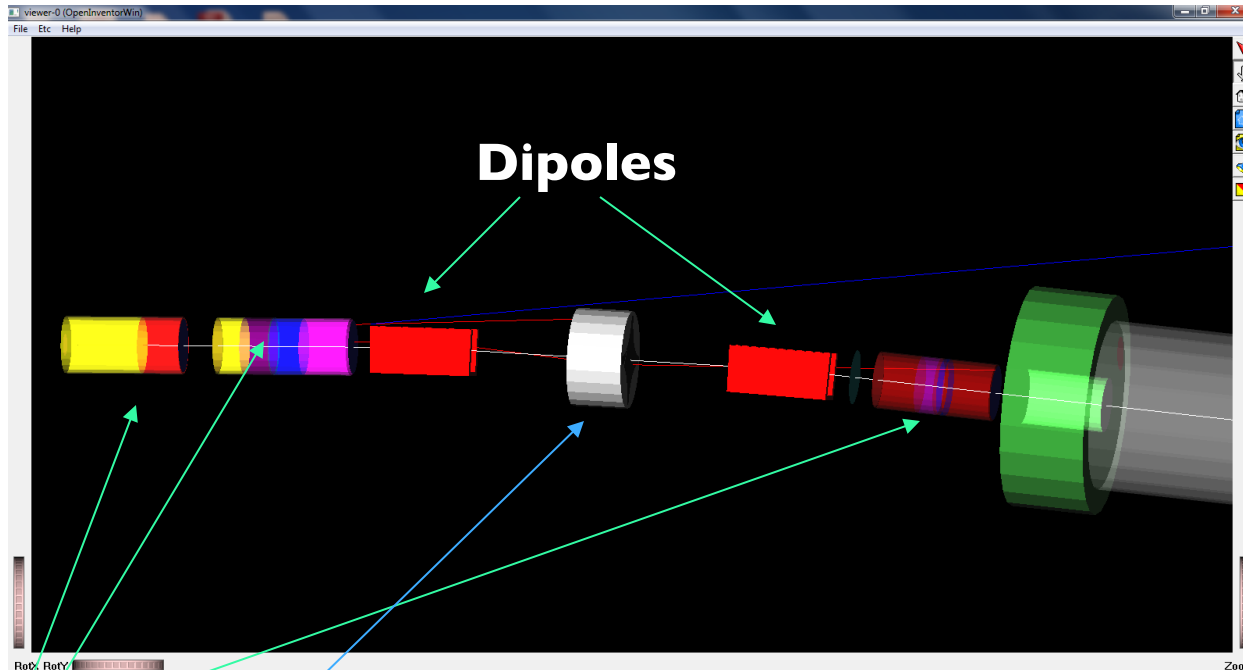


# Single Horn, or Triplet for DBA



**'Triplet'**

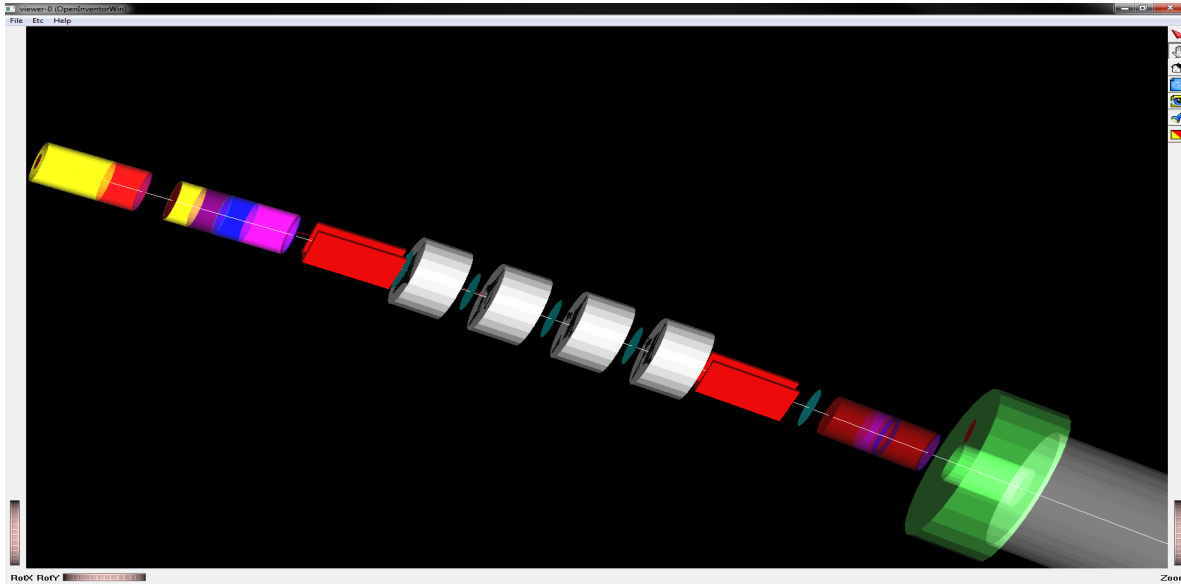




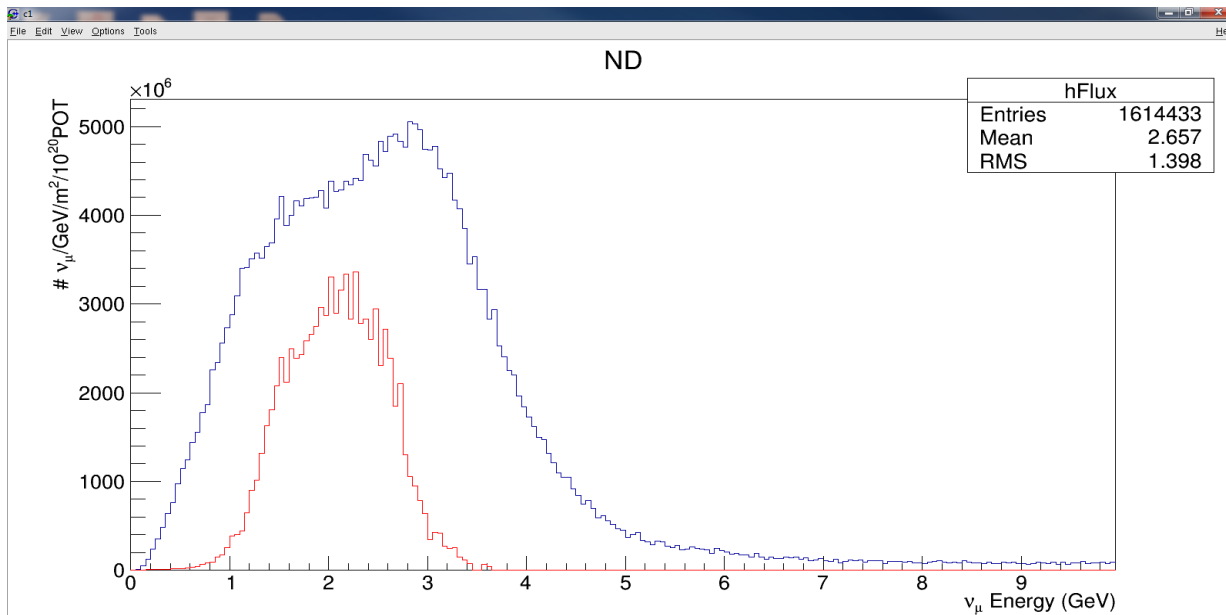
- **Horns are described only as fields, no material,  $I < 300\text{kA}$**
- **Horns dimensions are as in Laura presentation from January**
- **Quad and dipoles have material(iron)**
- **Dipoles are C-type, 2.4m long, gap=0.6m, w=1m, angle 2.88 degrees**
- **Quads are L=1.3m R=0.6,  $G < 3.2\text{T/m}$**



Dipoles,  $L=2.4\text{m}$   $B=0.34\text{T}$ ,  $Fq=1\text{T/m}$ ,  $Dq=0.6\text{T/m}$

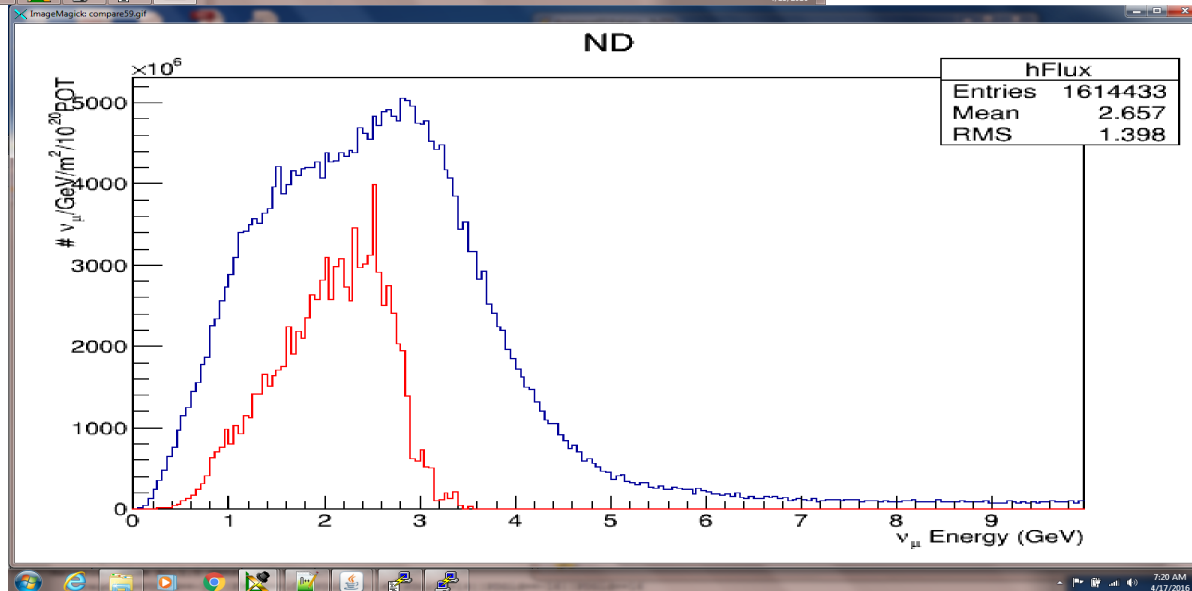
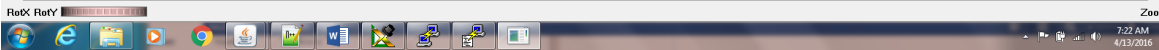
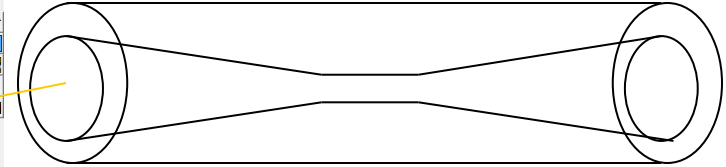
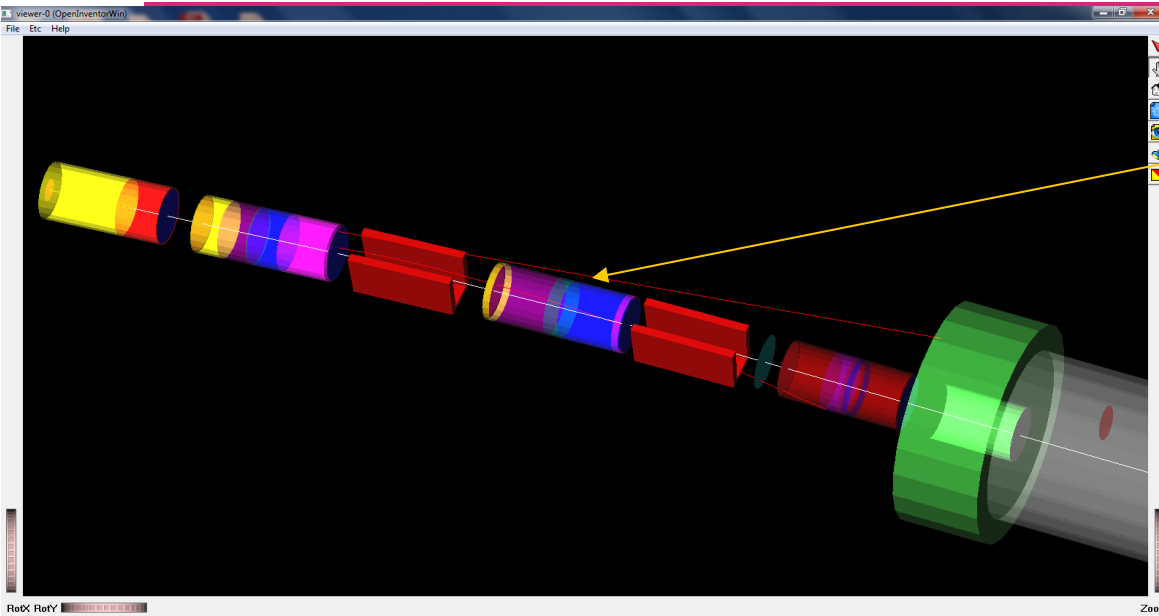


**Pions central energy**  
 **$E_{kin}=6\text{GeV}$**   
 **$H_{dipole}=0.6$ ,**  
 **$R_q=0.3\text{m}$ ,  $L_q=1.3\text{m}$**



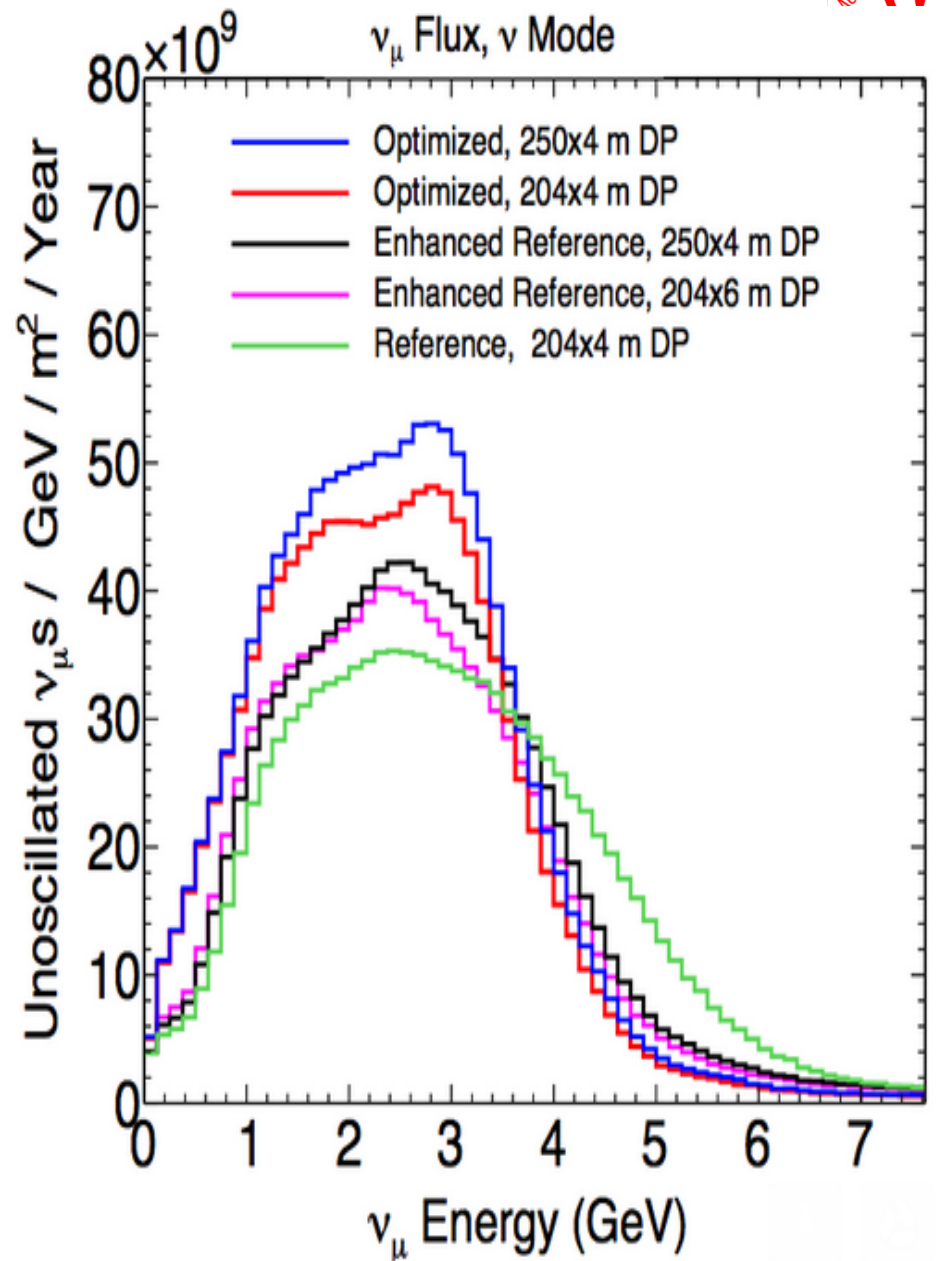
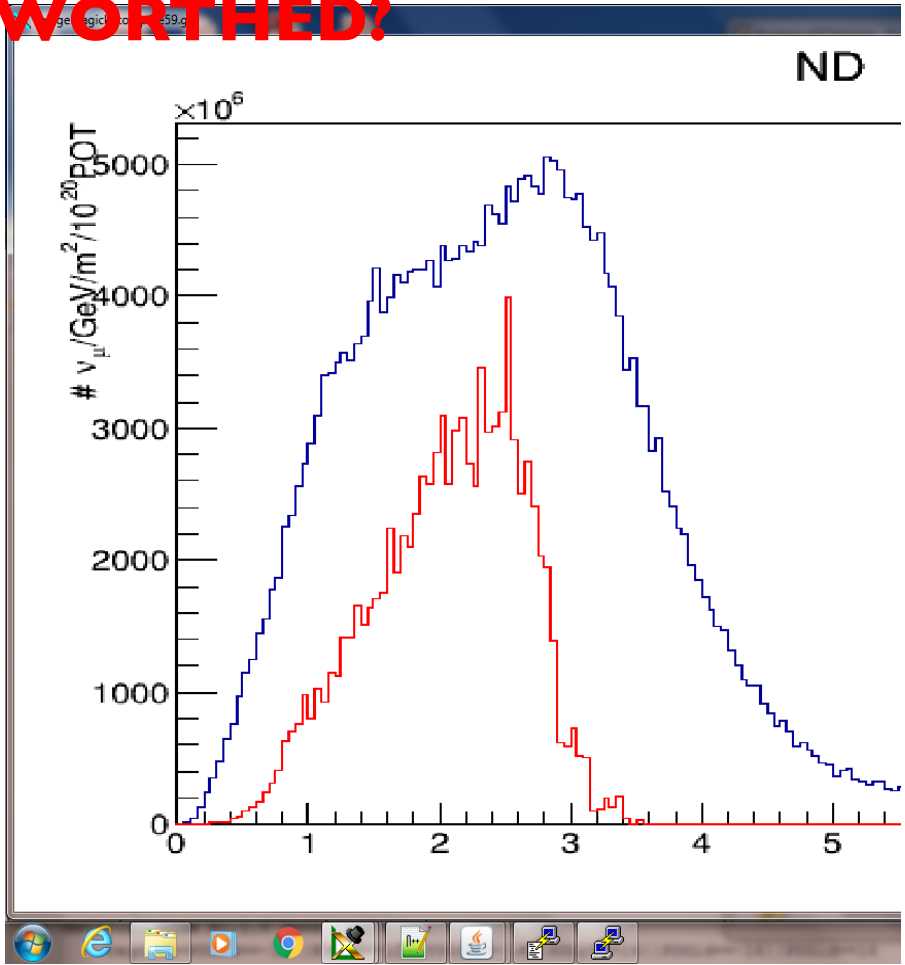


# Horns neck $r=0.1\text{ m}$ , $I=296\text{ kA}$ , $L_h=3.3\text{ m}$

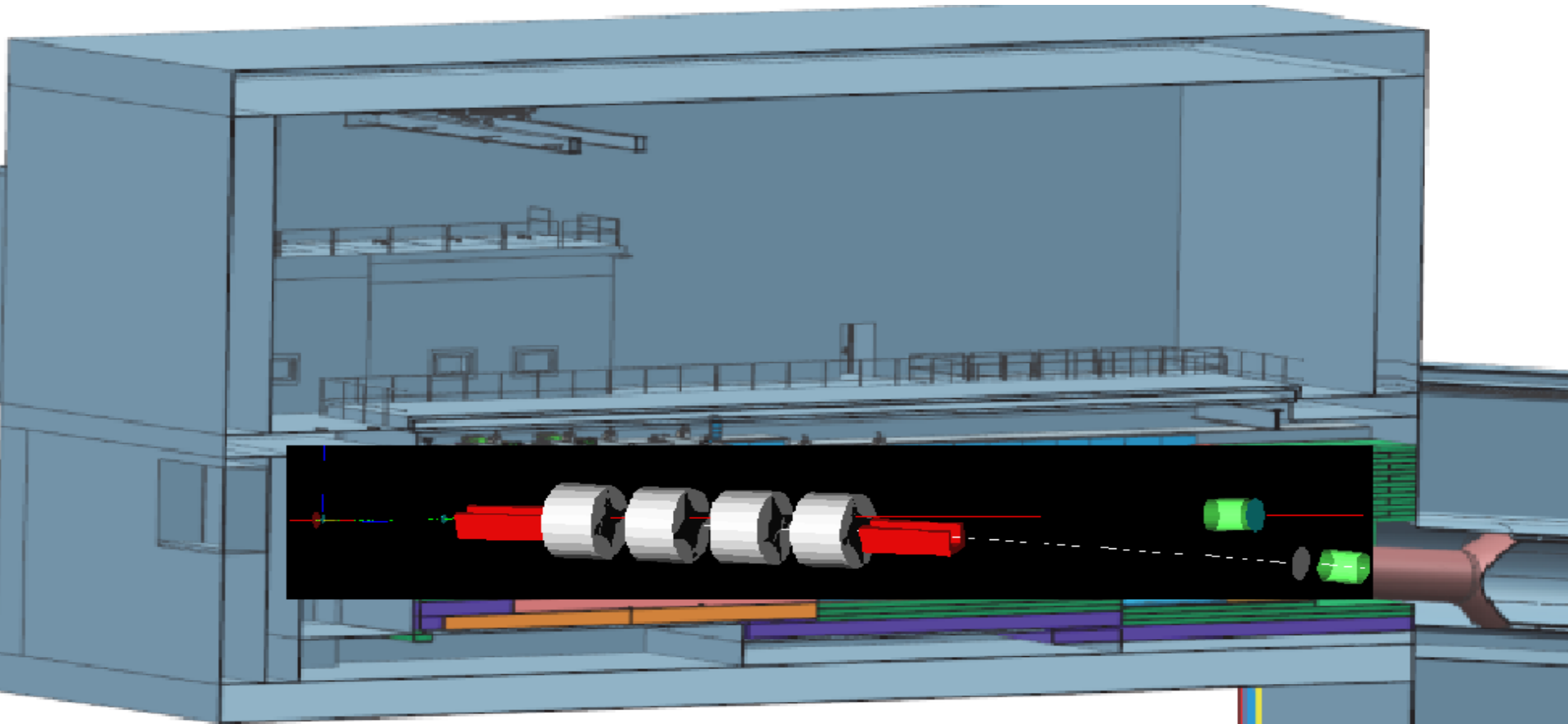




# IS THIS GOOD, WORTHED?



**There is no optimization of pion energy, horn, distances, ...it is just starting attempt**



**Assumption is that all fits in existing target hall**



# HELP

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- **Smaller Bending angle?**  
**(Bend protons & pions)**
- **Pion central energy?**
- **Longer/shorter dipoles?**
- **Horn or quads?**
- **Longer DBA?**
- **High Current Wire?**



- **Charge Selection**
- **Pion Energy Selection**
- **Reduction of power deposition in Decay Pipe**
- **Muon(Pion) Flux Measurements?**
- **Simplification of proton delivery**
- **Civil Construction, simpler, < \$\$**





# Modified DUNE at least 10 times less beam power in Decay Pipe

