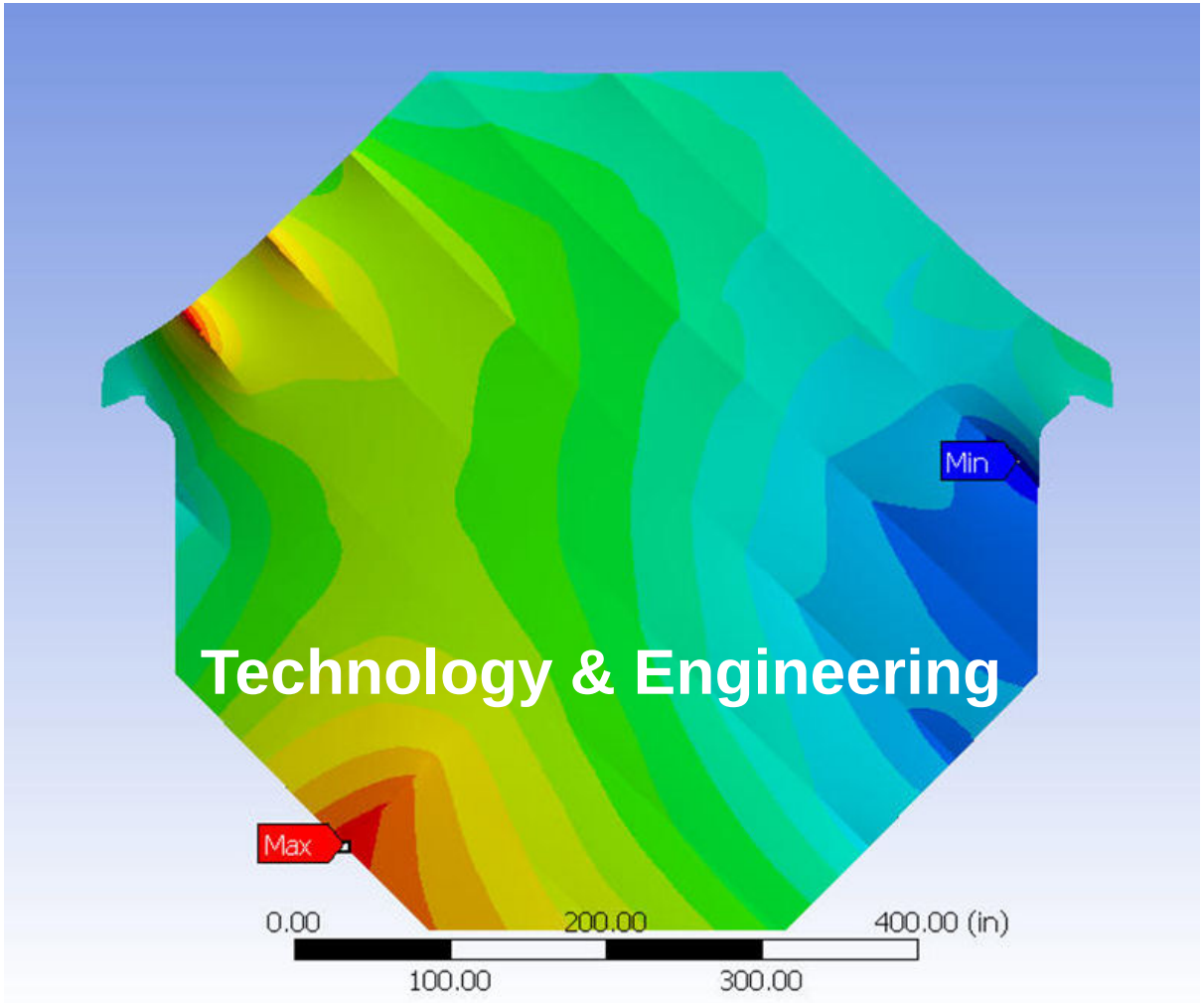
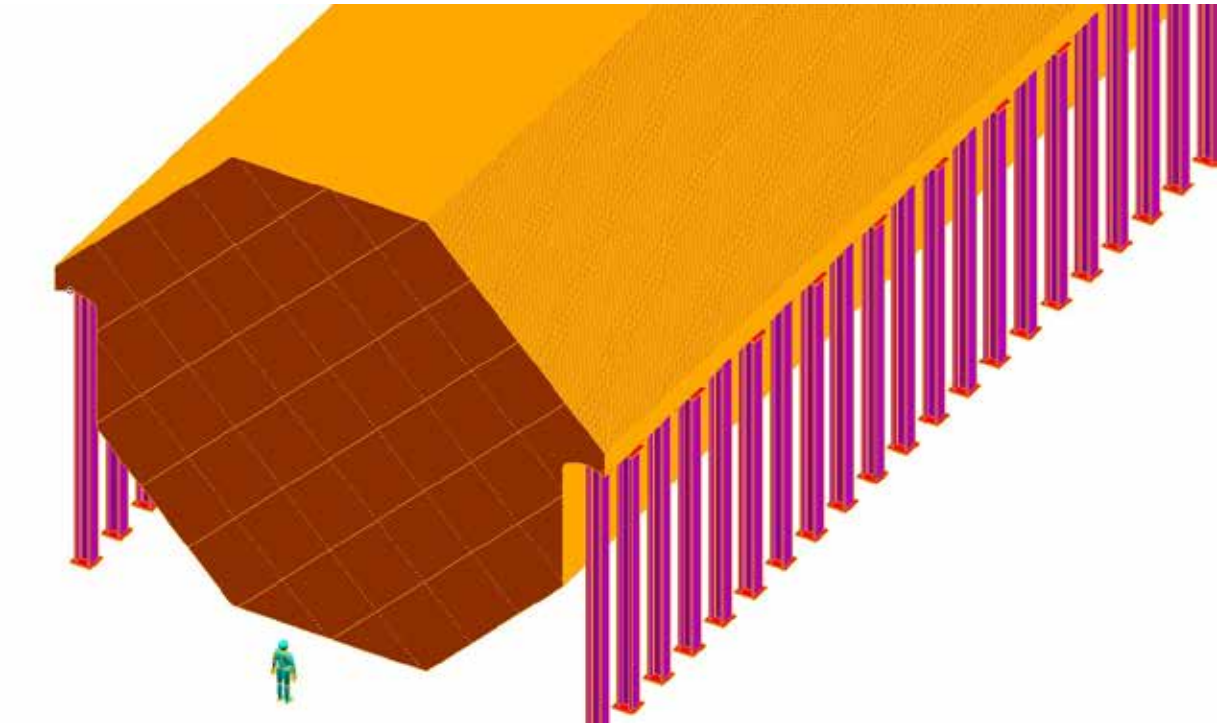
Magnetized Iron Neutrino Detector
MIND



- Outline
  - Basic concept
  - Technology choices
  - Engineering details
    - Where we are & where we are headed
  - R&D requirements
  - Costing
  - Conclusions

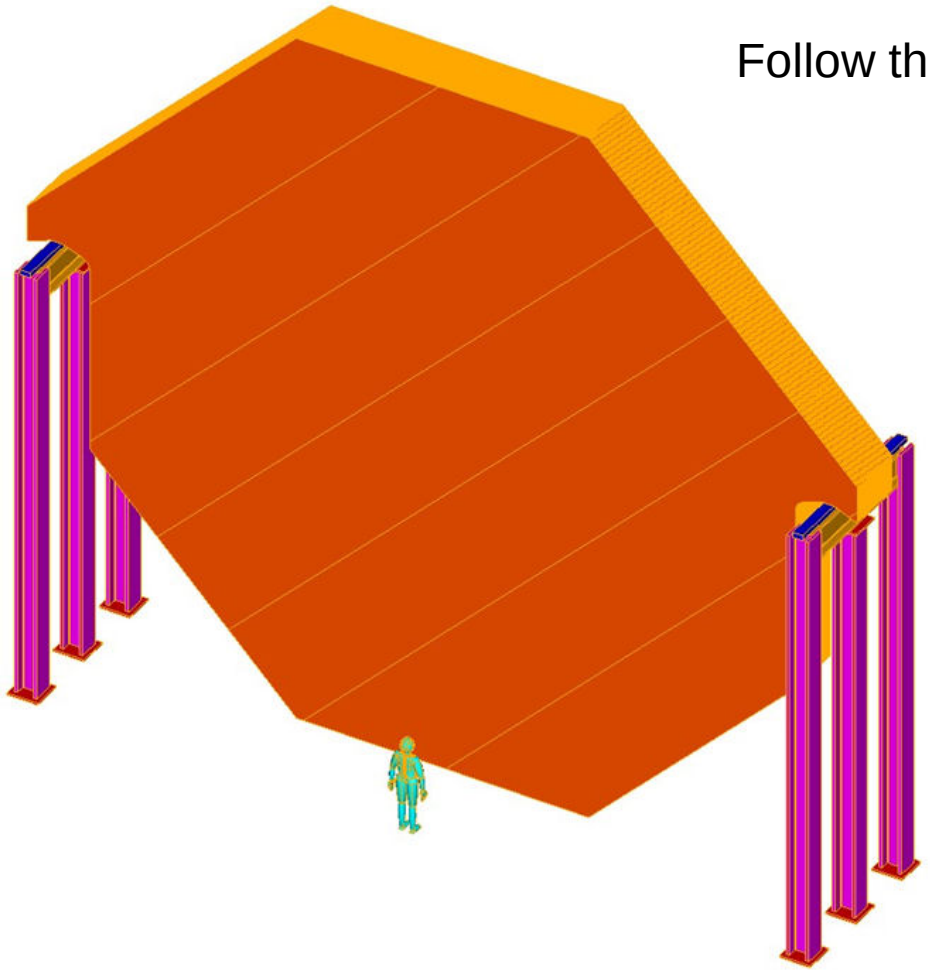
Basic Concept

- MIND is an iron and scintillator sampling calorimeter which is essentially a larger version of the MINOS detector (20X)

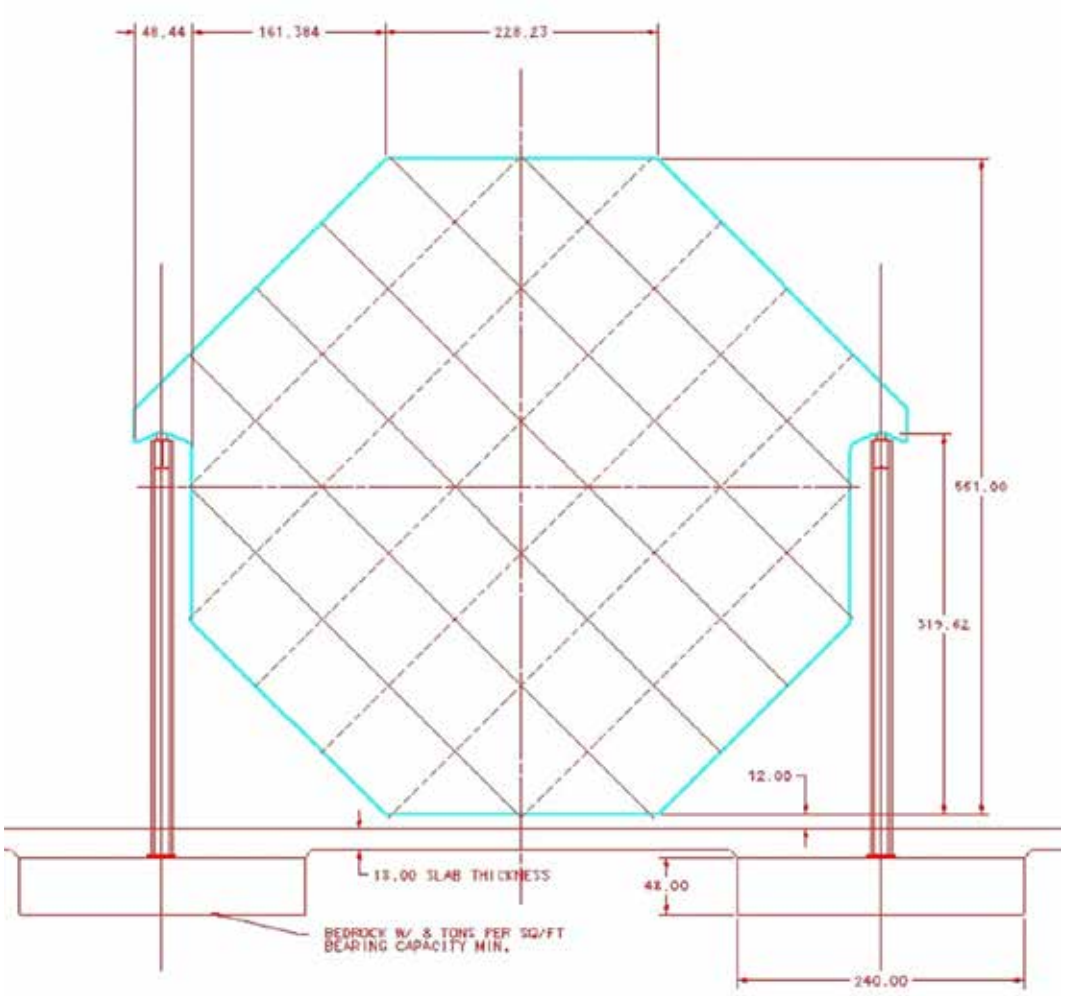


Draw from MINOS'

Follow the MINOS Assembly Approach

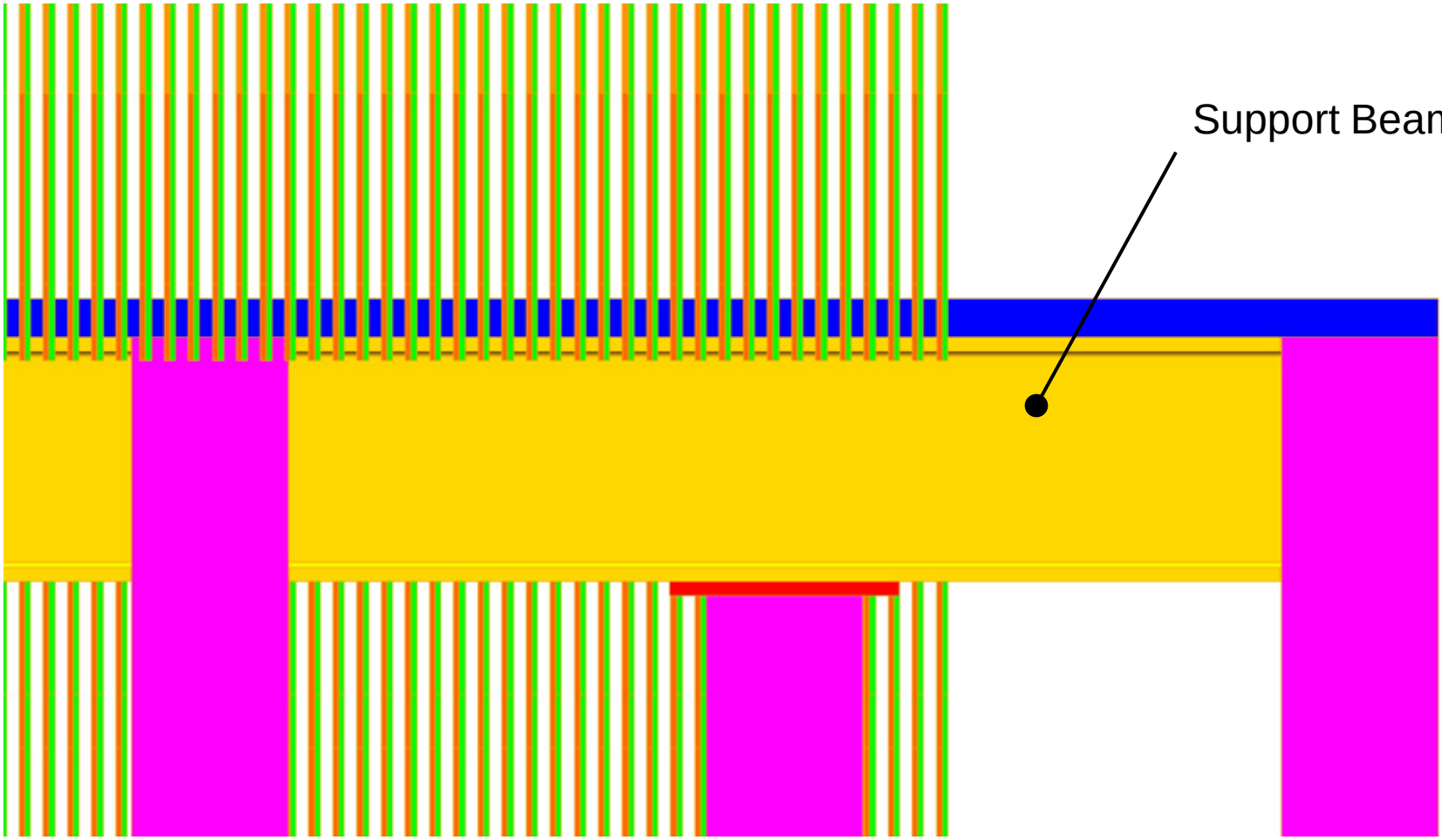


14m X 14m X 3cm Fe plate



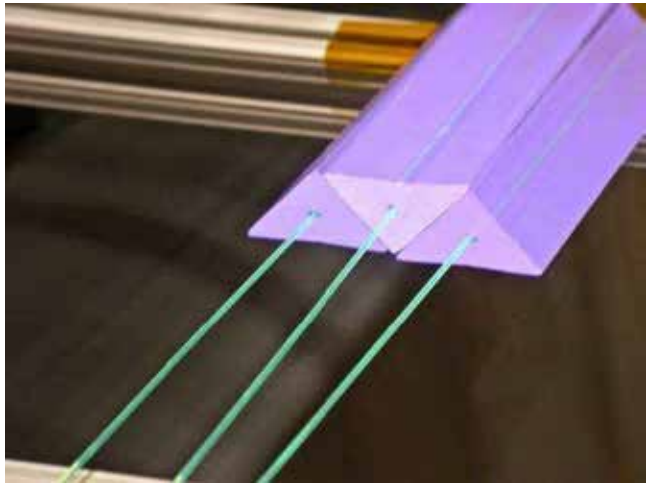
- Initial calculations indicated "hanging" stresses too large
- Detailed plate design + ANSYS analysis
  - OK

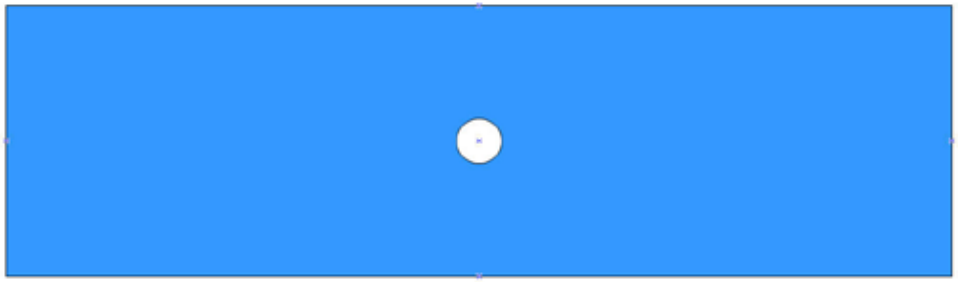
Side-View Detail



Readout planes

- X + Y views of scintillator extrusions between each plate (MINOS alternated, X or Y)



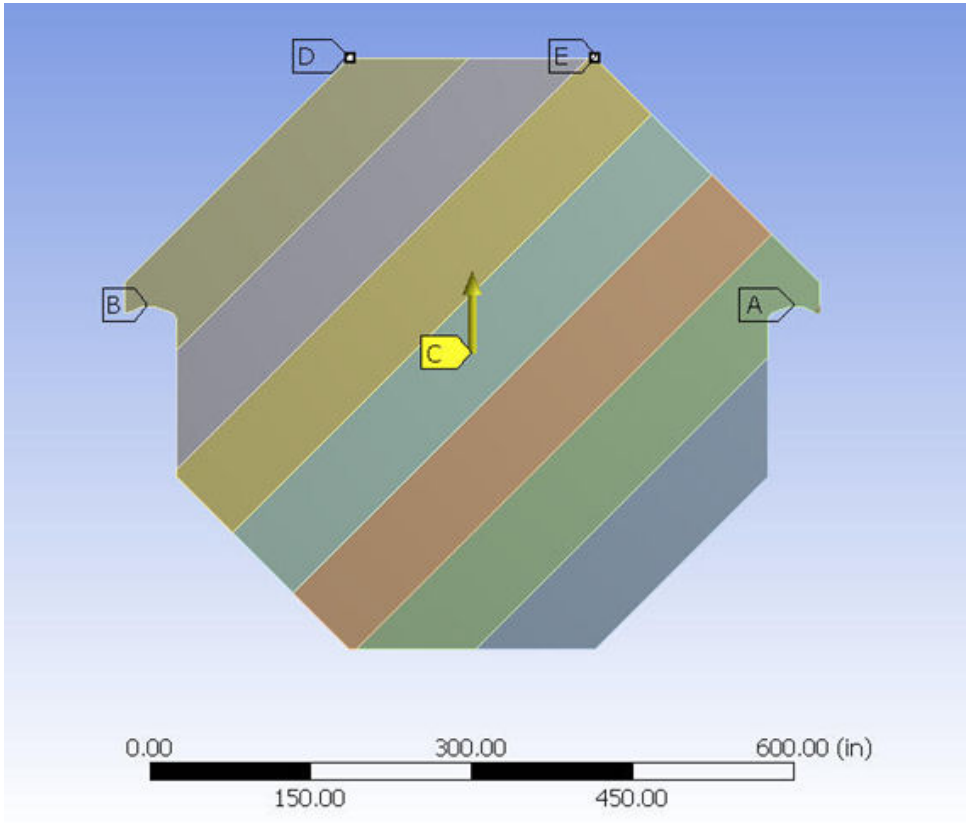


- Wavelength shifting fiber readout
- Solid-state photon detector (SiPM)

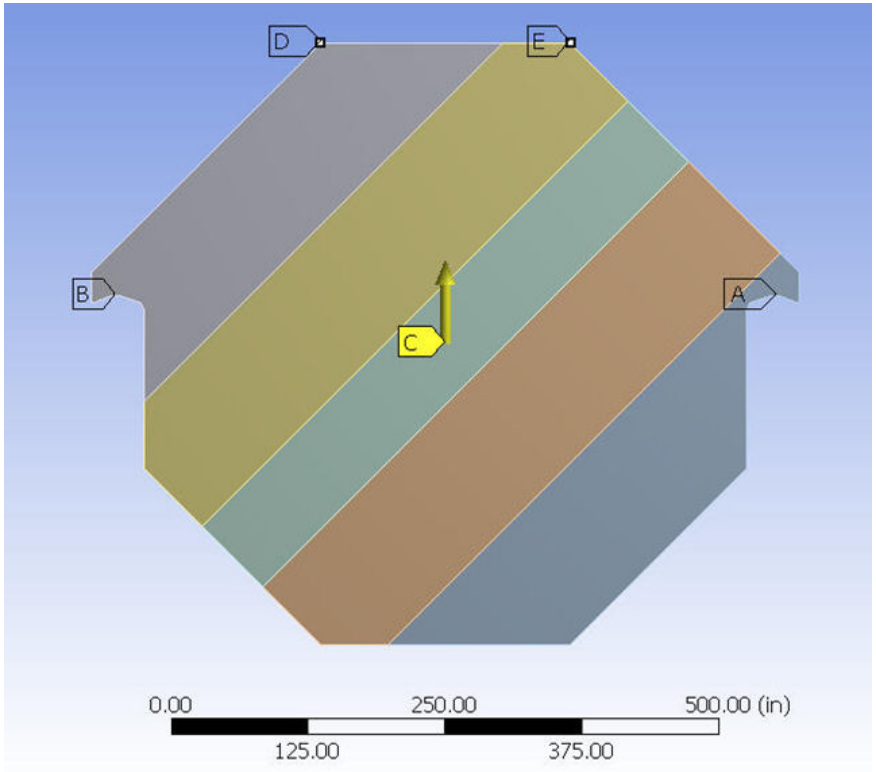
Engineering Details
Fe Plates

- Two plate models were developed
  - One with 2m strips
  - One with 3m & 2m strips
  - Two layer (1.5 cm thick each), cross-strip design
    - Plug welded mosaic
- Both yielded acceptable performance
  - Stresses
  - Buckling
  - Deformations

Fe Plate Designs

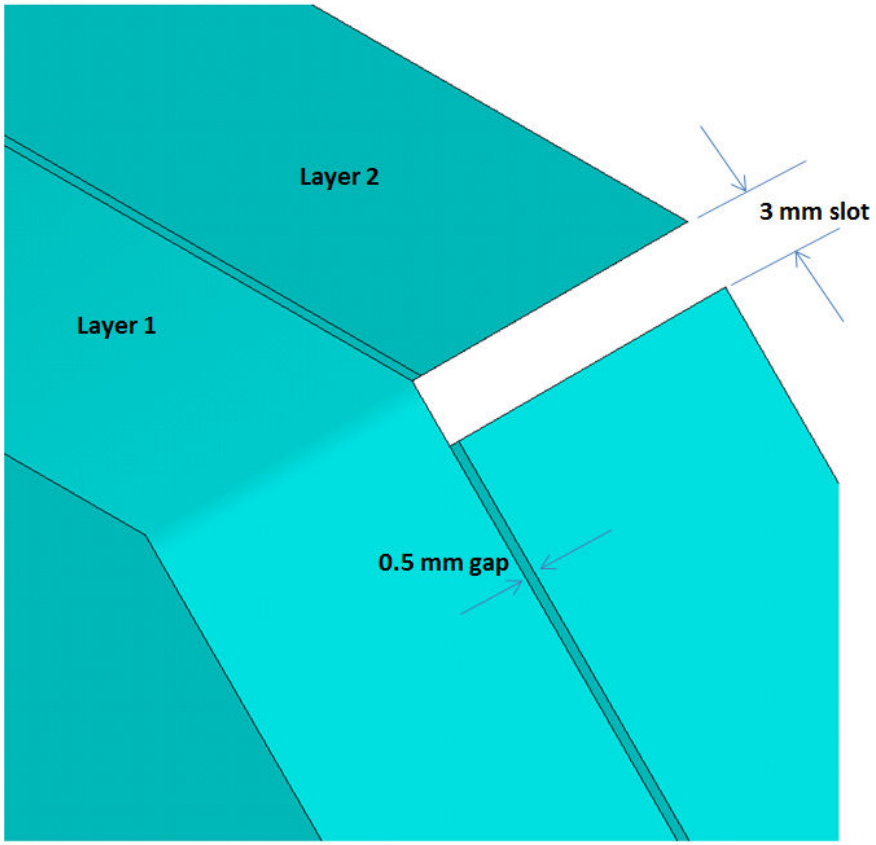


2m strip



2m & 3m strip

3D Plate Design



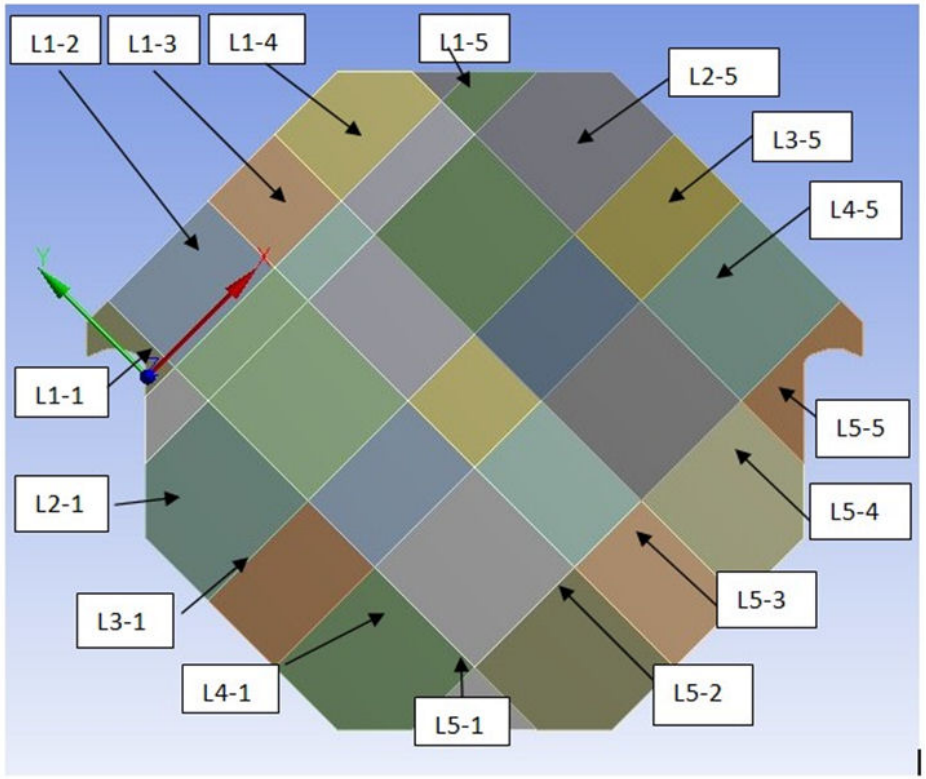
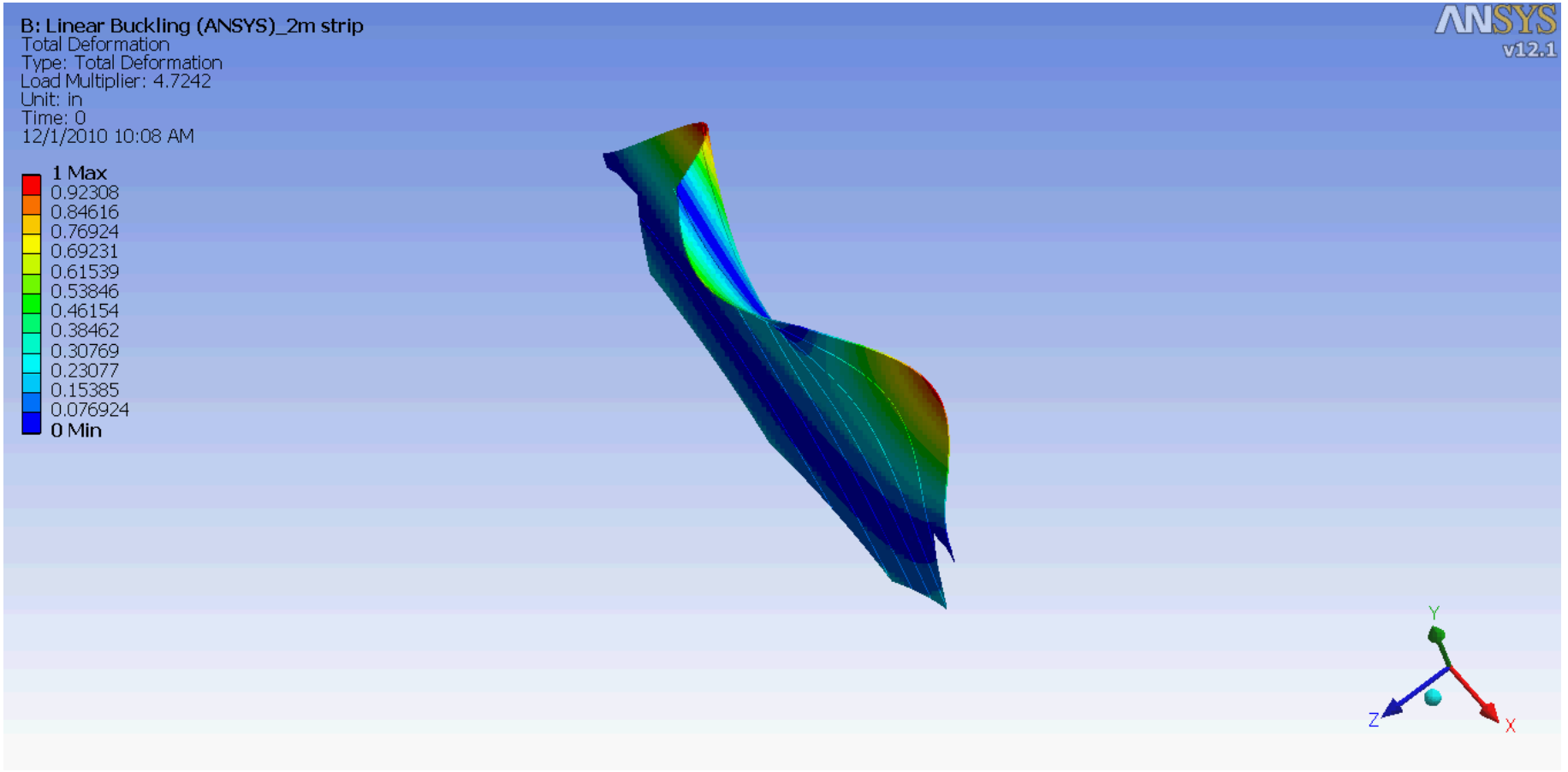


Plate deflections



Engineering Details Magnetization

- Baseline is to use the superconducting transmission line (STL) developed/prototyped for the VLHC
- 100kA-turn
- 80 mm diameter
  - 100mm hole
  - Average r » 0.5g/cm^3

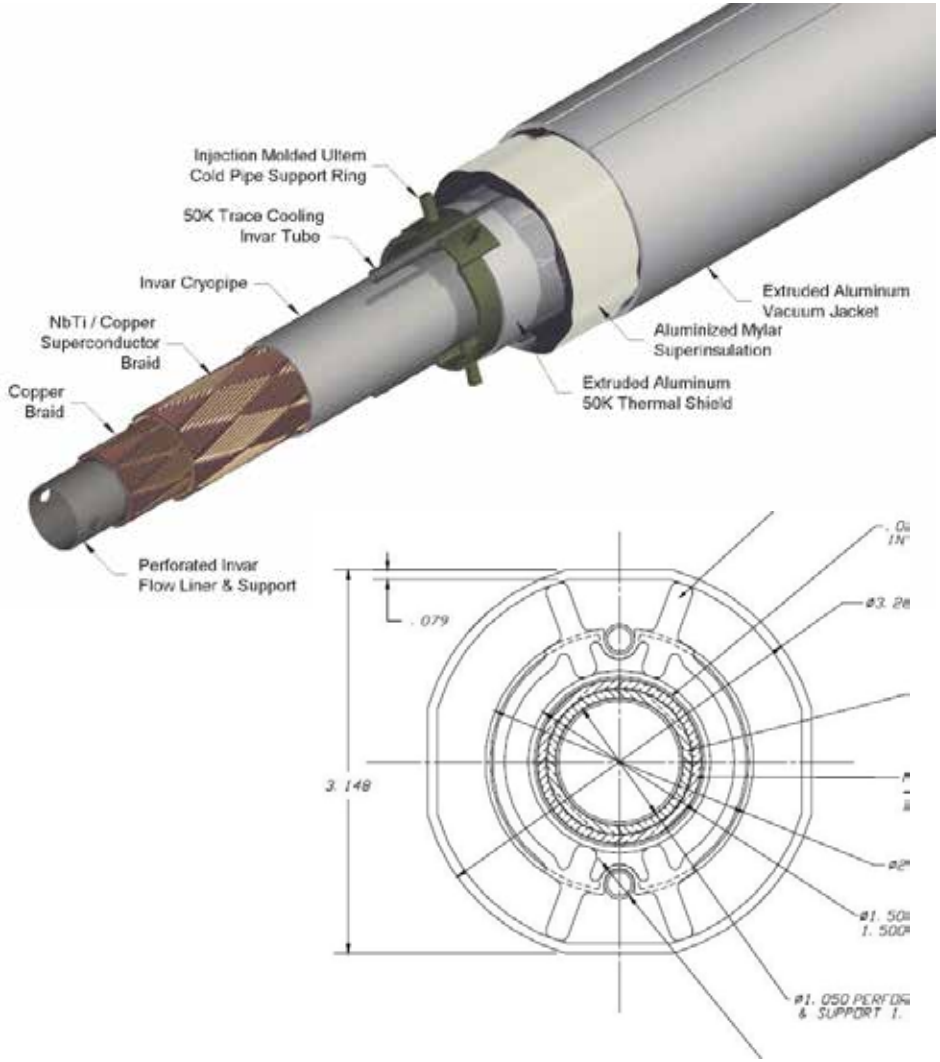
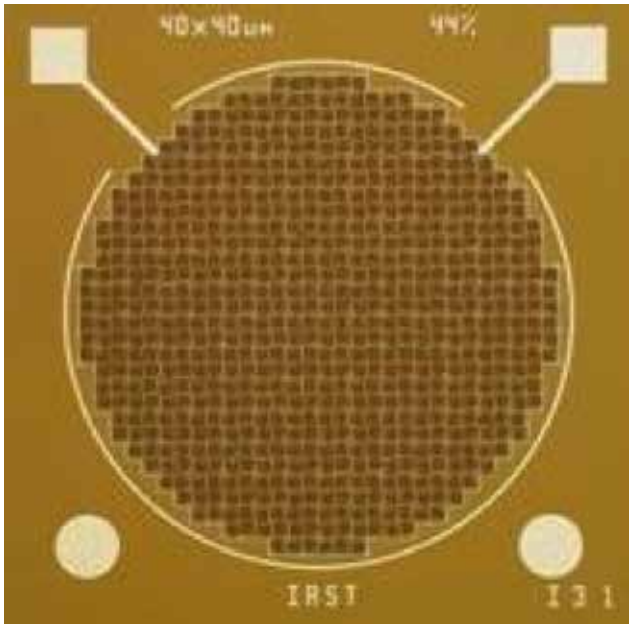


Photo-detector & Electronics

- Silicon avalanche photodiode operating in Geiger mode
  - SiPM, MPPC, MRS, etc
  - Aggressive, world-wide R&D
- Readout Electronics
  - Front-end chip on SiPM
  - ASIC back-end



R&D requirements

- Steel
  - None, mature technology.
- Magnetization
  - Investigate STL with multiple superconductor loops within the STL cryostat
    - Smaller external excitation current
- Photodetectors
  - None
    - On-going world-wide activities deemed sufficient for now
- Scintillator
  - Advanced and mature technology, however:
    - Need to specify final shape
      - Impact on production & cost
    - Engineer detector plane mechanics
- Fiber
  - Co-extrude with scintillator (good, but not essential)
  - Develop 2nd vendor with university participation

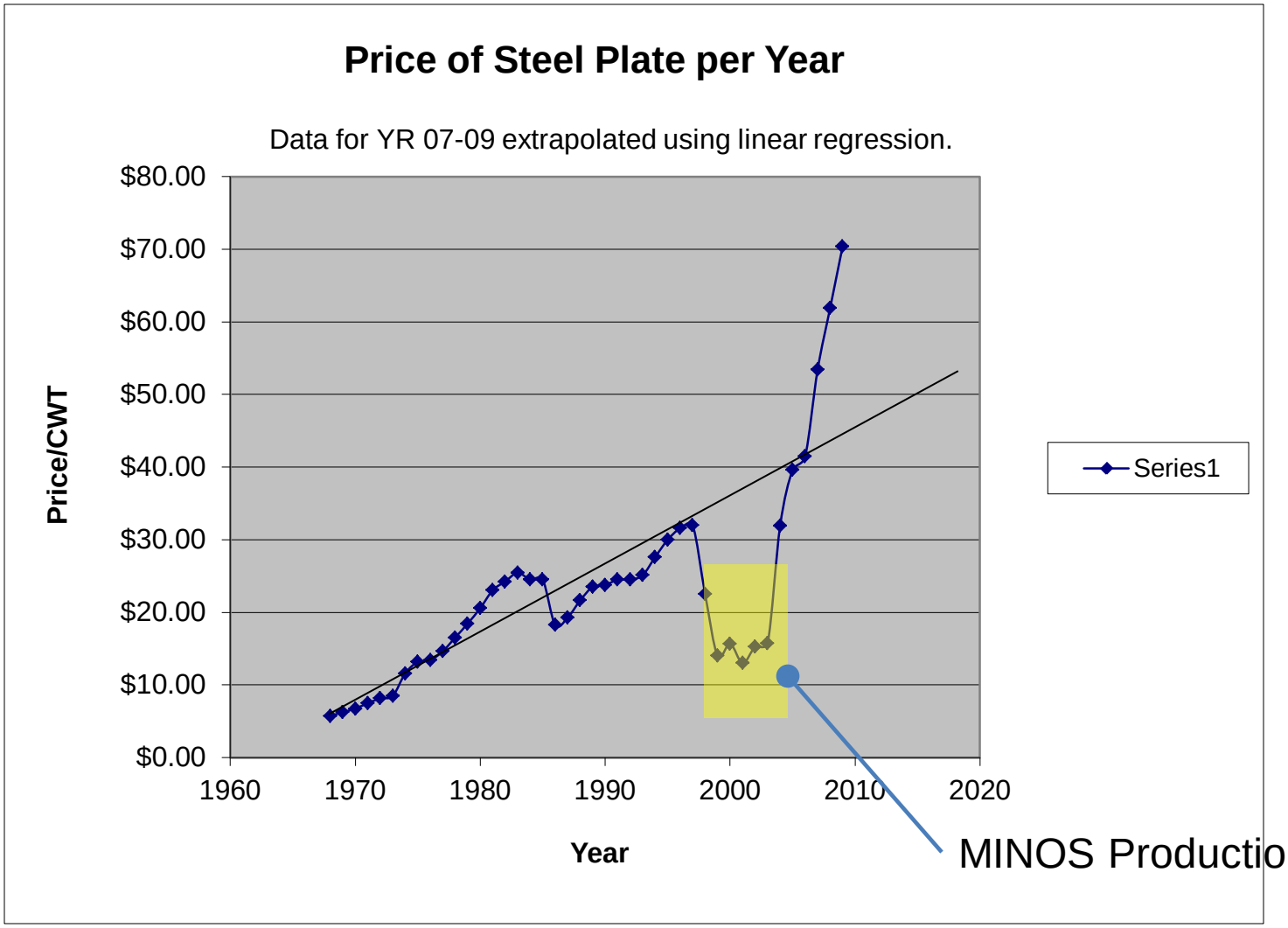
Costing

- Plan to use CERN costing model, but already have detailed template from MINOS
  - Steel
  - Cavern
  - Scintillator
- As built costs for surface building from Nona
  - Plus updated fiber cost for very-large quantity

MINOS Costing Model

	WBS	Cobra CA	Task Name	Mlstn Level	Base Cost	Instit G&A	Lab SWF	FY00 Obl	FY0' Obl
1	**2.0**		**MINOS Detector**		**$38,369,285**	**$2,940,485**	**$4,131,839**	**0**	**0**
2	2.0.MS.2		Near Hall Beneficial Occupancy (See TEC UID 8257	2	$0	$0	$0	0	0
3	2.0.MS.6		Start 4 Plane Prototype		$0	$0	$0	0	0
4	2.0.MS.7		Review of FNAL Title 1		$0	$0	$0	0	0
5	2.0.MS.8		Complete review of FNAL Title 1		$0	$0	$0	0	0
6	2.0.MS.9		Near Hall Footprint Design Approval		$0	$0	$0	0	0
7	2.0.MS.1		Review of FNAL Title 2		$0	$0	$0	0	0
8	2.0.MS.1		Complete Soudan Title 1 Excavation Review		$0	$0	$0	0	0
9	2.0.MS.1		Start System Commissioning (See TEC UID 73511)	1	$0	$0	$0	0	0
10	2.0.MS.1		Complete System Commissioning (See TEC UID 73		$0	$0	$0	0	0
11	2.0.MS.1		CD-4 Begin Operations	0	$0	$0	$0	0	0
12	2.0.MS.1		Begin Outfitting of Hall & Construction of Svc Bldg		$0	$0	$0	0	0
13	2.0.MS.1		DOE CD-4 Baseline Date	0	$0	$0	$0	0	0
14	2.0.MS.1		Near Detector Rigging Complete (See TEC UID 748		$0	$0	$0	0	0
15	2.0.MS.2		Start Absorber Installation (See TEC UID 73265)		$0	$0	$0	0	0
16	2.0.MS.2		Complete Absorber Installation (See TEC UID 7333		$0	$0	$0	0	0
17	**2.1**		**Magnets: Steel & Coils**		**$6,250,848**	**$17**	**$1,090,890**	**0**	**0**
336	**2.2**		**Scintillator Detector Fabrication**		**$16,296,301**	**$1,310,920**	**$103,859**	**0**	**0**
1192	**2.3**		**Electronics, DAQ & Database**		**$6,941,825**	**$893,518**	**$484,400**	**0**	**0**
1465	**2.4**		**Far Detector Installation**		**$3,416,127**	**$725,907**	**$72,640**	**0**	**0**
1589	**2.5**		**Near Detector Installation**		**$4,237,207**	**$0**	**$1,274,705**	**0**	**0**
1850	**2.6**		**NuMI-MINOS Project Management**		**$1,226,977**	**$10,122**	**$1,105,345**	**0**	**0**
1865	**3.0**		**Project Support**		**$18,383,948**	**$0**	**$0**	**0**	**0**
1866	**3.1**		**NuMI Conceptual Design**		**$1,535,179**	**$0**	**$0**	**0**	**0**
1874	**3.2**		**Detector R&D**		**$1,534,181**	**$0**	**$0**	**0**	**0**
1882	**3.3**		**MINOS Cavern**		**$13,730,705**	**$0**	**$0**	**0**	**0**
2071	**3.4**		**Soudan/MINOS Operating**		**$1,583,883**	**$0**	**$0**	**0**	**0**

It is Always better to be Lucky Than Smart



Conclusions

- Although the size (100kT) of MIND is daunting, the detector technology and engineering is mature
  - 5 kT prototype (MINOS)
  - Mature technologies with little or no required R&D
    - Steel and magnetization
    - Scintillator
      - Extruded scintillator technology significantly advanced since the time of MINOS production

Conclusions II

- Required R&D is limited and well-specified
  - Iteration on the superconducting transmission line design of the VLHC
  - Photon detector
    - Take wait and see approach for now
  - Scintillator
    - Details of extrusion shape
    - Study large-scale production issues
    - Co-extrusion of commercial fiber and bulk scintillator
      - Not a requirement – cost issue

END