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The 6th Near Detector WS Hamburg

Hamburg ND WS

- This open workshop concentrated on the MPD and, in particular, international contributions.
- Topics covered
 - Physics Opportunities
 - High Pressure Gas TPC
 - The SC magnet system
 - Calorimetry
 - Integration
 - Software

Hamburg ND WS



- Held at DESY
- 3 ½ days of meetings
- ~ 60 participants
- Organizers from the US, UK, Italy in addition to the local organizers from a number of German institutions
- A great deal of discussion on potential German contributions to the DUNE ND





Agenda (Pre-meeting)

[Go to day ▾](#)

Sunday, 20 October 2019

- 13:00 - 18:00 Discussion on Simulation studies ▾
- 13:00 **LAr size optimization 30'** ▾
Speaker: Dr. Chris Marshall (Lawrence Berkeley National Laboratory)
Material: [Slides](#) 
- 13:30 **ECAL configuration 30'** ▾
Speaker: Eldwan Brianne (DESY)
Material: [Slides](#) 
- 14:00 **Muon spectrometer specs – discussion 30'** ▾
- 14:30 **Coffee at Cafeteria 20'**

Monday, 21 October 2019

- 10:00 - 12:00 MPD simulation and configuration ▾
- 10:00 **LAr+MPD configuration optimization 30'** ▾
Speaker: Dr. Chris Marshall (Lawrence Berkeley National Laboratory)
Material: [Slides](#) 
- 10:30 **Coffee 20'**
- 10:50 **MPD exclusive channels studies 30'** ▾
Speaker: Dr. Chris Marshall (Lawrence Berkeley National Laboratory)
Material: [Slides](#) 
- 11:20 **Discussion 30'** ▾

Agenda II

14:00 - 18:05

Introduction

This session will give an overview of the ND complex, the physics that can be done with it and how it will be used in the oscillation analysis. It will also give an overview of the different detectors that are part of the complex.

Convener: Dr. Frank Simon (Max-Planck-Institute for Physics)

14:00 **Welcome 10'**

Speaker: Joachim Mnich (DESY)

14:10 **Introduction to the DUNE Near Detector 45'**

Speaker: Prof. Alfons Weber (University of Oxford and STFC/RAL)

Material: [Slides](#)  

14:55 **Use of ND for LBL oscillation physics 30'**

Speaker: Dr. Chris Marshall (Lawrence Berkeley National Laboratory)

Material: [Slides](#) 

15:25 **Searching for BSM with the DUNE ND 45'**

Speaker: Prof. Silvia Pascoli (University of Durham)

Material: [Slides](#) 

16:10 **Workshop Picture 5'**

16:15 **Coffee 15'**

16:30 **LAr Detector Overview 30'**

Speakers: Dr. James Sinclair (University of Bern), Mr. Patrick Koller (University of Bern)

Material: [Slides](#) 

17:00 **MPD Overview 30'**

Speaker: Jennifer Raaf (Fermilab)

Material: [Slides](#) 
















17:30 **KLOE/3DST Overview 30'**

Speakers: Dr. Davide Sgalaberna (CERN), Davide Sgalaberna

Material: [Slides](#) 

Agenda III

Tuesday, 22 October 2019

- 09:00 - 13:00 **ECal: to discuss requirements, current design and optimisation of the MPD/ECal** 
Convener: Prof. Alfons Weber (University of Oxford and STFC/RAL)
- 09:00 **Introduction 30'** 
Speaker: Dr. Frank Simon (Max-Planck-Institute for Physics)
Material: [Slides](#) 
- 09:30 **Performance, Simulations, Optimisation 30'** 
Speaker: Eldwan Brianne (DESY)
Material: [Slides](#) 
- 10:00 **Neutron Detection in ECal 30'** 
Speaker: Dr. Chris Marshall (Lawrence Berkeley National Laboratory)
Material: [Slides](#) 
- 10:30 **SiPM-on-Tile Technology 30'** 
Speaker: Dr. Felix Sefkow (DESY)
Material: [Slides](#) 
- 11:00 **Coffee 30'**
- 11:30 **Scintillator R&D in the SHIP Context 30'** 
Speaker: Rainer Wanke (Johannes Gutenberg University Mainz)
Material: [Slides](#) 
- 12:00 **ASIC for SiPM Readout 30'** 
Speaker: Dr. Wei Shen (University of Heidelberg)
Material: [Slides](#) 
- 12:30 **KLOE ECal 30'** 
Speaker: Dr. Lea Di Noto (INFN and University of Genova)
Material: [Slides](#) 

Agenda IV

14:00 - 18:45

HPgTPC: to discuss the R&D, design, requirements and optimisation

Convener: Dr. Asher Kaboth (RHUL)

14:00 High Pressure gas TPC (HPgTPC): Motivation and reference design 20'

Speaker: Dr. Alysia Marino (University of Colorado)

Material: [Slides](#) 

14:20 Coherent pion channel 20'

Speaker: Dr. Leo Bellantoni (FNAL)

Material: [Slides](#) 

14:40 Interactions in He-CH4 mixutre: Transverse variable analysis in 20'

Speaker: Dr. Xianguo Lu (Oxford University)

Material: [Slides](#) 

15:00 T0 via flourescence tag 20'

Speaker: Prof. Alan Bross (Fermilab)

Material: [Slides](#) 

15:20 IROC test stand 20'

Speaker: Dr. Tanaz Mohayai (Fermilab)

Material: [Slides](#) 

15:40 Aachen test chamber 20'

Speaker: Prof. Stefan Roth (RWTH Aachen)

Material: [Slides](#) 

16:00 Coffee 30'

16:30 OROC test stand 20'

Speaker: Alexander Deisting (Royal Holloway University of London)

Material: [Slides](#) 

16:50 Pressure vessel design 20'

Speaker: Mr. Prashant Kumar (Bhabha Atomic Research Centre)

Material: [Slides](#) 

17:10 Electronics 20'

Speakers: Patrick Dunne, Dr. Patrick Dunne (Imperial College London)

Material: [Slides](#) 

17:30 Test beams 20'

Speakers: Abigail Waldron, Dr. Abbey Waldron (Imperial College London)

Material: [Slides](#) 

17:50 ALICE Experience 15'

Speaker: Alexander Deisting (Royal Holloway University of London)

Material: [Slides](#) 










18:05 HPgTPC cost scaling exercise 15'

Speaker: Prof. Alan Bross (Fermilab)

18:20 Discussion 25'

Agenda V

Wednesday, 23 October 2019

09:00 - 13:00	Software/Simulation & Muon Systems Convener: Prof. Marco Pallavicini (INFN and University of Genova)	▼
09:00	Requirements for the MPD Muon System 20' Speaker: Eldwan Brianne (DESY) Material: Slides 	▼
09:20	Scintillator muon system 20' Speakers: Dr. Igor Kreslo (LHEP, University of Bern), Prof. Igor Kreslo Material: Slides 	▼
09:40	Straw Tube Detectors 20' Speaker: Mr. Nikoloz Tsverava Material: Slides 	▼
10:00	ND DAQ 25' Speaker: Dr. Asher Kaboth (RHUL) Material: Slides 	▼
10:25	Coffee 30'	
10:55	Current status of MPD software 25' Speaker: Eldwan Brianne (DESY) Material: Slides 	▼
11:20	Current status of LArTPC software 25' Speaker: Dr. Kazuhiro Terao (SLAC National Accelerator Laboratory) Material: Slides 	▼
11:45	Current status of 3DST software 25' Speakers: Dr. Guang Yang (Stony brook university), Guang Yang Material: Slides 	▼
12:10	ND Software Integration 25' Speaker: Mathew Muether (Wichita State) Material: Slides 	▼
12:35	Event simulation for CDR and initial validation 25' Speaker: Dr. Tanaz Mohayai (Fermilab) Material: Slides 	▼

Agenda VI

14:00 - 16:00

Magnet, Integration & other & wrap-up

Convener: Mr. Hirohisa Tanaka

14:00 **Magnet: Reference design 20'**

Speaker: Prof. Alan Bross (Fermilab)

Material: [Slides](#) 

14:20 **Alternate magnet design 20'**

Speaker: Andrea Bersani (INFN Genova)

Material: [Slides](#) 

14:40 **Hall reference design and infrastructure 20'**

Speaker: Matthaeus Leitner (LBNL)

Material: [Slides](#)  

15:00 **Coffee 20'**

15:20 **Summary, Discussion & Next steps 40'**



Highlights Reel

MPD ECAL - Overall Concept

Motivation & Goals

- The MPD will make high-precision measurements of ν interactions on Ar
 - Requires full coverage and precise measurement of charged and neutral particles with low thresholds
- ECAL and HPgTPC complement each other
 - Each is required for a full reconstruction of a neutrino interaction
- The ECAL has to provide:
 - Photon energy measurement
 - Neutral pion reconstruction
 - Particle identification (electron, muon, pion)
 - Determination of interaction time, muon tracking into and out of TPC
 - Ideally: Neutron detection and energy measurement

Frank Simon, MPP

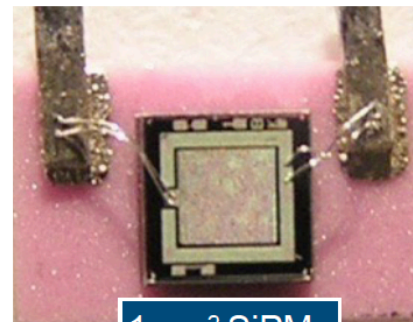
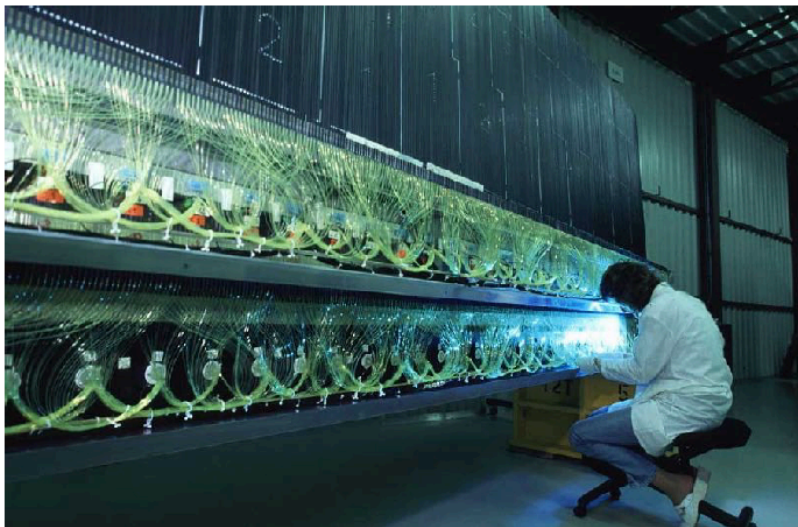
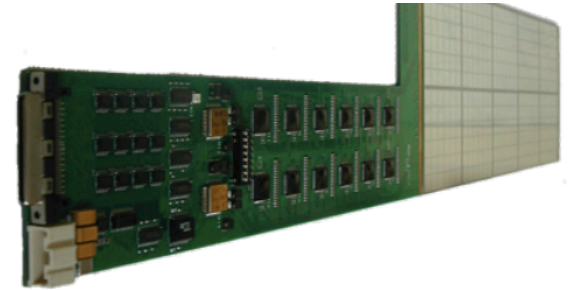
Technologies for Highly Granular Calorimeters (CALICE)

Large area silicon arrays

- silicon calorimetry grows out of the domain of small plug devices

New segmented gas amplification structures (RPC, GEM, μ Ms)

Silicon photomultipliers on scintillator tiles or strips

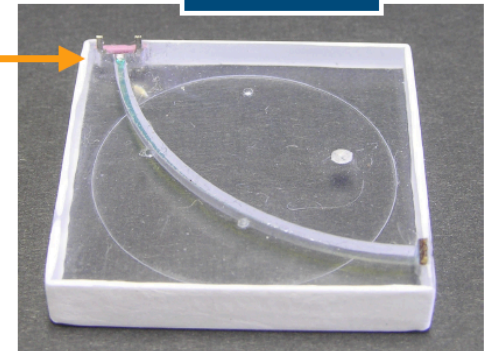


1mm² SiPM

2004

small, B-insensitive, cheap, robust

3x3cm² tile

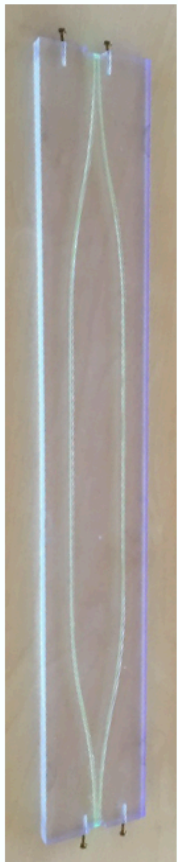


Felix Sefkow, DESY

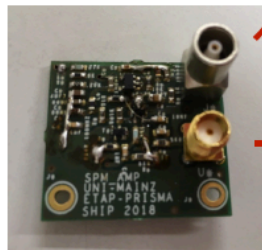
SHIP ECAL: Scintillator planes

Each scintillating plane consists of one absorber plate, with 7 scintillating strips mounted.

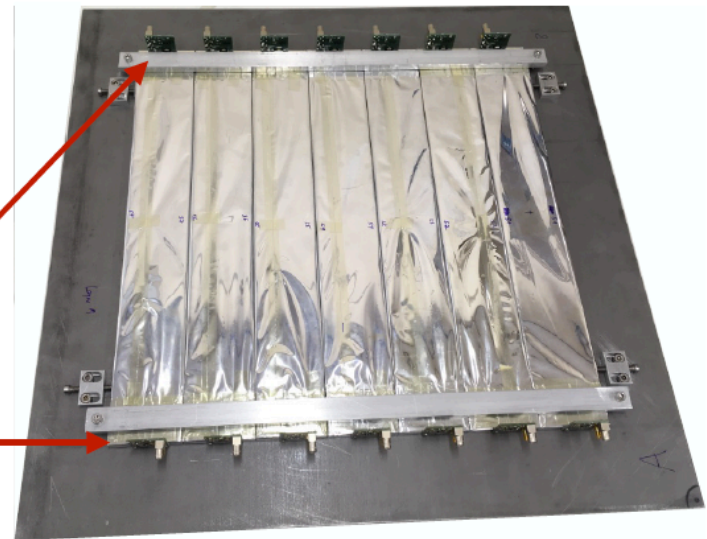
- ▶ Double-sided readout → $2 \times 7 = 14$ chan/plane.
- ▶ 2 horizontal & 2 vertical planes.
- ▶ SiPMs, preamps, and bias voltage mounted on a single PCB on the front faces of the strips.



Scintillating strip



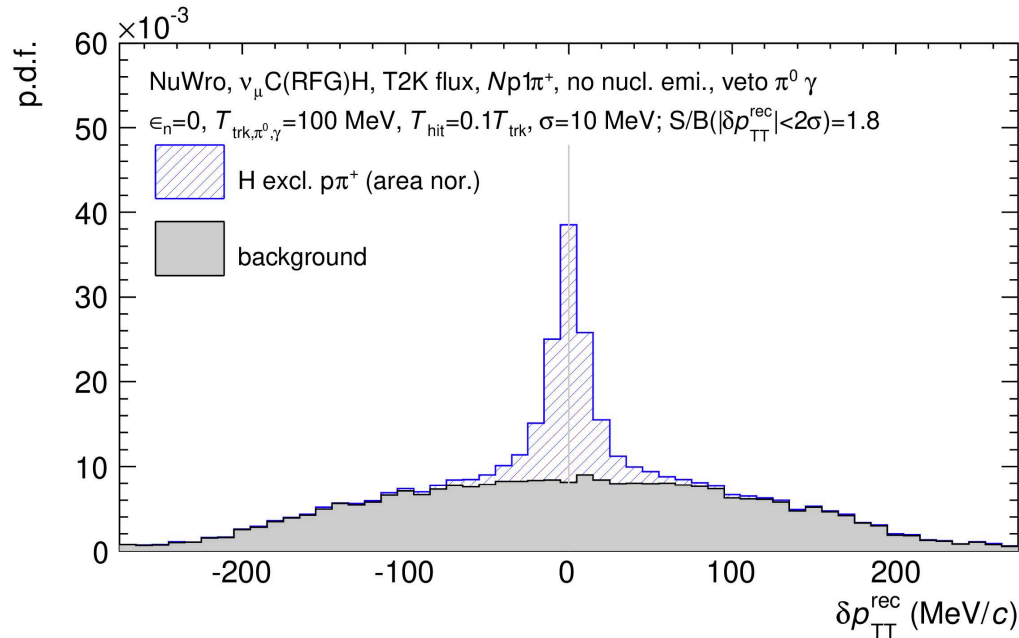
SiPM with preamplifier



Absorber plate with 7 strips

Rainer Wanke, JGU Mainz

ν -hydrogen interactions in HPgTPC



T2K on CH

Xianguo Lu, Oxford

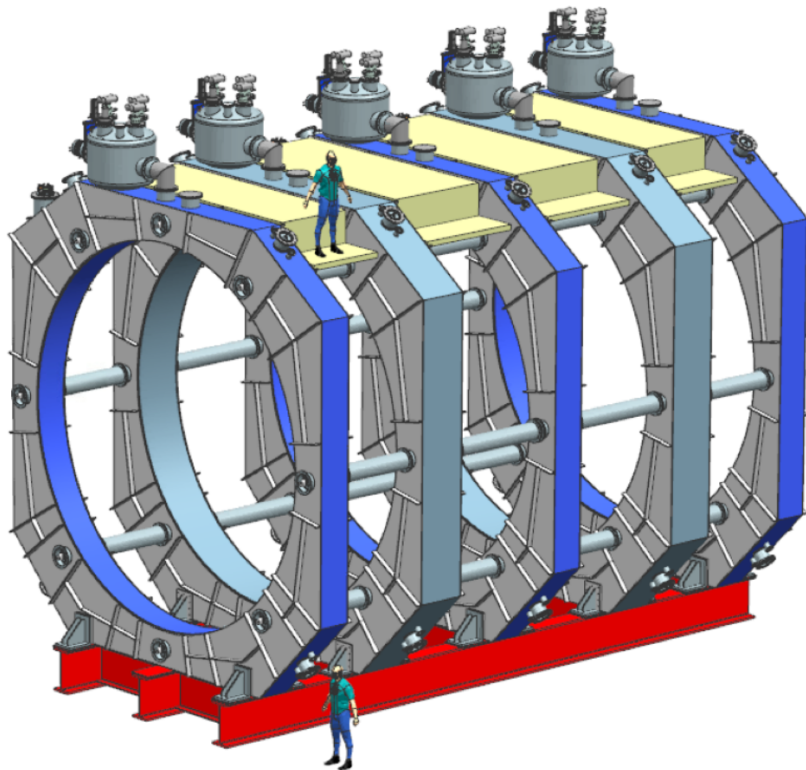
State-of-the-art tracking resolution in gas TPC

- ALICE TPC ($P_{\text{res}} \sim 1\%$ at 1 GeV/c, 10 times better than T2K)
 - S/B = 8 on CH target
 - T2K \sim S/B = 0.8
- HPgTPC
 - can achieve 95% ν H purity with 50% He + 50% CH₄
 - S/B = 24

MPD Magnet Reference Design: Superconducting 3-coil Helmholtz with 2 superconducting bucking coils

Reference design:

- All cryostats have the same inner radius (3.5m)
 - Permits ECAL to be inside
- Side coils at 2.5 m, shielding coils placed at 5 m from the magnet center in Z.
 - Center and shielding coils are identical.
- Central field = 0.5T
- **Overarching requirements**
 - Large acceptance for particles leaving LAr
 - Present minimal mass
- Field uniformity: $\pm 15\%$
- Sizeable stray field

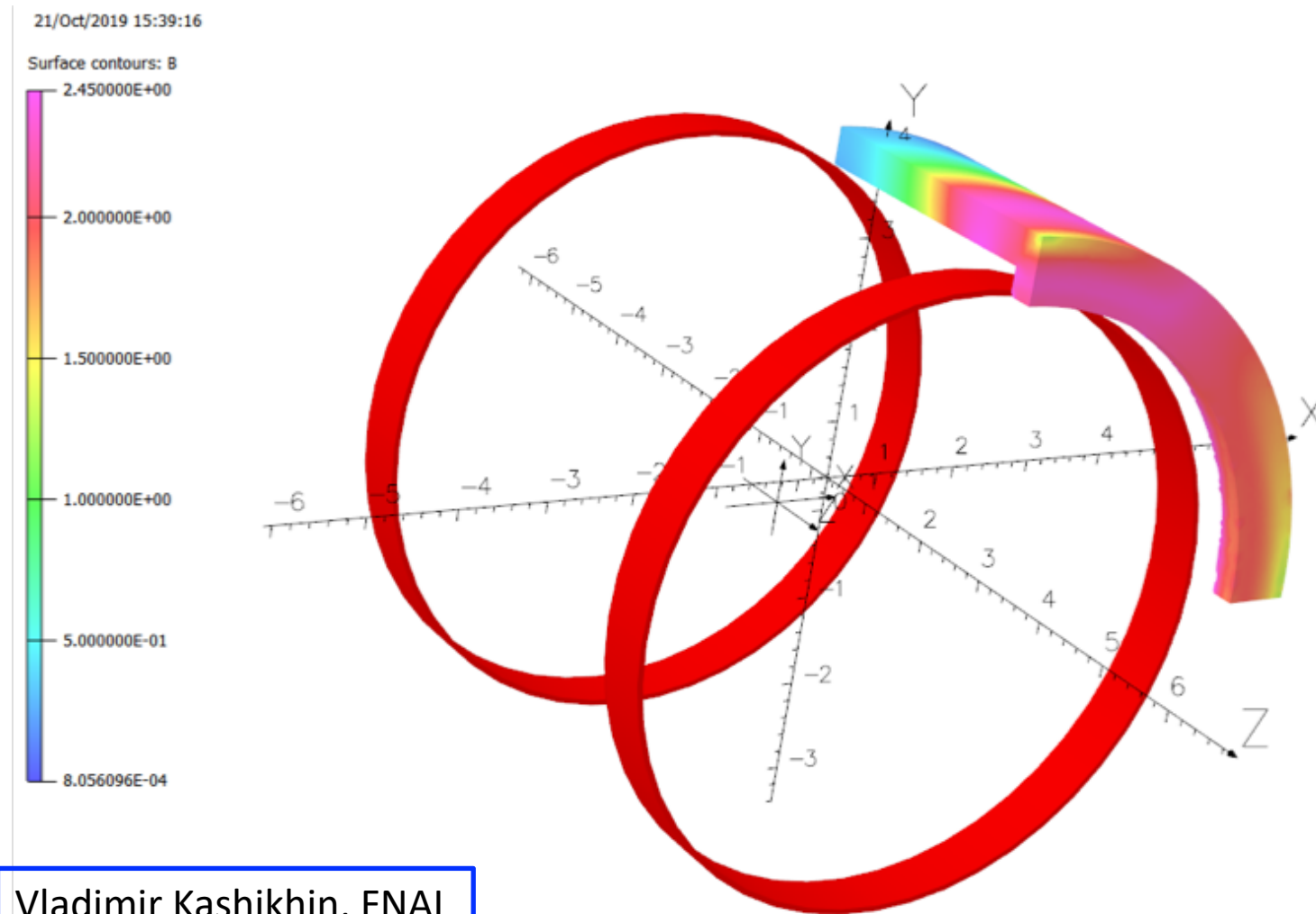


Magnet design concept

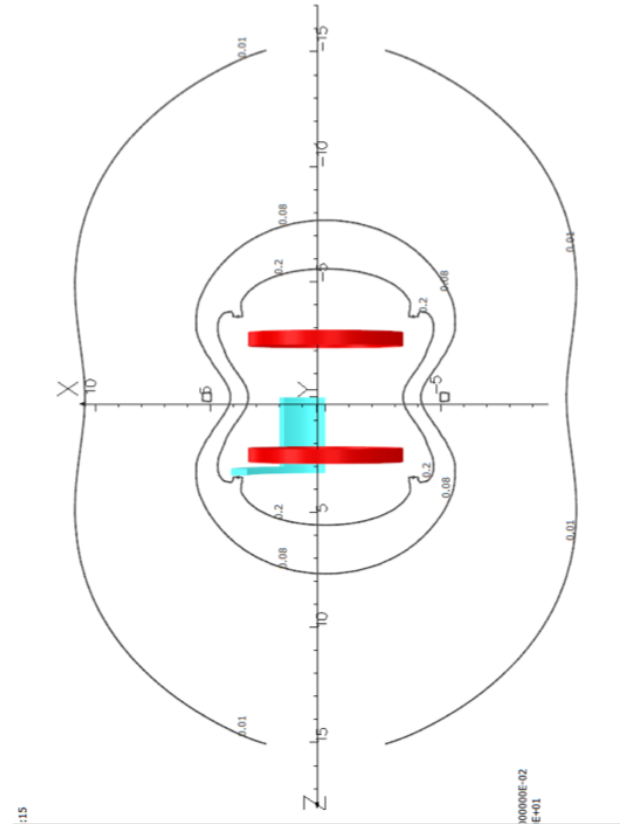
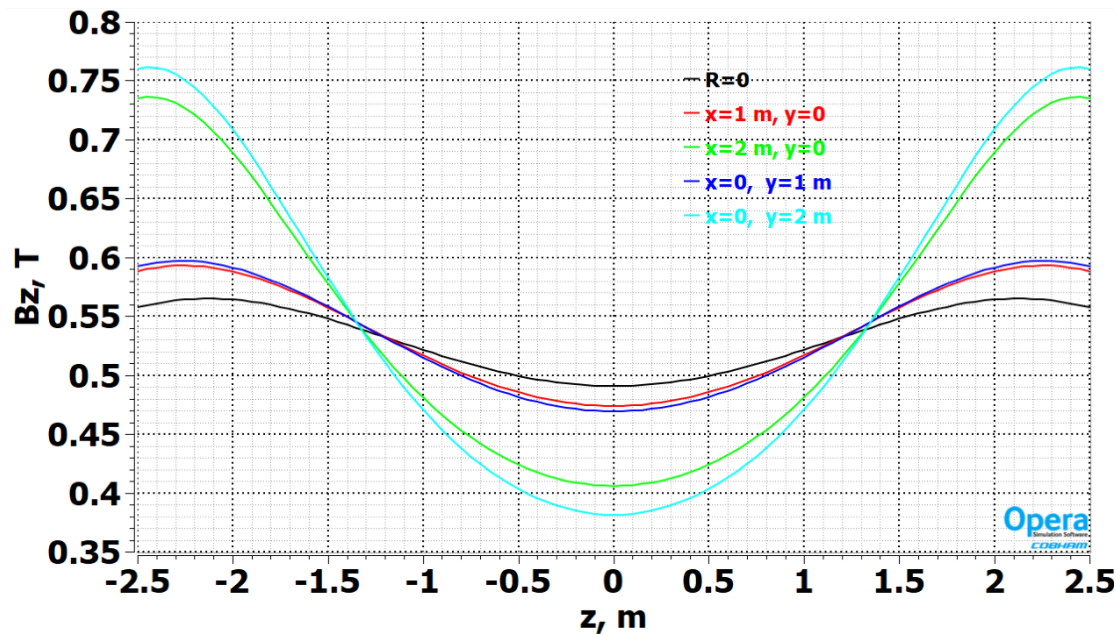
Magnet Options

Cost Savings

2-coil with partial return yoke



2-coil configuration with PRY

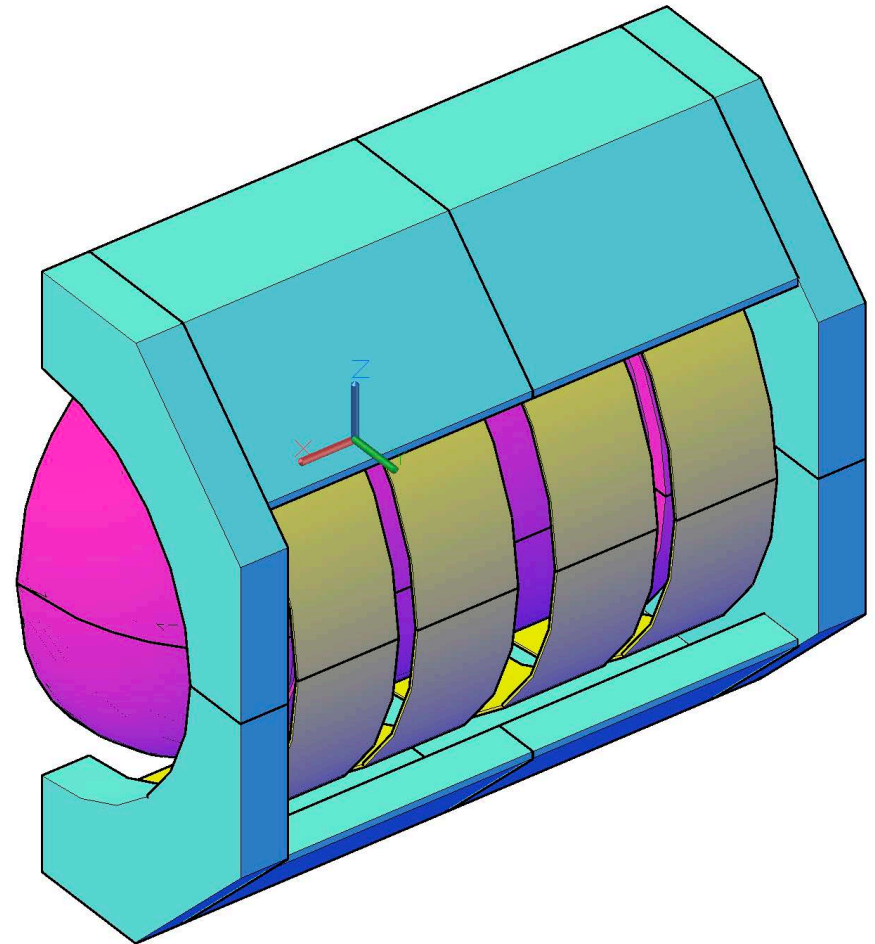


(-) PRY creates azimuthal asymmetry & lowers central field & adds dead material

(+) Can be used to support coils and for the μ tag

Solenoid with Partial Yoke (SPY)

- New concept from INFN
- Solenoid with a "window" in the yoke
 - closing the magnetic circuit where iron
 - does not affect particles
- Good for
 - reducing stray field
 - reducing stored energy
 - having uniform material budget
 - May be important for DUNE PRISM
- Bad for
 - heavier
 - ~10cm of aluminium along particles path (outside the calorimeter)



Andrea Bersani, INFN Genoa

Some Takeaways:

- Many potentially synergistic activities are on-going in Germany for the MPD ECAL
 - Readout electronics, SiPM development, scintillator development (SHIP) related/in addition to CALICE activities that are provided the basis for the current ECAL concept
- Significant interest in the UK for HPgTPC activities
 - Electronics, DAQ, test beam
- Georgian (GTU) interest and experience in straw tube production
 - MPD μ tagger
 - One option for tracking outside 3DST
- Benefits of partial yolk magnet
 - Reduces stray fields
 - Natural part of a muon detection system
 - Both MPD magnet design options with partial yolk will be taken forward and we aim to select one at the CM @CERN in January