AIDA

Advanced European Infrastructures for Detectors at Accelerators

AIDA

SPSC Meeting June 25th 2013

E. Noah (University of Geneva)

On behalf of the AIDA collaboration

AIDA is co-funded by the European Commission within the Framework Programme 7 Capacities Specific Programme, Grant Agreement 262025

Outline

- AIDA project introduction
- New irradiation facilities
- Test beam activities at PS/SPS
- MIND and TASD neutrino detector protos.
- SPS low energy beamline design

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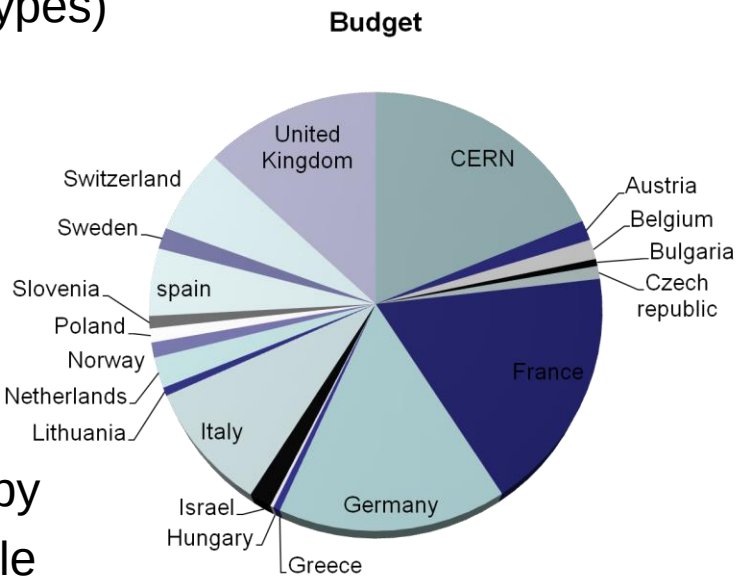
AIDA project

- AIDA is an Infrastructure Activity (IA) FP7-EU project started in Feb 2011 for a 4 years duration

- It is expected to offer /deliver facilities to the community. It contains Trans National Activities (CERN & DESY testbeam + irradiation sites), Network Activities (computing + micro-electronics) and Joint Research Activities (beam line equipment + ILC/Neutrinos/LHC detectors prototypes)

- 80 institutes from 23 EU countries
  Total budget is 26 M€ and 1960 person months
  → Strongly relying on Institutes,
  1/3 only covered by EU contribution

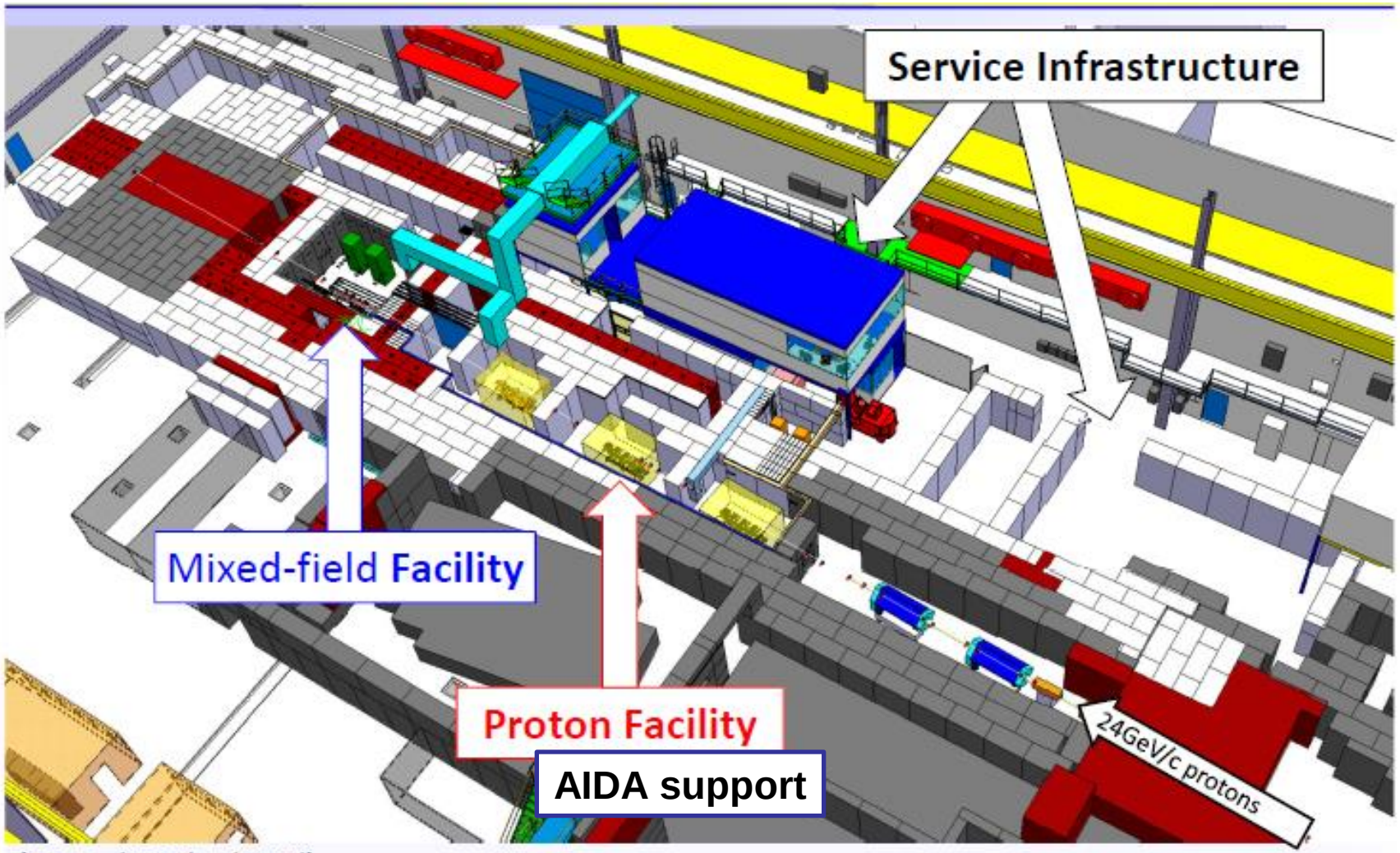
- Deliverables of the project need to be validated by Feb 2015 → new LHC/CERN test beam schedule impact the AIDA deliverables



New irradiation facilities

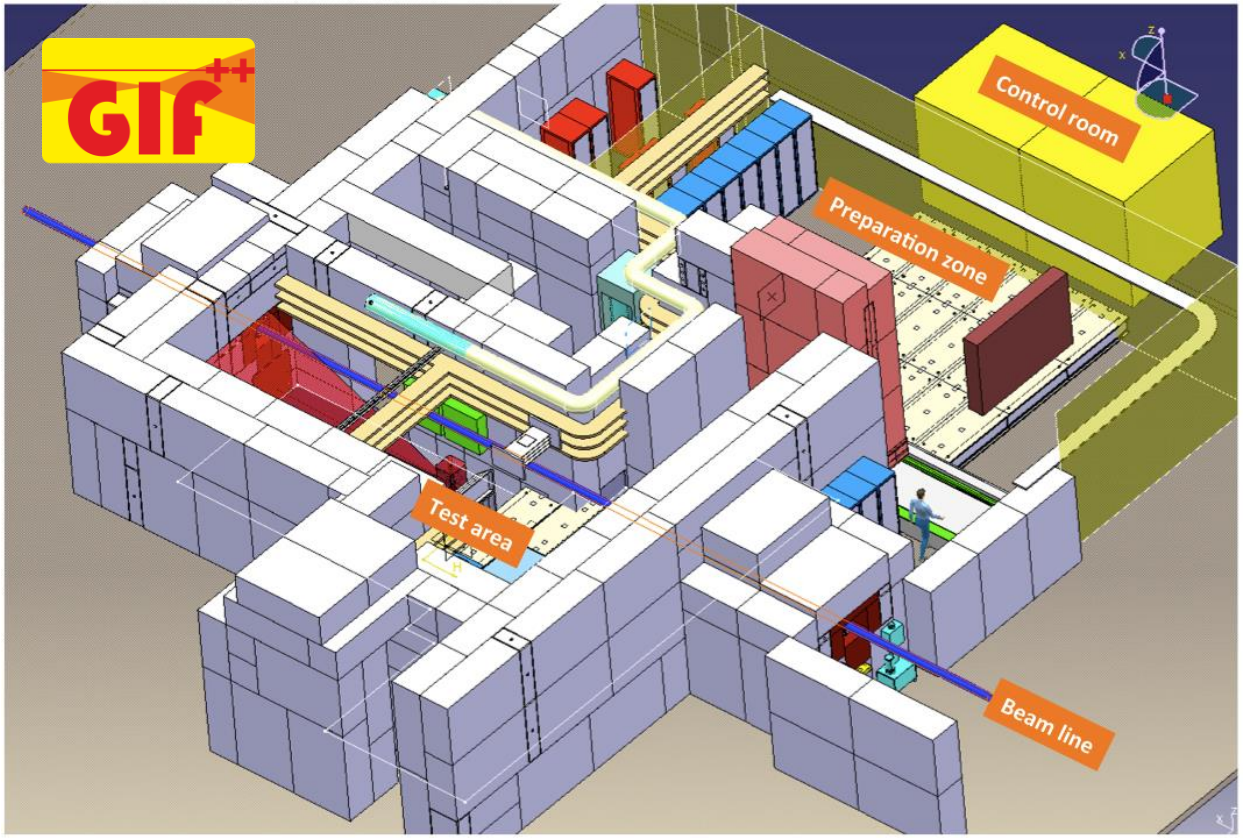
- Two facilities under construction at CERN
  - EAIRRAD in PS EAST AREA (T8)
    - Combination of a 24 GeV/c proton and mixed field facility
      - Replacing previous T7 and T8 facilities as well as CNRAD, H4IRRAD test fields
    - Aiming for typical fluence of:
      - ~10^{16} p/cm^2 in 5 days on 15x15 mm^2 FWHM
        (corresponding to 4 times higher flux than previous proton facility)
    - Construction in framework of EAST AREA renovation (PL: Lau Gatignon)
      - Equipment and design of proton facility (PH/DT) main clients: Experiments community
      - Equipment and design of mixed field facility (EN & R2E): Accelerator community
    - AIDA contribution (WP8.3): Layout and infrastructure of the proton facility
  - GIF++ in SPS H4 beam line
    - Combination of test beam with strong gamma source (17 TBq ^{137}Cs)
      - Main user community: Gaseous Detector performance and aging tests
    - AIDA contribution (WP8.5.3): GIF++ user infrastructure
- Both facilities expected to be operational at end of LS1

Layout of EAIRRAD facility



GIF++ in SPS North Area (H4)

- Design and construction of GIF++ (Gamma Irradiation Facility) by teams from CERN-EN & PH
- **AIDA contribution:** Infrastructure for the GIF++ Facility
  - Filters for radiation attenuator, beam tracker telescope, Cosmic trigger setup, radiation and environment sensors, DCS,DAQ, …
- **Location:** H4 line in SPS North Area100GeV muons 10x10cm^2
- **Size:** 170m^2 (2xGIF)
- **Source:** ^{137}Cs, 16.65 TBq (~6 Gy/h at 50 cm) 662 KeV, $\tau_{1/2}$= 30y
- **Status:**
  - Call for tender for the source published;
  - Area preparation will start in Sept. 2013;
  - Facility operational from 2015



The facility aim is to test large detector (like muon chamber) for HL-LHC

Beamline equipment

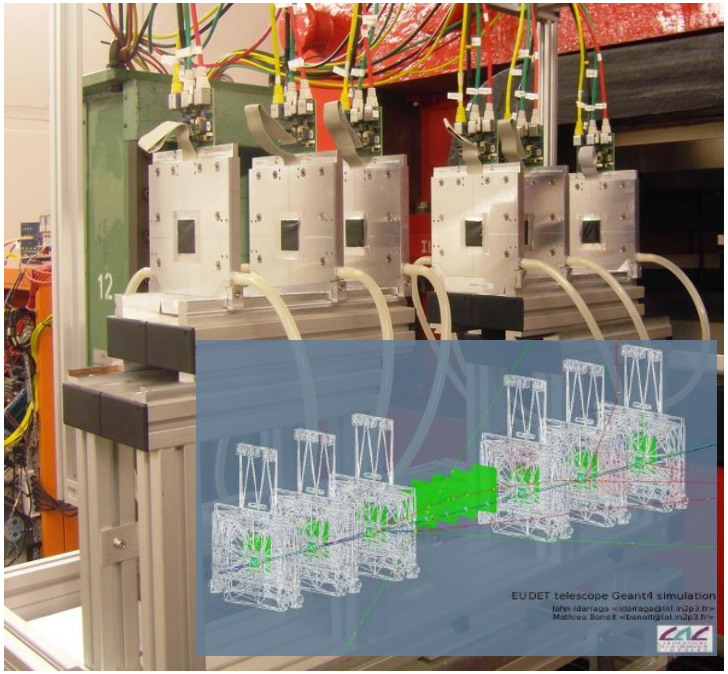
AIDA offers:

→telescope infrastructure based on MIMOSA inherited from EUDET

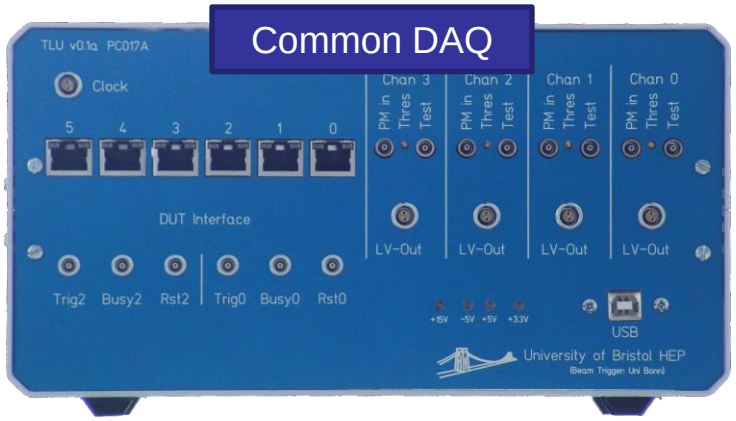
→continued support to large and diverse user base

→development of larger, more versatile, multi-technology telescope

→extended services (cooling, alignment box)

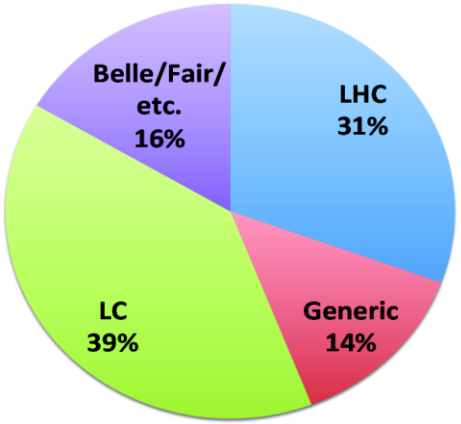


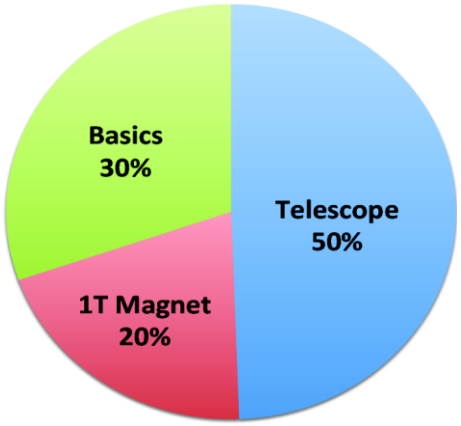
CO_2 cooling: AIDA funding NIKHEF/CERN/Krakow



Telescope usage

- Telescope moved to DESY during long shutdown at CERN
- Intense programme in three beamlines (fully booked through to spring 2014)
- MIMOSA telescope duplicated several times (with non-AIDA funding)





Intense demand from a diverse community

➔ Access to beams at CERN after LS1 required to relieve pressure on DESY beamlines

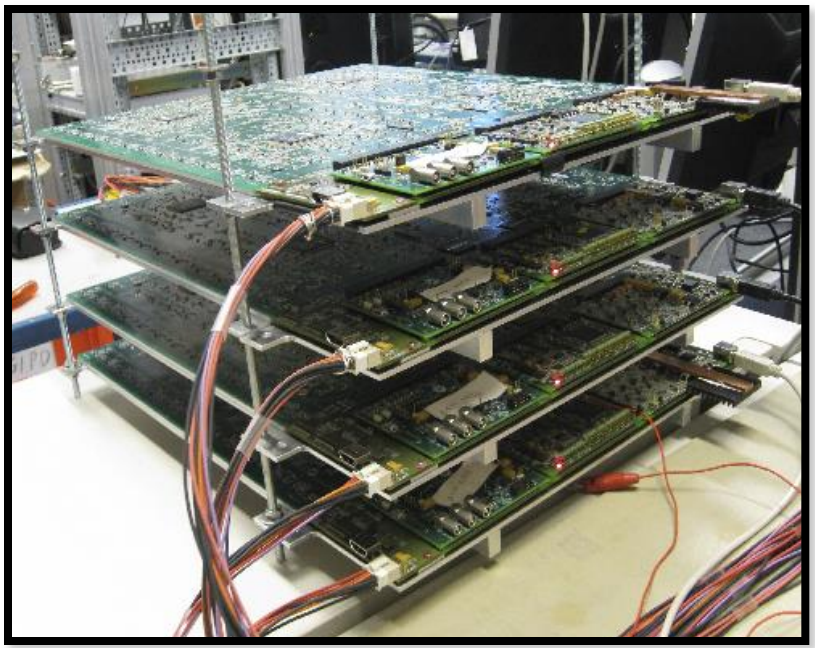
Existing calorimeter prototypes

Existing & tested in 2011-12

- Tungsten structure for extensive TB (~10w/y) at CERN with CALICE sensors:
  - AHCAL (3×3 to $12 \times 12 cm^2$ scintillator tiles with SiPM readout) 54 layers
  - DHCAL (1×1 cm^2 RPC, digital mode, embedded readout), 54 layers
  - S-DHCAL (1×1 cm^2 MicroMegas, semi-digital mode), 1 layer
  - T3B (1 row of $3 \times 3 cm^2$ scint. tiles with SiPM & picoscope readout; with DHCAL RPCs) ➔ timing of hadronic (esp. neutron) response.
- Stainless Steel structure with ancillaries & CALICE sensors:
  - S-DHCAL (1×1 cm^2 RPC & MicroMegas [48 + 2 layers])
- Clean, Low & High energy hadrons only available at CERN

Future calorimeter prototypes

- Full Si-W ECAL 18×18 cm^2
  - 0.5×0.5 cm^2 Silicon sensors with embedded and power-pulsed readout. R&D phase @ DESY 2013-14
  - High E electrons mandatory at CERN (saturation & X-talk events) [image square events]

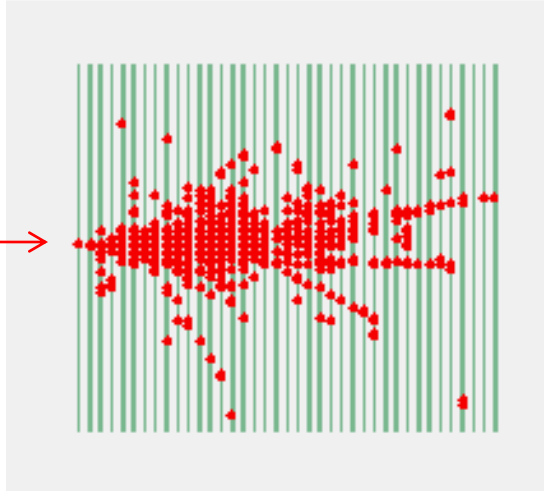


- 2nd generation HCAL layers
  - 3x3 cm^2 scintillator tiles with integrated electronics →

- FCAL Structure
  - Precision structure:
    high energy electrons, high rates, runs & irradiation tests needed (2015 ?).

Combined tests

DHCAL 210 GeV pion event display



Combined test: Trackers & Calorimeters (E+H)

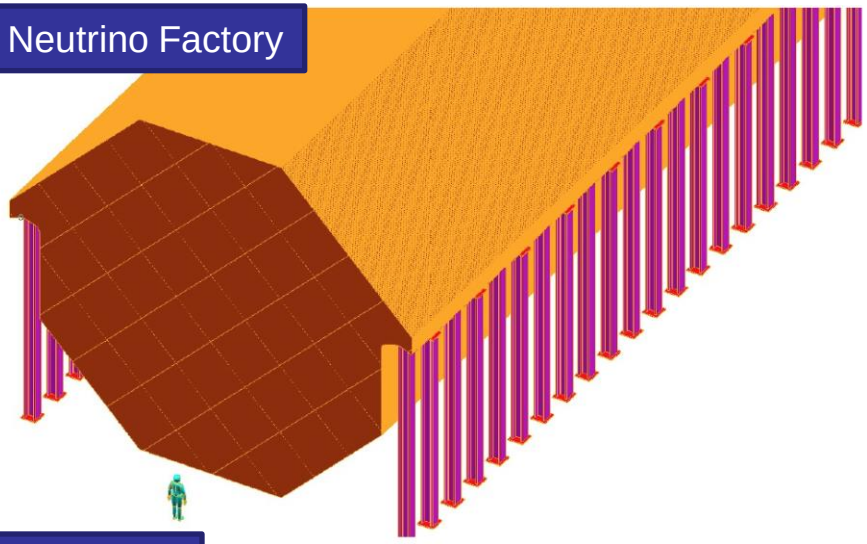
- Not suitable for direct PFA studies
  - p+target → pseudo-jets:
    - wrong pT distributions; Ω~ π Sr needed
- Ancillary studies for PFA:
  - Mechanical precision, EM compatibility, cooling
  - Reconstruction techniques;
  - Realistic dead material corrections;
  - Power pulsing;
- Community building: people, formats, tools on real data.
  - Common DAQ; Pile-up;

Part of the tests can be done @ DESY (SiTr + ECAL; reduced ECAL + HCAL with low E e-)

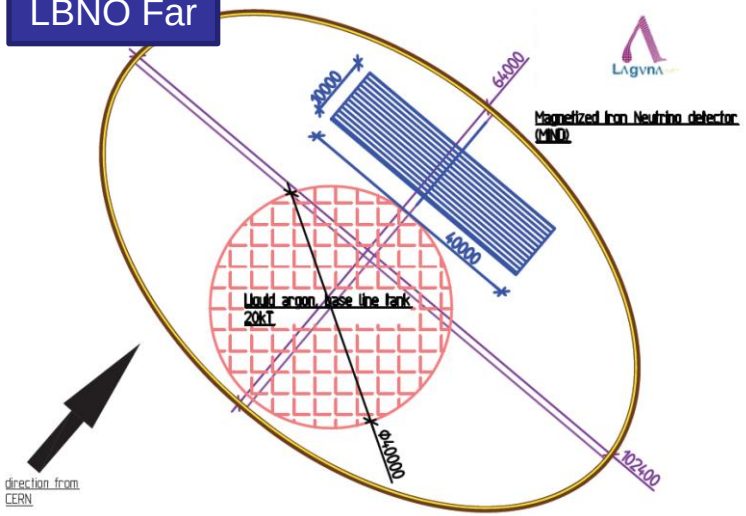
- Full program only at CERN

Some neutrino detector proposals

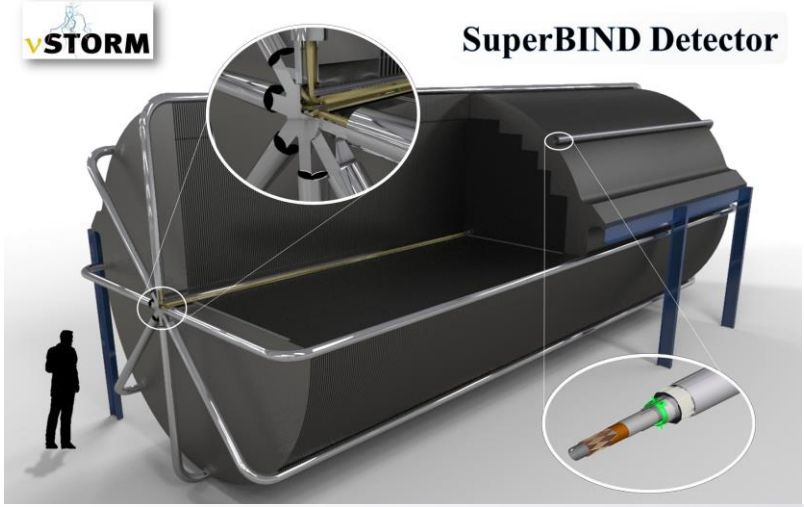
Neutrino Factory



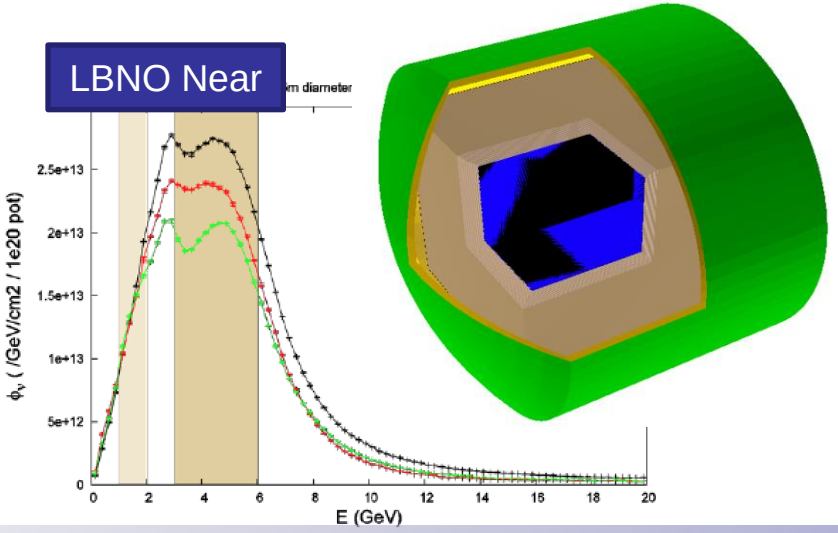
LBNO Far



nuSTORM



LBNO Near



Neutrino detector prototypes

- Motivation for prototypes:
  - Neutrino community: detector response for low energy interactions;
  - Beam line equipment: muon spectrometer becomes part of available equipment to test other detector prototypes (e.g. LAr, Gas TPC etc...) beyond AIDA 2015.
- MIND and TASD options:
  - Magnetized Iron Neutrino Detector: muon spectrometer;
  - Totally Active Scintillator Detector: electrons, low energy μ/π.
- Proposal/request to SPSC Q4-2013/Q1-2014.

Event topologies in MIND

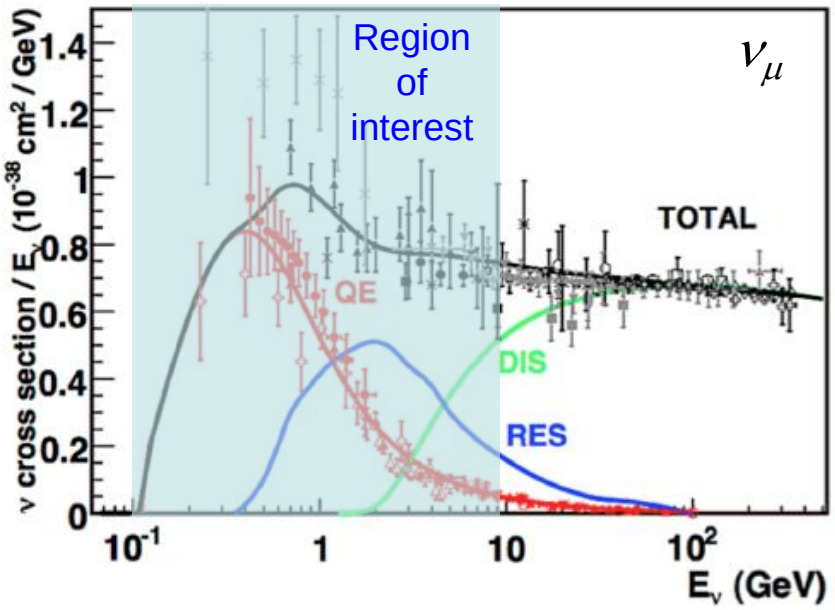
ν_μ appearance

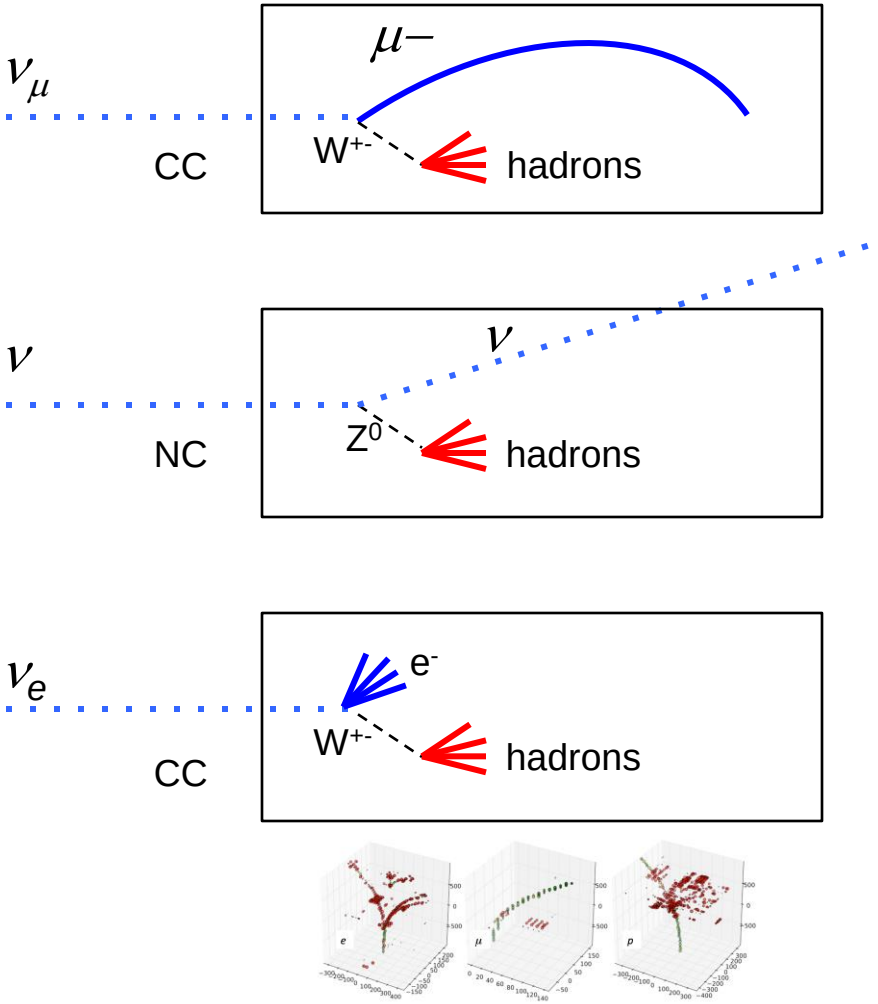
$\pi^+ \rightarrow \mu^+ + \nu_\mu$

$\downarrow$

$\mu^+ \rightarrow e^+ + \nu_e + \bar{\nu}_\mu$

Requires correct sign background rejection of 1 in 10^{-4}





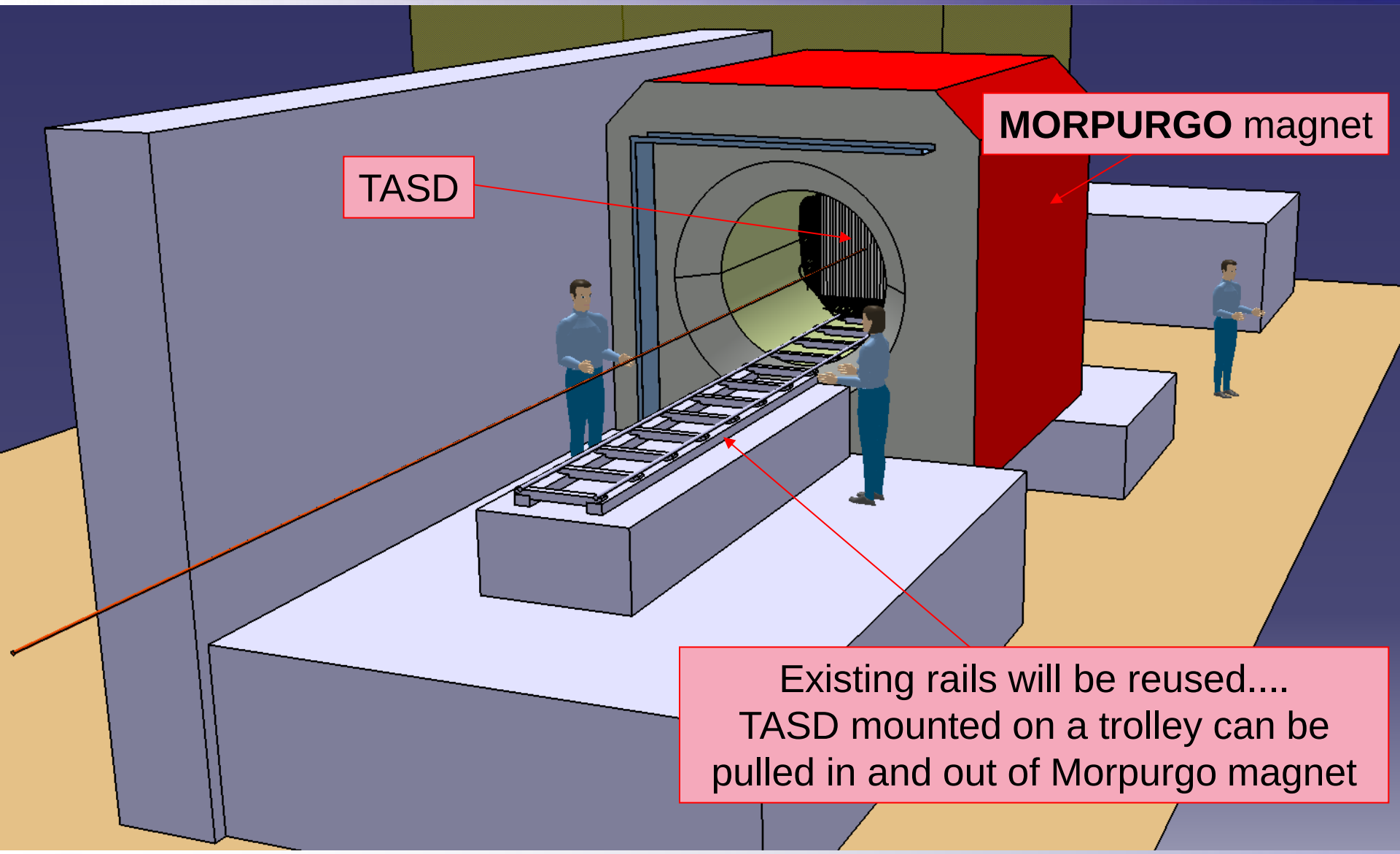
Planned test beam studies

- Particle identification:
  - Muon reconstruction in the MIND (range + bending);
  - Two classes (range out in detector/leave detector);
  - Direct comparison of momentum resolution between classes, also comparison of momentum measurements with data;
  - μ/π distinction (good in TASD, can it be done reliably in MIND?... to an extent that low E μ measurements are viable?);
  - Electron measurements in TASD.
- Hadronic energy resolution/reconstruction:
  - Refine CalDet results (B-field);
  - Software development required, comparison with real test beam data.
- Hardware:
  - Plate thickness (MIND and possibly TASD);
  - SiPM & electronics thresholds, especially relevant for large detectors.

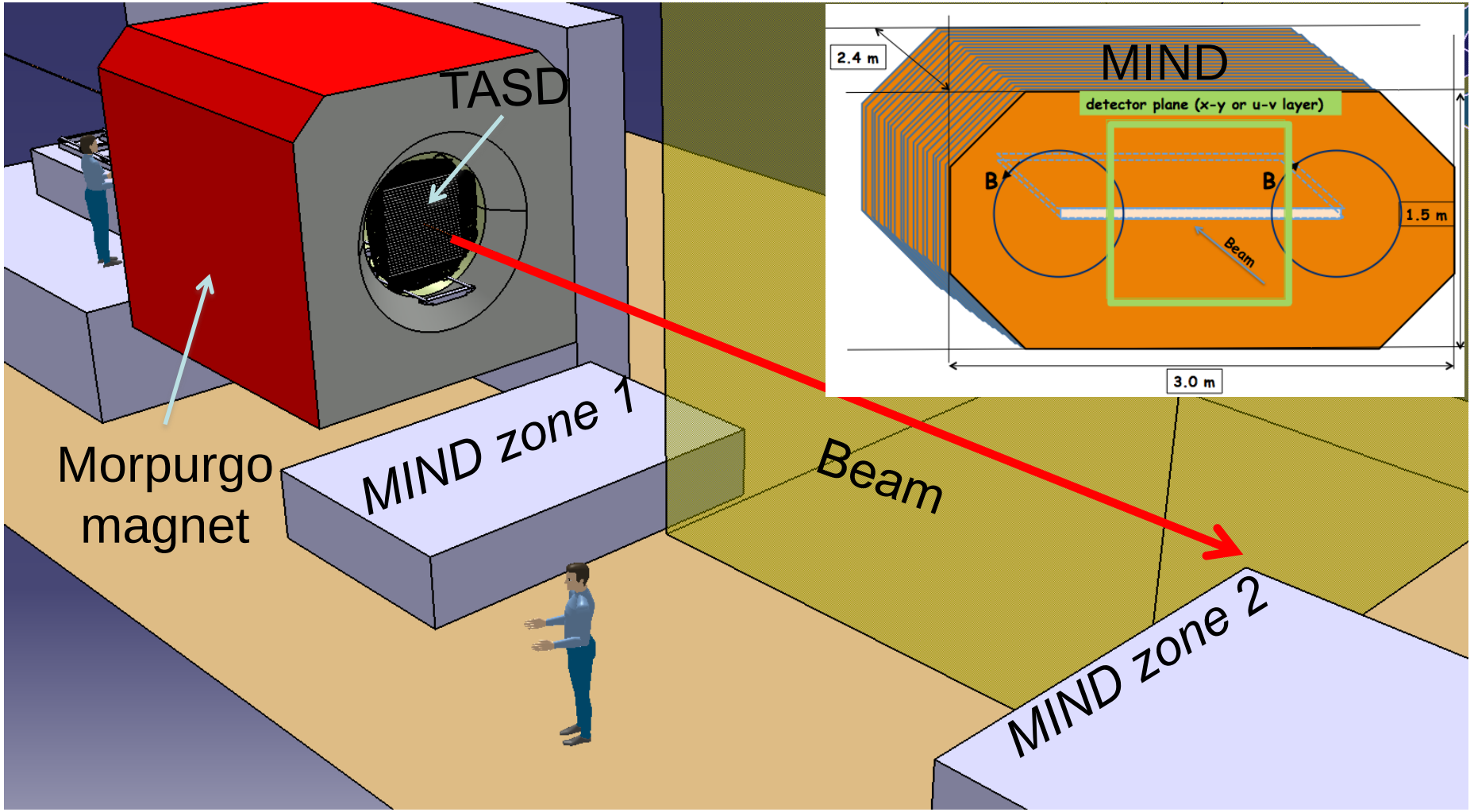
Beam requirements

- e, μ, π, p:
  - 0.5 to 10 GeV/c;
  - < kHz.
- Knowledge of beam:
  - PID (esp. μ/π ratio at low momenta);
  - Timing;
  - Flux.
- Large aperture magnet for TASD
  - e.g. Morpurgo magnet on H8.

TASD layout at H8

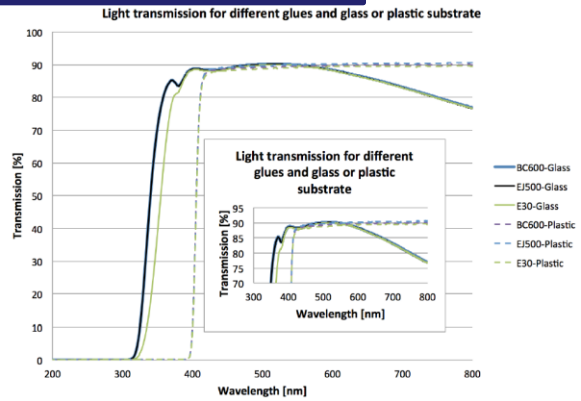


MIND layout at H8



Detector module R&D

Optical cement tests



Scintillator bar production

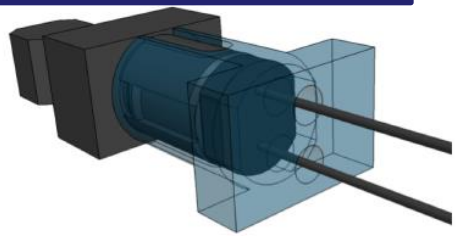
Photosensor tests

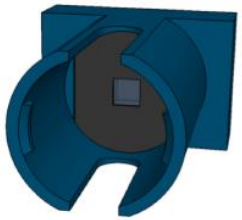
Parameters	MPPC	Ketek
Sensitive area, mm^2	1.69	1
Overvoltage, V	~ 1.4	5-6
Dark rate, kHz	600-1000	~800
Crosstalk, %	10	~40
Pulse shape	good	long tails
Temperature effects	large	small
PDE at 520 nm, %	25.6	42-45

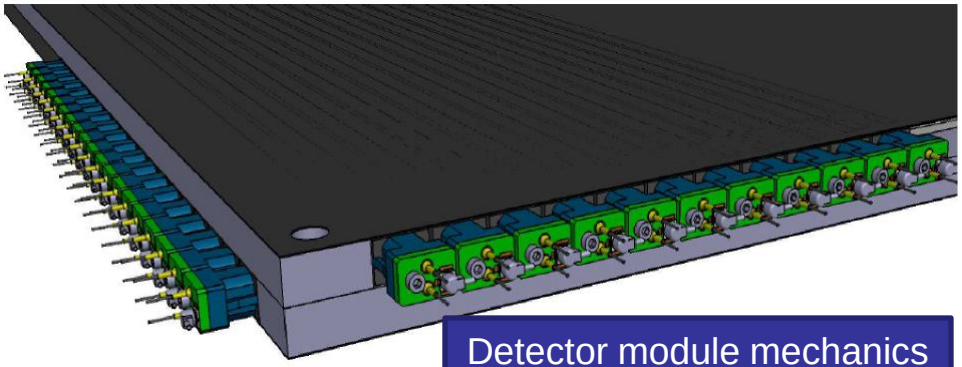
Light yield tests

Slab width [mm]	MPPC 1 L.Y. [p.e.]	MPPC 2 L.Y. [p.e.]	$\Sigma_{L.Y.}$ [1+2] [p.e.]
Chemical reflector			
10	46.0	36.8	82.8
20	39.7	35.7	75.4
20	32.6	28.2	60.8
30	31.2	26.6	57.8
Chemical reflector, w/o optical grease			
20 - grease	25.7	22.1	47.8
Chemical reflector + Tyvek paper reflector			
20 + Tyvek	49.3	44	93.3

Photosensor connector design

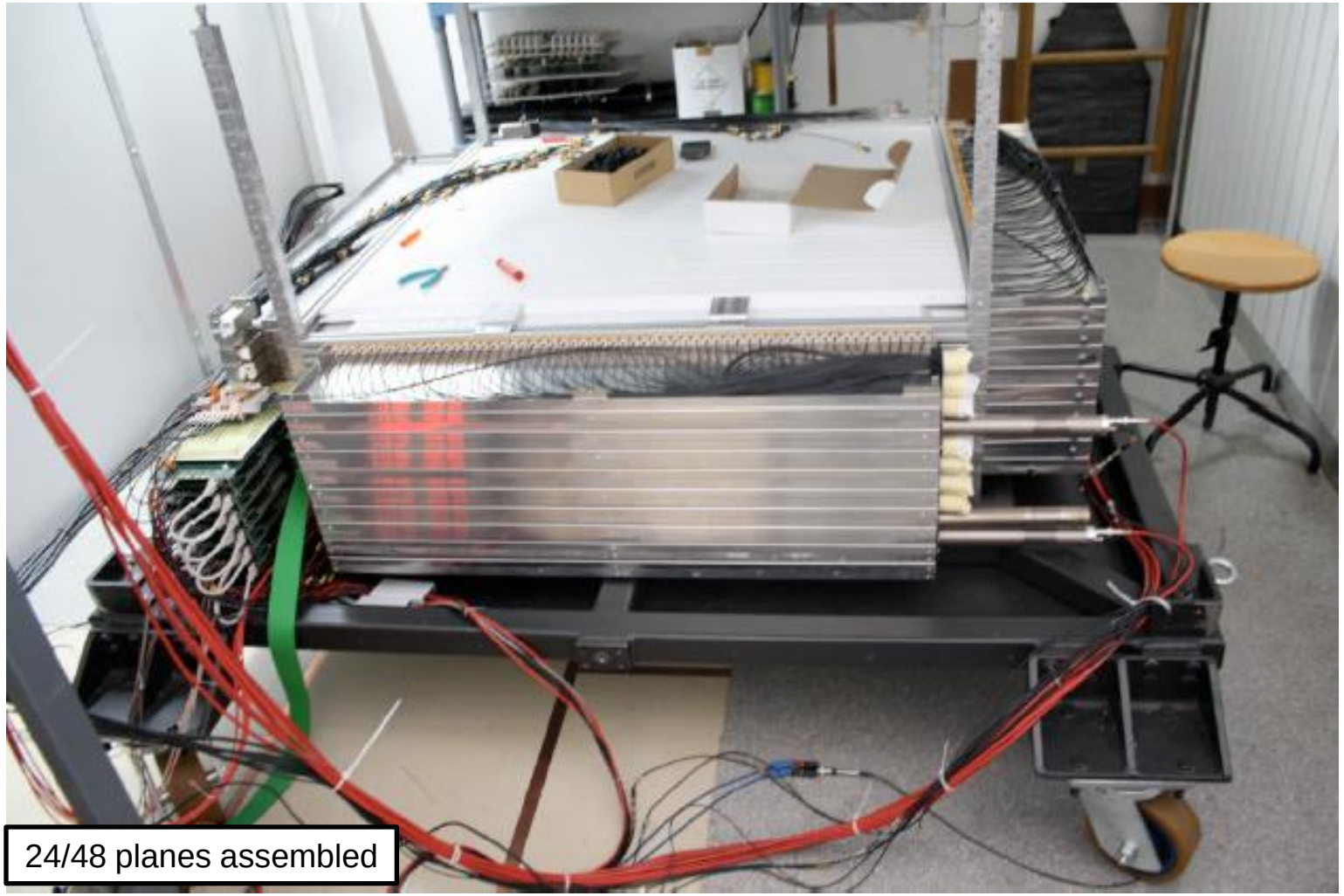






Detector module mechanics

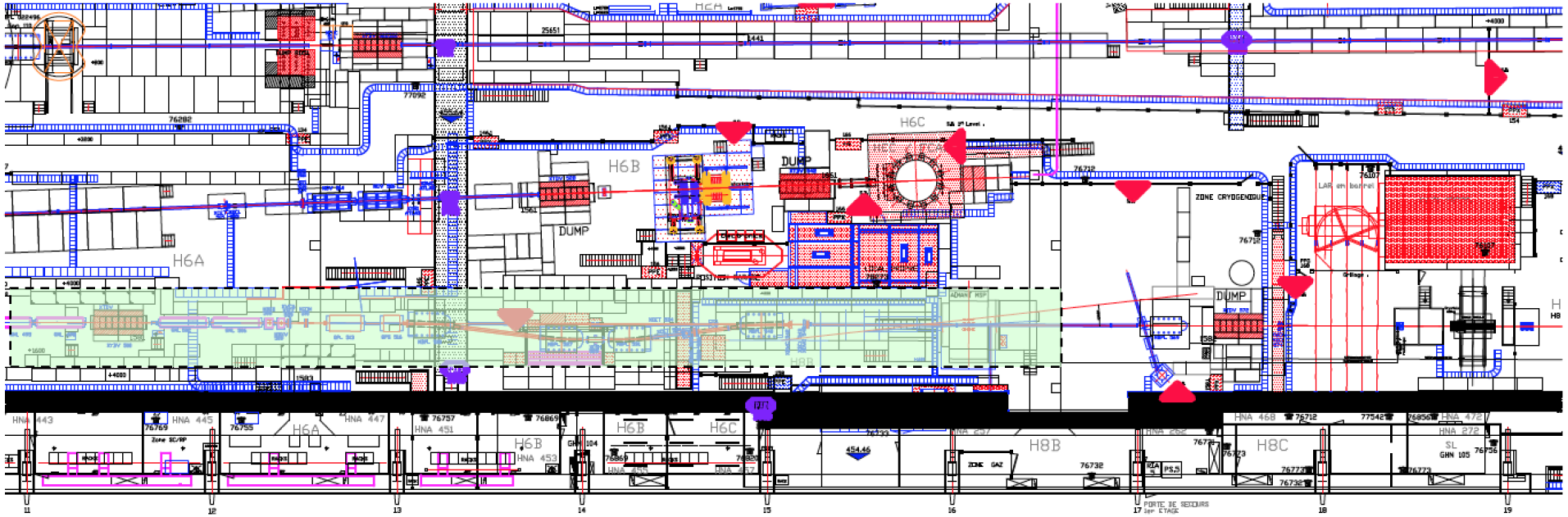
MICE EMR @ UNIGE



24/48 planes assembled

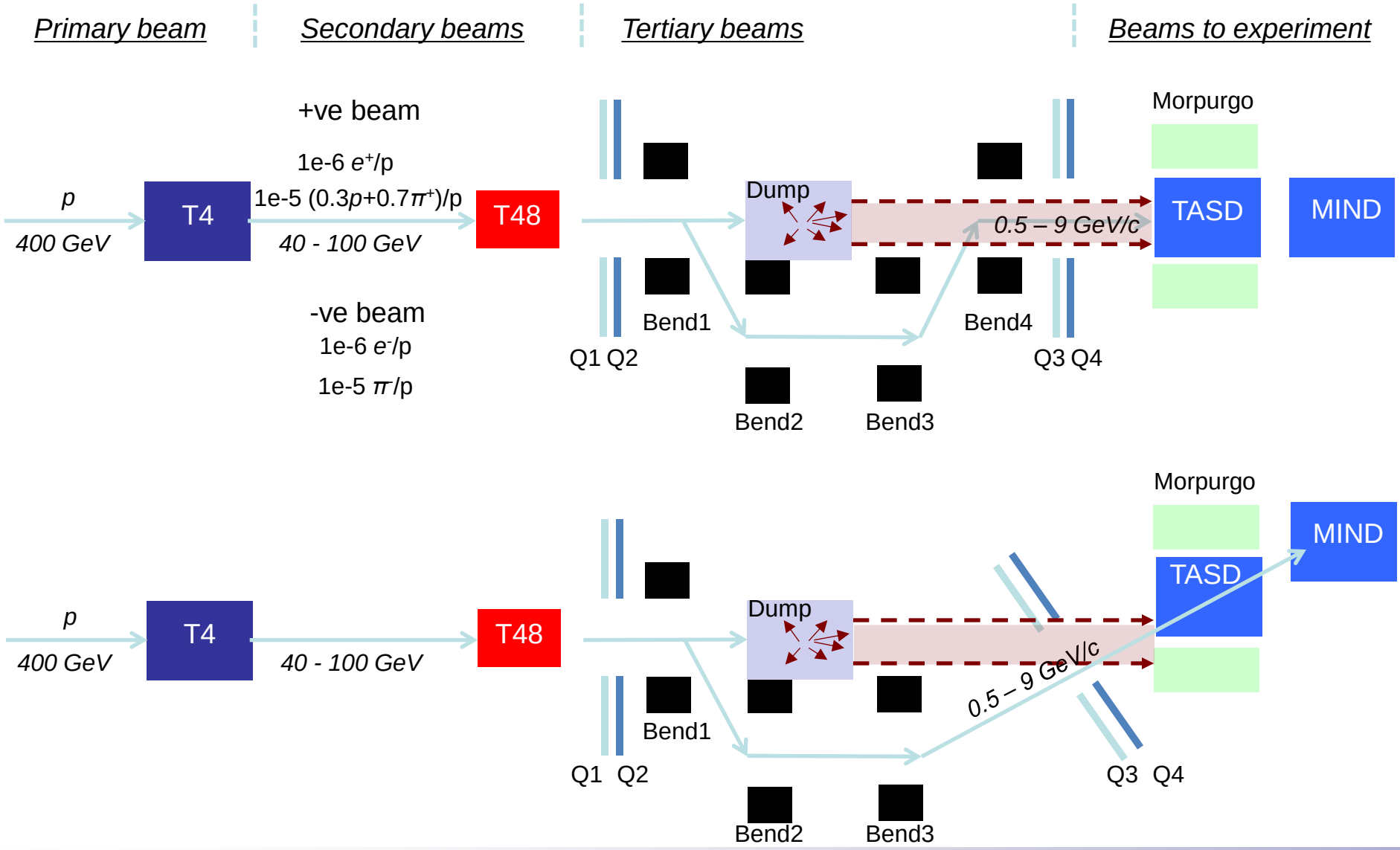
*Not funded by AIDA

H8 low energy beamline



- Potential users:
  - Neutrino community;
  - ATLAS, others?
- Length of beamline limited to 50m
  - Two beamline options, study funded by AIDA.

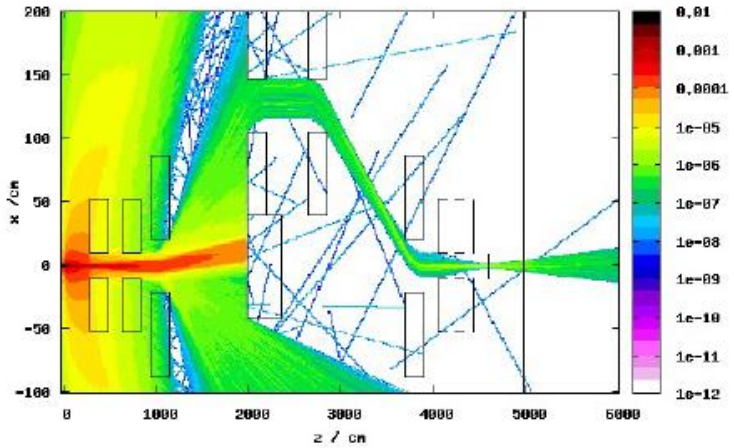
H8 beamline layouts



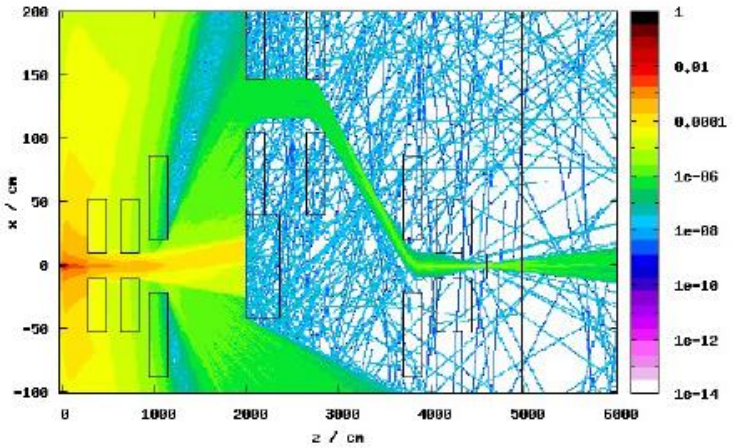
Low E *e* and π beams

Pion beam to exp:
80 GeV pencil beam incident on Be target
(50% π, 50% p)

π

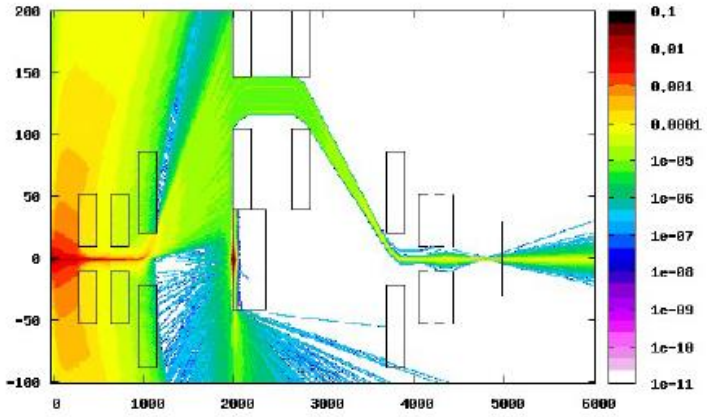


All

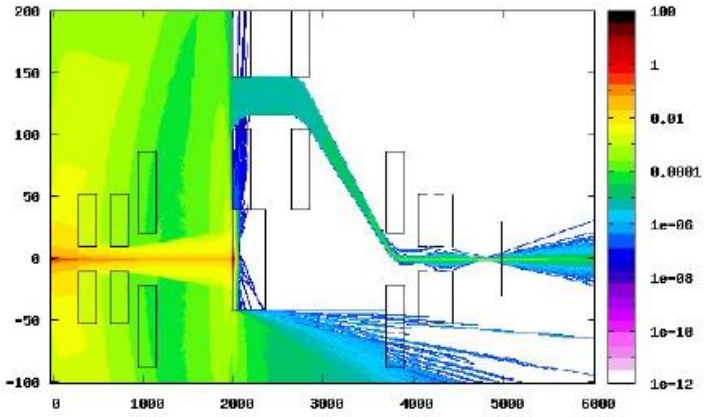


Electron beam to exp:
80 GeV *e* beam incident on lead target

e



All



Summary/Outlook

- AIDA activities end “formally” 31 Jan. 2015 :

  - Need to have access to test beam at CERN at restart after LS1 (neutrino detectors, ILC tracker and calorimetry) to validate the deliverables → Request to SPS committee.

- Equipment/facilities improvements produced by AIDA delivered to CERN after project-

  - Longer term maintenance and support of this equipment is a concern if no new EU project.

  - “AIDA continuation” topic selected during Infrastructure Activity survey done by EU, possible inclusion in first call early 2014.

- Low energy beam line

  - Design has been conducted under AIDA project (detailed report available soon). Neutrino community to make request for construction at CERN in a next SPSC.