Welcome to the Baby-MIND collaboration meeting!

A year of great achievements!

2017 Completion of detector:

-- magnet

-- scintillators

-- electronics

-- test beam

-- wrapping

-- shipping

Baby MIND: A magnetized segmented neutrino detector for the WAGASCI experiment

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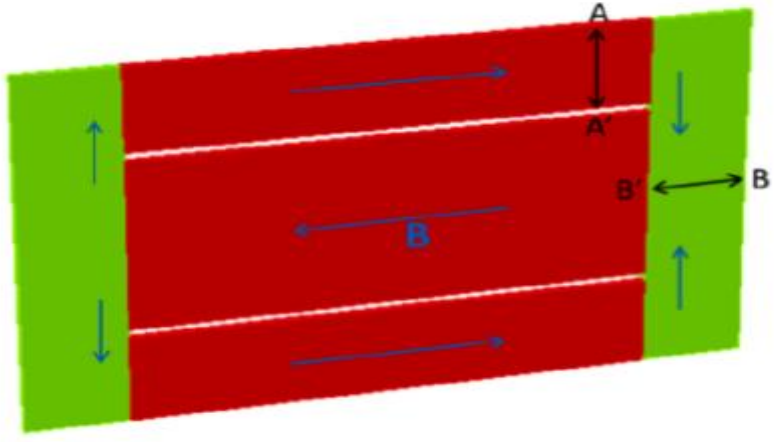
Geneva
Glasgow
CERN
Sofia
Fermilab
Valencia
Tokyo
Uppsala
Yokohama

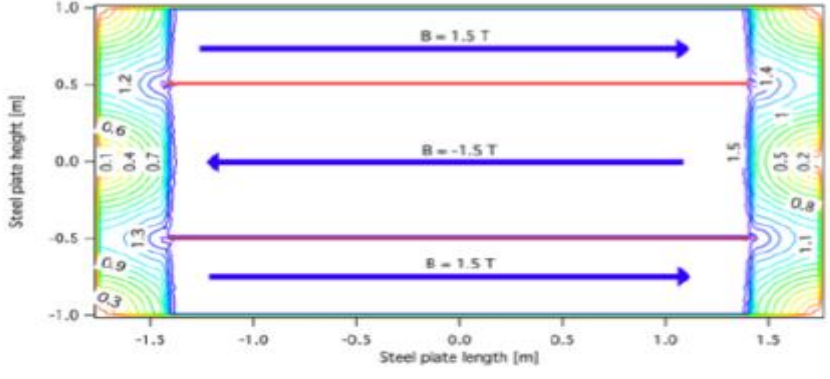
filiation: neutrino factory DS → AIDA→ LBNO→ WA105→ CERN NP05→ WAGASCI@B2

CERN contribution

- Individually magnetised iron (ARMCO) plates
- Two slit design, simple dipoles.
- Well contained and defined field lines.
- Very uniform in area of interest.
- Modular and flexible.
- Field $\approx$ 1.5 T for coil current $\approx$ 140 A
- Stray fields insignificant $<$ 15 mT.
- Power required for all 33 modules: 12 kW.
- ... and much more (logistics, handling, assembly space through the CERN Neutrino Platform)

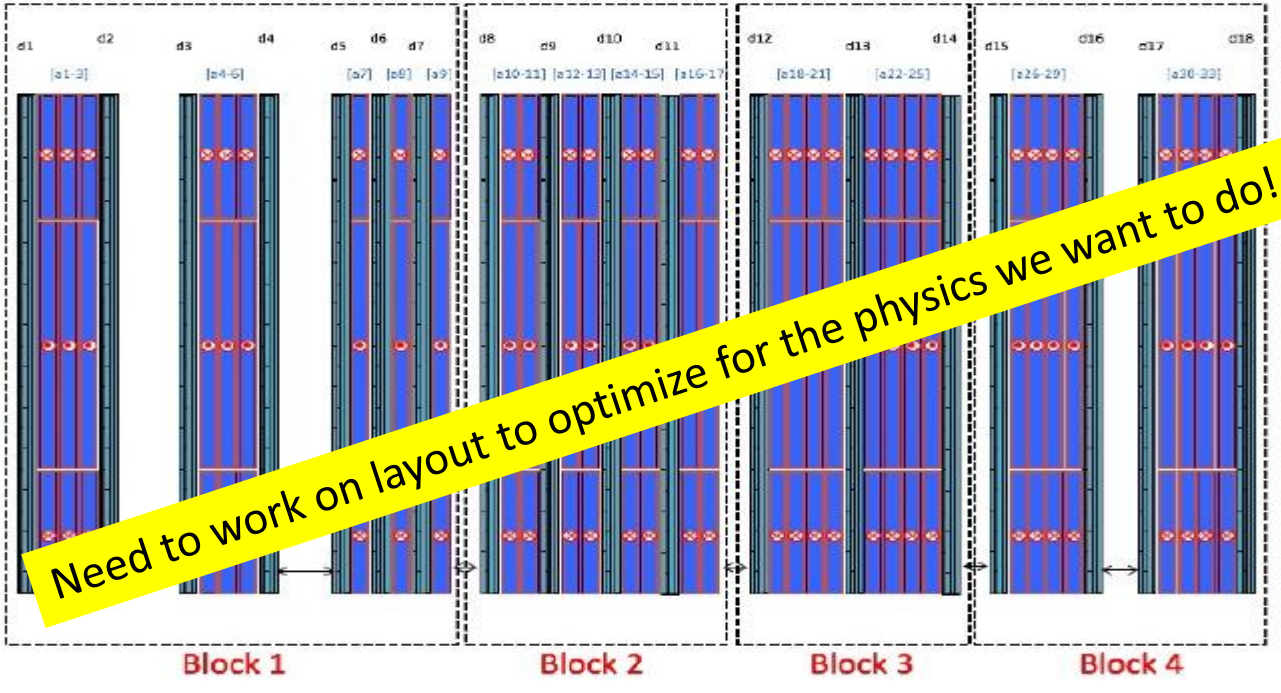
from original idea by M. Rayner





low power consumption and modularity well adapted to B2 pit installation.

Baby-MIND LAYOUT



Sccintillator planes with 1cm pitch in bending direction 10cm in horizontal direction.
Air gap after 9cm of iron for measurement of bending angle (charge sep. down to ~300 MeV)
total iron thickness 1m.

$\Delta\theta_{MS} = (0.015/P)\ \sqrt{L/X_0} = 0.034/P$ for 9cm of iron

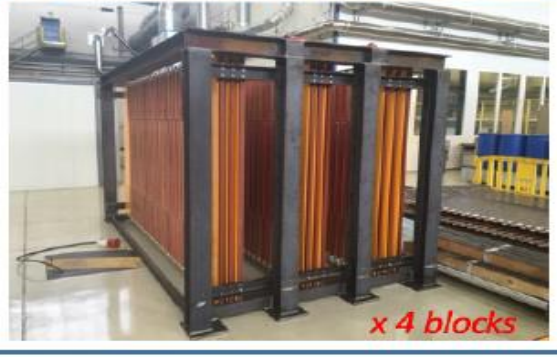
$\theta_B = 0.3\ BL\ /P = 0.040/P$ for 9cm of 1.5T magnetized iron

Baby MIND systems: [S. Parsa *et al.*, arXiv:1704.08917]

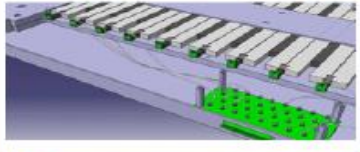
Novel magnet design — *x 33 modules*

Custom scintillator modules — *x 18 modules*

Support mechanics for transport to Japan



Cable bundles (scintillator-to-electronics)



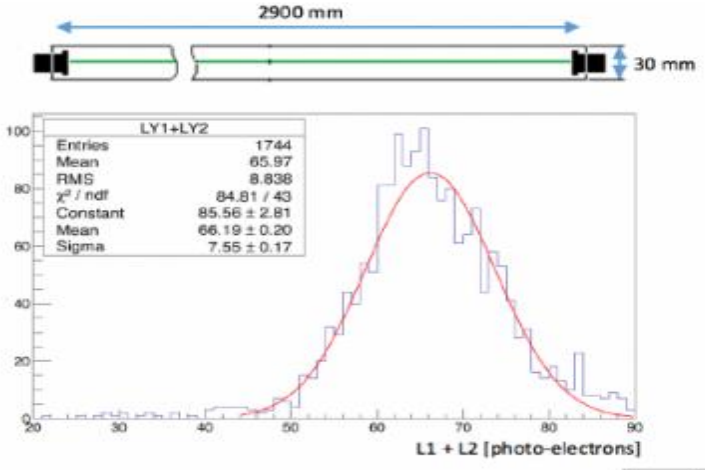
Custom readout electronics (USB3)

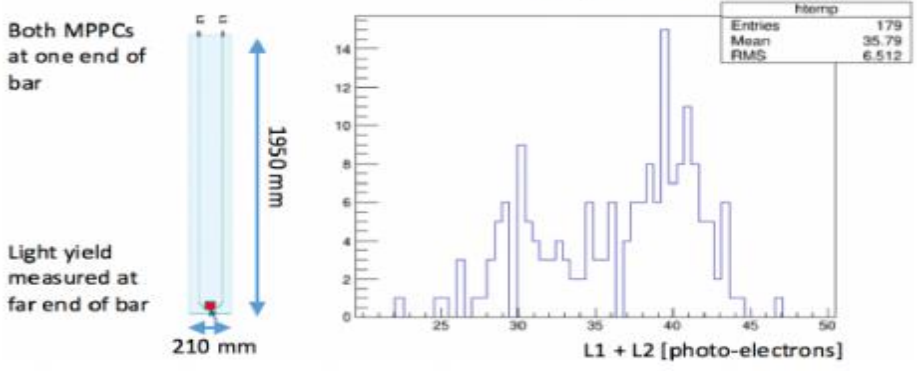
3cm wide every 2cm
→ 1cm 'pixel' in y

Scintillator bars [A. Mefodiev *et al.*, arXiv:1705.10406v3]

- Design and production by INR:
  - Polysterene based, 1.5 % PTP, 0.01% POPOP.
  - Reflective coating 30 to 100 μm from chemical etching of surface.
  - Kuraray WLS fiber (200 ppm, S-type), dia 1.0 mm.
  - Eljen EJ-500 optical cement.
  - Custom optical connector.
- Delivery schedule INR-CERN:
  - **First batch** delivered **March 2016**.
  - **Second batch** delivered **November 2016**.
- Individual bar tests:
  - **INR tests** before shipment to CERN with cosmics.
  - **CERN tests** upon reception of bars with LED.

4000 channels

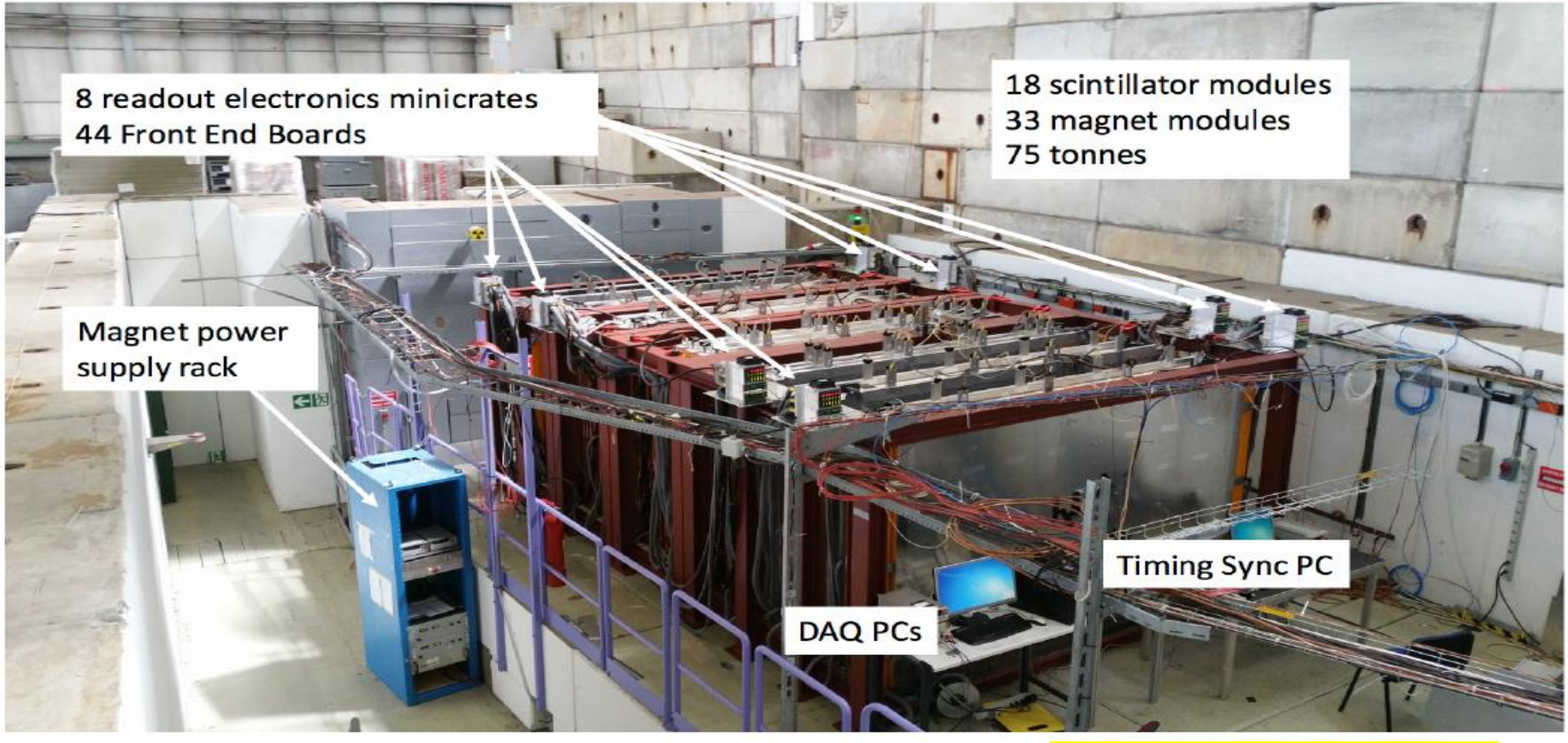




Scintillator module assembly

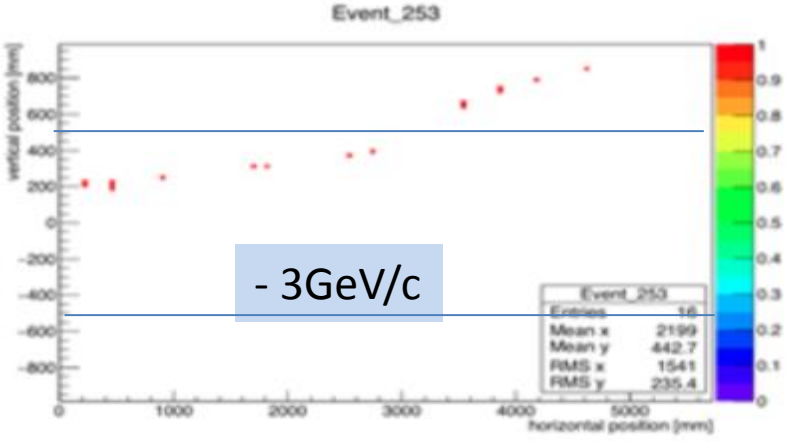
- Two half-modules assembled separately.
- Each half-module: 1 horizontal + 1 vertical plane:
  - 95 horizontal bars: 3000 x 31 x 7.5 mm^3
  - 8 vertical bars: 1950 x 210 x 7.5 mm^3
- Scintillators held together mechanically (no glue) within aluminium support frame.

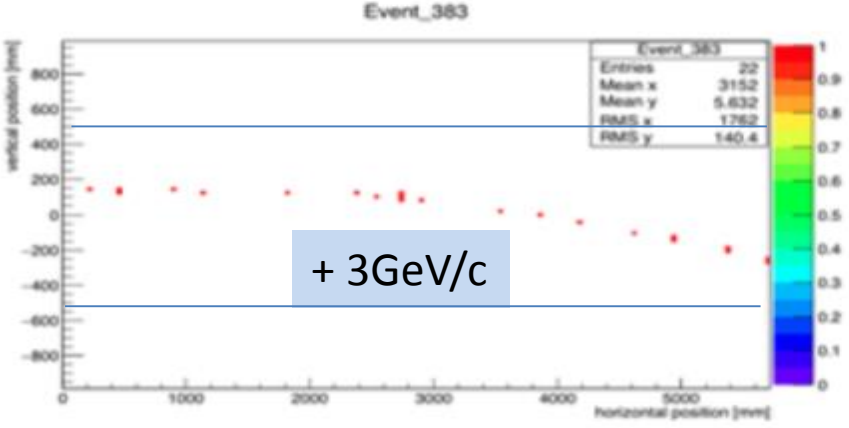
Baby MIND at PS-CERN experimental hall (T9 beam line): July 2017



Baby-MIND ready to go!

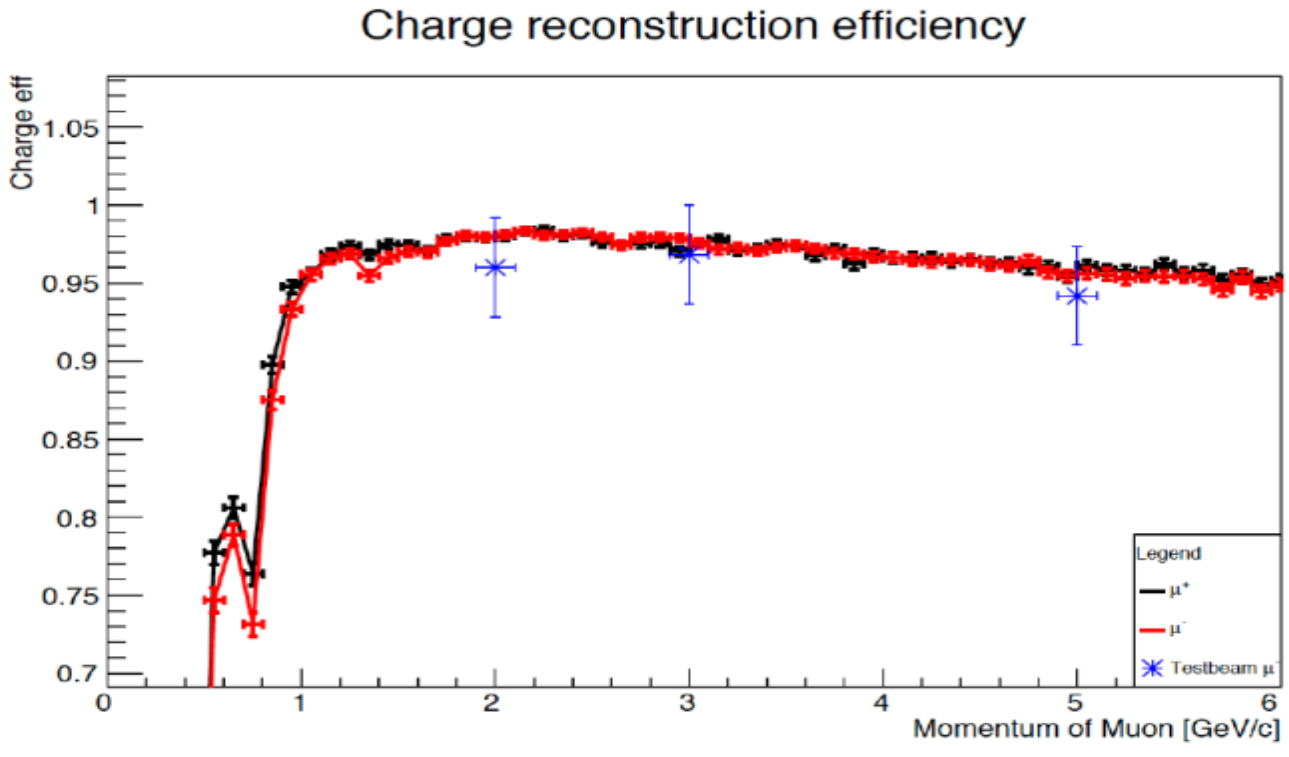
Muon events





Event displays, side view of the Baby MIND, -3 GeV/c muon on the left and +3 GeV/c muon on the right.

Preliminary: Charge ID efficiencies: [S-P. Hallsjö *et al.*, Proc. NuFACT 2017]



Also time resolution is ~1ns (Mefodev)

Project milestones

- **Electronics Front End Board** beam test at T9 in **June 2016**.
- **First** complete **Baby-MIND scintillator module** in **October 2016**.
- **Delivery** of all **scintillators** from Russia INR by **November 2016**.
- **Magnet modules** ready end of **February 2017**.
- **Detector modules** ready **June 2017**.
- **Beam tests** characterization with FEBv1 in **May 2017 - Block 1**.
- **Full detector** commissioning and beam tests in **June-July 2017**.
- **Shipment** to **Japan** October-to-December 2017.
  - *KEK green light on 29 September after "Request for reception by T59"*
- **Installation** at J-PARC **ND280 pit** in the planning for Q1 2018.
  - *About to submit test experiment proposal to J-PARC PAC.*
- **Commissioning** at J-PARC **ND280 pit** Q2 2018.

box: 17-18 October

CERN NEUTRINO PLATFORM

Neutrino detectors on the move

N Gonzalez and J Ordan, Julien Marius

A Blondel

ICARUS (above) on its departure day, and a section of BabyMIND (left) being moved to the test-beam area.

On 12 June, a 120 tonne cuboidal particle detector measuring 18 m long was loaded onto a lorry at CERN to begin a six-week journey to Fermilab in the US. Called ICARUS, the detector will form part of Fermilab's short-baseline neutrino programme, which aims to make detailed measurements of neutrino oscillations and search for eV-scale sterile neutrinos (*CERN Courier* June 2017 p25).

ICARUS, which is based on advanced liquid-argon time projection technology, began its life under a mountain at the Gran Sasso National Laboratory in Italy in 2010, recording data from neutrino beams sent from CERN. Since 2014, it has been at CERN undergoing an upgrade and refurbishment at the CERN Neutrino Platform (*CERN Courier* July/August 2016 p21). It left CERN by road and boarded a boat on the Rhine to a port in Antwerp, Belgium, where it was loaded in two identical pieces onto a ship. As the *Courier* went to press, ICARUS was already heading across the Atlantic to Indiana, equipped with a GPS unit that allows its progress to be tracked in real time.

Just two days after ICARUS left CERN, another key component of the CERN Neutrino Platform was on the move, albeit on a smaller lorry. BabyMIND, a 75 tonne prototype for a magnetised iron neutrino detector that will precisely identify and track muons, was moved from its construction site in building 157 to the east experimental hall of the Proton Synchrotron. Following testing and characterisation in a high-energy beam, at the end of July BabyMIND will be transported to Japan to be part of the WAGASCI experiment, where it will contribute to a better understanding of the T2K neutrino-oscillation experiment.

Shipping CERN to J-PARC

- **Logistics** and costs covered by Baby MIND collaboration.
- **Support** for Japan phase from KEK/T2K/T59 colleagues.
- **4 transport chassis** loaded into **4 containers**.
- **Special open top containers** loading/unloading **from top**.
- **Monitoring** of temperature/humidity **but no control**.
- **DBSchenker** transport company manages **all stages**:
  - *Loading at CERN: 2 containers/day, October 18 & 19*
  - *Truck CERN-to-Basel(CH)*
  - *Barge on river Rhine to ANTWERP(NL).*
  - *Ship NYK Olympus ANTWERP(NL) October 26-to-Tokyo(JP) December 3 (+/- 3 days)* **direct, no change of ship.**
  - *4 trucks from seaport to J-PARC.*
- **Customs (paperwork preparation ongoing).**
- **Unloading and storage at J-PARC, procedure elaborated.**

Baby-MIND NEXT STEPS

Baby-MIND group organized transport: transporter is responsible from CERN to JPARC,
Detector will be donated to KEK (letter written, agreement drafted)
18 October→ ~11 December (+- few days)
E. Noah/L. Nicola will arrive in Japan 11 December
14-15 Dec : reception and unloading of four detector blocks at J-PARC
Proposal for installation and operation was (re-)submitted as a T59 status update.

Storage in NA building (December)
installation in B2 pit (in early 2018)
+ first phase 1/8-1/22 (with 80% C.L. for readiness. to be confirmed at the end of Nov.)
+ second phase 2/12-2/26
will be supervised by Ichikawa, Tsukamoto, and neutrino facility group.
Engineers from UNIGE and CERN can be present as necessary.
(while T2K is not running and ND280 magnet is off).

400 V powerline needed for Baby-MIND magnet; under discussion with KEK neutrino group
-- will require approval from both J-PARC and T2K.

Commissioning, DAQ integration with Wagasci

and documentation will be provided by Baby-MIND team in ~Jan->March 2018

Then we will train our colleagues in Wagasci and operate as WAGASCI subdetector.

Proposal to run WAGASCI+Baby-MIND experiment will be submitted to JPARC and T2K

Cooperation and close communication between Wagasci/Baby MIND and T2K would be beneficially for both collaborations. We would like to discuss the format.

On a longer time scale the Baby-MIND detector could remain in B2 and be available as muon filter **facility** for possible other fine grain detectors such as

-- High pressure TPC

-- specific ν_e cross-section measurement

Off axis angle of 1.5 degrees as well as internal geometry of modules can still be discussed – detector geometry has some flexibility and in principle movable (as well as any 75 ton object, of course)

Study of neutrino-nucleus interaction at around 1 GeV using a 3D grid-structure neutrino detector, WAGASCI at J-PARC neutrino monitor hall

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