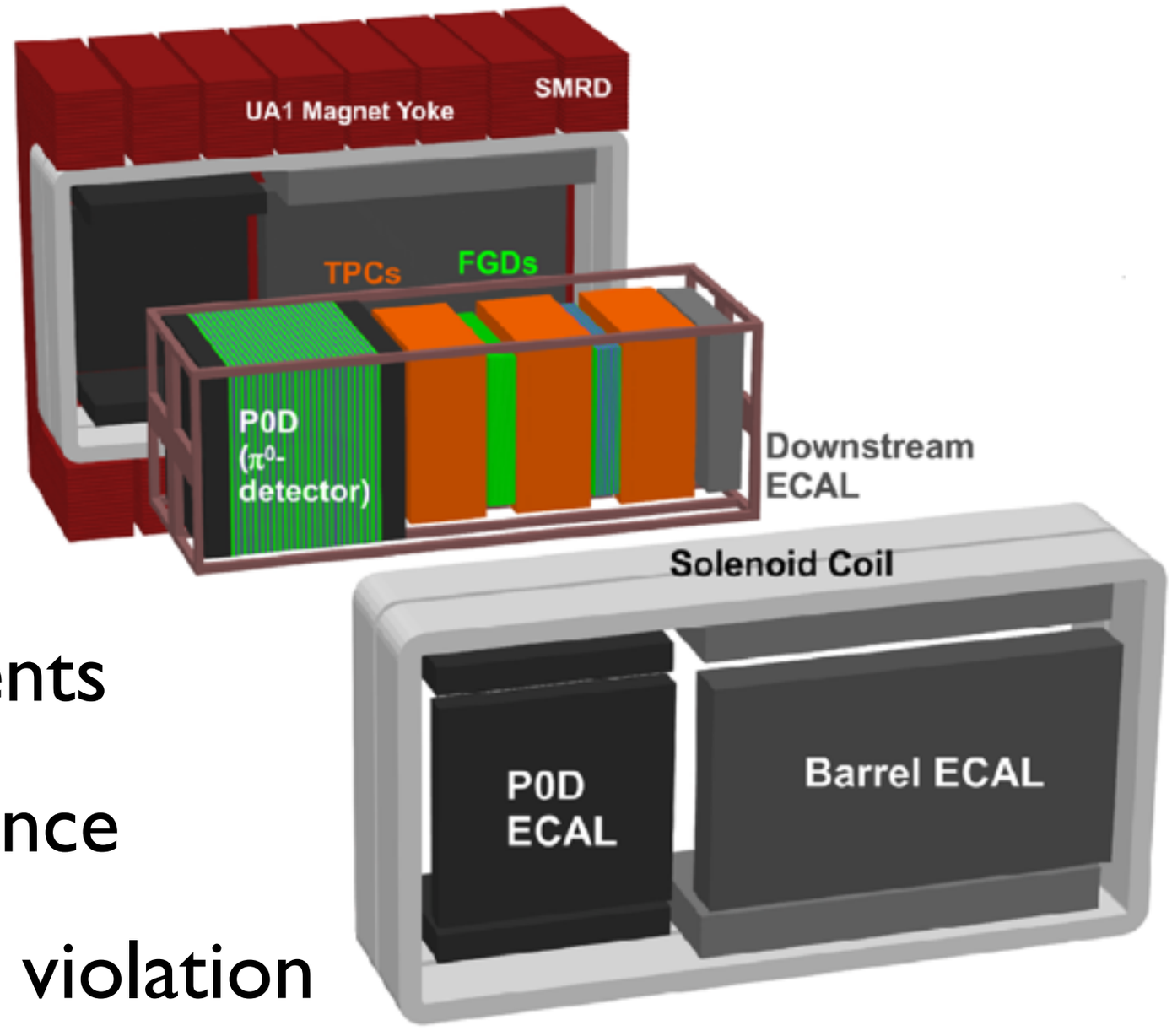
T2K ND280 Upgrade

Masashi Yokoyama
(Department of Physics, The University of Tokyo)
for the T2K Collaboration

masashi@phys.s.u-tokyo.ac.jp

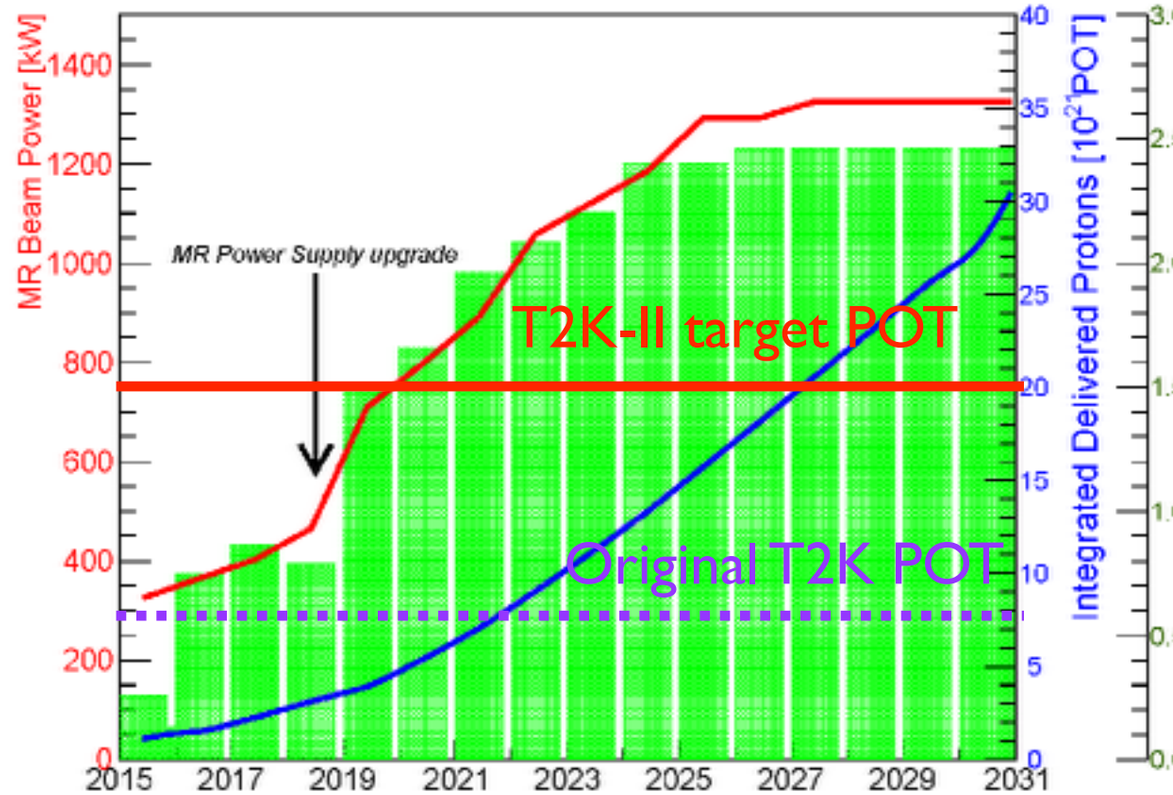
T2K ND280

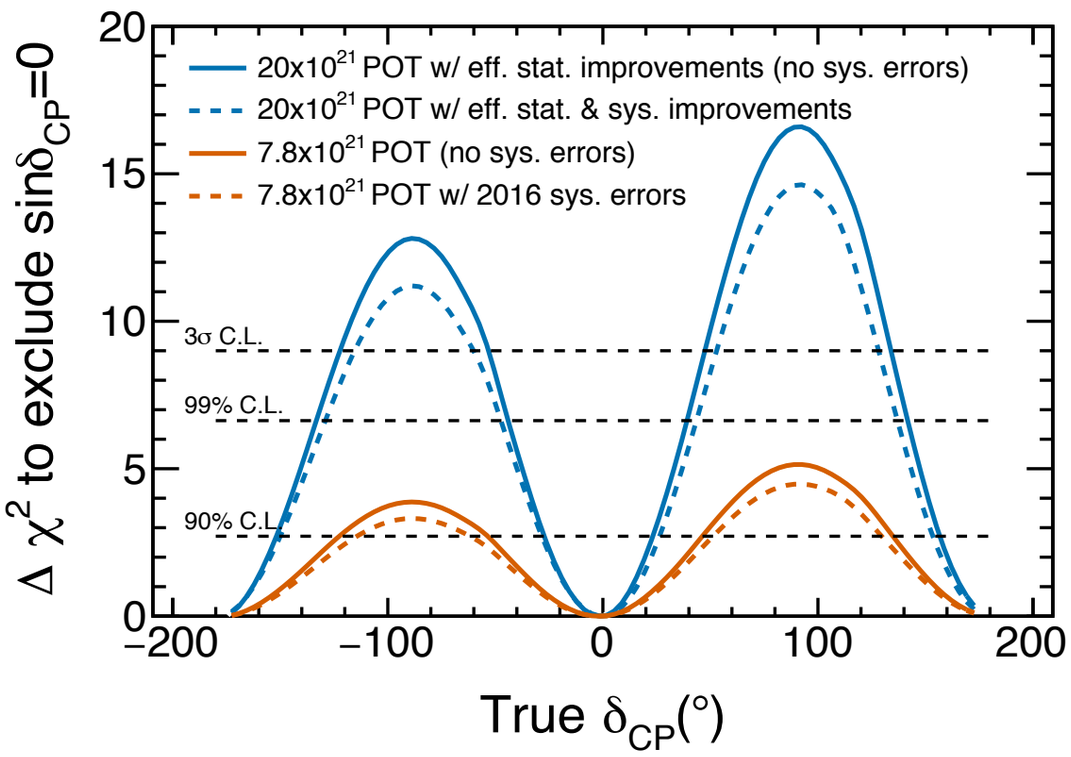


- Excellent performance, operated since 2010
- Providing critical input for oscillation measurements
  - Discovery of ν_e appearance
  - First hint of leptonic CP violation
- As well as cross section measurements
  - Many talks/posters in this NuINT

T2K phase II (T2K-II)

- J-PARC power increase plan: 0.47MW→1.3MW
  - Rep. cycle 2.48s→1.16s
  - #protons 2.4→3.2E14/spill
- Aim for 3σ CPV sensitivity by 2026 with 2×10^{22} POT
- Stage-1 status given by PAC



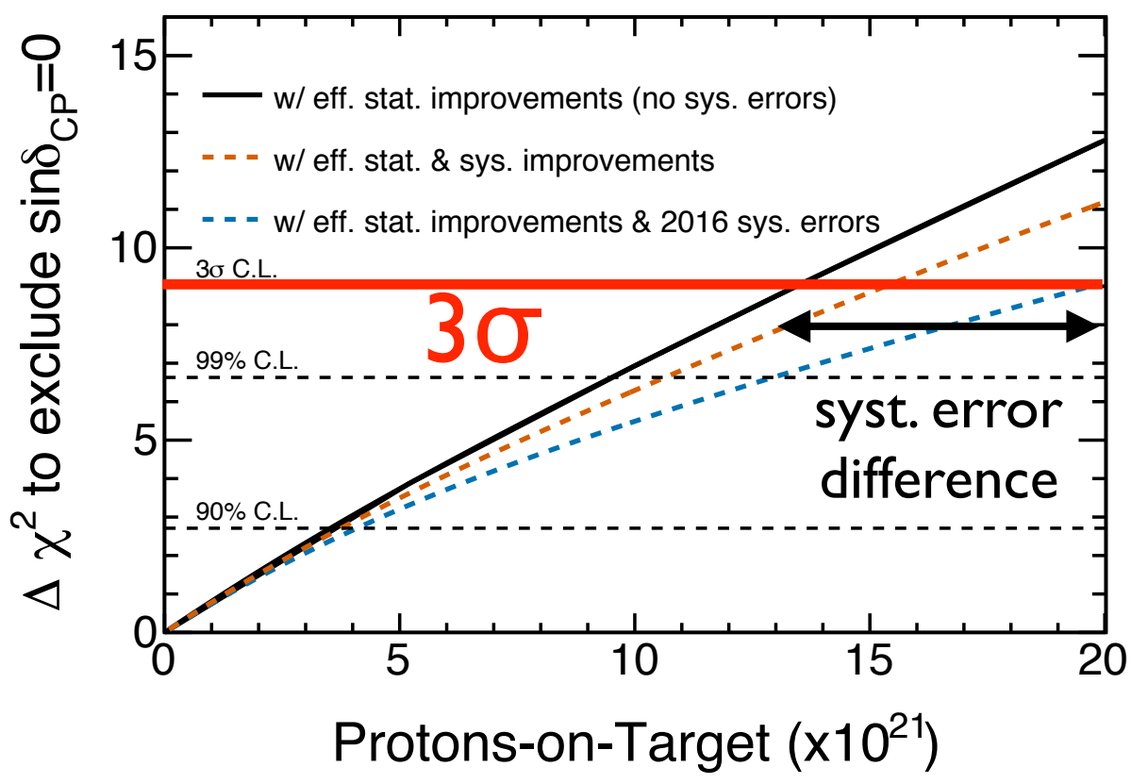


Improvement towards T2K-II

- More statistics / POT
  - Increased horn current
  - Additional samples
  - Enlarge fiducial volume
- Control of systematics
  - Reduction of flux and detector uncertainties
  - Reduction of neturino interaction systematics
    → Upgrade of ND280
  - Goal: ~4% total syst. error

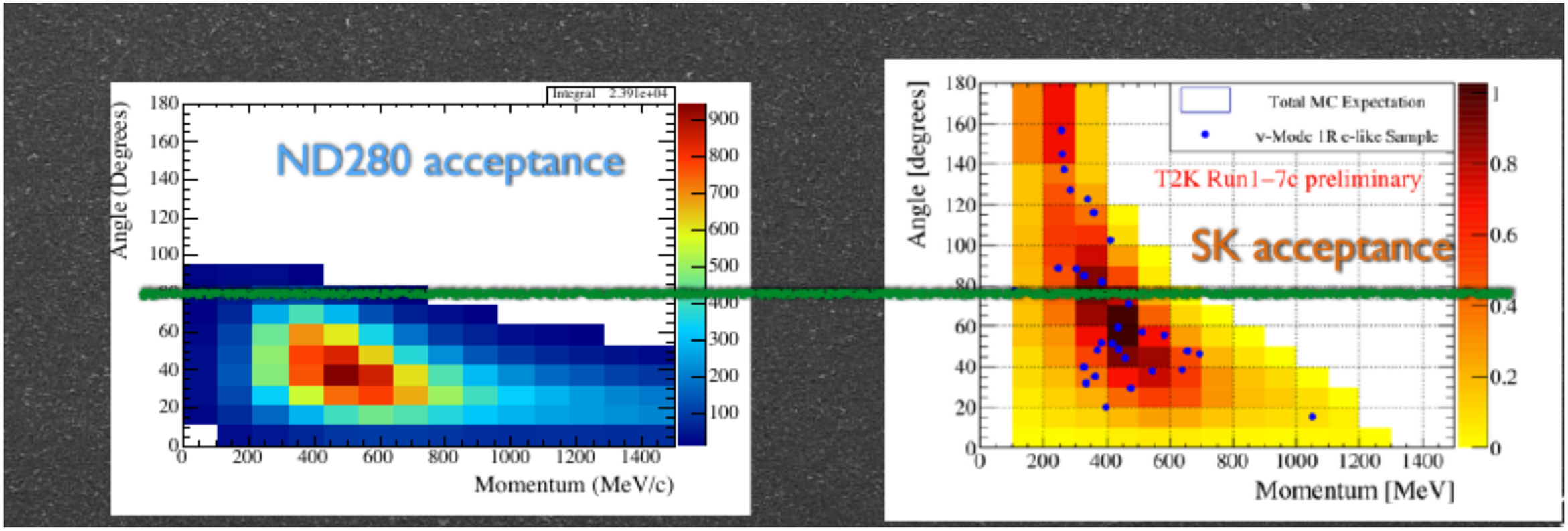
Expected number of events with 1×10^{22}POT each

	$\delta=-\pi/2$	$\delta=0$
FHC $\nu_\mu\rightarrow\nu_e$	449	356
RHC $\bar{\nu}_\mu\rightarrow\bar{\nu}_e$	52.3	73.6



ND280 upgrade

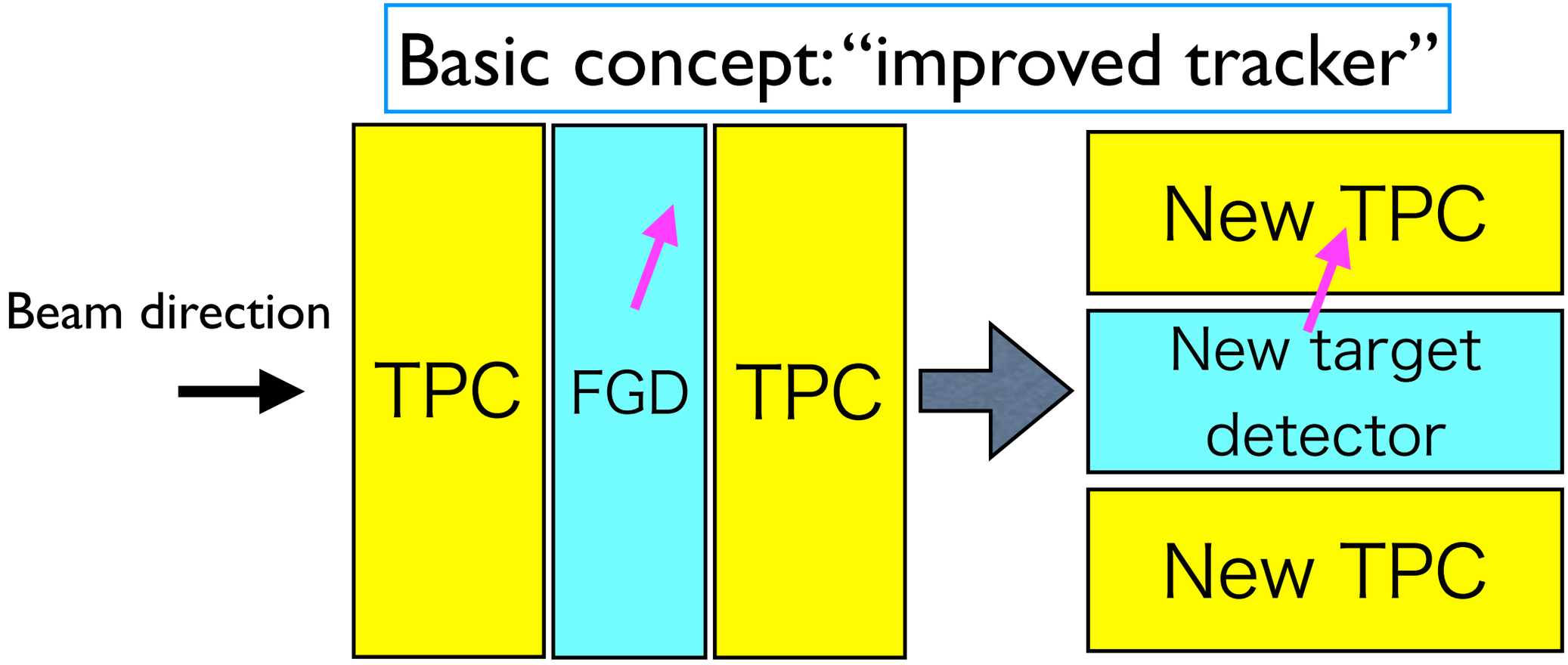
- Current ND280 has an excellent performance for forward tracks
- Limited performance for large angle tracks
  - Super-K has 4π uniform acceptance
  - Need extrapolation to full phase space with interaction models
- More complete information necessary to improve our knowledge



Criteria for upgrade detector

Timescale: installation in summer 2021

- Enlarge phase space — cover full polar angle
- Retain TPC capabilities
- Efficiency for short hadron tracks
- Improve electron neutrino selection



The ND280 upgrade project

- 2013-2015: ND upgrade R&D WG
- 2015-2016: ND280 upgrade task force formed in T2K
- November 2016: 1st Open Workshop at CERN
  https://indico.cern.ch/event/568177/
- January 2017: Expression of Interest submitted to CERN SPSC (towards a project in the framework of the CERN Neutrino Platform)
  [T2K itself is a CERN recognized experiment, RE13]
- February 2017: launched as official T2K project
- March & May: 2nd (@CERN) and 3rd (@Tokai) Open WS
  https://indico.cern.ch/event/613107/ https://indico.cern.ch/event/633840/
- **Next Open Workshop: Aug. 1-2 @ CERN**

You are welcome to join!

CERN SPSC-EOI-015

- Signed by ~190 physicists
  - From Bulgaria, Canada, France, Italy, Japan, Germany, Poland, Spain, Sweden, Switzerland, UK, USA
  - And CERN
- R&D for high-pressure gas TPC also in the scope
  - Synergy of development

Expression of Interest for the January 2017 SPSC

Near Detectors based on gas TPCs for neutrino long baseline experiments[1]

P. Hamacher-Baumann, L. Koch, T. Radermacher, S. Roth, J. Steinmann
RWTH Aachen University, III. Physikalisches Institut, Aachen, Germany

V. Berardi, M.G. Catanesi, R.A. Intonti, L. Magaletti, E. Radicioni
INFN and Dipartimento Interateneo di Fisica, Bari, Italy

S. Bordoni, M. Capeans Garrido, A. De Roeck, R. Giuda, B. Mandelli, D. Mladenov, M. Nessi, F. Resnati
CERN, Geneva, Switzerland

Z. Liptak, J. Lopez, A. Marino, Y. Nagai, E. D. Zimmerman
University of Colorado at Boulder, Department of Physics, Boulder, Colorado, U.S.A.

Y.Hayato, M. Ikeda, M. Nakahata, Y. Nakajima, Y. Nishimura
University of Tokyo, Institute for Cosmic Ray Research, Kamioka Obs., Kamioka, Japan

M. Antonova, A. Izmaylov , A. Kostin, M. Khabibullin, A. Khotjantsev, Y. Kudenko, A. Mefodiev, O. Mineev , T. Ovsiannikova, S. Suvorov, N. Yershov
Institute for Nuclear Research of the Russian Academy of Sciences, Moscow, Russia

F. Sanchez, M. Cavalli-Sforza, T. Lux, B. Bourguille, M. Leyton
Institut de Fisica d'Altes Energies (IFAE), The Barcelona Institute of Science and Technology, Campus UAB, Bellaterra (Barcelona) Spain

J. Amey, P.J. Dunne , P. Jonsson, R.P. Litchfield, W. Ma, L. Pickering M. A. Uchida, Y. Uchida, M.O. Wascko,C.V.C. Wret
Imperial College, London, United Kingdom

C. Bronner, M. Hartz, M. Vagins
Kavli Institute for the Physics and Mathematics of the Universe (WPI), University of Tokyo, Kashiwa, Chiba, Japan

S. Bolognesi , D. Calvet, P. Colas, A. Delbart, S. Emery, F. Gizzarelli, M. Lamoureux, M. Martini, E. Mazzucato, G. Vasseur, M. Zito
IRFU, CEA Saclay, Gif-sur-Yvette, France

1 Corresponding authors: Alain Blondel (alain.blondel@cern.ch), Marco Zito (marco.zito@cea.fr)

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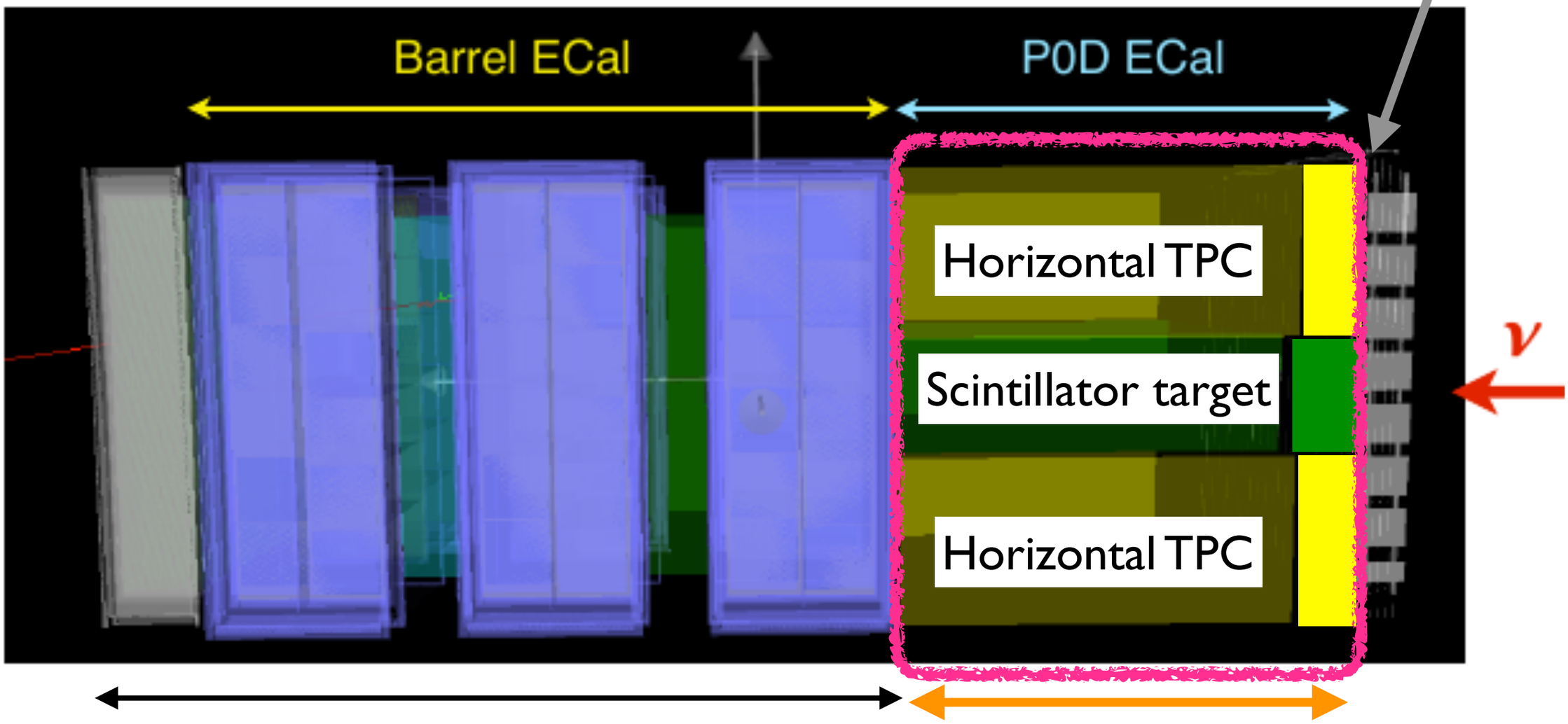
Work Packages

ND upgrade convener: Marco Zito, deputy: Masashi Yokoyama

- WP1: Mechanical design and integration
- WP2: TPC field cage and gas vessel
- WP3: TPC Readout technology
- WP4: TPC electronics and DAQ
- WP5: Gas system and calibration
- WP6: Scintillator-based trackers
- WP7: TOF system
- WP8: Test beam measurements
- WP9: High Pressure TPC
- WP10: Simulation and optimization studies
- WP11: Physics studies
- WP12: DAQ
- WP13: Software

Lots of opportunities to contribute

Baseline configuration



Keep current tracker + DS Ecal

New detectors

Magnet and surrounding Ecal
also preserved

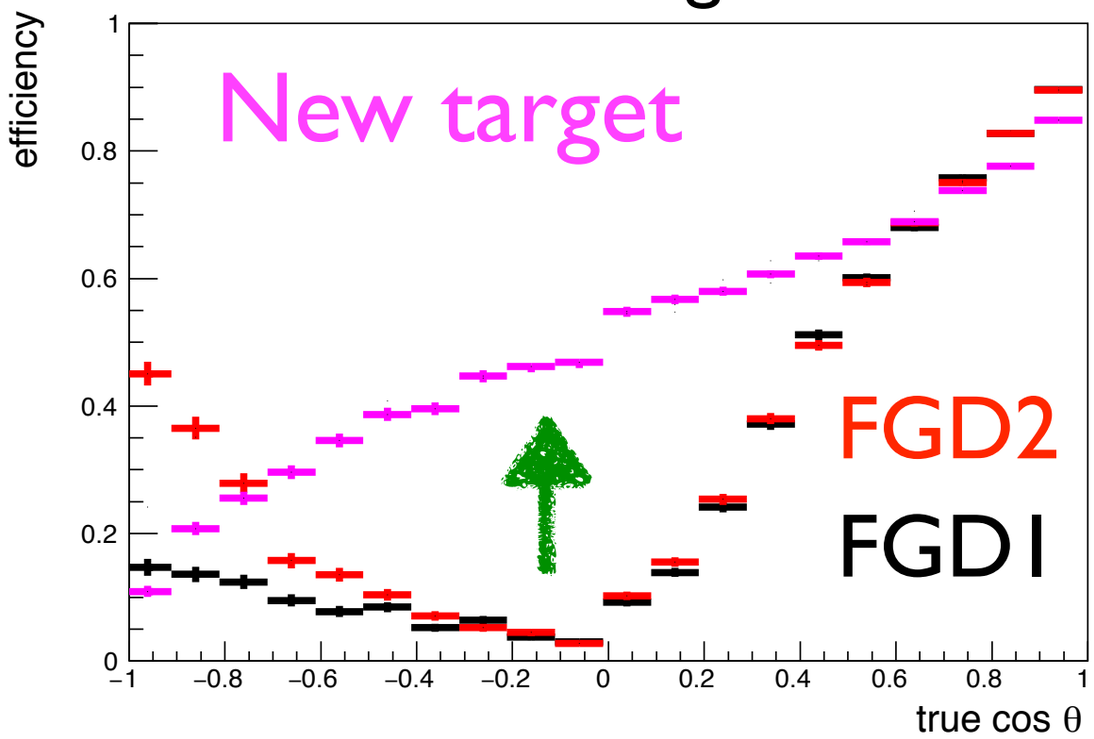
Two TPCs
Scintillator target
TOF detectors

Expected performance

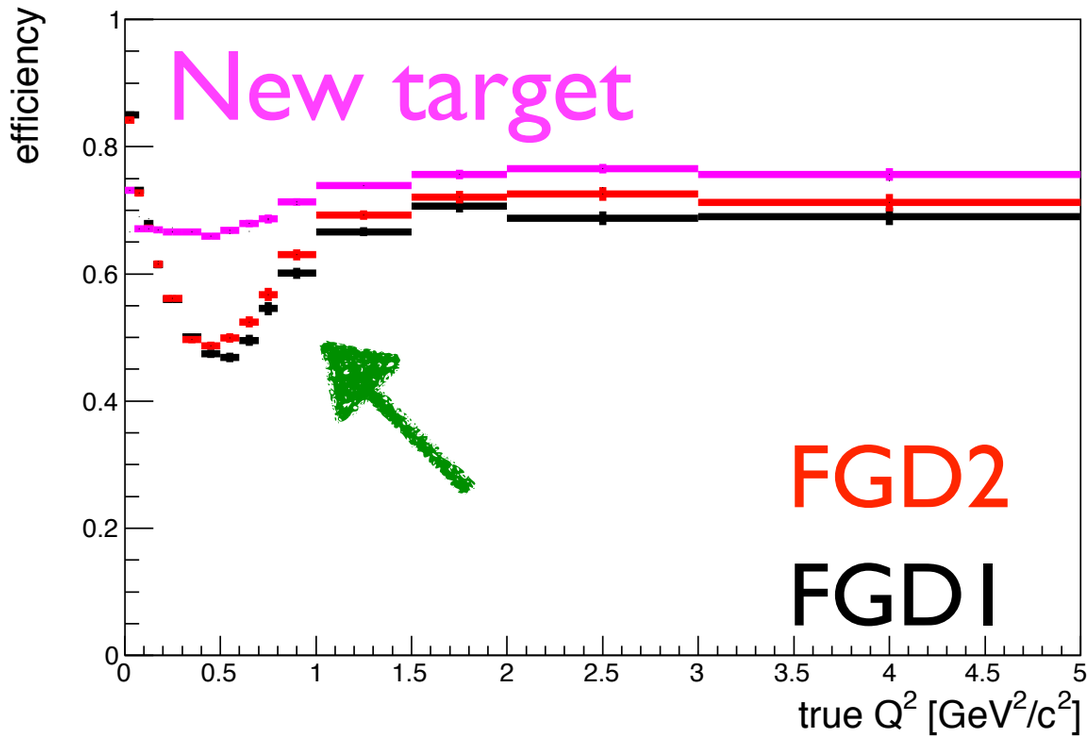
Efficiency estimated with GEANT simulation

Example: ν_μ CC inclusive selection

Muon angle



Q^2

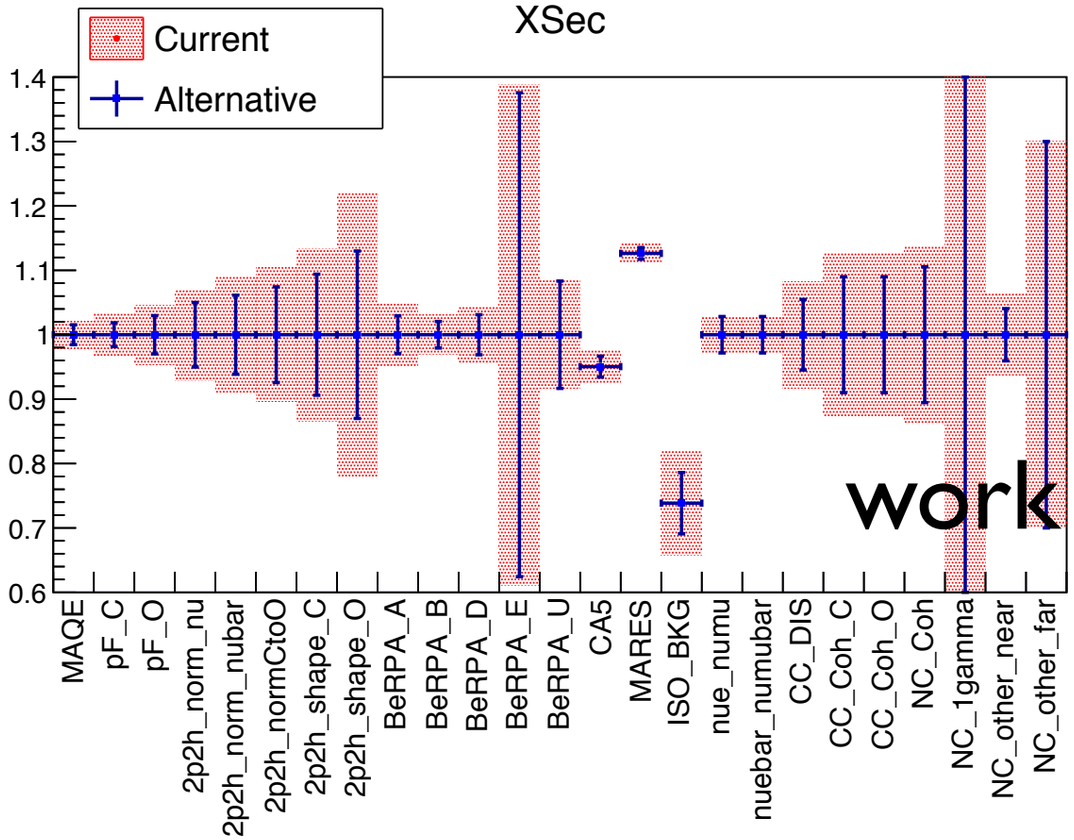


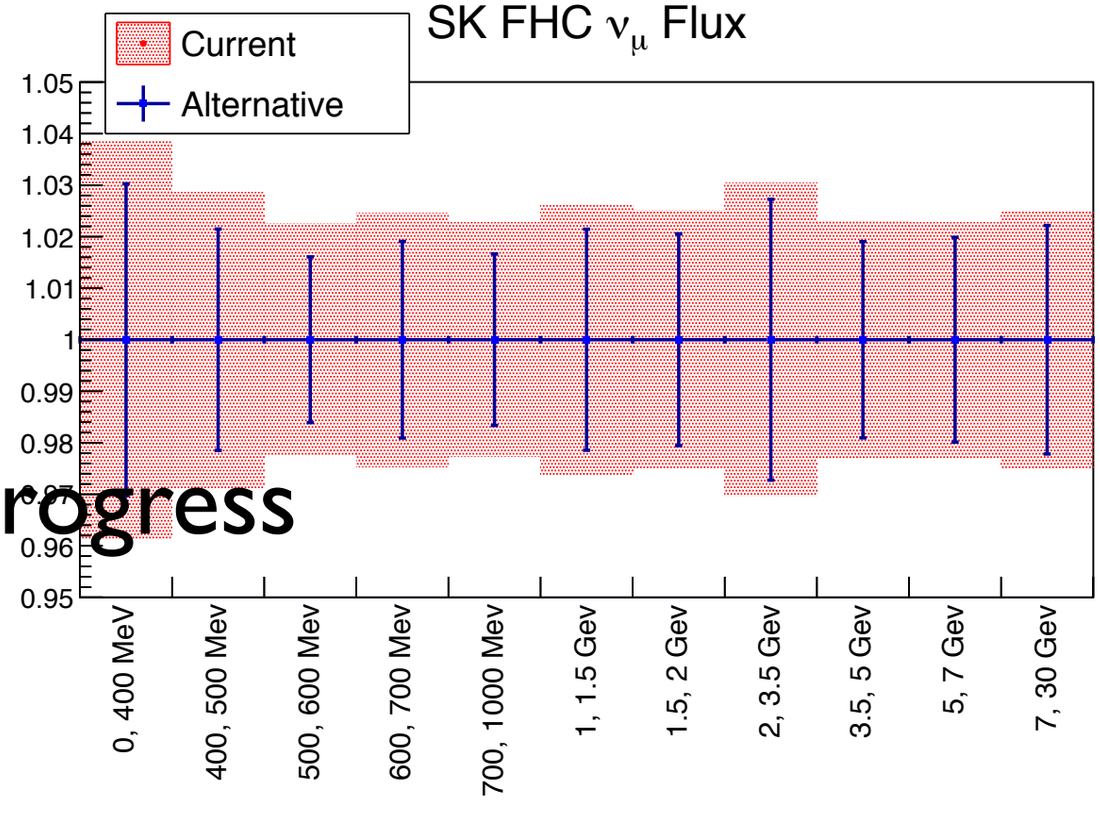
Large angle efficiency is improved as expected.

(preliminary: optimization still ongoing)

Expected performance

Asimov studies using ND fitting framework





work in progress

- Upgrade configuration can greatly reduce cross section uncertainties
- Effect on oscillation analysis also being estimated

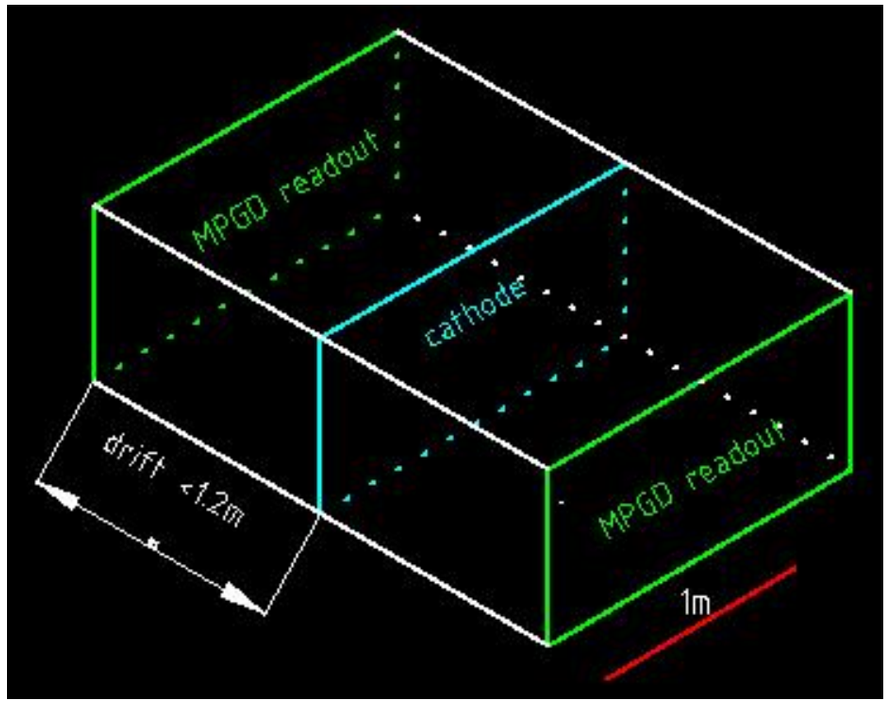
Horizontal TPCs

~1.8×0.8×2.0 m^3

Similar in size and technology to the existing TPC.

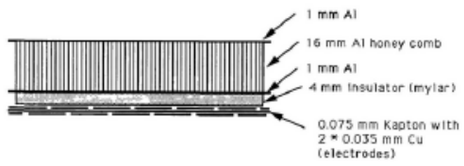
Resistive Micromegas for spreading the charge and spark protection.

Thin field cage along the lines of the Aleph TPC



G. Catanesi

Aleph / ILC scheme:
Strip layers glued / embedded in the mechanical structure (typically: composite materials)



Insulator from a thin Mylar foil winded around many times using a higly resistive glue

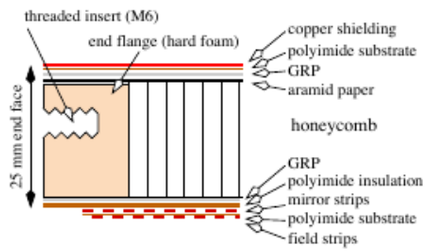
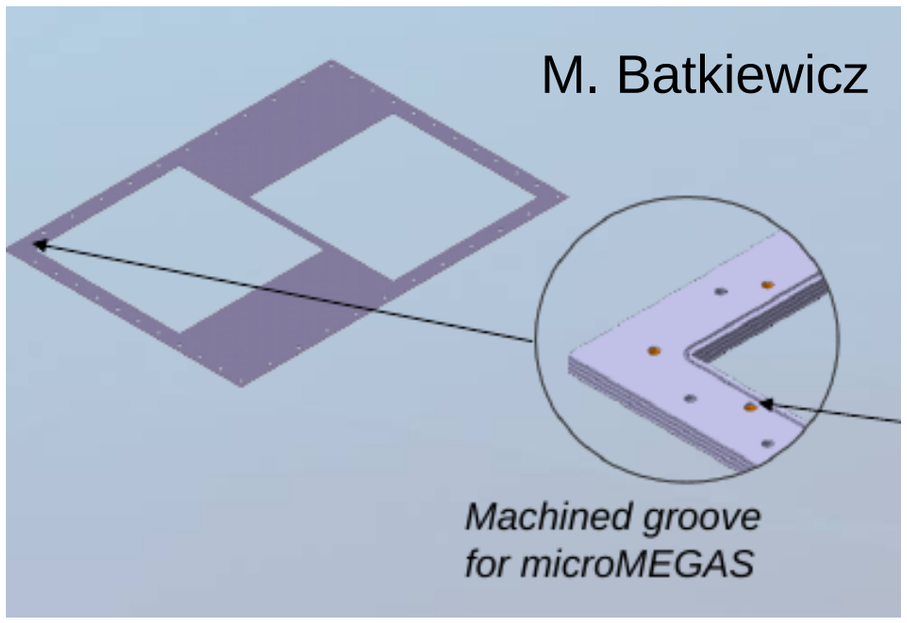
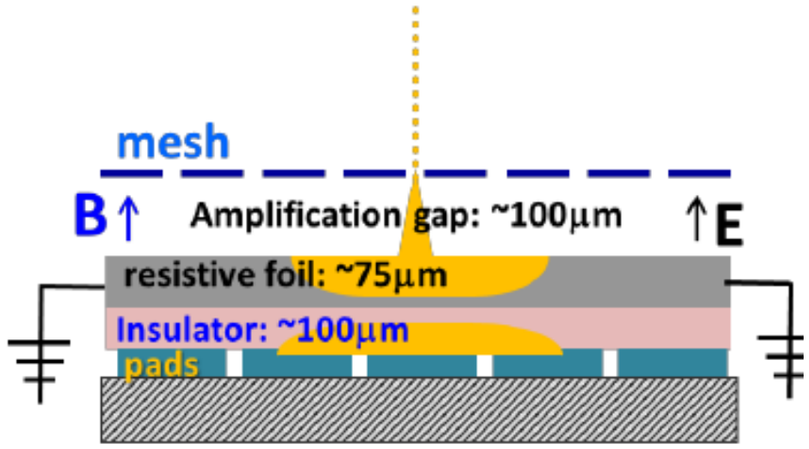


Figure 7: *Cross section of the Large Prototype field cage wall.*

M. Batkiewicz





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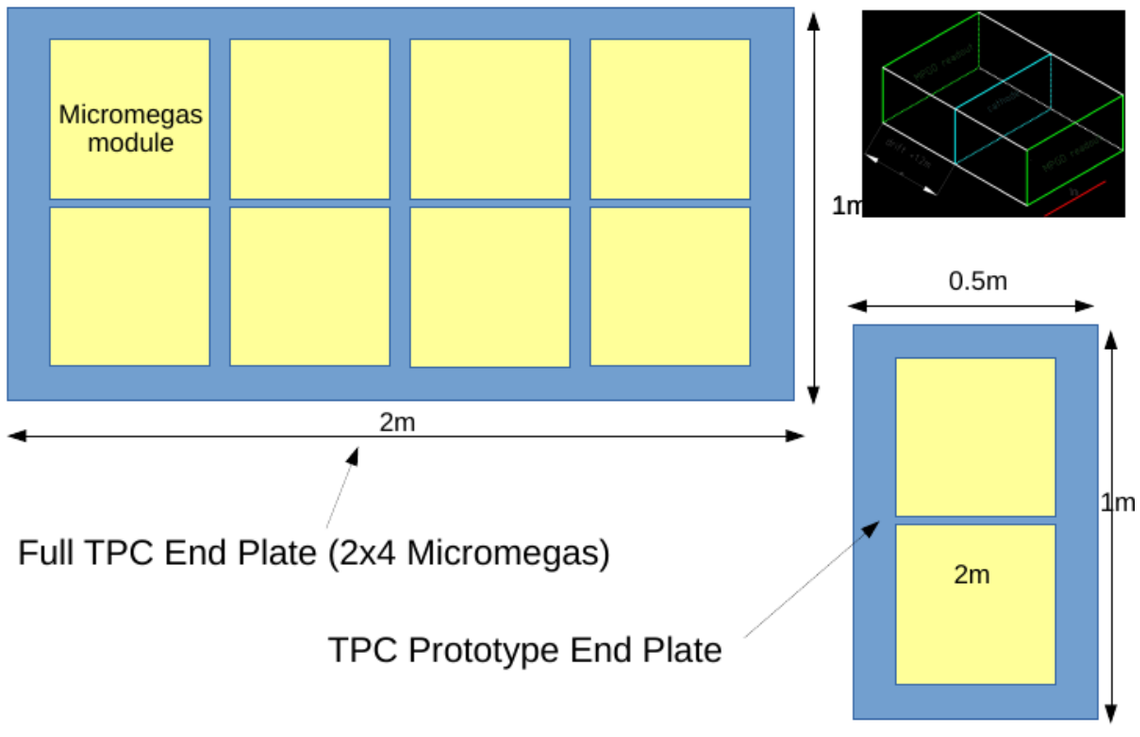
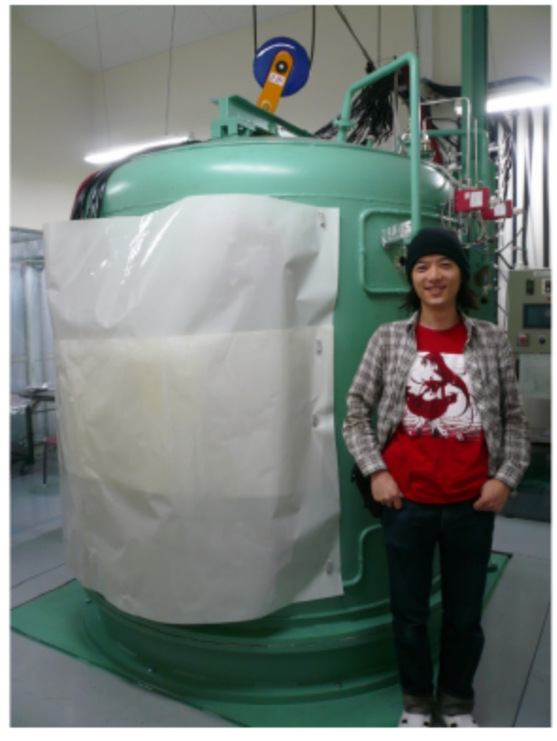
TPC development

- Aim to build and test a prototype at CERN next year
  - ~1m (drift) x 0.5 m x1 m
- Resistive foil for micromegas procurement in progress
  - Made by sputtering on a polyimide foil
- Field cage electronics, gas system, .. design ongoing

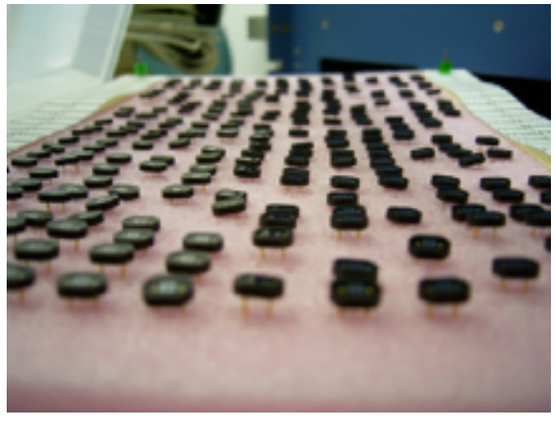


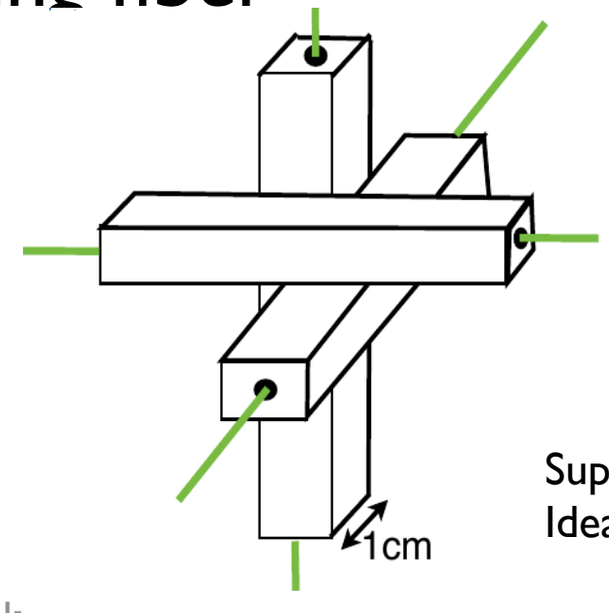


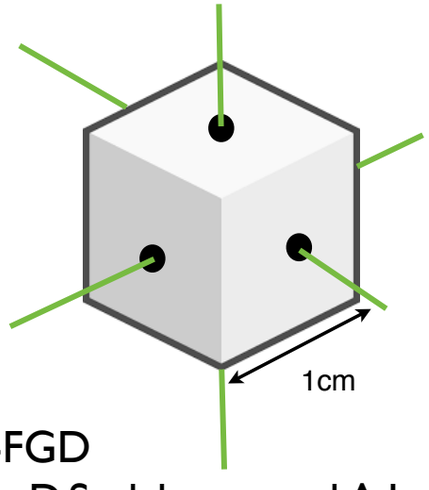
Sputtering chamber

Target Detectors based on scintillators

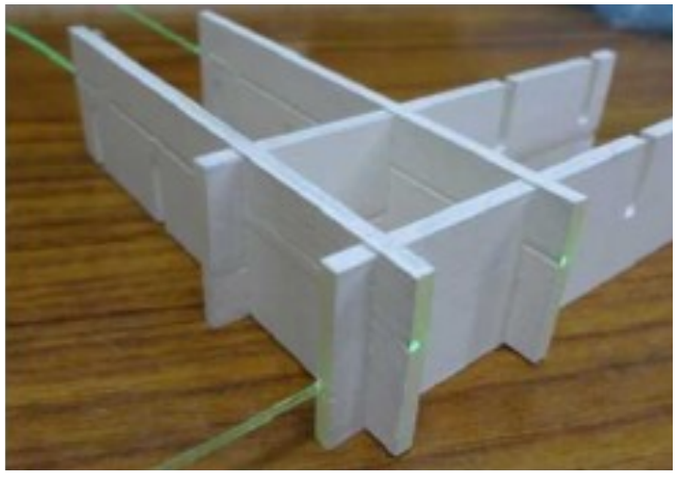
- ~1.8×0.6×2 m^3, ~2ton active target
- MPPC+WLS fiber readout established in T2K
  - New MPPC with higher PDE, low noise/cross-talk, possibly further improvement with R&D
- Several options under study
  - FGD-like bar structure (2- or 3-views)
  - "Super-FGD": cubes with 3-view readout
  - WAGASCI: grid with thin scintillators (J-PARC T59)
  - Scintillating fiber





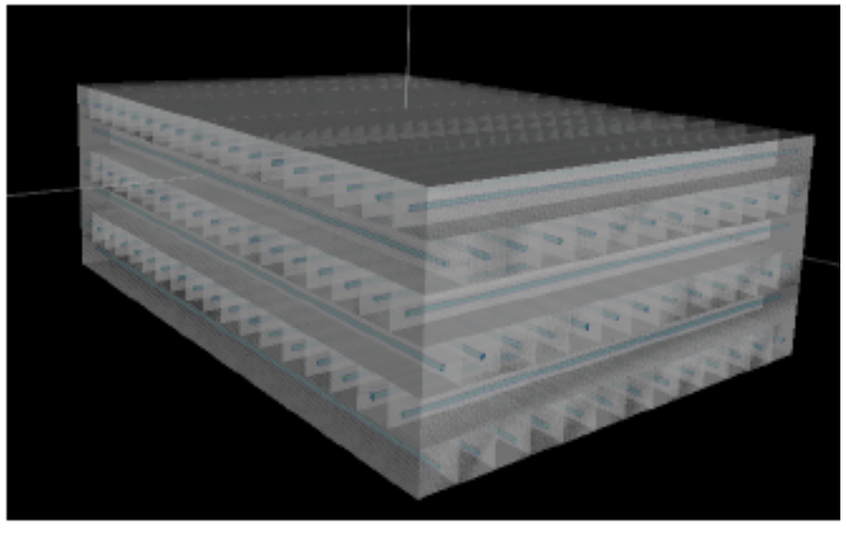


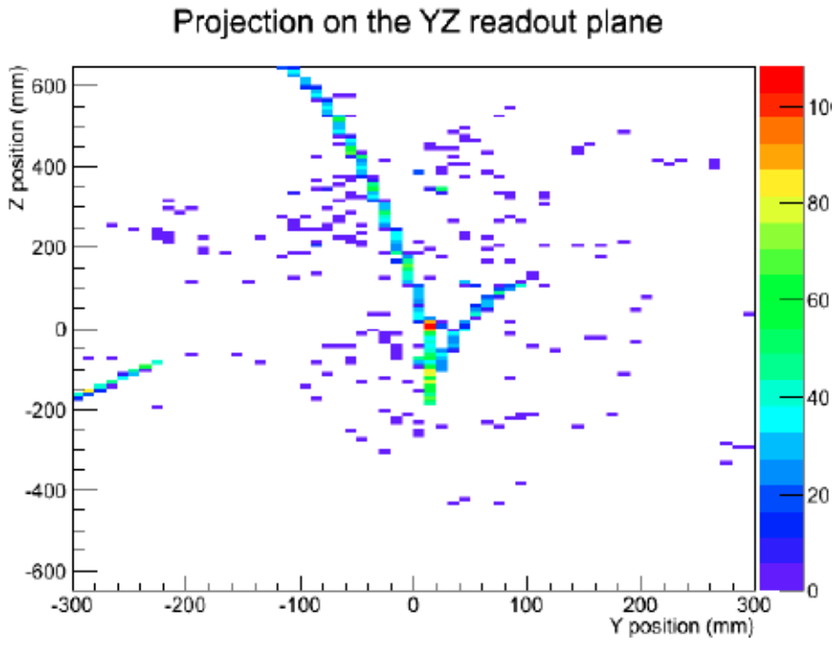
Super-FGD
Idea by D.Sgalaberna and A.Longhin

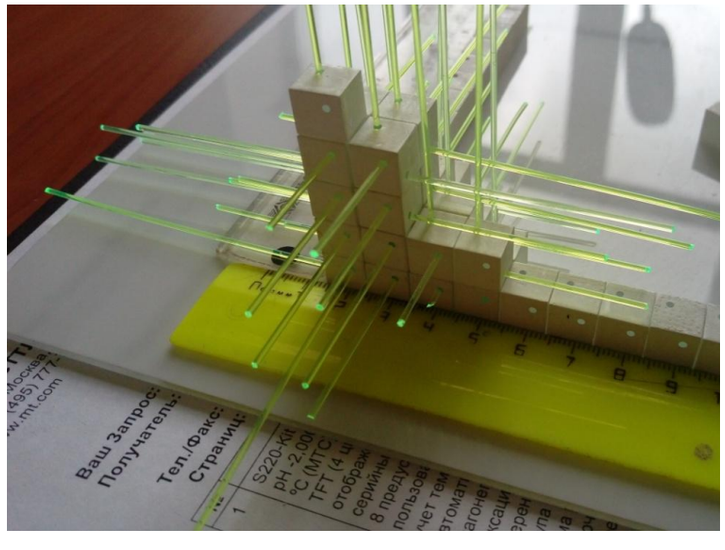


Target Detector Study

- Simulation study for optimization and comparison
  - Efficiency, particle ID, γ BG suppression for ν_e
- R&D of hardware rapidly starting up
  - Several cubes for super-FGD already being tested
- Prototyping and beam test under discussion

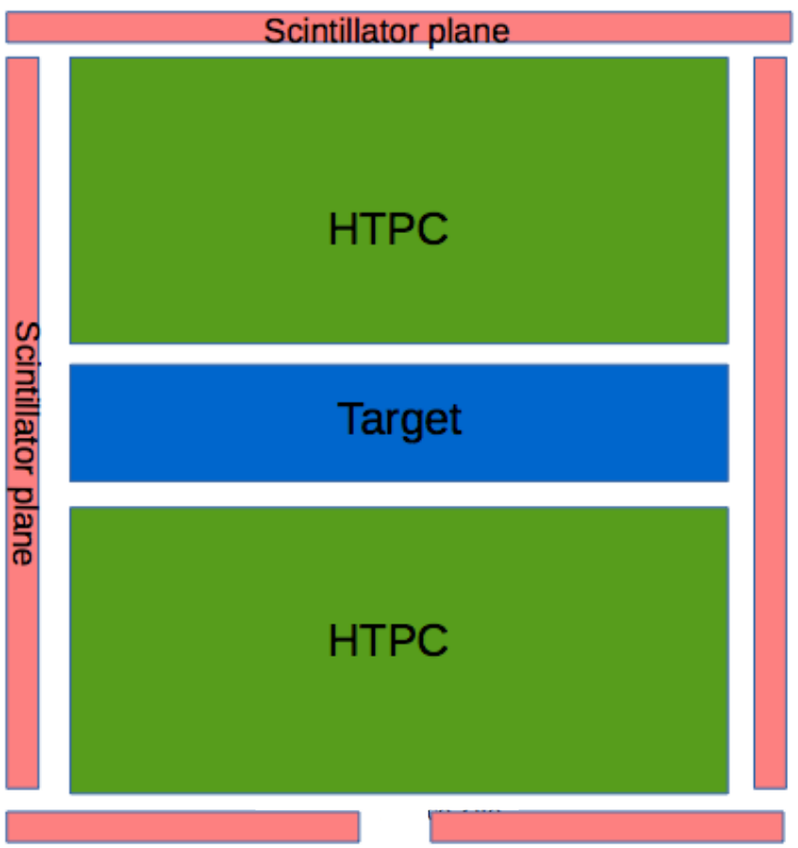




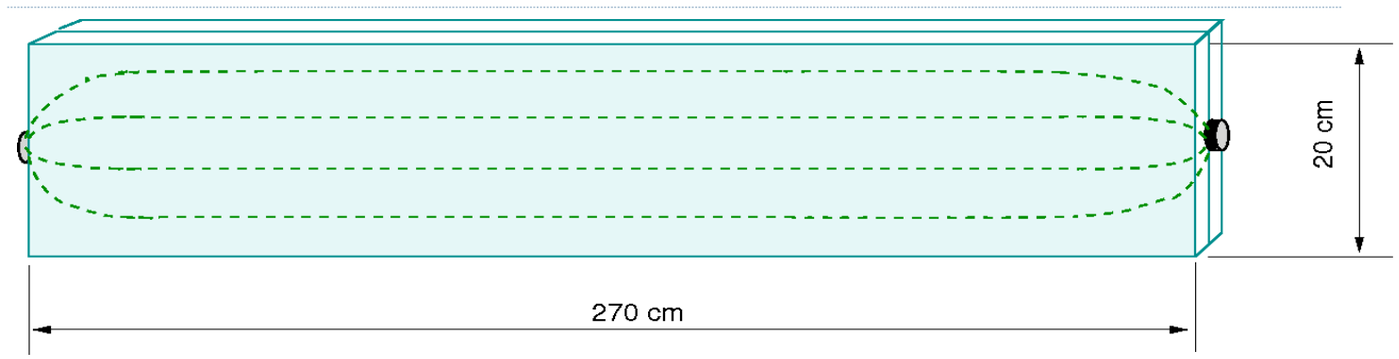


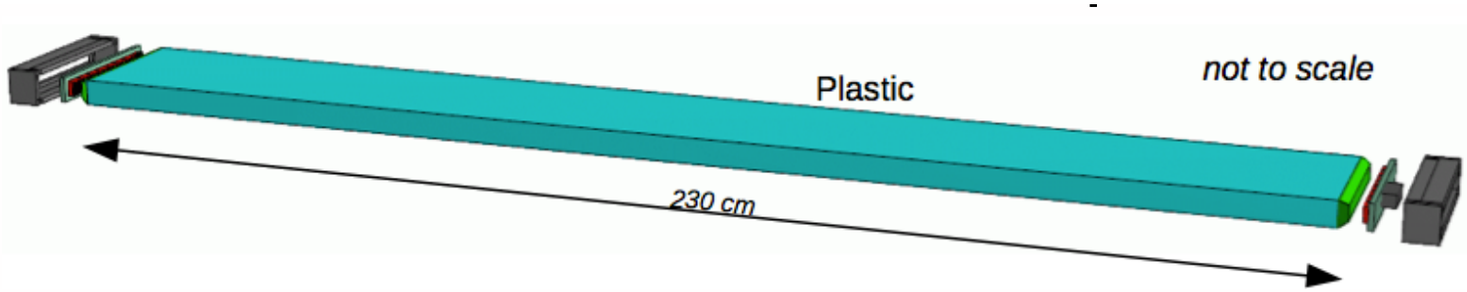
TOF detectors

- Provide timing for track reconstruction and particle identification
  - Configuration optimization ongoing
- R&D studies for options
  - Extruded scintillator (INR Moscow)
  - Cast scintillator (Geneva, w/ SHiP)



Example schematic configuration



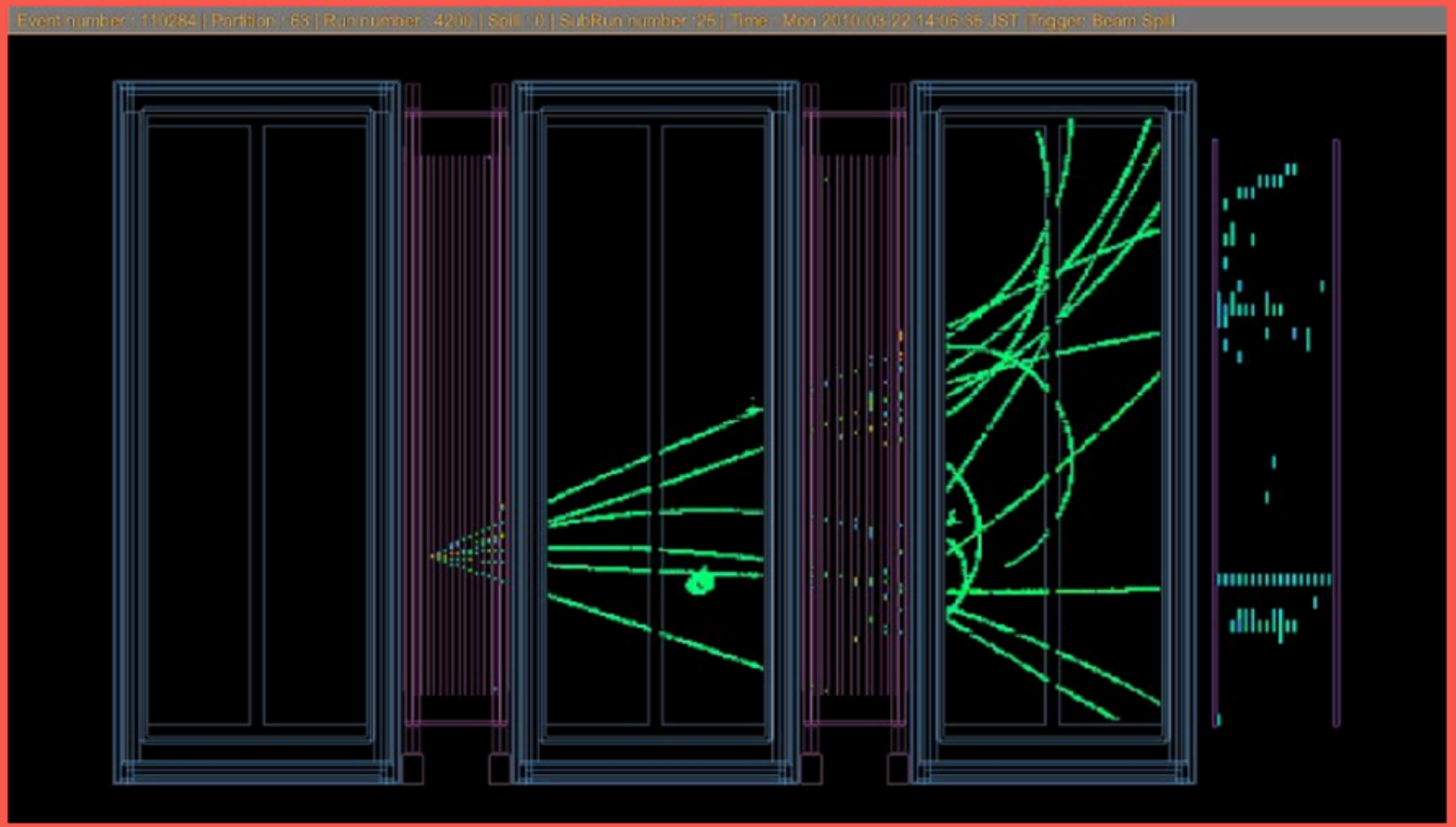


Summary

- **ND280 upgrade launched as a T2K-wide project**
  - Improvement of ND towards T2K-II (and Hyper-K)
  - Also new tools for neutrino interaction studies
- Foreseen timeline:
  - Proposal in the end of 2017, TDR in 2018
  - Construction and test 2019-2020
  - Installation planned in 2021
- New members are already joining, more are welcome
  - Input from NuINT community will be invaluable
- **Next Open Workshop at CERN, Aug.1-2**

https://indico.cern.ch/event/644360/

Let's build our 'future' together!



4th Workshop on Neutrino Near Detectors based on gas TPCs

1-2 August 2017
CERN
Europe/Zurich timezone

Search...

https://indico.cern.ch/event/644360/