T2K Near Detectors

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for T2K-ND280 group

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  - $\sin^2 2\theta_{13}$ to 0.008 (factor ~20 improvement over CHOOZ)

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  - 1% in $\sin^2 2\theta$, 3% in Δm^2

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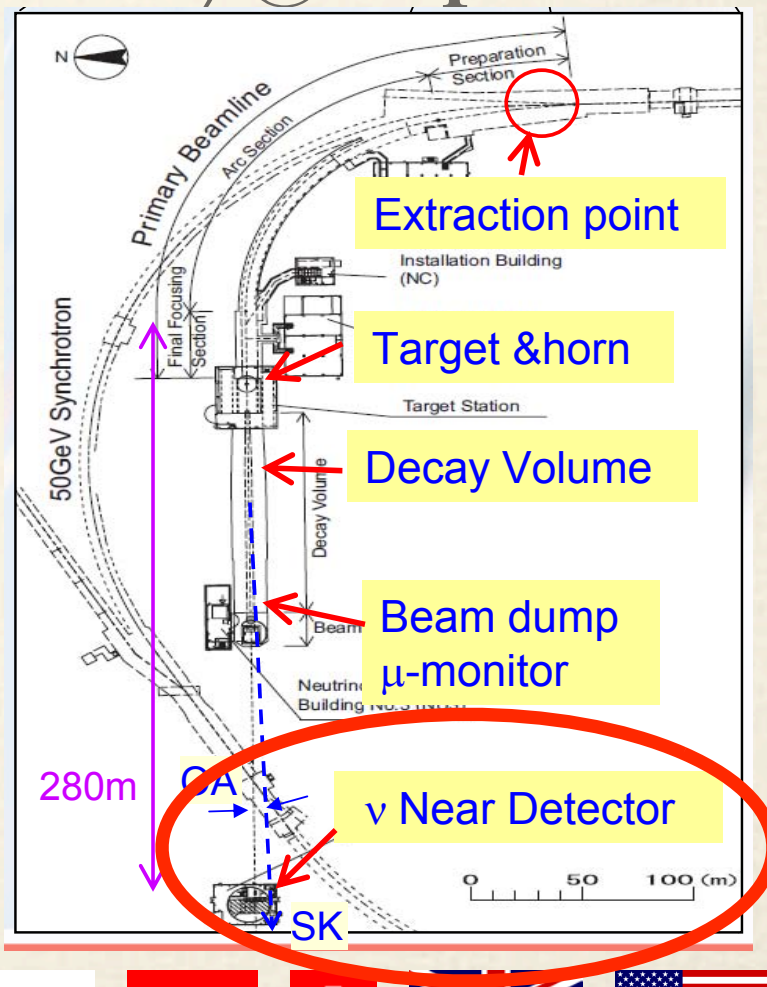
  - $\sin^2 2\theta_{13}$ to 0.008 (factor ~20 improvement over CHOOZ)
- **Precision measurements of ν_μ disappearance**
  - 1% in $\sin^2 2\theta$, 3% in Δm^2
- To achieve these precise measurements, understanding of ν beam and interaction indispensable!

Near Detectors @ 280m

Predict events (signal&BG) @ Super-K

- off-axis angle → on-axis detector
- ν_μ/ν_e flux, energy spectrum → off-axis tracker
- π^0 production → off-axis π^0 detector



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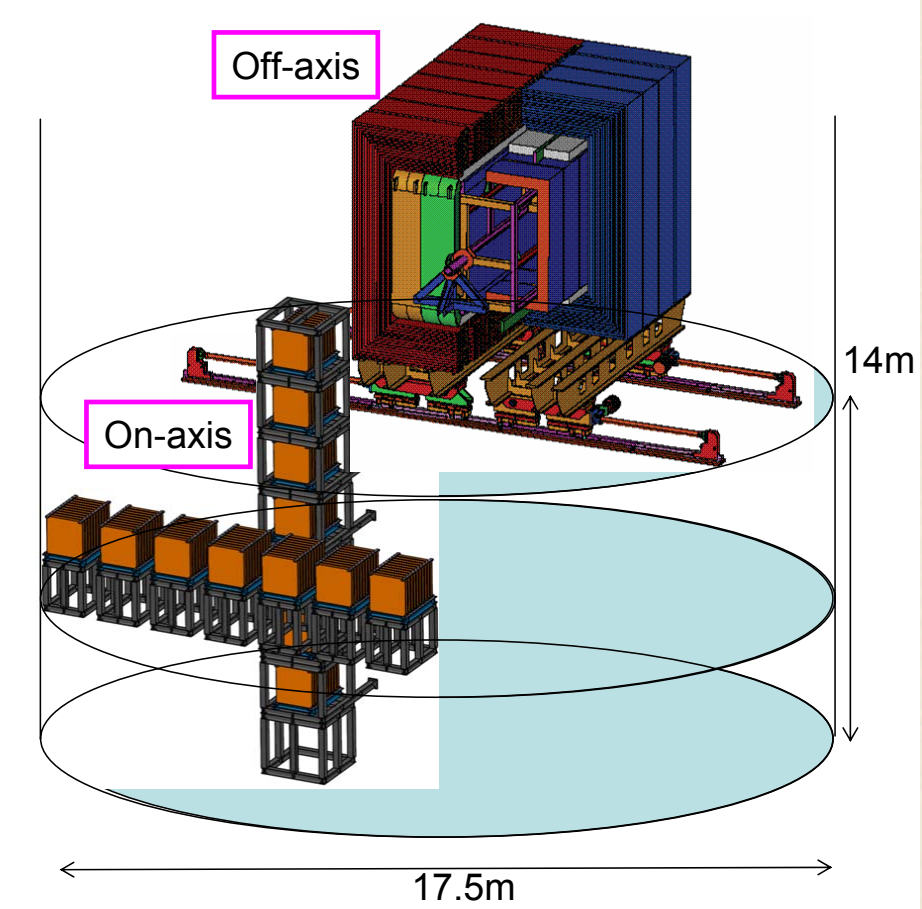
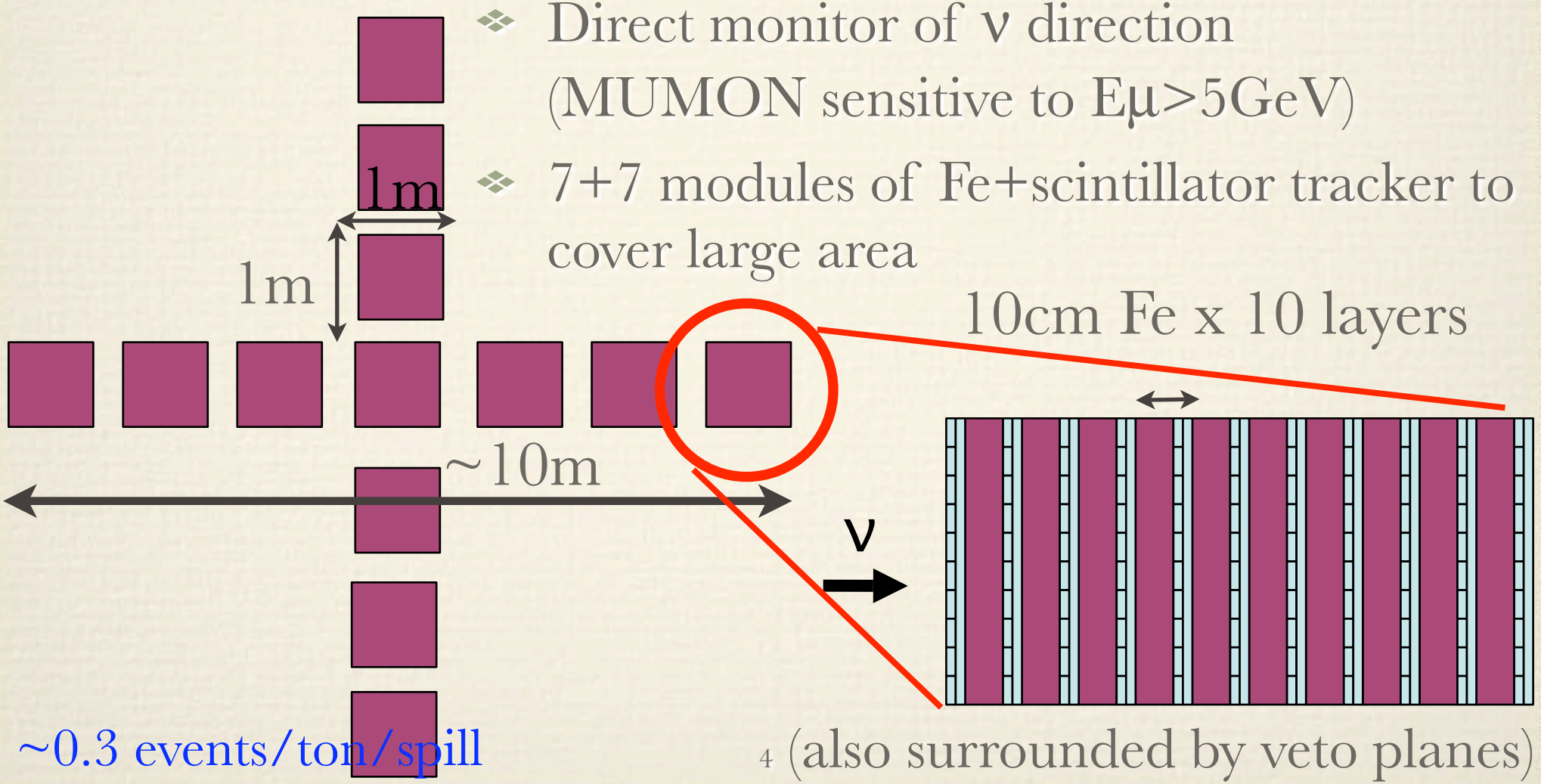


On-axis detector

- Off-axis scheme: 1 mrad ↔ ~20 MeV shift in Eν @ SK
  - Direct monitor of ν direction (MUMON sensitive to Eμ>5GeV)
  - 7+7 modules of Fe+scintillator tracker to cover large area

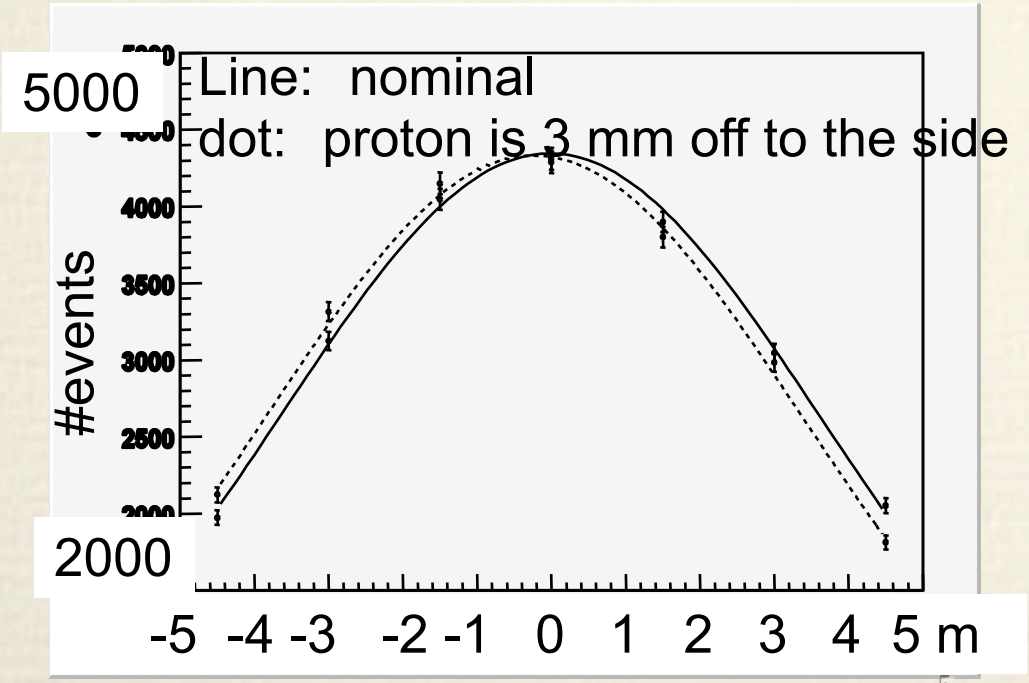


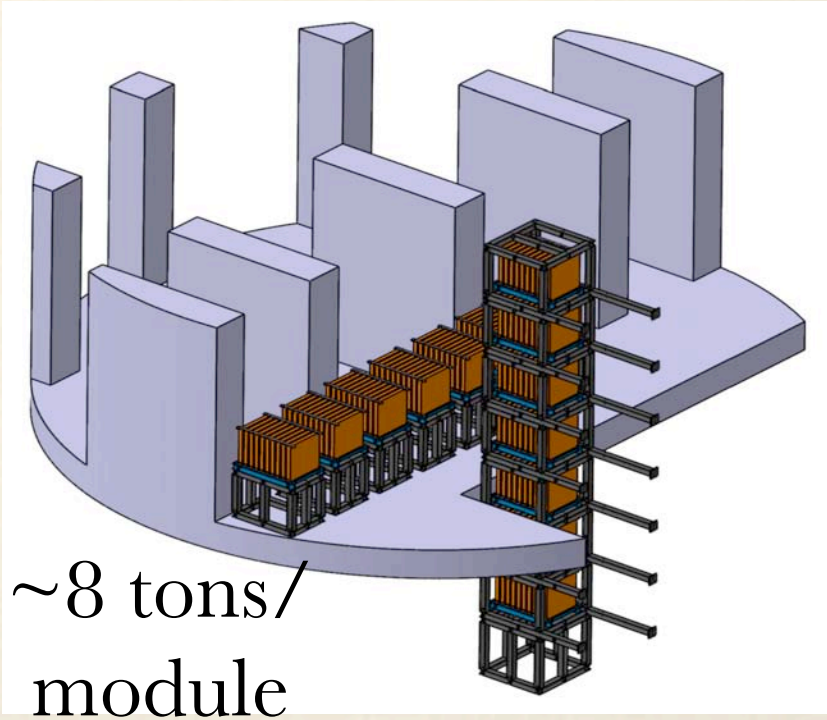
~0.3 events/ton/spill

(also surrounded by veto planes)

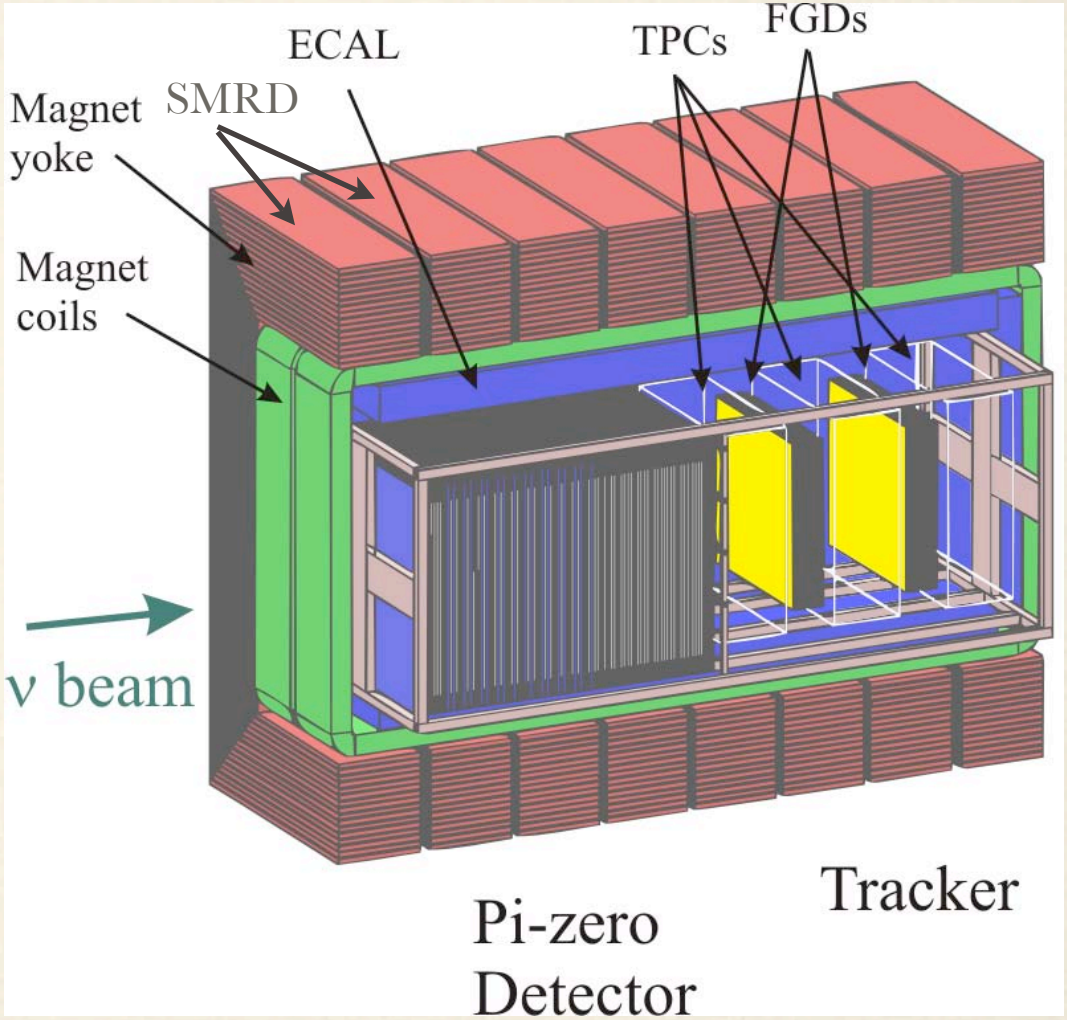
On-axis detector

- Beam direction measured with ~0.15mrad precision @ 1% intensity, 1 month (MC)
- Detector component to be tested
- Engineering design ongoing



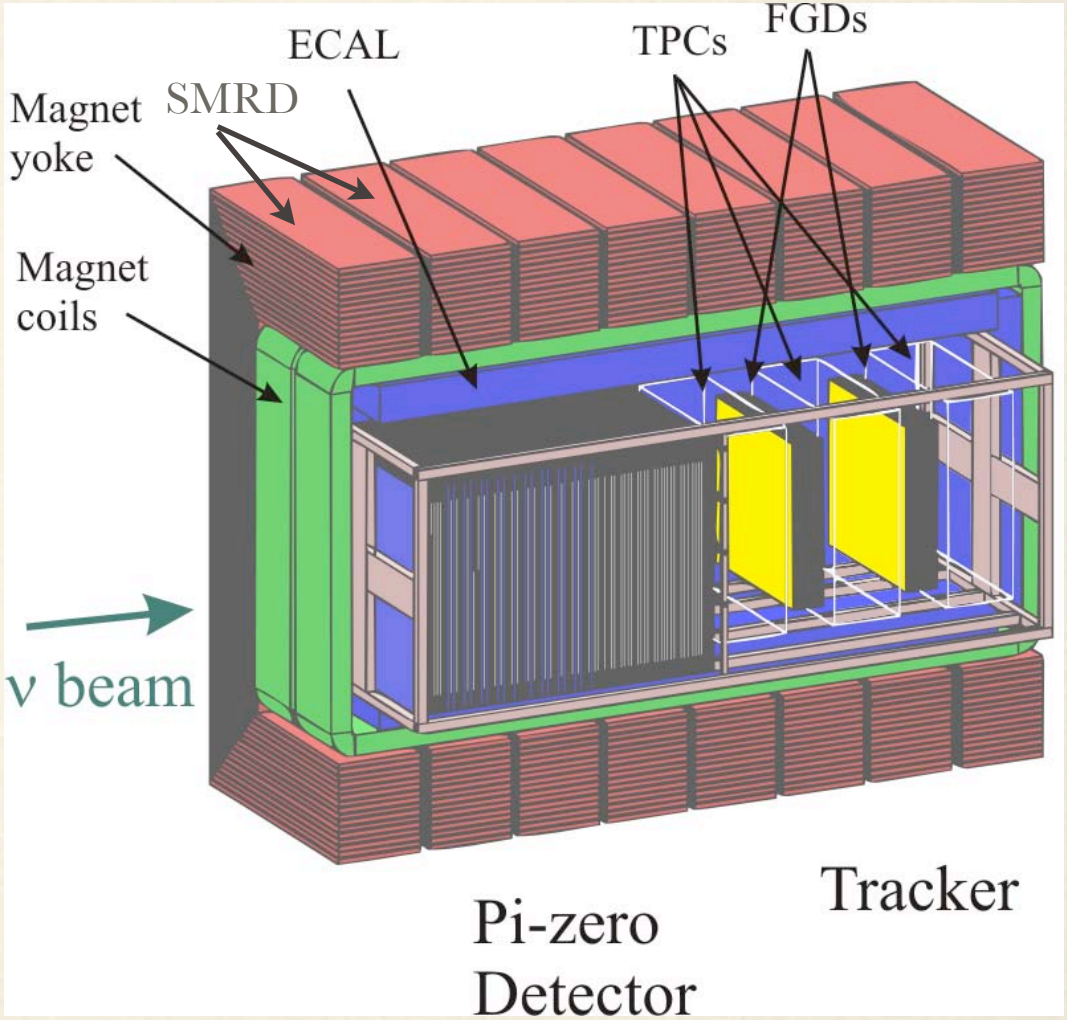


Off-axis detector



Off-axis detector

- Reuse UA1 magnet (0.2T dipole)



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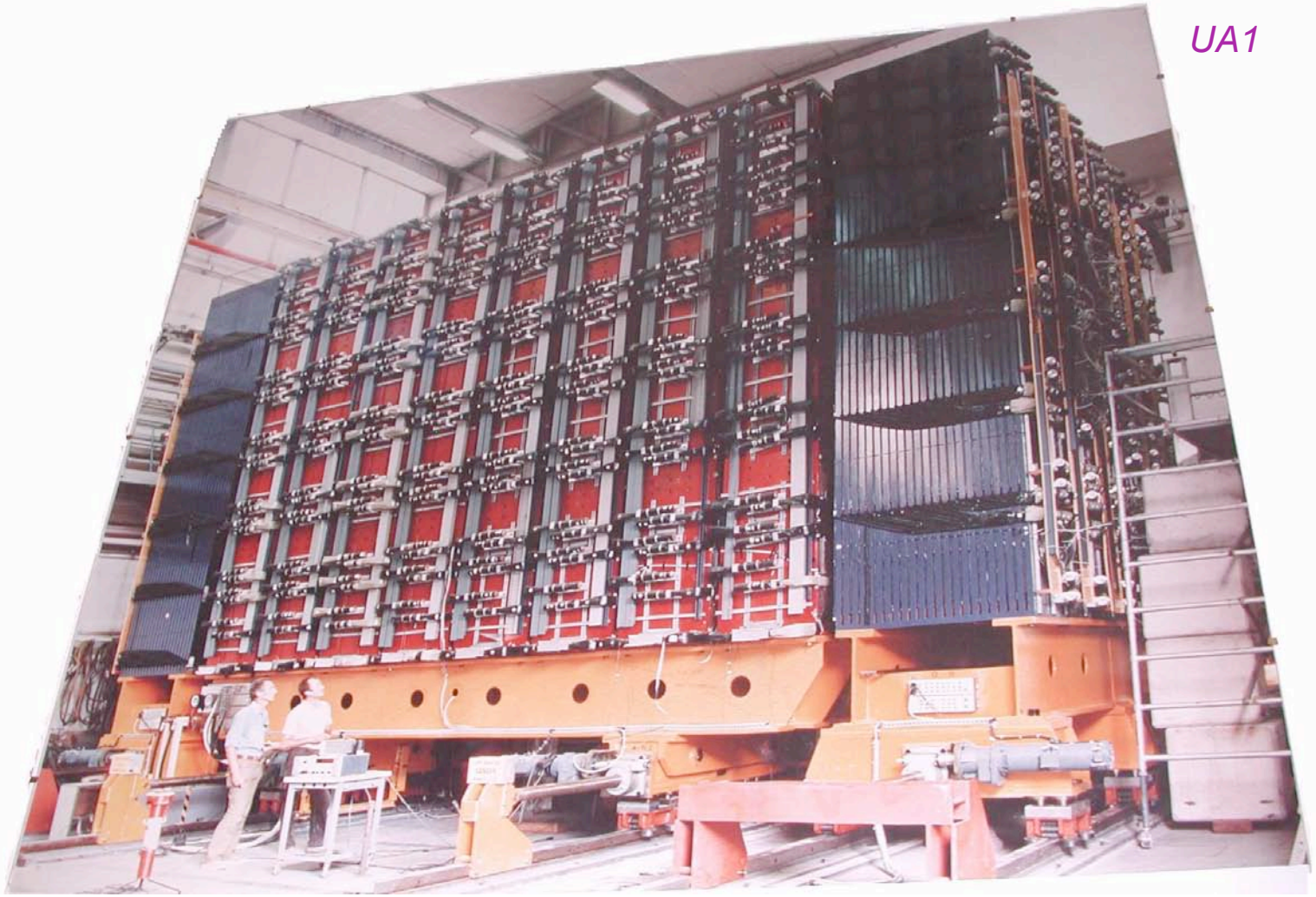

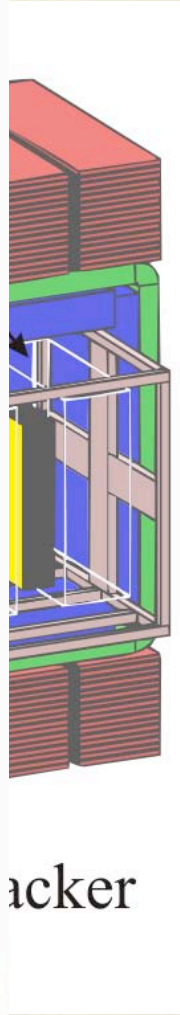

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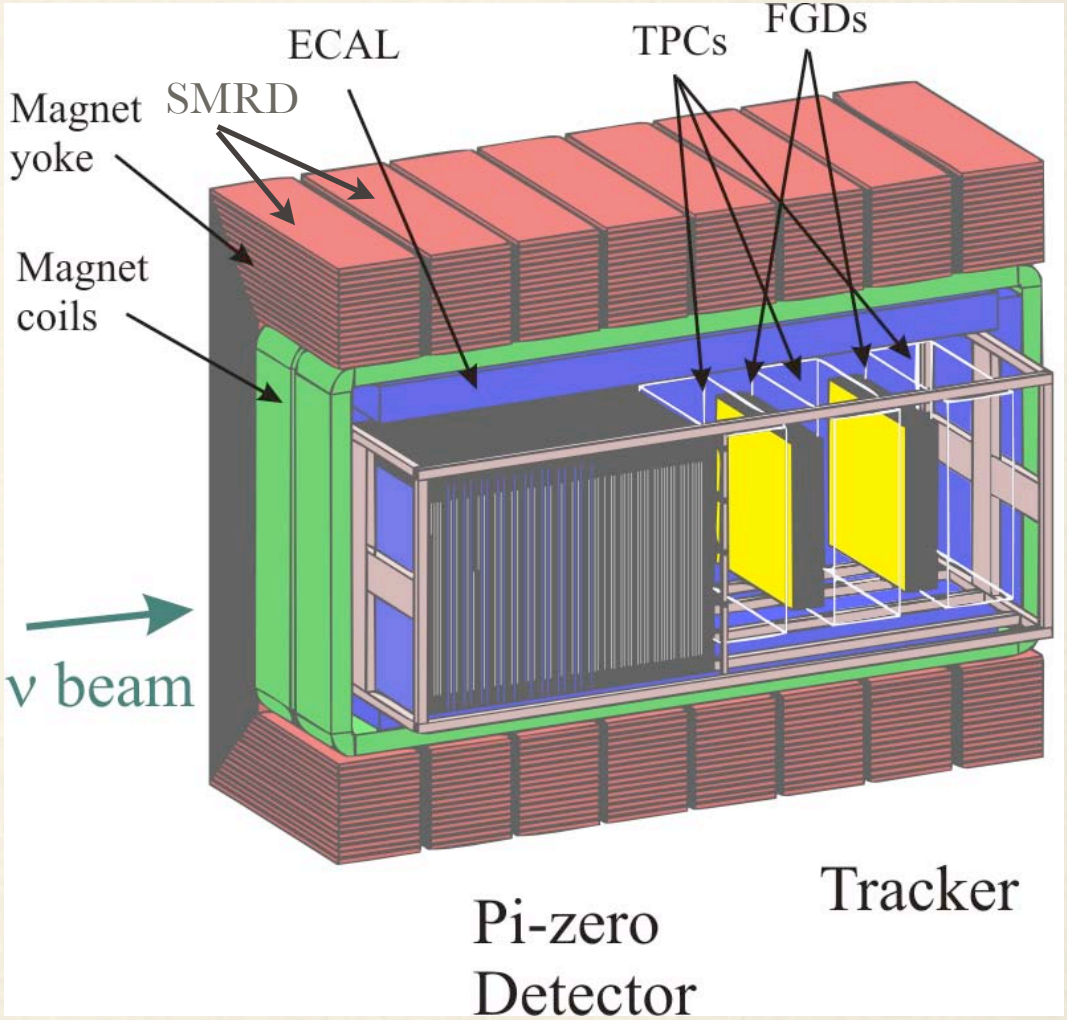

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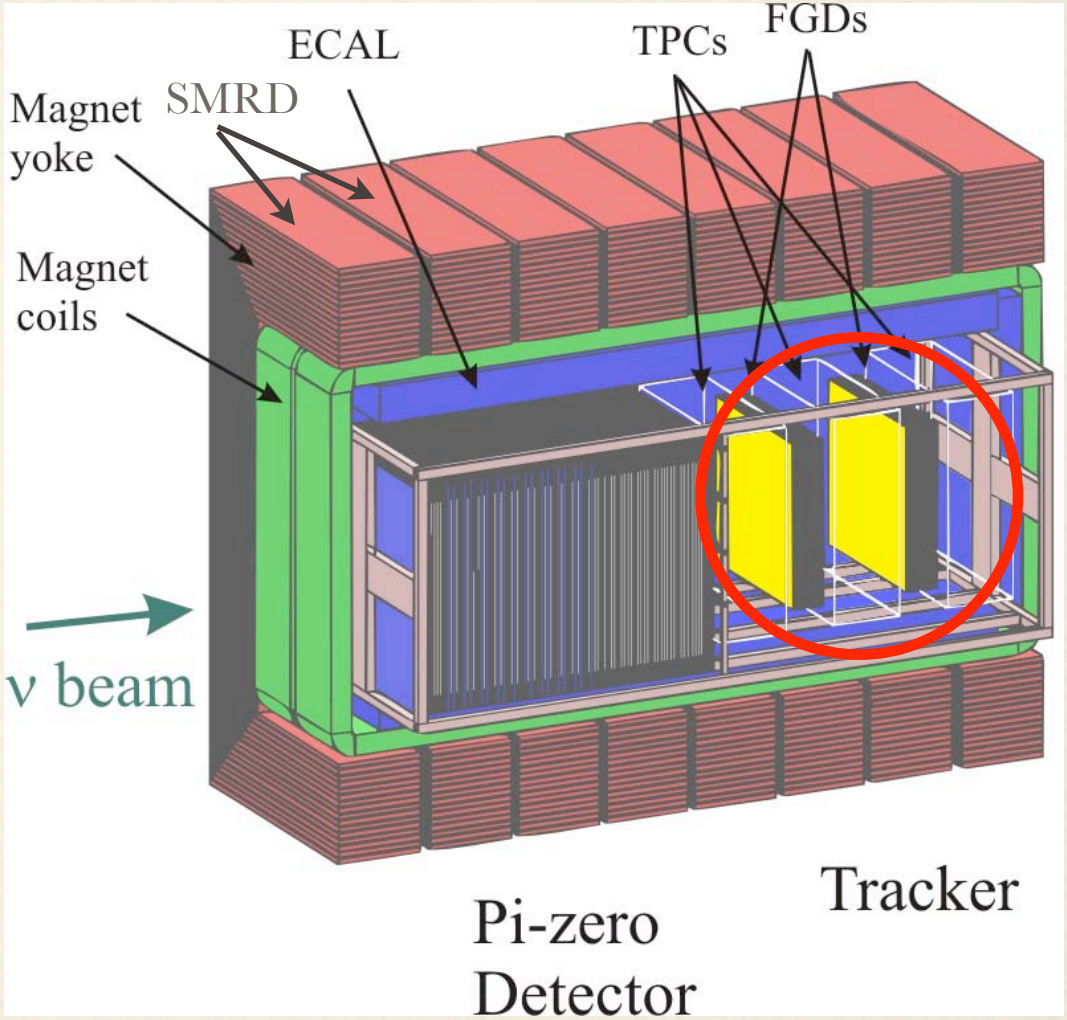

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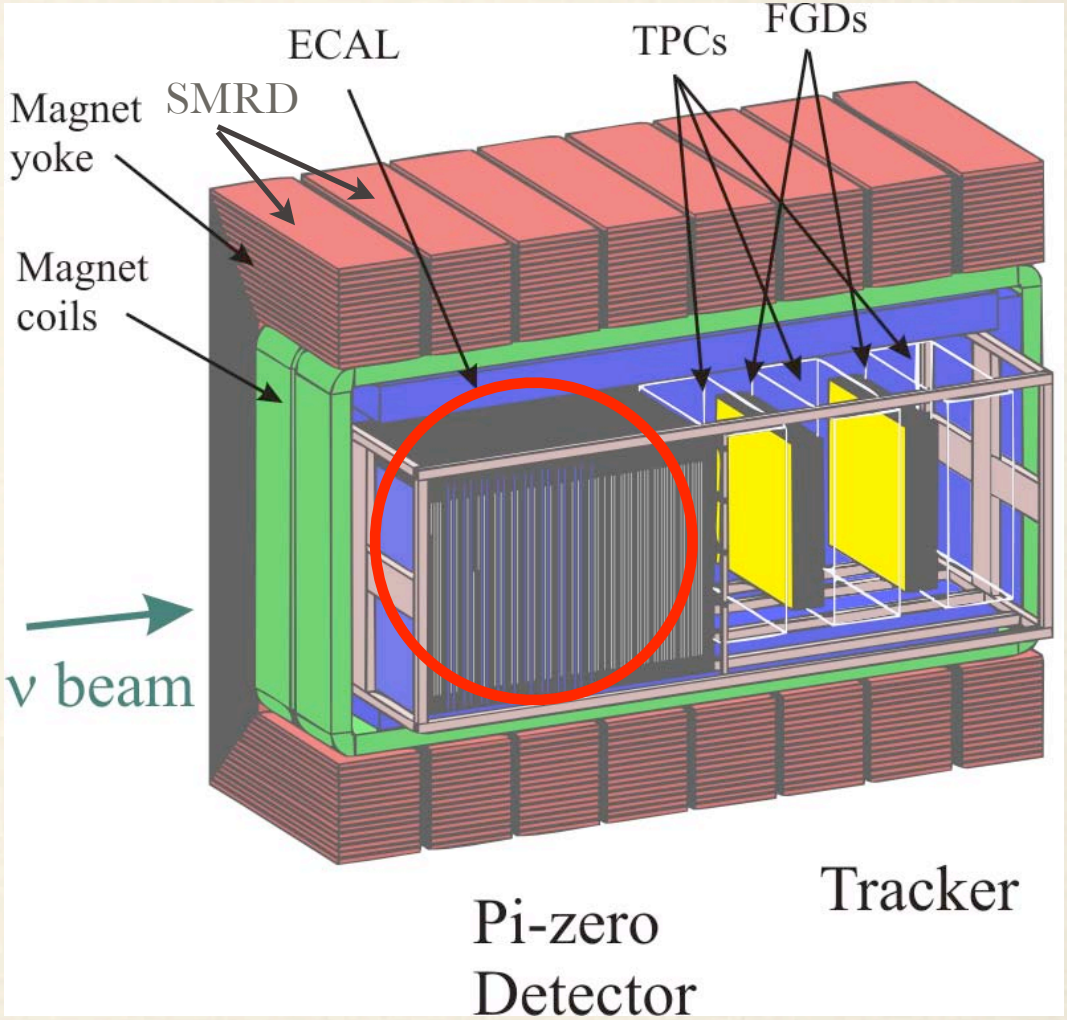

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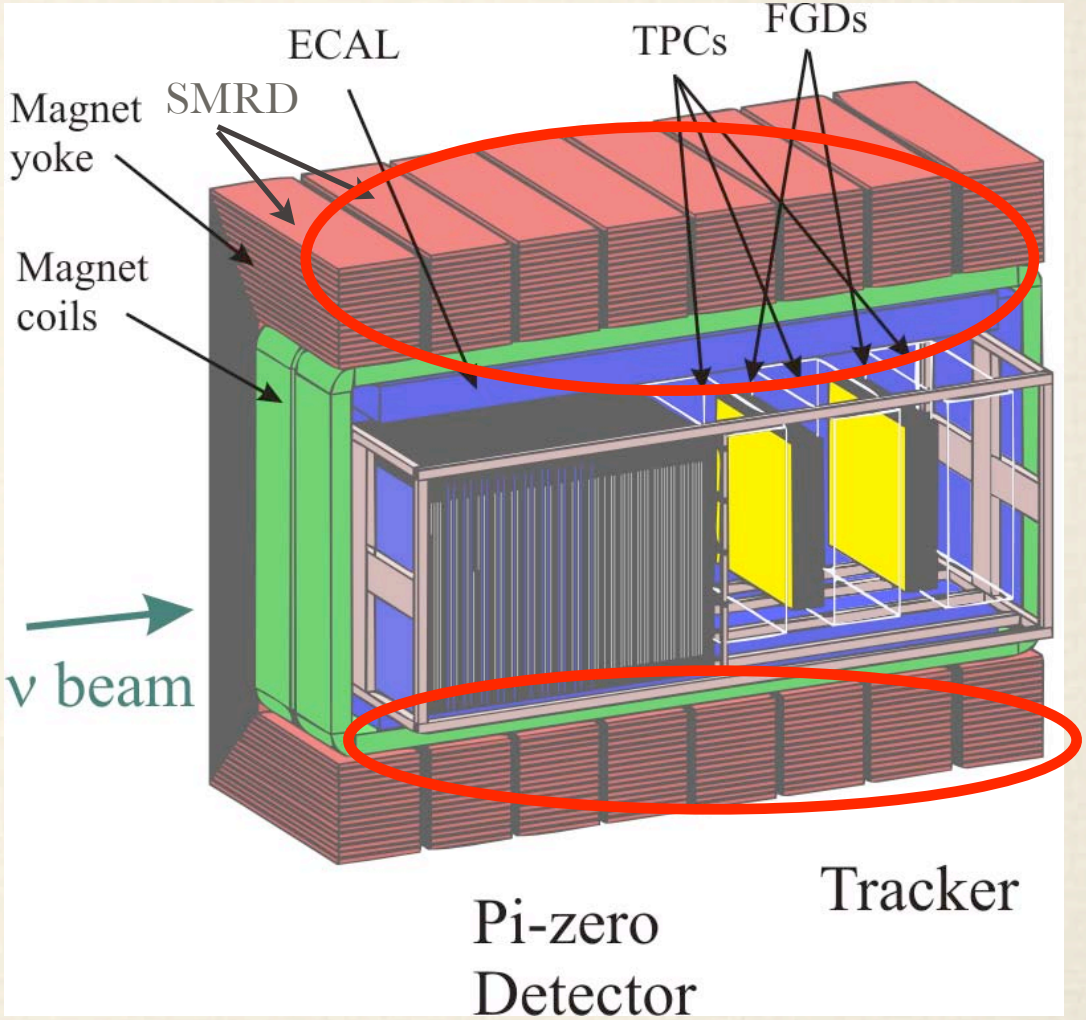

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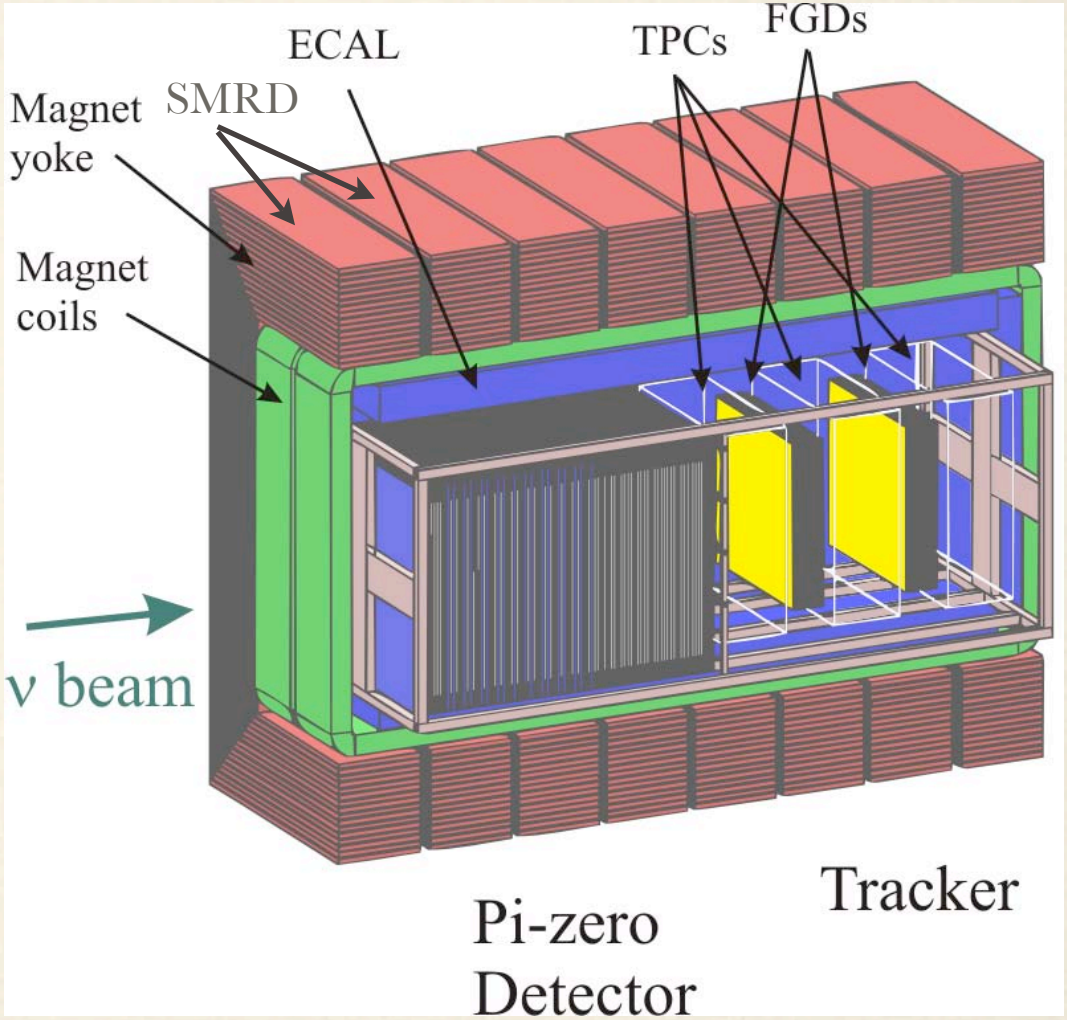
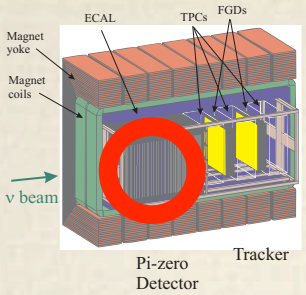
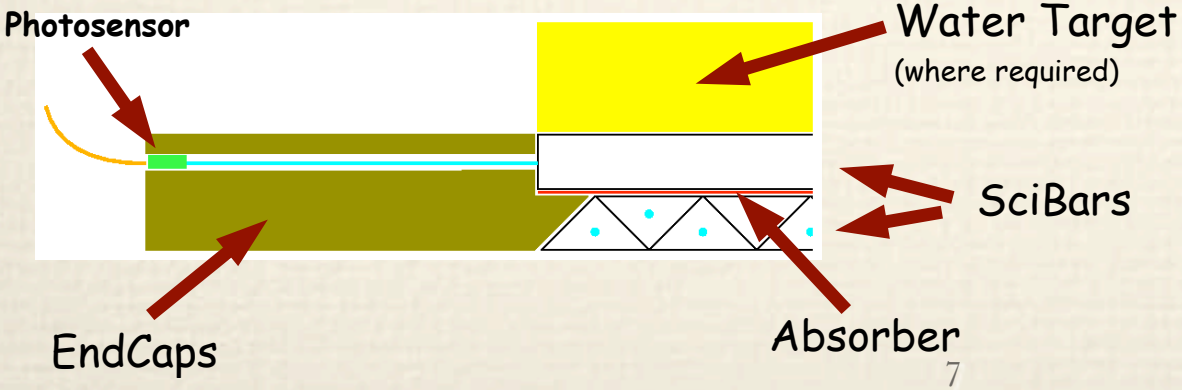


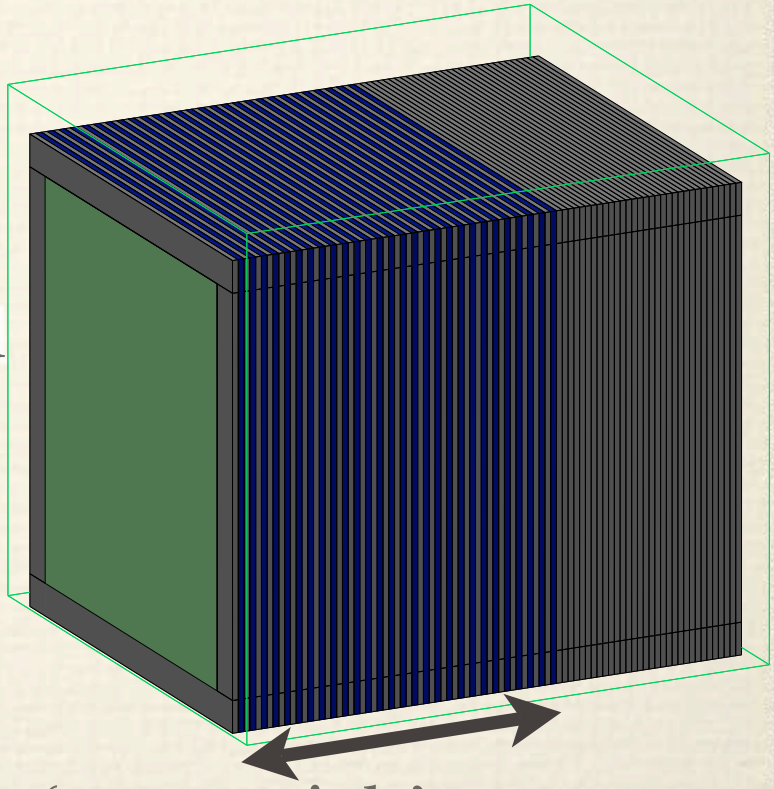
Sounds like a collider detector...?



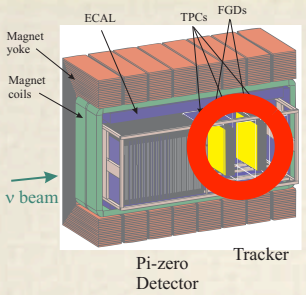
π^0 detector (POD)

- Measure π^0 production cross section
- Scintillator+Pb layers
  - Upstream 2/3 interleaved with water target
- ~60K single π^0 events expected with 10^{21} POT



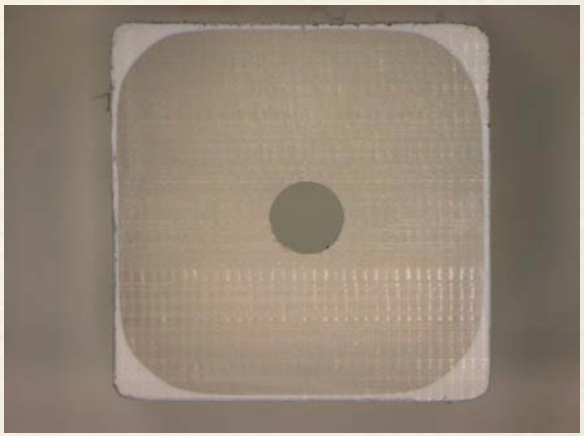


'water rich' part

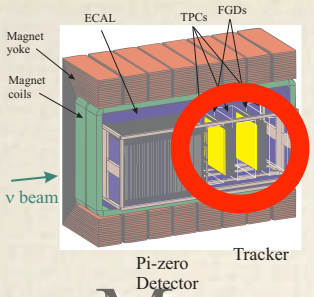


Fine Grain Detector (FGD)

- Provide active target (~1.2 tons / module) to tracker part by plastic scintillator (a la K2K-SciBar)
- 1x1cm^2 segmentation, 192x192x30cm^3 module
- Two modules
  - One fully scintillator
  - The other interleaved with H_2O target
- ~4x10^5 events expected with 10^{21} POT



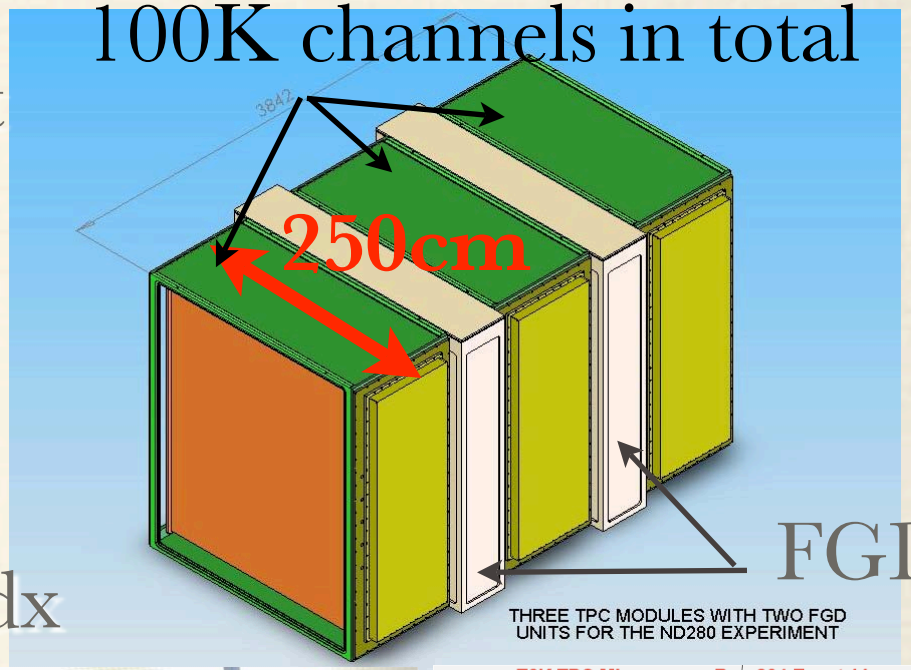
FGD scintillator prototype @ TRIUMF

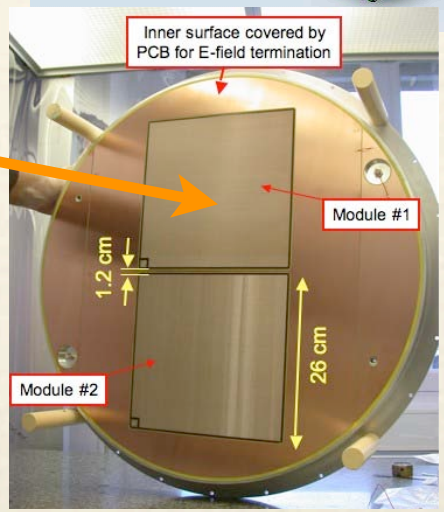


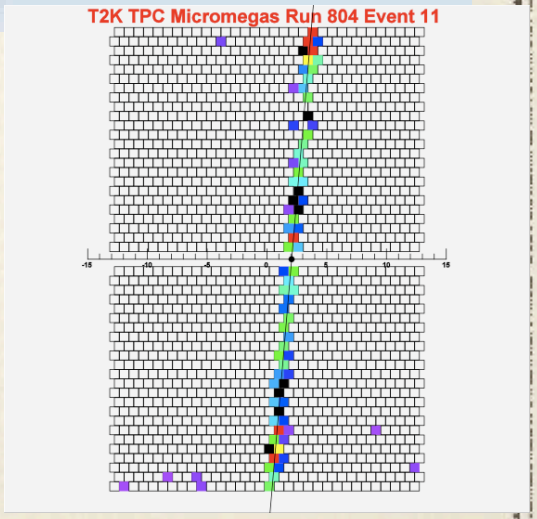
TPC

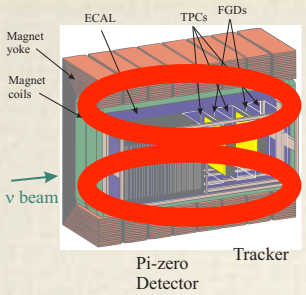
- Measure momentum of charged particles coming out of FGD
  - <10% resolution below 1GeV/c
  - Also provides PID by dE/dx
- Chosen micromegas as gas amplification system
- Prototype working, technical design being fixed

Three identical modules
100K channels in total



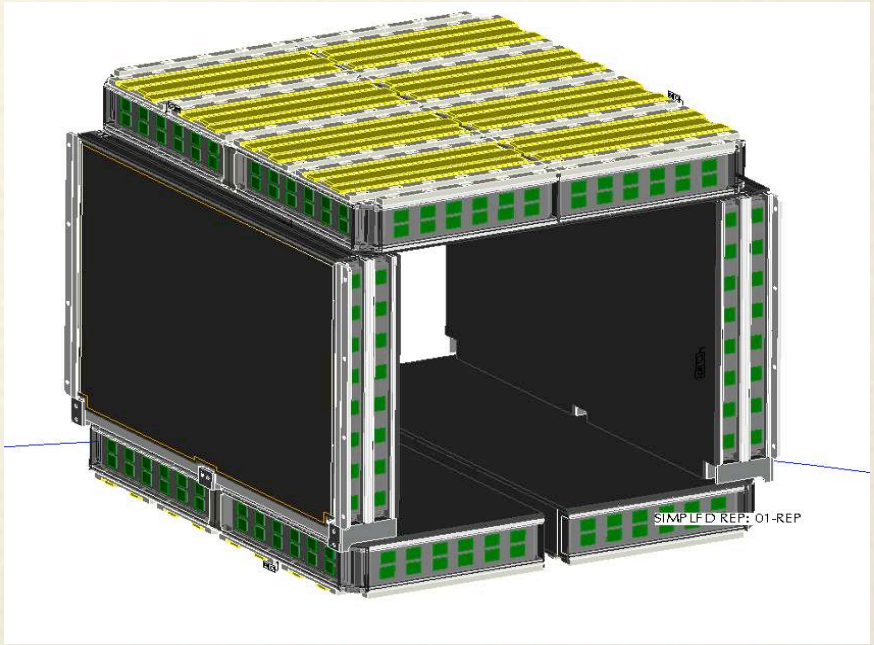


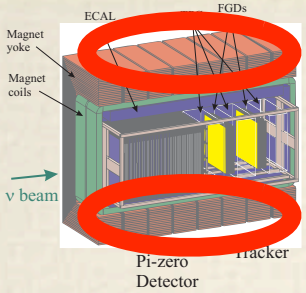




ECAL

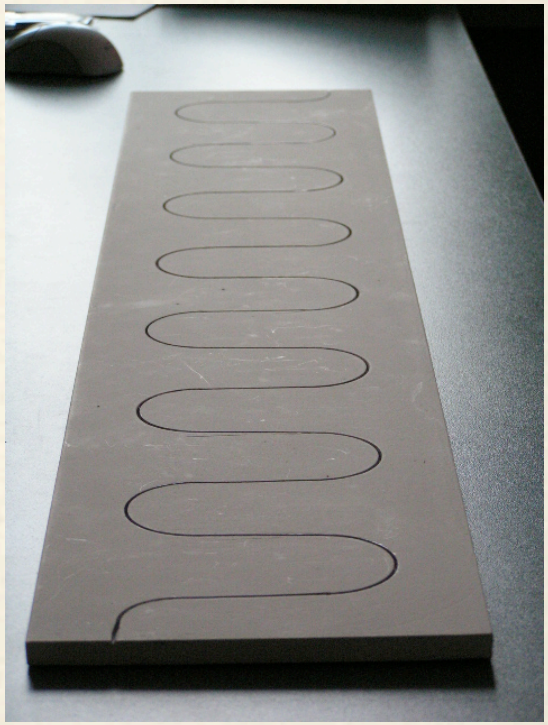
- EM measurement for pi0 and nue measurements.
- Lead-scintillator sampling calorimeter
  - $10X_0$ around tracker
  - $\sim 4.5X_0$ around POD
  - $\sim 12\ X_0$ downstream
- Design optimization ongoing



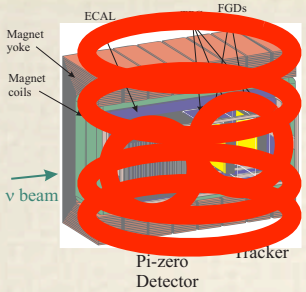


Side MRD

- Instrument gaps of magnet yoke to measure muon range
- Also provides trigger for calibration
- Prototype test soon
- Installation scheme being developed
  - Measurement of UA1 yoke gaps



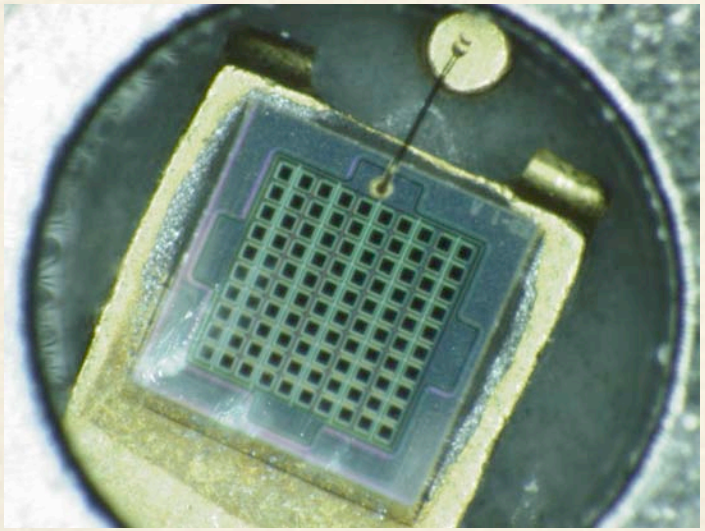
scintillator prototype @ Russia



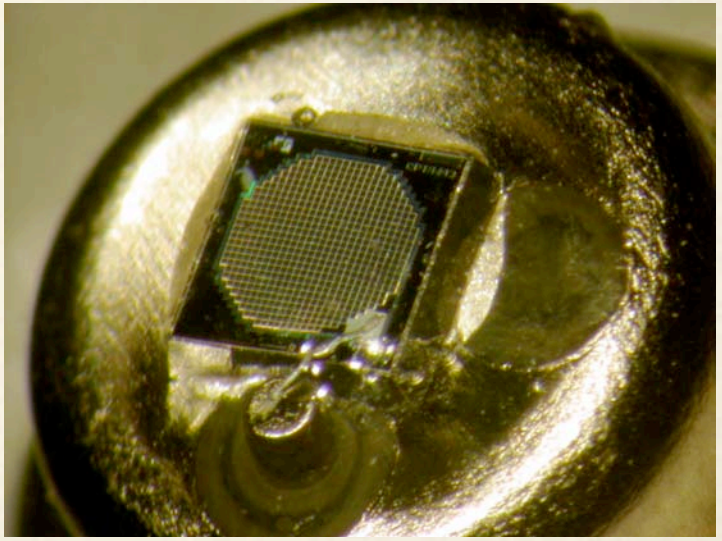
Photosensor

- All but TPC will use scintillator + WLS fibers
- Magnetic field, limited space, many channels

Development of new photo-sensors!



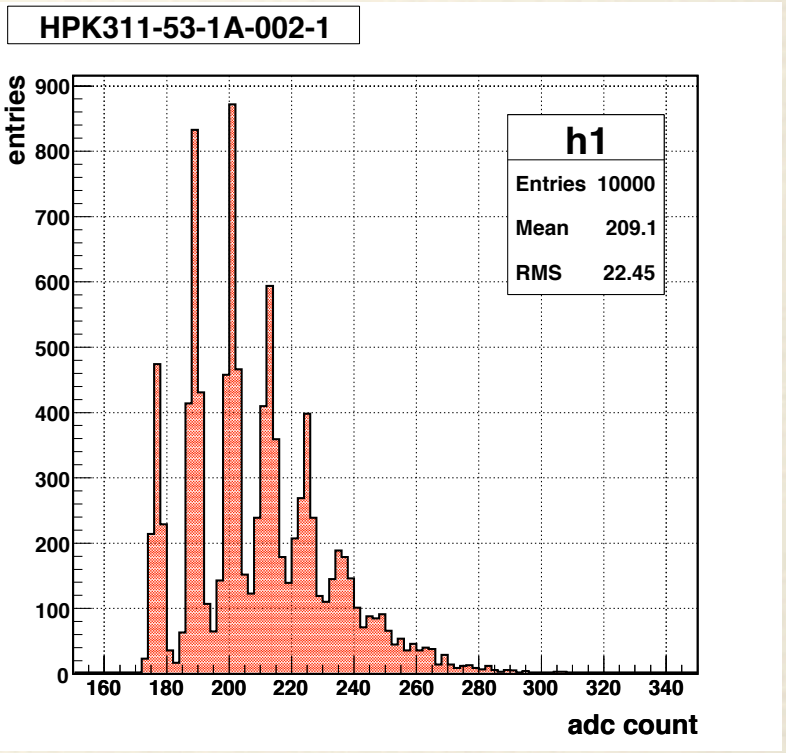
Multi-Pixel Photon Counter
by Hamamatsu, Japan



MRS-APD
by CPTA, Russia

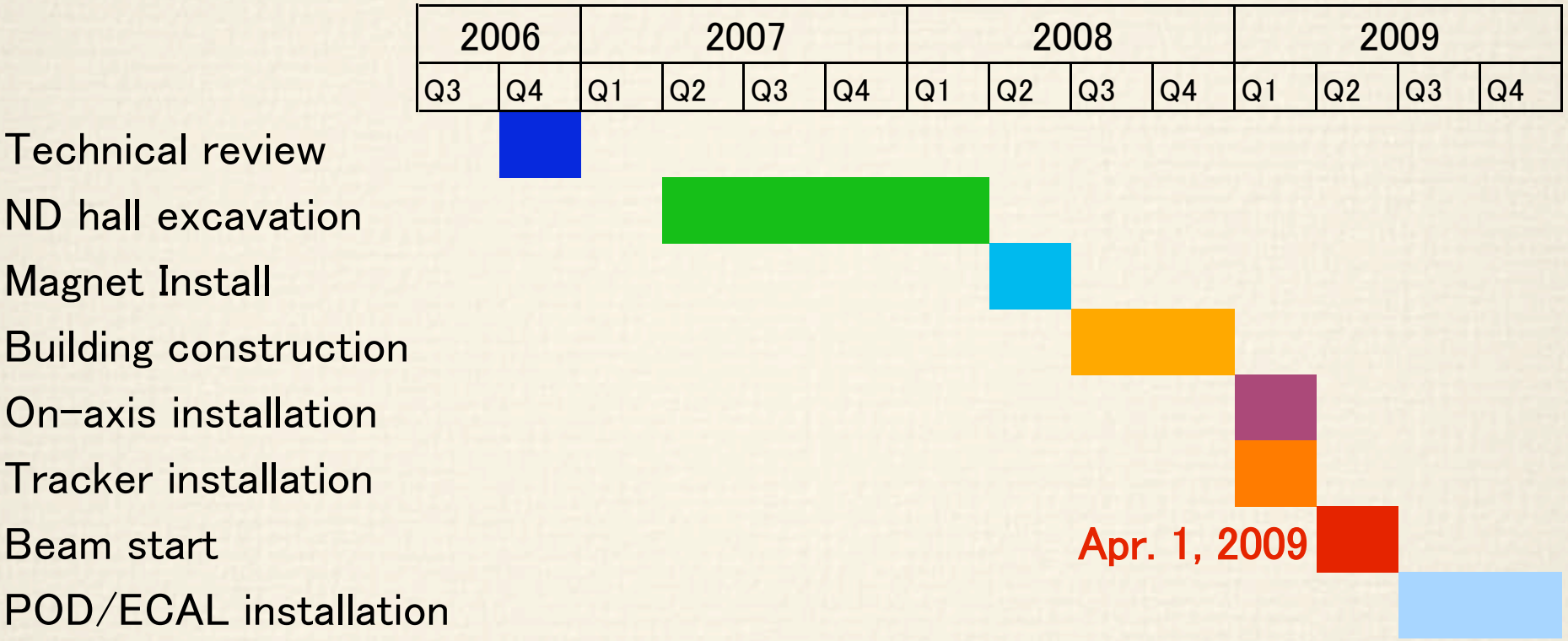
Photosensor status

- Excellent photon counting capability.
  - Gain 10^5-10^6 with <100V voltage
  - Photon yield ≥ PMT
  - Noise ~<1MHz (>0.5p.e.)
- Shifting to mass-production
  - Quality control
  - Connection to WLS fibers



MPPC ADC distribution

Schedule



- Not shown: development/production of each sub-detector
- Also need hard work!