



Flavour in the era of the LHC , 3rd meeting
15-17 May 2006, CERN

Update on the status of MEG

Hajime NISHIGUCHI
University of Tokyo
for the MEG collaboration

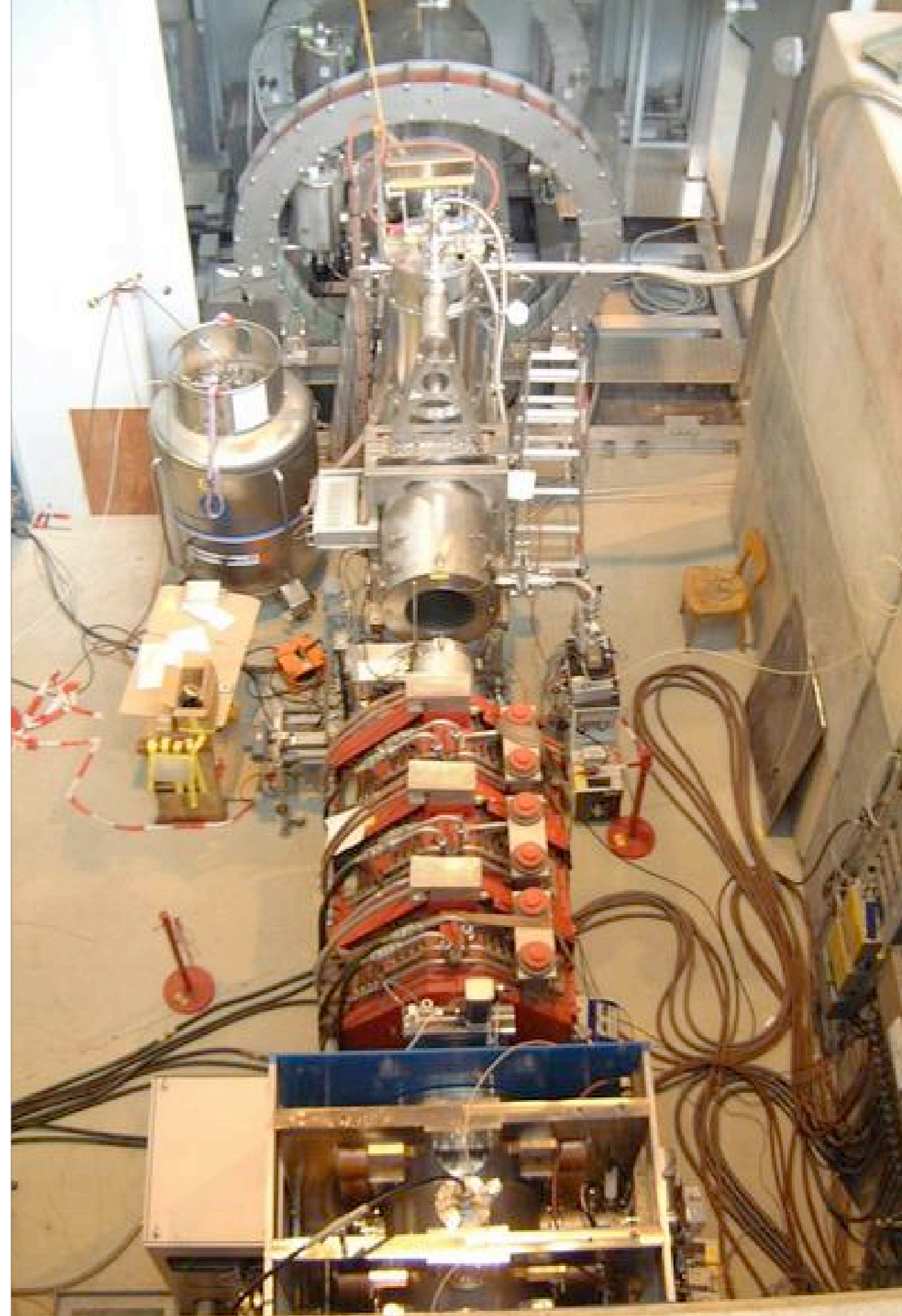
“MEG” in this workshop

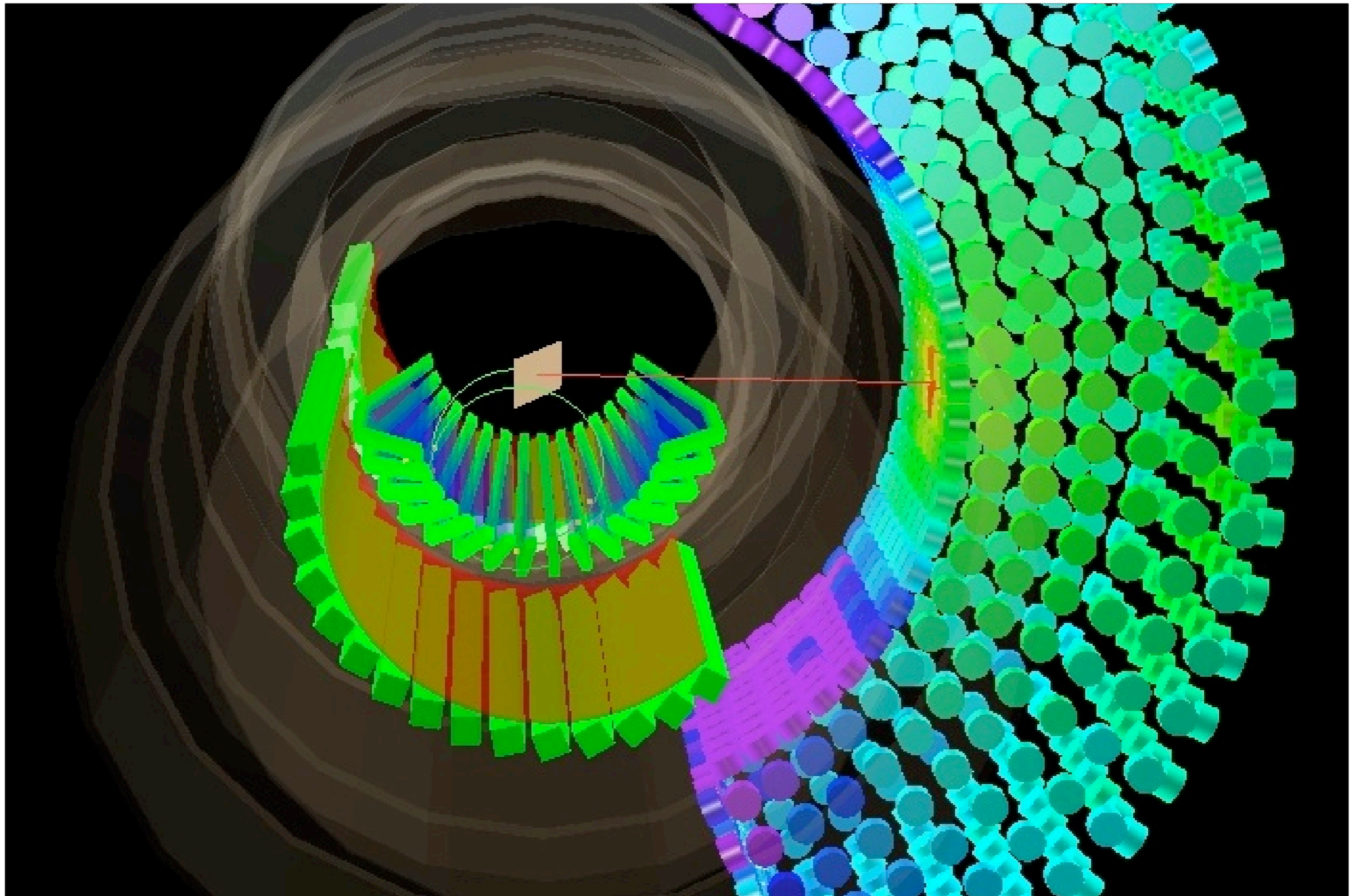


- 1st meeting, (Nov., 2005)
 - “*LFV, status and prospects*”, by T.Mori (Tokyo) -plenary-
 - “*Improving the sensitivity, MEG and beyond*”, by A.Baldini (INFN-Pisa) -WG3-
- 2nd meeting, (Feb., 2006)
 - no presentation
- 3rd meeting (this time)
 - updates after the 1st meeting and the newest schedule, prospects

CONTENTS

- MEG experiment
- current status
 - beam line & target
 - photon detector
 - positron spectrometer
 - trigger & electronics
 - software & analysis
- schedule & prospects
- conclusion





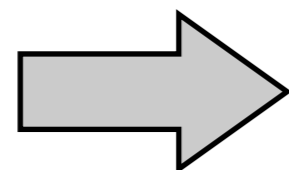
MEG experiment

search for $\mu \rightarrow e\gamma$ decay

- quark mixing (B-factories, etc.)
- neutrino oscillation (SK, KamLAND, etc.)
- charged lepton must also mix
 - but not observed yet
- $\mu \rightarrow e\gamma$ decay is the most sensitive, exploring GUT/seesaw via SUSY
 - current experimental limit : $\text{Br}(\mu \rightarrow e\gamma) = 1.2 \times 10^{-11}$ (MEGA, PRL83('99)p83)
 - $\text{Br}(\mu \rightarrow e\gamma) = 10^{-11} \sim 10^{-14}$ are predicted
 - predicted branching ratios are within the reach of the next experiments

quark flavor violation is generally contaminated by SM

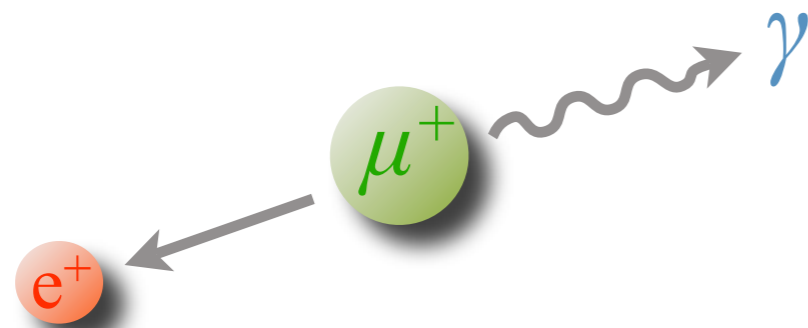
Charged LFV is "BEYOND SM"



MEG @ PSI, starts in this year

$\mu \rightarrow e \gamma$ Signal and Background

- Signal



- $E_e = E_\gamma = m_\mu/2 = 52.8\text{MeV}$
- $\theta = 180\text{deg.}$
- time coincidence

Clear 2-body kinematics

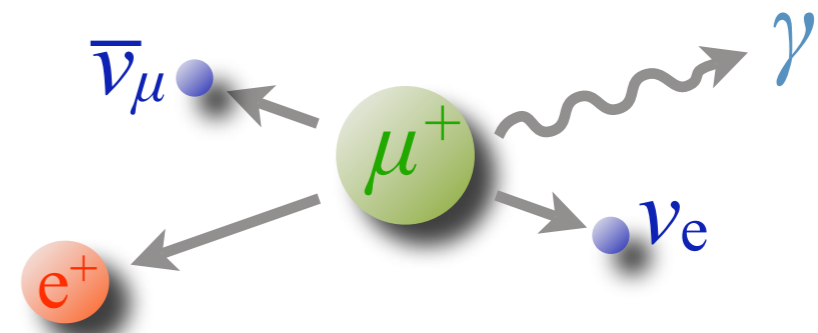
use μ^+ to avoid capture inside stopping target

Background dominated by Accidental overlap

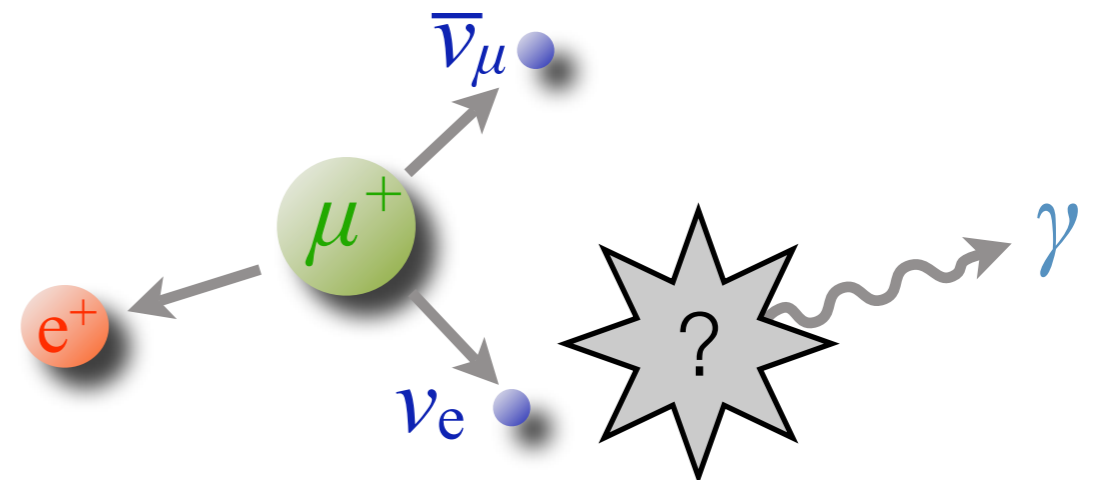
- lower muon beam rate is better
- DC muon beam is the best

- Background

- radiative muon decay



- accidental overlap



Detector and Collaboration



COBRA magnet (COntant Bending Radius) 

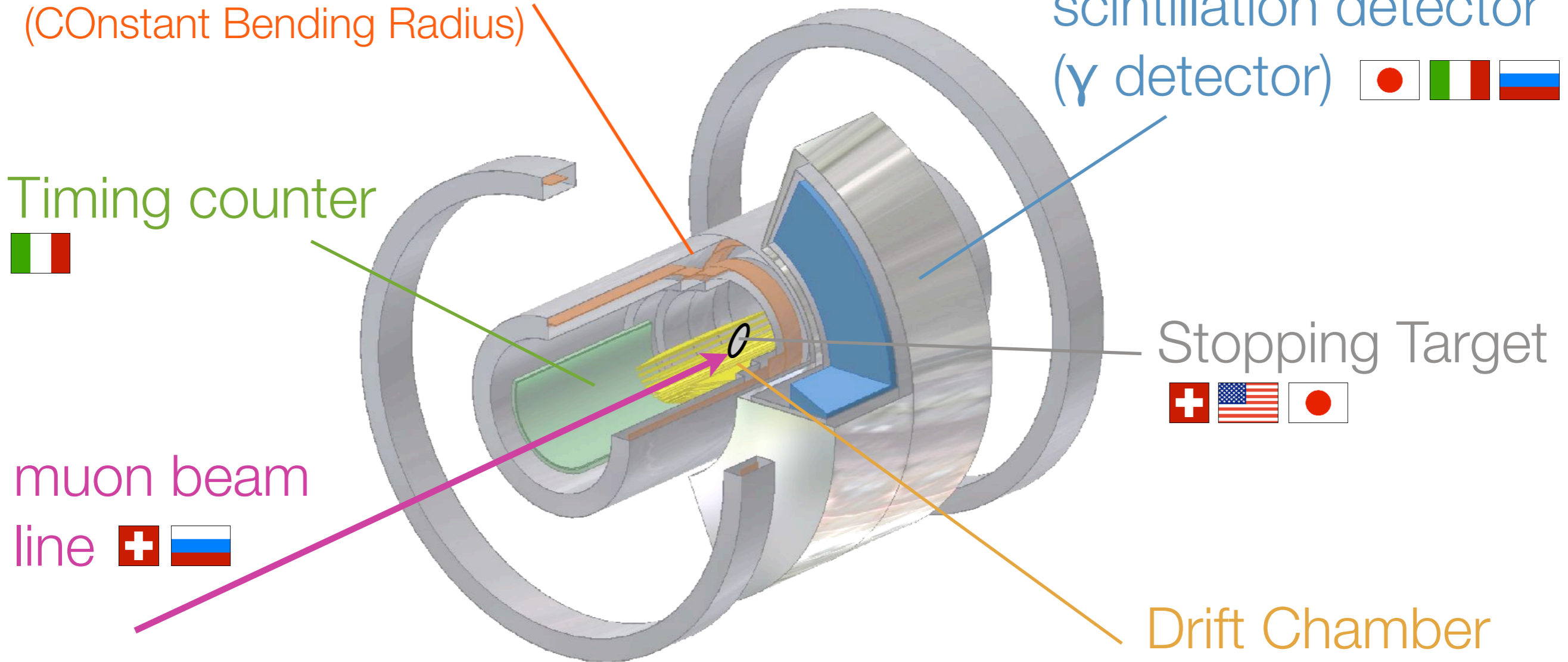
Liquid Xenon scintillation detector (γ detector) 

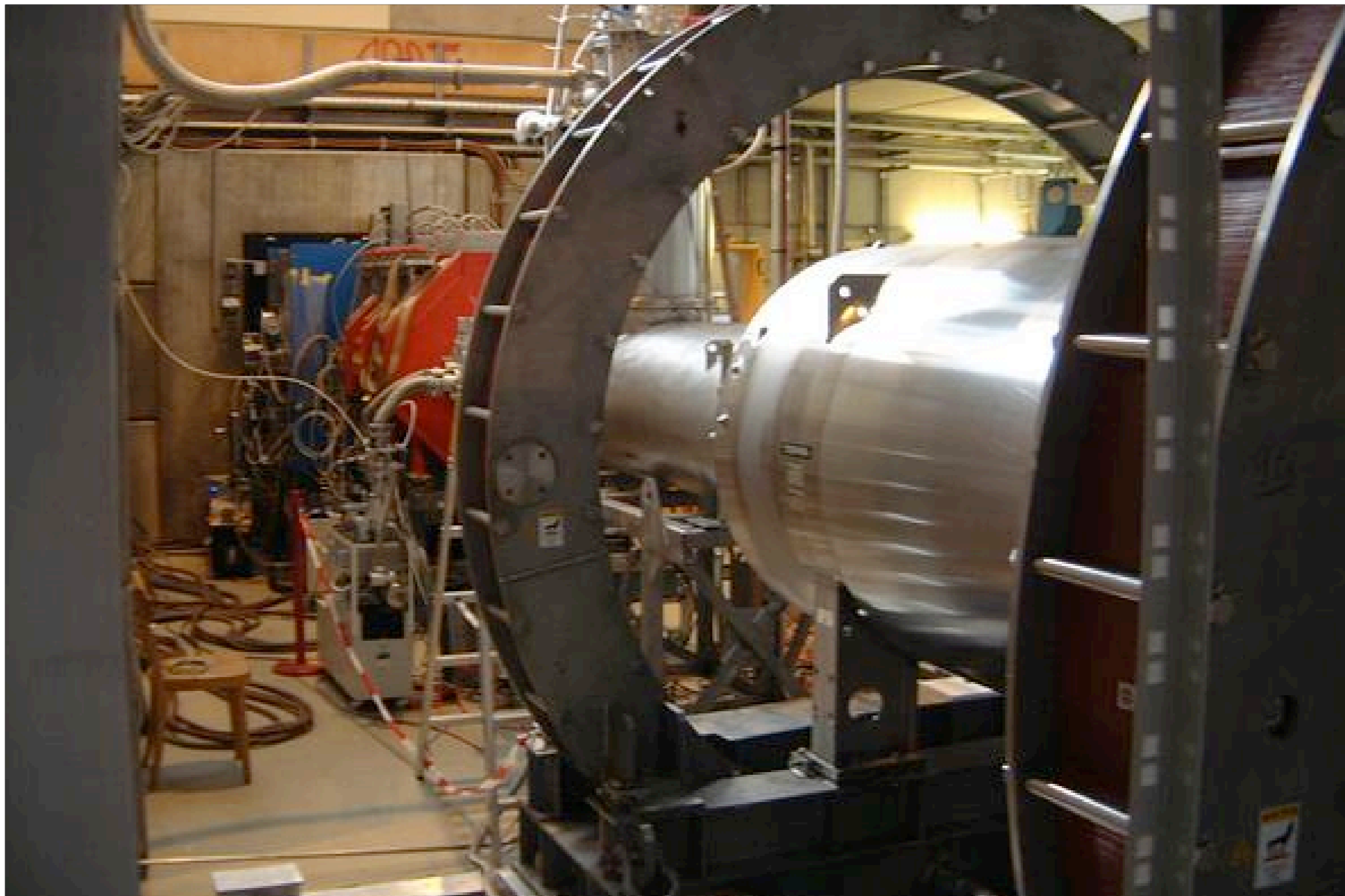
Timing counter 

muon beam line 

Stopping Target 

Drift Chamber 





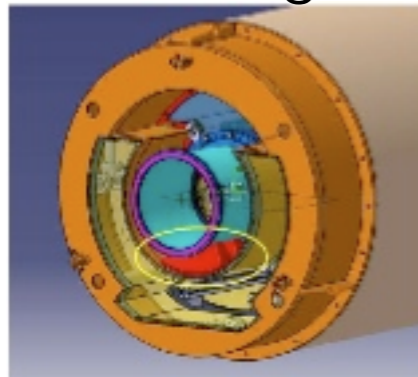
Current Status

Beam line commissioning

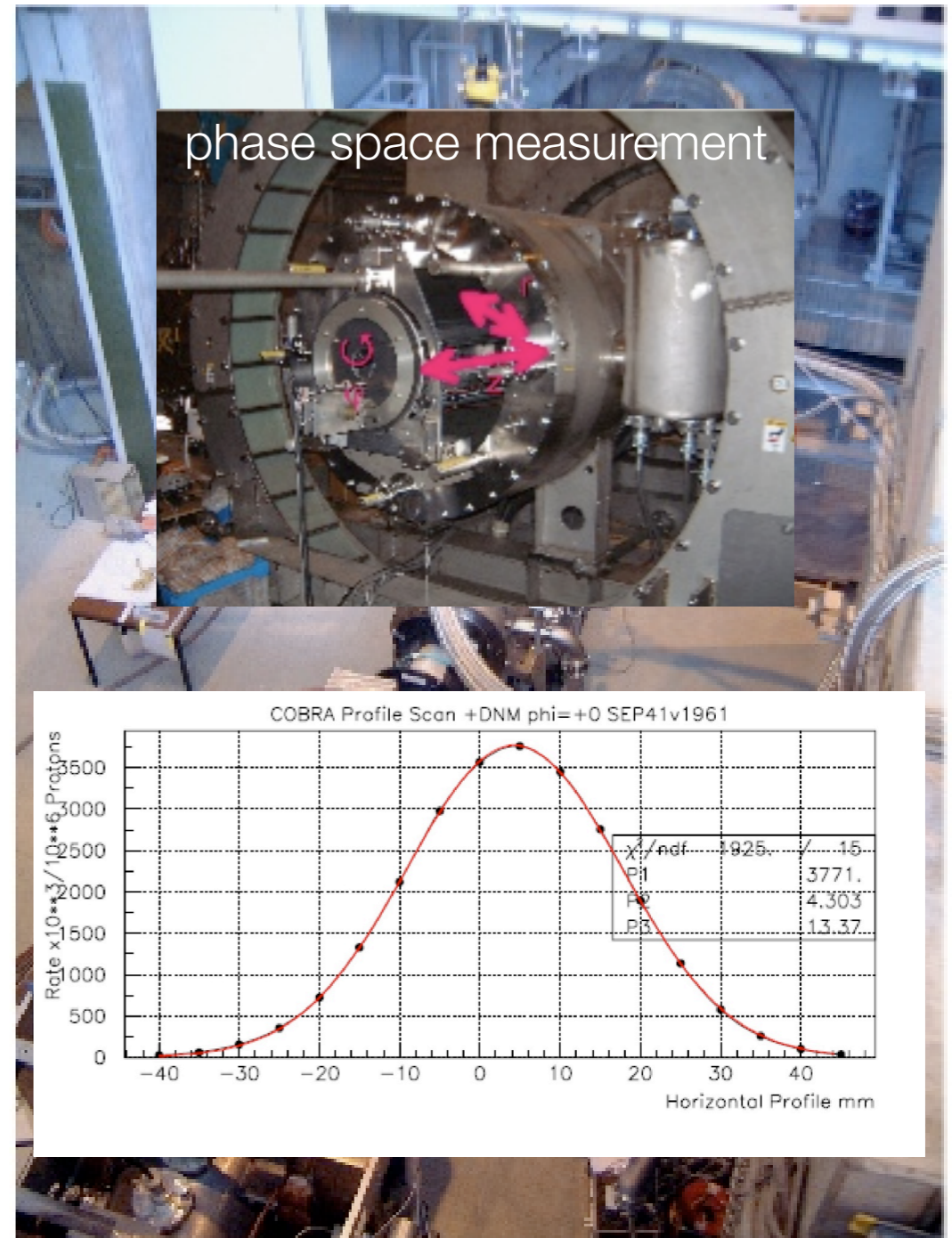
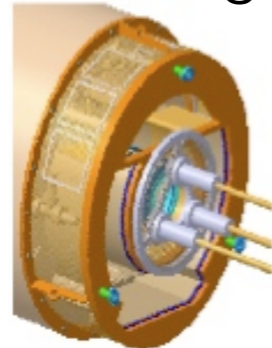
- 2005
 - beam transport solenoid (BTS) commissioning
 - B-field mapping
 - phase space measurements up to end of BTS
 - commissioning BTS with Cryo-plant
 - phase space measurements inside COBRA magnet
- 2006
 - final beam commissioning with degrader
 - control system test

$2.5 \sim 3.5 \times 10^7 \mu/\text{sec}$ (normal)
 $\sim 1.2 \times 10^8 \mu/\text{sec}$ available

US flange

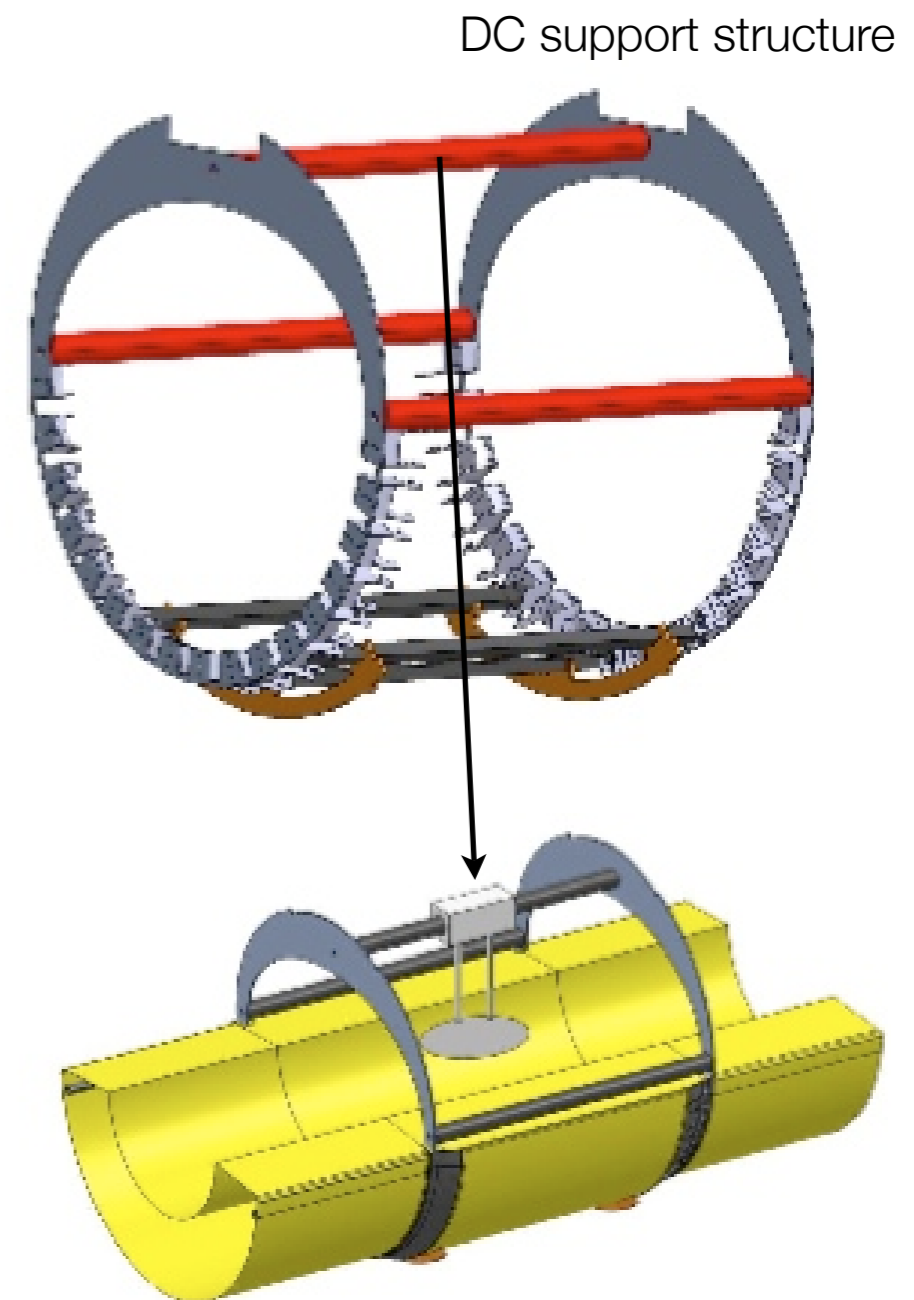


DS flange



Target system

- Material
 - Rohacell form / CH₂ combination
 - Complete Rohacell
 - Ch₂ or polystyrene target + wire frame
- Support
 - from DC frame, rotatable or translational
 - prototype is investigated
- position monitoring
 - idea of using several holes in target => x,y,z



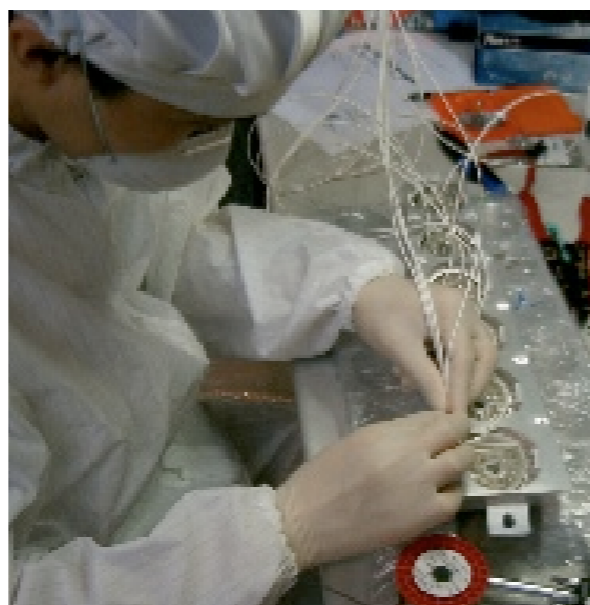
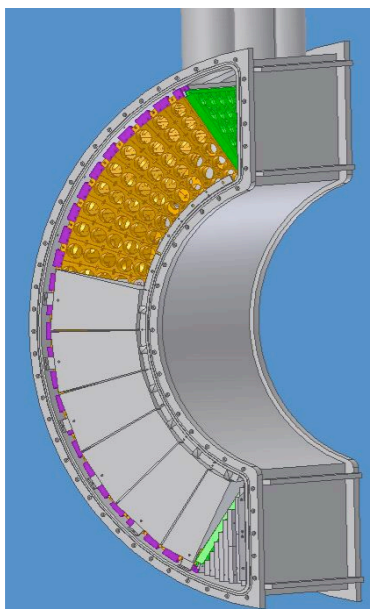
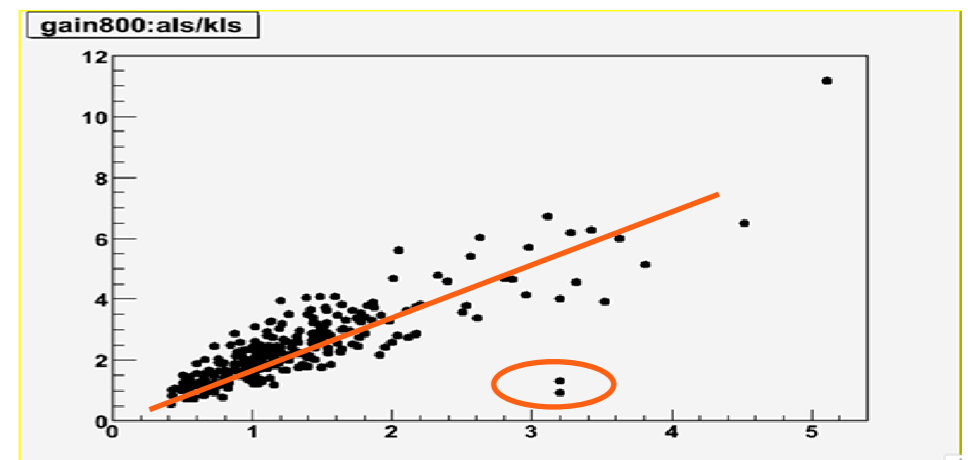
photon detector, Cryostat

- R&D with prototype completed 2004
- test, calibration, construction phase
- cryostat construction in progress in Italy
- completed soon and several tests will be performed in the factory
- delivery in July
- PMT installation and setup after that
- ready in September as a whole photon detector system



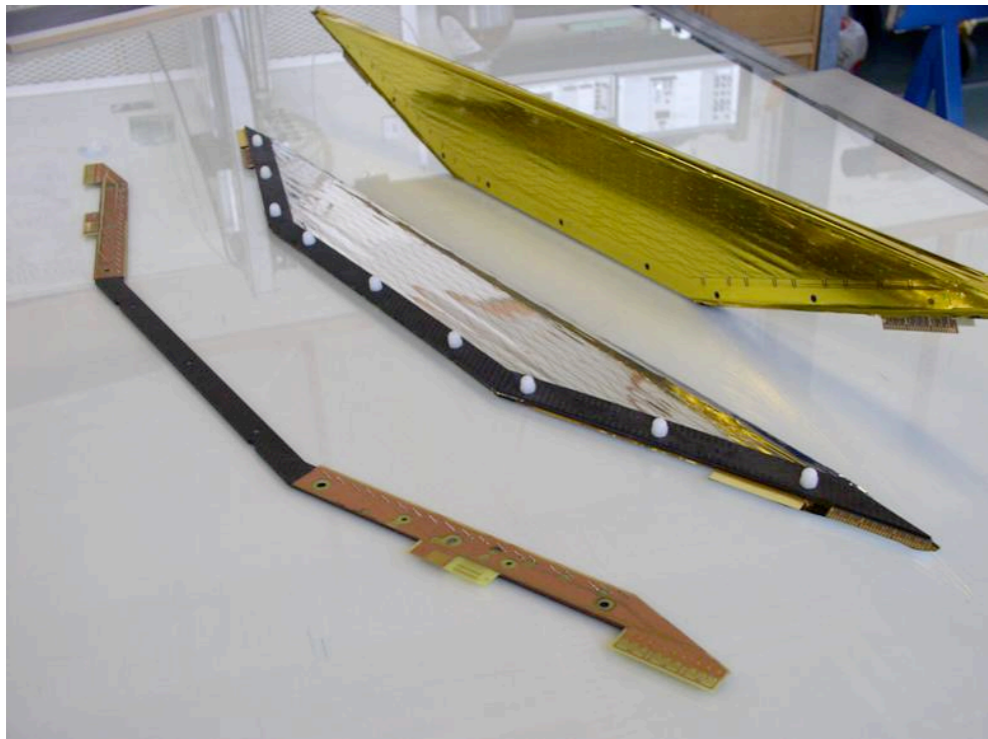
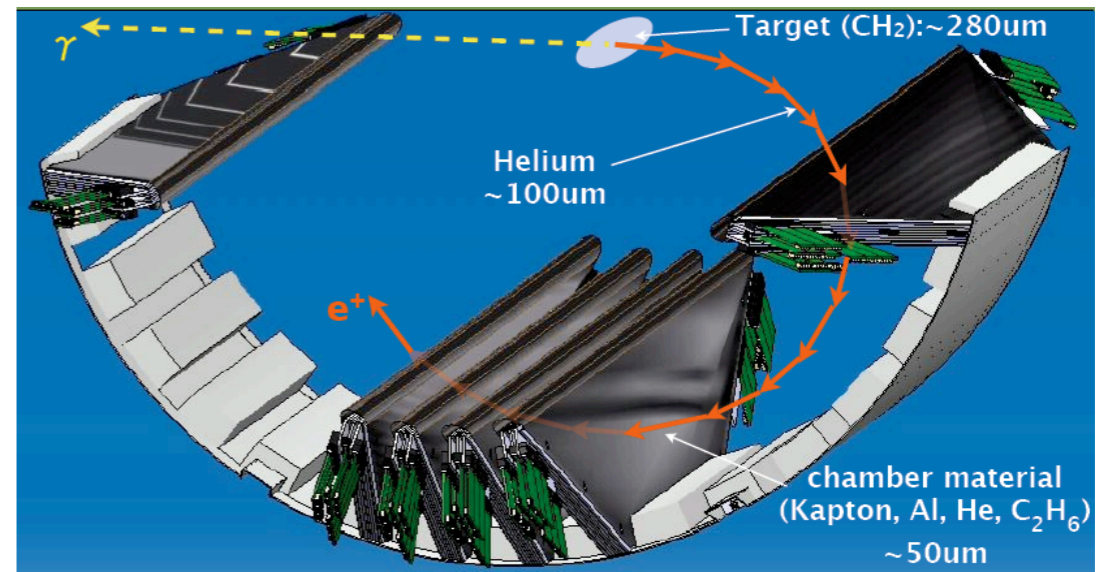
photon detector, PMTs and holder

- PMT test
 - all PMTs(>1000) were tested in LXe before installing to the detector
 - Pisa LXe PMT test facility
 - Xenon detector large prototype
 - QE, gain, response linearity
- PMT support holder
 - assembly is progressing now



e^+ spectrometer, Drift Chamber

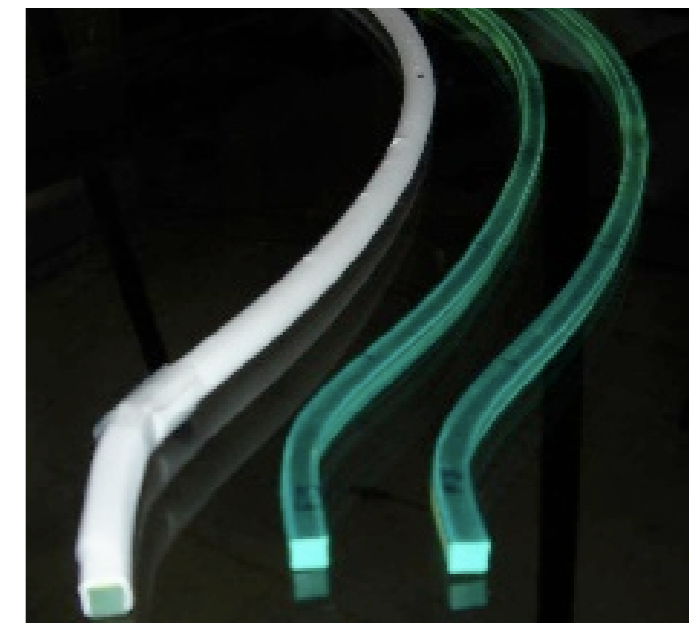
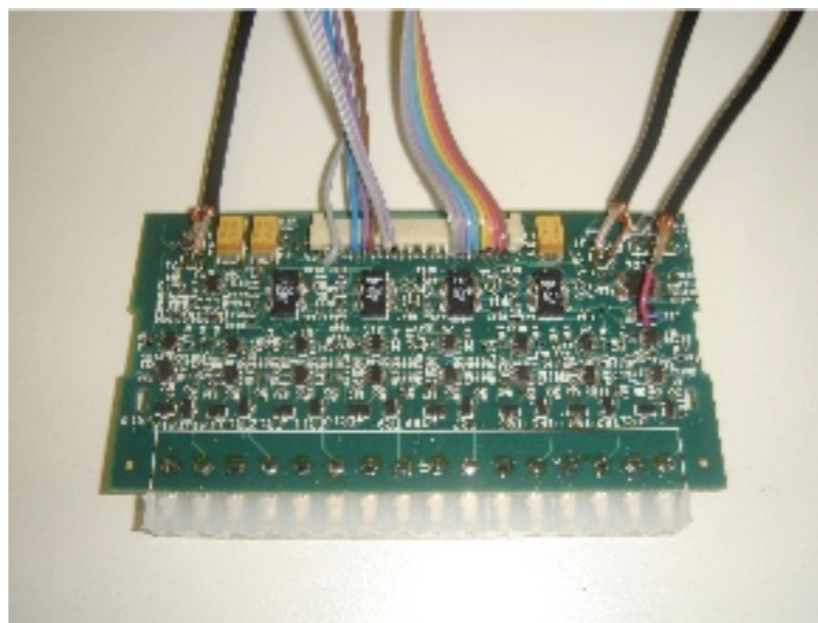
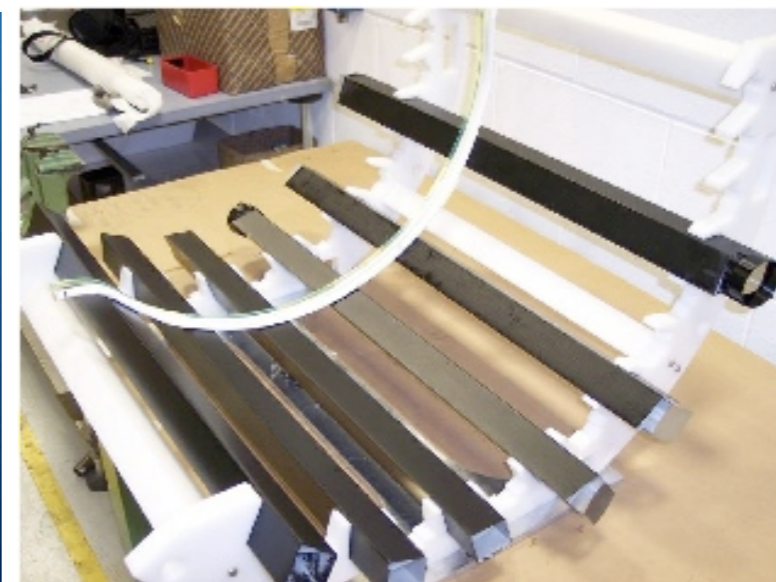
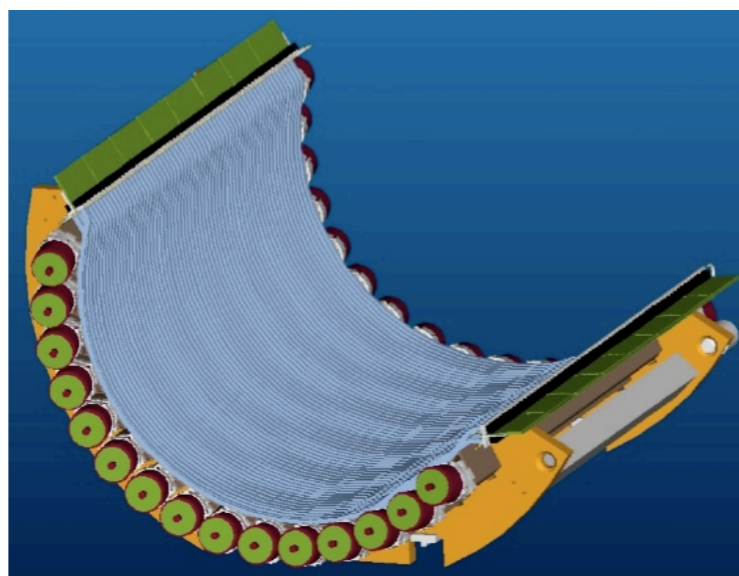
- prototype R&D completed
- construction study in 2005
- final production started
- front-end elec./ pressure system
- beam test is being performed now



- 4 DCs are ready (16DCs we need)
- ~ 2 DC / week
- final production will be completed beginning of this summer
- September, we will start commissioning run with TC, target

e^+ spectrometer, Timing Counter

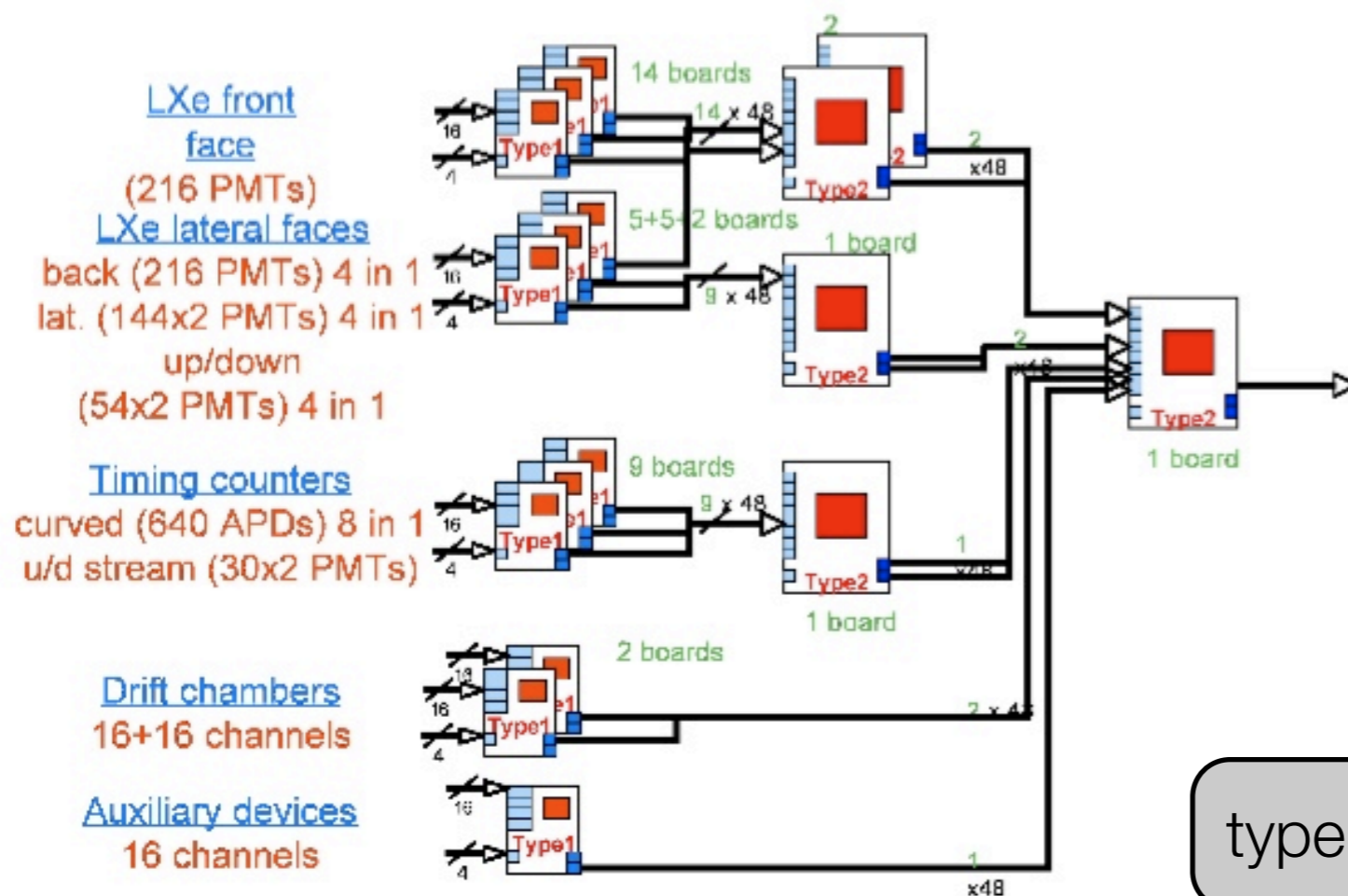
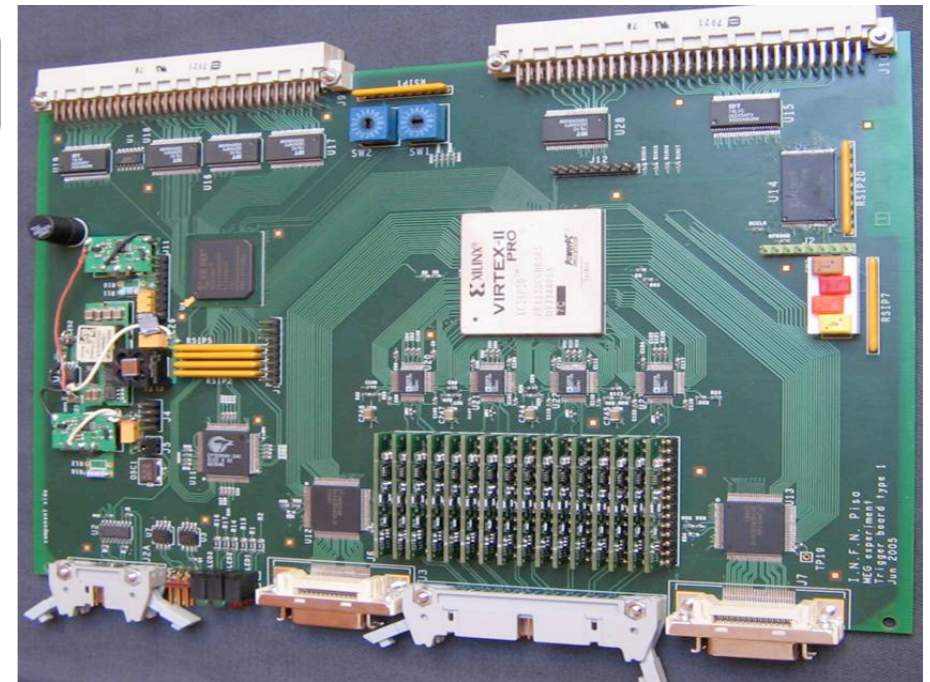
- counter test completed
- PMTs
 - tested, selected
- APD electronics
 - prototypes ready
- TC bag, getting ready
- calibration laser, ordered
- mass-pro. is progressing
- installation test
 - tested by mockup construction



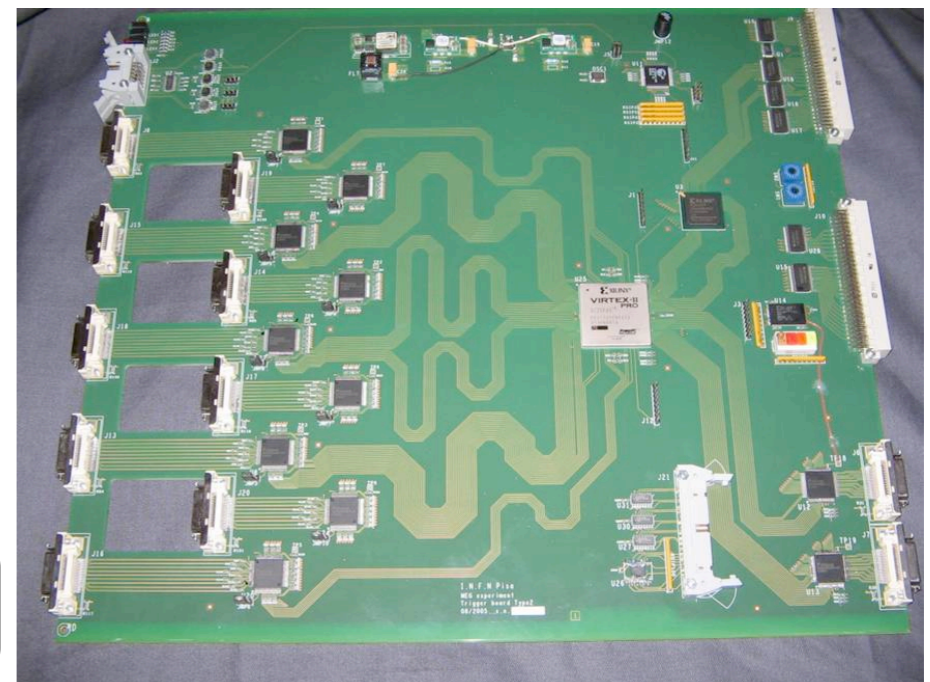
trigger electronics

- PCB production finished
- board mounting in progress
- ready to install in June

type-1

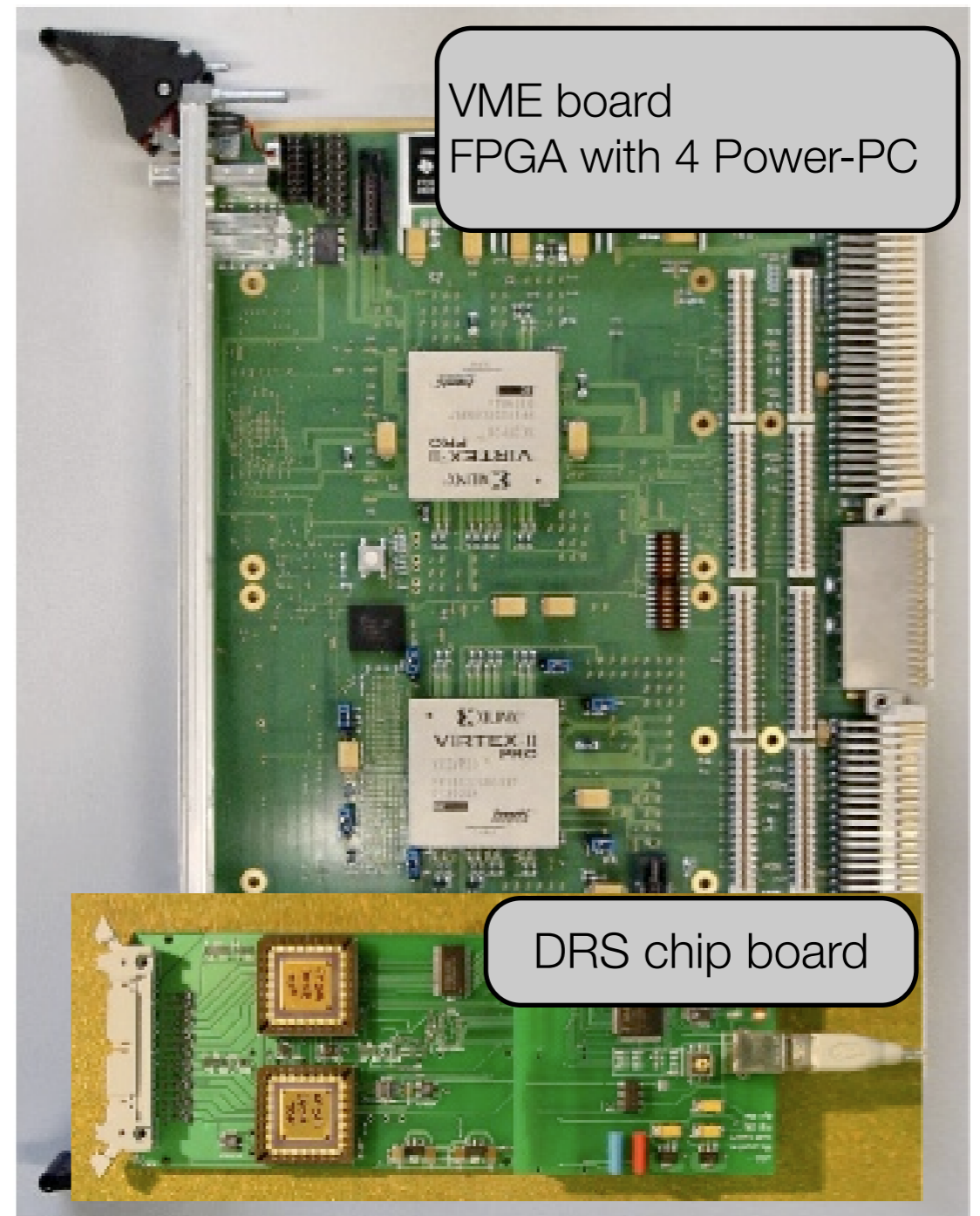
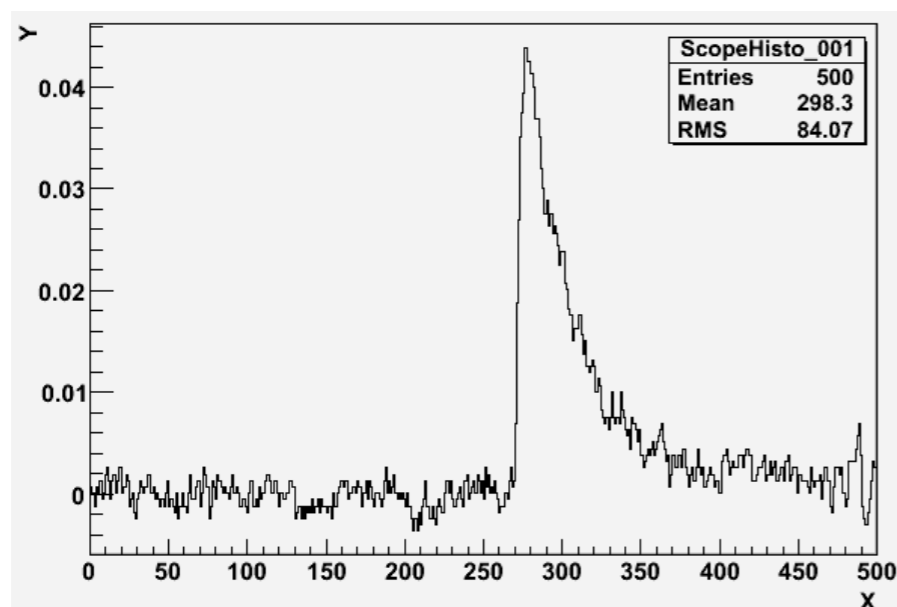


type-2



DAQ, waveform digitizer

- all channel read out by waveform digitizer, DRS (Domino Ring Sampler)
- all channel ready in June.
- DAQ(trigger and readout) electronics ready to start in June.



Software (framework)

- ROME based analysis tools are under developing (http://meg.web.psi.ch/wiki/index.php/MEG_Software)

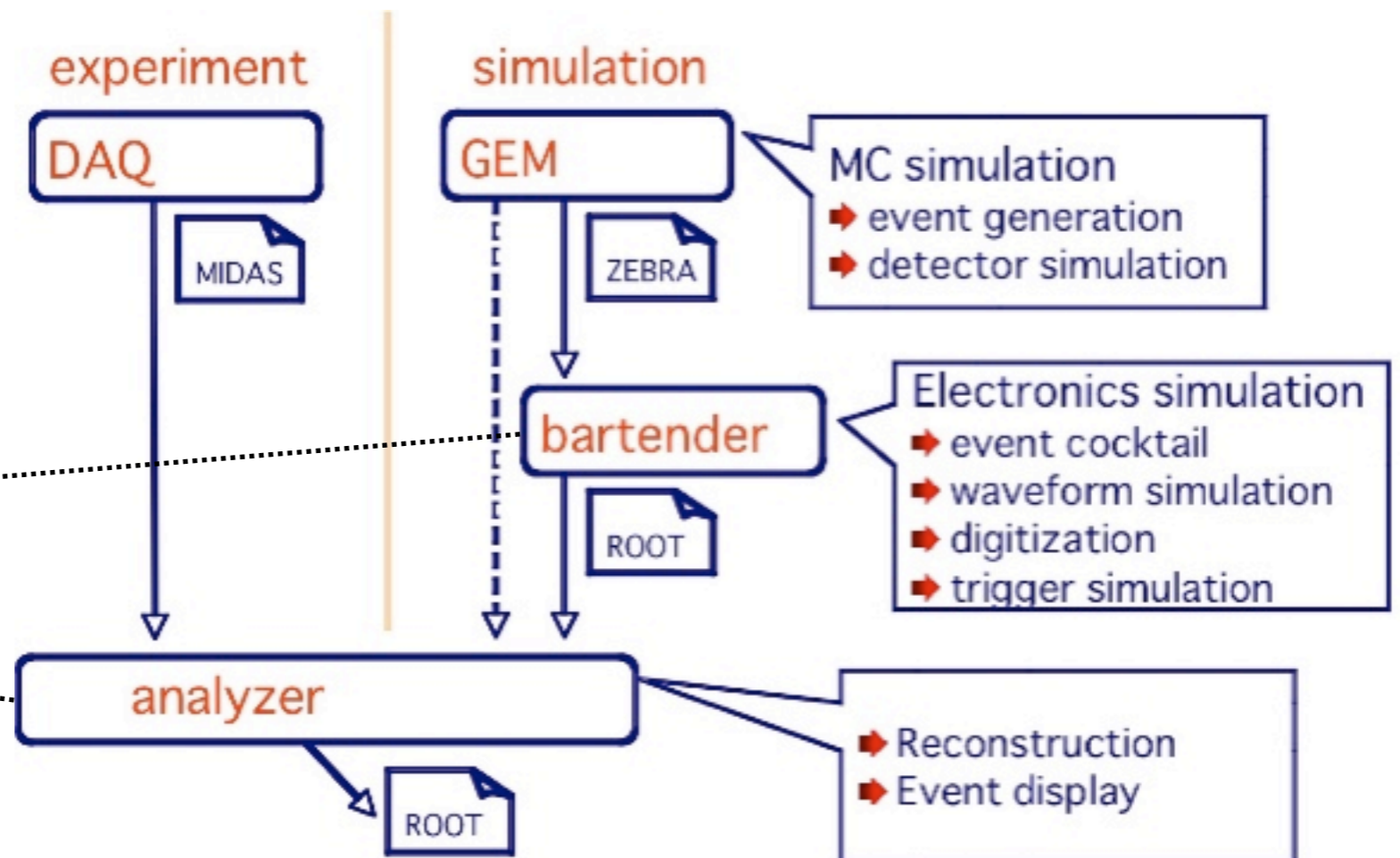
- ROME : see <http://midas.psi.ch/rome/>

- same analysis framework for experiment/simulation.

- offline software is developed in 2 parts

- bartender

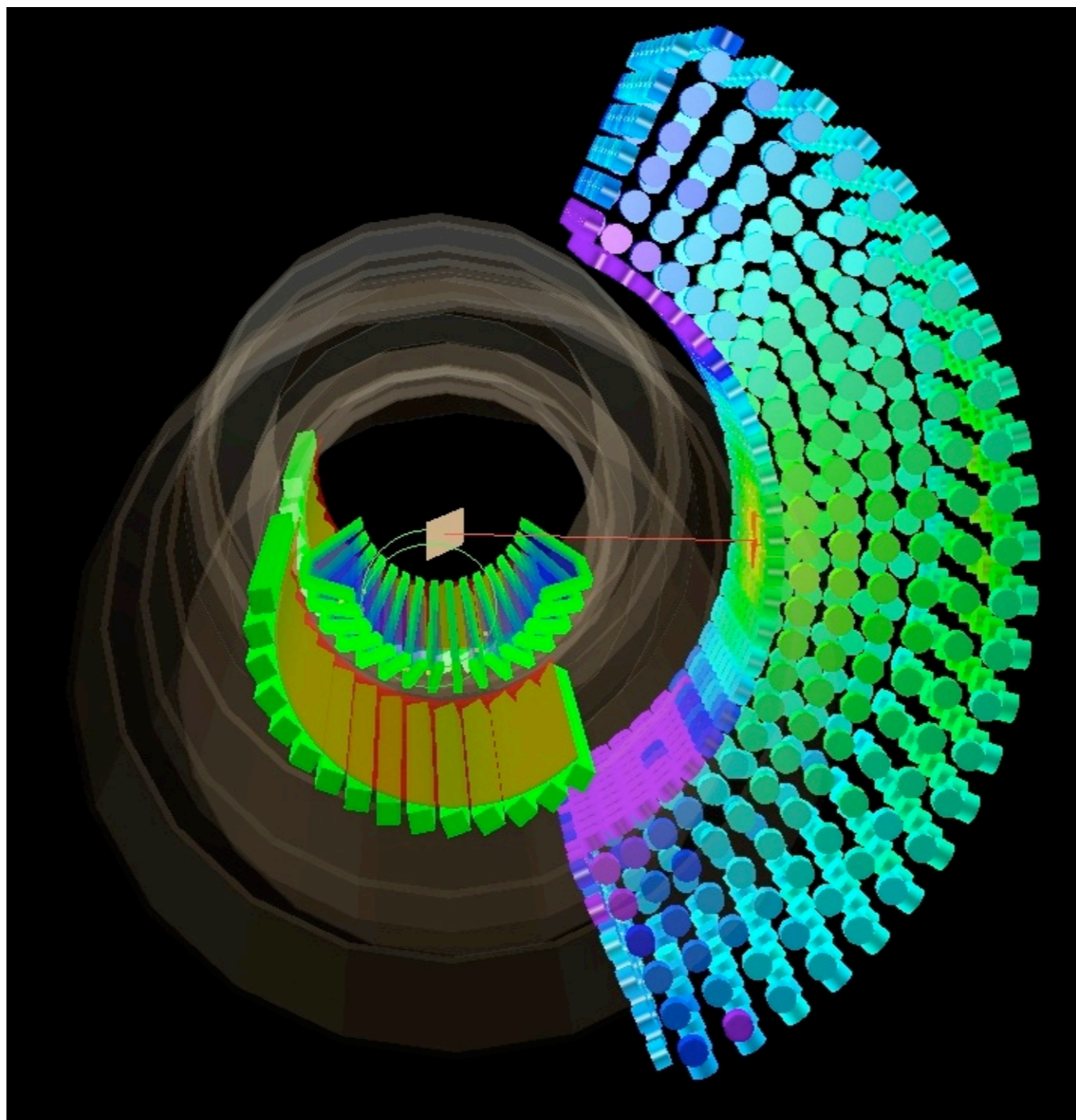
- analyzer



Software (simulation)

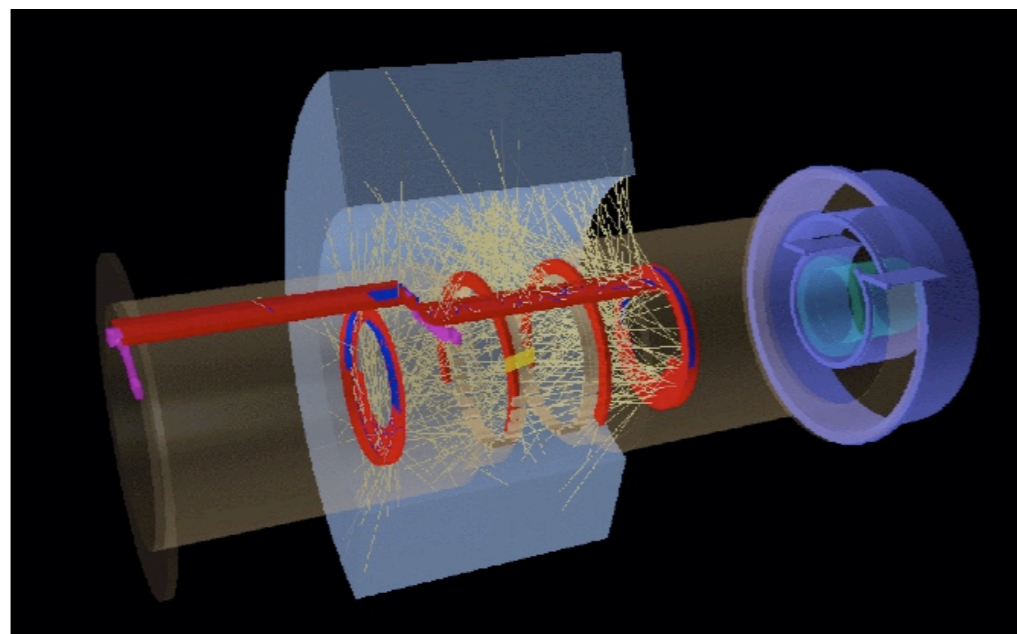
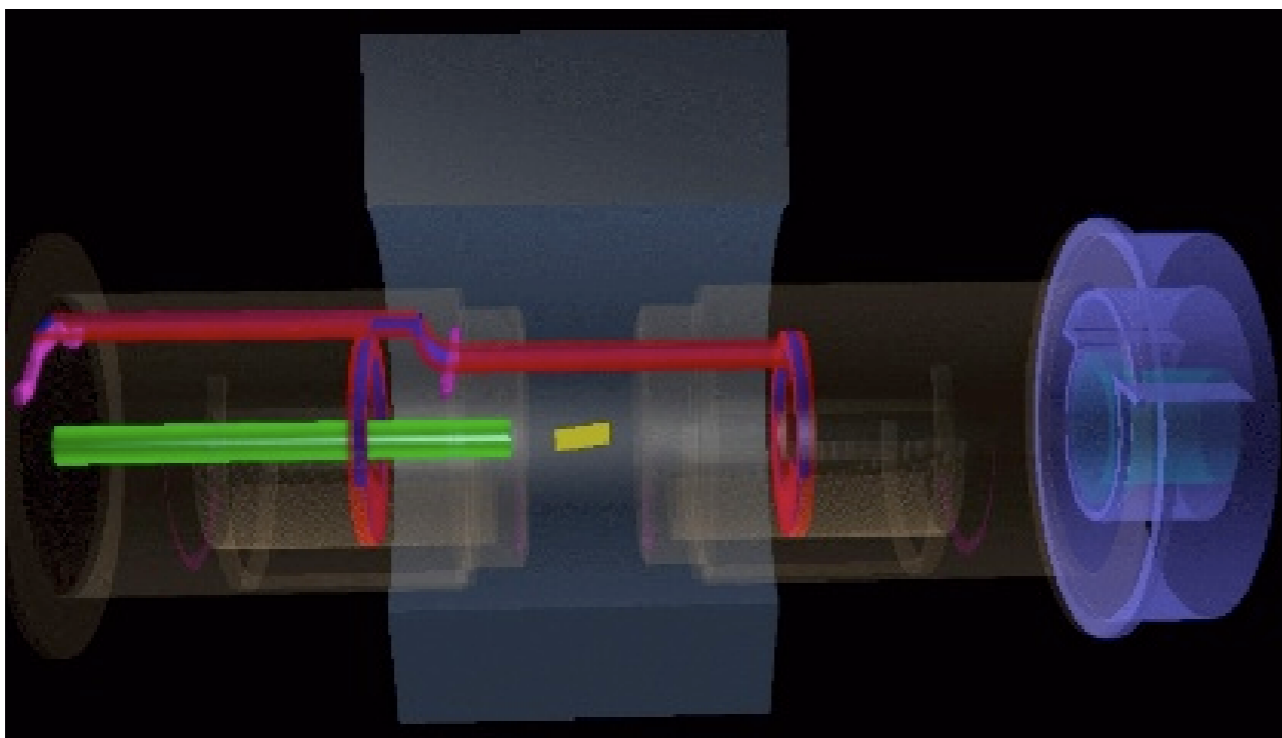
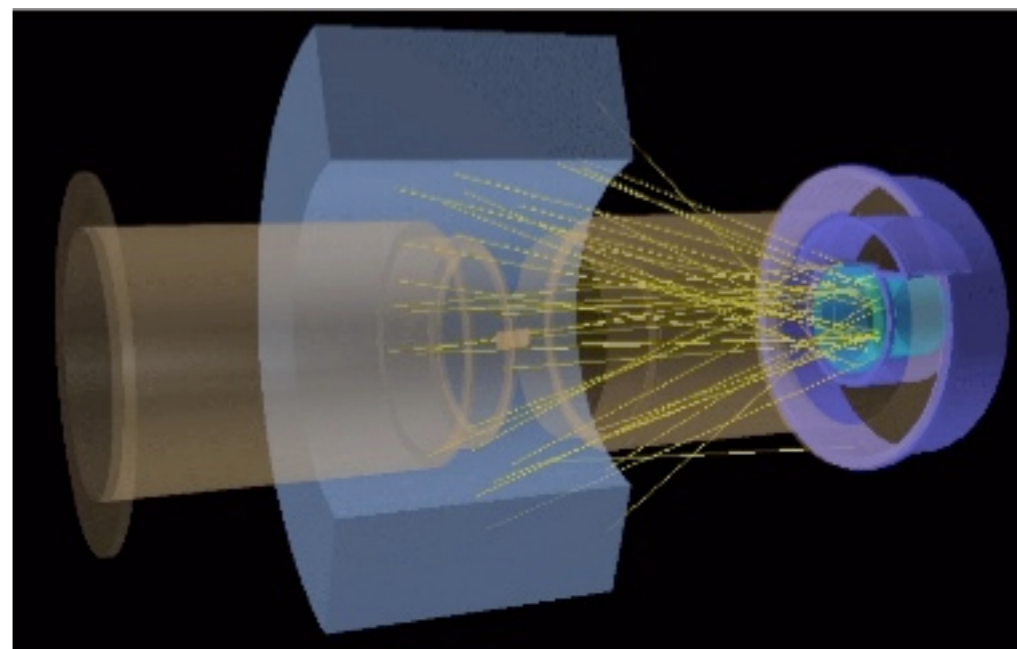
- Geant3 based MC simulation
 - event generator
 - signal event
 - Michel decay
 - radiative muon decay
 - Annihilation in Flight
 - muon beam and related
 - calibration event (RI source, gamma beam, LED, laser)
 - detector simulation
 - detector geometry and material
 - physics processes
 - scintillation ray-tracing and initial waveform simulation (w/o electronics simulation) for PM
 - developer's preview released, public release will be soon.

Software (event display)



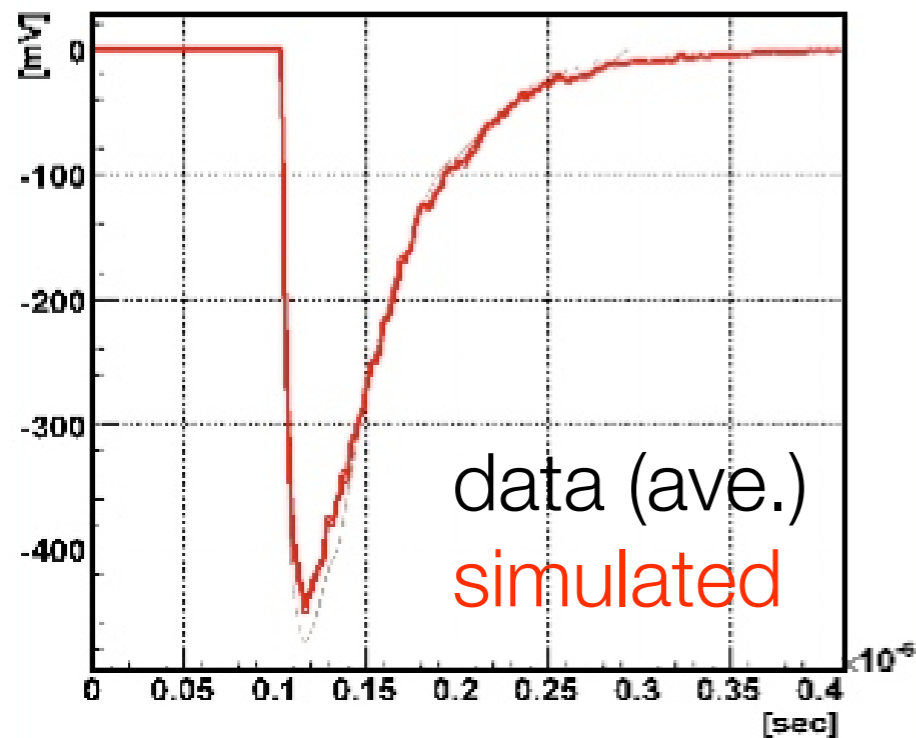
Analysis preparation with MC

- BG source study
 - A.I.F.
 - Bremsstrahlung
 - beam related



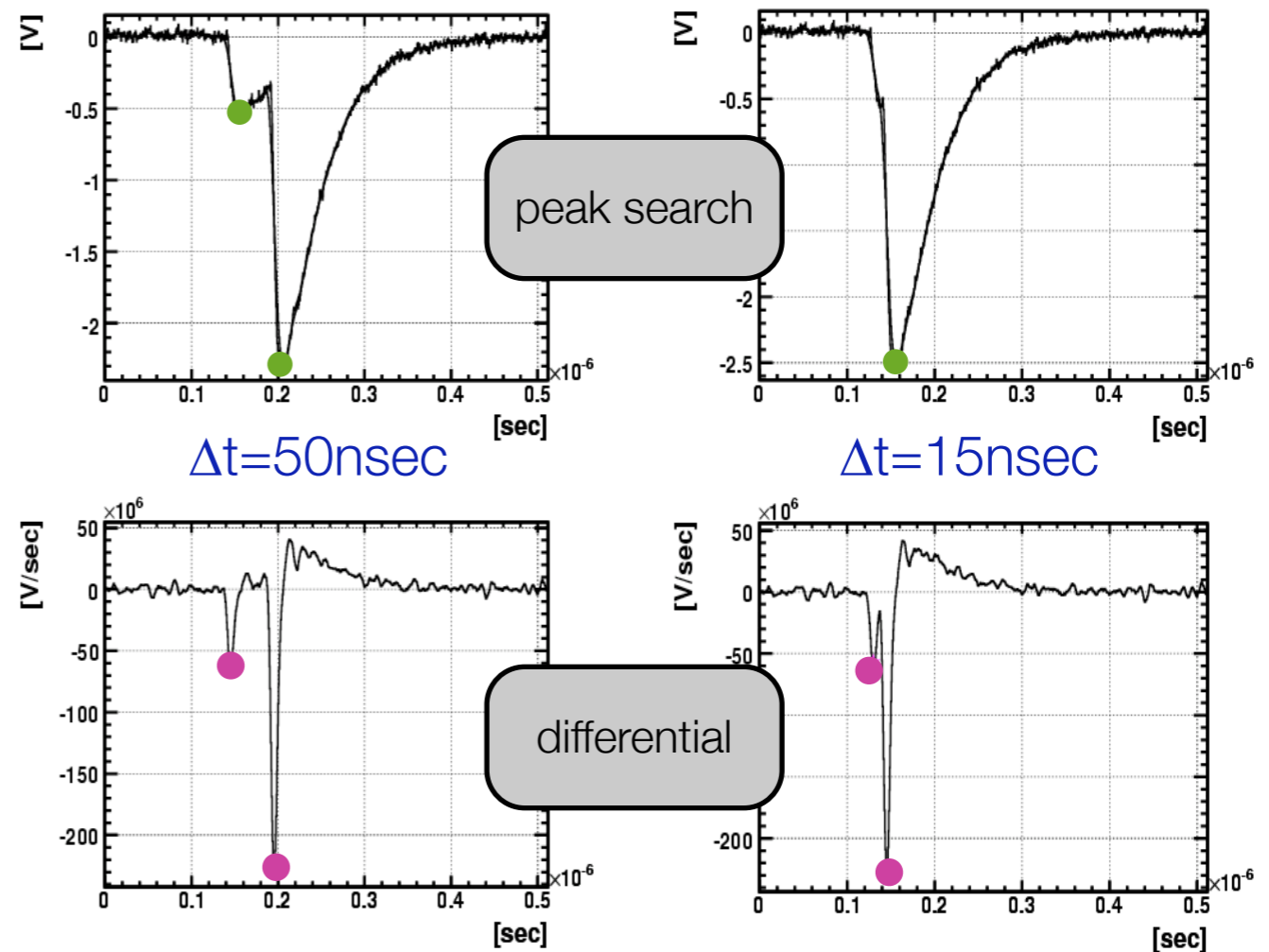
Analysis preparation with MC -cont.

- waveform analysis and pileup rejection study



- *megbartender* (post-processor for MC) generates waveform outputs
- using this tool, waveform analysis is developing

- pileup rejection algorithm is progressing
- use waveform information



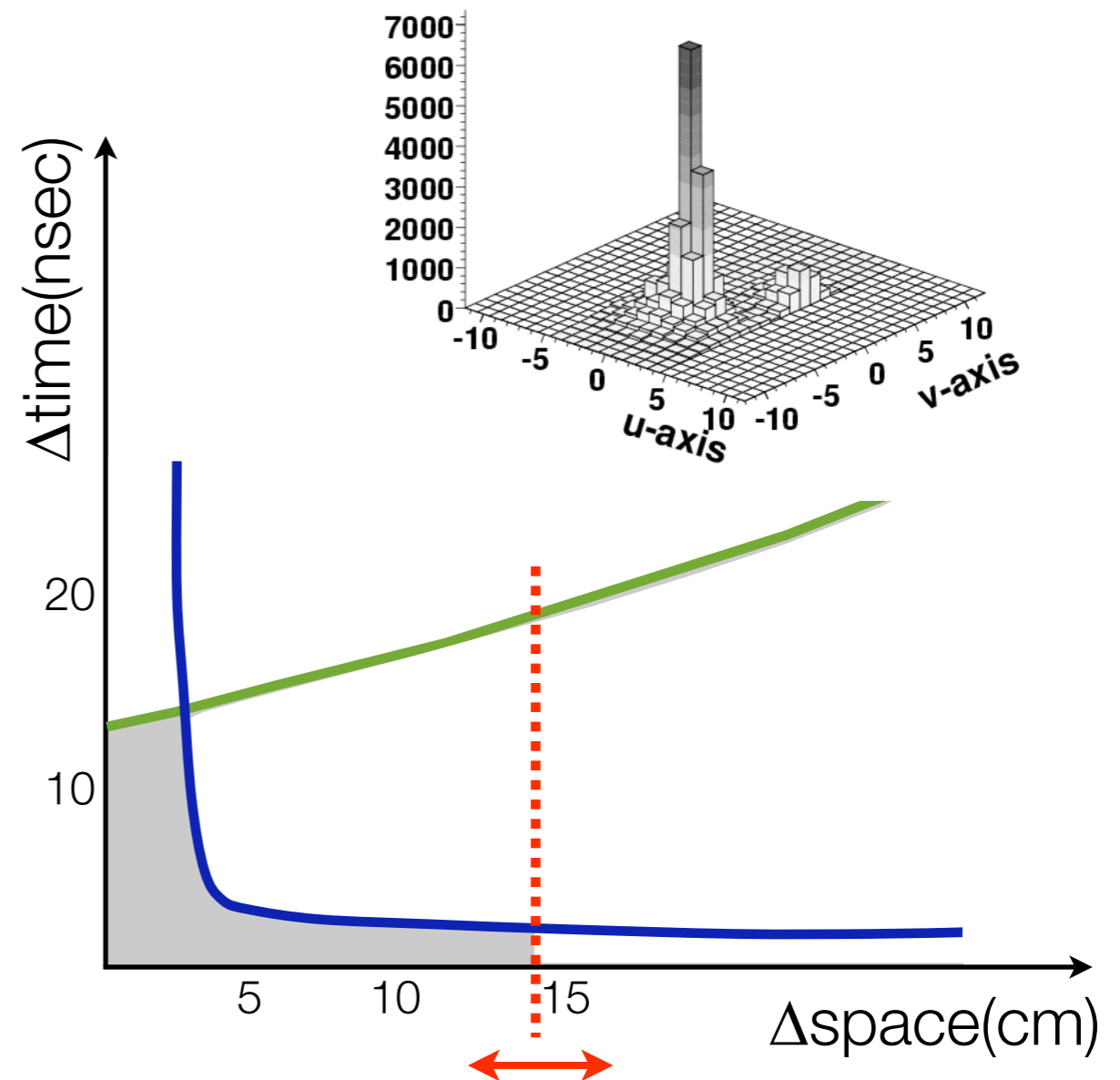
Pileup rejection study -cont.

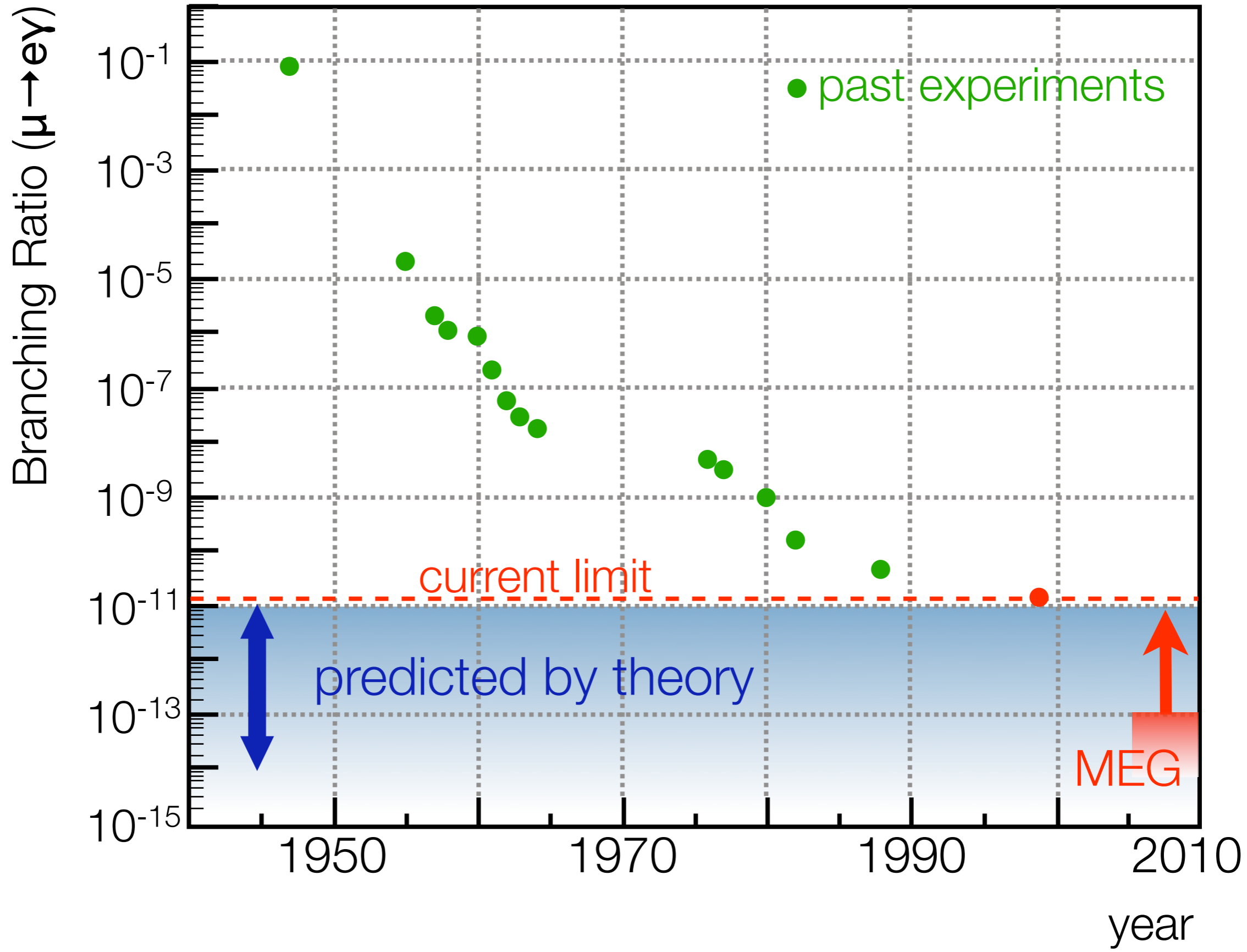
- now, we can reject many of pileups by 3 different way,

using waveform

using timing info

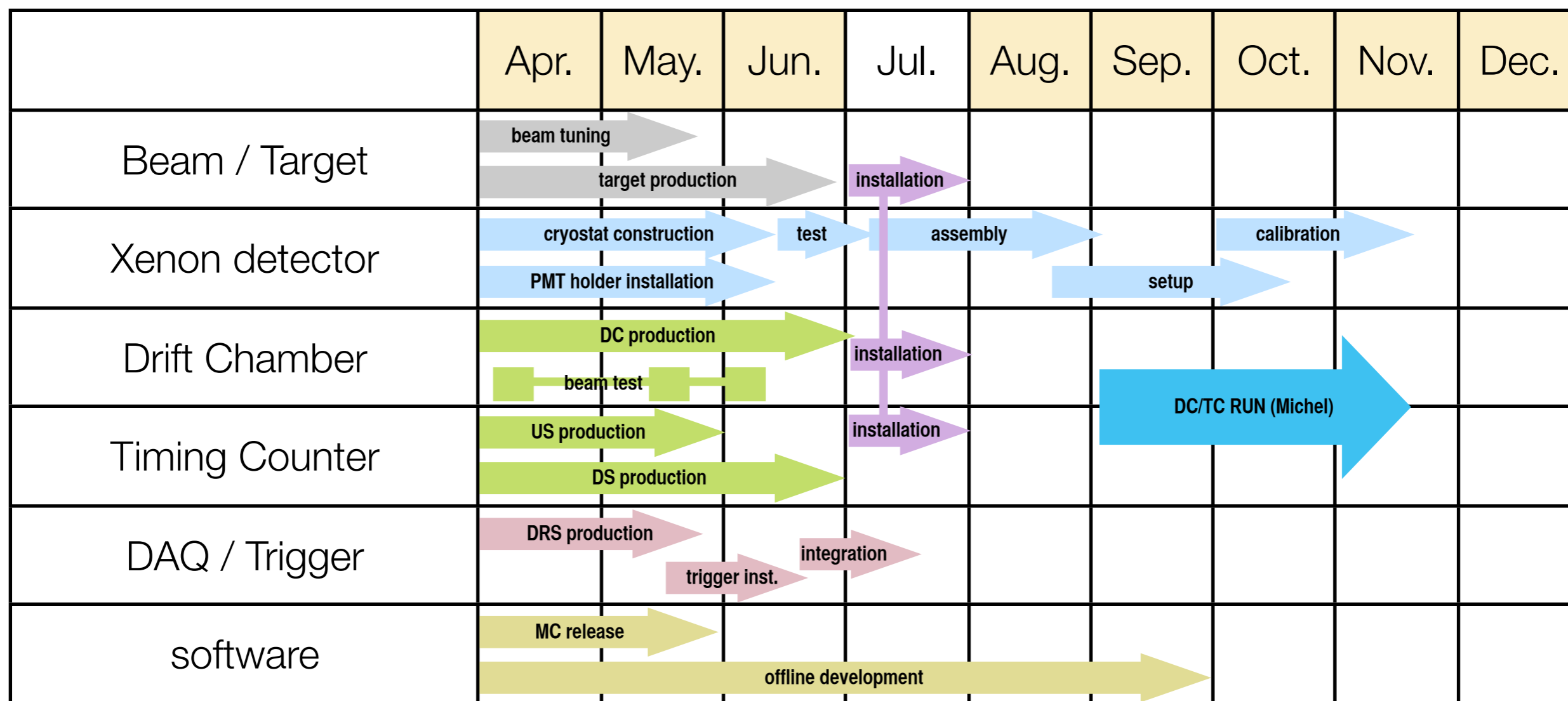
using light dist.





Schedule in 2006

MEG beam time ; April-June, August-December

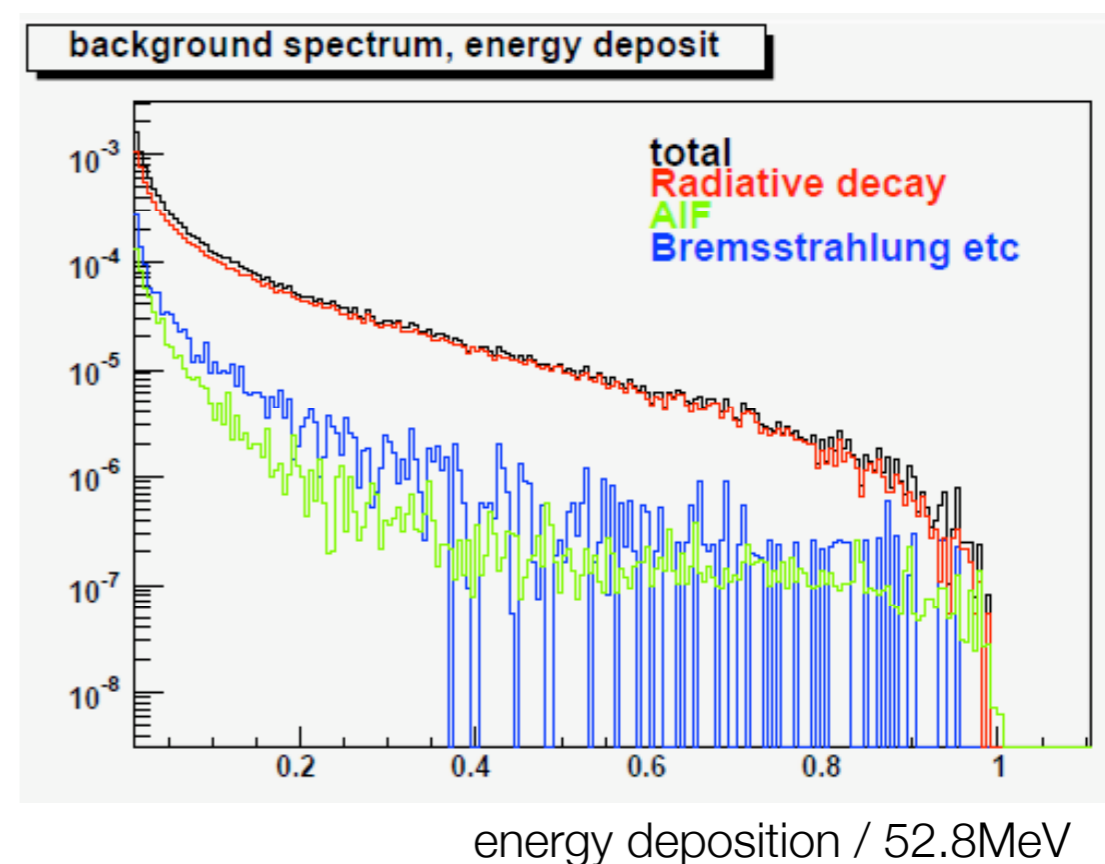


Ready to start MEG commissioning RUN in November



Expected Background and Reachability

- background rate is being estimated by the newest MC data
- BG related part needs careful tuning (ex. radiative decay spectrum, AIF process etc)
- very preliminary sensitivity estimation
 - beginning 1 month
 - $10^7 \mu^+/\text{sec} \rightarrow \text{Br}(90\% \text{CL}) \sim 2 \times 10^{-12}$
 - 2 year RUN
 - $10^7 \mu^+/\text{sec} \rightarrow \text{Br}(90\% \text{CL}) \sim 2.1 \times 10^{-13}$
 - $3 \times 10^7 \mu^+/\text{sec} \rightarrow \text{Br}(90\% \text{CL}) \sim 1.2 \times 10^{-13}$
 - $10^8 \mu^+/\text{sec} \rightarrow \text{Br}(90\% \text{CL}) \sim 1.5 \times 10^{-13} \rightarrow$ this should be improved by our detector and analysis algorithm enhancements.



Conclusion

- MEG is search experiment for $\mu \rightarrow e\gamma$ decay
- Beam line commissioning and photon/positron detectors are getting ready
- Online/Offline softwares are also developing
- MEG will start data taking this year
- According to the newest detector simulation, the sensitivity will reach $\sim 10^{-13}$ by 2 years running (2 order improvement than current limit)
- Even if 1 month running, we will be able to reach $\sim 2 \times 10^{-12}$ (1 order improvement than current limit)