

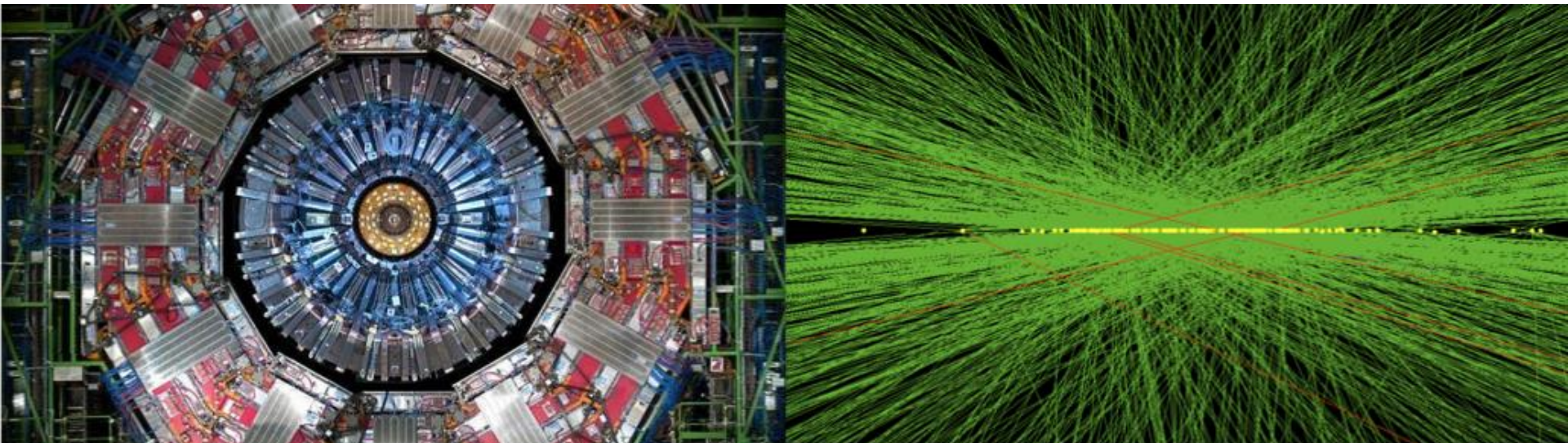


ME0: Design Status, Prototypes, and Schedule

Marcus Hohlmann (FIT)

24th CMS GEM Workshop

Oct 2, 2019



Overview

- Detector design & prototyping
- Electronics prototyping
- Aging tests - status quo and plans
- Milestones & Schedule



Detector

Original Detector Prototyping Plans

- The original plan (4/19) was to produce 10 ME0 modules:
 - 6 modules for integration of a first full ME0 stack at CERN
 - 2 modules for electronics integration testing at FIT
 - 1 module for irradiation test at Louvain (INFN)
 - 1 module for aging test in Korea (using double-segmented Korean foils)
- 5 complete kits to be produced at CERN
- 5 sets of foils from Mecaro with other module parts coming from CERN
- Build long-term aging test setup in Korea to qualify double-sided MECARO foils

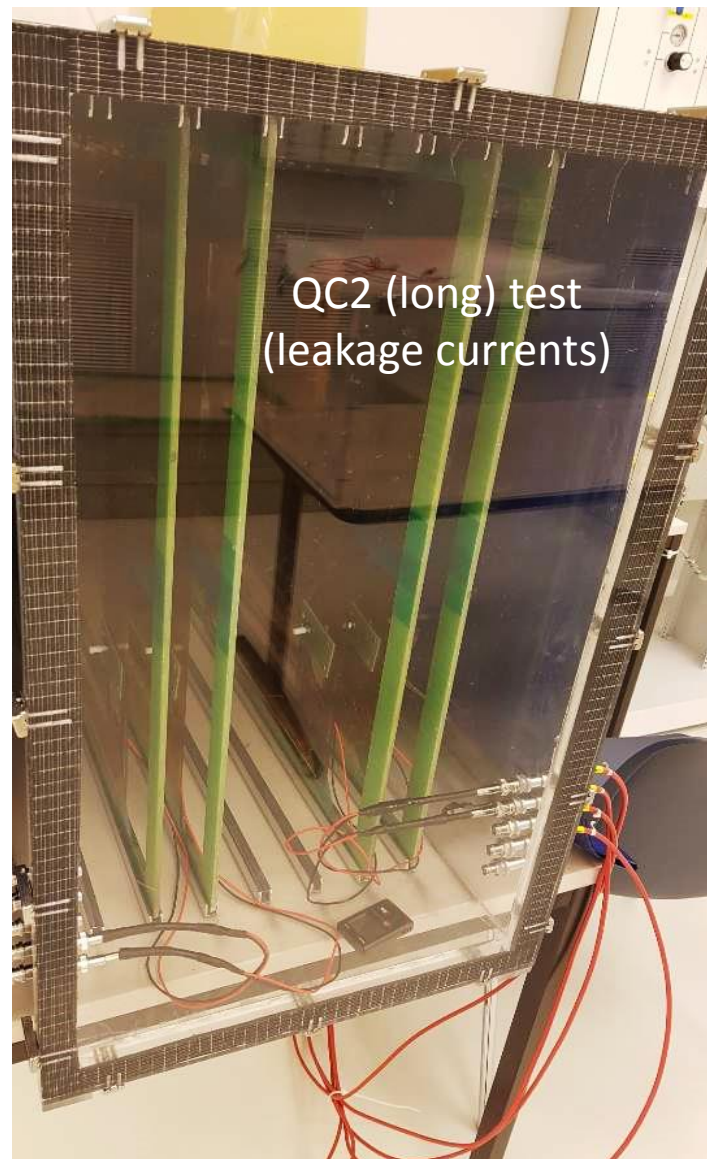
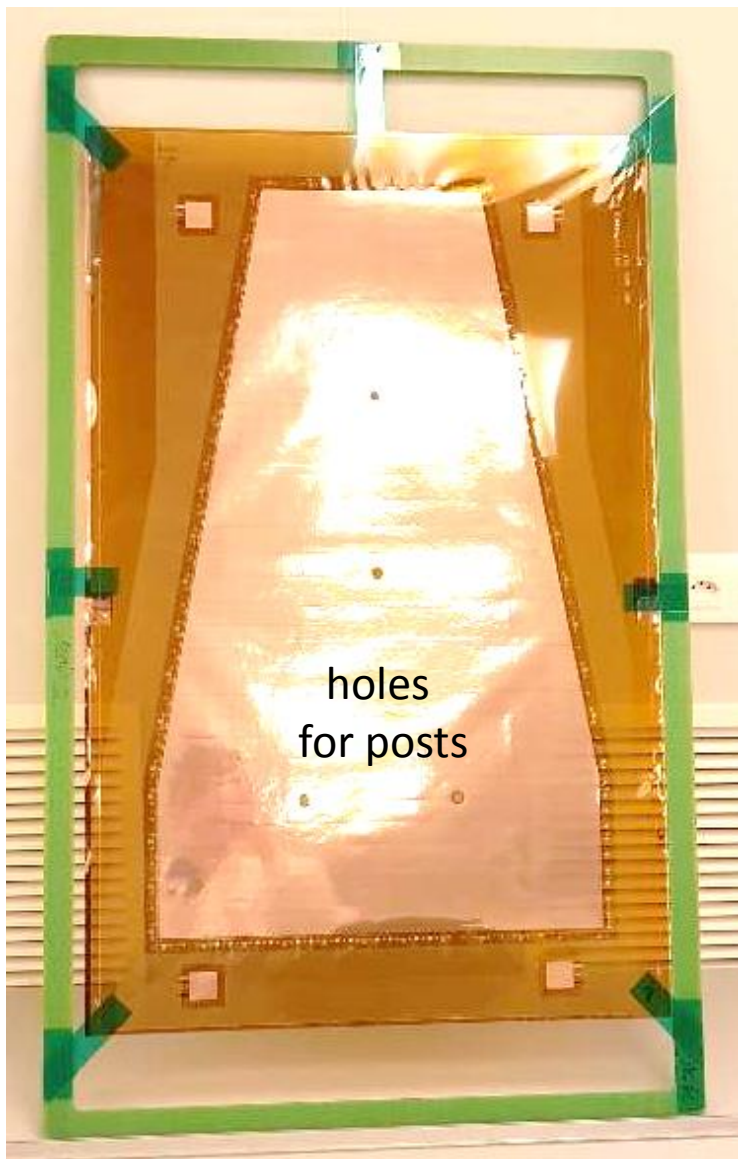
Korean ME0 Foils & Module

- MoU for Korea-CMS Contributions to the Phase-2 GEM Detector Upgrades was signed on April 17, 2019 between CERN and Korean Ministry of Science & Technology
 - 666 ME0 foils (648 + **9 for testing** + 9 spare) for **all 216 ME0** modules and corresponding pair(s) of masks.
 - In principle, can order 9 foils for testing in 3 modules with MoU in place. However, production at MECARO just now coming back online. Also, MECARO priority for 2019 has shifted to foil production for a domestic project.
 - KCMS has funds to procure non-foil materials for one module with Korean foils; module will be assembled in Korea.
- MECARO will not produce ME0 foils until foil design is final
- More details during dedicated session on GEM foils on Friday

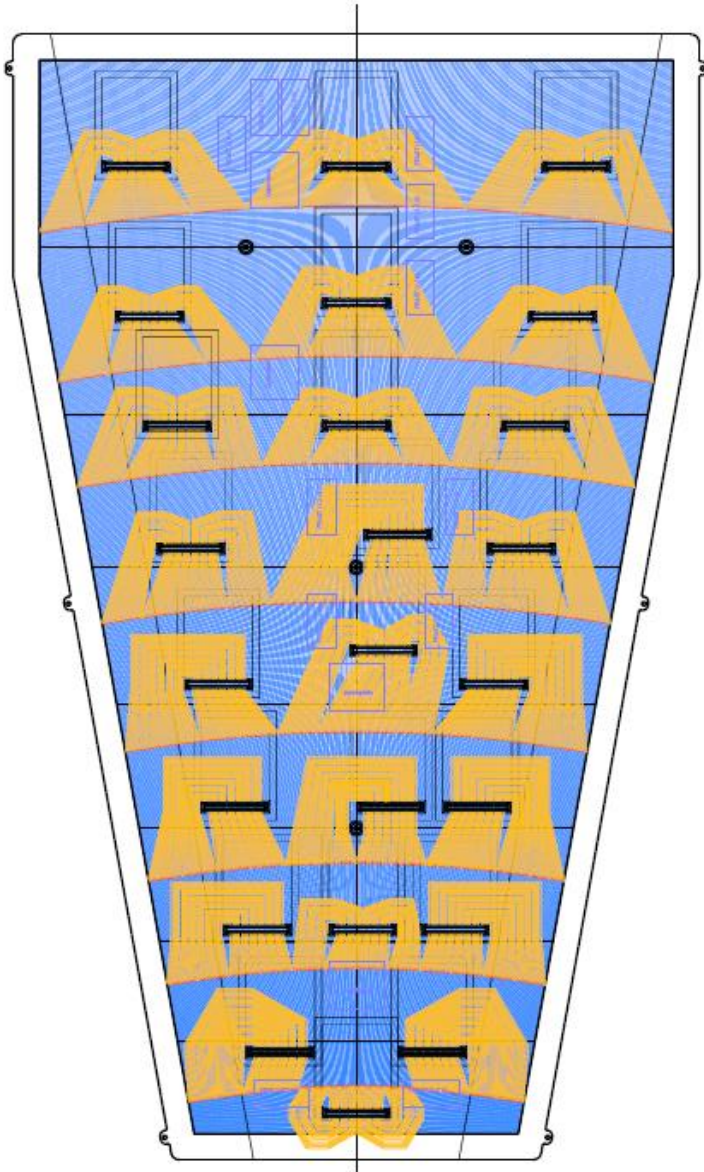
Detector Prototyping Status

- April 2019 - Order for 5 complete ME0 module kits submitted to Rui's workshop (CERN/FIT/INFN)
- June 2019 - 4 additional complete ME0 module kits ordered from Rui's workshop (CERN/INFN) due to delays in Korea
- Currently, kits for 9 modules are in production at CERN:
 - 6 modules for integration of first fully active ME0 stack at CERN
 - 2 modules for electronics integration testing at FIT
 - 1 module for irradiation test at Louvain (INFN)
- Status of kits
 - 27 GEM foils have been produced. Most have completed and passed the QC2-long test (leakage current measurement)
 - Components for 5 kits ready (except ROB PCB; see below)
 - Foils & components for next 4 kits expected to be ready in two weeks
 - Module assembly: 5 at CERN, 2 in Bari, 2 at FIT

ME0 GEM foils under test at CERN



ME0 Readout Board Status



- Design complete
 - 24 VFATS accommodated
 - Signal trace routing pretty tight
 - First prototypes in production
 - 3 mm thickness requirement on PCB (vs. 3.2 mm for GE1/1) (to make ME0 fit into allocated space) has delayed procurement of base material
 - First round of production failed during plating stage at outside company
 - New batch submitted
- => Delivery delayed from Sep 10 to Oct 10, 2019



Aging Tests

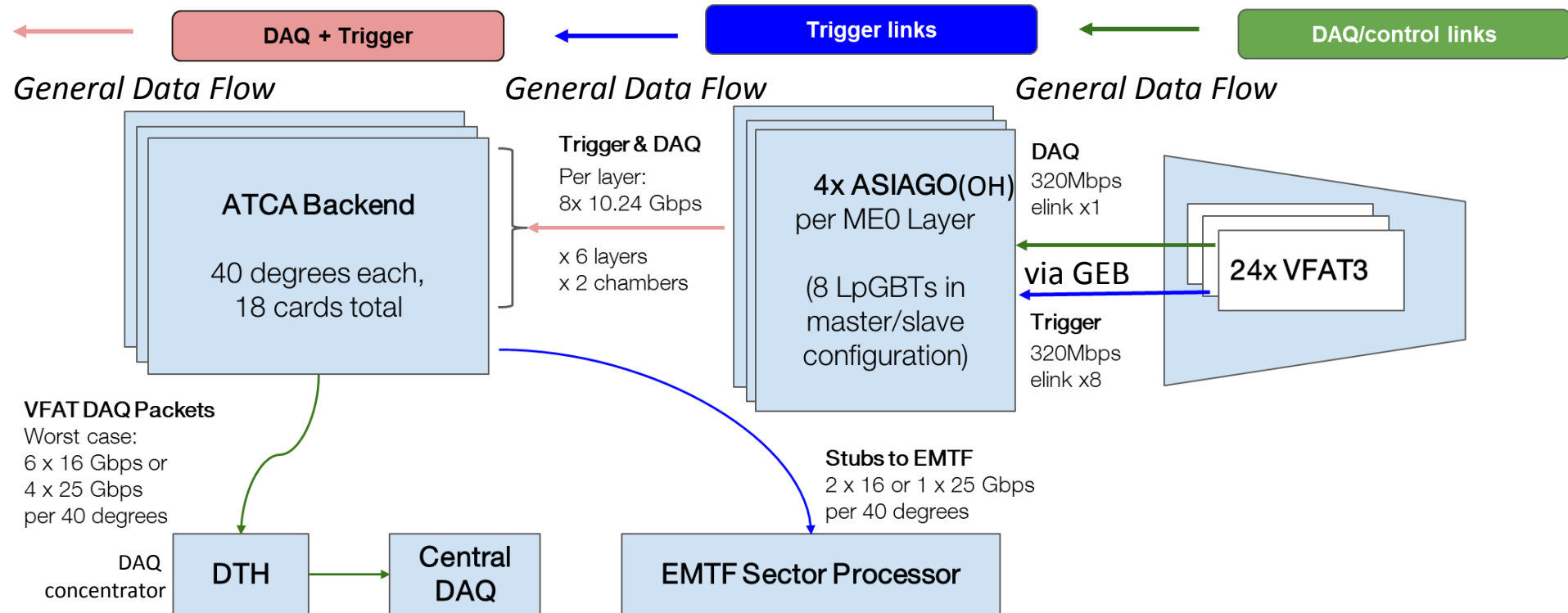
ME0 – Aging Tests

- Current final results from GEM aging tests (all tests stopped right now)
 - GIF⁺⁺
 - Chamber with CERN foils: 197 mC/cm² (SF 0.7) accumulated
 - Chamber with Korean foils: 66 mC/cm² (SF 0.2) accumulated
 - X-rays in Bldg.. 904
 - Chamber with CERN foils: 1560 mC/cm² (SF 5.5) accumulated
 - No aging observed anywhere
- Korean foils still to be validated up to at least SF 3.0 (850 mC/cm²)
- Until the design of double-segmented ME0 foils is finalized and validated with CERN modules, MECARO will not produce ME0 masks
- Will likely delay start of Korean aging tests until 2020
- Consequently, aging test of Korean foils will be performed with a GE2/1 M7 module with double-segmented foils in Korea using an Amptek X-ray source with twice the standard flux rate
- Aging test expected to last ~1.5 years if running continuously. If start is in early 2020, that will be just in time for ME0 foil PRR (June 2021)
- Procurements and safety review currently ongoing in Korea



Electronics

ME0 DAQ System Overview

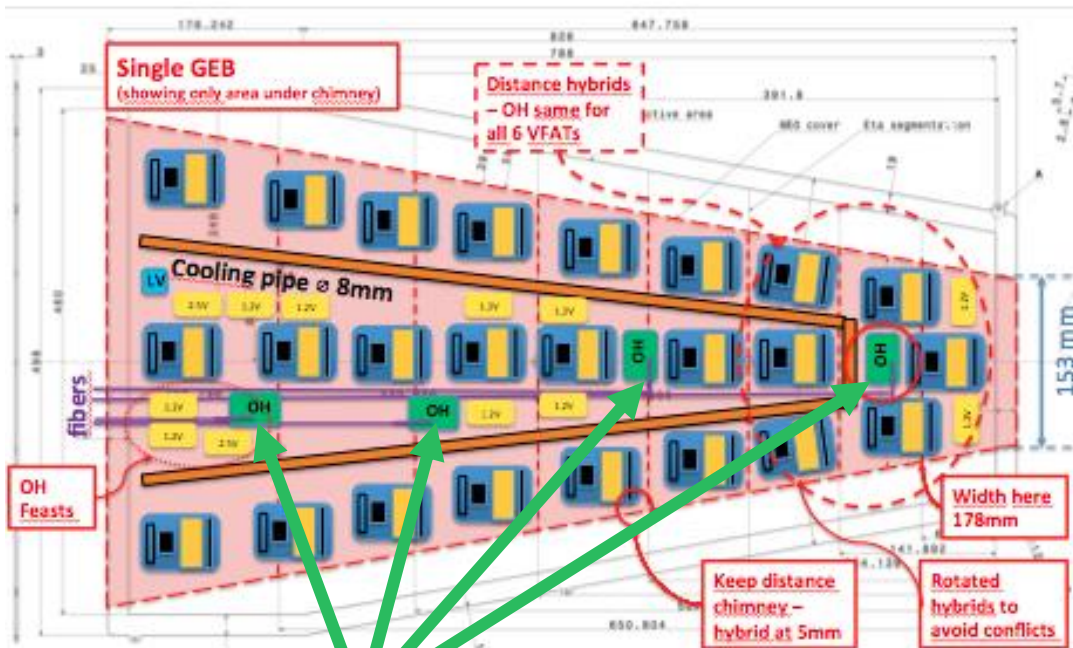


- Each ATCA card handles 2 ME0 stacks (40 degrees in φ)
- ▶ Each stack is composed of 6 layers of GEM chambers
- Front-end links (per ATCA card)
 - ▶ **96 10.24 Gbps LpGBTs** for Trigger, DAQ, and Control
- Back-end links (per ATCA card)
 - ▶ 1 x 25 Gbps or 2 x 16 Gbps to EMTF
 - ▶ 4 x 25 Gbps or 6 x 16 Gbps link to DTH (DAQ concentrator analogous to AMC13)

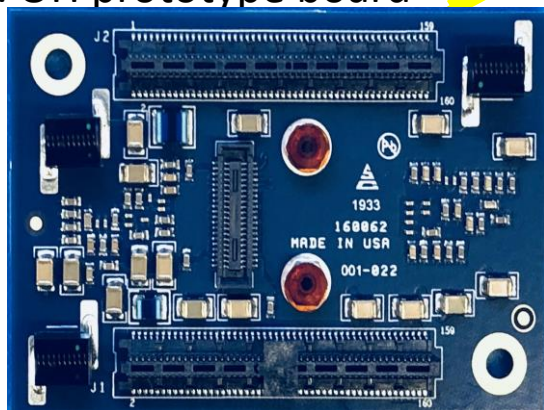
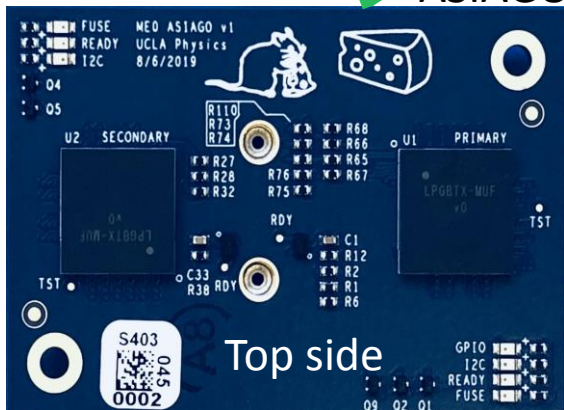
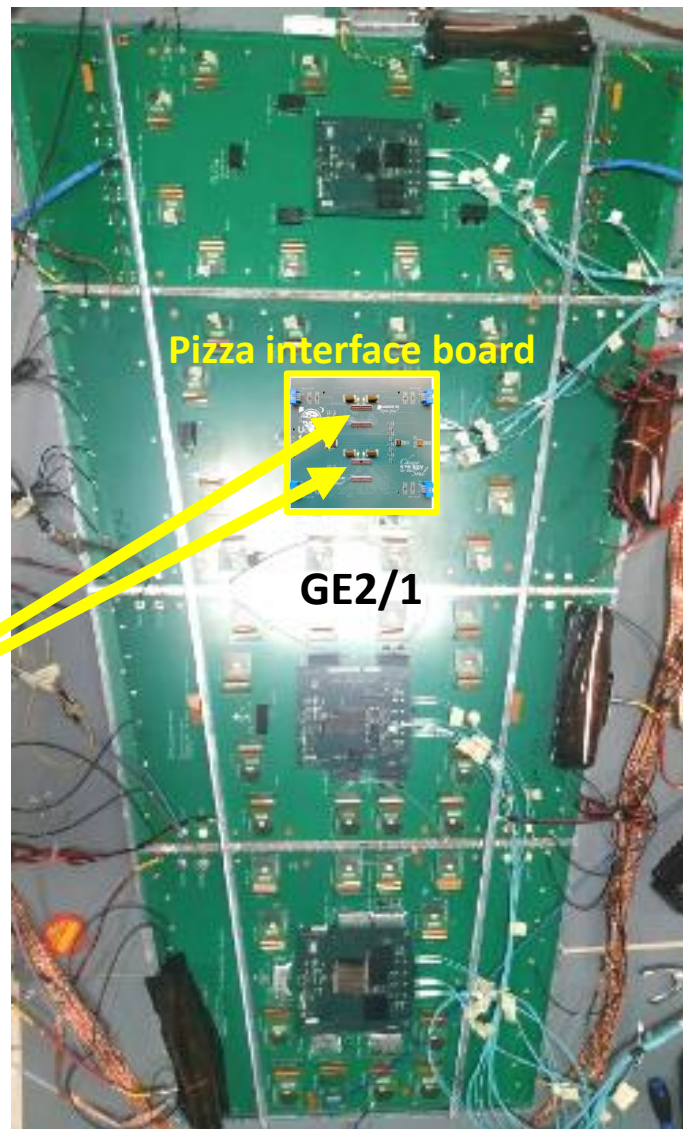
ME0 Electronics – On Chamber

ME0 Electronics Design:

In the interim, use GE2/1 until we have an ME0 GEB:



ASIAGO: OH prototype board



ME0 Electronics - Status

■ All ME0 prototype electronics in hand at UCLA (received 08/29/2019)

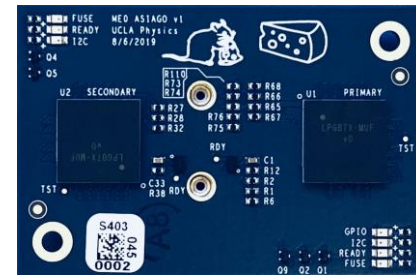
- ASIAGO -- ME0-like LpGBT prototype without FPGA
- CACIO -- Adapter to use Samtec Firefly in place of VL+
- PIZZA -- Adapter to connect ASIAGO to a GE2/1 GEB

■ Testing and development progress: [Evaldas + Andrew]

- Wrote software for I2C control of LpGBT
- Wrote LpGBT-based GE2/1 firmware around the ASIAGO + PIZZA
- Wrote scripts for i2c configuration of master + slave LpGBT
- Tested optical links: Ok
- Communications established with VFAT3 (M+S)
- Internal control (IC) path established and working
- Control of GPIO (reset pins) working

■ All the details in Andrew's talk!

■ ME0 GEB to be tackled next by designers (once all GE2/1 GEBs are in production)

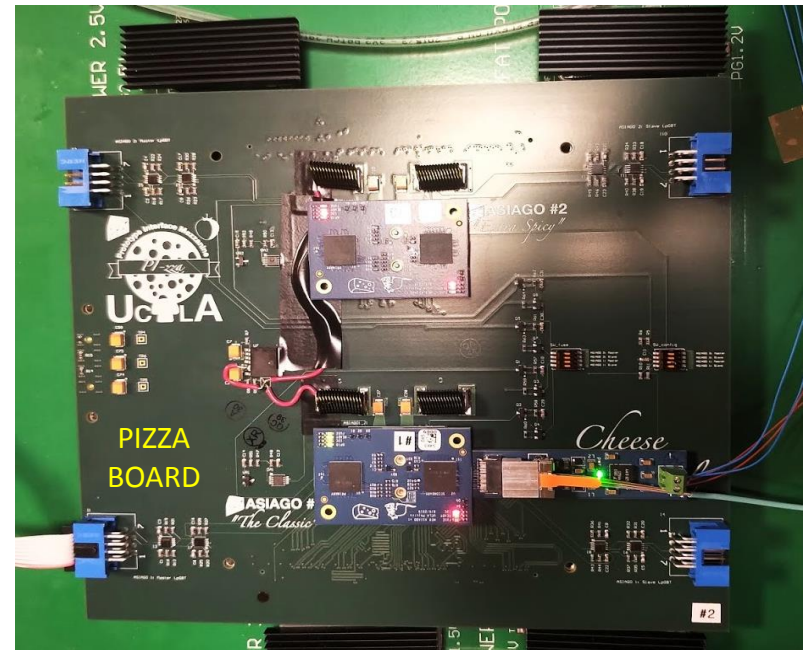


ASIAGO



CACIO

PIZZA & ASIAGO & CACIO on GE2/1 GEB



Milestones



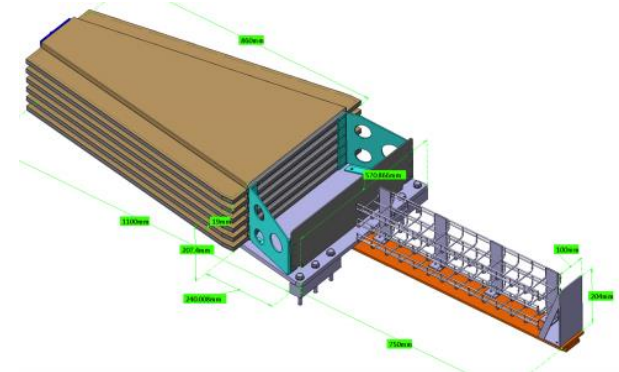
ME0 – (Upcoming) Milestones

ME0.RD.DET.1	done	21.03.2017	21.03.2017		ME0 R&D: Key detector system design parameters are defined based on performance requirements
ME0.RD.FE.1	done	21.03.2017	03.02.2017		ME0 R&D: On-Chamber Electronics Preliminary Principal Design Complete and Specs Defined
ME0.RD.BE.1	done	21.03.2017	26.05.2017		ME0 R&D: Off-Chamber Electronics Preliminary Principal Design Complete and Specs Defined
ME0.RD.DET.2	done	11.07.2017	11.07.2017		ME0 R&D: Irradiation studies and assessment of performance and longevity with small prototypes
ME0.RD.FE.2 ME0.RD.BE.2	done	25.07.2017	25.07.2017		ME0 R&D: On-chamber & off-chamber electronics preliminary principal design complete and i
ME0.RD.DET.3	done	18.12.2018	18.12.2018		ME0 R&D: Chamber (stack) prototype mechanical design completed
ME0.RD.FE.3	delayed	23.08.2019	14.01.2020	8 mos.	ME0 R&D: On-chamber electronics engineering design completed and validated (DELAY: 8 mos.)
ME0.RD.DET.4	on time?	24.12.2019	24.12.2019	6 mos.	R&D: Chamber (stack) prototype mechanical prototype testing and validation complete
ME0.RD.FE.4	delayed	21.08.2020	12.01.2021	8 mos.	R&D: On-chamber electronics prototype electronics manufacturing and testing complete
ME0.RD.BE.3		08.01.2021	08.01.2021		R&D: Integration of the on-chamber and off-chamber electronics and performance assessment
ME0.RD.DET.5 ME0.RD.FE.5		30.03.2021	30.03.2021		R&D: Assessment of the electronics performance and integration with the CMSnstrator chamber
ME0.RD.DET.6		31.08.2021	31.08.2021		R&D: Beams and Cosmics testing of the demonstrator chamber and performance qualification
ME0.PRR.1		14.06.2021	14.06.2021		ME0 PRR for the Foil Production
ME0.ESR.1		27.04.2021	27.04.2021		ME0 ESR
ME0.EDR.1		28.10.2021	28.10.2021		ME0 Detector EDR
ME0.PR.FE.1		29.03.2022	29.03.2022		ME0 On-Chamber Electronics Manufacturing and Testing complete, ready for chamber (stack)
ME0.PR.DET.1		04.05.2023	04.05.2023		ME0 Chambers for Disk-1 are assembled, tested, and ready for installation
ME0.PR.BE.1		08.06.2023	08.06.2023		ME0 Off-Chamber Electronics Manufacturing & Testing complete
ME0.PR.DET.2		07.03.2024	07.03.2024		ME0 Chambers for Disk-2 are assembled, tested, and ready for installation
ME0.PR.DET.3		23.05.2024	23.05.2024		All ME0 Stacks Installed in the New Nose. Detector is ready for installation as part of the end
ME0.PR.DET.4 ME0.PR.FE.2 ME0.PF.1		12.09.2025	12.09.2025		Construction Project Complete. Ready for Global System Commissioning

- ME0.RD.FE3 on critical path (GEB design still to be done)
- ME0.RD.DET.4 moving closer to the critical path
- ME0.RD.FE4 should be still on track
- ME0.RD.BE3 should be still on track

ME0 – Desired Near-term Schedule

- Oct 2019
 - Delivery of components for 9 modules to CERN
 - Shipment of components to Bari, FIT
- Oct – Dec 2019
 - Assembly & testing of modules (CERN, Bari, FIT)
 - Design of ME0 GEB (PKU)
- Jan – Feb 2020
 - Construction & testing of first full ME0 stack at CERN (1 month delay of ME0. RD.DET.4) milestone
 - Production of ME0 GEBs
- Remainder of 2020
 - Electronics and Integration tests





The End