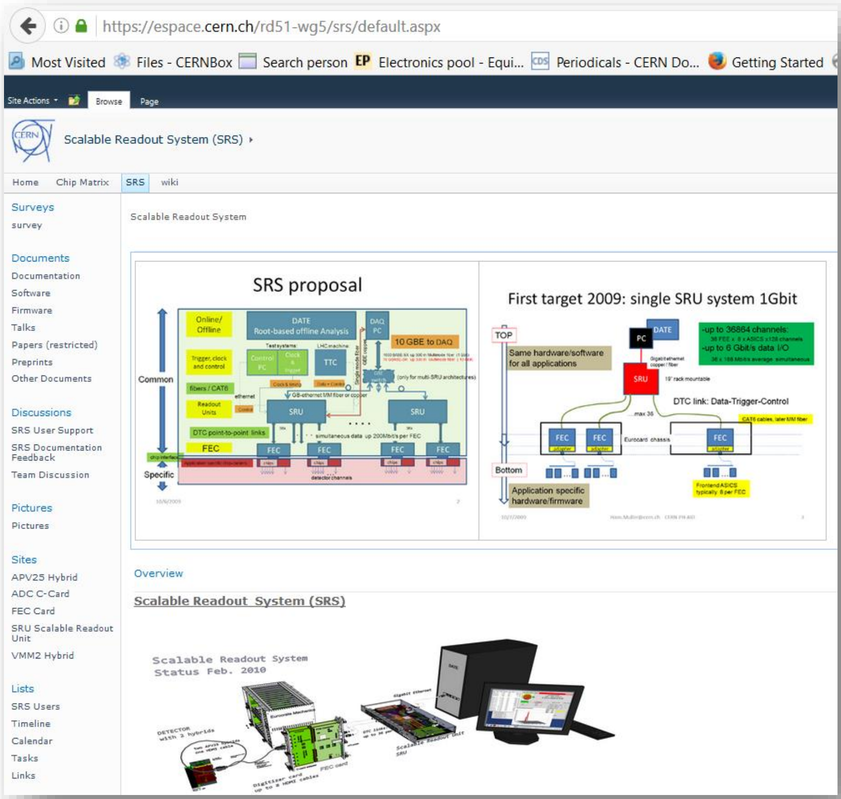
WP13
Innovative gas detectors

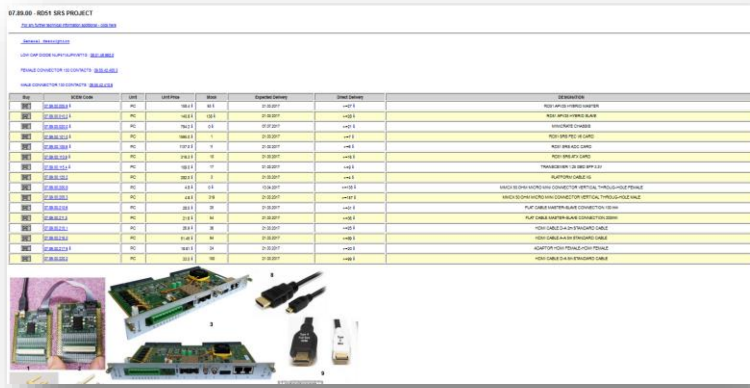
WP13 Task 13.3.1 and 13.3.2

"Tools to facilitate detector development"

WP13 Task 13.3.1:

Interfacing FE-chips specific to gas detectors to the Scalable Read-out System (SRS)





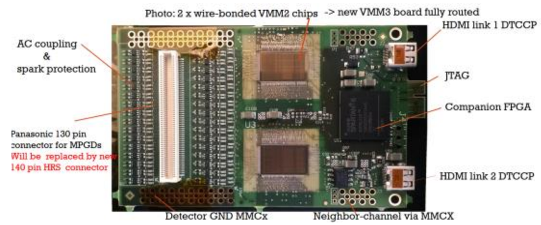
Task 13.3.1	AIDA 2020 Key/Partner Institutes
VMM (ATLAS NSW, ESS, RD51)	CERN
GEMROC	AGH Krakow/CERN
Timepix3 (LC-TPC)	University of Bonn

AIDA2020 in the VMM&SRS integration.

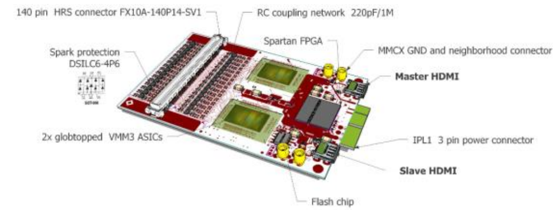
https://indico.cern.ch/event/588409/contributions/2402680/attachments/1386875/2110888/SRS_status_in_December_2016.pdf

Support for the RD51 hybrid (wire bonded) VMM

VMM2 done
VMM3 ongoing



RD51 VMM2 Hybrid done (@CERN) and tested



RD51 VMM3 Hybrid at the bonding lab (@CERN) - 20th March 2017

Support for the interface digital card (CARD)

New Design finalized (powering schema driven) Few test needed before going to production

Support for the development of a new powering and connectivity schema

<u>New Development</u>
Prototype tested
PCB design started

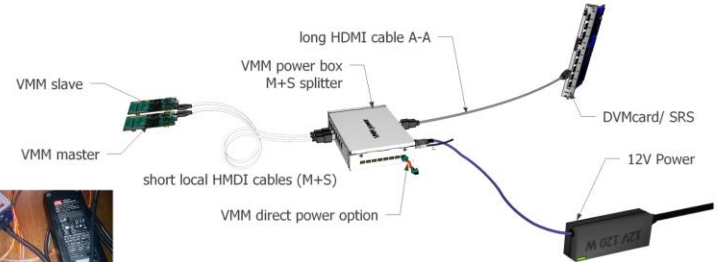


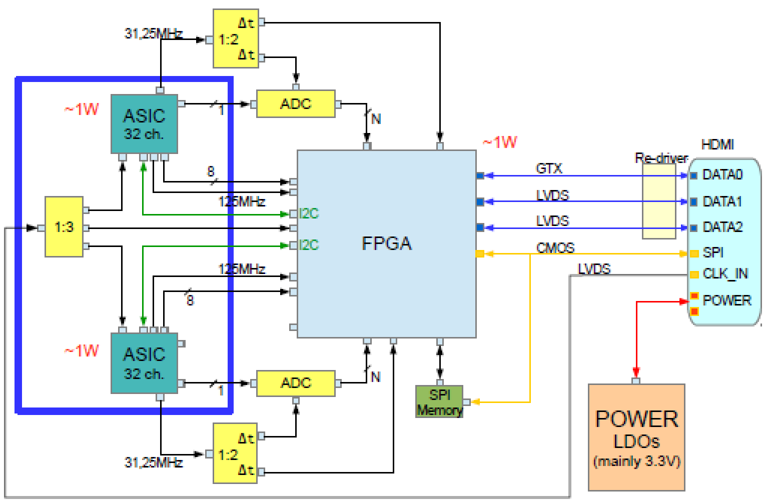
photo prototype power box

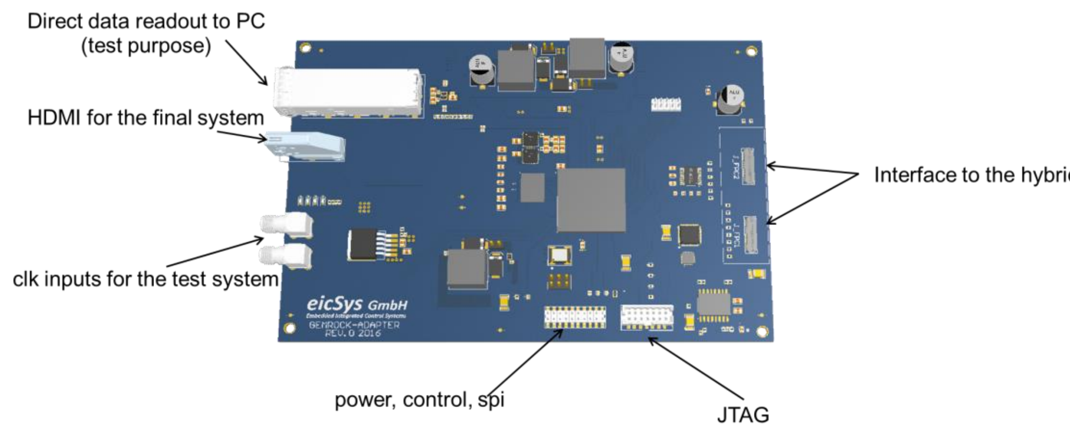
Support for the commercialization process in view of future production processes (Bonding outside CERN and parts procurements for users)

Starting the process...

GEMROC and ATCA SRS

https://indico.cern.ch/event/496113/session/2/contribution/11/attachments/1241018/1824951/ATCA-SRS-GEMROC.pdf





Initial Plan: development of a new hybrid to host the GEMROC interface with SRS ATCA.

Current Plan: use the developed adapter to complete (firmware/software) an SRS-ATCA readout system of GEMROC (and leave the design of a new hybrids eventually for the new GEMROC chips).

- GEMROC AGH hybrids @ eicSys
- Adapter for AGH hybrid manufactured and assembled
- 1st firmware version ready
- Testing expected in Spring 2017

eicSys GmbH

AGH

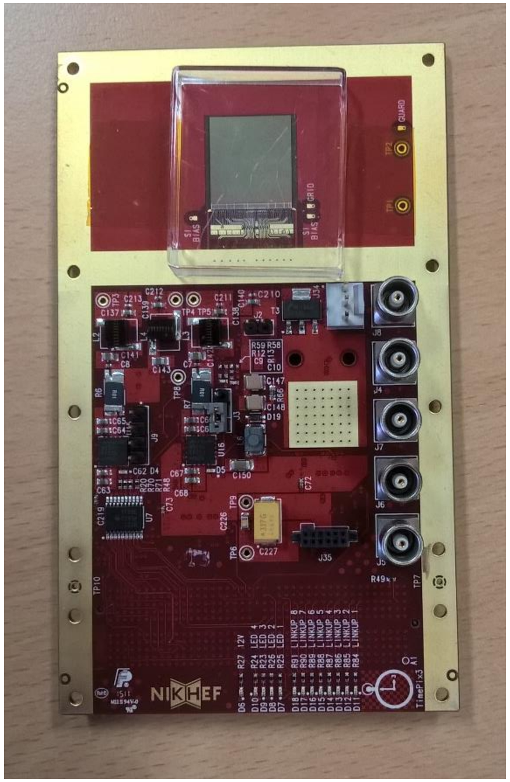
Timepix3 Readout for SRS

Status:

- Man power has been identified
- Planning for readout has started
- First Timepix3 ASIC has been bonded on chip carrier provided by Nikhef.
- SPIDR readout for cross checks is available.

Current plan (might change!):

- Implement communication with ASIC
- Implement ASIC control
- Implement reduced set functionality for readout mode (e.g. only frame based readout)
- No high rate readout is envisioned for now.
- Expand system to a large number of ASICs.



First Timepix3 bonded in Bonn

SRS/FE ASICs Summary

VMM

- RD51 wire bonded hybrid (VMM2 done/tested, VMM3 ongoing – probably done at the day of the meeting).
- Digital Interface Card DCARD (new design done and ready for production).
- Alternative powering/connectivity schema.
- Industrialization/Commercialization process.

GEMROC

- AGH Hybrid in eicSys.
- Adapater card finalized, ready for production, test planned for spring 2017.
- Adapter considered as final final solution for the ACTA-SRS/GEMROC readout

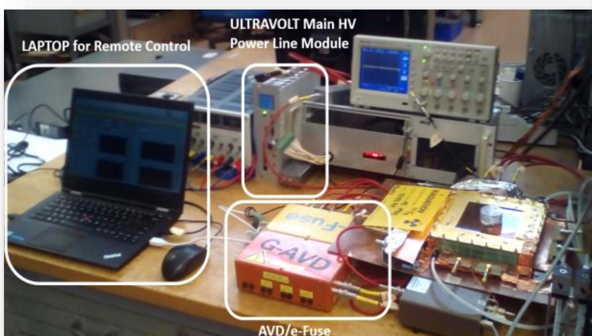
Timepix3

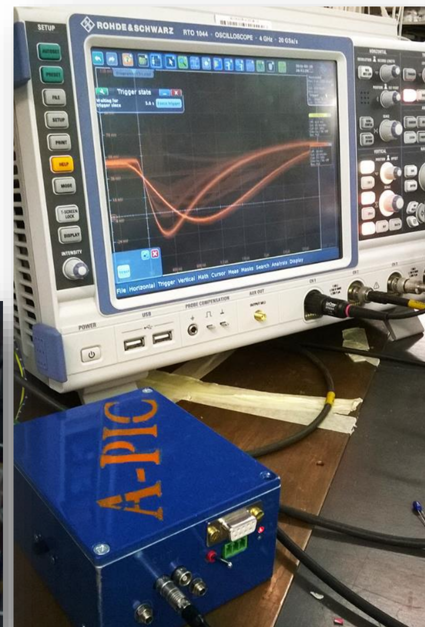
- Timepix3 bonded in BONN
- SPIDR readout ready for cross check studies
- SRS Integration (frame-based) to cope with large number of hybrids (high rate readout not envisioned)

WP13 Task 13.3.2:

Development of cheap, standard MPGD dedicated laboratory instruments

Task 13.3.2	Ref. Institute/Person
High Voltage Power Supply for MPGD	CERN
Signal Processing	CERN
(Floating) Pico ammeter	CERN
Win_CC integrated Monitoring Unit	NTUA





High Voltage for MPGDs: AIDA2020 Deliverable [M24]

***Compact MPGD HV power supply**: The desktop AVD is a remotely controllable, compact HV power supply for the operation of MPGD based detectors with up to nine user-defined fields. Specially designed for the operation of gaseous detectors, this supply includes active field stabilizers to compensate for dynamic loads and circuitry to protect from short circuits and sparking. The embedded control and monitoring system supervises all parameters and, associated with online Labview software, records and displays trending data of all HV channels. The front panel controls, combined with a status display, allow for local operation. The NIM-AVD unit will be fully contained within a dual-sized NIM module and, via a power adapter, it can be operated as desktop MPGD supply without NIM crate.*

AIDA 2020

Grant Agreement No: 654168

AIDA-2020

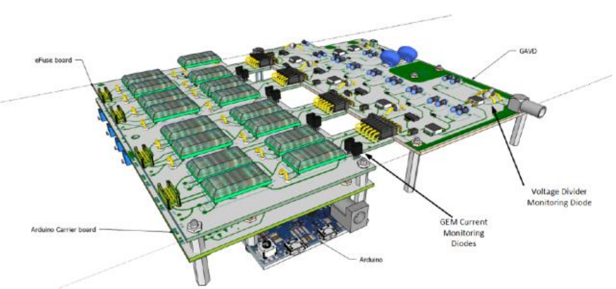
Advanced European Infrastructures for Detectors at Accelerators

Horizon 2020 Research Infrastructures project AIDA-2020

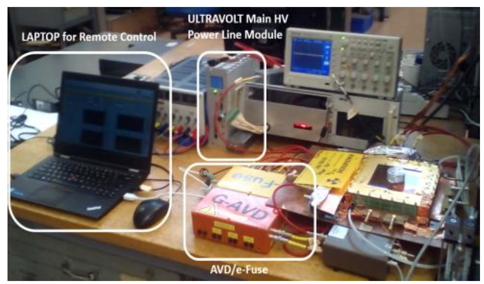
DELIVERABLE REPORT

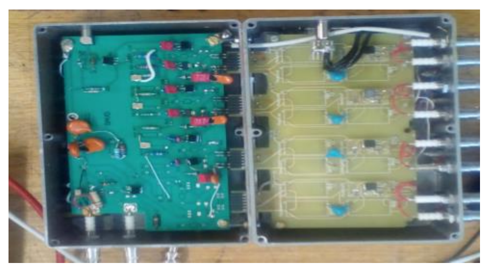
MINIATURISED HV POWER SUPPLY

MILESTONE: D13.6

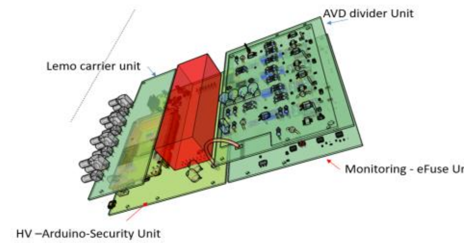


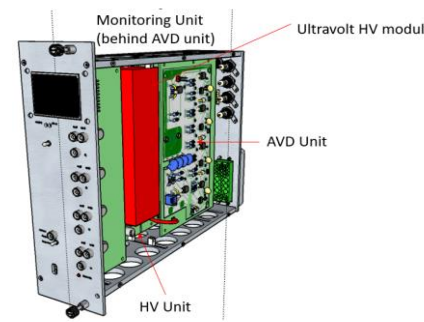
From Active Voltage Divider design..





.. To demonstrator..





.. In view of indust./commerc. version

Muller, H: https://indico.cern.ch/event/525268/contributions/2296989/attachments/1335971/2009486/AVD_NIM_for_Aveiro_2016.pdf

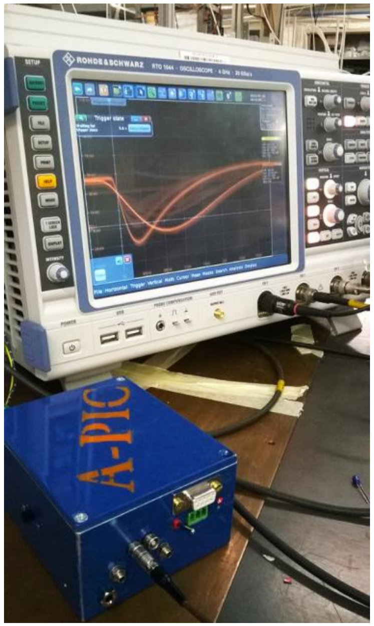
Dimitris, K. V.: https://cds.cern.ch/record/2047018/files/GEM%20voltage%20supply%20and%20real-time%20monitoring%20V.%20Karaventzas.pdf

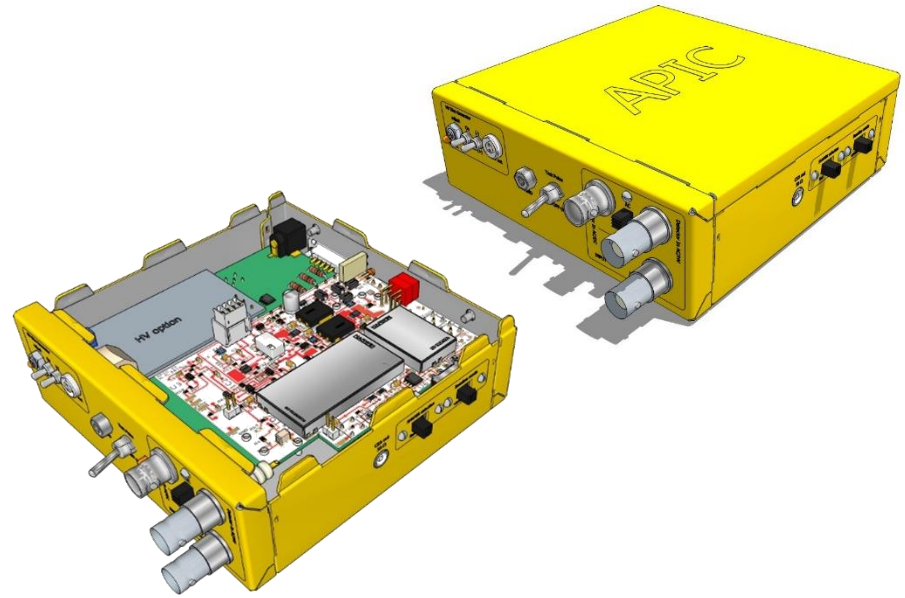
Ginting, M. F. : https://cds.cern.ch/record/2205761/files/Program-Controlled%20HV%20Module%20in%20AVD%20for%20MPGD.pdf

Ginting, M. F. :https://indico.cern.ch/event/525268/contributions/2296989/attachments/1335979/2009499/High_Voltage_Module_in_AVD.pdf

A-PIC.. CSA & shaper & ….

Prototyping completed (all components commercially available – nothing custom), Ready for industrialization/commercialization





- 50 OHM outputs: Preamplifier and 2 x Shaper (+)/(-)
- Spark protection: 0-failure since > 1 year in experiments
- Preamplifier gain 2mV/fC
- AC Input coupling from HV planes (SHV) or DC from strips/pads (BNC)
- SHV input for detector Bias Voltage (RF filter included)
- Gain trimmer 1-1000 (max +/-1.5V)
- Baseline selection fixed (0V) or tunable +/- 1.5V
- Input rates up 4 MHz rates with 20 ns shaper
- MPGD version: shaper 20ns/400 ns
- MPPC version: shaper 4000/8000ns

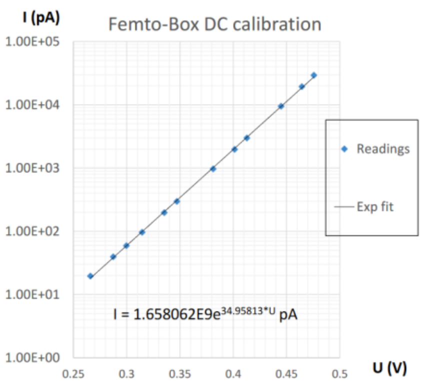
- Test pulse 5ns rise time (switch permanent/off/ single)
- Battery autonomy 24h, charger cables from NIM or Solar panel
- Battery-low blinking LED
- commercial APICs: NIM trigger (CSA), Bias 25-70V for MPPC

FemtoBox (femto ammeter) – Calibration Stability, Real-time and floating operation

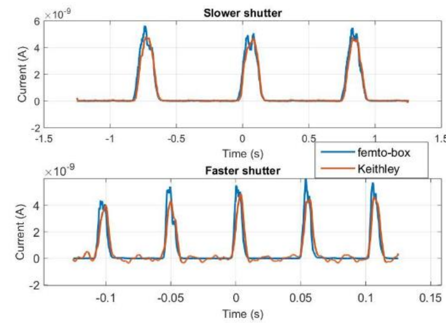
Still Prototyping phase – no AIDA resources used until now

Calibration and stability

- Optimization of the readout schema for fast response and double polarity readout done
- Real-time measurement @ GND
  Real-time measurement floating

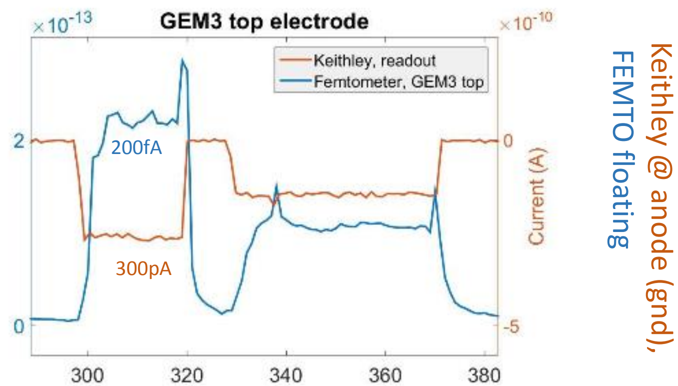


Real Time Anode Current readout with shuttered source



Floating Operation,

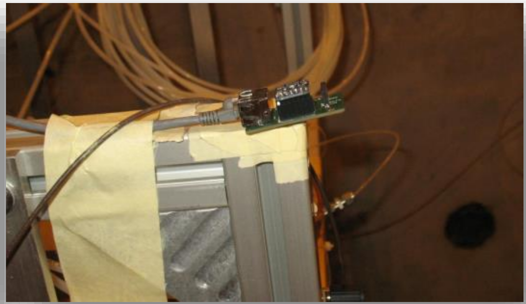
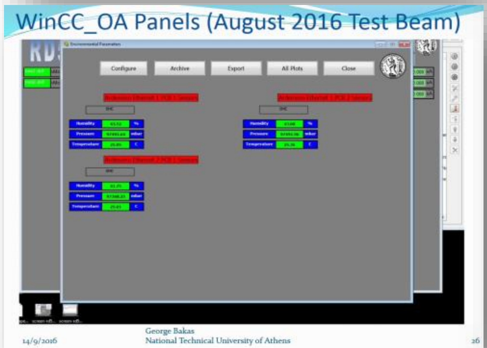
preliminary tests: Electrons and ions (floating readout) currents on top/bottom GEM3 electrodes (shuttered source)

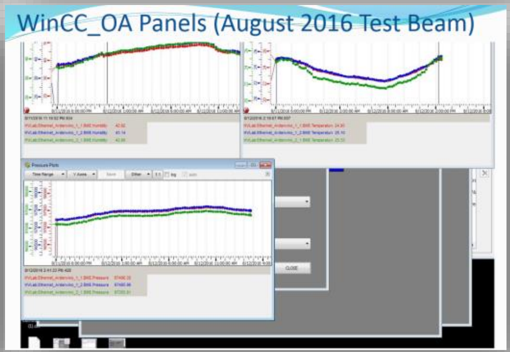


Studies performed within a 2016 CERN Summer Student Project

More details on: L. Kähkönen https://indico.cern.ch/event/525268/contributions/2296990/attachments/1335996/2009717/Femto-box_presentation3.pdf

Microcontroller based monitoring System integrated in WIN_CC OA



- *Implementation of additional and delocalized sensors done*
- *Control and monitoring Interface* ***implemented in Win_CC*** *DCS*
- *Operation in RD51 test beam in the Slow Control DCS framework*

Next: Raspberry Pi based version

More details on: G.Bakas https://indico.cern.ch/event/525268/contributions/2297858/attachments/1336293/2010154/presentation_port1.pdf

Instrumentation Summary…

Active Voltage Divider (High Voltage for multi electrodes MPGDs)

- Active Voltage Divider and e-fuse protection prototype ***done***
- High voltage main power module ***implemented***
- Control/Monitoring Software ***available***

- *NIM type version as a next step for the final version*

Charge sensitive preamplifier & Shaper (APIC)

- Finalized and ready for commercialization

- Femtobox
  - New studies performed (new circuit implemented, calibration, real-time measurements and floating operation) – Still R&D Phase

- PVSS/Win_CC integrated monitoring unit
  - Arduino Version operative
  - New Rasberri Pi Version in the plans

About 7.5k spent

Tools for MPGD developments

Control of foil/micromesh mechanical tensioning by optical techniques

WP 13

Task Coordinator L. Benussi

WP13
From AIDA2020 proposal

- *Control of foil/micromesh mechanical tensioning by optical techniques*
  - engineering an optical system for quality assessment of mechanical tensioning and flatness of MPGD films and meshes.
  - prototyping integrated Fiber Bragg Grating sensors for monitoring the mechanical tension of MPGD films (GEMs) and meshes (MICROMEGAS).

- Flatness of MPGD foils/meshes must be assured within about 100microns and monitored over long term detector lifetime (10-20 years)
- Flatness QC during assembly
- Continuous monitoring during operation

Sharing of activities among partners

- Laboratori Nazionali di Frascati
  Engineering, Fiber Bragg Grating sensors deployment, tests in clean room
- INFN Bari
  Film stretching mechanics
- INFN Bologna
  Tests of stretched foils

WP13 Milestones

MS Number	MS Description	Task	Due by	Result type
MS13.8	Optical system for the quality assessment of MPGD foil/mesh mechanical tensioning	13.4.3	M12	Demonstrator
MS13.9	Integrated FBG sensors for monitoring the mechanical tension of MPGD films and meshes	13.4.3	M24	Prototype

Matched !

Report in preparation

Milestones	Year 1	Year 2	Year 3	Year 4
Design/qualify an optical interferometric system				
Engineering interferometric system MS13.8				
Qualify FBG sensors				
Proof of concept integration of FBG MS13.9				
Long term characterization of FBG				
Qualification at test beams				

WP13
Optical setup for Moiré fringes

<u>Moiré interferometry for large area surfaces</u>

Phase shift algorithm greatly improves resolution on transverse displacement

- R= ± 30um reached over small areas
- Engineering over large areas in progress
- Milestone JUNE 2016

White light projector and viewing TV camera equipped with identical objectives and grating (grating: 120 lines/mm)

Viewing TV camera on step-motor translation stage to implement precise Phase Shift

Setup optical geometry: reference plane perpendicular to bisector of angle between projection and viewing direction

Procedure:

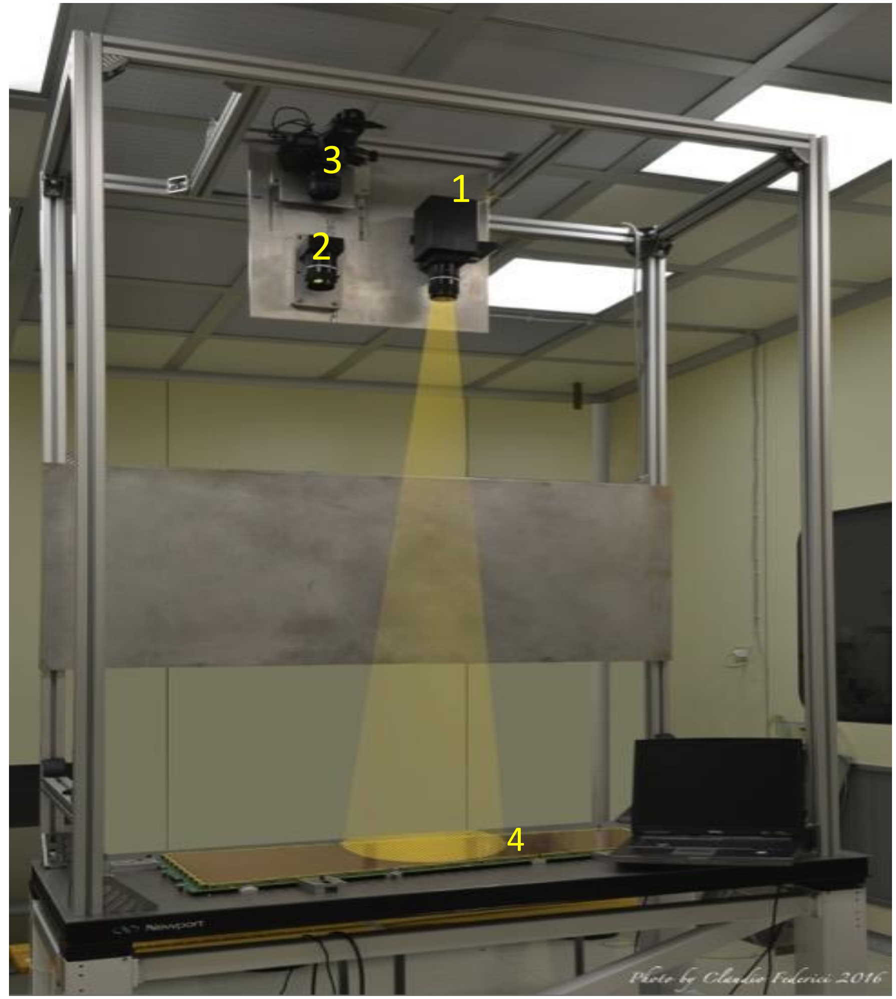
Optimize intensity and contrast of Moiré fringes with live visual inspection of un processed image;

Define required translation of TV-camera to produce 360° degree Phase Shift;

Grab n.5 images with precise phase shift and PC-processing according to 5-bucket algorithm

WP13
Optical setup for Moiré fringes, large size version

1. Project Ronchi grating on MPGD
2. View Ronchi grating through second identical grating
3. Detect Moiré fringes
4. View Moiré fringes



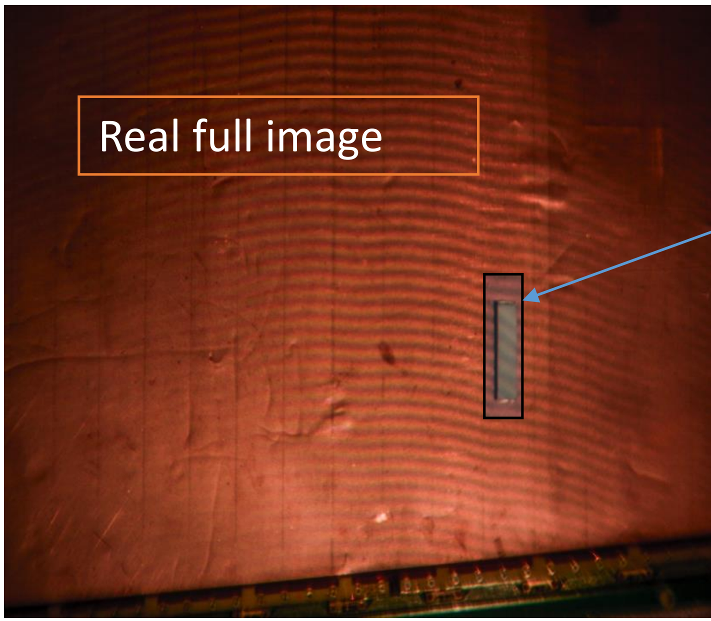
- After completing the system engineerization, focus of work on solving light reflex on full GEM chamber surface making the fringes non optimally clear
- Also analyzing the calibration wedge

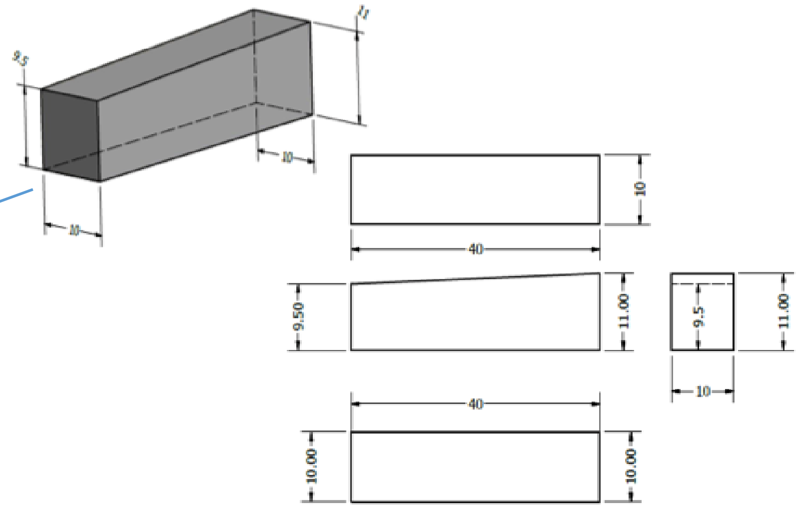
The light reflection solved by tilting the GEM chamber (about 10deg). This introduces a global fringe shift known and easy to be corrected.

WP13
Optical setup for Moiré fringes

Wedged specimen is used for resolution calibration

A first evaluation of the Resolution R con be done by counting N fringes between points with known Δh provides resolution R (points are chosen at center of dark fringe for best precision) can be easily calculated R = Δh/N. For the specimen used we have Δh=1.5 mm

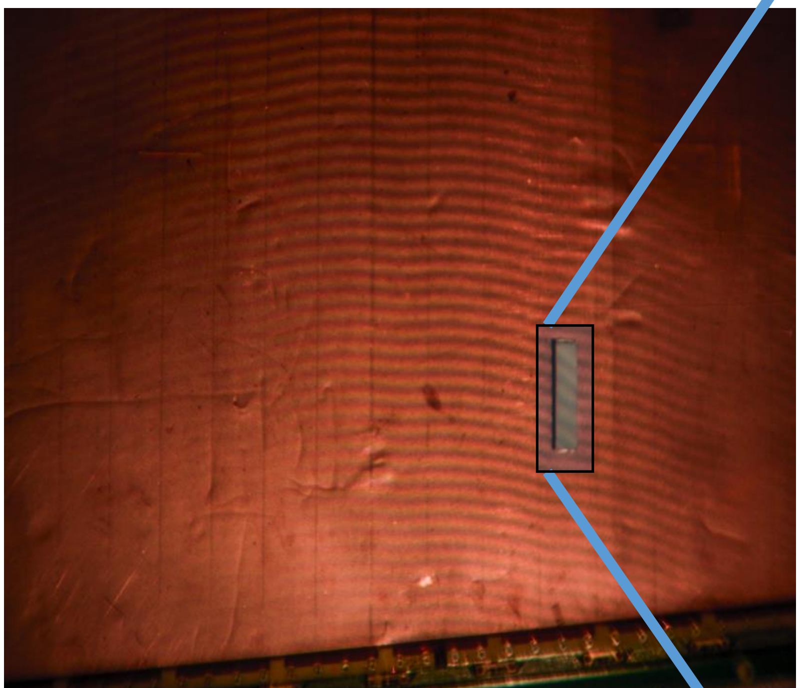




If we are able to evaluate possible substructure or light intensity variations between the N fringes the resolution R can be further improved

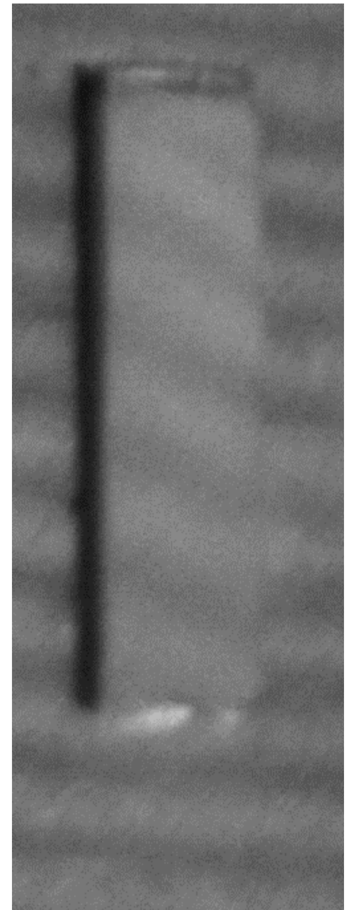
WP13
Optical setup for Moiré fringes

Real full image

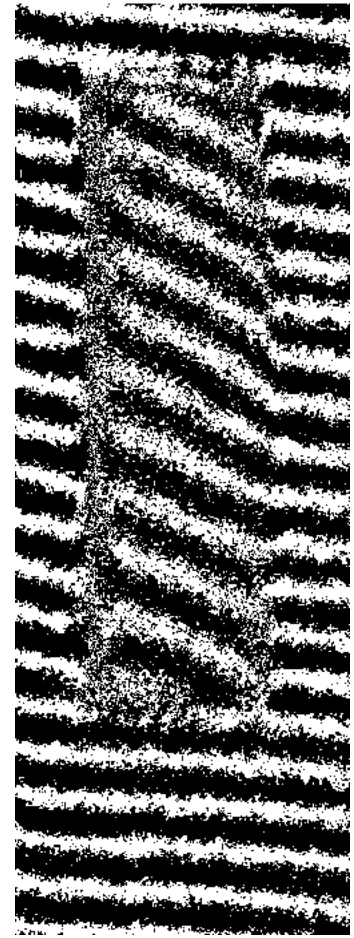


After the Phase-shift corrections 16 fringes are visible on the total specimen length.

Real image specimen piece

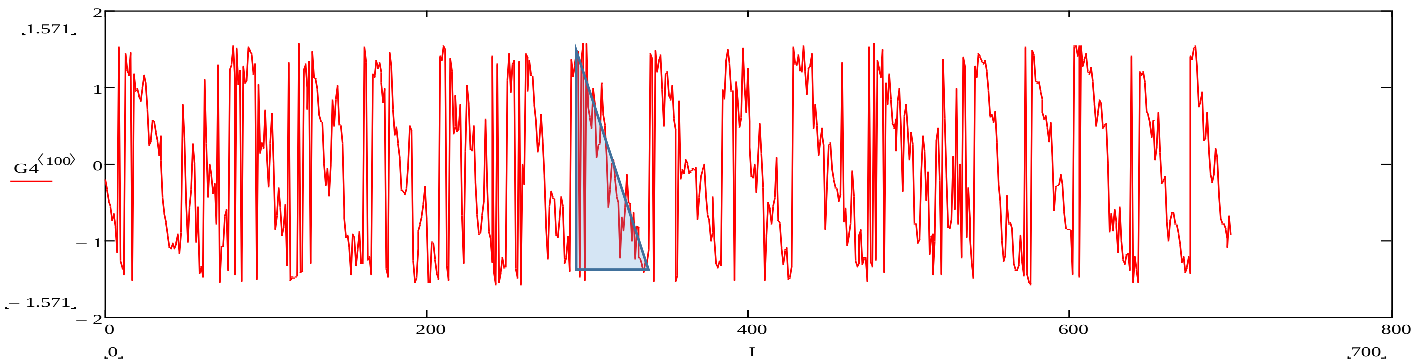


Software generated without phase shift algorithm



By applying 5 bucket phase shift algorithm

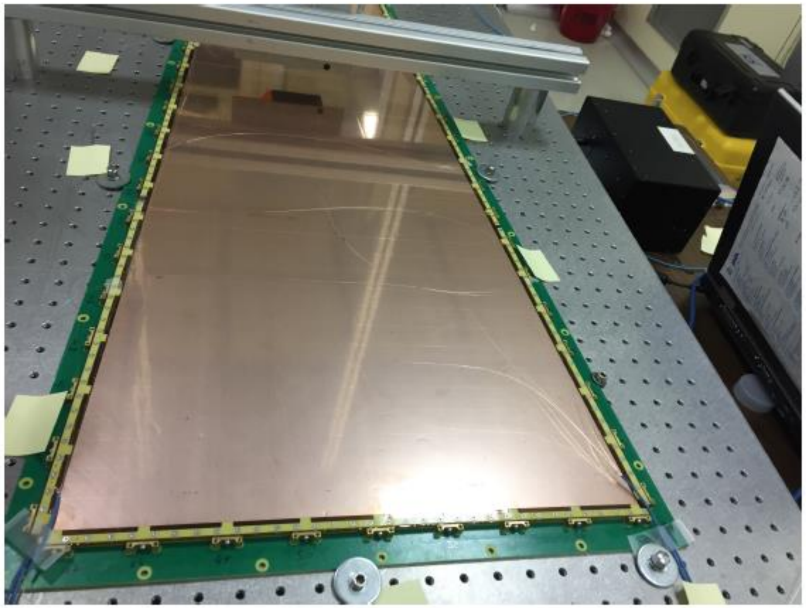
WP13
Optical setup for Moiré fringes

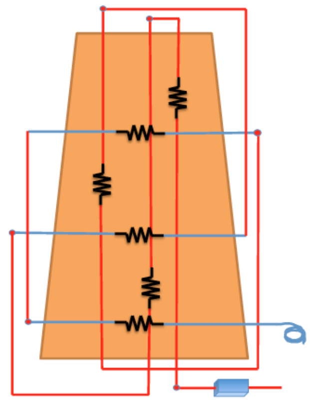


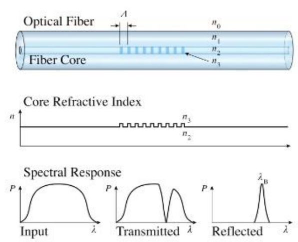
Between the 16 fringes is clearly possible observe the variation from dark to light pixels represented in the upper plot by the slopes between the peaks (the dark max of the fringes). By evaluating the slope we can assume we can appreciate 1/3 of the single peak height.

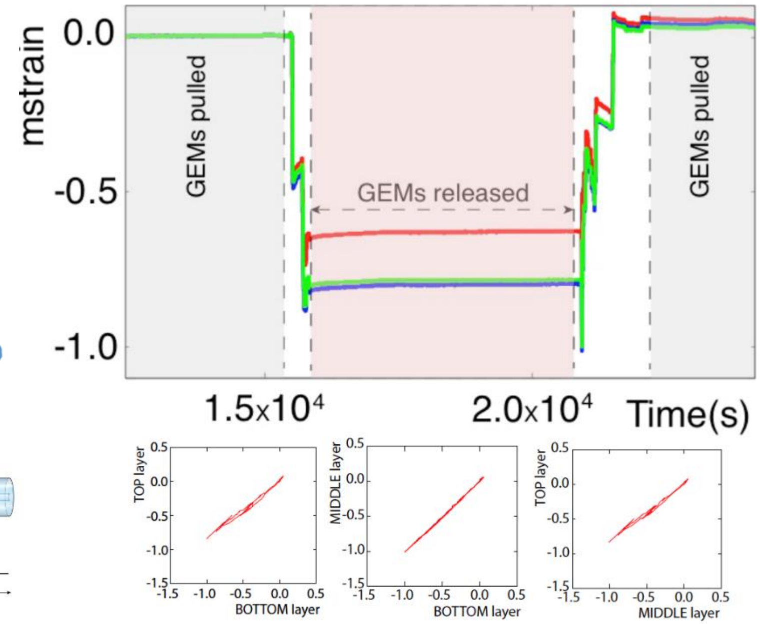
This leads to the resolution R = $\Delta h/N$ = (1500/16)*(1/3) = 31 µm, very close to the target resolution of 30 µm

WP13
FBG sensors embedded in MPGD detectors







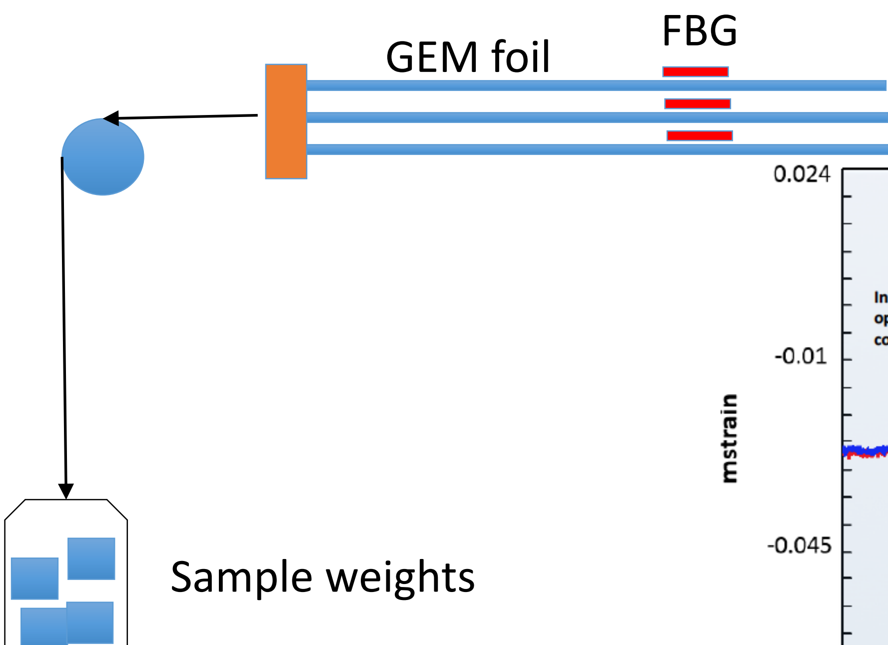


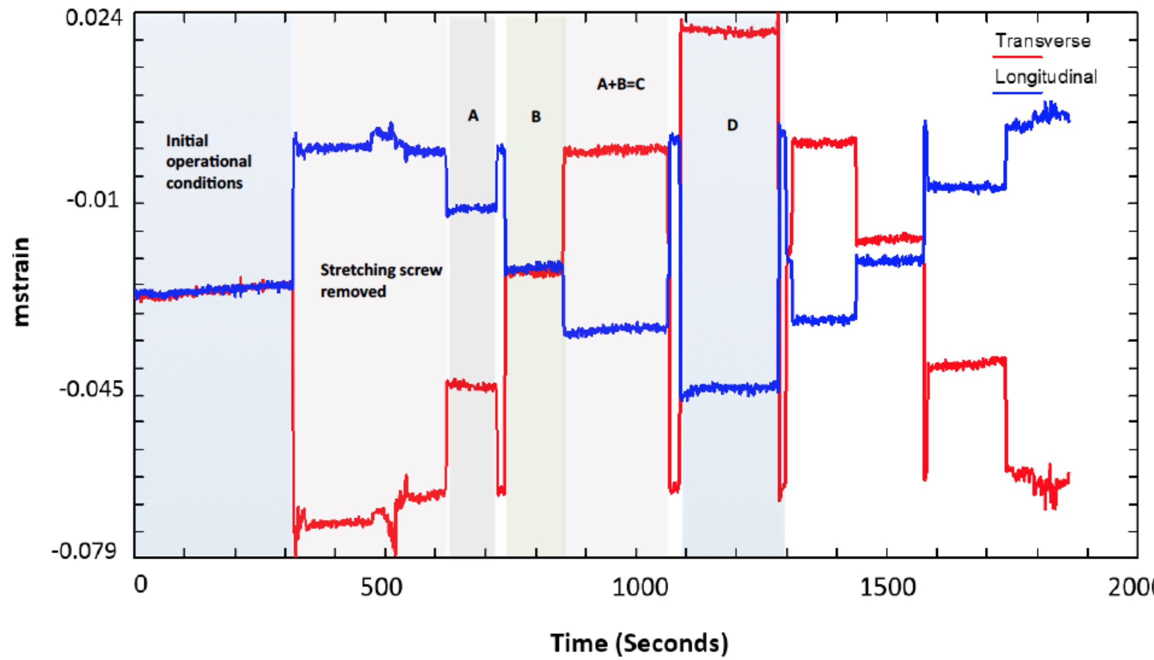
A Fiber Bragg Grating (FBG) is a type of phase Bragg grating written in a short segment of optical fiber that reflects by diffraction only specific wavelengths of light and transmits all others. The sensitivity of FBG in terms of strain, relative elongation w.r.t. the initial length is of the order of 1 p.p.m. A FBG can therefore be used as a strain measurement tool since variation of the FBG translates into different light frequency response. In order to validate the mechanical stretching technique used in GE1/1 assembly we affixed a network of FBG sensors

WP13
FBG as tensile load gauge

Another important application of FBG in GEM chamber construction is the possibility to perform precise measurement of the tensile load applied to the foils, of the different layers, in the same moment.
We successfully verified the possibility of this idea on a large size area triple GEM chamber (~1m^2)

☞ **Not in the AIDA2020 original program. NEW IDEA!**





WP13
Conclusions

- Target resolution than 30um reached with Moiré setup✓
- Moiré Engineering demonstrator ready (milestone M12) ✓
- FBG test on CMS GE11 chamber completed successfully both as tensile load monitor and as tensile load gauge✓

Both task have been successfully completed ✌

Results have been presented in several international conferences during last year.

Elba2015

MPGD2015

IWASI2015

EPS2015

SIF2015