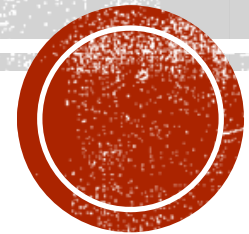


# BESIII UPDATE

G. Cibinetto

riunione referaggio BESIII – 12 luglio 2019



# SCOPO DELLA RIUNIONE

- Progetto RISE - FEST
- anagrafica del gruppo
- questioni generali
- aggiornamento attività critiche CGEM
- stato milestones 2019 e proposta 2020
- richieste per la prossima riunione di commissione
- richieste per il 2020

# FEST

Future Experiments seek  
Smart Technologies

Si tratta di un progetto che coinvolge 11  
istituti e industrie, e ben 14 sezioni  
INFN, da 8 nazioni, europee e non,

Proposta di finanziamento da parte  
della Commissione Europea di  
2,106,800€ che si tradurrà in un  
finanziamento all'INFN di 1,426,000€.

Work Package No	Work Package Title	Activity Type (e.g. Research, Training, Management, Communication, Dissemination...)	Number of person-months involved
1	BESIII CGEM-IT detector and Physics	Research, Training	211
2	Detectors for future experiments	Research, Training	118
3	Readout electronics for future experiments	Research, Training	55
4	Medical applications	Research, Training	10
5	Future accelerators Physics	Research, Training	56
6	Data Challenge	Research, Training	14
7	Dissemination and Outreach	Dissemination, Outreach	0
8	Management	Management	0



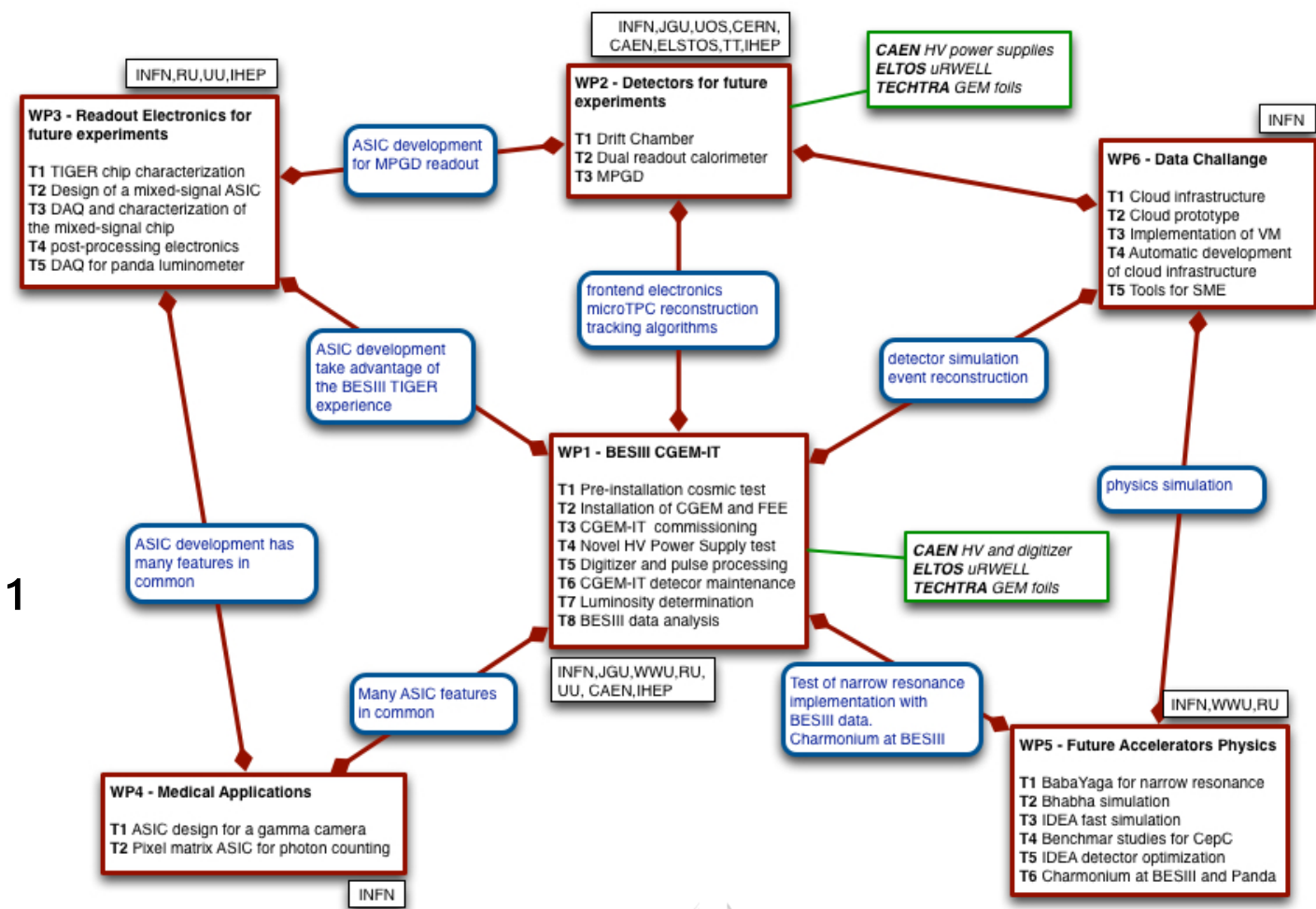
H2020-MSCA-RISE-2019

# FEST

Future Experiments seek  
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H2020-MSCA-RISE-2019

Per la maggior parte va a coprire attivita' gia' programmate!!!

# FEST WP5 - Medical applications

10 HM, M1-M48:

- T4.1 Design and test of a 64-channel readout ASIC for a gamma camera based on CZT detectors:

- ASIC with adjustable shaping time, gain and threshold per channel
- including amplification, signal conditioning and digitisation
- providing time and charge information for each event
- rate > 10 kHz/ch, over 100 fC dynamic range, ENC < 65 e/pF

- T4.2 Design and test of a pixel matrix ASIC for photon counting:

- application to breast CT based on GaAs/CdTe detectors
- optimized for the 30 – 160 keV energy range
- pixel matrix (50x50  $\mu\text{m}$  – 100x100  $\mu\text{m}$ ) with multiple energy binning
- event rate  $\sim 10$  / mm
- sensor mounted on top of the readout ASIC with a flip-chip assembly

•  
Present status:

- design of an ASIC with 64ch for semiconductors in progress @ INFN-TO (& IHEP)
- architecture based on TIGER, dedicated low-noise front-end for silicons and CZT
- submission expected in Q2-2020

•  
Riccheste finanziarie 2020: 6 k€

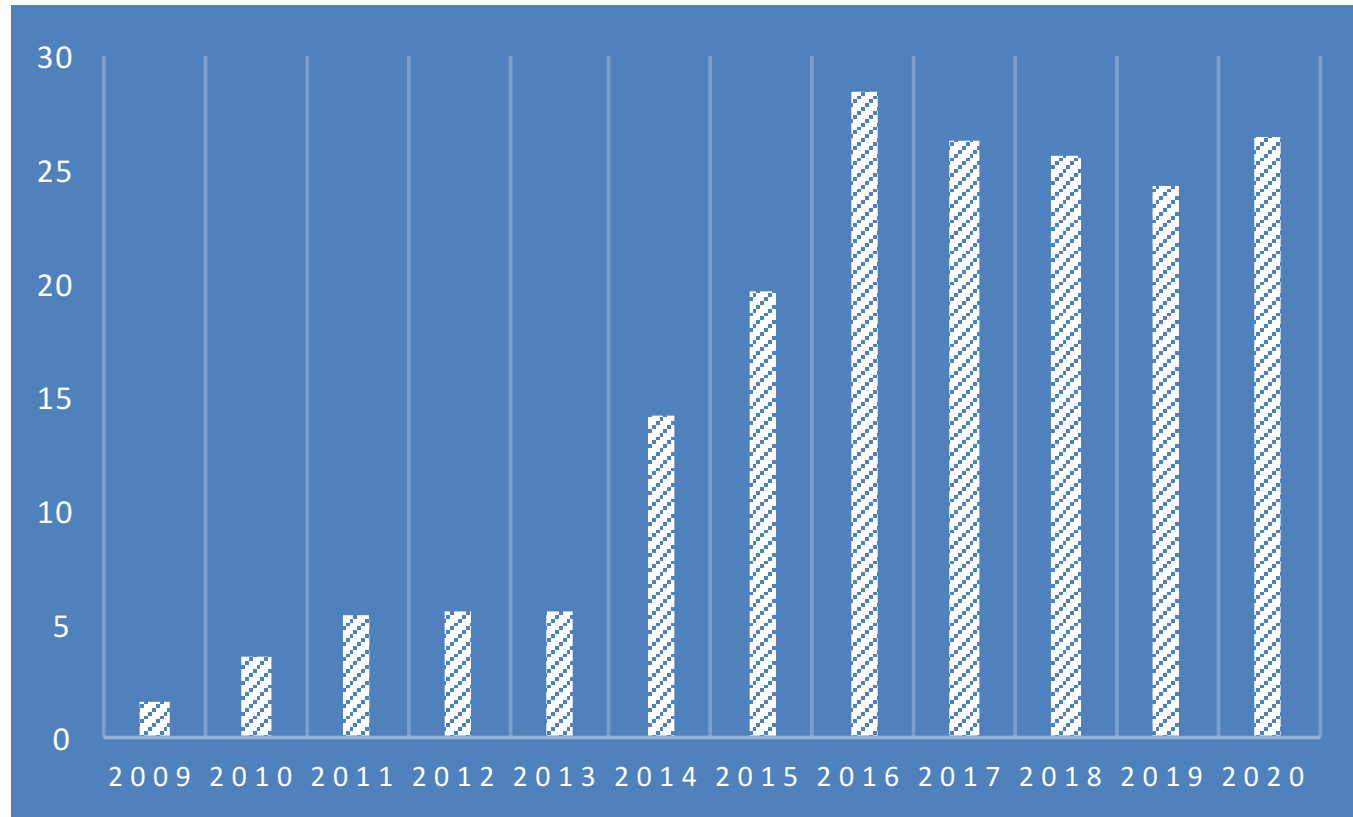
- produzione di front-end board (FEB-A per host ASIC, FEB-S per il sensore CZT)
- FPGA per DAQ



**BESIII**



# ANAGRAFICA



Negli ultimi anni il numero di FTE (ricercatori + tecnologi) e' rimasto pressoché costante attorno a 25.

Il numero di persone circa 40.

Per ricercatori FTE/teste  $\sim 0.76$

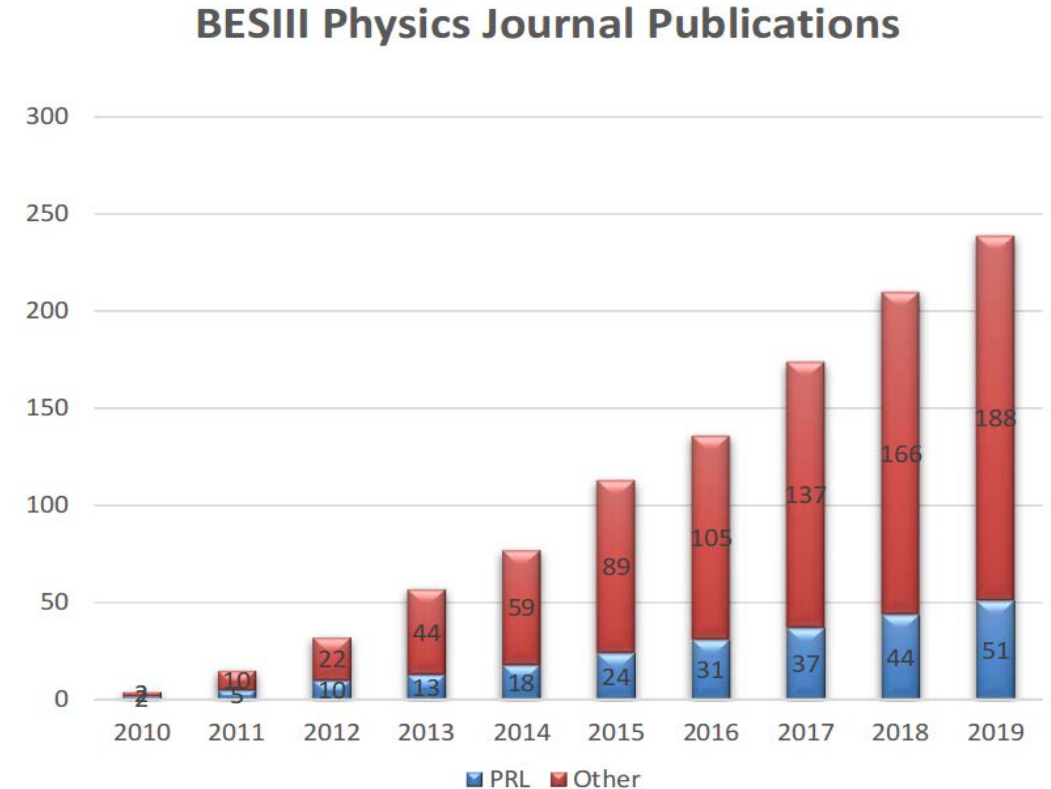
7 tecnici con impegno importante sull'esperimento

Supporto servizi 34 M.U.



# Status of the publications

Year	PRL	PRD	PLB	EPJC	CPC	Total
2010	2	1	0	0	1	4
2011	3	8	0	0	0	11
2012	5	10	1	0	1	17
2013	3	20	0	0	2	25
2014	5	13	2	0	0	20
2015	6	24	4	0	2	36
2016	7	10	3	1	2	23
2017	6	22	7	0	3	38
2018	7	23	3	0	3	36
2019	7+	18+	1+	0+	2+	29+
<b>Total</b>	<b>51</b>	<b>149</b>	<b>21</b>	<b>1</b>	<b>16</b>	<b>238</b>

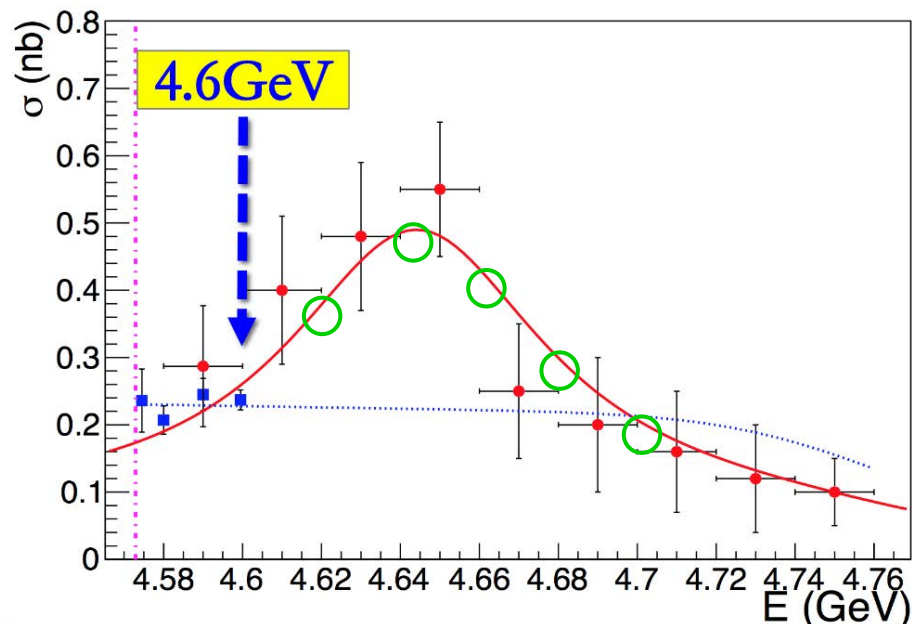


238 papers in 10 years. Roughly 30/40 papers per year since 2015  
 Already 99 talks assigned for 2019 (still missing PIC2019).  
 10% performed by italian collaborators



# 2020 Data taking





- 1) 500 pb<sup>-1</sup> per energy value at  $E_{\text{cm}} = 4.62, 4.64, 4.66, 4.68$ , and  $4.7$  GeV
- 2) Stay at  $E_{\text{cm}}$  which corresponds to the maximum cross section for  $\Lambda_c$  pair production for the remaining part of the year.



Expected outcome (statistic wise):

- Roughly 2.7 M  $\Lambda_c$  pairs
- Fine scan of Y(4660) lineshape for XYZ searches
- Strong contributions from italians in proposal

# White paper review and symposium on 30 years of BES Physics

Tuesday, 3 September 2019		Go to day ▾
09:00 - 09:30	Committee meeting	
09:30 - 11:00	Session I	
	Convener: Prof. Haibo Li (IHEP)	
	Location: A415	
09:30	<b>Introduction of the IRC 5'</b>	
09:35	<b>Welcome address 5'</b>	
	Speaker: Prof. Yifang WANG (IHEP)	
09:40	<b>Welcome by representatives of CAS headquarter 5'</b>	
	Speaker: Prof. Liangqiang Peng (Bureau of Facility Support and Budget CAS)	
09:45	<b>Overview of BESIII program at BEPCII 25'</b>	
	Speaker: Prof. Changzheng YUAN (IHEP)	
	Material: <a href="#">Slides</a>  <a href="#">White Paper</a> 	
10:10	<b>BEPCII status 25'</b>	
	Speaker: Dr. Chenghui Yu (IHEP)	
	Material: <a href="#">Slides</a> 	
10:35	<b>BEPCII upgrade 25'</b>	
	Speaker: Dr. Yuan Zhang (IHEP)	
	Material: <a href="#">Slides</a> 	
11:00 - 11:30	Coffee Break & Group Photo	
	Location: A415	

International Review Committee for the new White Paper to present the next 10 years of BESIII physics had the first meeting on Sept 3-4.

Expected release by the end of the year.  
Few italian contribution in QCD part (baryon-antibaryon cross section and polarization measurements)

Two days (Sept 5-6) symposium to celebrate the origin and the future of BES project.

CGEM as “the single most important contribution of european groups” during one of talks

### Symposium on 30 years of BES Physics

from Thursday, 5 September 2019 at **08:00** to Friday, 6 September 2019 at **18:00** (Asia/Shanghai)  
at **IHEP, Main Building ( A214 )**  
19B Yuquan Rd., Institute of High Energy Physics, Chinese Academy of Sciences

Description

Time flies!

BES, the Beijing Spectrometer, began its first groundbreaking physics run in 1989, already 30 years ago! This was the first high energy physics experiment in China, and has been unique, throughout the world, for its thorough and extended coverage of the tau and charm energy region. Over these 30 years, the BES detector has been steadily improved, upgrading to BESII in 1998 and to BESIII in 2008. And over the same period, the collaboration has evolved from including about 150 members from 10 institutions in China and the United States to about 500 members from 72 institutions in 15 countries. The physics program, too, has extended from light hadron spectroscopy, tau, and charm physics to the discovery of exotic charmoniumlike states, precision tests of the Standard Model of particle physics, and searches for new physics beyond the Standard Model.

To celebrate the great achievements of the BES, BESII, and BESIII experiments, and to also look to the future, a symposium will be held from September 5 to 6, 2019. The early days of the BES experiment will be remembered, the achievements of all of the BES experiments will be highlighted, and the future physics program at BESIII will be previewed. If you have been a member of the BES collaborations, or if you have contributed to any aspect of the BES detectors or physics, you are cordially invited to join the Symposium.

# STATUS OF NEW L1 CONSTRUCTION-I

## ✓ Clessidra alignment

- ✓ *earthquake on June 23<sup>rd</sup> centered in Colonna very close to Frascati, 3.6<sup>0</sup> Richter scale → Clessidra moved on x-axis by 1.4mm !*
- ✓ aligned with all the five L1 molds → OK

## ✓ material procurement and tests :

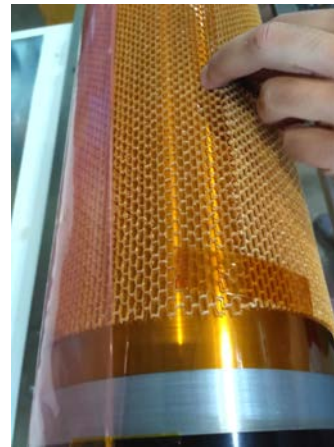
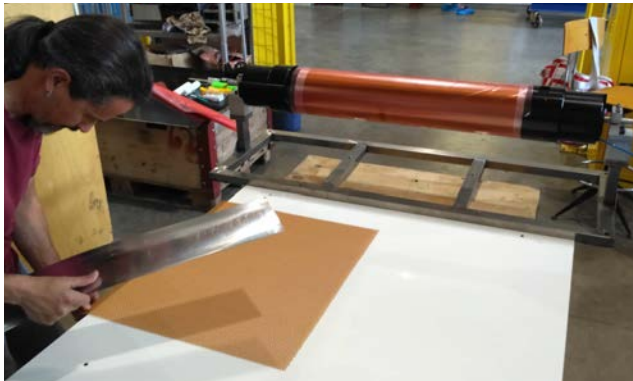
- ✓ CGEM : inspected, HV tested, cutting refined → OK
- ✓ Anode: on PCB found some defects and lateral cuttings that was not required and never done before, we recovered → now OK
- ✓ Cathode arrived last Friday, not very good looking but *should be* OK
- ✓ R&D test for Cathode with Honeycomb&Kapton structure → OK

# STATUS OF NEW L1 CONSTRUCTION-II

- ✓ Anode with honeycomb+Carbon fiber @LOSON → OK
- ✓ G3 → OK
- ✓ G2 → OK
- ✓ G1 → OK
- Cathode → OK
- Cathode test with honeycomb+Kapton structure



GEM3



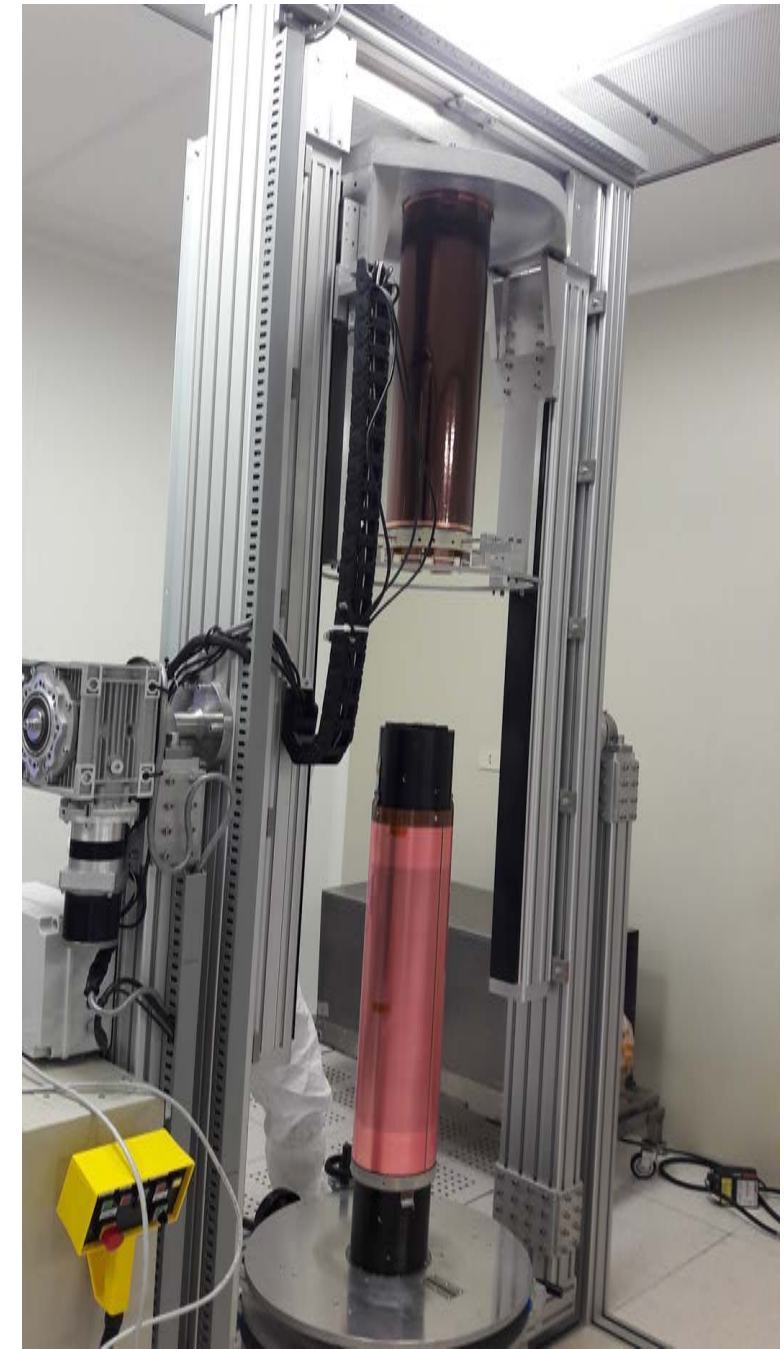
Cathode  
test



Anode in  
Clessidra



G3 going into  
Anode



# CONSTRUCTION SCHEDULE

- nL1 construction is going to be finished and tested by the first week of October
- nL3 material are being produced at CERN
  - issue about schedule.



FEBRUARY  
Arrival

MARCH  
Assembly

APRIL

MAY  
Cosmic Stand

JUNE

JULY

AUGUST  
Separation

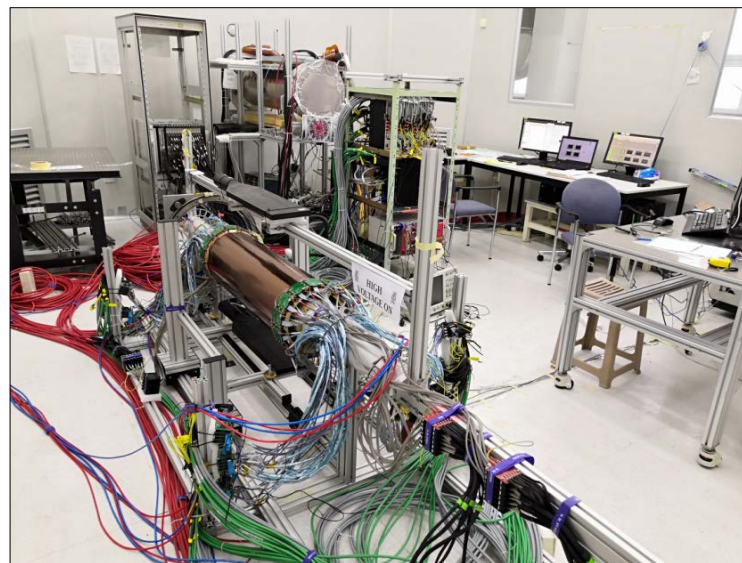
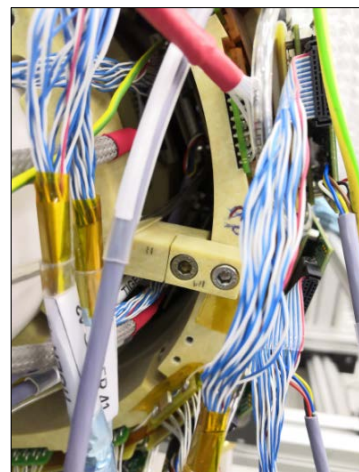
SEPTEMBER  
Service



INSULATED  
BOX

CONNECTION  
FLANGES

ASSEMBLY  
PHASE



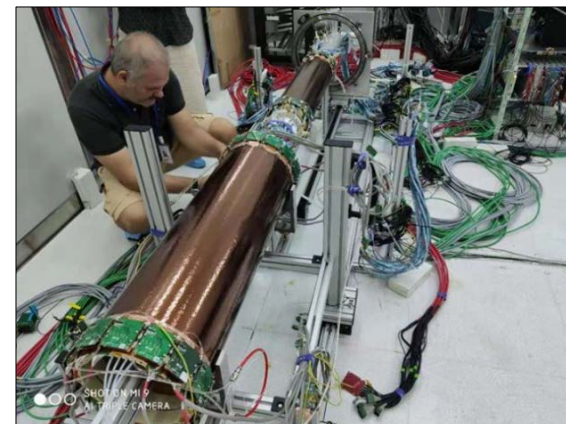
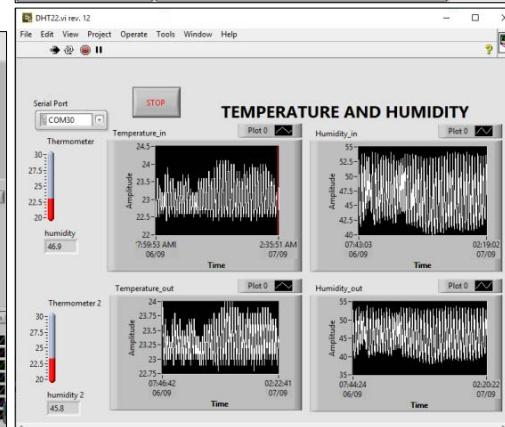
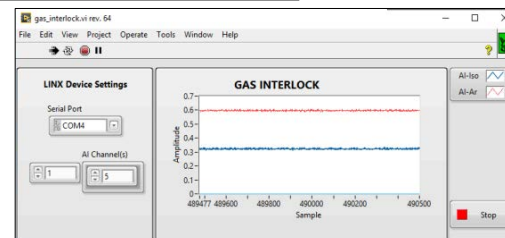
TRACKING  
TESTS

ELECTRONICS  
DEVELOPMENT

CURRENT  
ABSORPTION  
MONITORING

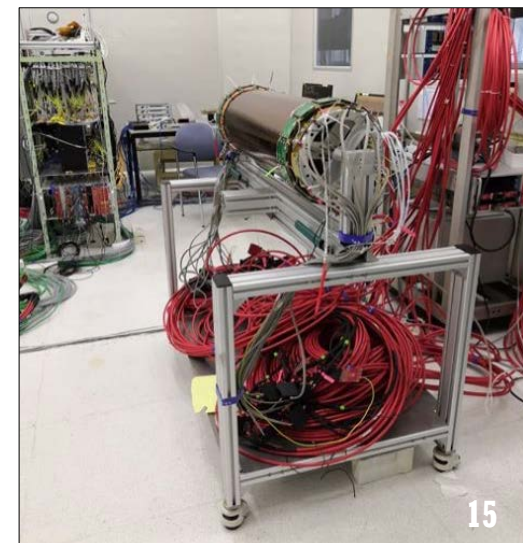
TEMPERATURE  
HUMIDITY  
CONTROL

GAS  
CONTROL



SEPARATION  
PHASE

POWER ON  
STAND ALONE



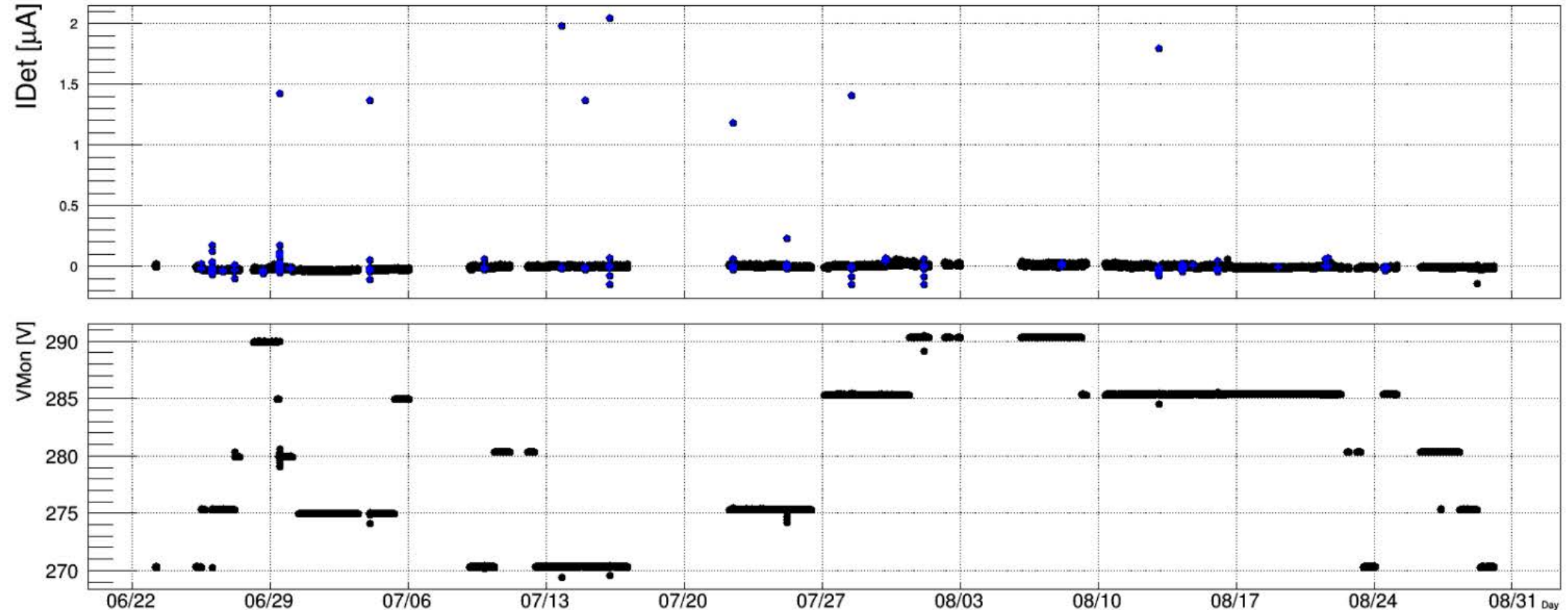
# ELECTRICAL STATUS OF CGEM

\*

NOMINAL OPERATION  
ALARM OCCURED

GEM 1

GEM  
CURRENT



\*

VOLTAGE  
APPLIED

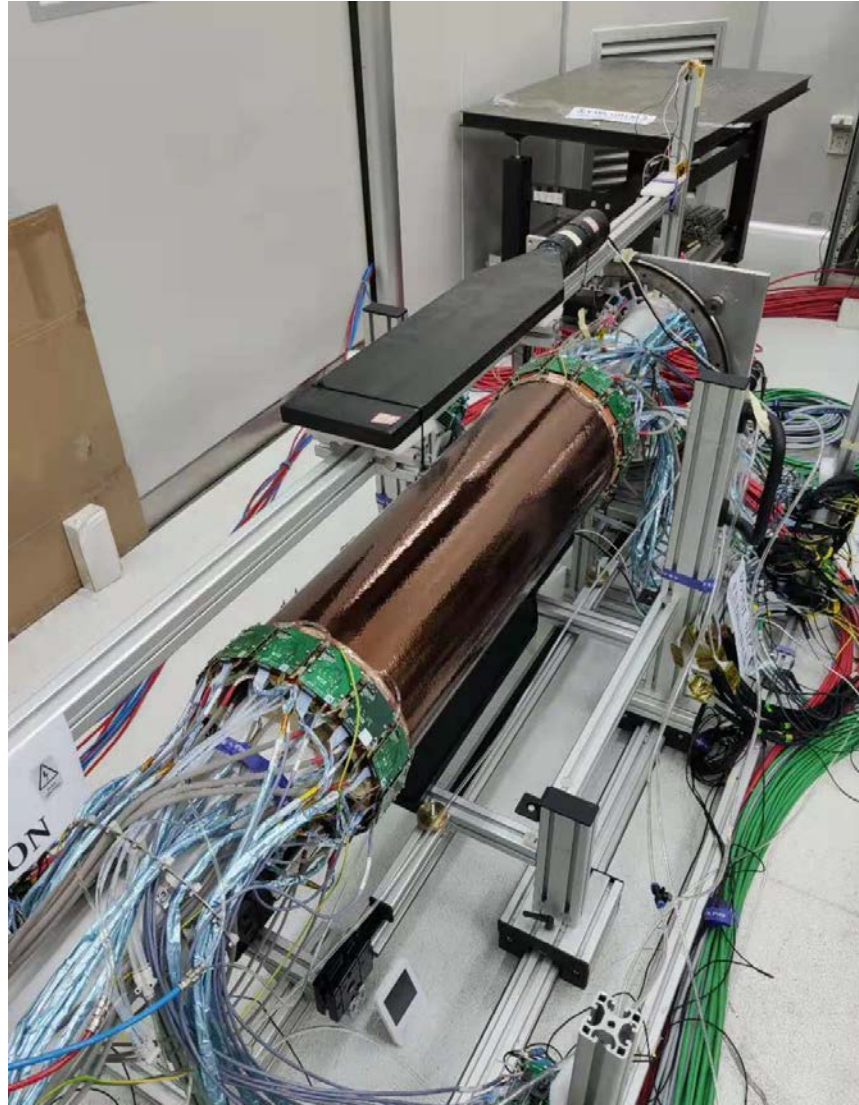
It was tested at different Gains



# Layer1+Layer2 Integration

10/12-days work periods at  
IHEP with people from Torino-  
Ferrara-Uppsala,

- End of April
- Mid June
- Mid August



**GEMROC:**  
Efficient  
trigger-matched operation

**TIGERs:**  
operation at a threshold  
of 3-4 fC

**Grounding:**  
optimization

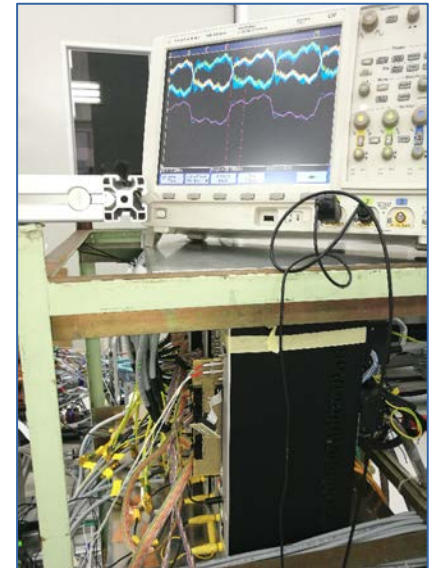
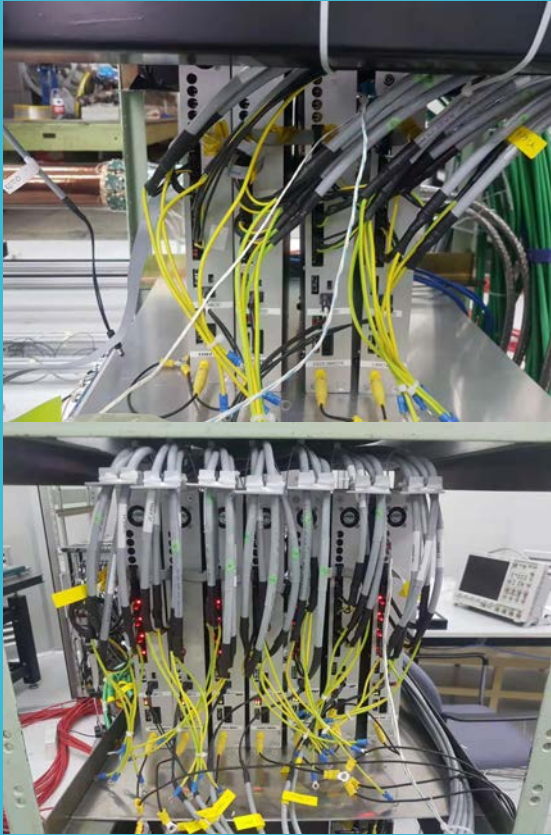
→Cosmic runs: data tracking

# GEMROCs

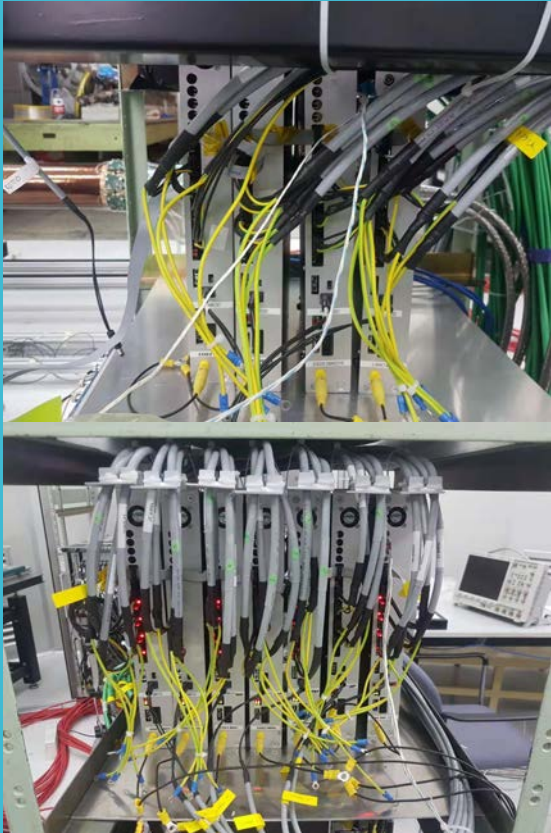
## 1) one GEMROC has been temporarily modified to distribute Fast Control Signals

### Features :

- Generation of the main clock for all the GEMROCs in the setup
- Fanout, over 4 identical ports, of:
  - **Clock** : internally generated.
  - **In-time** signal : received from the PMT front end. Used to generate a test pulse in coincidence with the cosmic event to a dedicated TIGER channel
  - **Trigger** : received from a delay module. The signal, arriving 8.6us after the “In-time” pulse is used to trigger the event readout
- Programmable self generation of all fast timing signals listed above.



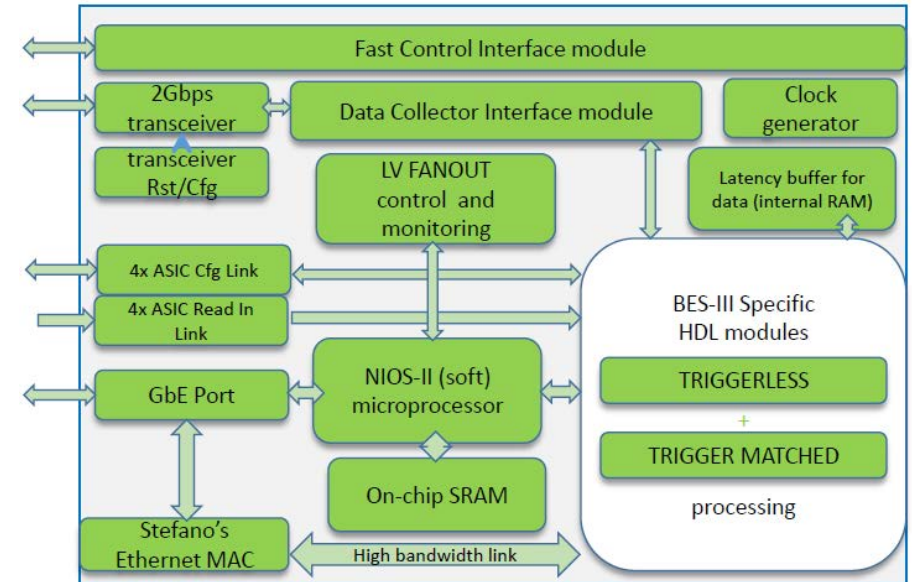
# GEMROCs



2) one GEMROC has been replaced  
( no reset signal due to a misconfigured internal connection)

3) new Firmware:  
significant reduction of  
8b/10b communication  
errors  
→ change of clock edge (now  
rising edge)

FPGA block scheme

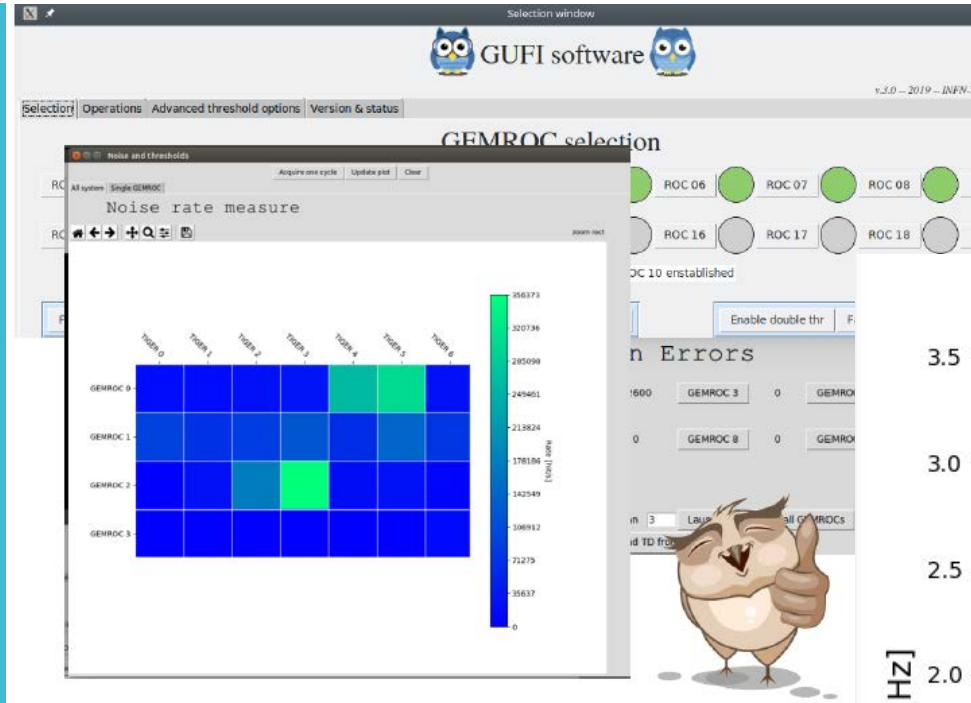


- full synchronization (through a common Clock and Trigger signal) across all GEMROCs
- system stability by distributing a slower ( $\frac{1}{4}$  BES-III clock frequency) and better terminated reference clock

“Trigger Matched” efficiency: 98%

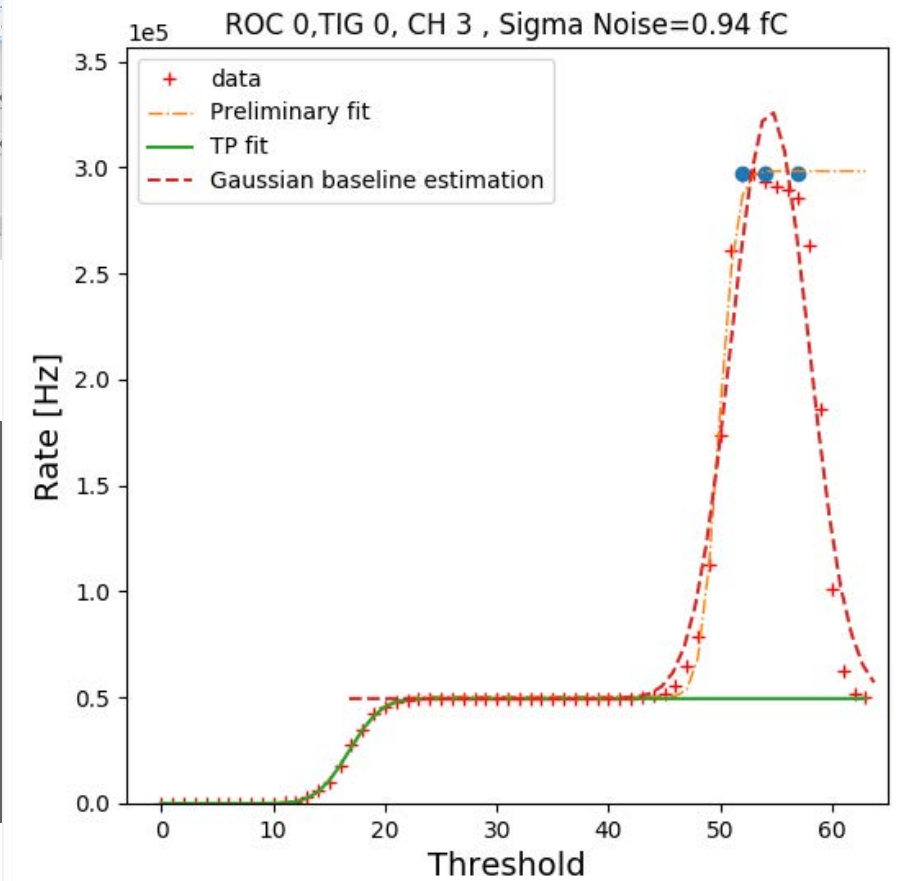


# TIGERs



## Graphical User Frontend Interface Interface among GEMROCs and TIGERs

- Configuration
- Acquisition management
- Threshold scans
- Measure Noise Rate





# TIGER<sub>s</sub>

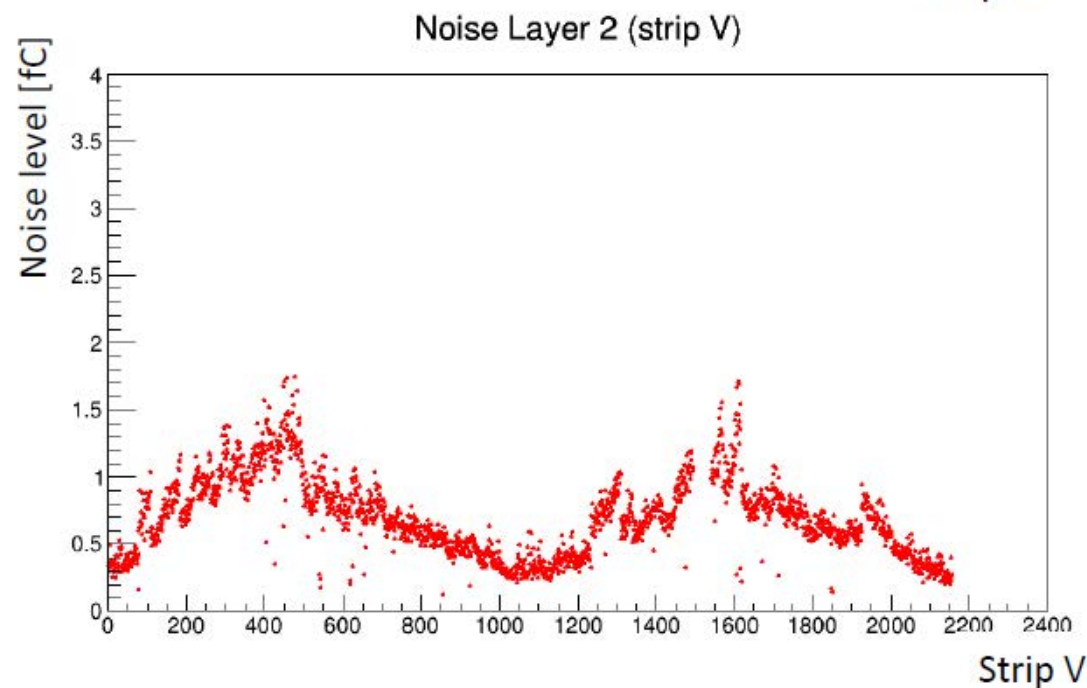
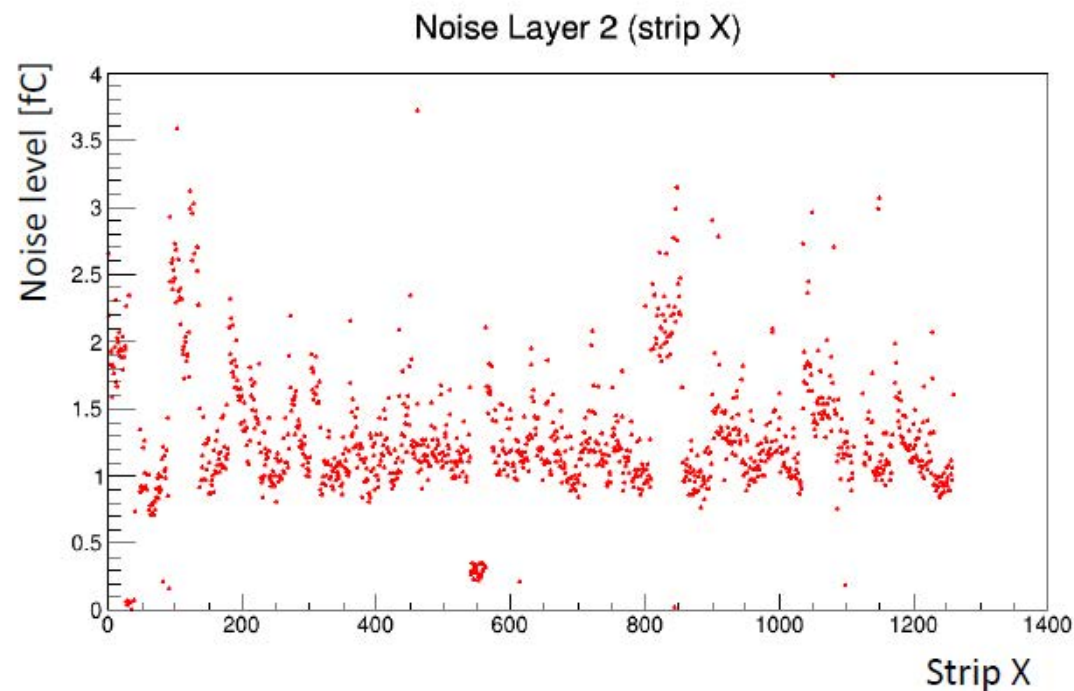
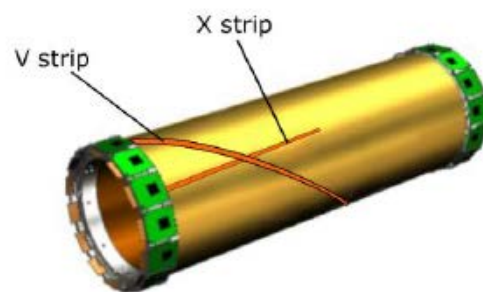
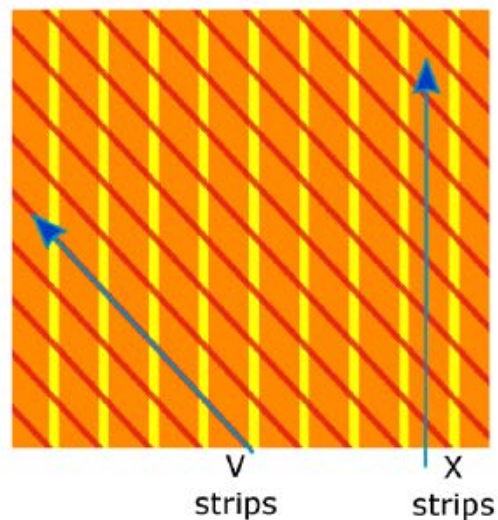
84% strips under 5 fC

70% under 4 fC

Mean noise rate:

X: 826 Hz

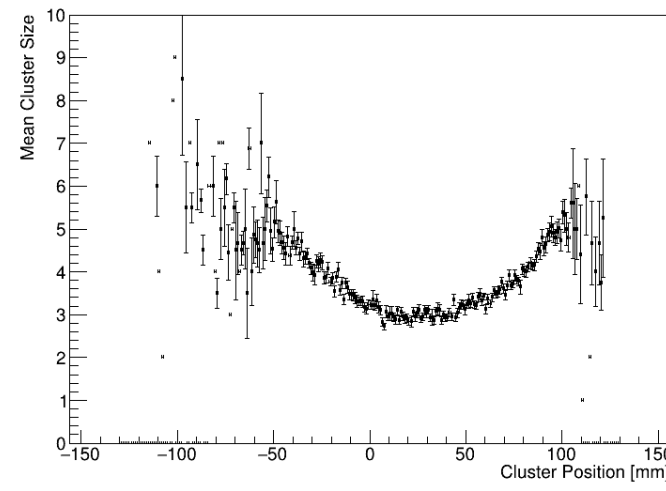
V: 929 Hz



# Floating detector with one “ground strap” (star structure)

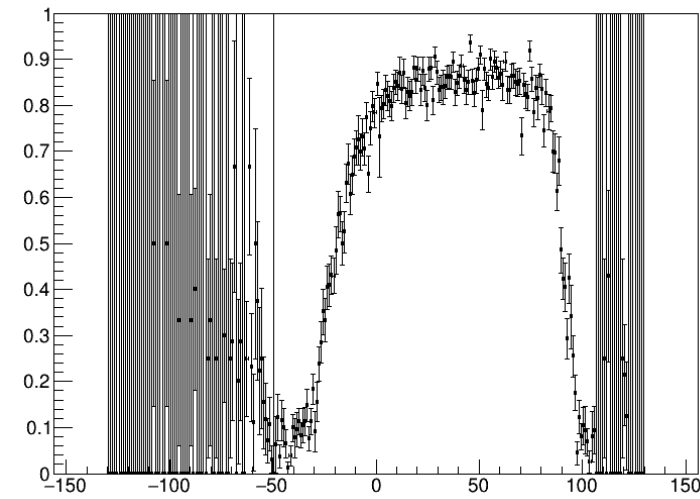
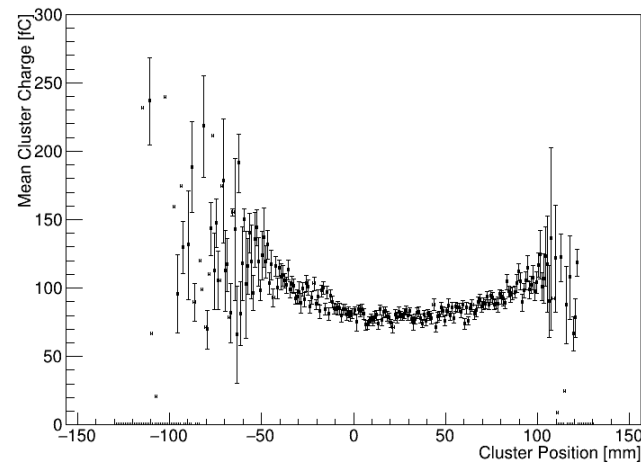


# DATA preliminary analysis



cluster size

cluster charge



efficiency

RUN 251 - L2up





# CGEM Software Updates



## GEOMETRY

- **Complete geometry** with cables, flanges and passive elements in CGEMBOSS release “E”, available for everybody
- Missing the latest updates in design of L1/L3, minor task for the future

## DIGITIZATION

- **Good agreement** with test beam data and APV25
- **Improvement in induction**, now “full” and “fast” produce comparable results (saving computing time) ➔ now porting into CGEMBOSS
- Simulation tuning will be done soon with new induction, **automatically**
- Missing TIGER simulation, tuning of CGEM with TIGER (starting after collection of a good sample of data)





# Full Tuning of Simulation Digitization



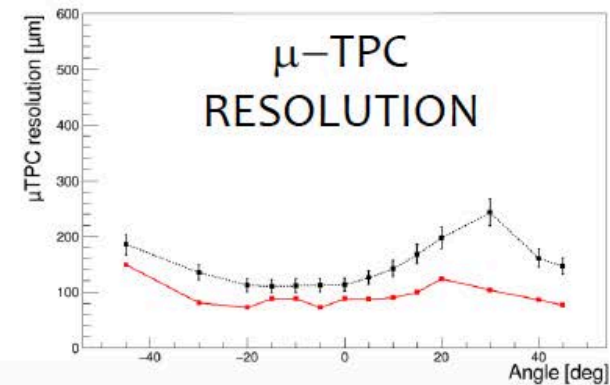
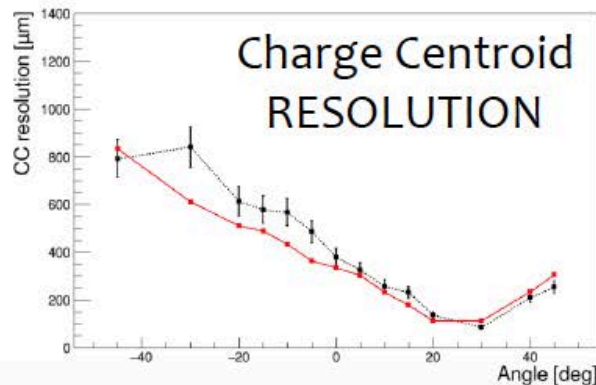
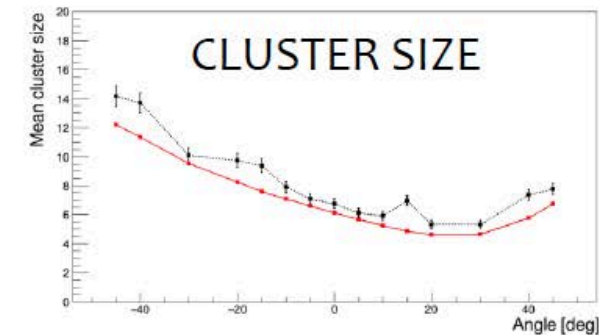
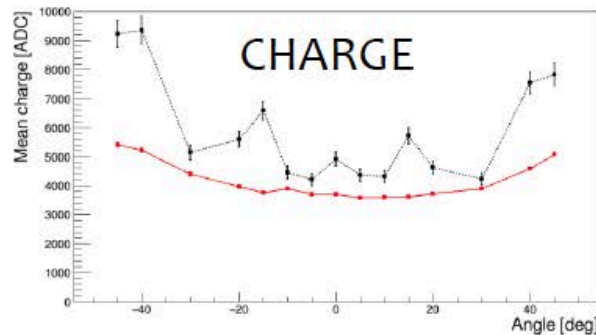
MILESTONE - 31/07/19 ➤ Done for APV25 and planar GEMs  
 75% ➤ Not yet done for TIGER and CGEM

- ✓ Missing TIGER simulation and a larger set of data with CGEM
- ✓ It should be just matter of TIGER tuning

**SIMULATION  
TESTBEAM**

Gain x 4.5  
Spatial diffusion x 2

Match within 30%





# Automatization of tuning



- The values that minimize the chi-square will be used for the final tuning

$$\sum_{i,j} \frac{exp_{i,j} - sim_{i,j}}{error_{i,j}}$$

where  $i$  is the angle\_ID from 0° to 60°

$j$  is the variable of interest (charge, size, CC,  $\mu$ TPC)

the error is measured from the experimental data

Procedure to speedup the tuning

RUN ID	GAIN FACTOR	DIFFUSION FACTOR	CHI2	CHI2/ndf	@ 0°	@ 5°	@ 10°	@ 15°	@ 20°	@ 30°	@ 40°	@ 45°	@ 60°
1	1	1	130850	3634.74	30.429	26.243	25.107	90.972	257.11	620.18	21979	6758.9	2924.7
2	1	2	1002.6	27.851	47.038	22.095	33.325	22.687	22.268	19.744	23.541	27.85	32.108
3	1.5	1	990.14	27.504	29.791	32.158	20.66	16.531	18.853	18.748	25.432	41.393	43.97
4	1.5	2	599.73	16.659	14.386	20.066	21.665	15.526	15.054	13.803	15.12	18.551	15.761
5	2	1	749.15	20.81	20.552	28.71	15.899	12.886	14.791	13.38	18.199	28.056	34.814
6	2	2	432.22	12.006	12.187	14.498	14.439	10.842	10.896	9.994	10.671	13.357	11.172
7	2.5	1	598.1	16.614	15.056	26.292	12.253	10.327	11.343	14.011	14.386	20.077	25.779
8	2.5	2	323.29	8.9804	9.539	12.341	11.736	8.062	7.6367	6.8982	7.2925	9.1863	8.132
9	3	1	450.77	12.521	13.097	24.447	9.5927	8.3415	8.3625	7.081	9.4729	13.831	18.468
10	3	2	246.23	6.8398	7.8676	10.875	8.46	5.4488	5.1921	4.5186	4.6133	8.0462	6.5366
11	3.5	1	387.08	10.752	12.114	22.183	8.3482	6.9056	5.9857	5.0298	8.1441	11.334	16.725
12	3.5	2	203.76	5.6599	9.714	10.538	5.8436	3.939	3.7086	2.5871	3.0199	6.1328	5.4567
13	4.5	1	310.18	8.816	10.815	20.894	6.8043	4.3043	4.7709	2.9087	5.2008	10.166	11.681
14	4.5	2	190.9	5.3027	15.835	11.29	4.2346	2.1265	1.591	0.44998	1.2952	5.0154	5.8864
15	5	1	306.87	8.5243	14.696	21.233	6.3119	4.0966	3.1279	2.9302	5.6703	7.7163	10.936
16	5	2	215.45	5.9846	18.856	14.109	5.1842	1.964	1.4254	0.10904	1.2573	4.6395	6.3172
17	5.5	1	291.82	8.1061	13.047	20.65	6.4254	3.3257	3.0527	2.835	4.8381	7.0817	11.699
18	5.5	2	265.61	7.378	22.089	17.523	5.9614	2.9284	1.5399	0.19361	2.2084	6.1009	7.8577
19	6	1	308.7	8.575	14.733	20.062	6.4315	3.1956	2.9664	2.0894	5.7698	10.473	11.454
20	6	2	301.44	8.3732	24.44	17.354	7.2097	3.518	2.2276	0.84134	2.9579	7.5984	9.2124
21	6.5	1	321.16	8.921	16.418	20.744	6.4249	3.2912	3.2256	3.8037	5.7953	9.3571	11.229
22	6.5	2	356.92	9.9144	29.481	18.315	8.2026	4.9659	3.2906	1.4331	4.4374	8.017	11.086
23	7	1	351.45	9.7624	17.637	20.633	6.3875	3.7279	3.7801	3.8216	7.2288	11.461	13.184
24	7	2	443.22	12.312	34.152	20.284	10.308	6.5898	5.4355	2.7119	6.0847	11.742	13.497



### RECONSTRUCTION

- Hough Transform, improved efficiency for multi-particle events, now comparable with MDC tracking (still under testing)
- Few features to understand in track fitting (and memory cleaning)
- Linear track fitting ready and under test with MC

### COSMICS DATA

- Data sharing with the collaboration at IHEP CC
- Conversion in CGEMBOSS implemented and working
- Now validating data import
- Calibration and alignment ready to be tested with real data



## Reconstruction of $\psi' \rightarrow J/\psi \pi^+ \pi^-$ ( $J/\psi \rightarrow e^+ e^-$ )

Efficiency	MDC		NEW CGEM algorithm	
		Boss665p01	Hough V12	Hough V13
	$\pi^+ \pi^- e^+ e^-$	65.71	58.55	63.67
	4 good tracks events	63.25	60.16	62.68
	4C fit events	57.84	52.68	54.20
	4C fit()	57.36	51.37	50.41
	4C fit()	38.70	30.14	25.36

### Under investigation:

- Kalman Filter fitting is failing for 20% of the tracks (spurious hits?)
- Large usage of memory (needed more object clearing)

Plan: finalize the code and release it in October 2019

# RICHIESTE PER IL 2020

Sede	FTE	Missioni 2020		Missioni 2019	
		Richieste	SJ	Richieste	SJ
FE	7.9	143.1	88.4	205.0	0.0
LNF	3.3	53.9	26.7	88.5	0.0
PG-DTZ	0.6	0.0	0.0	11.5	0.0
TO	14	230.3	124.7	368.0	0.0
<b>TOT BESIII</b>	<b>25.8</b>	<b>427.3</b>	<b>239.7</b>	<b>673.0</b>	<b>0.0</b>

Sede	FTE	Consumi		licenze-sw		inventario		trasporti		altri consumi		apparati	
		Richieste	SJ	Richieste	SJ	Richieste	SJ	Richieste	SJ	Richieste	SJ	Richieste	SJ
FE	7.9	11.9	0.0	1.5	0.0	0.0	0.0	2.0	0.0	1.5	0.0	16.5	22.5
LNF	3.3	6.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	1.5	0.0	0.0	0.0
PG-DTZ	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TO	14	28.5	0.0	3.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0	0.0
<b>TOT BESIII</b>	<b>25.8</b>	<b>46.4</b>	<b>0.0</b>										

# RICHIESTE PER QUESTA RIUNIONE

- Missioni
  - sblocco SJ 5kE a Ferrara (per costruzione CGEM e integration)
  - sblocco SJ 5 kE a LNF (per costruzione CGEM)



# MILESTONES 2019

1. **CGEM:** commissioning of the CGEM-IT electronics with cosmics (acquire and process cosmic data) 30-04-2019

Alla luce dei problemi avuti durante il trasporto, il lavoro di commissioning con i cosmici e' comunque proseguito con il layer 2 e parte del layer 1; al momento il rumore e' sotto controllo, l'efficienza di trasmissione al 98%. Proposta 90%. (Pag. 17-22)

2. **CGEM:** misura delle prestazioni del CGEM-IT con run di cosmici 31-07-2019  
dipende da quella sopra, siamo in ritardo ma abbiamo iniziato a studiare le prestazioni del layer 2: proposta 75% (pag. 23)

3. **CGEM:** installazione CGEM in BESIII 31-12-2019  
chiediamo di portare questa al 2020.

6. **SOFTWARE CGEM:** full tuning of the simulation digitization including micro-TPC. 31-07-2019  
completata 75% (pag. 26)

# MILESTONES 2019

**4. COMPUTING:** implementazione server VMDIRAC INFN per gestione comune risorse computing BESIII e BELLEII 31-12-2019

100% il server è attivo ed in grado di ricevere sia per BESIII che per BELLEII. È integrato nel BESIII DC ma non ancora in quello di BELLEII.

**5. COMPUTING:** integrazione server VMDIRAC INFN con servizi di installazione e contestualizzazione automatica di (micro-)infrastrutture cloud 31-12-2019

70% abbiamo preparato la parte server e testato su un'istanza di cloud toy, dobbiamo ancora automatizzare il tutto.

**7. PHYSICS:** sottomissione dell'articolo sullo studio delle proprietà delle distribuzioni angolari dei decadimenti dei mesoni  $J/\psi$  e  $\psi(2S)$  in coppie  $\Lambda$ -Anti $\Lambda$  e  $\Sigma$ -Anti $\Sigma$ . 31-12-2019

ci sono due articoli in preparazione invece di uno solo perche' sono stati fatti studi aggiuntivi e il materiale e' tanto. La rivaluteremo a fine anno.

# PROPOSTA MILESTONES 2020

1. CGEM: accensione del CGEM-IT con i due rivelatori nuovi a Pechino 31-01-2020
2. CGEM ELETTRONICA: integrazione elettronica CGEM con DAQ di BESIII 30-04-2020
3. CGEM ELETTRONICA: montaggio sistema finale di cooling 30-06-2020
4. SOFTWARE CGEM. misura delle prestazioni del CGEM-IT con run di cosmici utilizzando software ufficiale CGEMBOSS 31-07-2020
5. COMPUTING. Ottimizzazione dell'integrazione tra infrastruttura VMDIRAC INFN e Cloud Toy 31-08-2020
6. COMPUTING. Creazione di un'infrastruttura ONE, interfacciata con il BESIII Distributed Computing, per gestione nazionale del cloud bursting BESIII 31-12-2020
7. PHYSICS completamento dello studio di  $e^+e^- \rightarrow \pi^+\pi^-\pi^+\pi^-$  nell'intervallo di energia tra 3.58 e 3.71 GeV 31-12-2020



**THANKS**