



CMS: Anagrafica & Stato esperimento & Richieste 2021

G. Pugliese, Responsabile Locale 2020
A. Pompili, Responsabile Locale 2019

Composizione del gruppo CMS



Attività di Analisi: N. De Filippis

Computing: G. Donvito

Attività MUONI: P. Verwilligen

Attività Tracker: D.Creanza

Staff: M. Abbrescia, A. Colaleo, M. de Palma, G. de Robertis, L.Fiore, G. Iaselli, F. Licciulli, F. Loddo, A. Pompili, G. Pugliese, M.Maggi, G.V. Matarrese, C.Marzocca, S.My, A.Ranieri, L.Silvestris, R. Venditti

Assegnisti/Borsisti: M. Gul, A. di Florio, S. Lezki, G. Miniello J. Merlin

Dottorandi: R. Aly, C. Aruta, W.Elmetanawee, M. Ince, A. Pellecchia, A. di Pilato, V. Mastrapasqua, I. Marjeka, D. Ramos, F. Simone

Anagrafica CMS 2021 (1)

Nome	CMS (%)					TOT (%)	CMS-Phase 2 (%)			TOT (CMS+Ph2) (%)	Sinergiche Esterne (%)	Sinergiche CSN5 (%)	GRAN-TOT (%)
	Analisi	Calcolo	Tk	RPC	GEM		Tk	RPC	GEM				
M. Abbrescia				30	20	50		35		85			85
A. Aly	30					30		40		70			70
A. Aruta					60	60			30	90			90
A. Colaleo					30	30			35	65		10 FTM_NEXT	75
D. Creanza			30			30	70			100			100
N. De Filippis	60					60		10		70			70
M. De Palma			40			40	30			70			70
G. De Robertis						0	30		10	40			40
A. Di Florio	10	40				50	30			80	10 IBISCO	10 ML_INFN	100
A.Di Pilato		60				60	30			90	10 IBISCO		100
G. Donvito		10				10				10	15 IBISCO		25
W.Elmetenawee	40					40		30		70			70
L. Fiore						0	100			100			100
M. Gul						0			100	100			100
G. Iaselli				30		30		50		80			80
M. Ince						0	100			100			100
S. Iezki	60	10		30		100				100			100
F. Licciulli						0	10		20	30		10 FTM_NEXT	40
F. Loddo						0	70			70			70

Nome	CMS (%)					TOT (%)	CMS-Phase 2 (%)			TOT (CMS+Ph2) (%)	Sinergiche Esterne (%)	Sinergiche CSN5 (%)	GRAN-TOT (%)
	Analisi	Calcolo	Tk	RPC	GEM		Tk	RPC	GEM				
M. Maggi						0			60	60		10 FTM_NEXT	70
I. Marjeka	40					40		40		70			70
C. Marzocca						0	80			80			80
V. Mastrapasqua	60	20			20	100				100			100
G. V. Matarrese						0	80			80			80
J. Merlin					100	100				100			100
G. Miniello	10					10				10			10
S.My			10			10	80			90			90
A. Pellecchia					30	30			40	70		30 FTM_NEXT	100
A. Pompili	50	20	10			80	10			90	10 IBISCO		100
G. Pugliese				40		40		40		80			80
D. Ramos				40		40		60		100			100
A. Ranieri						0			70	70		30 FTM_NEXT	100
F. Simone					60	60			30	90			90
L. Silvestris				25		25	55			80		5 ML_INFN	85
R. Venditti					30	30			45	75		10 FTM_NEXT	85
P. Verwilligen						0			60	60		30 FTM_NEXT	90
TOT	3,6	1,6	0,9	1,95	3,5	11,6	7,8	3,1	5	27,35	0,5	1,45	29,3

Responsabilità (LV1 e LV2) 2021

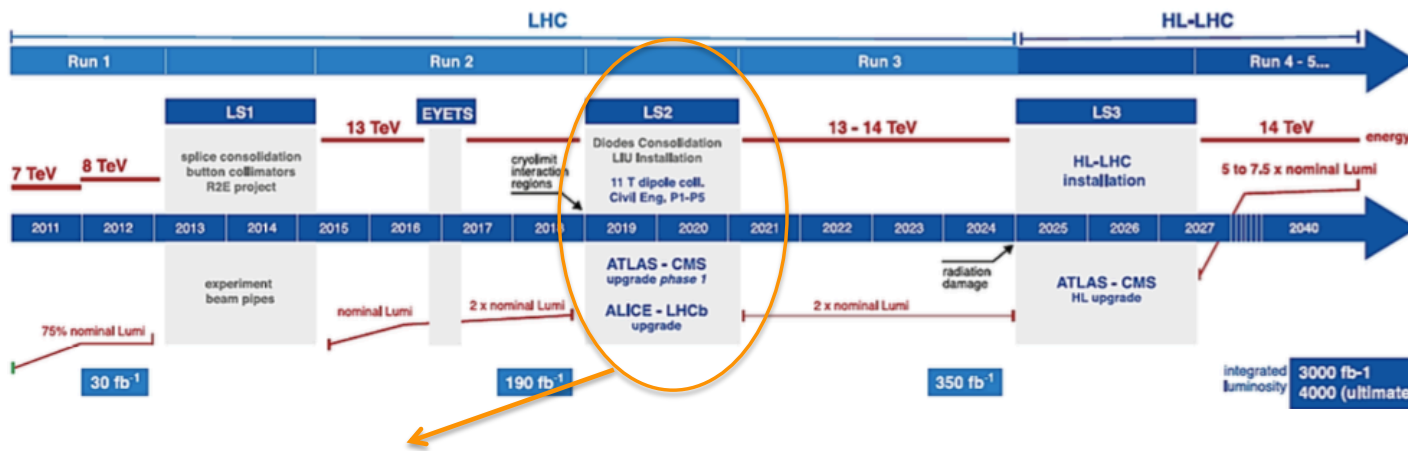


Sub-System	LV1	Task name
RPC	Gabriella Pugliese	RPC System manager

Sub-System	LV2	Task Name
FIS	Alexis Pompili	BPAG coordinator
TRK-PIX	Flavio Loddo	RD53 Project Leader Engineer
GEM	Francesco Licciulli	GEM Electronics coordinator
GEM	Jeremie Merlin	GEM production manager
Muon	Anna Colaleo	Muon IB Chair
PPD	Rosamaria Venditti	Data Quality Monitoring and Certification

LV3 sono indicati nelle successive slides per ogni attività

LHC & HL-LHC schedule vs. Covid



➤ 2019 – 2020 Long Shutdown (LS2)

Impatto del COVID sulla schedula 2020:

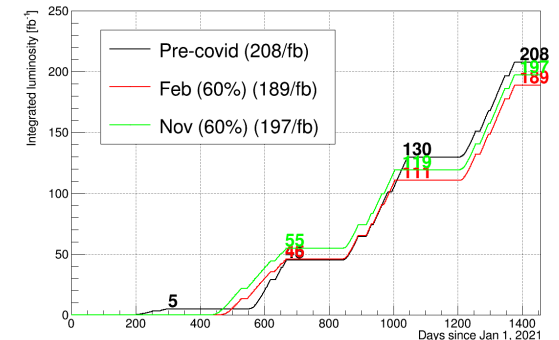
➤ **marzo– maggio 2020: Il CERN è stato ufficialmente chiuso per il COVID. Attività anti-Covid**

➤ **Dal 18 maggio sono riprese le attività al CERN (con specifici protocolli anti-COVID) e le missioni INFN al CERN per attività essenziali e non rinviabili.**

➤ **Definito un nuovo programma che prevede come baseline l'inizio del RUN3 a febbraio 2022 (alternativamente a nov. 2021).**

13/07/20

Luminosità integrata attesa per RUN3



	Pre-Covid		Nov 2021 (no NSW-C)		Feb 2022	
	pp	HI	pp	HI	pp	HI
2021	61	28	0	0	0	0
2022	74	24	171	24	143	24
2023	142	0	108	28	108	28
2024	123	49	123	49	123	49
Total	400	101	402	101	374	101

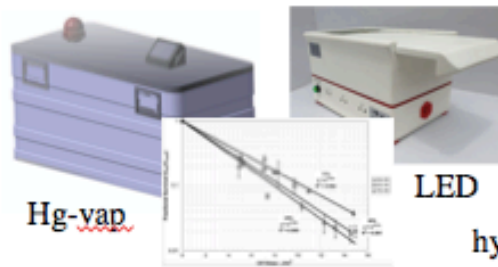
Giorni di presa dati per RUN3

CMS vs COVID

the "BTN" mask project



Sterilisation



Hg-vap

LED

UV-C box projects



Self-Temperature monitor

Valves for "Scuba mask" respirators



hypochlorous acid

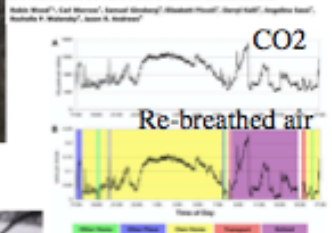


hands-free ---> brass

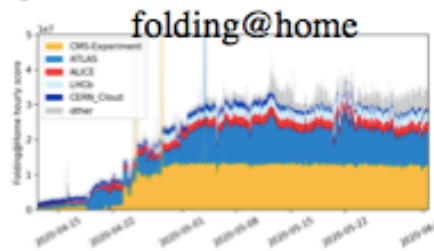
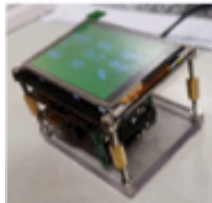
Patient/doctor isolation



Quantification of Shared Air: A Social and Environmental Determinant of Airborne Disease Transmission

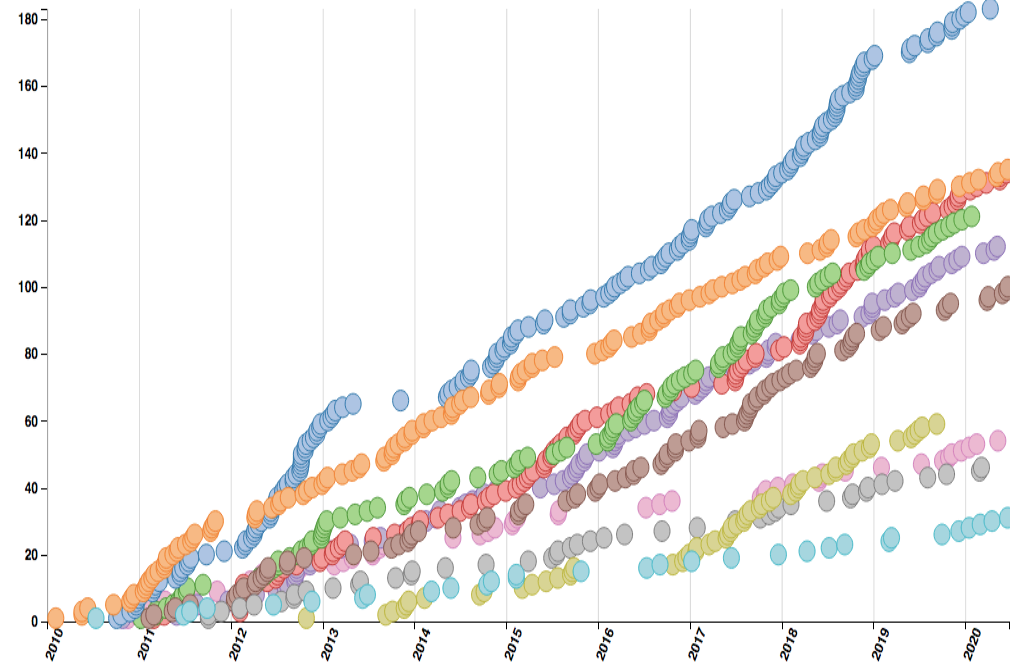
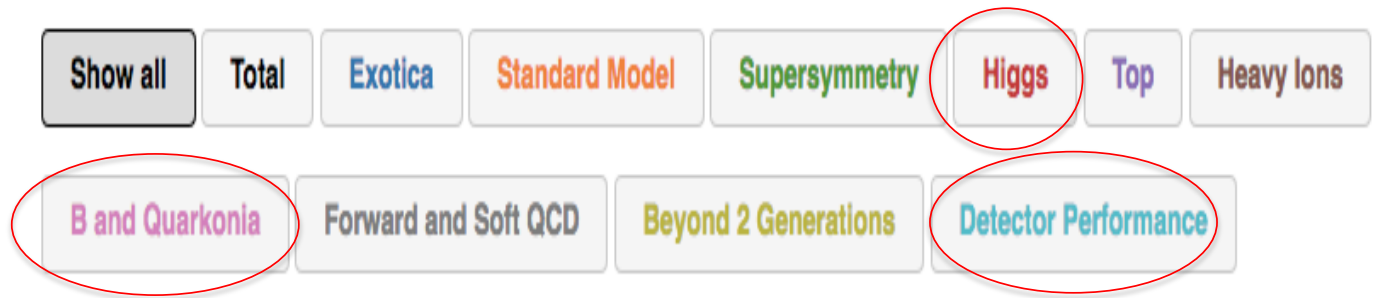
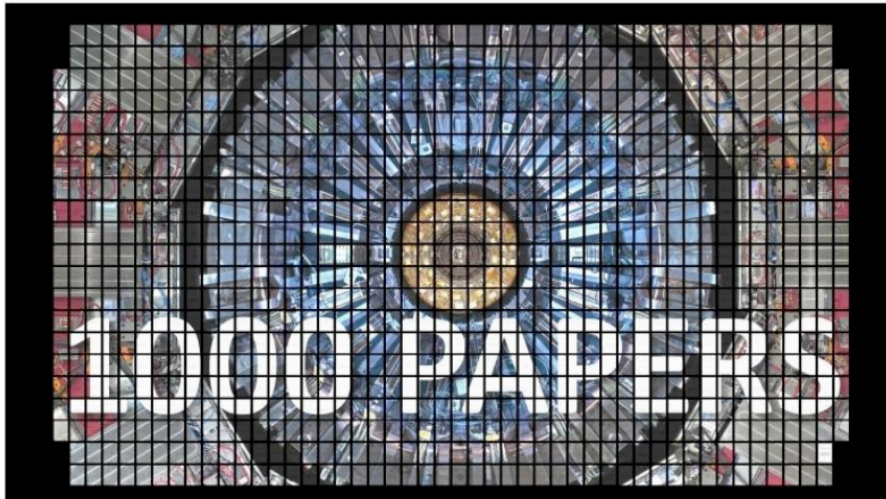


CO2 ventilation level monitor prototype



CMS ANALISI

➤ **Analisi dati:**
sottomesso il 1000simo
articolo scientifico...



...17 autori appartengono al gruppo CMS di Bari

Contributo di Bari nella "Higgs Physics"

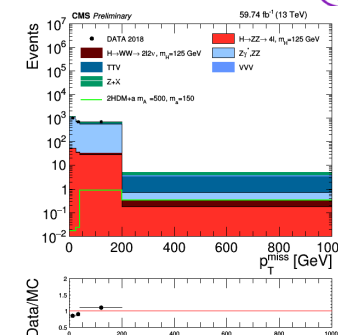


DIPARTIMENTO INTERATENEIO DI FISICA "MICHELANGELO MERLIN"

➤ Ricerca di materia oscura con la segnatura di "MonoHiggs", $H+MET$, con $H \rightarrow ZZ \rightarrow 4l$

R. Aly, N. De Filippis, G. Miniello, F. Procacci, + UCDavis + LIP + FNAL

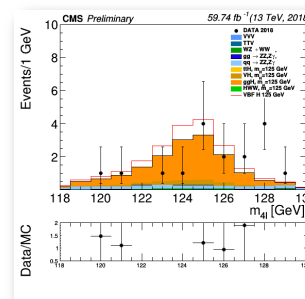
- Pubblicata analisi con dati 2016: **JHEP 03 (2020) 025**
- **analisi dati 2017 e 2018 in corso**
 - Modelli studiati: **2HDM+a**
 - segnatura: $H \rightarrow ZZ \rightarrow 4e - 4\mu - 2e2\mu + E_t^{\text{miss}}$
 - discrepanza dati-MC su E_t^{miss} sotto studio
- fondo Z+X stimato dai dati
- analisi multivariata con BDT
- analisi "blind" per $MET > 200$ GeV



➤ Misura della sezione d'urto di produzione del bosone di Higgs in topologia di fusione di bosoni vettori: $VBF H \rightarrow ZZ \rightarrow 4l$

W. Elmetenawee, N. De Filippis + UERJ + FNAL

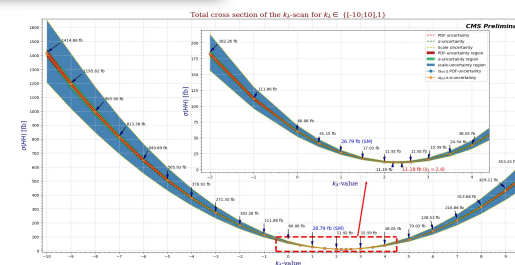
- AN_2018_120 con i dati 2016
- **Analisi dati 2017 and 2018 in corso**
- uso di reti neurali (DNN) per discriminazione segnale da fondo
- segnatura: $H \rightarrow ZZ \rightarrow 4l$ + due jet energetici in avanti



➤ Ricerca di eventi di doppio Higgs nel canale $HH \rightarrow bbZZ \rightarrow bb4l$

I. Margjeka, V. Lacetera, N. De Filippis + Louvain, Torino + FNAL et al.

- Full Run 2 results under approval
- AN-2019/117, PAS HIG-20-004



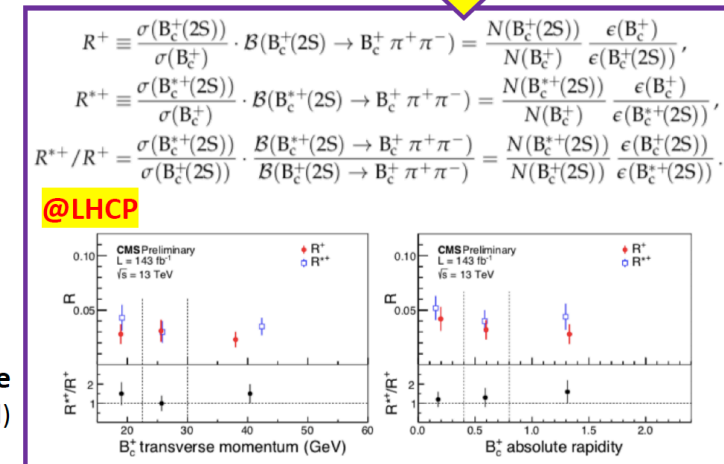
$$\sigma(14\text{TeV})^{\text{NNLO}} [fb] = 36.69 \quad (\text{scale}) \pm 2.1\%(\text{PDF}) \pm 2.1\%(\alpha) \pm 2.7\%(\text{top})$$

Contributo di Bari nella "B Physics"



- A. Pompili "LV2 B-Physics (BPAG) convener, Sept. 2019-21"
- A. P. CMS representative in HFLAV cross-experiment since 2018 [https:hflav.web.cern.ch/] paper accepted to EPJC [arXiv:1909.12524]
- ❖ S. Lezki, A. P., A. Di Florio + CINVSTAV (Mexico City) [Progetto MAECI Italia-Messico 2018-2020]
 - Inclusive search for exotic X_b state [b-partner of $X(3872)$] in the final states $\chi_{b1}(1P)\pi\pi$ & $Y(1S)\pi\pi$ pre-approval in fall
 - Production studies of the excited B_c states in pp collisions at 13 TeV
- ❖ A. di Florio (BPAG Combine contact), A. P.
 - Inclusive search for exotic $X(4140)$ state & partners in $J/\Psi \Phi$ final state (pre-approval in fall)
- ❖ C. Aruta, A. Colaleo, M. Maggi, F. Simone, R. Venditti, P. Verwilligen
 - Search for $\tau \rightarrow 3\mu$ decays in Heavy Flavor channel pre-approval in fall [AN-20-102]
- ❖ V. Mastrapasqua, A. P.
 - B_c spectroscopy (RUN2/B-parking)
 - Charged exotic Z spectroscopy with the 3-body decay $B_d^0 \rightarrow J/\psi K\pi$ (full amplitude fit on GPUs) + ADF + TIFR [BPH-14-003]
 - B-Physics trigger menu for Run3

[relative Xsections of $B_c^{(*)+}(2S)$] (BPH-19-001) (going to FR)

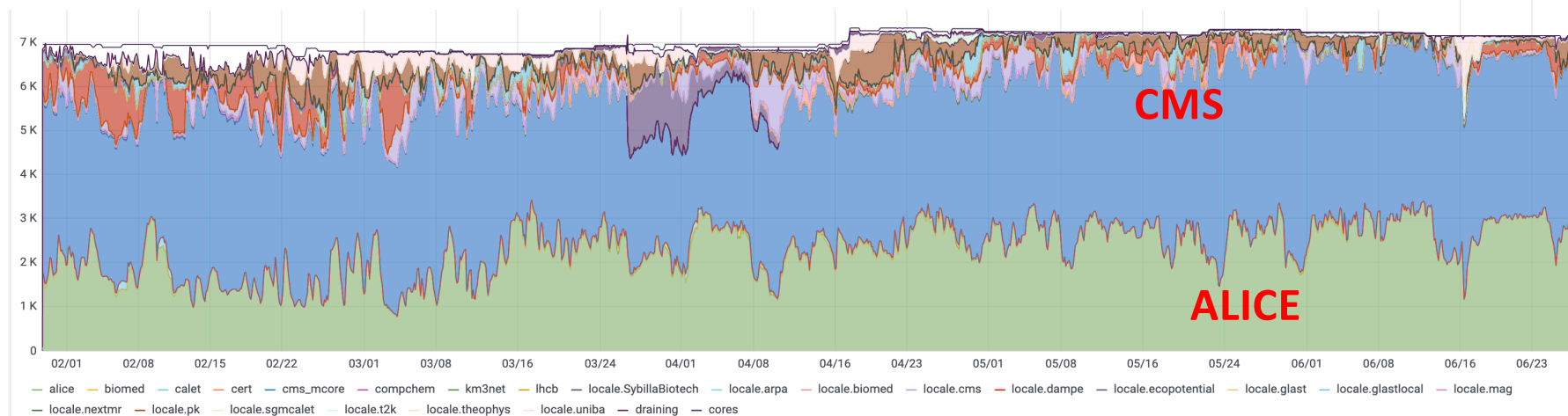


Attività Computing @ Bari Tier2

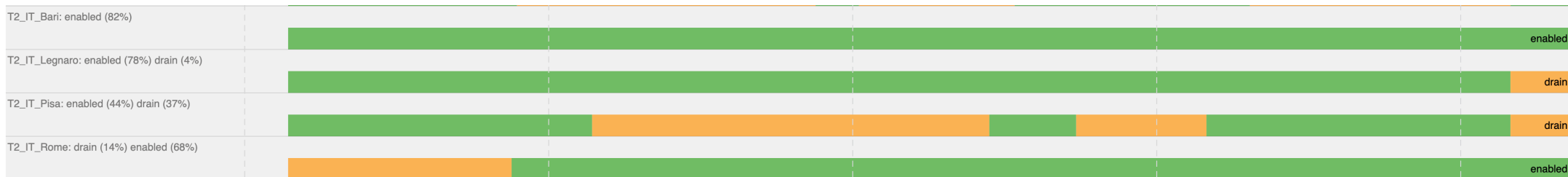


Utilizzo delle risorse:

- Monitoring della farm HTC di Bari: la farm è sempre in saturazione con CMS e Alice che contribuiscono in modo proporzionale allo share dei due esperimenti.



- Eccellenti performance del tier 2 di Bari in confronto con i tier2 italiani (negli ultimi 2 mesi, nonostante il lockdown).



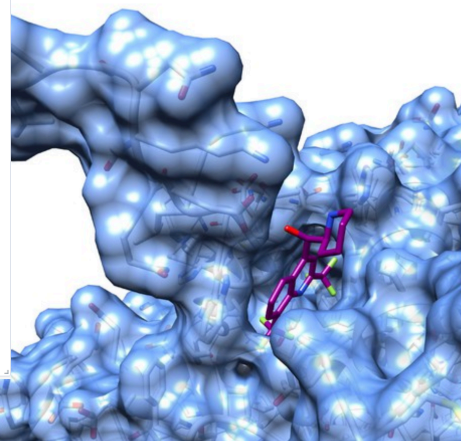
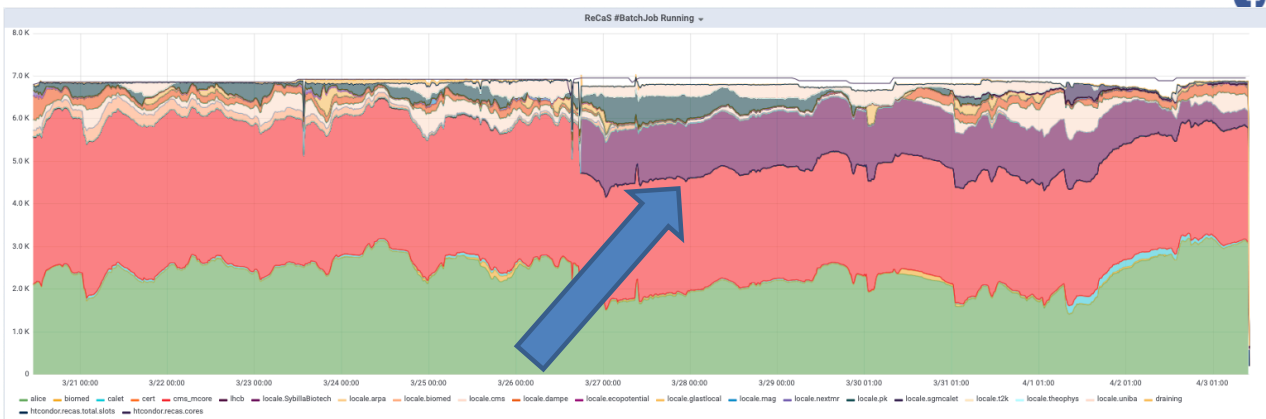
Tier2 e Covid-19

Coronavirus, scoperte 35 molecole per combatterlo

Una appartiene alla stessa famiglia chimica dell'idrossiclorochina



Redazione ANSA 29 aprile 2020 17:56



Struttura della molecola meflochina (fonte: Sibylla Biotech) - RIPRODUZIONE RISERVATA

Scoperte 35 molecole per combattere il virus SarsCoV2, grazie a una potenza di calcolo analoga a quella che l'Italia ha utilizzato per scoprire il bosone di Higgs; una appartiene alla famiglia dell'idrossiclorochina. Descritte sul sito ArXiv, ora potranno affrontare i test per capire se potranno diventare farmaci anti-Covid-19. Sono state selezionate fra le 9.000 analizzate dal progetto guidato dall'azienda Sibylla Biotech e dall'Istituto Nazionale di Fisica Nucleare (Infn).

SITE	Max number of cores for Covid Sibylla simulation	CPU source	Core h dedicated to the project	Fraction (%)
CNAF	17500	Generic	3630067	64.79%
PI	2556	CMS, Theory	498284	8.89%
BA	1280	ReCaS, CMS, ALICE	251725	4.49%
RM1	1536	ATLAS	347525	6.20%
MI	1280	ATLAS	145103	2.59%
LNL-PD	2560	CMS, ALICE (70%/30%)	416083	7.43%
NA	1024	ReCaS, ATLAS	185536	3.31%
LNF	1280	ATLAS	128576	2.29%
TOT CPU Cores	29016	TOT Core.h	5602899	

- Di comune accordo con il management di WLCG, l'INFN ha deciso di mettere a disposizione parte delle risorse di calcolo usate da LHC, per attività per combattere il COVID-19
- Come chiesto dal presidente, anche Bari ha aiutato la Sibylla Biotech (spinoff INFN) a cercare molecole candidate per il vaccino

Informazione pubblicitaria

SUPER FIBRA
26,98€ AL MESE
TUTTO INCLUSO

NUOVA MINI FULL ELECTRIC.
CHARGED WITH PASSION.

RICHIEDI PREVENTIVO

ATTIVA GRATIS

MINI ELECTRIC

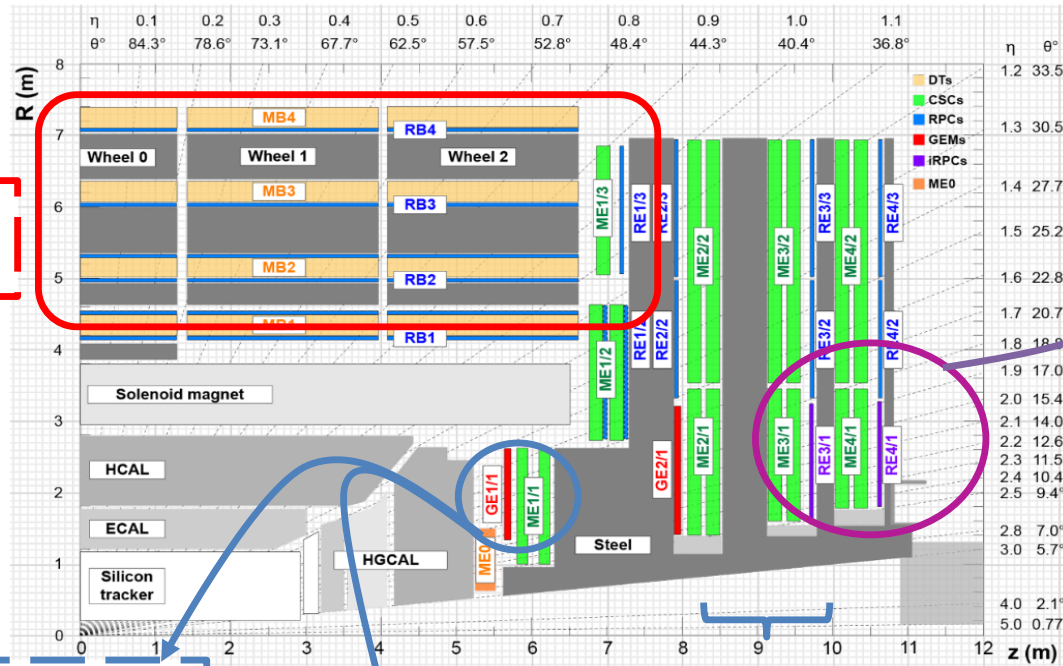
CLICCA PER INGRANDIRE

ALLA HOME SCIENZA&TECNICA



LS2: 2019 - 2020 e 2021

Overview attività Muoni @ CMS in LS2 (focus sulle attività con sostanziale contributo di Bari)

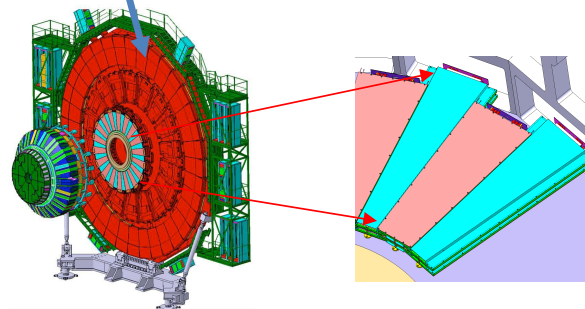


2

RPC campagna di riparazione perdite di gas

1

Stazioni GE1/1
 - *Costruzione & Quality control delle 144 Triple-GEM camere*
 - *Installation SuperCamere e servizi*
 - *Commissioning*



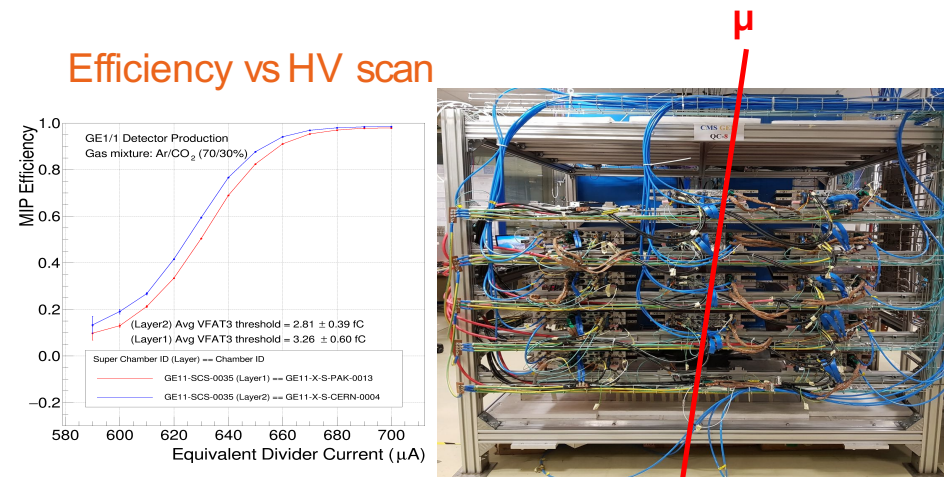
- Super Chambers = 2 coupled chambers
- 72 Super Chambers in total (36 per endcap)
 - Each Super Chamber covers 10.15° (overlap)
 - Digital readout (VFAT3)

Installazione servizi per RPC3.1 e 4.1

3

1 Costruzione e installazione GE1/1

- **GE1/1 FE (VFAT3) designed by Bari Team**
F.Licciulli, G.De Robertis & students (C. Aruta, F.Ivone, F. Simone)
Francesco Licciulli LV2 Electronics Coordinator
- **GE1/1 Production finished** (160 chambers constructed)
 - **Jeremie Merlin --- LV2 Production Coordinator**
 - **Bari produced 18 chambers in 2018; first site to finish production**
 - *A.Ranieri, S.Nuzzo, R.Venditti, A.Sharma, E. Soldani & P.Verwilligen*
 - **LV3 P.Verwilligen GEM Production Site Manager**
- **Super – Chamber construction and final validation ongoing (@ 904 Cosmic Stand)**
 - Bari involved in super-chamber assembly @ CERN
 - *M. Franco, N. Lacalamita, S. Martiradonna, P. Dipinto, D. Dell’Olio*
E.Soldani, S.Nuzzo, R.Triggiani
 - Analysis of Chamber performance: *E.Soldani* → **1 PhD thesis 2019**
 - **Running Cosmic Stand @ 904; Data analysis & Operation**
F. Simone + A.Pellecchia & C.Aruta
 - **M. Maggi LV 2 Run coordinator 2015-2019**
- **GE-1/1 installed with Bari contribution (commissioning ongoing)**
 - *M. Franco, F. Maiorano*



Attività RPC @ CMS

RPC gas leak repair

2

Intensa attività di riparazione delle camere RPC nel barrel (leak durante run 2 circa 900 l/h) importante per ridurre emissione di GHG. Tools per estrarre e riparare la camera sono stati sviluppati dai tecnici di Bari. Gli interventi, sospesi per il COVID, riprenderanno a Settembre 2020.

Example of repair procedure

G. Pugliese, M. Franco



REPAIRED	potentially REPAIRABLE	Leak not identified	NO reparation possible
53%	3.5%	23.5%	20%

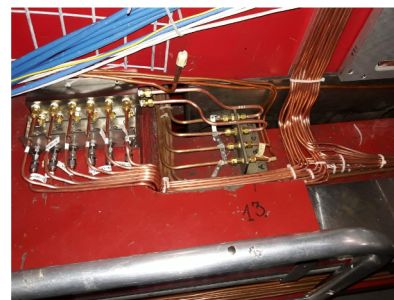
G. Loddo LV3 Electronics responsible

3

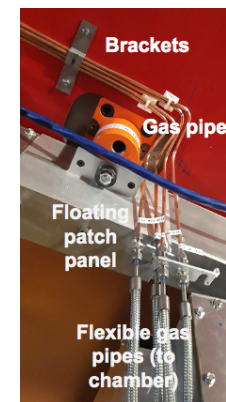
Installazione servizi per la stazioni 3.1 e 4.1

- Installation of RE-3/1 and RE+4/1 services: completed (in 2019)
- Installation of RE+3/1 services completed in Feb/July 2020.
- Installation of RE-4/1 planned for end of 2020/beginning of 2021

G. Pugliese e N. Lacalamita



Gas impedance boxes



Study of RPC Performance in Run-2

Cluster size studies M.Abbrescia & W. Elmatanawee

Commissioning e MWGR in 2019-2020

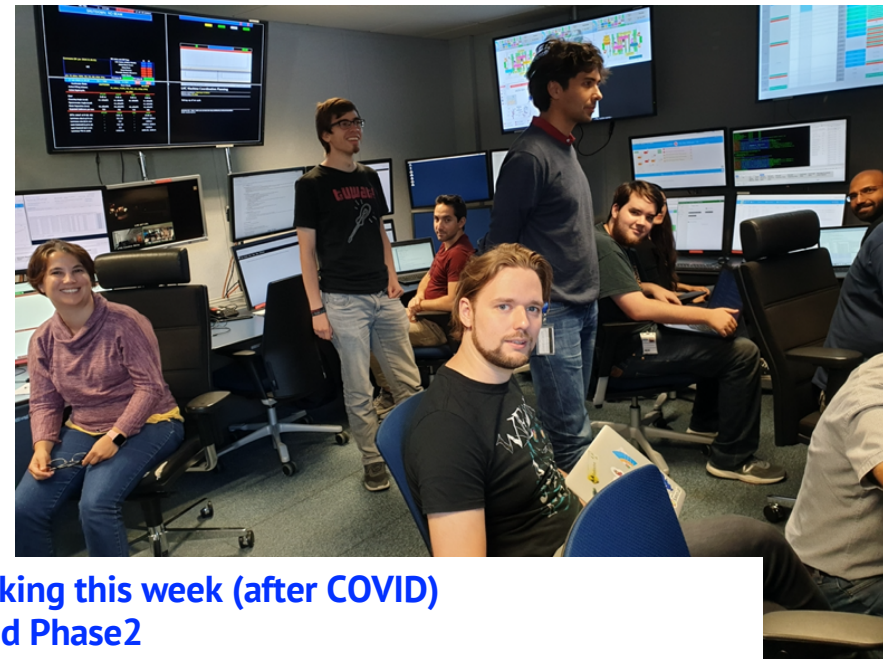


3 days of global cosmic data taking every 2 months in 2019 and 2020 pre-COVID

- Full shift crew 24h /24h
- Cosmics data reconstructed at Tier0
- Data Quality Monitoring (Online –Offline)
- Event Display

Trained technical shifters:
C. Aruta, A. Pellecchia, F. Simone

L. Silvestris: LV1 Run Coordinator (2016- 2020)



- **Re-starting Global cosmic data taking this week (after COVID)**
- **Several tests to prepare Run 3 and Phase2**
 - Detector (re-commissioning)
 - DAQ, trigger ...
 - Test of new operation software tools
 - Database storing run information
 - Monitoring system
 - Training newcomers of the operation crews, keep operation experience up

CMS HL-LHC Upgrade

Technical proposal CERN-LHCC-2015-010 <https://cds.cern.ch/record/2020886>

Scope Document CERN-LHCC-2015-019 <https://cds.cern.ch/record/2055167>

Trigger TDR
APPROVED



L1-Trigger/HLT/DAQ

<https://cds.cern.ch/record/xxxxxxx>

<https://cds.cern.ch/record/2283193>

- Tracks in L1-Trigger at 40 MHz
- Pflow selection 750 kHz L1 output
- HLT output 7.5 kHz
- 40MHz scouting

Calorimeter Endcap

<https://cds.cern.ch/record/2293646>

- 3D showers and precise timing
- Si, Scint+SiPM in Pb/W-SS

Tracker <https://cds.cern.ch/record/2272264>

- Si-Strip and Pixels increased granularity
- Design for tracking in L1-Trigger
- Extended coverage to $\eta \approx 3.8$

Barrel Calorimeters

<https://cds.cern.ch/record/2283187>

- ECAL crystal granularity readout at 40 MHz with precise timing for e/γ at 30 GeV
- ECAL and HCAL new Back-End boards

Muon systems

<https://cds.cern.ch/record/2283189>

- DT & CSC new FE/BE readout
- RPC back-end electronics
- New GEM/RPC $1.6 < \eta < 2.4$
- Extended coverage to $\eta \approx 3$

BARI

Beam Radiation Instr. and Luminosity, <https://cds.cern.ch/record/002706512>

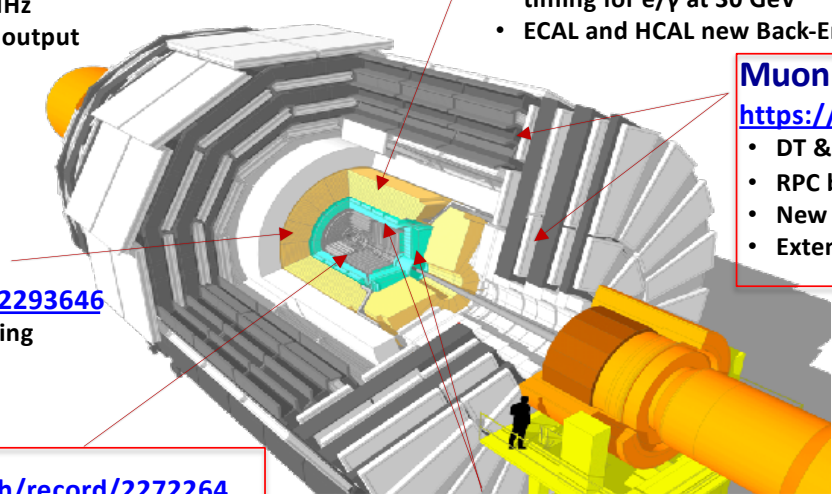
- bunch-by-bunch (BbB) lumi precision
 - Offline 1% / Online 2%

MIP Timing Detector

<https://cds.cern.ch/record/2296612>

Precision timing with:

- Barrel layer: Crystals + SiPMs
- Endcap layer: Low Gain Avalanche Diodes



BARI

New paradigms (design/technology) for an HEP experiment to fully exploit HL-LHC luminosity

Attività di analisi per HL-LHC



Contributi alle pubblicazioni:

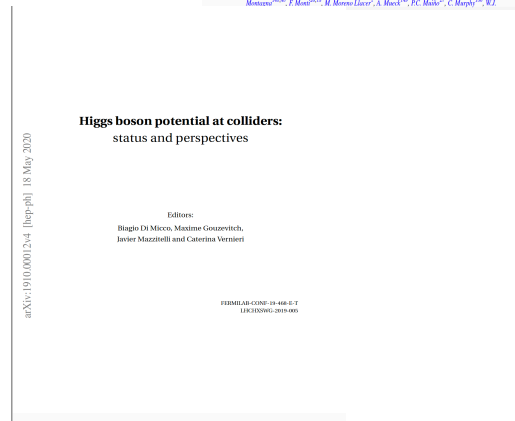
a) Analisi $HH \rightarrow bb4l$ per Yellow Report per HL-LHC :
 «Higgs Physics at the HL-LHC and HE-LHC»

[arXiv:1902.00134v2](https://arxiv.org/abs/1902.00134v2)

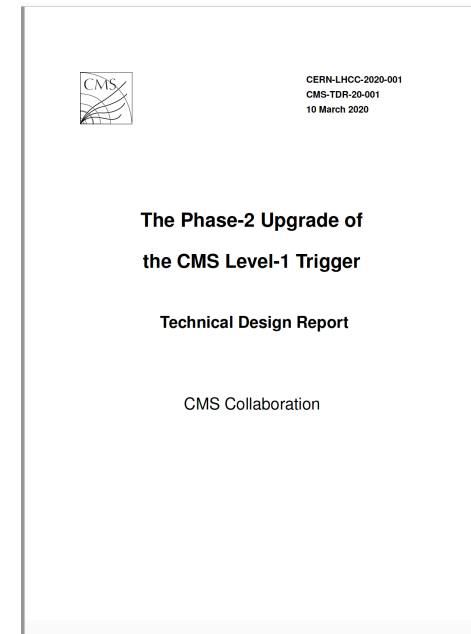


b) Coord. analisi HH per White paper:
 «Higgs boson potential at colliders»

[arXiv:1910.00012v4](https://arxiv.org/abs/1910.00012v4)



c) Coord. analisi Higgs per L1 Trigger TDR: «The Phase 2 Upgrade of the CMS Level-1 Trigger»



N. De Filippis: LV3 “Higgs Future Analysis” convener, Sept.2018-20

d) Coord. Analisi per HLT TDR

Attività software for Phase II



Development of the software **reconstruction for the new HGICAL system** based on new clustering algorithm with **GPUs usage**.

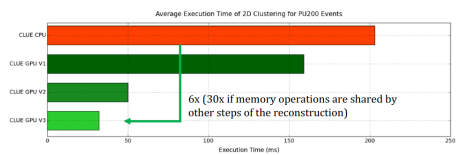
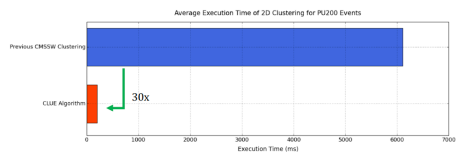
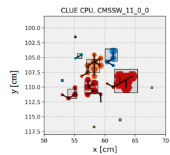
A. Di Pilato et al. in coerenza con il programma scientifico del dottorato industriale.

Development of the software for **Pixel Tracks and vertices reconstruction** based on **GPU usage** for the L1 trigger and HLT for HL-LHC but also likely to enter in production in RUN3 .

A. Di Florio L3 TRK @ HLT coordinator (Tracking POG)

HGICAL reconstruction: new clustering algorithm (*)

- CLUE: Clusters of energy**
- based on energy density of hits
 - $n = 10^5$ hits $\rightarrow k = 10^4$ clusters
 - small clusters ($n/k \sim 10$)
 - fast
 - GPU-friendly

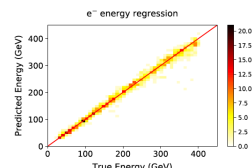
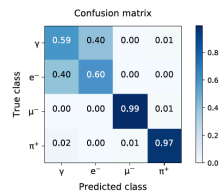
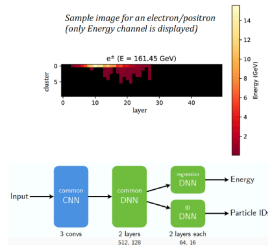


Ref. A. Di Pilato et al., JINST 15 (2020) C06023 (arXiv:2004.11002v2) (*) in coerenza con il programma scientifico del Dottorato Industriale

HGICAL reconstruction: particleID and energy regression (*)

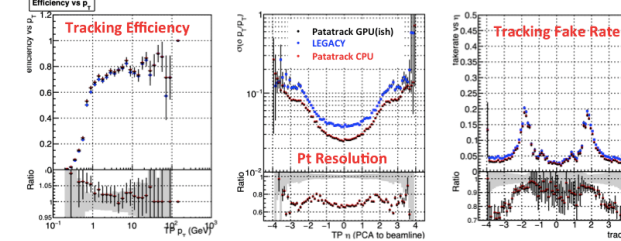
Tracksters (collections of clusters on each layer aligned like tracks - 3D objects) are the target objects on which particle identification and energy regression are performed with a Convolutional Neural Network

Tracksters represented as images of size **50** (number of HGICAL layers per endcap) \times **10** (maximum number of clusters on each layer for tracksters) \times **3** (features - energy, eta, phi)



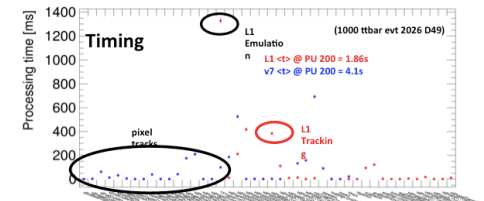
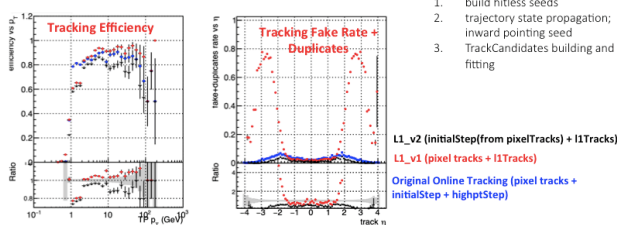
L1 and HLT track reconstruction for Phase 2 HL-LHC

Patatrack workflow



From Phase2 L1 Trigger will provide as input to HLT tracks reconstructed with the strip detector for $pT > 2 \text{ GeV}$. Studies are being carried on to understand how to integrate them in the online menu. After an initial test for matching pixelTracks with L1 Tracks the use of L1 Tracks for hitless seeding has been tested:

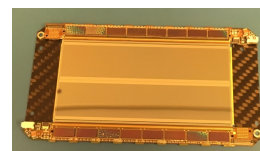
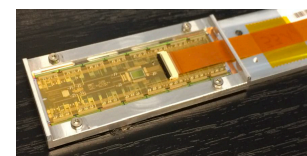
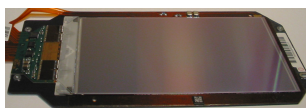
- hitless seeding runs
 - build hitless seeds
 - trajectory state propagation; inward pointing seed
 - TrackCandidates building and fitting
- L1_v2 (initialStep from pixelTracks) + I1Tracks
 L1_v1 (pixel tracks + I1Tracks)
 Original Online Tracking (pixel tracks + initialStep + highptStep)



Attività Tracker per Phase II (1)

Detector Construction:

- 1994-2006 ½ Inner CMS Tracker
 - 2000 modules: automated assembly (gantry), wirebonding and testing
- 2010-2017 ½ L3 Bpix of CMS phase1 Upgrade
 - 300 modules: assembly and, wirebonding and fast testing
- 2017- oggi CMS Outer Tracker (TBPS) Phase2
 - 1000 PS Modules: assembly, wire bonding and testing



Phase 1 Tracker

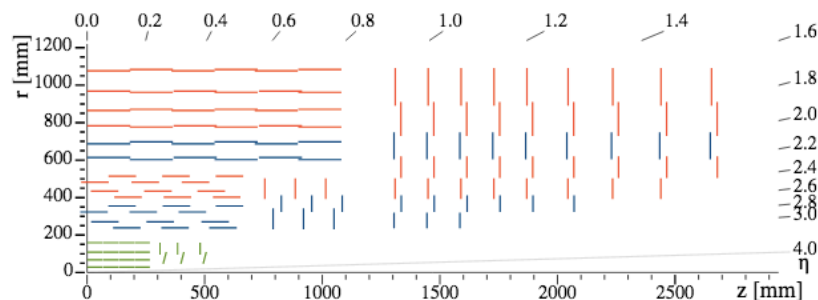


Figure 2.1: Sketch of one quarter of the Phase-1 CMS tracking system in r - z view. The pixel detector is shown in green, while single-sided and double-sided strip modules are depicted as red and blue segments, respectively.

Phase 2 Tracker

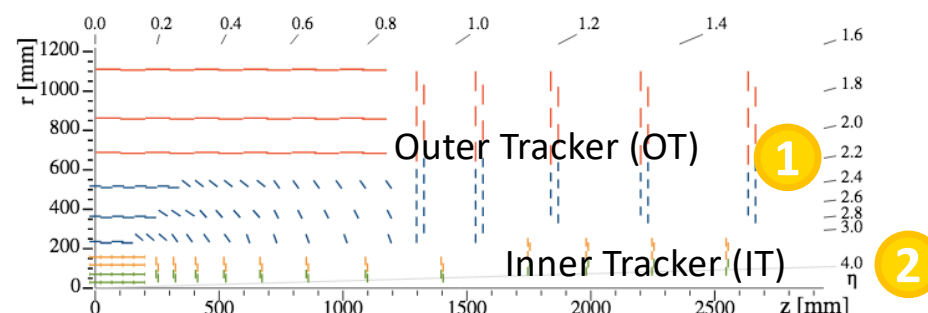
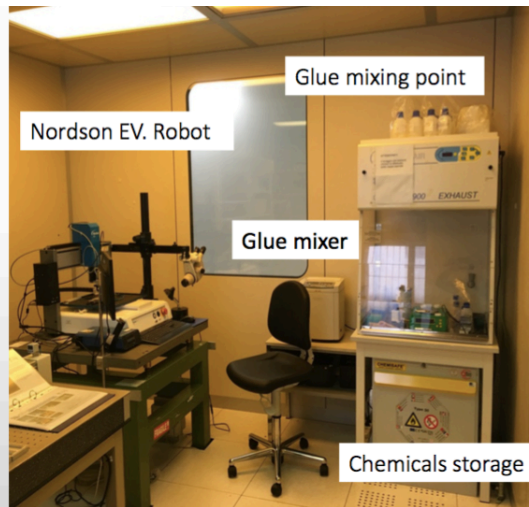
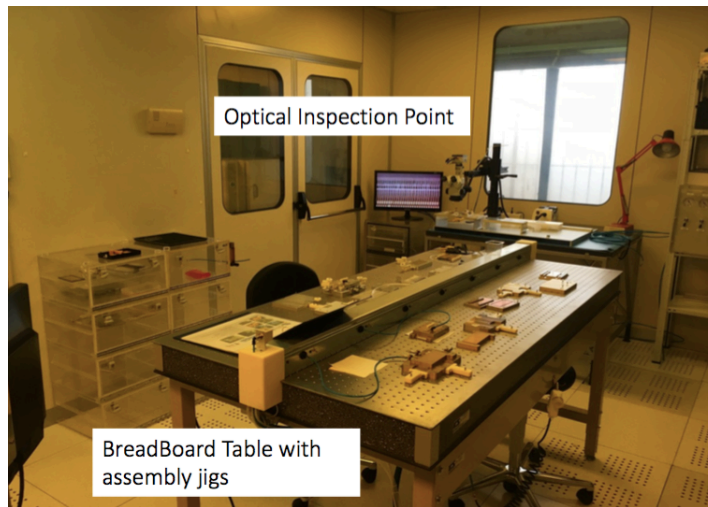


Figure 2.3: Sketch of one quarter of the tracker layout in r - z view. In the Inner Tracker the green lines correspond to pixel modules made of two readout chips and the yellow lines to pixel modules with four readout chips. In the Outer Tracker the blue and red lines represent the two types of modules described in the text.

Outer Tracker: PS Modules production

1



**Bari è impegnata:
assembly, wire bonding and testing**

P.Cariola e G.Sala (CleanRoom)

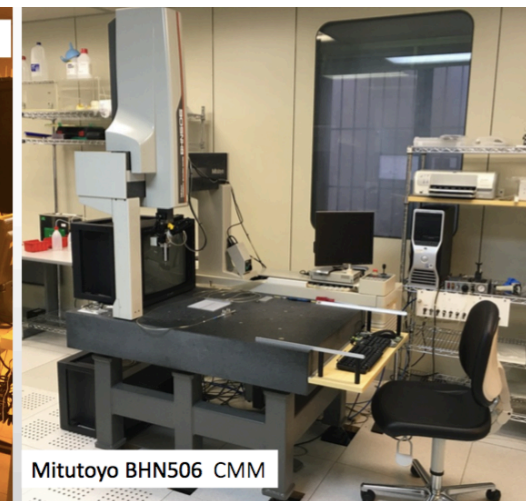
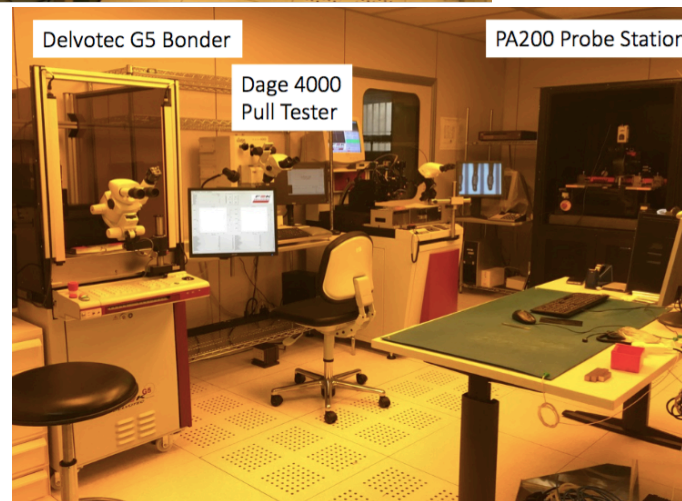
S. Martiradonna (INFN Mech. Service), M. Mongelli (INFN Tech. Design)

D.Creanza, M.dePalma, L.Fiore, S.My

Attività nel 2020-2021

Realizzazione di 5 moduli funzionali per la qualifica del centro:

- Finalizzare e ottimizzare del jig di assemblaggio;
- Messa a punto del sistema di test;
- Studiare le procedure di produzione dei moduli.

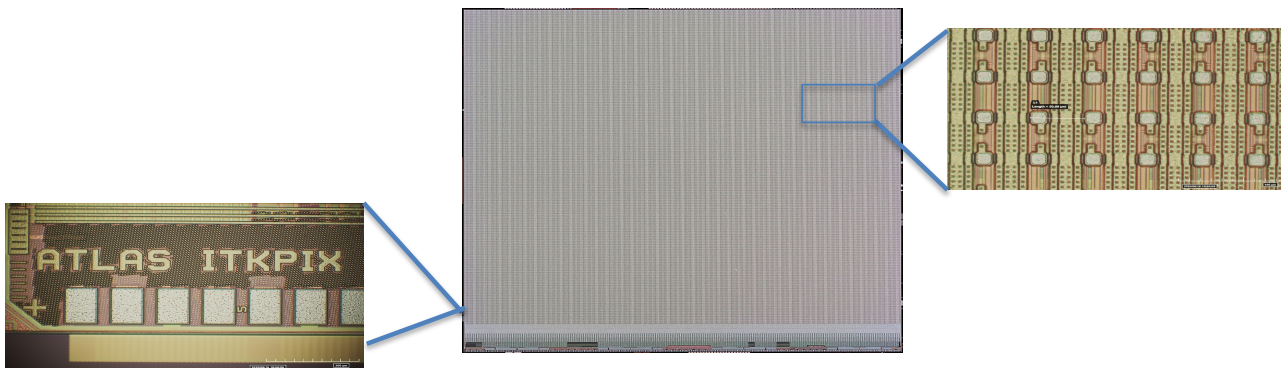


Attività CMS Tracker per Phase II (2): 2

Sviluppo dei pixel chip di ATLAS e CMS:

- Attività iniziata nel 2013 nell'ambito della collaborazione **RD53** e dell'esperimento **CHIPIX65** di gruppo V
- Dopo aver realizzato il dimostratore a larga scala "**RD53A**" (2017) attualmente utilizzato da entrambi gli esperimenti per procedere con l'R&D dei sensori, la collaborazione RD53 è ora impegnata nella progettazione dei prototipi finali, sulla base delle misure sul dimostratore RD53A e delle specifiche finali dei due esperimenti.

Il gruppo di Bari sta partecipando alla progettazione dei pixel chip, con sottomissione in fonderia in Q1 2020 della versione Atlas e Q4 2020 per il chip di CMS (C-ROC)



F. Loddo e G. De Robertis

Progettazione:

- Convertitore Digital-to-Analog a 10 bit per il bias dei Front-End analogici
- Architettura e implementazione della rete di bias
- Floorplan del chip
- Studio ed implementazione di soluzioni circuitali per aumentare la testabilità del chip in fase di produzione
- Verifiche sign-off

Attività prevista e responsabilità

Attività prevista nel 2020-2021:

- Marzo 2020: sottomissione in fonderia del pixel chip RD53B-ATLAS (ITKPIX V1)
- Prototipi arrivati al Cern a Giugno 2020 → test inizieranno a breve
- Aprile 2020: inizio finalizzazione del pixel chip RD53B-CMS (C-ROC v1), la cui sottomissione è prevista ad Ottobre 2020
- Collaudo dei prototipi e progettazione dei chip di produzione (2021)

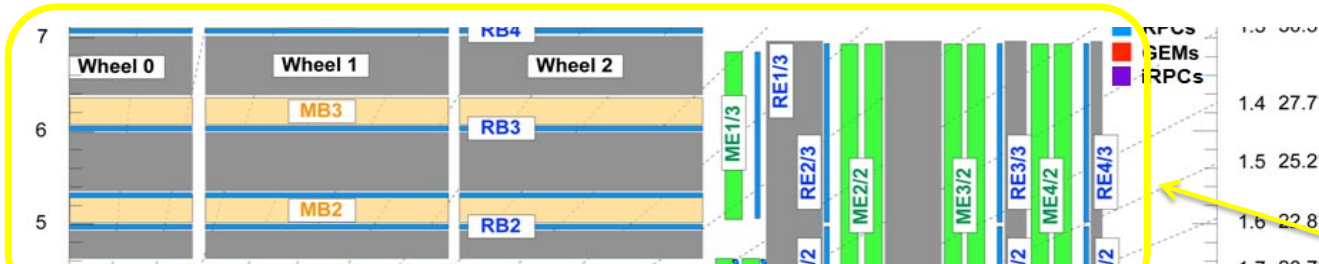
Responsabilità:

- Da giugno 2016 F. Loddo è LV2 “RD53 Project Engineer”, con responsabilità di coordinamento ed integrazione dei chip
- Da Maggio 2018 F. Loddo è LV3 “CMS Ph2 IT ASIC project coordinator”

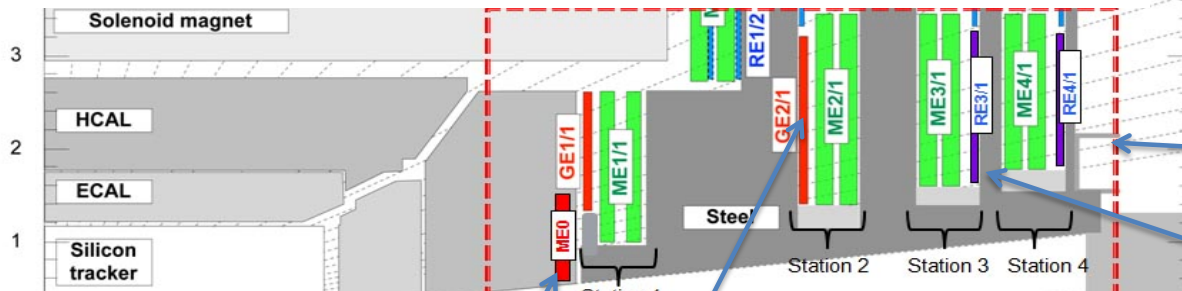
Attività Muon per Phase II



DIPARTIMENTO
INTERATENEO
DI FISICA
"MICHELANGELO MERLIN"



Estensione copertura dello spettrometro a muoni

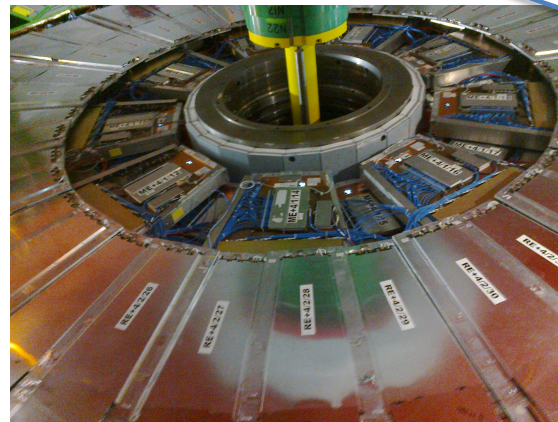


1.3	33.0°
1.4	27.7°
1.5	25.2°
1.6	22.8°
1.7	20.7°
1.8	18.8°
1.9	17.0°
2.0	15.4°
2.1	14.0°
2.2	12.6°
2.3	11.5°
2.4	10.4°
2.5	9.4°
3.0	5.7°
4.0	3.4°

4
Longevity and ecogas studies

1
2

- ME0 & GE2/1**
- Prototype Design & Construction
 - Discharge tests @ CERN & Bari
 - Test Packaged VFAT3 chip @ Bari
 - Simulation of various HW design
 - Simulation of HGAL & Neutron Bkg

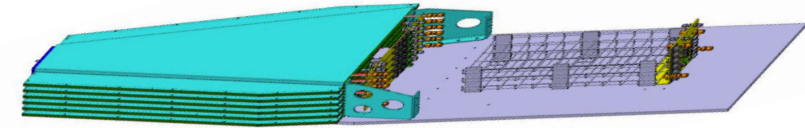


3
New RPC3.1 e 4.1

Stato MEO

1

➤ Re-evaluation of MEO background after HGAL Design improvements point towards much higher rates that MEO need to maintain. Design of new MEO Shielding using Fluka simulations *P. Verwilligen*



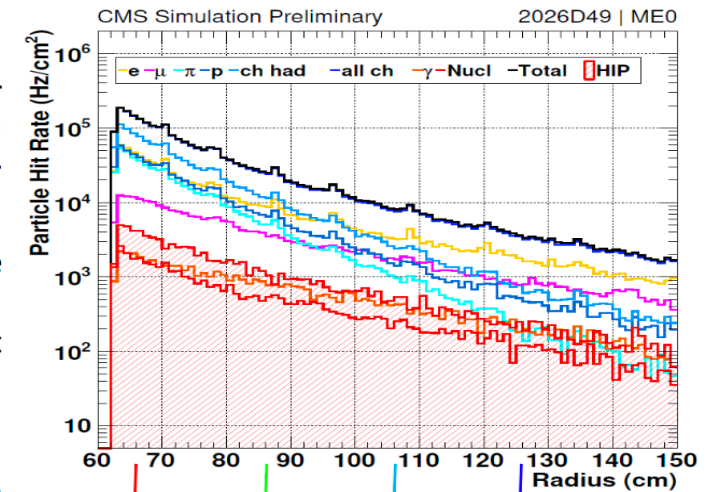
➤ Redesign MEO GEM Foils & MEO powering to deal with Rate. Simulation studies to design size of HV segments *A. Pellecchia*

➤ Design MEO Readout Board & MEO GEM Electronics Board (GEB) inside GEM Electronics "Triad" group: complex interplay between electronics & mechanical design *P. Verwilligen*

LV3 responsibilities:

Phase-2 Simulation Coordinator *P. Verwilligen*

GEM Detector Response Modeling Coordinator *P. Verwilligen*



MEO OH will be based on LpGBT allowing for power consumption reduction
MEO GEB will be split in two separate domains powered by the same LV channel but now electronic components of mechanical parts will be shared between the two GEB domains which will act independently like the GEBs on the GE2/1 modules



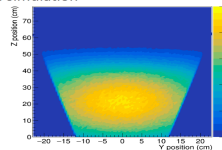
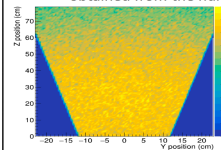
1 X 2.5V FEAST + 2 x 1.2V FEAST are enough to power 2 x OH and 12 x VFAT2 hybrid board

Due to the *non-uniform irradiation*, each HV sector receives a *different photon*

1) a dedicated *numerical simulation* was developed to estimate the *HV sector weights* w_i :

→ w_i is the fraction of total current flowing through the protect. resistor of the *i-th* HV sector (in case of non-uniform irradiation)

→ w_i is equal to fraction of total photons hitting the *i-th* HV sector obtained from the numerical simulation



2) the *HV sector weight* w_i is calculated as follows:

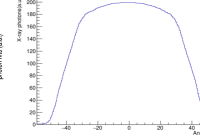
$$w_i = \frac{\text{current on the } i\text{-th HV sector}}{\text{total current on foil}} = \frac{\text{photon hits on } i\text{-th HV sector}}{\text{total photon hits}}$$

Francesco Fallavollita

GEM Phase 2 Upgrade Workshop

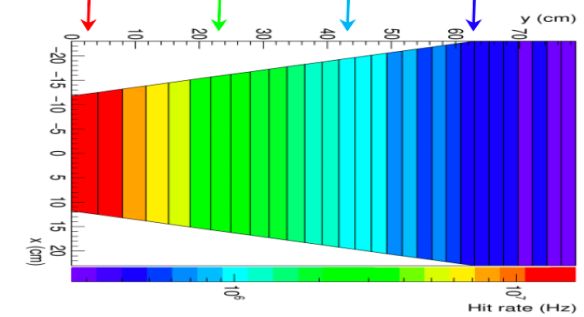
numerical simulation developed by *Alessandro Pellecchia* (University of Bari and INFN)

X-ray gun angular distribution



- the horizontal alignment precision of X-ray gun ~ 1 cm gives uncertainty on the HV sector weights
- the error propagation gives an uncertainty of ~ 0.2 on the gas gain drop

CERN, May 19th, 2020



Stato GE2/1

2

Some modification on GE2/1 have been implemented after tests performed on GE1/1 chambers:

- Sustained Operation'' to understand channel loss Slice-Test
C.Aruta, F.Simone & F.Ivone → 1 Master Thesis (2019)
G.De Robertis & F. Licciulli
- Study of impact of discharges on GEM with setups in Bari & CERN
- Discharges at high Rate & Rate-Capability test in Bari
J.Merlin, A.Stamerra & A.Colaleo → 1 Master Thesis 2020

GE2/1 modifications:

1. Double Segmented foils reducing the discharge damage to FE
2. Packaged VFAT3 chip to avoid bounding problems on small pads

1. GE21 Double-Segmented foils reduce detector capacitance

But parasitic signal is picked up
 Careful balance between discharge protection & cross talk required
 Production of GE2/1 foils halted
 Investigations in Lab ongoing, solution identified but verification interrupted due to COVID

2. Packaged VFAT3 chip --- INFN Bari responsibility

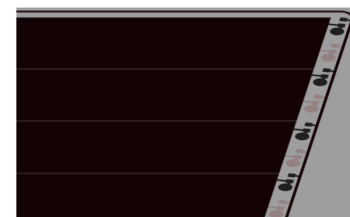
First production of ~200 packaged chips done
 Validation of packaged VFAT3 planned for this summer
 Test setup HW & FW ready @ Bari;
 SW being developed waiting for CTS Technologist to have VISA to travel to Bari

LV3 responsibilities:

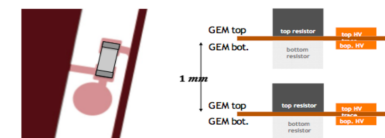
GE21 ASIC-DAQ Integration *F. Licciulli*
 GE21 Construction Manager: *J. Merlin*

Double segmented foils for GE2/1

- GEM double segmentation would:
 - Reduce the propagation probability and the damage probability
 - Improve the high voltage stability of the GEM-foil in case of discharges
 - Allow efficient de-coupling of the bottom foil through protection resistor



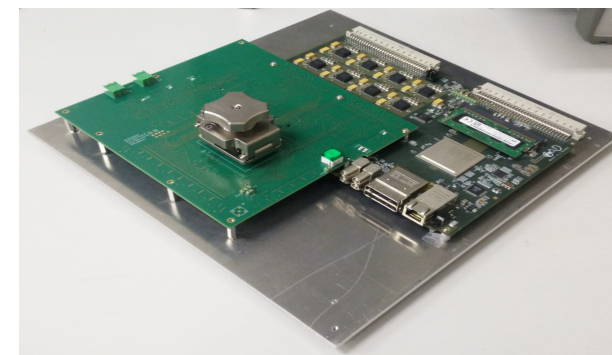
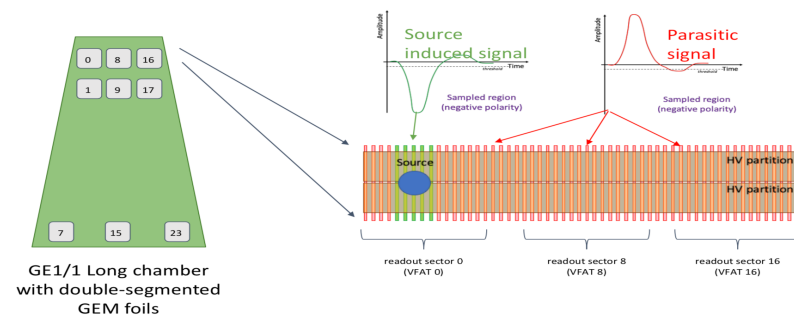
TOP side (in BLACK)
 BOTTOM side (in RED)



Bottom pad placed near the lower side of the same HV sector.

HV traces were moved away from the active area.

GMM CMS-Week GE2/1-MEO Status Report CERN, Feb. 4, 2020 p. 12

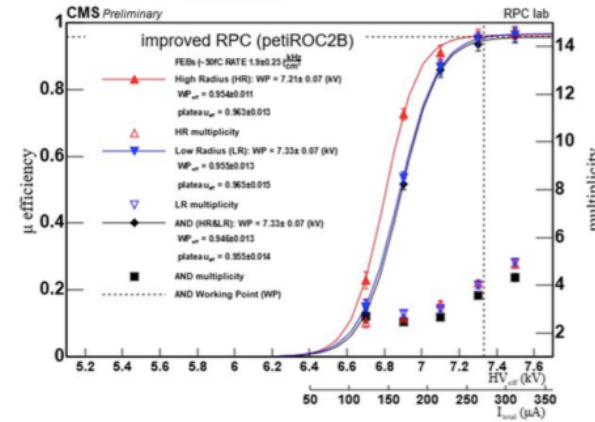


Packaged VFAT3 Test Setup @ Bari

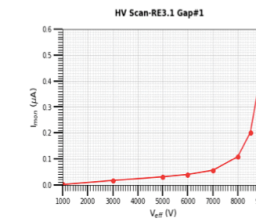
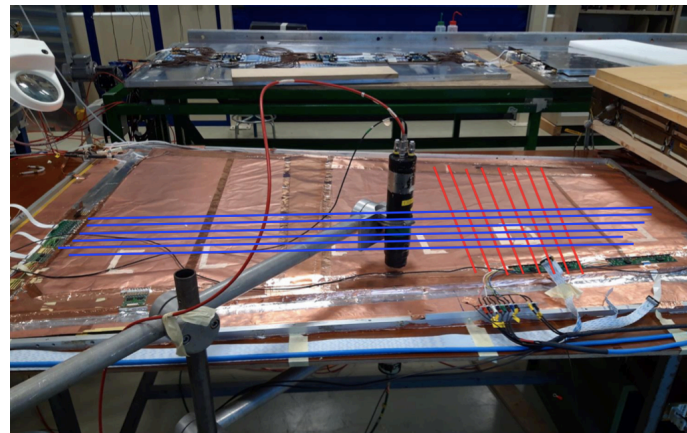
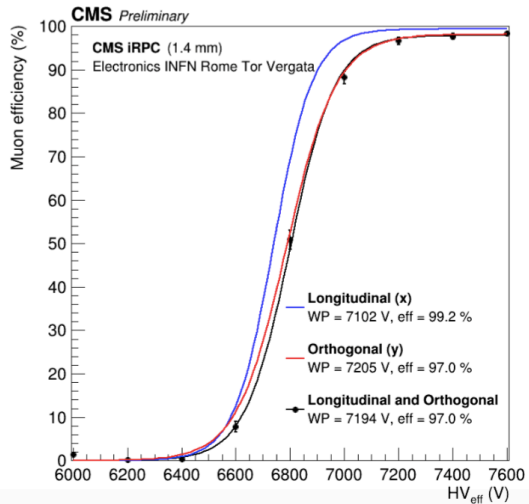
Stato RE3.1 e RE4.1 3

- **Validation of RE3.1 and 4.1 prototype:**
 - Chamber equipped with FEB V1 electronics (Petiroc chip) validated in March 2020 @ 2kHz/cm². Full validation with final electronics is the next step.
 - Backup option based on INFN – Tor Vergata electronics studied on prototype iRPCs tested in 904 and GIF++.

I Margjeka, G. Pugliese



First RE3.1 prototype assembled and tested in Ghent lab



RPC Longevity and eco-gas studies

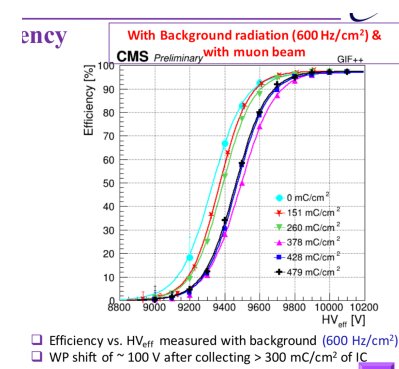
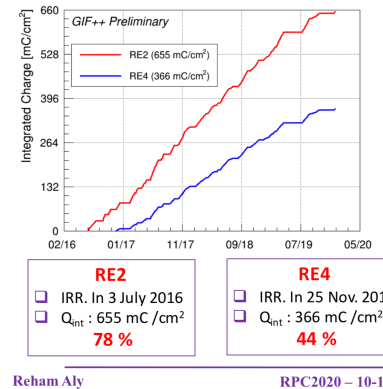
4



➤ RPC Longevity studies @ GIF++ since 2018:

- Ageing tests on spare RPC endcap chambers
- 78% Complete for RE2; 44% Complete for RE4
- Performance stable

LV3 Responsibility Longevity studies: R. Aly



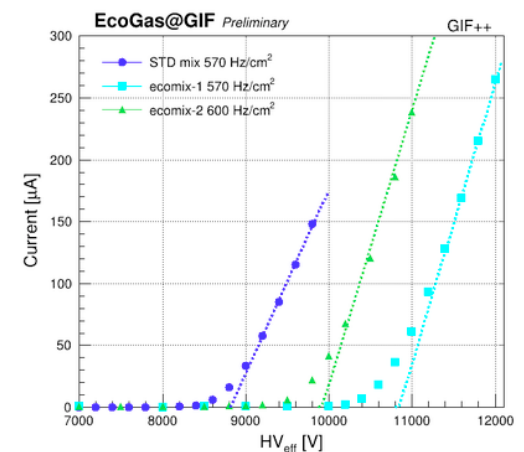
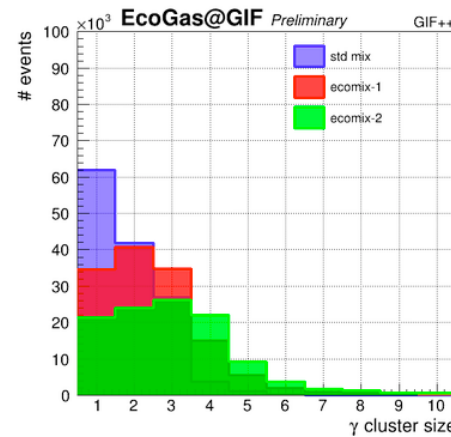
➤ R&D on new ecological RPC gas mixture @ GIF++ since April 2019:

- Five RPCs (2 CMS, ATLAS, ALICE, EP-DT) under test. One RPC equipped with CMS electronics.
- Two eco-gas mixture based on HFO 1234ze (C₃H₂F₄) tested so far:
 - HFO - CO₂ - iC₄H₁₀ - SF₆ (45 - 50 - 4 - 1%)
 - HFO - CO₂ - iC₄H₁₀ - SF₆ (35 - 60 - 4 - 1%)
- Larger cluster size, average charge per hits and HF production

• A. Gelmi & G. Pugliese → 1 PhD thesis

All results are here:

<https://twiki.cern.ch/twiki/bin/view/CMS/ECOGASRESULTS>



Richieste Tecnici della sezione 2021



Detector	Servizio	Mesi	Task	CERN
Tracker	Camera Pulita	12		
	Progettazione Meccanica	6		
	Officina Meccanica	3		
MUON	Progettazione Meccanica	2	Progettazione costruzione GE2/1	
	Officina Meccanica	12	Cost. Ge2/1 +Mech+kits prep+ Inst. Servizi 2.5	11
	Servizio Elettronico	3	Test Setup GE2/1 + Test packaged VFAT3	
	Officina Meccanica	7	RPC Installazione Servizi e demonstrator, Leak repair, GIF++	7

Richieste Finanziarie 2021



Missioni	Keuro
Metabolismo Estero (1m.u./FTE)	118,5
Metabolismo Interno (1kEURO/FTE)	29,3
Services duties & Shifts (1 m.u./FTE)	118.5
Responsabilità (L1 5 m.u. & L2 3 m.u.)	93.2
Attività di Manutenzione e Commissioning	85,1
Attività per Phase 2	113,4
TOT	558

Costruzione Apparati (CMS)	KEuro
Bari Tier2 storage (dismissioni + nuovi acquisti) 1425 TBN	199.5
Bari Tier2 CPU (dismissioni + nuovi acquisti) 10.3 kHS06	102.7
Bari Tier2 rete	16
Bari Tier2 server	21
Manutenzione storage DELL (settimo anno)	25
TOT	364,5

Consumi	Keuro
Camera Pulita	4
Metabolismo (1.5 kEuro/FTE)	44
	48

Phase 2		KEuro
Costruzione Apparati	detector components GE21	25
	Contributo OPTS	20
Consumo	Test elettronica x RPC	3
	Test beam x GEM	5
Contributo RD50&RD53		3,5



Backup

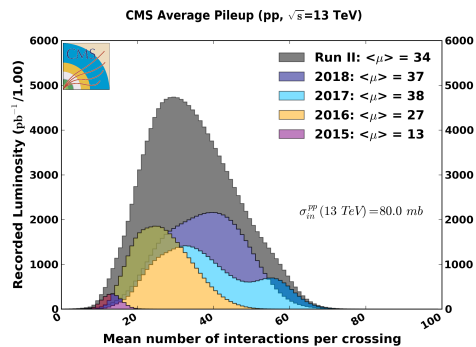
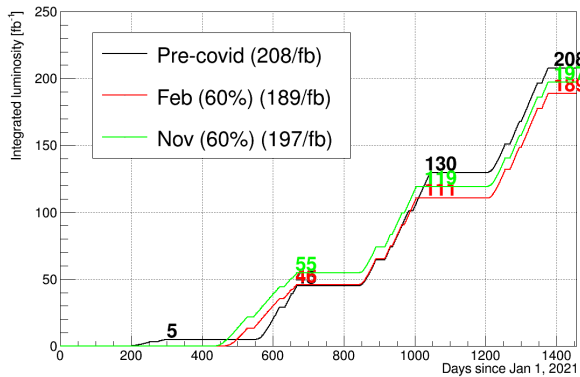
	Pre-Covid		Nov 2021 (no NSW-C)		Feb 2022	
	pp	HI	pp	HI	pp	HI
2021	61	28	0	0	0	0
2022	74	24	171	24	143	24
2023	142	0	108	28	108	28
2024	123	49	123	49	123	49
Total	400	101	402	101	374	101

..previsioni per RUN3

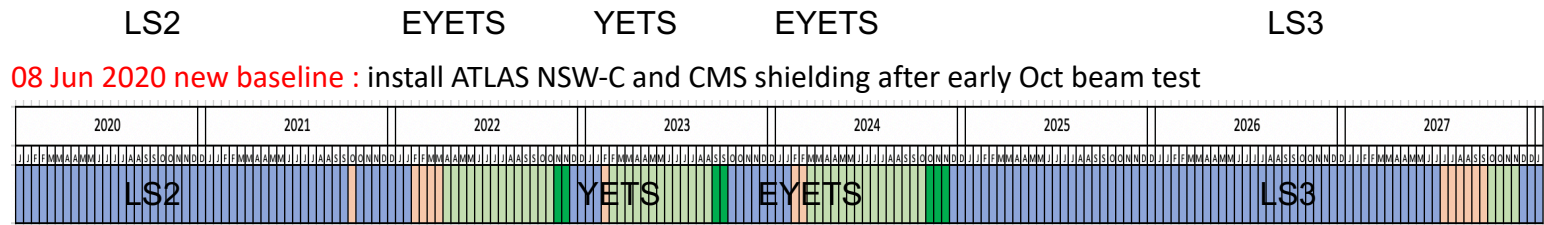
➤ Prodotta una nuova schedula per Run3 (baseline) con un inizio RUN3 a febbraio. Alternativamente a novembre 2021



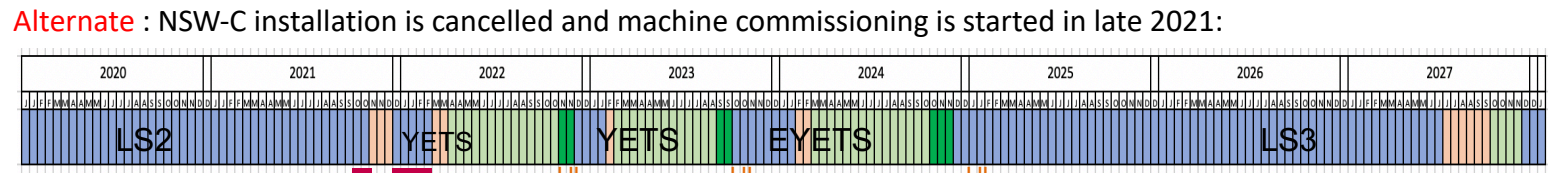
27 Nov 2019 plan: recall LHC start in May-July 2021 depending on ATLAS NSW-A installation



PU in 2022 \approx 2018

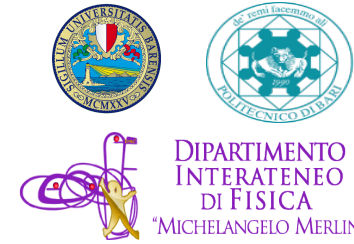


with the only other major intervention pre LS3 being EYETS 23-24 (infrastructure + endcap muon)



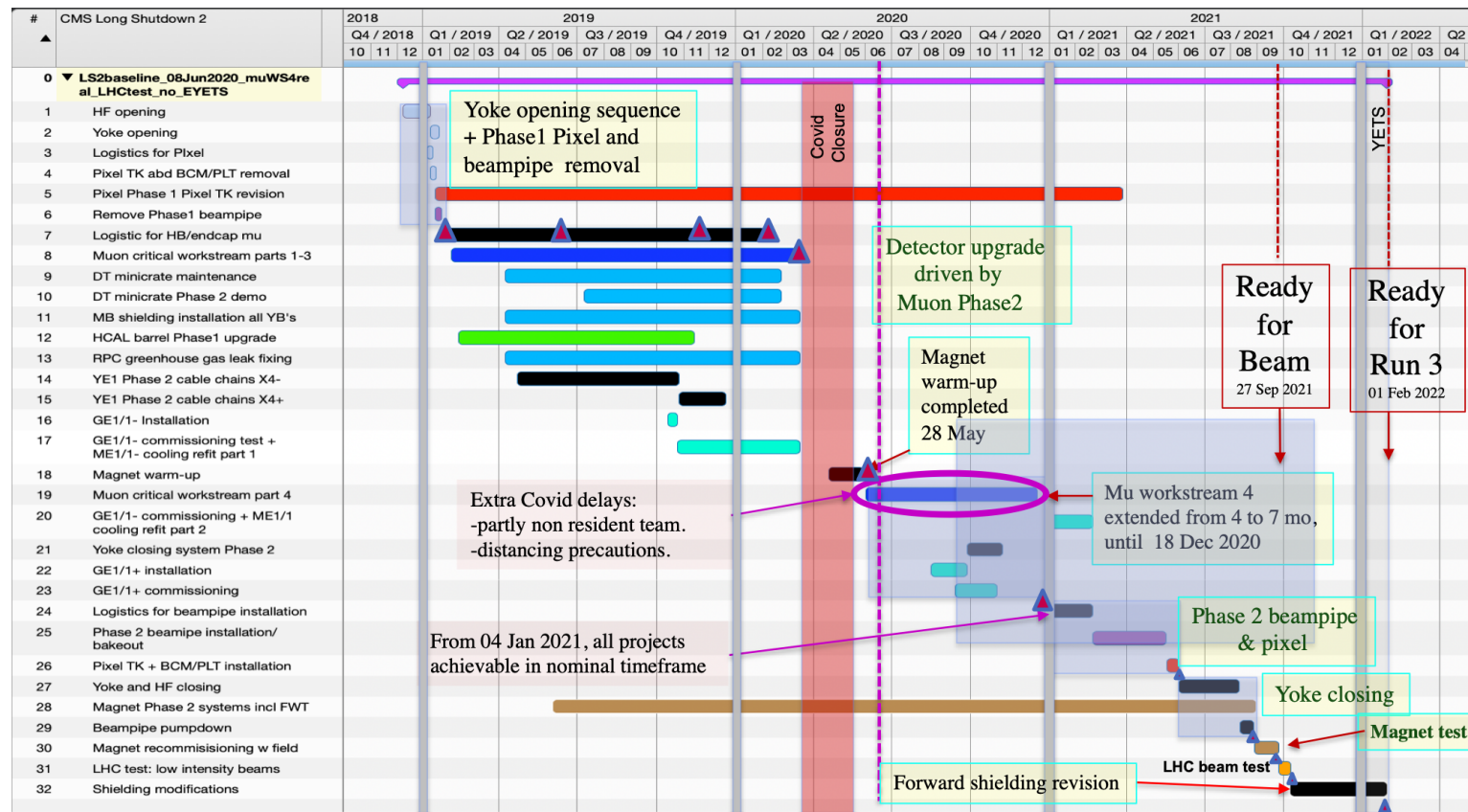
YETS 21-22 still has to be long enough to finish the shielding work & teams have to still be there!!

Nuova schedula LS2 (post COVID) e..



Post-COVID:

- lentamente ripresa al CERN l'attività (da metà maggio)
- Prodotta una nuova schedula per completare le attività di LS2 (8 giugno 2020)
- Ready for beam 27 settembre.



Ready for beam
Feb 1st 2022

Richieste finanziarie (Bari Tier2)



- Costruzione apparati:
 - Bari Tier2 storage (dismissioni + nuovi acquisti) 1425 TBN → 199.5 k€
 - Bari Tier2 CPU (dismissioni + nuovi acquisti) 10.3 kHS06 → 102.7 k€
 - Bari Tier2 rete → 16 k€
 - Bari Tier2 server → 21 k€
 - **Totale = 364.5€**

Manutenzione storage DELL per il settimo anno → 25k€

	TOT (euro)	disco TBN	disco Eur	CPU kHS06	CPU Eur	Rete Eur	Server Eur
Bari	339547.50	1425	199500	10.3	102750	16140	21157.5
Pisa	269451.50	805	112700	12.7	126750	13240	16761.5
Legnaro	268935.50	1335	186900	5.3	52750	12510	16775.5
Roma1	209351.50	955	133700	5.3	52750	9850	13051.5
TOT	1087286.00	4520.00	632800.00	33.5	335000.00	51740.00	67746.00

Richieste Finanziarie 2021



SEZIONE	CAPITOLO	Detector	CMS/FASE2	Descrizione	Richiesta (m.u.)	Richiesta (kEuro)
BARI	missioni	RPC		responsabilità L1 Gabriella	5	20,25
		RPC		responsabilità L3 Flavio	0	0
4.05 /m.u		RPC	FASE2	test & longevity GIF++ Ecogas (m.u. tecnici)	2	8,1
		RPC	FASE2	test & longevity GIF++ Ecogas (m.u. fisici)	4	16,2
		RPC	FASE2	testbeam dimonstratore @GIF++ (mu tecnici)	1	4,05
		RPC	FASE2	testbeam dimonstratore @GIF++ (mu fisici)	2	8,1
		RPC	FASE2	test dimonstratore @904 (m.u. tecnici)	1	4,05
		RPC	FASE2	test dimonstratore @904 (m.u. fisici)	2	8,1
		RPC	LS2	commissioning Barrel + Endcap (m.u. fisici)	4	16,2
		RPC	LS2	riparazione leak (m.u. tecnici)	2	8,1
		RPC	LS2	installazione servizi RE3/1 RE4/1 (m.u. tecnici)	1	4,05
	Totale Missioni	RPC	LS2		7	28,35
	Totale Missioni	RPC	FASE2		12	48,6
	consumo	RPC	FASE2	consumo per test elettronica con iRPC (elettronico CTS)		3
	Totale consumo	RPC				3

Tracker

tecnico manutenzione Power Supply 1

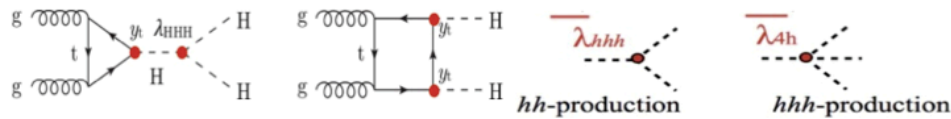
riunioni CORE team CMS-ROC (2 FTE) 4

Test Beam 1

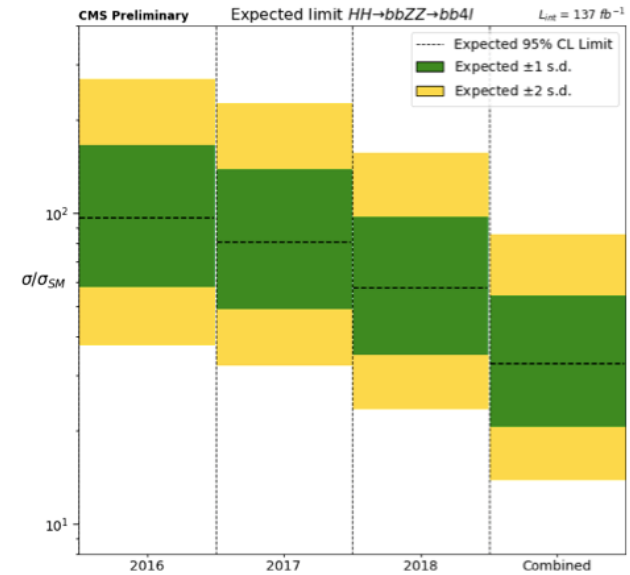
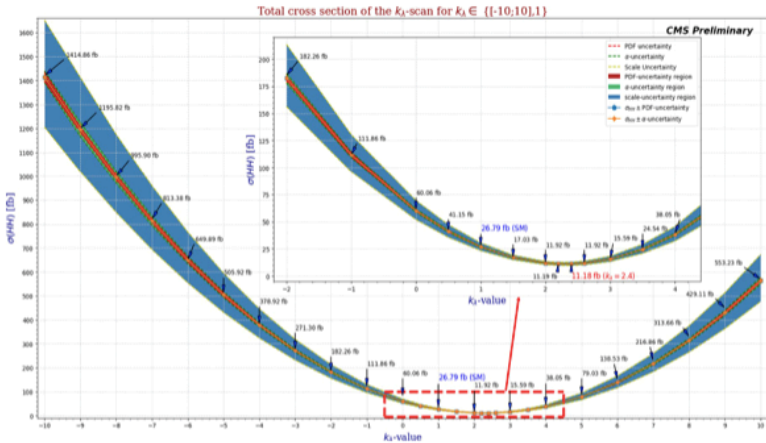
Bari	MIS	Fase2	servizi GEM Phase 2 (m.u. tecnici)	3	12,2
	MIS	Fase2	QC/QA Cosmic Stand (m.u. fisici)	2	8,1
	MIS	LS2	installazione camere (m.u. tecnici)	2	8,1
	MIS	LS2	commissioning GE11 in P5 (m.u. fisici)	6	24,3
	MIS	Fase2	test elettronica GEM Phase 2 (m.u. tecnologico)	1	4,1
	MIS	Fase2	Testbeam GE2/1 (m.u. fisici)	4	16,2
	MIS	Fase2	GE2/1 demonstrator installation (m.u. tecnici)	1	4,1
	MIS	Fase2	Preparation of GE2/1 assembly kits (m.u. tecnici)	3	12,2
	MIS	Fase2	modification QC8 + assembly rotating tables (m.u. tecnici)	2	8,1
	CON	Fase2	Cavi + Meccanica Testbeam GE2/1		5
Totale Missioni				24	97,2
Totale Consumo					5

In the SM, the Higgs self-couplings are determined by the structure of the scalar potential:

$$V = m_H^2 H^2 + \lambda_{HHH} v H^3 + \frac{1}{4} \lambda_{HHHH} H^4, \quad \lambda_{HHH} = \lambda_{HHHH} = \frac{m_H^2}{2v^2} \approx 0.13$$



$$\sigma(14\text{TeV})_{\text{NNLO}}^{\text{FTapprox}} [\text{fb}] = 36.69^{+2.1\%}_{-4.9\%} (\text{scale}) \pm 2.1\% (\text{PDF}) \pm 2.1\% (\alpha_s) \pm 2.7\% (\text{top})$$



- Studies, comparison and validation of candidates for SM-NLO signal models of non-resonant ggF – HH production
- Full Run 2 results under approval
- AN-2019/117, PAS HIG-20-004
- Work on-going for the resonant ggF-HH analysis with full RunII data

Contributo di Bari nella "B Physics" (1)



➤ A. Pompili "B-Physics" (BPAG) convener (L2), Sept.2019-21

+ CMS representative in HFLAV cross-experiment group since 2018 [<https://hflav.web.cern.ch/>]

"Averages of b-hadron, c-hadron, and τ -lepton properties as of 2018» accepted by publication by EPJC [arXiv:0808.1297](https://arxiv.org/abs/0808.1297)

➤ S. Lezki + A.P. + A. Di Florio + CMS CINVESTAV (Mexico City) [Progetto MAECI Italia-Messico 2018-2020]

- Inclusive search for exotic X_b state [b-partner of X(3872)] in the final states $\chi_{b1}(1P)\pi\pi$ & $Y(1S)\pi\pi$ (pre-approval in the fall)

- Production studies of the excited B_c states in pp collisions at 13 TeV [relative Xsections of $B_c^{(*)+}(2S)$] (BPH-19-001)(going to FR)

➤ V. Mastrapasqua + A.P. + N. Sur (TIFR)

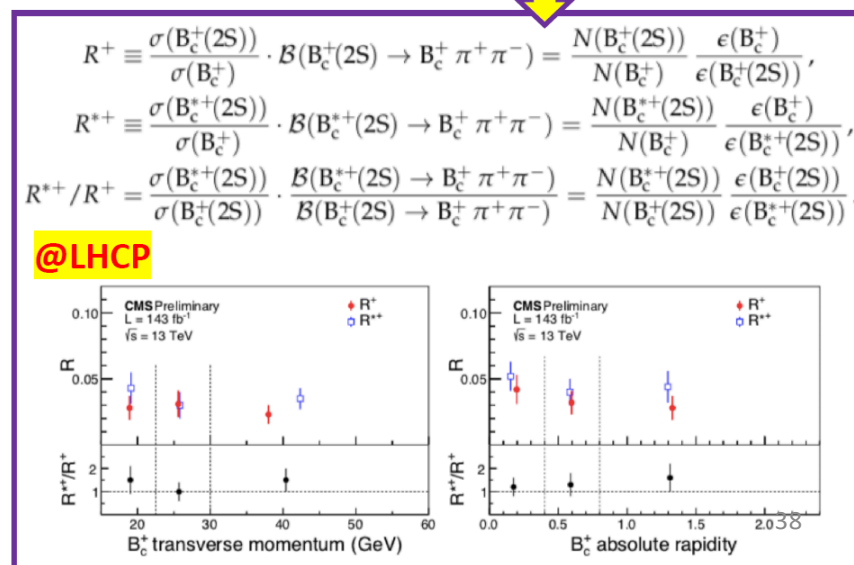
- Charged exotic Z spectroscopy with the 3-body decay $B_d^0 \rightarrow J/\psi K\pi$
(full amplitude fit on GPUs) [BPH-14-003]

- B_c spectroscopy (Run-2/B-parking)
- HLT for Run-3 & HLT Validation

(thesis endorsement;
to be continued)

➤ A. Di Florio (L3 Tracking @ HLT, BPAG Combine contact) + A.P.

- Inclusive search for exotic X(4140) state & partners in $J/\psi \phi$ final state
(pre-approval in the fall)



Contributo di Bari nella “B Physics” (2)



➤ Search for $\tau \rightarrow 3\mu$ decays in Heavy Flavor channel
C. Aruta, A. Colaleo, M. Maggi, F. Simone, R. Venditti, P. Verwilligen

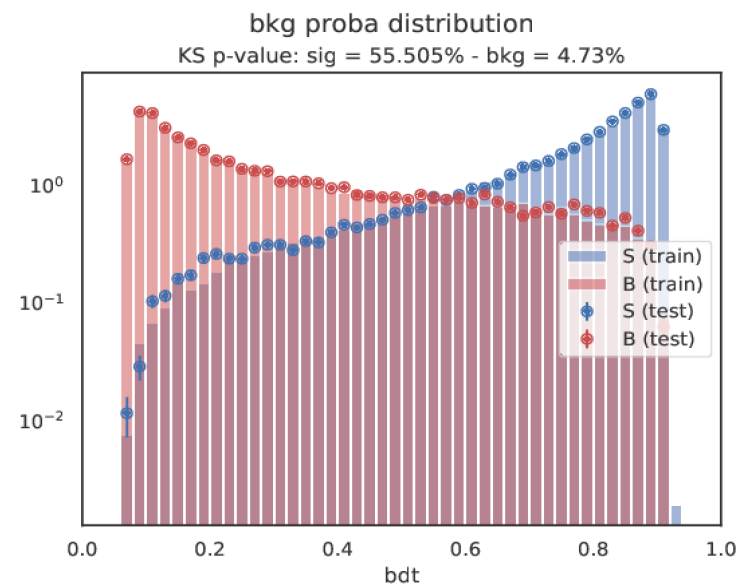
- ❖ Current upper limit on $BR(\tau \rightarrow 3\mu) = 2 \cdot 10^{-8}$ by Belle 1
- ❖ CMS: HF channel: $\mathcal{O}(10^{13})$ produced events
 - Challenge: low p_T muons mainly in forward region, background from combinatorial+fakes
 - Analysis approved on 2016 dataset : observed UL = $8.8 \cdot 10^{-8}$
 - **Goal is to beat Belle I with full Run 2 dataset, targeting to Moriond 2021:**
 - Present UL $\sim 4 \cdot 10^{-8}$ on full 2018 dataset
 - **Plan to start the approval process in September**, just start to write documentation (**AN-20-102**)
- **Analysis optimization for Run3 data-taking. Goal is to be competitive with Belle II.**

Analysis Strategy

- search for a bump at nominal **tau mass peak**
 - smoothly distributed background expected
 - signal from Monte Carlo simulations
- control channel for trigger monitoring
- MVA discriminator for **background rejection**

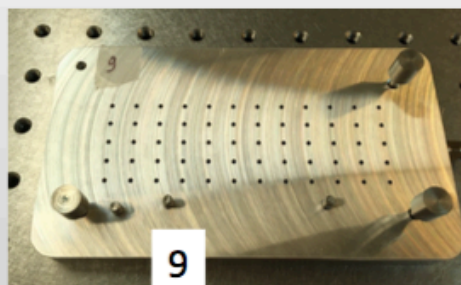
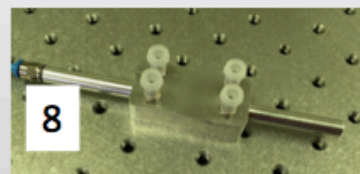
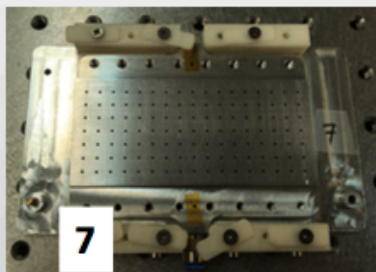
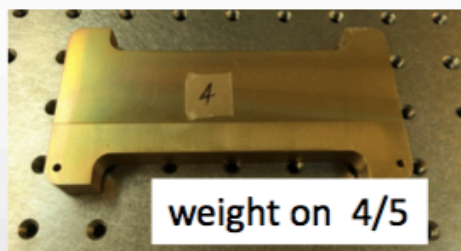
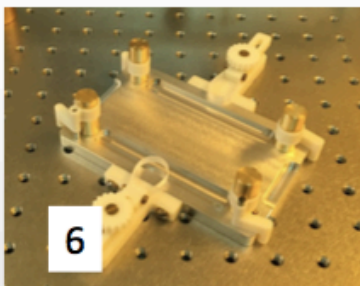
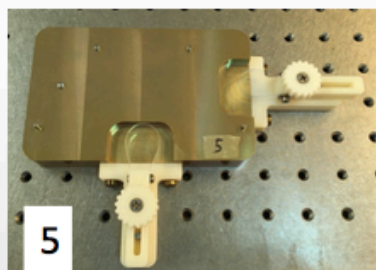
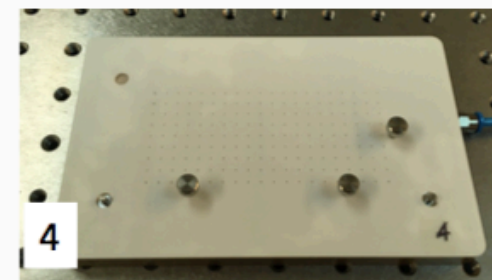
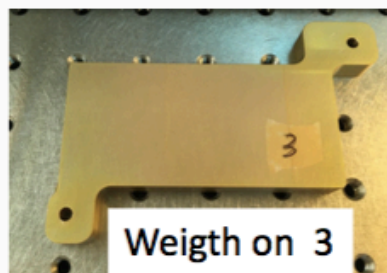
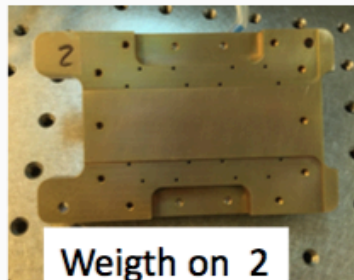
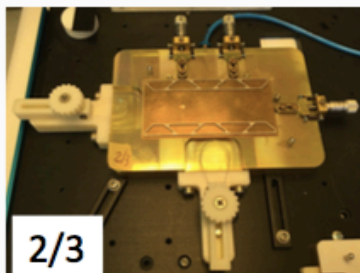
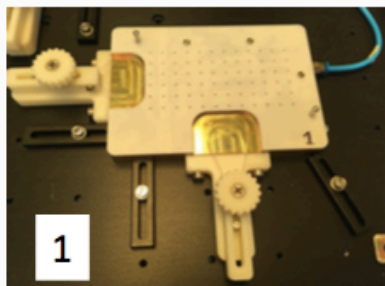
Ongoing Developments:

- Analysis on B –Parking dataset
- Optimize event categorization
- Switch to Ultra Legacy dataset
- Trigger development for Run 3





Complete set of PS prototype jigs designed and built till now at Bari



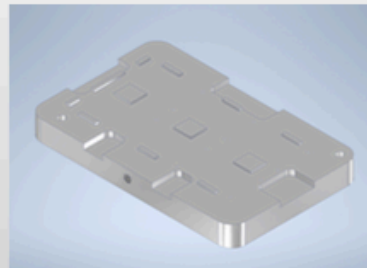
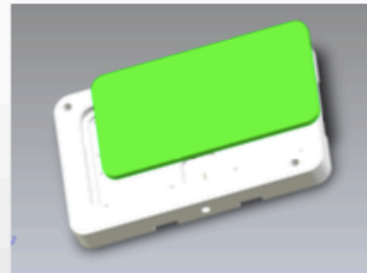
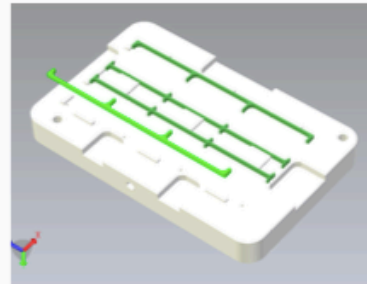
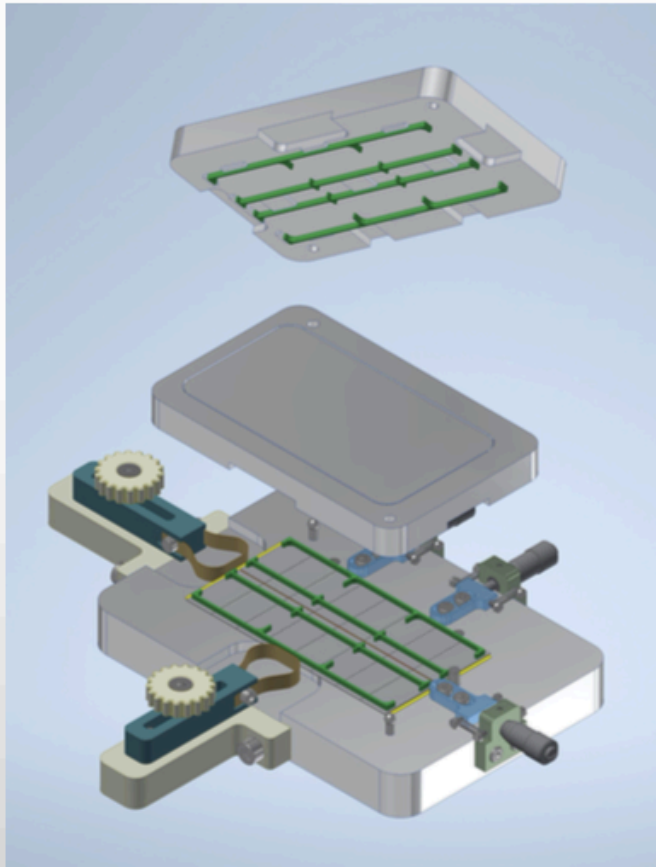
1. To glue the kapton strips on PS-s sensor
2. To glue the spacers on MAPSA
3. To make the sensor stack (PS_S + spacers + MAPSA)
4. To glue the kapton sheet on the baseplate
5. To glue the baseplate with kapton sh. on the sensor stack
6. To place and glue the hybrids on the baseplate
7. For the Module wirebonding and encapsulation
8. To handle the sensors
9. To glue the inserts onto the baseplate

19/6/2020

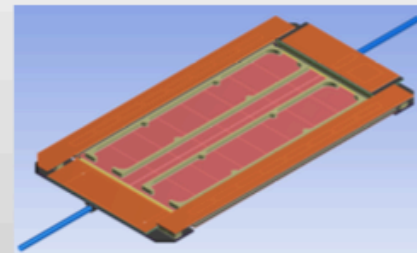
L.Fiore - status TK activity



New design of jig#2

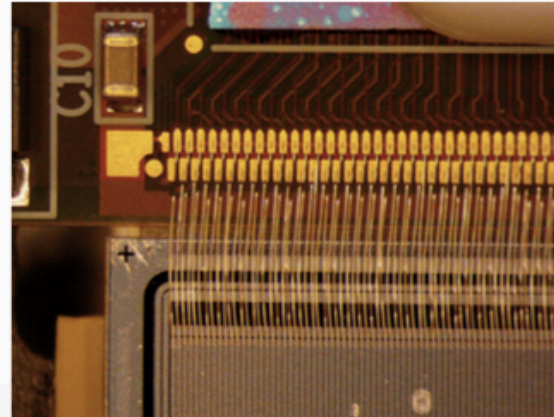


- the new design follows the results of the latest FEA studies which introduce a new shape of spacers
- The vacuum will be used to pickup the spacers
- alternatively the use of adhesive tape will be studied
- When the new shape of the spacers will be endorsed, the new jig will be fabricated

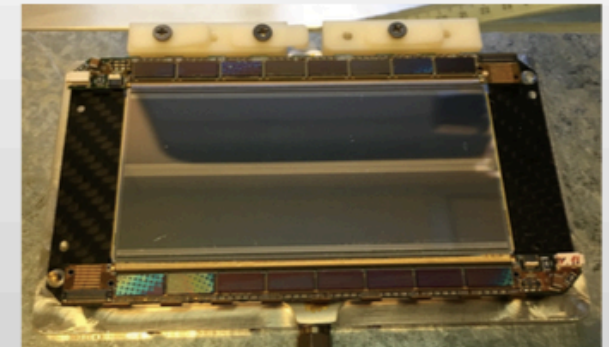
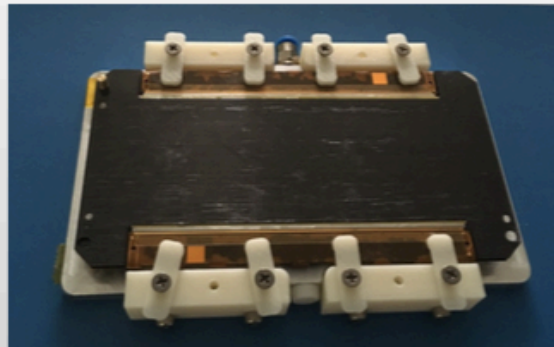




Module bonding (jig#7 under delvotec G5 bonder)



- a bonding test was done on both sides of the semi-dummy module, using the same jig , inserting different thicknesses for each side



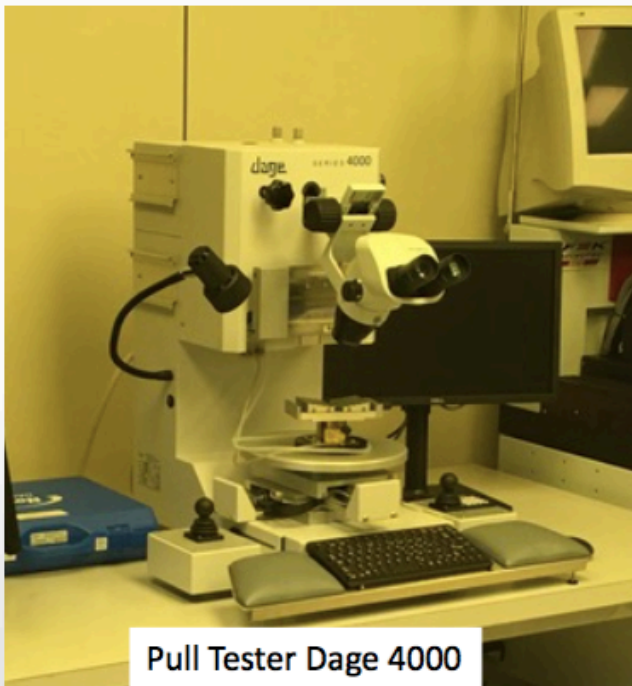
19/6/2020

L.Fiore - status TK activity

6



Pull test



Pull Tester Dage 4000

Pull force (gr)	Alpha (deg)	Beta (deg)	Loop height (microns)
4,5	12,3	11,5	422
4,6	12,1	11,7	422
4,7	12,4	11,8	432
4,8	12,2	11,7	424
4,9	12,5	11,8	432
5	12,7	12,2	439
5,1	12,7	12,4	443
5,2	12,6	12,4	441
5,3	12,7	12,5	447
5,4	12,7	12,8	451
5,5	12,9	13	457

- With:
 - 1% Si-Al , 25 microns diameter wire
 - Loop length = 3,063 mm
 - loop_height = 400 microns
 - $a = b = 13$ deg
- our measured mean $F_{pull} = 5,44$ gr
- correspond to f_1 and f_2 (components along the wire) = 12,22 gr
- or f_1 and $f_2 = 2,22 F_{pull}$

