Gruppo 1 - BARI
Preventivi 2020

Salvatore My

CdS – 11 luglio 2019

SIGLE nella CSN1

Esperimenti a LHC

CMS + FASE2_CMS
G.M. Bilei (Pg)
BARI, BOLOGNA, CATANIA, FIRENZE, GENOVA, LNF, LNL, MILANO-BICOCCA, NAPOLI, PADOVA, PAVIA, PERUGIA, PISA, ROMA1, TORINO, TRIESTE

LHC-b
A. Cardini (CA), M. Palutan (LNF)
BARI, BOLOGNA, CAGLIARI, FERRARA, FIRENZE,GENOVA, LNF, MILANO, MILANO-BICOCCA, PADOVA, PISA, ROMA1, ROMA2, TRIESTE

UA9
G. Cavoto (RM1)
FERRARA, ROMA1, LNF, NAPOLI

ATLAS + FASE2_ATLAS
S. Giagu (RM1)
BOLOGNA, COSENZA, GENOVA, LECCE, LNF, MILANO, NAPOLI, PAVIA, PISA, ROMA1, ROMA2, ROMA3, TIFPA, UDINE

TOTEM
F. Cafagna (BA)
BARI, PISA, SIENA

LHC-f
A. Tricomi (CT)
CATANIA, FIRENZE

Esperimenti a SPS

COMPASS
A. Martin (TS)
TORINO, TRIESTE

P-SHiP
W. Bonivento (CA)
BARI, BOLOGNA, CAGLIARI, LNF, NAPOLI, ROMA1

Fisica Adronica

BESIII
G. Cibinetto (FE)
FERRARA, LNF, PERUGIA, TORINO

Asimmetria Materia-Antimateria

BELLE2
G. Finocchiaro (LNF)
LNF, NAPOLI, PADOVA, PERUGIA, PISA, ROMA1, ROMA3, TORINO, TRIESTE

GMINUS2
G. Venanzoni (PI)
LNF, NAPOLI, PISA, ROMA2, TRIESTE

MEG
A. Baldinii (PI)
GENOVA, LECCE, PAVIA, PISA, ROMA1

KLOE
E. De Lucia (LNF)
CATANIA, COSENZA, LNF, ROMA1, ROMA2, ROMA3

P-MU2E
S. Miscetti (LNF)
GENOVA, LECCE, LNF, PISA, TRIESTE

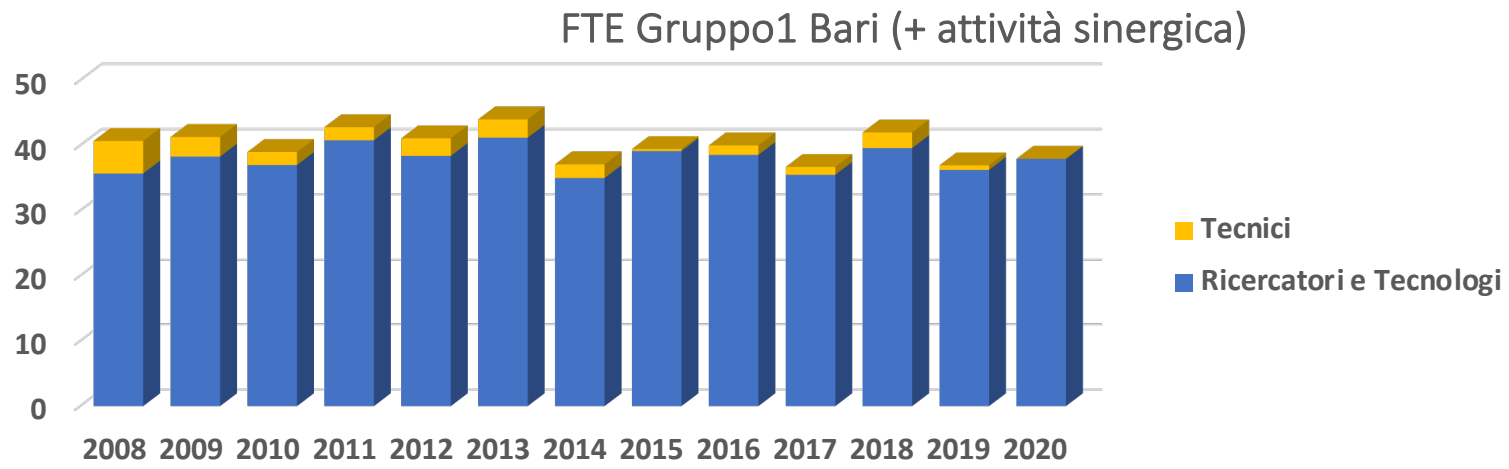
PADME
M. Raggi (LNF)
LECCE, LNF, ROMA1

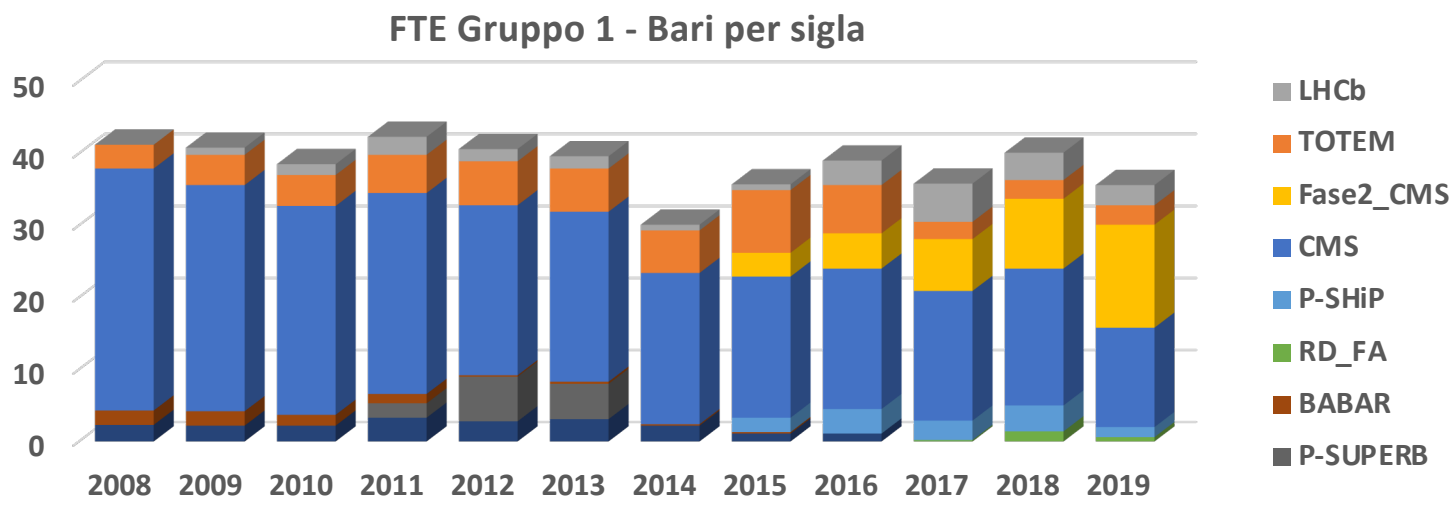
NA62
F. Ambrosino (NA)
FERRARA, FIRENZE, LNF, NAPOLI, PERUGIA, PISA, ROMA1, ROMA2, TORINO

Futuri Acceleratori

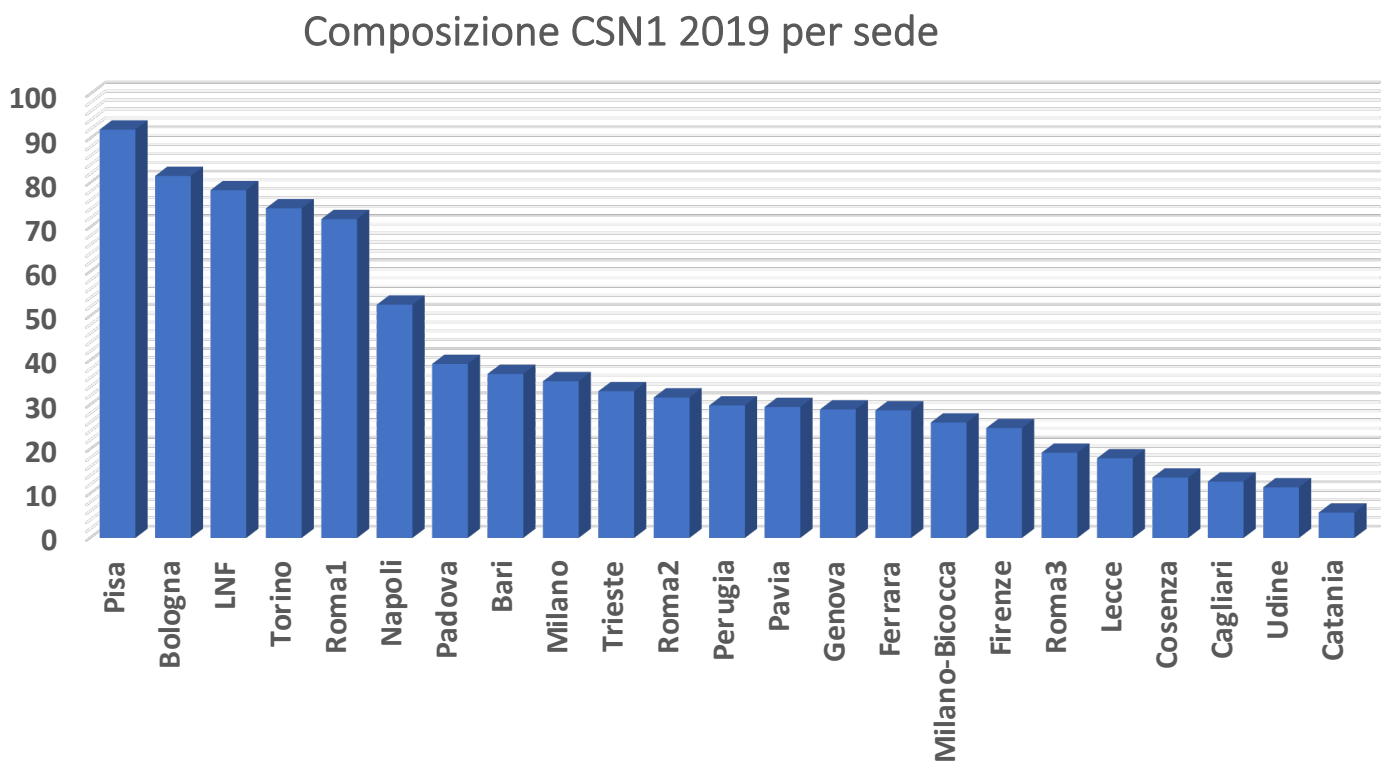
RD_FA
F. Bedeschi (PI)
BARI, BOLOGNA, CATANIA, FERRARA, FIRENZE, GENOVA, LECCE, LNF, MILANO, MILANO-BICOCCA, NAPOLI, PADOVA, PAVIA, PISA, ROMA1, ROMA3, TORINO, TRIESTE

Composizione Gruppo 1 - Bari





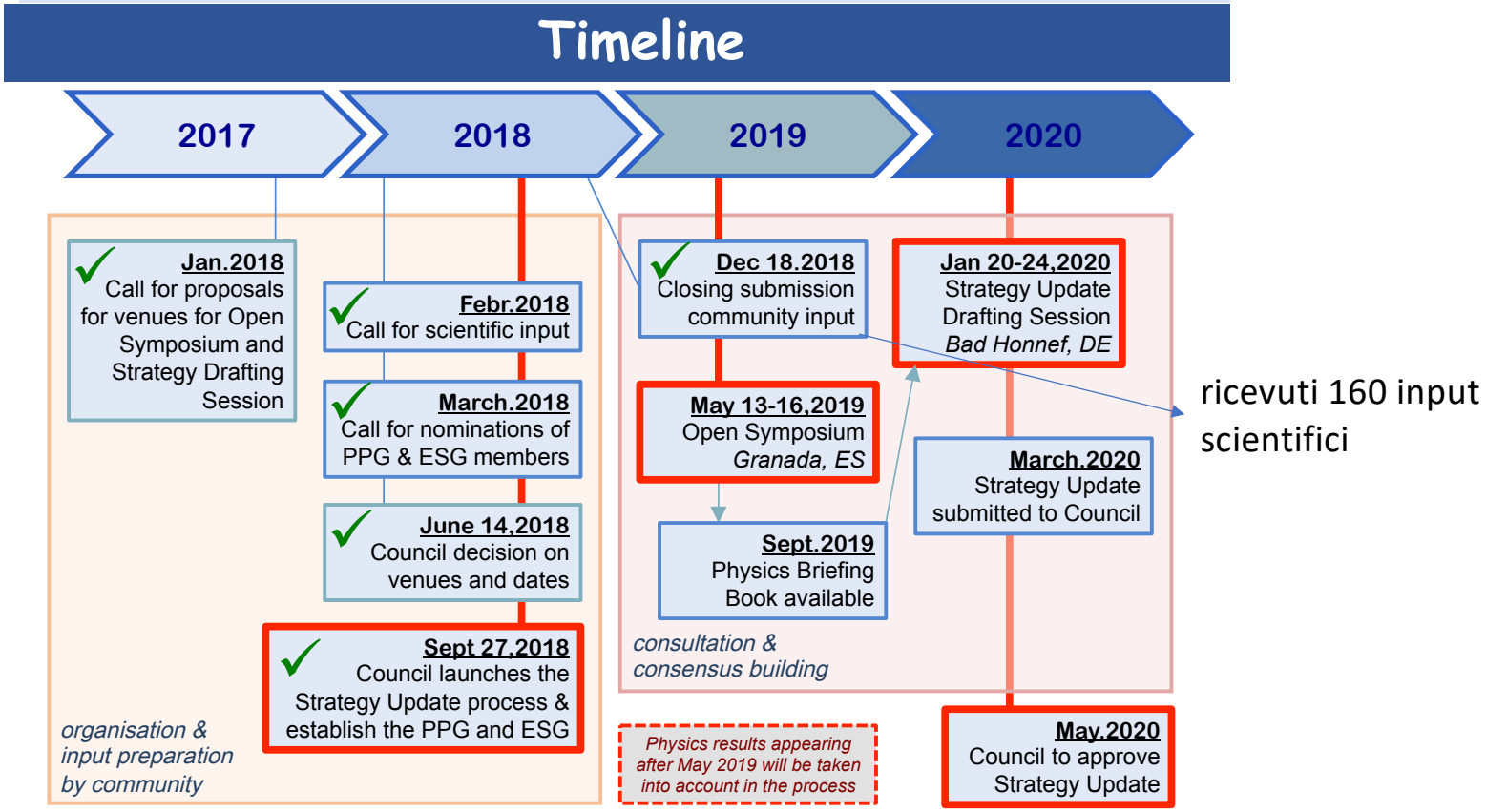
Gruppo 1 – Bari nella CSN1



	FTE CSN1
2014	836,16
2015	847,25
2016	892,80
2017	865,29
2018	884,49
2019	883,38

Update 2020 della European Particle Physics Strategy

The European Strategy for Particle Physics is the cornerstone of Europe's decision-making process for the long-term future of the field. Mandated by the CERN Council, it is formed through a broad consultation of the grass-roots particle physics community, it actively solicits the opinions of physicists from around the world, and it is developed in close coordination with similar processes in the US and Japan in order to ensure coordination between regions and optimal use of resources globally.



Contributo della CSN1 - I

1. The European Strategy for particle physics in the post-LHC era should be based on a **new collider at CERN**, that can be made operational on the time scale of the completion of the HL-LHC program

2. **A circular electron-positron collider in a 100 km tunnel,** operating from 90 to 365 GeV at high luminosity, provides an outstanding program of precision and discovery physics. Such a collider is feasible with current technology at an acceptable cost. The practical feasibility of building such a collider at CERN should be understood as soon as possible and, in case of a positive conclusion, a decision to go ahead with the construction will be fully supported

3. **A muon collider in a multi-TeV range** has the extraordinary advantage to open up a new territory for discovery only if the feasibility of the technology could be fully demonstrated in a few years on an international coordinated effort. Extensive studies must be focused to address necessary R&D, which are mandatory to demonstrate the feasibility of a machine and detector complex design.

   CSN1 is fully supporting the ongoing effort to prepare an end-to-end scheme of a LEMMA concept muon collider, where the critical issues should be investigated with dedicated studies

4. **A hadron collider with an energy of 100 TeV** or higher is in principle feasible provided magnets with critical currents much larger than those currently available can be built. Such a machine would have a direct discovery potential in the tens of TeV range and explore a large area of physics, including the dark sector. There is a strong synergy between this machine and the large circular e^+e^- collider. Indeed a 100-TeV-class proton collider could be located in the same tunnel of the previous electron machine

Contributo della CSN1 - II

5. the B-physics capabilities of the ATLAS and CMS experiments will be enhanced by their Phase II Upgrades. These improvements, together with the very large data sets that are foreseen, will allow for precise measurements to be performed, in particular in final states including muons. The evolution of flavor physics suggests a more extensive program of precise measurements and supports a dedicated new **LHCb Phase II Upgrade**, which has the capability of fully exploiting the flavor physics potential of the LHC

6. Complementary opportunities to **explore a lower mass (1 MeV–10 GeV)** regime have been summarized within the CERN-driven Physics Beyond Colliders effort. A complementary physics program, enabling to address all the searches and dedicated rare measurements which could offer unique probes of physics beyond the standard model, has been always supported by CSN1, whenever a strong physics case has been presented by a motivated community

Experiment	Primary	PoT/year	Secondary	Location	Beam line
NA61++	ions/p scan		ions/hadrons < 120 GeV	ENH1	H2
NA61++	400 GeV p		hadrons < 10 GeV (tertiary)	ENH1	H2
NA64++(e)	400 GeV p	1×10^{18}	100 GeV e-	ENH1	H4
COMPASS+	400 GeV p		muons, pions	EHN2	M2
COMPASS++	400 GeV p		100 GeV K; $\bar{p}$; RF-separated	EHN2	M2
MUonE	400 GeV p		150 GeV muons	ENH2	M2
NA64++(h)	400 GeV p		20-50 GeV π; K^-; 200 GeV p	ENH1	H4
NA64++(μ)	400 GeV p		100 GeV muons	ENH2	M2

Experiment	Primary	PoT/year	Secondary	Location	Beam line
NA62++	400 GeV p	1×10^{18}	Hidden sector	ECN3	K12
KLEVER	400 GeV p	1×10^{19}	K_L	ECN3	P42/K12
NA60++	ions/p scan			ECN3	
DIRAC++	400 GeV p		pions; kaons	ECN3	
SHiP	400 GeV p	4×10^{19}	Hidden sector	BDF	TT21
TauFV	400 GeV p	8×10^{17}		BDF	TT21
REDTOP	2-3 GeV p	1×10^{18}		PS	

ANAGRAFICA 2020 CMS+FASE2_CMS e RD_FA

	NOME	ETA'	POSIZIONE	QUALIFICA	CMS	FASE2_CMS	P_SHIP	RD_FA_DTZ	Totale CSN1	IBISCO_CMS	ML_INFN	FTM_NEXT
1	Abbrescia Marcello		Inc. Ric.	Prof. Associato	50	40		10	100			
2	Altieri Palma Rita		Associato		50				50			
3	Aly Reham		Associato	Dottorando	40	40		20	100			
4	Colaleo Anna		Dipendente	I Ricercatore	70			20	90			10
5	Creanza Donato Maria		Inc. Ric.	Prof. Associato	30	70			100			
6	Cristella Leonardo		Assegn./Bors.	Assegno di Ricerca	100				100			
7	De Filippis Nicola		Inc. Ric.	Prof. Associato	70	10		20	100			
8	De Palma Mauro		Inc. Ric.	Prof. Ordinario	60	10			70			
9	Di Florio Adriano		Associato	Dottorando	50	30			80	10		
10	Di Pilato Antonio		Associato	Dottorando	100				100			
11	Elemtenawee Walaa		Associato	Dottorando	50	40		10	100			
12	Fiore Luigi		Dipendente	I Ricercatore		100			100			
13	Gelmi Andrea		Associato	Dottorando	20	80			100			
14	Gul Muhammad		Assegn./Bors.	Assegno di Ricerca		100			100			
15	Iaselli Giuseppe		Inc. Ric.	Prof. Ordinario	30	60	10		100			
16	Ince Lezki Merve		Associato	Dottorando	20	80			100			
17	Lezki Samet		Associato	Dottorando	100				100			
18	Maggi Giorgio Pietro		Inc. Ric.	Prof. Ordinario					0			
19	Maggi Marcello		Dipendente	I Ricercatore		70		20	90			10
20	Marjeka Ilirian		Associato	Dottorando	50	40		10	100			
21	Merlin Jeremy		Assegn./Bors.	Borsa Stranieri	100				100			
22	My Salvatore		Inc. Ric.	Prof. Associato	20	70		10	100			
23	Nuzzo Salvatore		Inc. Ric.	Prof. Ordinario					0			
24	Pompili Alexis		Inc. Ric.	Ricercatore	80	10			90	10		
25	Pugliese Gabriella		Inc. Ric.	Prof. Associato	50	50			100			
26	Ranieri Antonio		Dipendente	Dirigente Ricerca		70			70			30
27	Selvaggi Giovanna		Inc. Ric.	Prof. Associato					0			
28	Silvestris Lucia		Dipendente	I Ricercatore	80			10	90	5	5	
29	Simone Federica		Associato	Dottorando	60	40			100			
30	Soldani Elisabetta		Associato	Dottorando		100			100			
31	Venditti Rosamaria		Assegn./Bors.	Assegnista	10	80			90			10
32	Verwilligen Piet Omer J		Dipendente	Ricercatore		70		10	80			20
1	De Robertis Giuseppe		Dipendente	I Tecnologo		40	10		50			
2	Donvito Giacinto		Dipendente	I Tecnologo	10				10	15		
3	Licciulli Francesco		Dipendente	Tecnologo		40			40			20
4	Loddo Flavio		Dipendente	I Tecnologo	10	90			90			
5	Marzocca Cristoforo		Associato	Prof. Associato		80			80			
6	Matarrese Gianvito		Associato	Ricercatore		80			80			

	CMS	FASE2_CMS	RD_FA
RICERCATORI	13,0	12,6	1,4
TECNOLOGI	0,2	3,3	0

ANAGRAFICA 2020 TOTEM

	NOME	ETA'	POSIZIONE	QUALIFICA	TOTEM	Totale CSN1
1	Berardi Vincenzo		Inc. Ric.	Prof. Associato	30	30
2	Cafagna Francesco Saverio		Dipendente	I Ricercatore	70	70
3	Catanesi Maria Gabriella		Dipendente	I Ricercatore	30	30
4	Radicioni Emilio		Dipendente	I Ricercatore	60	60
1	De Leonardis Francesco		Associato	Prof. Associato	30	30
2	Passaro Vittorio		Associato	Prof. Associato	50	50

	TOTEM
RICERCATORI	1,9
TECNOLOGI	0,8

ANAGRAFICA 2020 LHCb e P_SHiP

	NOME	ETA'	POSIZIONE	QUALIFICA	CMS	FASE2_CMS	LHC-b	P_SHIP	Totale CSN1
1	De Serio Marilisa		Inc. Ric.	Ricercatore			70	30	100
2	Fini Rosa Anna		Dipendente	I Ricercatore			70	30	100
3	Iaselli Giuseppe		Inc. Ric.	Prof. Ordinario	30	60		10	100
4	Marrone Antonio		Inc. Ric.	Prof. Associato				10	10
5	Palano Antimo		[P] Associato	Prof. Ordinario					0
6	Pastore Alessandra		Dipendente	Ricercatore			70	30	100
7	Simone Saverio		Inc. Ric.	Prof. Ordinario			70	30	100
1	De Robertis Giuseppe		Dipendente	I Tecnologo		40		10	50

	LHCb	P_SHIP
RICERCATORI	2,8	1,4
TECNOLOGI	0	0,1

FTE - Totale Gruppo 1

	CMS	FASE2_CMS	LHCb	P_SHIP	RD_FA	TOTEM	TOTALE
RICERCATORI	13,0	12,6	2,8	1,4	1,4	1,9	32,0
TECNOLOGI	0,2	3,3	0	0,1	0	0,8	4,5

Richieste Servizi – Totale Gruppo 1

	CMS	FASE2_CMS	LHCb	P-SHiP	TOTEM	TOTALE
Camera Pulita		12				12
Elettronica		3	1	2	1	7
Officina Meccanica	5,5	11,5		1,5	0,5	19
Progettazione Meccanica		8		1,5		9,5

CMS e FASE2_CMS

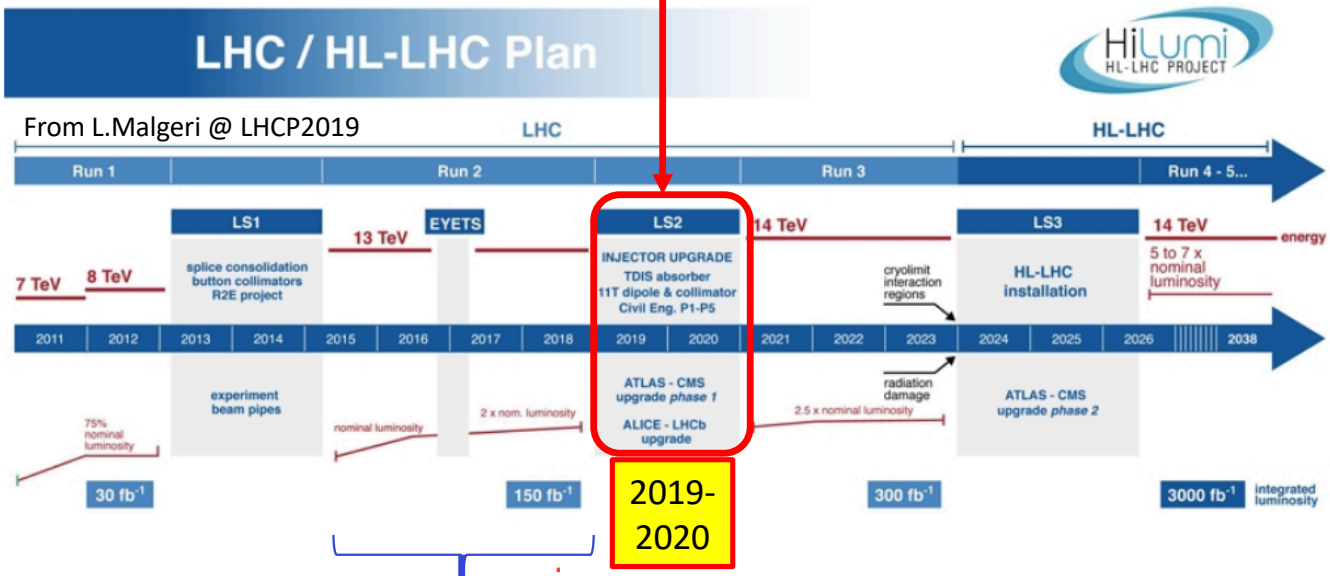
Responsabile locale: A. Pompili

Attività del Gruppo di Bari

- Analisi dati
  - referente locale: A. Pompili
- Tracciatore
  - referente locale e rappresentante nella Tracker Institution Board: S. My
- Sistema Muoni
  - referente locale e rappresentante nella Muon Institution Board: P. Verwilligen
- Calcolo
  - referente locale: G. Donvito

Long-shutdown (LS2) has started in 2019

- **LS2 will continue through 2019 till full 2020 :**



2019-2020

Run 2 2015-2018
<μ>~37
L up to 2.0E34 Hz/cm²

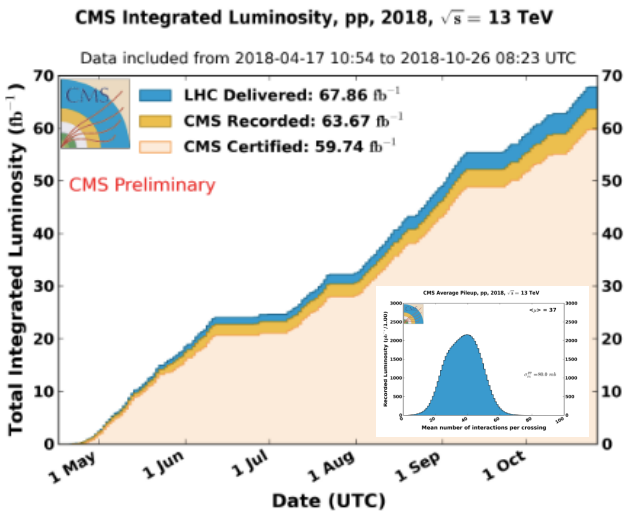
Run 3 2021-2023
<μ>~55
L up to 2.0E34

Run 4-5
<μ>~140-200
L up to 7.5E34

End of Run-2 & Status of CMS - I

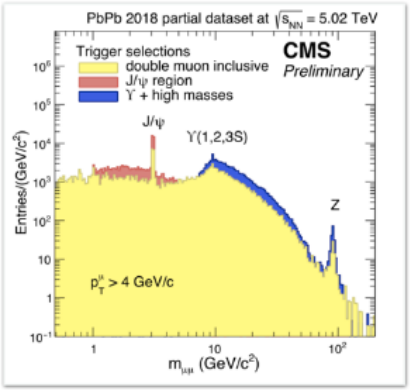
- **The LHC machine and the CMS detector had very well performing in 2018 data taking:**

- **pp run**



- ~ 94% recording efficiency
  - recorded/delivered
  - peak luminosity grazing 2x10^{34} Hz/cm^2
- ~ 95% validation efficiency
  - validated/delivered

- **PbPb run**

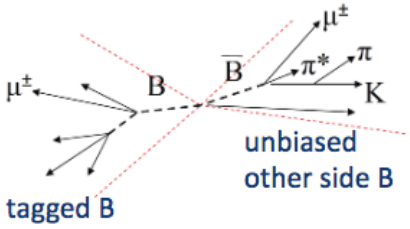


- Collected luminosity ~ 1.80 nb^{-1}
  - about 4.5 billions minimum bias triggers
  - Data quality good: 95% data taking efficiency

- **L. Silvestris : Run Coordinator**

End of Run-2 & Status of CMS - III

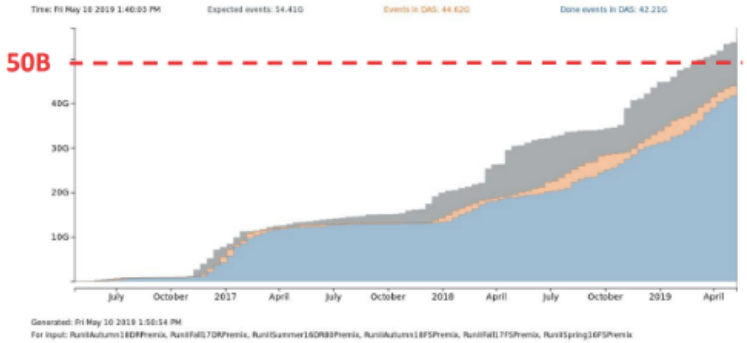
2018 Non-orthodox data taking : B-parking - a swiss knife for Heavy Flavour studies



Plan: store a large unbiased B hadron sample by tagging on the «opposite side» B

- CMS parked (→ no prompt reconstruction) 12 billions of B triggers, a sample 20x larger than Babar's
- Fit within available computing resources
  - Up to 6 kHz additional rate to tape

Offline & Computing



O+C systems were able to cope for simultaneous

- data taking with larger-than-expected parking and Heavy Ions data taking
- support for analyses, with 50kCores at any moment (out of 250kCores total)
- preparation of samples for Phase-II TDRs
- evolution of our software and services
- preparation of 50B ('17-'18) MC events

Long shutdown periods are the most busy for computing :

- Full Run-2 reprocessing
- Get prepared for Phase-2: adapt to GPUs, FPGAs, via an heterogeneous framework

End of Run-2 & Status of CMS - IV

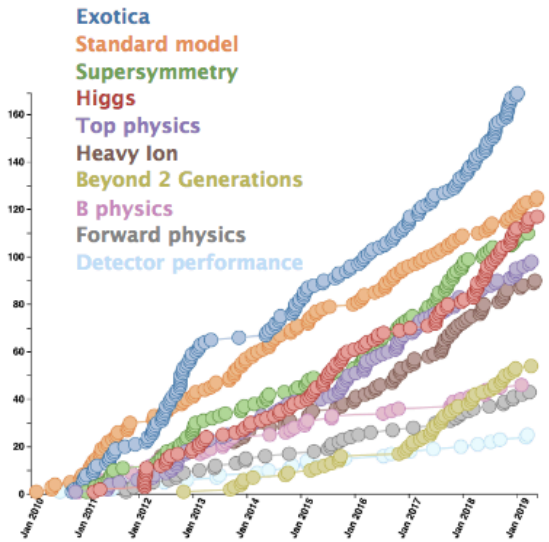
Impressive physics output :

From L.Malgeri @ LHCP2019

876 papers on collider's data out of 901 published

We just celebrated the 900th submitted papers last Friday (and we are now at 901)!

- 141 papers submitted in 2018 (new record!)
- first LHC full run2 statistics paper submitted on on Feb. 1, 2019 (Phys. Rev. Lett. 122 (2019) 132001
- 9 results with full Run 2 data
- ~50 new results since the beginning of 2019
- in the following only few selected results shown



- Summary at:

  http://cms-results.web.cern.ch/cms-results/public-results/publications/

CMS-Bari - participated actively to some of them

- also provided ~10 Collaboration Wide Reviews (and participated to ARCs)

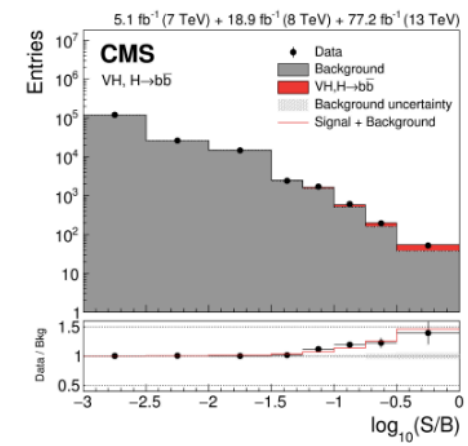
Physics Highlights

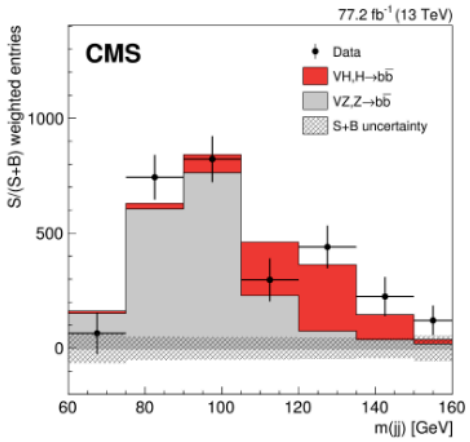
- **Since last year : Higgs to bottom Yukawa couplings**

Channel	Date
H→ττ	May 2017
pp→ttH	Apr 2018
H→bb, pp→VH	Aug 2018

- $H \to b\bar{b}$ **observation :**

PRL 121 (2018) 121801





- Both ATLAS and CMS have observed it (>5σ)
- Very complex analyses (multivariate techniques used in every step)

Notes:

- in CMS the first DNN based analysis
- in CMS first analysis based on 1kB/event data format (0.1% of the raw format!)

Current analysis activities with CMS-Bari involvement

Data Analysis Activities - I

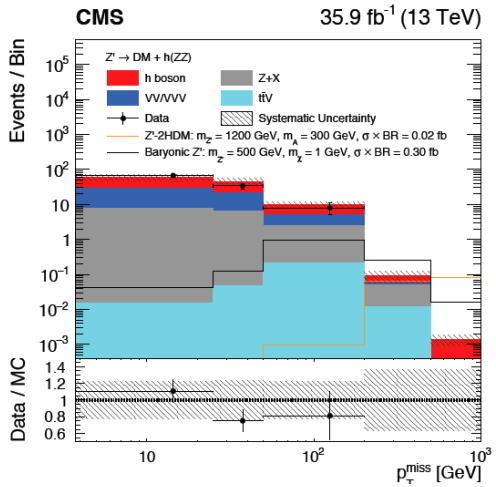
Higgs Physics + DM search

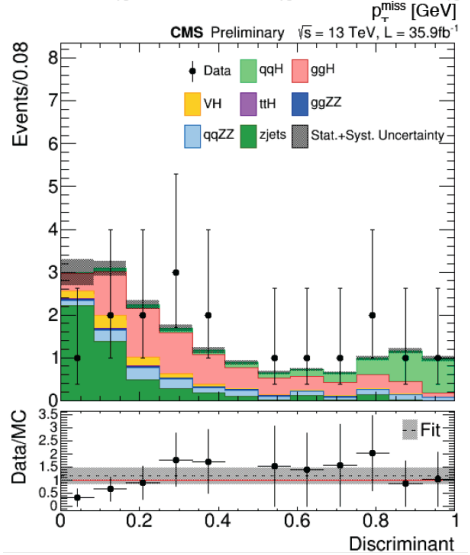
- Ricerca di materia oscura con la segnatura di "MonoHiggs", H+MET, con H→ZZ→4l (**R. Aly, N. De Filippis**)
  - Analisi con dati 2016 pubblica EXO-18-009 e finalizzata in un paper EXO-18-011 (Final reading) in combinazione con le altre analisi monoHiggs
  - Analisi dati 2017 e 2018 in corso

- Misura della sezione d'urto di produzione del bosone di Higgs in topologia di fusione di bosoni vettori: VBF H→ZZ→4l (**W. Elmetenawee, N. De Filippis**)
  - AN_2018_120 con i dati 2016
  - analisi con dati 2017 and 2018 in corso

- Determinazione *self-coupling* dell'Higgs attraverso la ricerca di eventi di produzione di **HH→bbZZ→ bb4l** (**I. Margjeka, N. De Filippis**)

  + studi finalizzati nello Yellow Report per HL-LHC: "**Higgs Physics at the HL-LHC and HE-LHC**", https://arxiv.org/abs/1902.00134





- **N. De Filippis**: **"Higgs Future Analysis" convener**, Sept.2018-20

Data Analysis Activities - II

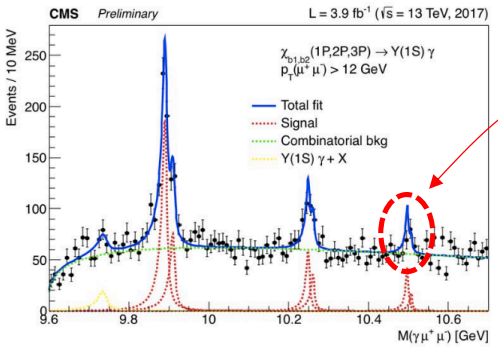
B-physics & quarkonia

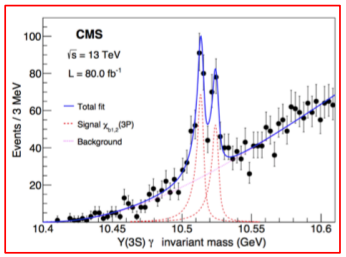
L. Cristella + A. Pompili + A. Di Florio + V. Mastrapasqua (similfellow junior) + N. Sur (TIFR)

- **charged exotic *Z* spectroscopy with the 3-body decay** $B_d^0 \to J/\psi K\pi$ **(**full amplitude fit on GPUs**) [**BPH-14-003**]**
- **enough statistics with 2012 data -** going to pre-approval

A. Di Florio + A. Pompili - **inclusive search for exotic *X(4140)* state & partners** in the final state $J/\psi\,\phi$
- use late 2017-2018 data **(dedicated triggers) -** going to preapproval

S. Lezki + A. Pompili + A. Di Florio + CMS CINVESTAV(Mexico City) [Progetto MAECI Italia-Messico 2018-2020]
- **inclusive search for exotic X_b state [beauty partner of X(3872)]** in the final states $\chi_{b1}(1P)\pi\pi$ & $\Upsilon(1S)\pi\pi$
- use 2017-2018 data





A. Pompili "B-Physics" convener, Sept.2019-21

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

More Data Analysis Activities & Computing activities

- **To be mentioned (for activities till end 2018)**

  Search for high-mass resonances into two muons (contribution to dilepton final states) [$Z' \to \mu\mu$]

  F. Errico[(1)] + R. Radogna[(2)] + A. Colaleo (contributing within Z' task force)

  [(1)] now in CMS @ Florida Univ. [(2)] now @ University College London (no more in CMS)

- **R. Venditti + F. Simone + A. Colaleo + P. Verwilligen (+ laureande : C. Aruta, L. Lorusso)**
  starting a new search : $\tau \to 3\mu\ (LFV)$

- **Deep Learning for tracking (with GPUs usage): A. Di Florio + A. Di Pilato (*dottorato industriale*)**

- **Statistical analysis studies (using *GooFit* on GPUs): A. Di Florio + A. Pompili**

  - Clustering technique to include Look-Elsewhere-Effect (LEE) in the global significance estimation

  - Check of Trial factors method for LEE (Gross-Vitells approx.)**[**presented to *XIII Quark Confinement: statistics session***]**

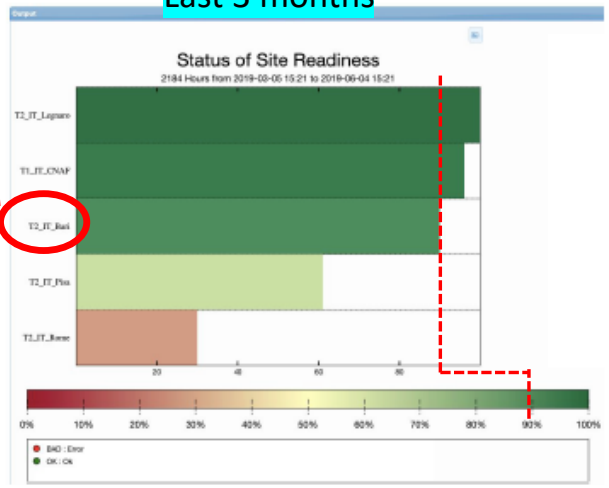
- CMS experiment has a workload management system that …
  schedules & executes production and user tasks in a distributed Grid infrastructure.
  Submission is performed via the tool CMS Remote Analysis Builder (CRAB),
  … developed & maintained by L. Cristella.

Computing infrastructure & activities (Bari Tier2)

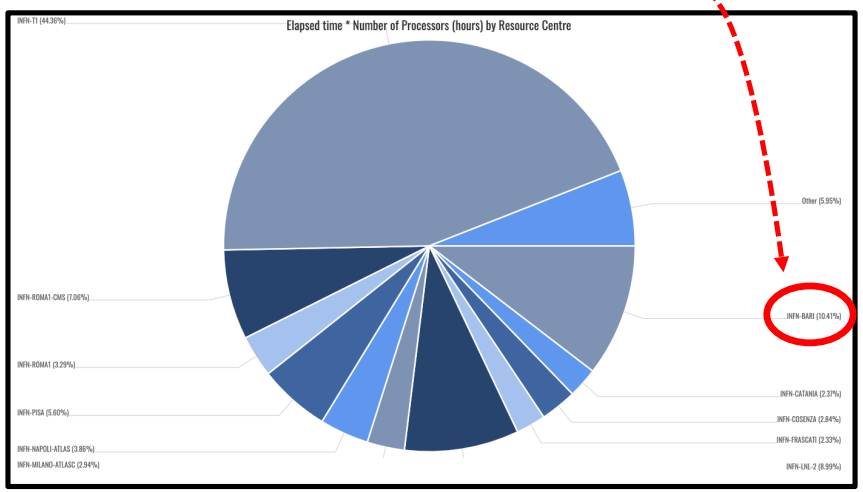
CMS-T2 operational status - I

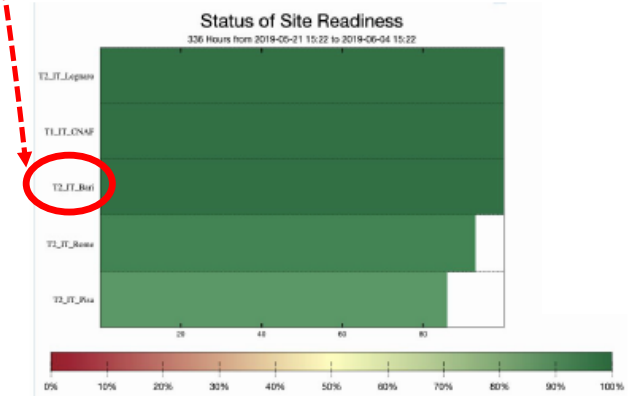
- **The Bari CMS-T2 is the 2nd best reliable site in Italy** (even considering long time periods)

Last 3 months



It is the 2nd site in Italy after the T1 as far as the CPU resources' usage is concerned :

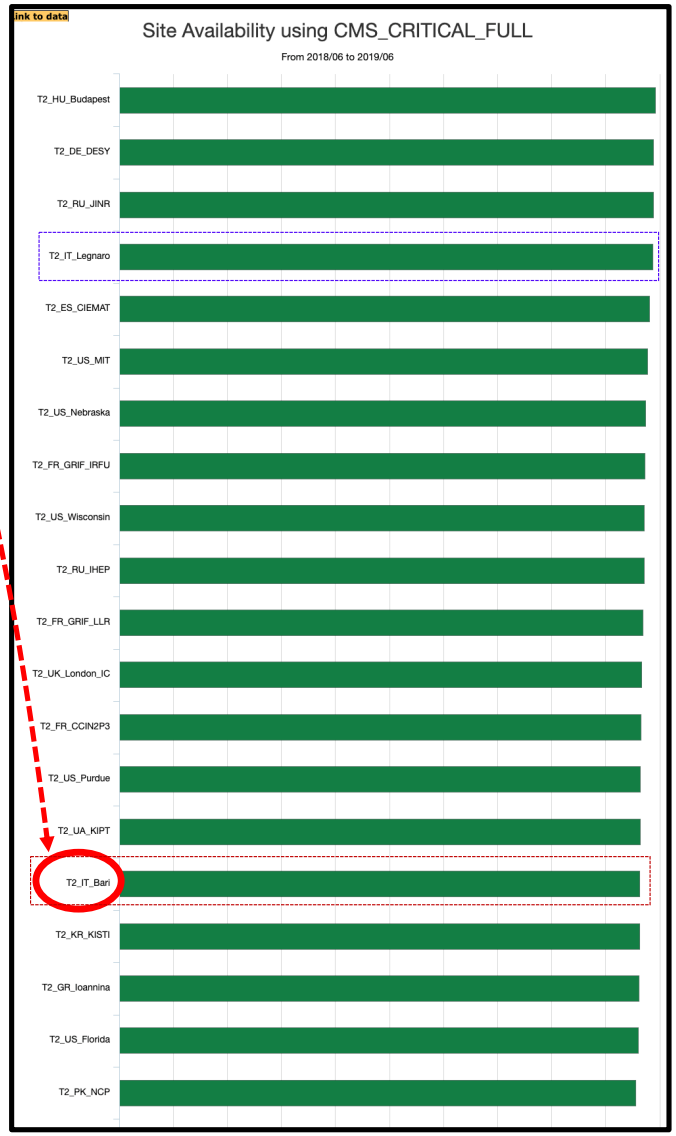




Last 2 weeks

CMS-T2 operational status - II

- The Bari CMS-T2 is a reliable site also considering the international «landscape»:



- G. Donvito is replacing G. Maggi as CMS-T2 manager
  - G. Donvito, G.Maggi, L. Cristella (CMS side) *et al.*, but - regardless the official affiliations/tags – all IT group (staff & TD) collaborates, at different levels of involvement, to the maintenance of infrastructure and computing resources !

CMS-T2 : tenders' status & new resources

- New purchases on 2018 funds for the Bari T2 concern only storage : 600TBN (Lenovo) are arriving
- The situation of italian pledges is not good (well <13% of CMS)
  Italian T2s are requesting in 2020 to rescue the **cuts experienced in 2019**.
- Future purchases on 2019 funds (2020 requests), either for CPUS and storage, will be (fully) funded but on funds of PON IBISCO, for the Bari T2
- Let us consider the ***standard scenario*** (1. flat distribution of new resources among the 4 italian T2s,
  2. missing pledges to be fully rescued)

Richieste 2020 Tier2, scenario A

- Italia: 13% di CMS
- 1 TBN = 140€
- 1 HS06 = 10€

Recup. pledge	Fraz. pledge PON
1	0.25

	recupero D-pledge 2019 (kHS06)	recupero D-pledge 2019 (TBN)	Dismissioni 2019 (not granted) kHS06	Dismissioni 2020 kHS06	Totale dismissioni CPU kHS06	Dismisioni 2020 disco TBN	Totale CPU	Totale disco	CPU (euro)	Disco (euro)	Recupero pledges CPU 2018 (Eur)	Rete	Server	Totale (euro)
Bari	2.75	217.5	0.00	4.6	4.60	640	7.35	857.5	73500	120050		5206.25	6774.25	205530.5
Pisa	2.75	217.5	2.55	4.75	7.30	120	10.05	337.5	100500	47250	8400	4196.25	5171.25	165517.5
Legnaro	2.75	217.5	4.05	6.9	10.95	704	13.70	921.5	137000	129010	18800	7335.25	9310.35	301455.6
Roma1	2.75	217.5	2.45	5	7.45	0	10.20	217.5	102000	30450	10600	3821.25	4635.75	151507
Totali	11	870	9.05	21.25	30.30	1464	41.30	2334	413000	326760	37800	20559	25891.6	824010.6

IBISCO

Spesa extra PON: 618481 €

CMS-T2 requests in 2019-21 (IBISCO for Bari)

- However the problem is that IBISCO tenders will be concentrated in just one (!) either for CPU & storage at the end of 2020 (or even beginning 2021); thus new computing resources will arrive **only** in 2021! This is a relevant issue because of the obsolescence of wide part of the CPUs .

- **In the next 3 years the Bari T2 will be bringing into production 2.7PB of disk & 4000 cores !**

  Considering only the resources pledged for CMS **it would be like doubling the current farm**.

- **IBISCO will be much wider than that! [** see G.Donvito's presentation on projects/external funds **]**

Tier2: acquisti/anno 2019-21 (overview richieste)

Assumendo zero recupero "d-pledge 2019" nel 2020

Disco/tier2 (d-pledge)	**218**	**0**	**725**	
Acquisti Disco Tier2 (TBN/anno)	**2019**	**2020**	**2021**	**TOT (19-21)**
Bari	358	640	1695	2693
LNL	394	704	1605	2703
Pisa	218	120	1075	1413
Roma	218	0	1225	1443
Totale	1188	1464	5600	8252
CPU/tier2 (d-pledge)	**2.75**	**0**	**12.5**	
Acquisti CPU Tier2 (kHS06/anno)	**2019**	**2020**	**2021**	**Tot (19-21)**
Bari	15.7	4.6	20.5	40.8
LNL	10.4	10.95	15.5	36.85
Pisa	3.5	7.3	22.9	33.7
Roma	7.3	7.45	15.5	30.25
Totale	36.9	30.3	74.4	141.6

Previsioni spesa 2021: ~ 546 k€ (storage) + 539 k€ (CPU) nel 2021 (extra PON)

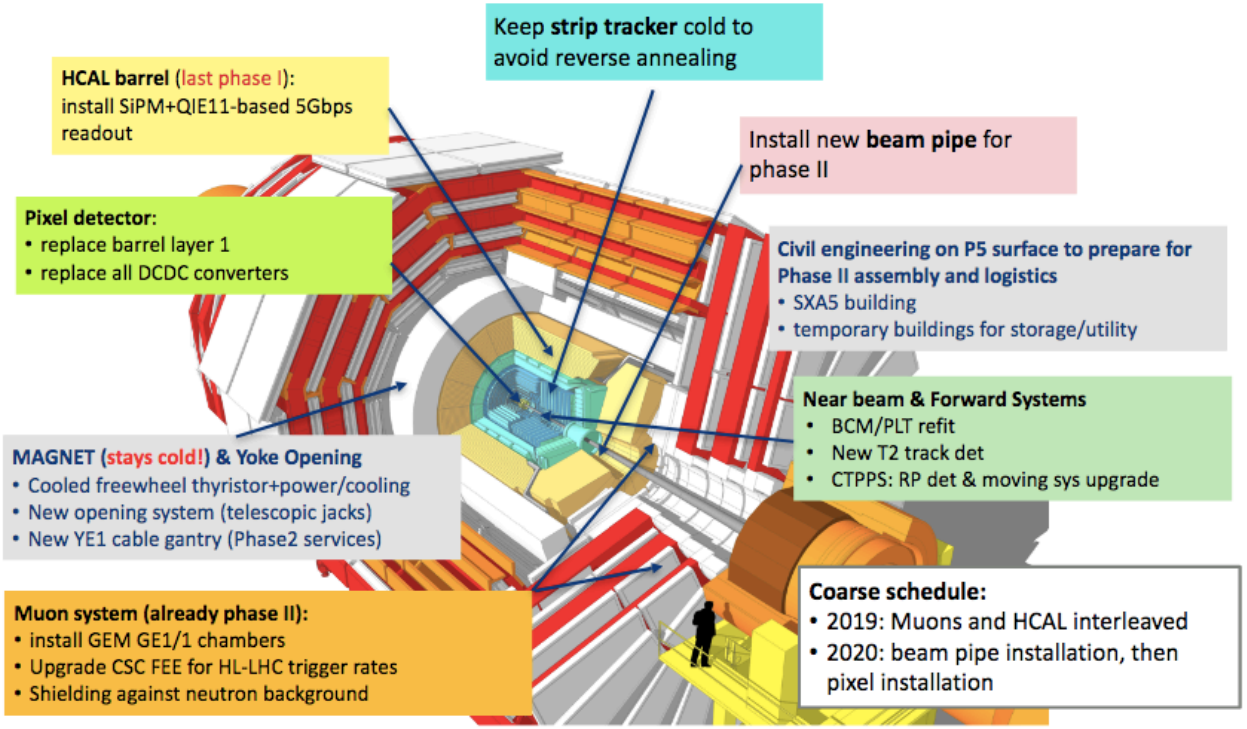
- **Assumendo gli incrementi pledge 2021/2019 della slide precedente**
  - **Incluso il d-pledge ½ del 2019 "ritardato" al 2021**
- **Incluse le dismissioni di CPU e storage**
- **N.B.: Per il 2019 i numeri sono quelli gia' finanziati**

- D-pledge 2019 not granted (tier2 federation)
  - CPU: 11 kHS06
  - Disk: 870 TBN
- D-pledge: 2021-2019 (estimated)
  - CPU: 39 kHS06
  - Disk: 2028 TBN

36

Long-shutdown (LS2) will continue in 2020

- **LS2 will continue for 2020; activities foreseen:**



From L.Malgeri @ LHCP2019

- **Phase-1 upgrade is almost done** (and in line with the planned schedule providing benefits already during Run-2)

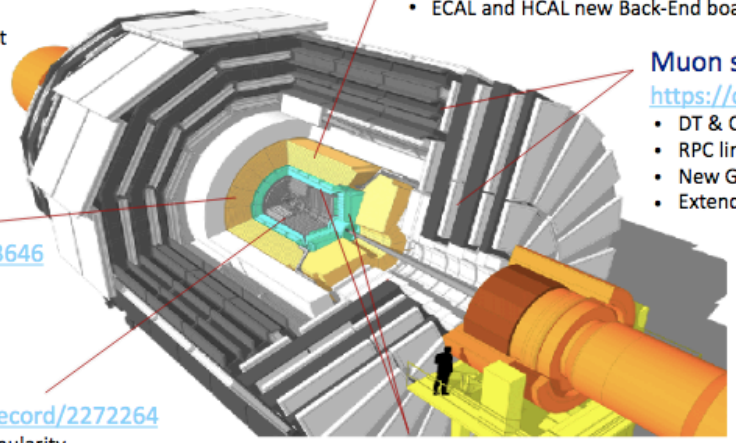
  Phase-2 upgrade started (Run-3 will benefit from part of them; will be continued in LS3 -2024/5)

CMS HL-LHC Upgrade (Phase-2)

Technical proposal CERN-LHCC-2015-010 https://cds.cern.ch/record/2020886
Scope Document CERN-LHCC-2015-019 https://cds.cern.ch/record/2055167/files/LHCC-G-165.pdf

L1-Trigger/HLT/DAQ
https://cds.cern.ch/record/2283192
https://cds.cern.ch/record/2283193
- Tracks in L1-Trigger at 40 MHz
- PFlow-like selection 750 kHz output
- HLT output 7.5 kHz

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 link -board
- New GEM/RPC $1.6 < \eta < 2.4$
- Extended coverage to $\eta \simeq 3$

Calorimeter Endcap
https://cds.cern.ch/record/2293646
- 3D showers and precise timing
- Si, Scint+SiPM in Pb/W-SS

Beam Radiation Instr. and Luminosity, and Common Systems and Infrastructure
https://cds.cern.ch/record/2020886

Tracker https://cds.cern.ch/record/2272264
- Si-Strip and Pixels increased granularity
- Design for tracking in L1-Trigger
- Extended coverage to $\eta \simeq 3.8$

MIP Timing Detector
https://cds.cern.ch/record/2296612
Precision timing with:
- Barrel layer: Crystals + SiPMs
- Endcap layer: Low Gain Avalanche Diodes

Innovative and extremely challenging new capabilities:
- **Highly granular endcap calorimeter**
- **Level 1 track trigger**
- **Timing detector**

From L.Malgeri @ LHCP2019

CMS Money Matrix as April 2019

INFN

CMS Phase-2 Internal Money Matrix (in kCHF), 15 April 2019									
FA/Subsystem	EC-CALO	Barrel - CALO	Muons	Tracker	MIP-TD	BRIL	TDAQ	Common Fund	Total Phase-2
CORE Costs (kCHF)	67'127	13'255	25'187	111'900	15'796	2'600	18'500	25'000	279'365
Austria	900			800				326	2'026
Belgium FNRS			100	4'800				489	5'389
Belgium FWO				5'000				417	5'417
Brazil/FAPESP				1'291				127	1'418
Brazil/RENAFAE								380	380
Bulgaria			360					181	541
CERN	21'500	2'000	1'524	19'500		1'200	4'500	1'322	51'546
China	900		1'450				400	254	3'004
Colombia			80					72	152
Croatia	1'350							145	1'495
Cyprus								127	127
Egypt			200					54	254
Estonia							522	54	576
Finland			150	1'100	1'000			236	2'486
France-CEA	1'000	1'815			500			308	3'623
France-IN2P3	6'400		600	4'600				924	12'524
Germany BMBF			1'920	9'450				1'196	12'566
Germany Helmholtz	100			9'107			500	634	10'341
Greece	350			1'400			1'000	326	3'076
Hungary			225	300	150	225		181	1'081
India	2'060		1'479	2'000			250	598	6'387
Iran			1'390					145	1'535
Ireland								36	36
Italy		1'900	5'150	14'000	3'600		200	3'007	27'857
Korea			2'056					562	2'618
Lithuania							348	36	384
Malaysia	870							91	961
Mexico			1'000					199	1'199
New Zealand						70		36	106
Pakistan	1'100		550	1'600				36	3'286
Poland							300	272	572
Portugal	420	460			960			109	1'949
RDMS-DMS-Russia	8'200		629			350		1'522	10'701
Serbia		80						54	134
Spain			1'500	1'200	200		100	779	3'779
Switzerland		2'500		9'113	1'000			707	13'320
Taipei	2'600							272	2'872
Thailand	100							54	154
Turkey	2'094							217	2'311
United Kingdom	3'500	500		2'500			500	1'033	8'033
USA-DOE	14'500		2'698	13'691	5'000		3'886	5'431	45'206
USA-NSF		4'194	2'199	12'512			900	1'381	21'186
USA-DOE-NP							5'305	525	5'830
Ecuador								36	36
Montenegro	190							36	226
Sri Lanka			760					72	832
Latvia	380							36	416
Qatar			300						300
Georgia	500							36	536
Funding (kCHF)	69'014	13'449	26'320	113'964	12'410	1'845	18'711	25'071	280'784
Uncertainty low	90%	99%	84%	96%	92%	100%	63%	100%	92%
Uncertainty Medium	6%	1%	14%	4%	8%	0%	7%	0%	5%
Uncertainty High	4%	0%	1%	0%	0%	0%	30%	0%	3%
Funding/CORE Costs	103%	101%	104%	102%	79%	71%	101%	100%	101%
Funding-CORE Costs	1'887	194	1'133	2'064	-3386	-755	211	71	1'419

- **Funding slightly increased ≃ 280.7 MCHF**
  - The value shown at the October RRB was 278.8
- **FAs are committed to cover 100% of the total cost with little uncertainty.**
- Significant progress on the uncertainty levels (colours), grey now reduced to 3%

CMS Phase-2 Upgrade & related activities : TRACKER

CMS Pixel Chip for Inner Tracker (IT) : development for Phase-2

- Activity started in 2013 within the Collaboration ***RD53*** & the experiment ***CHIPIX65*** (INFN-Gr.V)

- **Purposes/timeline** :

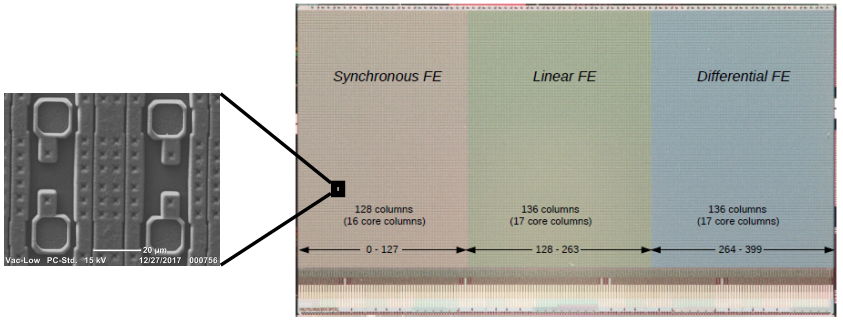
1. **Study of the radiation tolerance of the TSMC CMOS 65nm technology**, to evaluate the adequacy for the more inner layers of the tracker (radiation level > 500Mrad)

2. **Development of a Front-End library & IP blocks** on the basis of the CMS & ATLAS requirements/specs

3. **Design, production & test of a pixel chip demonstrator** (64x64) within Chipix65 (2016)

4. **Design, production & test of a pixel chip demonstrator** (large scale «RD53A») (2017-2018)

5. **Design of the «production» pixel chip for CMS & ATLAS** (2018-2020) on the basis of the measurements carried out on the RD53A demonstrator and of the final specs of the two experiments.



RD53A:
- **size: 20.066 x 11.538 mm**
- **400x192 pixel array**

CMS-Bari contribution to IT

- **Personpower : F. Loddo, G. De Robertis, M. Ince**

- **Responsibilities :**

  - since June 2016: F. Loddo is Project Engineer,
  with responsibility of the overall coordination and the chip integration

  - since May 2018: F. Loddo is responsible of the development of the pixel ASIC
  within the "IT coordination" for the Phase-2 upgrade

- **Design :**
  - 10-bit Digital-to-Analog Converter for the bias of the analog Front-End
  - architecture & implementation of the bias circuit
  - chip Floorplan
  - study & implementation of circuit design solutions
    to enhance the chip testability during the production phase

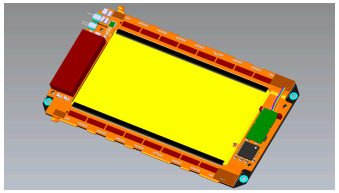
- **Activity foreseen in 2019-2020 :**
  - participation to the pixel chip design & submission to factory (foundry) foreseen for :

  - Q3 2019 for the Atlas version of the chip
  - Q2 2020 for the CMS version (CROC) of the chip

INFN-Bari Outer Tracker (OT) Phase-2 contribution

- **Deliver Tilted Outer Tracker mounted, integrated and tested with 1956 PS modules**

  (≈ 40 m^2 surface detector)

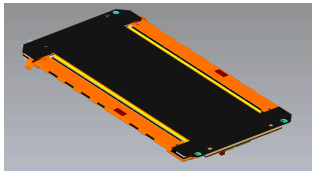


- Development and Qualification
  - Service Hybrid testing (Genova)
  - FE Hybrids testing (Catania)
  - Silicon Sensors Process Qualification (Perugia)

- Construction and integration of PS Modules (1956 installed)
  - module assembly, wire bonding and testing (**Bari**, Perugia)
  - module Burn in and Calibration (Pisa)
  - module mechanical integration and testing in 72 rings (Pisa + all)

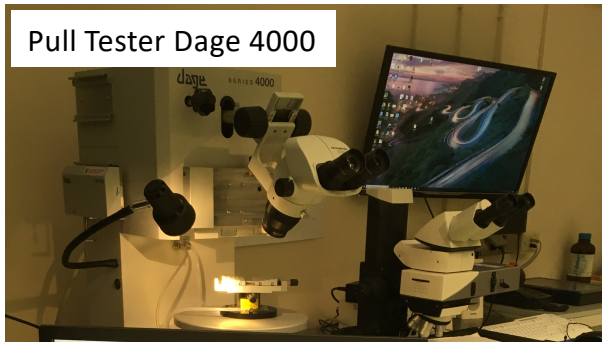
- **D. Creanza**
- **M. de Palma**
- **L. Fiore (Resp. of Center)**
- **S. My**
- **Mech. Design Service (M. Mongelli)**
- **Clean Room (P. Cariola)**
- **Mech. Service**

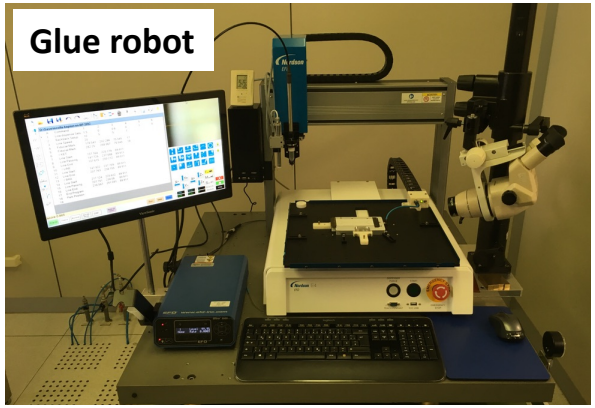
- Contribution to development, qualification of commons systems
  - Track Trigger electronics system (Pisa)
  - Power supply system (Firenze, Perugia)
  - DAQ and Control Systems (Pisa, Catania, **Bari**)
  - Safety System (Pisa)



- **D. Creanza is the Responsible Person of the OT module construction in Italy**

OT activities : operational infrastructure



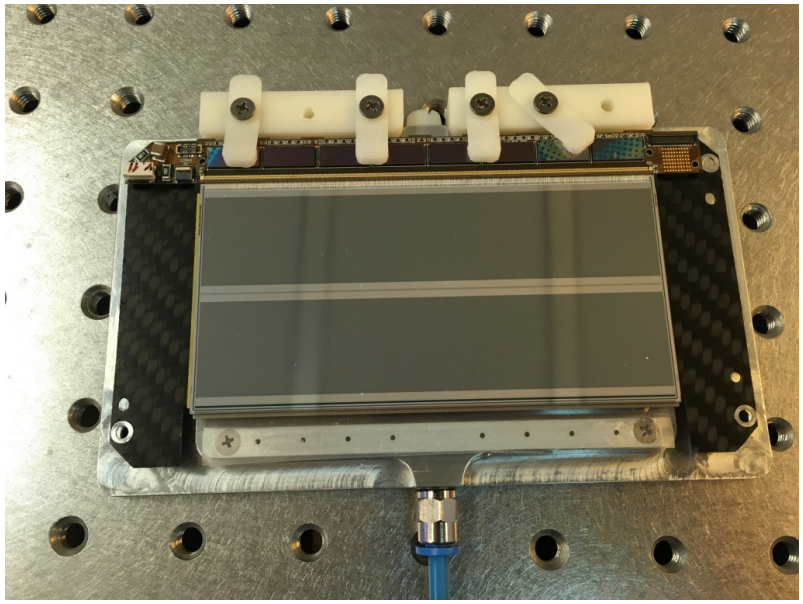


Recent purchase & setup of the Bari glue robot

➢ The Pull tester & the bonder are ready to deal with the CMS PS modules

OT activities : 2019-2020 plan

- **So far : 2 mechanical modules has been assembled using the prototype jigs,** just to setup the infrastructure (assembly lines) in the Clean Room.



- In the fall of 2019 we should get the **final set of jigs**

- We plan to build at least 3 dummy modules within the end of 2019 to allow ... the assembly of the 5 functional modules during 2020, to qualify the Assemby Center

- we are waiting for the full set of dummy components.

OT activities : requests for 2020

- In order to get 5 **functional modules** done for the center qualification, we need to:
  - finalize & optimize the assembly jigs
  - fine tune the test system
  - study meticulously the procedure for the modules' production

Correspondingly our personpower requests for 2020 are (evaluated in *mesi persona*):

SERVICE	REQUEST	Activity
Progettazione Meccanica	**6**	jigs' design
Officina meccanica	**3**	jigs' optimization
Camera Pulita	**12**	functional modules

- We are optimizing the 2020 funding requests together with the other Tracker sites
  ... under the coordination of the Tracker activity responsible (RA)

- In 2020 we'll have an «assegno di ricerca tecnologico» for 2 years
  (assigned on central funds and according to the plan in the CTS doc)

CMS Phase-1/2 Upgrade & related activities : MUON SYSTEM

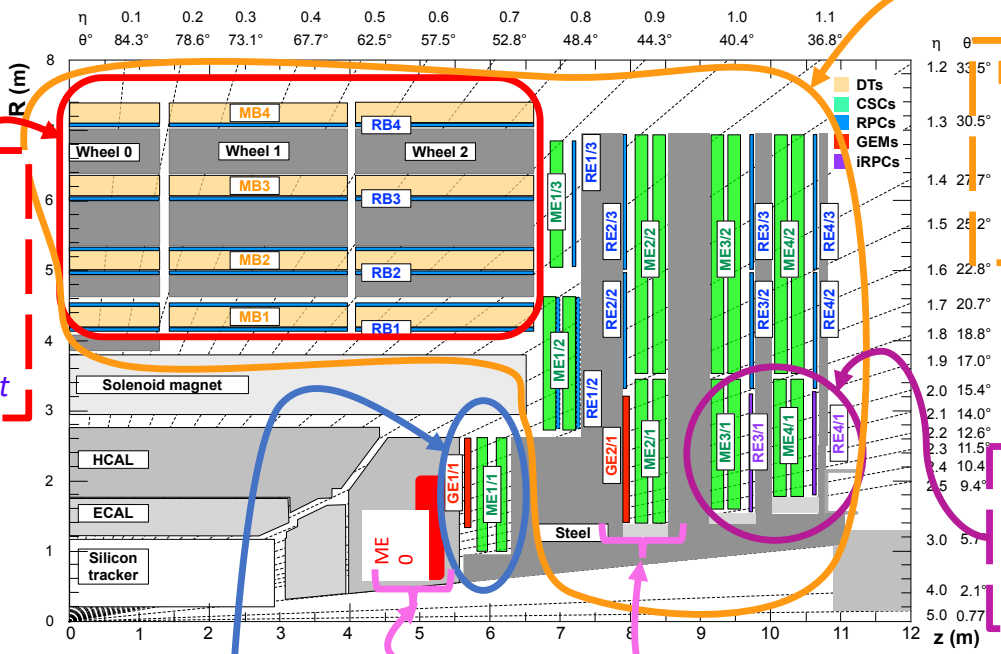
- A. Colaleo, Muon System Manager
- G. Pugliese, RPC System Manager

Overwiew of CMS-Bari Muon system activities

4

RPC Leak Repair campaign

- *priority for CERN to reduce GWP exhaust to environment*
- *heavy CMS-Bari involvement*



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RPC Ecogas Studies

- *poss. replacement R134 → HFO*
- *studies under bkg radiation in GIF++*

3

Improved RPC (RE3/1 & RE4/1)

- *prototype Tests*
- *services installation*

1

GEM GE1/1 Project (CMS Phase-1 upgrade)

- *Construct & Qualify 144 Triple-GEM detectors*
- *installation during LS2*

Priority of CMS during LS-2 all eyes are on us!

GEM Phase-2 upgrades: GE2/1 & ME0

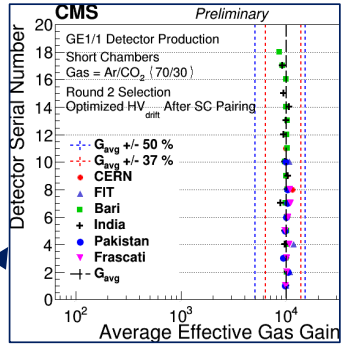
- *prototype Design & Construction*
- *discharge tests @ Neutron Facility*
- *simulation of various HW design*
- *simulation of HGCAL & Neutron Bkg*

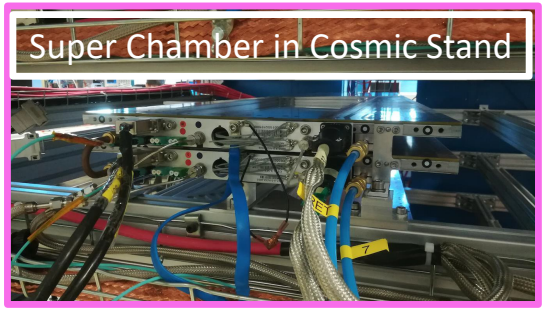
2

Construction & Test of GE1/1 detectors 1

- **GE1/1 Production finished** (160 constructed / 154 valid - 144 needed)
  - **Bari produced 18 chambers in 2018; first site to finish production**
  - also contribution in **testing & installing the chambers,** installing the services.
  - **A. Ranieri, S. Nuzzo, R. Venditti, A. Sharma, E. Soldani, P. Verwilligen, F.Simone**
    - + technicians (M. Franco, N. Lacalamita, S. Martiradonna, D. Dell'Olio)
    - + students (C. Aruta, F. Ivone)

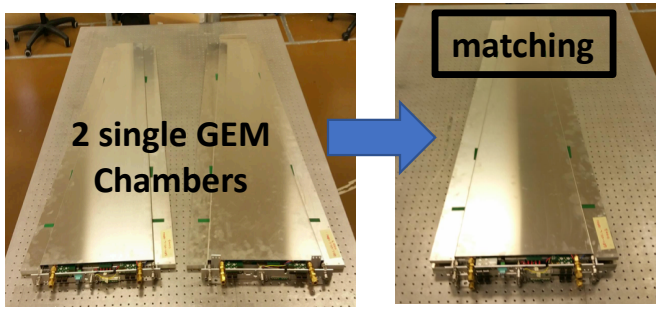
- **Super Chamber (SC) assembly ongoing:**
  - equip 2 chambers w/ electronics
  - **J. Merlin (GEM production manager), S. Nuzzo**
    + technicians (P.Dipinto, D.Dell'Olio)
  - *Analysis of Chamber data x matching*: **E. Soldani**



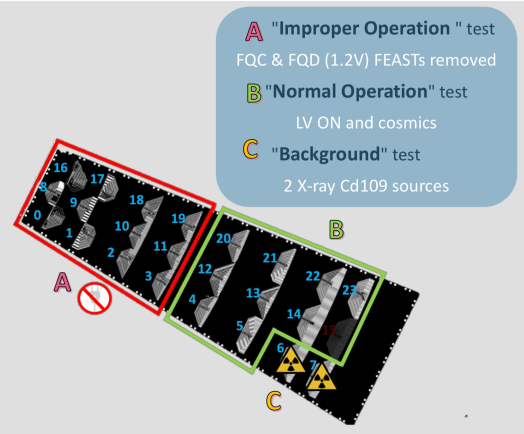


- **VFAT3 design, production/test & packaging**
  G. De Robertis, F. Licciulli (+ P. Mastrapasqua**)**

- **QC6-7-8 ongoing at CERN:** Cosmic-Ray Stand
  - *Bari physicists in leading role*: **M. Maggi (GEM Run coordinator), F. Simone**



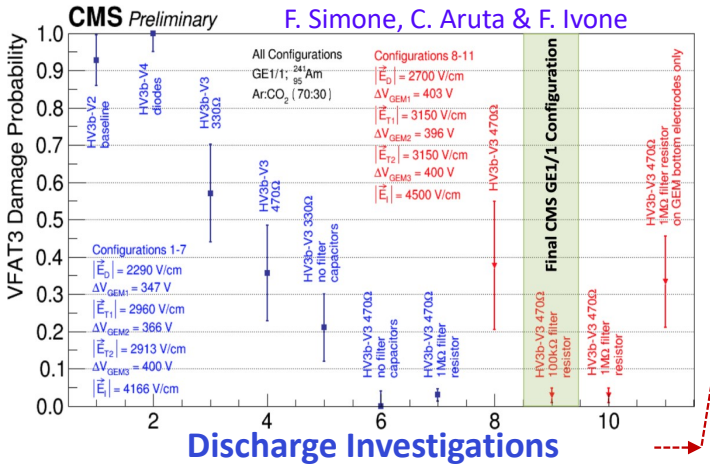
GEM Sustained Operation Studies 1



- **Slice-Test (2017-2018) was a success:**
  - Integration in central CMS operations (DCS & DAQ)
  - Experience in running GEMs under high background
    --> found abnormal channel dead rate

Creation of workgroup to reproduce in Lab & Mitigate for final installation

- *Bari Expertise on electronics indispensable*: **G. De Robertis & F. Licciulli**
- **F. Simone +** students **(F. Ivone, C. Aruta)** **(all** *giving crucial contribution)*



- **R&D campaign (GEM «Sustained Operation»)** lauched this summer to
  - **understand the origin of the channel loss**
  - study the effect of discharges on **VFAT3** --> spark-resistant version of hybrid designed under coordination of Bari electronics team
    (after intense test campaign **v3** VFAT3 hybrid was selected for GE1/1)
  - **reduce sparks in future Triple-GEM detectors:**
    - Double-segmented foils for GE2/1 & ME0

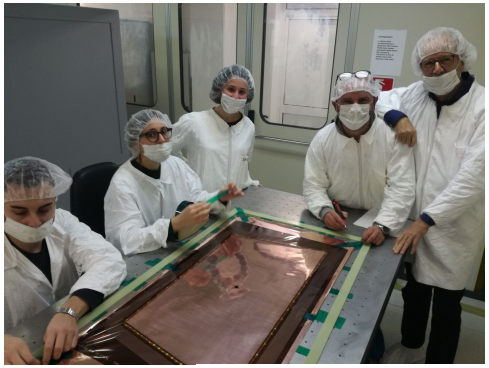
A. Colaleo, M. Maggi, J.Merlin, P.Verwilligen, F. Licciulli, G. De Robertis

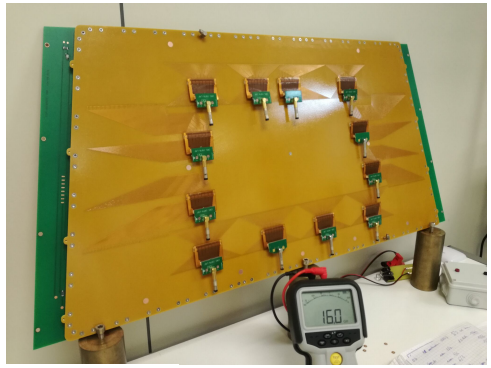
- **GEM aging studies** (V. Mastrapasqua)

GEM Phase-2 activities 2

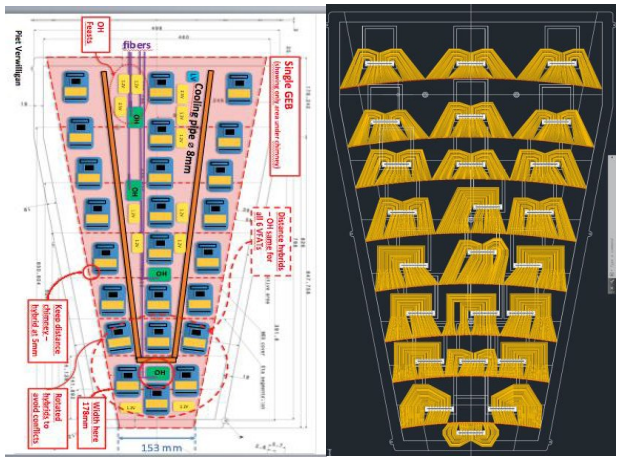
CMS-Bari also involved in GEM Phase-2 activities:

- Construction & Test of GE2/1 Prototypes — **A.Ranieri, R.Venditti, J.Merlin** (GE2/1 prod. manager) **& P.Verwilligen**
- Design of ME0 Readout Board (complex interplay between services, readout, daq & detector) — **P. Verwilligen**
- Stand-Alone & CMSSW integrated simulation of GEM Detectors — **Simulation coordinated by P. Verwilligen**
- Preparation of Phase-2 Electronics: packaged VFAT3: **design** & **tender** — **GEM Electronics coordinated by F. Licciulli**
- Preparation for Neutron Beam Test (Discharges) in October 2019 – in collaboration with INFN Pavia





Construction & Test GE2/1



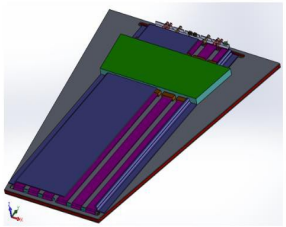
Design of ME0 readout

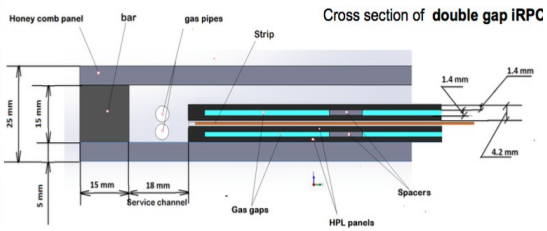
iRPC Design for RE3/1 & RE4/1 : 2D readout 3

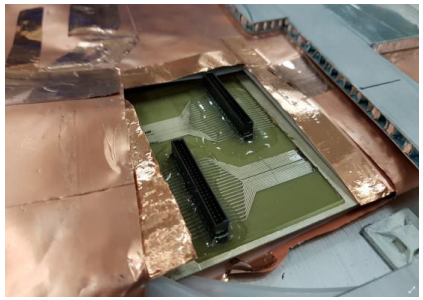
The design of the improved RPC has been defined

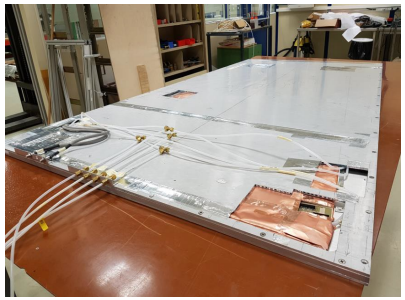
	iRPC	RPC
High Pressure Laminate thickness	1.4 mm	2 mm
Num. of Gas Gap	2	2
Gas Gap width	1.4 mm	2 mm
Resistivity (□cm)	0.9 - 3 x 10^{10}	1 - 6 x 10^{10}
Charge threshold	50 fC	150 fC
h segmentation	2D readout	3 h partitions

2D readout design:
Readout Strips (with a pitch ≈*0.6÷1.0* cm) are readout from both-ends and connected to a new Front-End Boards equipped with a TDC





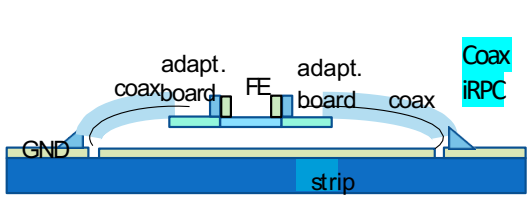


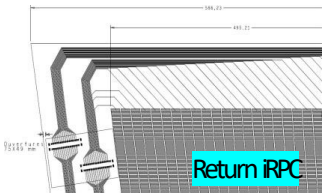


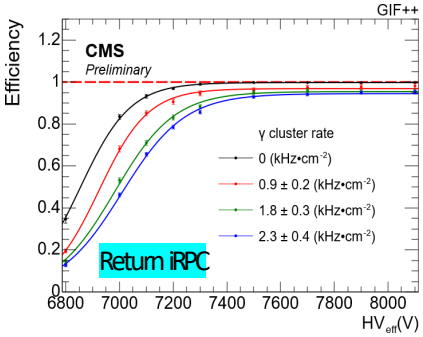
Two full size-RPCs with new FEBs have been tested at GIF++:
- Coaxial design: strips connected to FEB through coaxial cables
- Return design: return lines embedded on PCB

Return design adopted for ease of constr & impedance match

Validation of new FEB_V1 (PETIROC) ongoing @ 2kHz/cm^2 γ





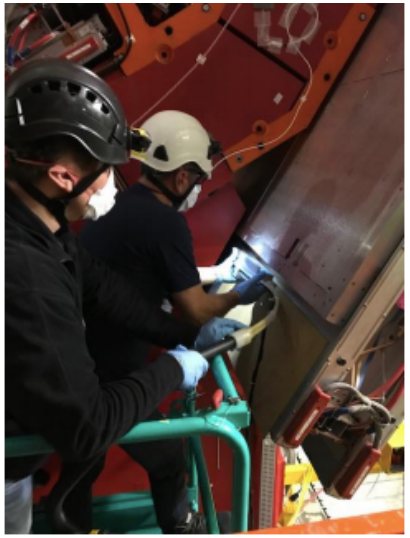


Prototypes tested at GIF++
by **A. Gelmi, R. Aly**

RE3/1 & 4/1 Services
installation by **N. Lacalamita**

R&D upgrade
W.Elmetenawee, I.Margjeka

RPC Gas Leak reparation 4



In 2018, the RPC gas system was operated with:

- **Total flow** ~8800 l/h
- **Leak rate:** ~900 l/h (constant)

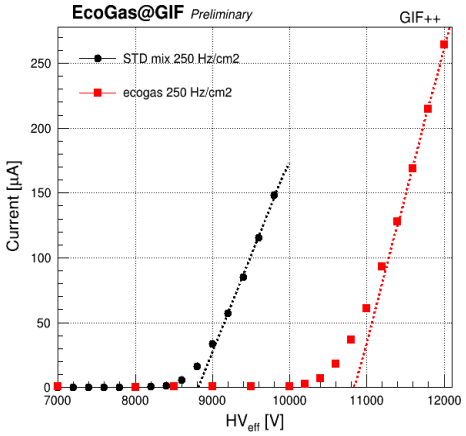
Leaky chambers are located:

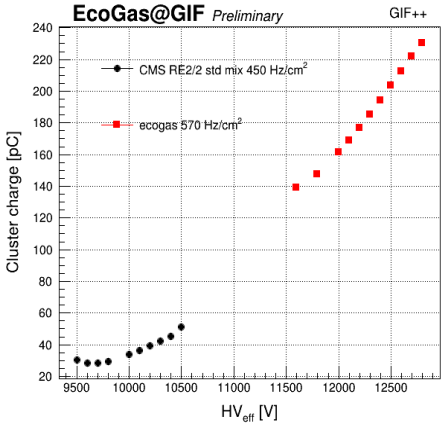
- 63 in the Barrel → 800-850 l/h
- 8 in the Endcap → 50-100 l/h

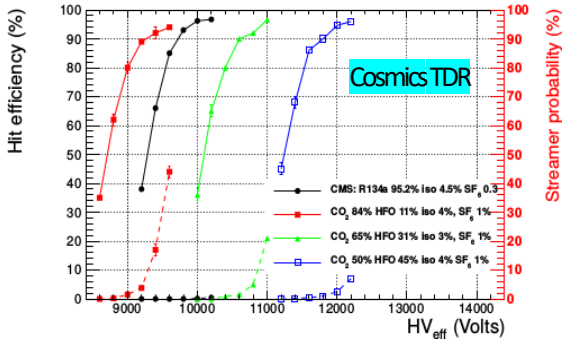
- In the framework of CMS strategy for GHG emission reduction, a massive leak repair campaign started in March 2019.
  - carried out by **G. Pugliese, M. Franco**
  - **Encap region:** five leaky chambers have been replaced with spare chambers, leading to a **leak reduction of ~ 35 l/h.**
  - **Barrel region:**
    - Access to the positive side from April to June 2019. All leaky chambers have been first inspected to localize the source of leak.
    - A new procedure to repair the leaky RPCs was also successfully implemented allowing access to the broken gas component by a partially extraction of the station (RPC & DT). **Strong contribution of Bari Technicians in all phases !**
    - **27% of leaky chambers have been repaired. Leak reduction of ~ 90 l/h.**

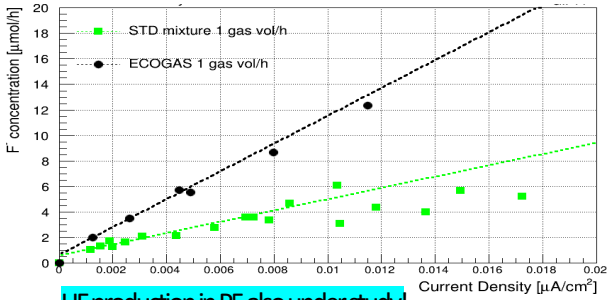
RPC & iRPC Longevity studies @ GIF++ 5

- **Main goal: validate existing RPCs & iRPC for HL-LHC (1C/cm²); test iRPC prototypes rate-capability**
- **GIF++ is interesting place to study RPC detector performance & investigate new GWP-neutral gas mixtures**
  - 5 RPCs (2 CMS, 1 ATLAS, 1 Alice, 1 EP-DT) under test in common project; 1 RPC with CMS electronics
  - Ecogas mix based on HFO1234ze ($C_3H_2F_4$) under study: 45% HFO, 50% CO_2, 4% iC_4H_{10}
  - 2kV shift of HV Working Point @ 250Hz/cm² – in agreement with TDR (Cosmics only)
  - Study of HF production (2.5 x higher) & Study of Cluster Size & Cluster Charge ongoing
  - carried out by **G. Pugliese, A. Gelmi**









HF production in P5 also under study!

RPC & GEM personpower requests for 2020

Servizio	GEM	Task	At CERN	Access
Progettazione Mecchanica	2	Progettazione Costruzione GE2/1	-	-
Officina Meccanica	8	GE2/1 (2) + SC (2) + Inst & Serv (2.5) + Serv (1.5)	6	-
Camera Pulita	-	Modules Construction GE2/1	-	6
Progettazione Elettronica	-		-	-
Servizio Elettronico	3	Test Setup GE2/1 + Test packaged VFAT3	-	-

Servizio	RPC	Task	At CERN	Access
Progettazione Mecchanica	-		-	-
Officina Meccanica	6	Services (1.5) + Leak (4) + GIF++ (0.5)	6	-
Camera Pulita	-		-	-
Progettazione Elettronica	-		-	-
Servizio Elettronico	-		-	-

GEM Activities 2020:

- [at CERN] Installation 2nd endcap GE1/1; Services GE1/1 & GE2/ [Technicians]
- [at CERN] Data taking & Analysis @ Cosmic Stand; Commissioning @ P5; Global Runs [Phycisists]
- [in Sezione] Construction & Test GE2/1 (40 modules) [Tech & Phys]

RPC Activities 2020:

- [at CERN] Leak Repair Campaign (expertise Bari) + Services RE3/1 & RE4/1 [Technicians]
- [at CERN] Commissionning @ P5 (RE4); GIF++ (ecogas); Global Runs. [Phycisists]

We will host *CMS-Italia annual meeting* (2019 november 13th-15th)

CMS overall request for INFN-Bari services in 2020 - Recap

- Overall requests evaluated in *"mesi persona"* :

SERVICE	TRK	GEM	RPC	
Progettazione Meccanica	**6**	**2**	**-**	→ **8**
Officina meccanica	**3**	**8 (2+6@Cern)**	**6(@Cern)**	→ **5+12(@CERN)**
Camera Pulita	**12**	(6 access only)	**-**	→ **12**
Servizio Elettronico	**-**	**3**	**-**	→ **3**

Current/future Contributions/Responsibilities within CMS

2019 → 2020

BARI				
Responsabilita`subdetectors	**Cognome**	**Nome**	**Livello**	**descrizione responsabilita**
TK	Silvestris	Lucia	L1	Run coordination
MUO	Colaleo	Anna	L1	Muon System manager → **ends august 2019**
RPC	Pugliese	Gabriella	L1	RPC System manager
FIS	Pompili	Alexis	L2	BPAG convener → **starts september 2019**
GEM	Venditti	Rosamaria	L2	GEM Upgrade Physics coordinator
TK	Loddo	Flavio	L2	RD53 Project Leader Engineer/TK-Ph2 IT-ASIC Coordinator
GEM	Maggi	Marcello	L2	GEM Run coordinator
GEM	Licciulli	Francesco	L2	GEM Electronics coordinator
CALC	Maggi	Giorgio	L2	T2 site manager
GEM	Merlin	Jeremie	L2	GEM production manager
FIS	De Filippis	Nicola	L3	Future Higgs WG convener
GEM	Licciulli	Francesco	L3	ASIC-DAQ Integration
GEM	Merlin	Jeremie	L3	GEM GE2/1 Production Manager
GEM	Verwiligen	Piet	L3	GEM Detector Response Modeling Coordinator
GEM	Verwilligen	Piet	L3	GEM Phase-2 Simulation Coordinator
GEM	Verwilligen	Piet	L3	GEM Production Site Manager

Other involvements in Committees : M. de Palma (Career Committee)

N. De Filippis (Schools & PhD Thesis awards commitees)

Team responsibilities :

A. Pompili (Team Leader)

S. My (deputy Team Leader / Tracker IB representative)

P. Verwilligen (deputy Team Leader / Muon IB representative)

Trimestral support for young students @ CERN

- **In the period 2016-2019 CMS-Bari benefitted from six 3-month scolarships funded by INFN ("similfellow junior") to support activities of our young students @ CERN, provided through a public call on a merit basis [related to their academic path (marks reported, final degree evaluation)].**
  This number is well beyond the average over the all INFN CMS groups!

Name	Current position
A. Di Florio	INFN post-doc
F. Simone	Phd student
A. Taliercio	Phd student (@Louvain)
F. Ivone	Master student
V. Mastrapasqua	Graduate student
A. Zaza	Master student

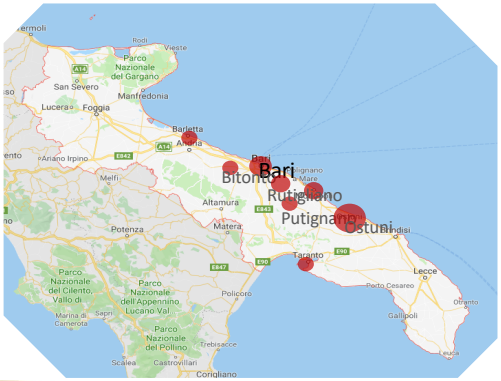
Wide support to conference/workshop participation

- **In 2018 CMS-Bari supported a rather wide participation to Conferences & Workshops, (a large part for the non-staff members of the group); this table is the comparison with other INFN CMS groups (not normalized to the number of group members). Our involvement is higher than the average over the all INFN CMS groups.**

	Num. Talks con proceedings	Num. talks senza proceedings
Bari	22	12
Bologna	13	1
Catania	0	0
Firenze	4	3
Genova	3	1
LNF	0	1
LNL	0	0
Milano	7	10
Napoli	7	5
Padova	8	4
Perugia	6	5
Pisa	7	4
Pavia	14	0
Roma 1	6	5
Torino	21	11
Trieste	1	2
TOT	119	64

Masterclass CMS - 21 marzo 2019

45 partecipanti da 10 scuole diverse



TOTEM

Responsabile nazionale: F. Cafagna

Responsabile locale: E. Radicioni

Status of physics papers

- "First measurement of elastic, inelastic and total cross-section at √s = 13 TeV by TOTEM and overview of cross-section data at LHC energies"
  - Published in EPJC. [arXiv:1712.06153, Eur.Phys.J. C79 (2019) 103]

Eur. Phys. J. C (2019) 79:103
https://doi.org/10.1140/epjc/s10052-019-6567-0

THE EUROPEAN PHYSICAL JOURNAL C

Check for updates

Regular Article - Experimental Physics

First measurement of elastic, inelastic and total cross-section at $\sqrt{s}$ = 13 TeV by TOTEM and overview of cross-section data at LHC energies

TOTEM Collaboration

Abstract

The TOTEM collaboration has measured the proton-proton total cross section at $\sqrt{s}$ = 13 TeV with a luminosity-independent method. Using dedicated $\beta^* = 90$ m beam optics, the Roman Pots were inserted very close to the beam. The inelastic scattering rate has been measured by the T1 and T2 telescopes during the same LHC fill. After applying the optical theorem the total proton-proton cross section is $\sigma_{tot} = (110.6 \pm 3.4)$ mb, well in agreement with the extrapolation from lower energies. This method also allows one to derive the luminosity-independent elastic and inelastic cross sections: $\sigma_{el} = (31.0 \pm 1.7)$ mb and $\sigma_{inel} = (79.5 \pm 1.8)$ mb.

$$\sigma_{TOT} = \frac{16\pi(\hbar c)^2}{1+\rho^2} \cdot \frac{\left.\frac{dN_{EL}}{dt}\right|_{t=0}}{N_{EL}+N_{INEL}}$$

TOTEM detectors integrated in CMS (T1, T2)

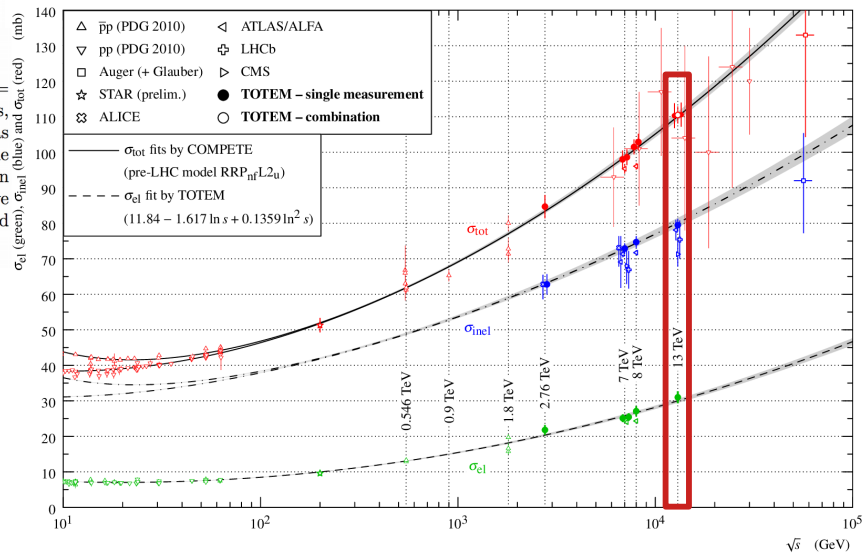
TOTEM detectors integrated in LHC (RP)

Luminosity independent

$$\sigma_{tot} = 110.6 \pm 3.4 \text{ mb}$$

$$\sigma_{inel} = 79.5 \pm 1.8 \text{ mb}$$

$$\sigma_{el} = 31.0 \pm 1.7 \text{ mb}$$

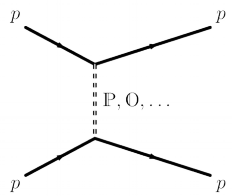


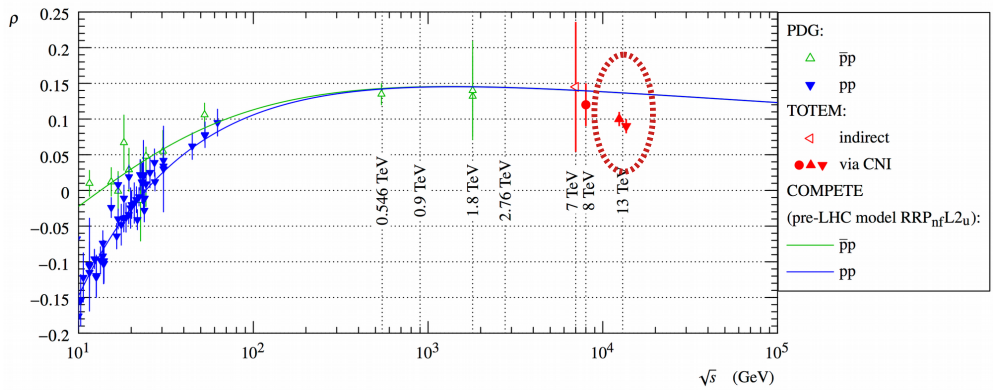
Status of physics papers

- "First determination of the ρ parameter at $\sqrt{s}$ = 13 TeV – probing the existence of a colourless three-gluon bound state"
  - Submitted to EPJC (ref. comments). [arXiv:1812.04732, CERN-PH-EP-2018-335]

Abstract

The TOTEM experiment at the LHC has performed the first measurement at $\sqrt{s} = 13\,\text{TeV}$ of the ρ parameter, the real to imaginary ratio of the nuclear elastic scattering amplitude at $t = 0$, obtaining the following results: $\rho = 0.09 \pm 0.01$ and $\rho = 0.10 \pm 0.01$, depending on different physics assumptions and mathematical modelling. The unprecedented precision of the ρ measurement, combined with the TOTEM total cross-section measurements in an energy range larger than 10 TeV (from 2.76 to 13 TeV), has implied the exclusion of all the models classified and published by COMPETE. The ρ results obtained by TOTEM are compatible with the predictions, from alternative theoretical models both in the Regge-like framework and in the QCD framework, of a colourless 3-gluon bound state exchange in the t-channel of the proton-proton elastic scattering. On the contrary, if shown that the 3-gluon bound state t-channel exchange is not of importance for the description of elastic scattering, the ρ value determined by TOTEM would represent a first evidence of a slowing down of the total cross-section growth at higher energies. The very low-$|t|$ reach allowed also to determine the absolute normalisation using the Coulomb amplitude for the first time at the LHC and obtain a new total proton-proton cross-section measurement $\sigma_{tot} = (110.3 \pm 3.5)$ mb, completely independent from the previous TOTEM determination. Combining the two TOTEM results yields $\sigma_{tot} = (110.5 \pm 2.4)$ mb





Status of physics papers

- "Elastic differential cross-section measurement at √s = 13 TeV by TOTEM"
  - Observation of diffractive dip at 13 TeV with high precision, absence of structure beyond second maximum
  - To be submitted to EPJC. [arXiv:1812.08283, CERN-PH-EP-2018-338]

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

TOTEM 2018-003
December 13, 2018

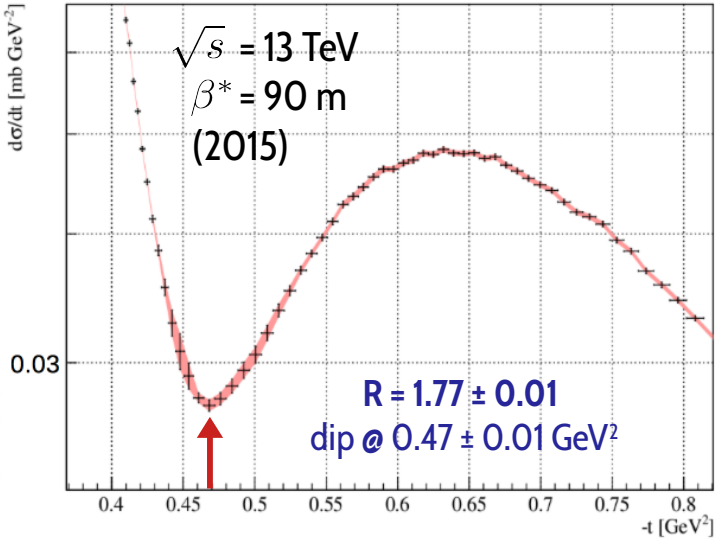
CERN-EP-2018-338
17 December 2018

Elastic differential cross-section measurement at $\sqrt{s} = 13$ TeV by TOTEM

The TOTEM Collaboration

Abstract

The TOTEM collaboration has measured the elastic proton-proton differential cross section $d\sigma/dt$ at $\sqrt{s} = 13$ TeV LHC energy using dedicated $\beta^* = 90$ m beam optics. The Roman Pot detectors were inserted to 10σ distance from the LHC beam, which allowed the measurement of the range $[0.04\ \mathrm{GeV}^2; 4\ \mathrm{GeV}^2]$ in four-momentum transfer squared $|t|$. The efficient data acquisition allowed to collect about 10^9 elastic events to precisely measure the differential cross-section including the diffractive minimum (dip), the subsequent maximum (bump) and the large-$|t|$ tail. The average nuclear slope has been found to be $B = (20.40 \pm 0.002^{\mathrm{stat}} \pm 0.01^{\mathrm{syst}})\ \mathrm{GeV}^{-2}$ in the $|t|$-range 0.04 GeV^2 to 0.2 GeV^2. The dip position is $|t_{\mathrm{dip}}| = (0.47 \pm 0.004^{\mathrm{stat}} \pm 0.01^{\mathrm{syst}})\ \mathrm{GeV}^2$. The differential cross section ratio at the bump vs. at the dip $R = 1.77 \pm 0.01^{\mathrm{stat}}$ has been measured with high precision. The series of TOTEM elastic pp measurements show that the dip is a permanent feature of the pp differential cross-section at the TeV scale.



R = max/dip ratio of $\mathrm{d}\sigma_{\mathrm{el}}/\mathrm{d}t$

Status of physics papers

- "Elastic differential cross-section at √s = 2.76 TeV and implications on the existence of a colourless 3-gluon bound state"
  - Observation of diffractive dip at this energy, comparison with D0 measurement at Tevatron
  - To be submitted to EPJC. [arXiv:1812.08610, CERN-PH-EP-2018-341]

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

TOTEM 2018-002
December 13, 2018

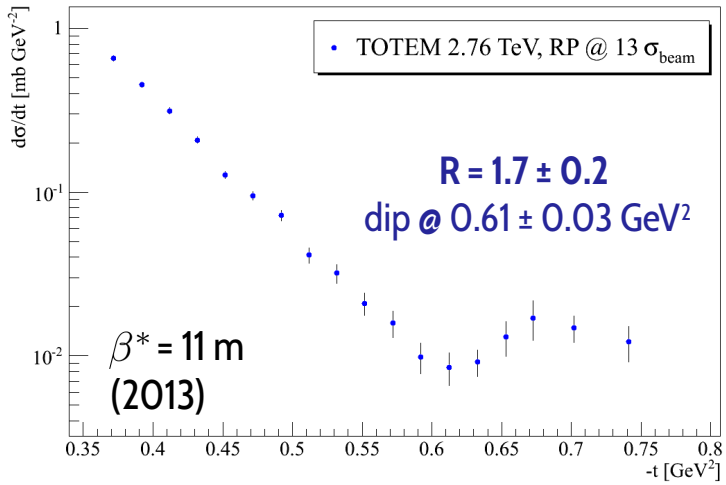
CERN-EP-2018-341
18 December 2018

Elastic differential cross-section $d\sigma/dt$ at $\sqrt{s}$ =2.76 TeV and implications on the existence of a colourless 3-gluon bound state

The TOTEM Collaboration

Abstract

The proton-proton elastic differential cross section $d\sigma/dt$ has been measured by the TOTEM experiment at $\sqrt{s} = 2.76$ TeV energy with $\beta^* = 11$ m beam optics. The Roman Pots were inserted to 13 times the transverse beam size from the beam, which allowed to measure the differential cross-section of elastic scattering in a range of the squared four-momentum transfer ($|t|$) from 0.36 GeV^2 to 0.74 GeV^2. The differential cross-section can be described with an exponential in the $|t|$-range between 0.36 GeV^2 and 0.54 GeV^2, followed by a diffractive minimum (dip) at $|t_{dip}| = (0.61 \pm 0.03)$ GeV^2 and a subsequent maximum (bump). The ratio of the $d\sigma/dt$ at the bump and at the dip is 1.7 ± 0.2. When compared to the $p\bar{p}$ measurement of the D0 experiment at $\sqrt{s} = 1.96$ TeV, a significant difference can be observed. Under the condition that the effects due to the energy difference between TOTEM and D0 can be neglected, the result provides evidence for a colourless 3-gluon bound state exchange in the t-channel of the proton-proton elastic scattering.



Status of physics papers

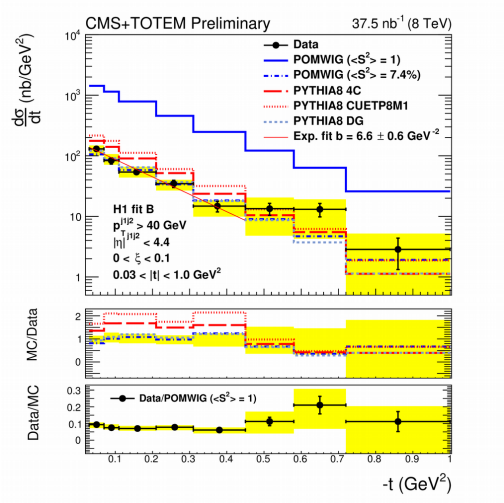
- "Measurement of dijet production with a leading proton in proton-proton collisions at √s = 8 TeV"
  - first single-diffractive dijet measurement at LHC with measured protons
  - PAS released, paper in preparation. [PAS-FSQ-12-033, TOTEM-NOTE-2018-001]

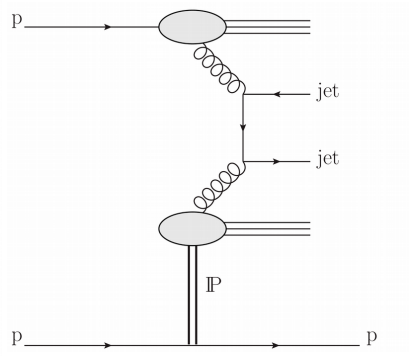
Measurement of dijet production with a leading proton in proton-proton collisions at $\sqrt{s} = 8$ TeV

The CMS and TOTEM Collaborations

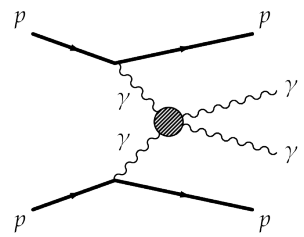
Abstract

A study of dijet production associated with a leading proton is presented. The analysis is based on a common data set collected simultaneously with the CMS and TOTEM detectors at the LHC with proton-proton collisions at $\sqrt{s} = 8$ TeV during a dedicated run with $\beta^* = 90$ m, at low instantaneous luminosity. The data correspond to an integrated luminosity of 37.5 nb^{-1}. The analysis presents the measurement of the dijet production cross section, as a function of ξ, the proton fractional momentum loss, and as a function of t, the 4-momentum transfer squared at the proton vertex. The dijet cross section in the kinematic region defined by $\xi < 0.1$, $0.03 < |t| < 1$ GeV^2, with at least two jets with transverse momentum $p_T > 40$ GeV, and pseudorapidity $|\eta| < 4.4$, is measured as 21.7 ± 0.9 (stat) $^{+3.0}_{-3.3}$ (syst) ± 0.9 (lumi) nb. Both the processes pp → pX and pp → Xp, i.e. with the proton scattering to either side of the interaction, are measured, with X including a system of two jets. The results correspond to the average of their cross sections. The ratio of the single-diffractive to inclusive dijet yields, normalised per unit of ξ, is presented as a function of x, the longitudinal momentum fraction of the proton carried by the struck parton. The ratio in the kinematic region defined above, for x values in the range $-2.9 \leq \log_{10} x \leq -1.6$, was measured as $R = \left(\sigma_{jj}^{pX}/\Delta\xi\right)/\sigma_{jj} = 0.025 \pm 0.001$ (stat) ± 0.003 (syst). The results are compared to the predictions from models of diffractive and non-diffractive interactions.



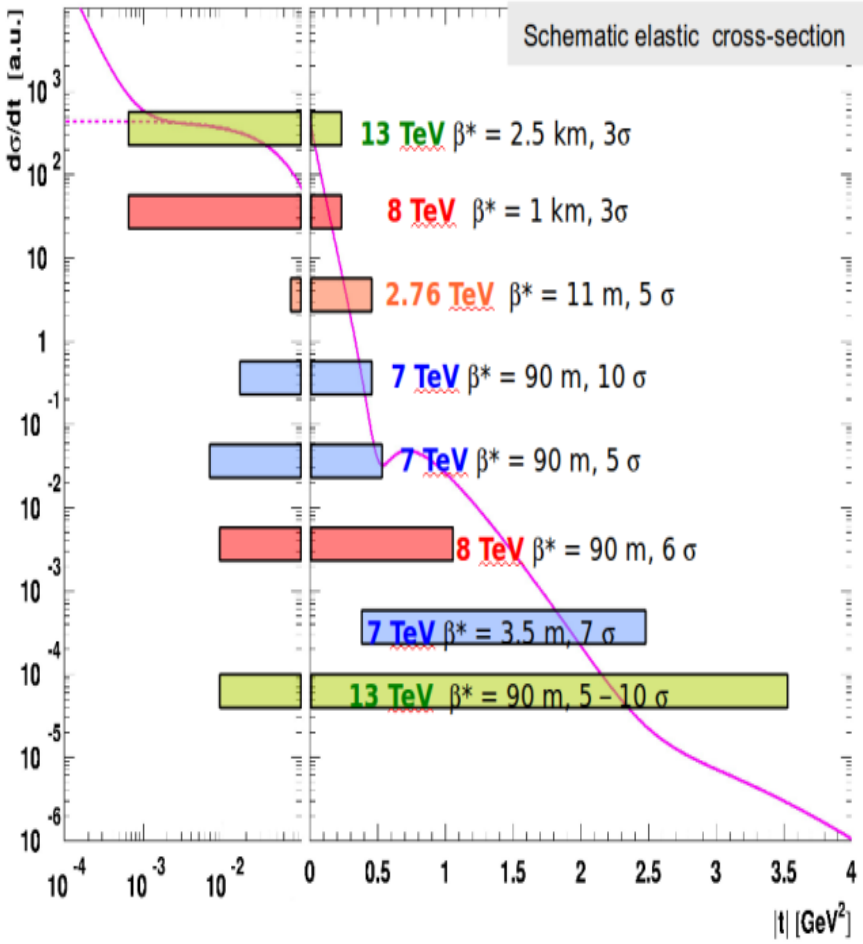


- "Search for central exclusive diphoton with proton tag using CT-PPS 2016 data"
  - under joint CMS-TOTEM review. [PAS-EXO-18-014]



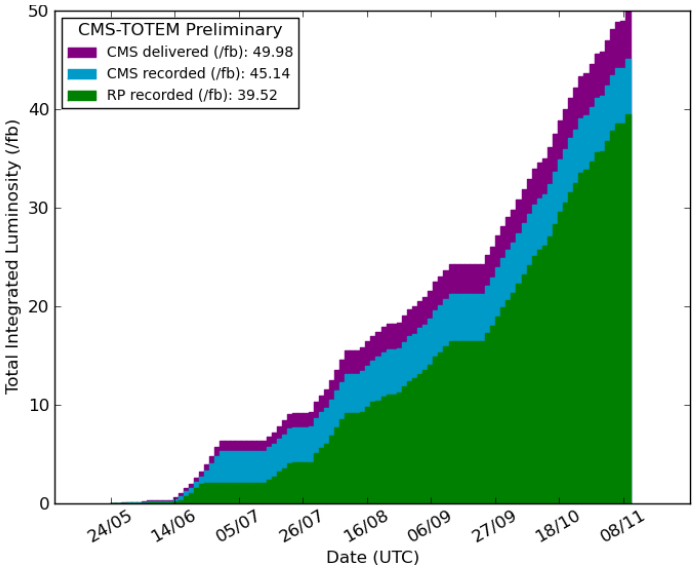
σ related measurements in Totem

2011	Elastic scattering @7TeV. EPL 95-41001 First σ_{tot}@ 7TeV. EPL 96-21002 σ_{tot} lumi. independent @7TeV.
2012	Elastic (full t-range), inelastic cross section. EPL 101-21004/21003/21002
2013	σ_{tot} lumi. independent @ 8TeV. PRL 111-12001
2015	$^{d\sigma}/_{dt}$ elastic: non-exp. behavior @8TeV. NPB 899-527
2016	ρ measurement @8TeV. EPJ C76-661
2017	σ_{tot} lumi independent @ 2.76 TeV. PoS (DIS2017) 059 σ_{tot} lumi independent @ 13 TeV. CERN-EP-2017-321 ρ measurement @ 13 TeV. CERN-EP-2017-335
2018	$^{d\sigma}/_{dt}$ elastic: DIP @ 13 TeV (Preliminary)

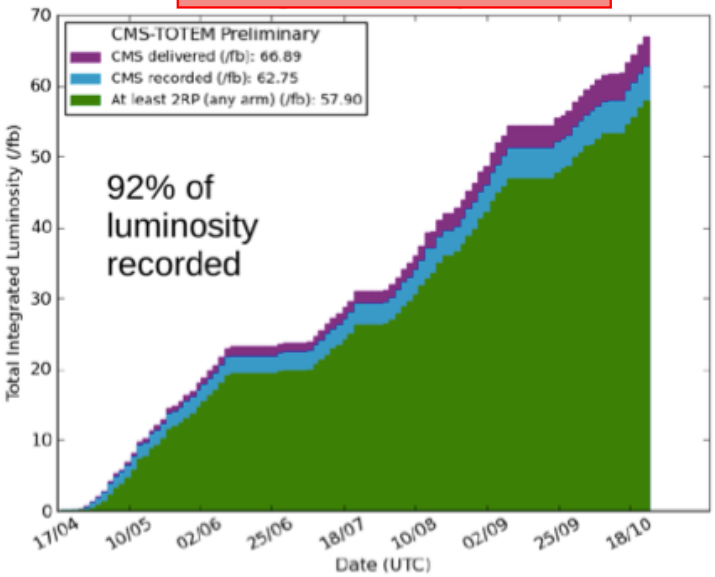


Luminosity with RP inserted

2017

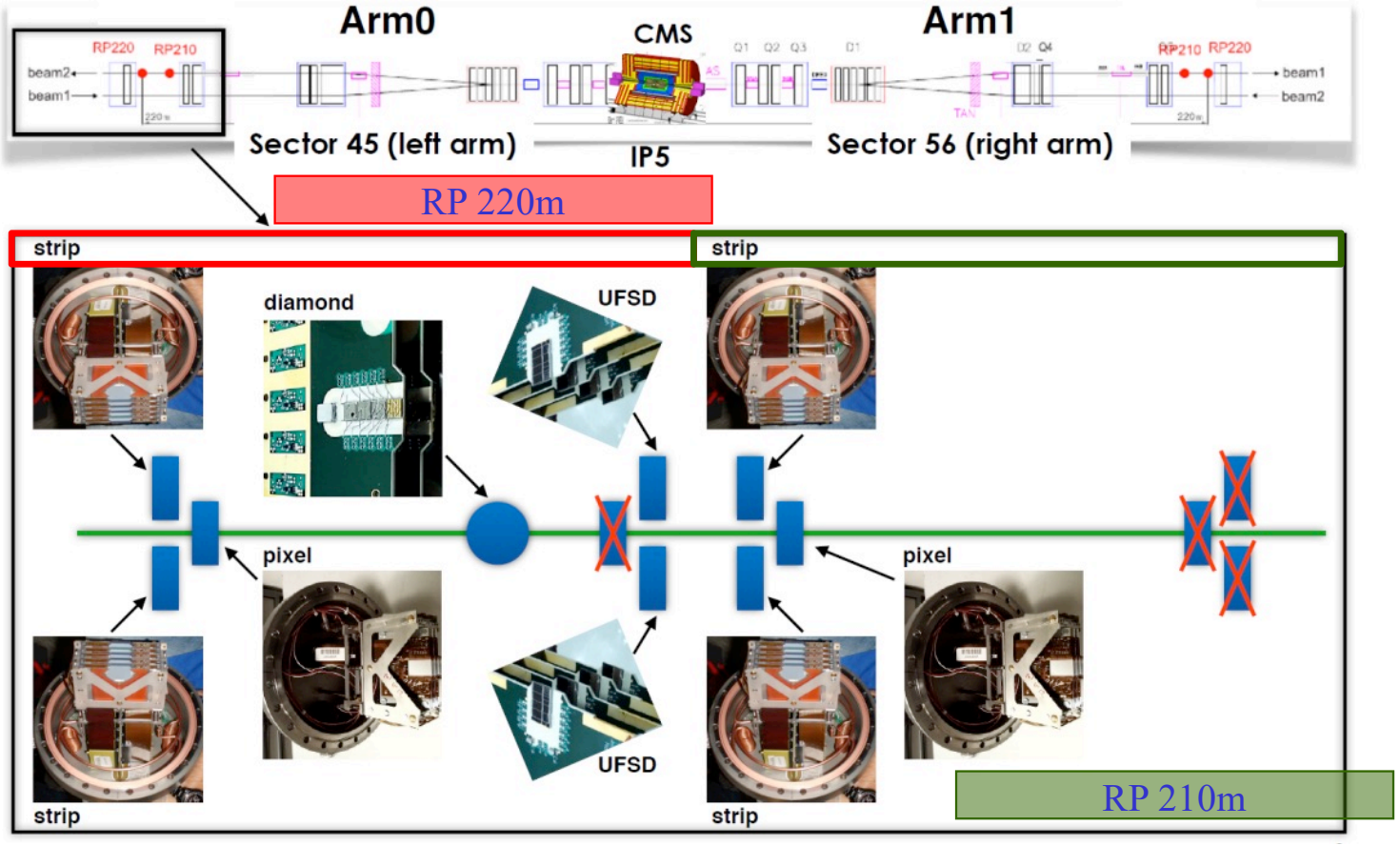


2018

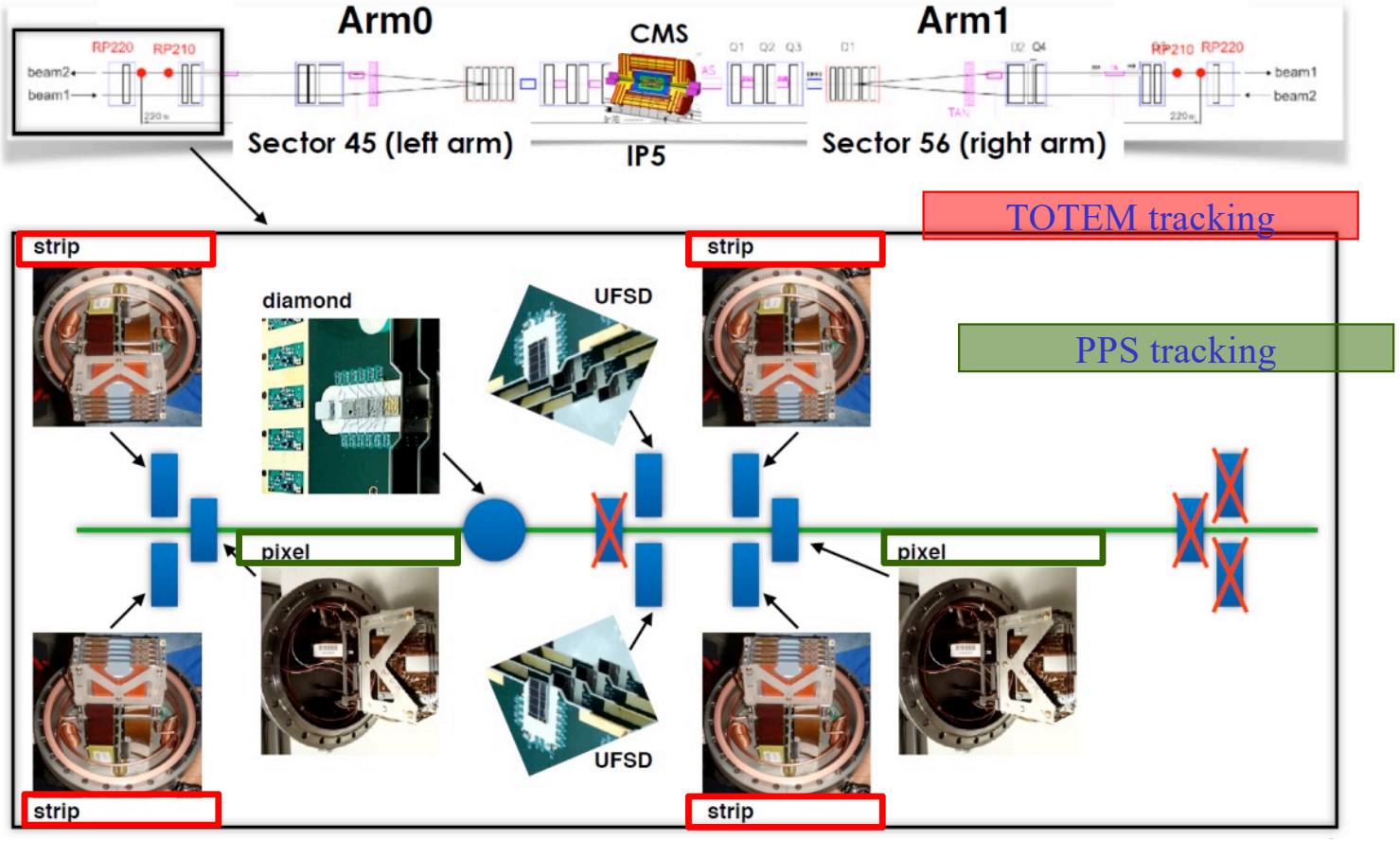


- In green, the luminosity collected by CT-PPS & PPS with RPs inserted in the beam.
- ~40 fb^{-1} collected in 2017, while > 50 fb^{-1} collected in 2018.

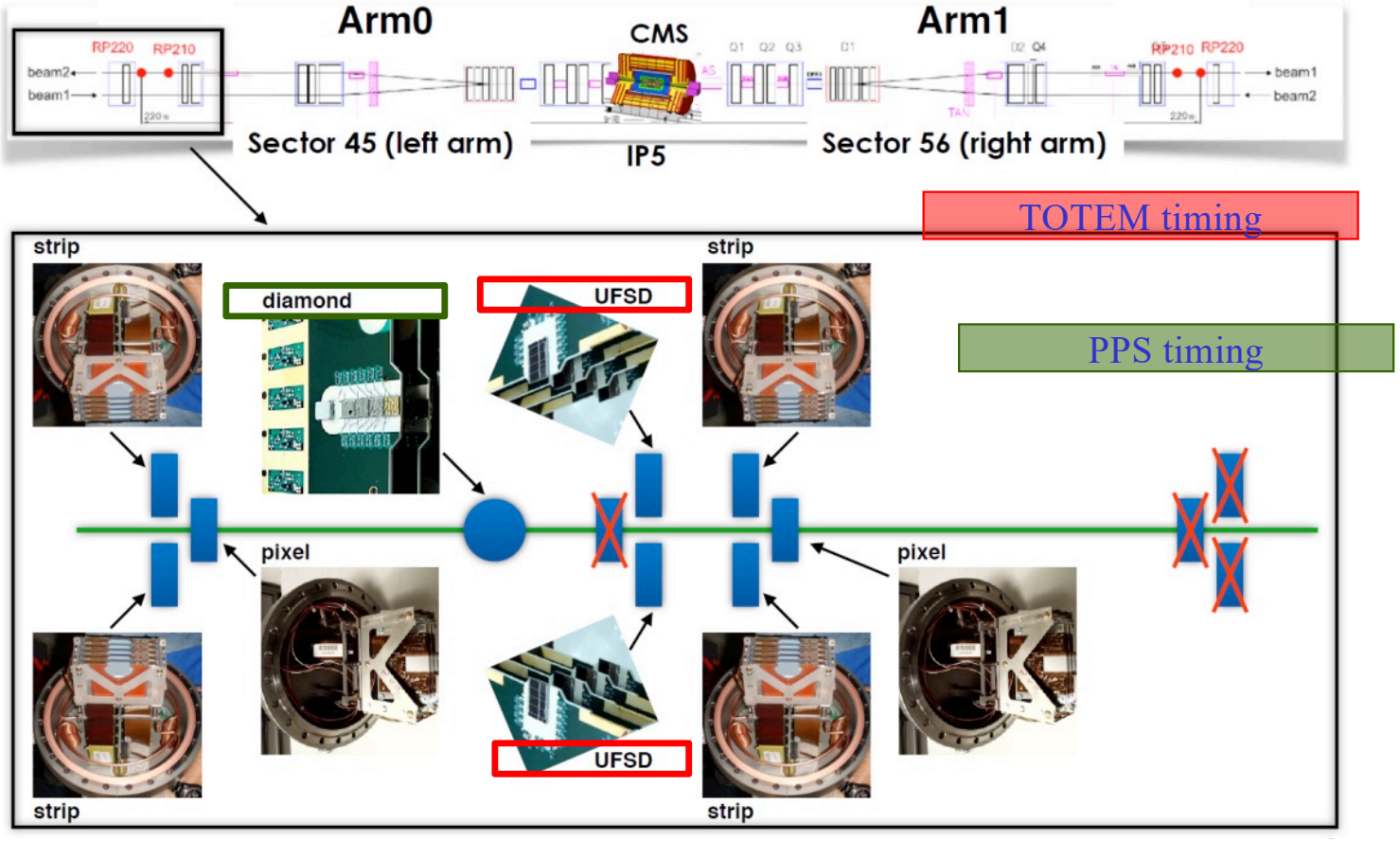
present layout



present layout



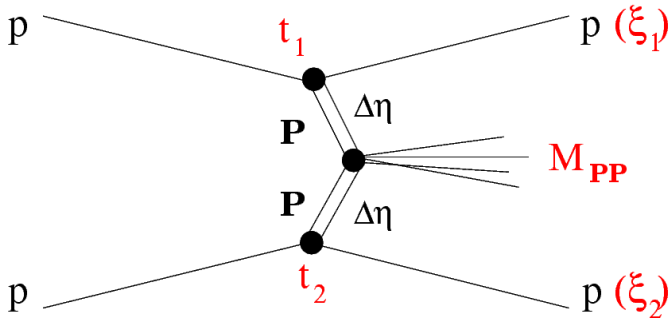
present layout

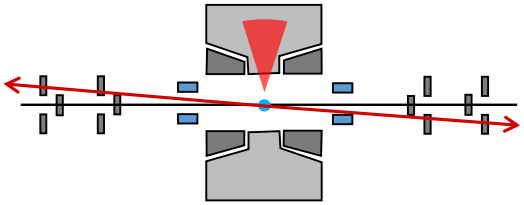


Special β^*= 90 m run

Main physics goal:

- Studies of glueball candidates
- Low mass spectroscopy ($\pi\pi$, KK, $\rho\rho$):
  - Spin
  - Decay modes
  - Branching ratios





Comparison/prediction from forward (TOTEM) to central (CMS) system: M_{PP}, $p_{T,Z}$, longitudinal vertex coordinate, …

CMS-TOTEM collected ~0.4 pb^{-1} of low-PU (μ=0.06-0.13) data at 13 TeV in 2015
Need to increase the statistics

Commissioning and operation

Timing system commissioning:

- Installation of new UFSD timing detectors and readout electronics (YETS1, completed during TS1)
- DAQ integration (ready in April 2018)
- Commissioning of UFSD during the low-beta alignment run and LHC rump-up fills (RP inserted and low radiation damage to the sensors)

Trigger commissioning (CMS and TOTEM):

- New TOTEM trigger with «antielastic» trigger (more later)
- CMS Special menu based on TOTEM RP triggers (L1) and track selections in central Pixel (HLT)

Reconstruction:

- Special track reconstruction in central tracker
- Timing Detector reconstruction

<u>90 m operations</u>

Alignment on June 24:

- All systems validated.
- Detector and trigger fine tuning performed.

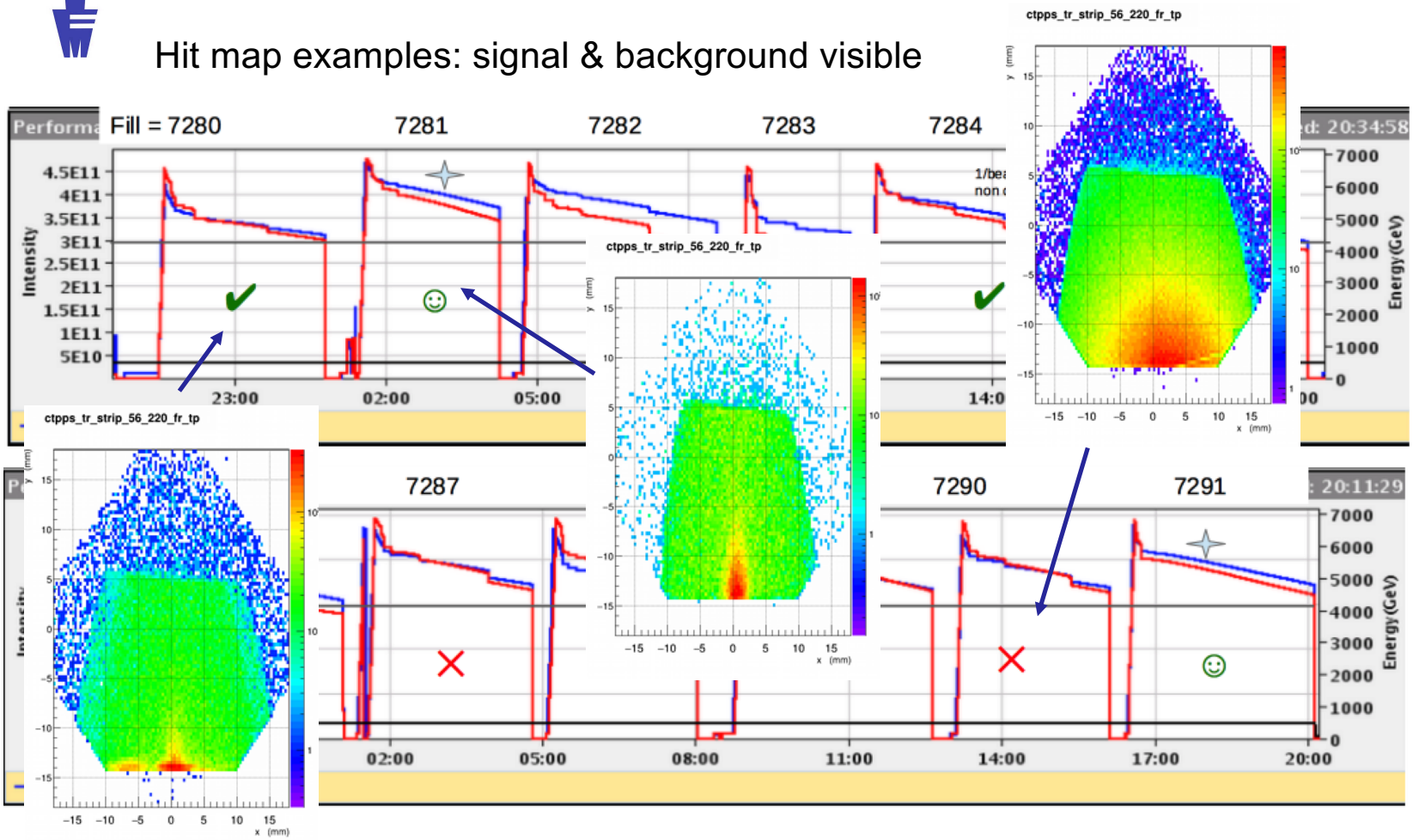
Special run successfully performed in 6 intense days (2-7 July):

- All machine luminosity rump-up step completed
- All detectors and systems worked as expected

Recorded luminosity $\sim 5.6\ \mathrm{pb}^{-1}$.
10 times the 2015 statistics!!

900 GeV run: summary high β^* fills

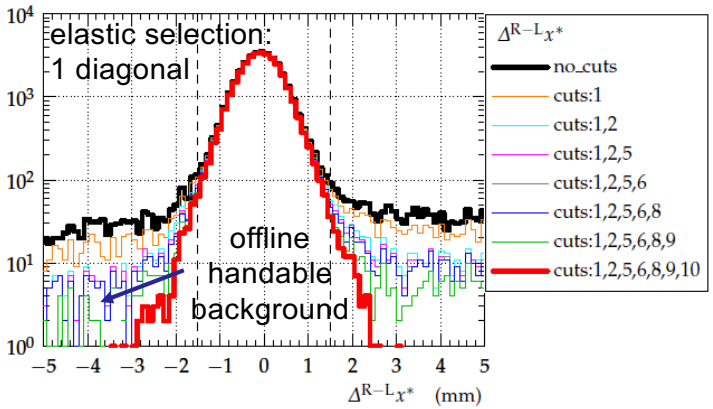
Hit map examples: signal & background visible



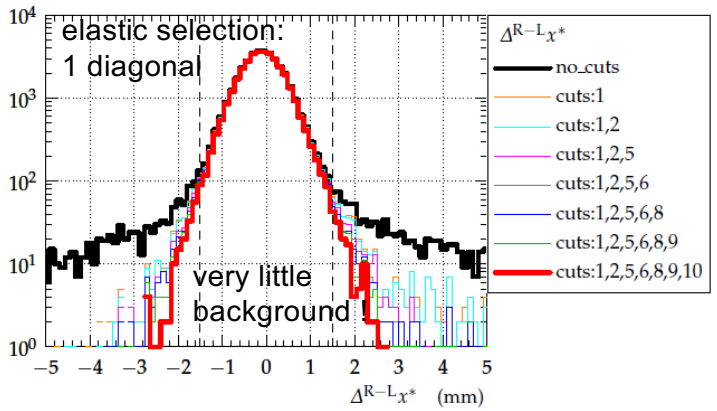
900 GeV run: operations & summary

- Two collimation scheme: standard (tight) & crystal
- Both challenging: required stability ~ 0.2σ

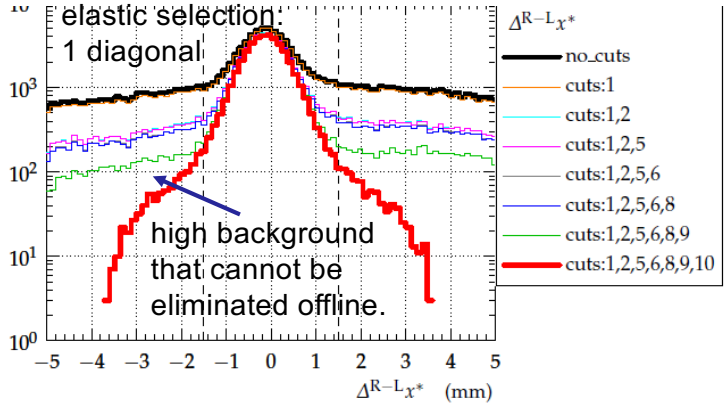
standard collimation working (✔)



crystal collimation (✦)



standard collimation NOT working (✕)



- # of collected good elastics:

~ 1M high β^* & ~ 2M β^* = 11m

Big thanks both to LHC team (especially collimation team) & CMS for the succesful run & data taking !!

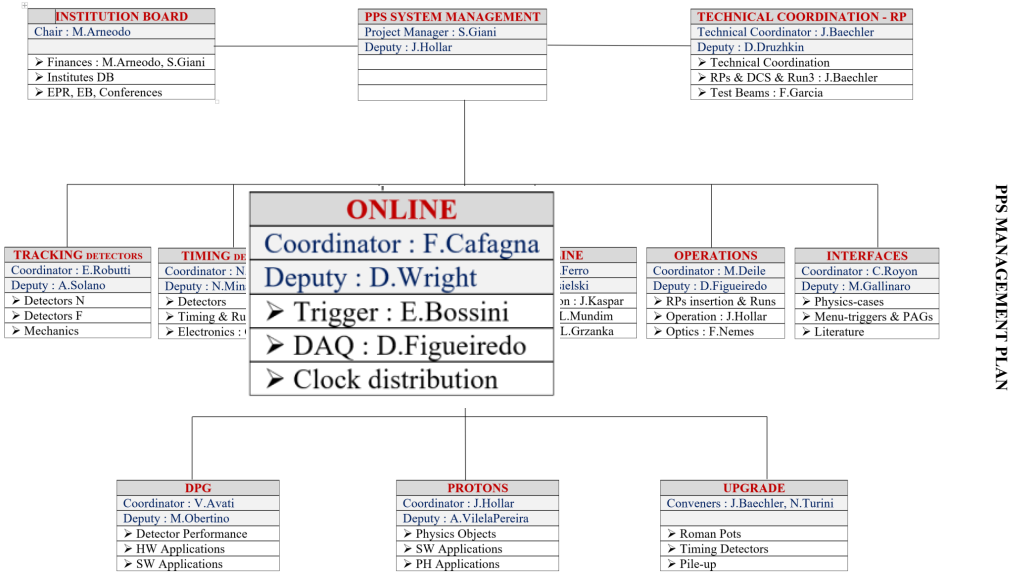
E. Elsen congratulated TOTEM for their forward program at 900 GeV

Update on LS2 activities

- Detector packages have been removed and stored for consolidation and tests.
- Discussion currently underway about the schedule for RP levelling, removal of RP 210 near and reposition on 220m station.
- Work on going on RP movement system upgrade. Updated PXI at CERN and test started on RP motor system.
- Upgrade of the monitor of the RP motor current.
- Refurbish of RP infrastructure parts.

Responsabilità del Gruppo

- F. Cafagna responsabile DAQ/online
  - → **a cui si aggiunge ONLINE di PPS**
- G. Catansi chairman Editorial Board
- F. Cafagna Timing di precisione
- E. Radicioni Resource coordinator & Management Board
- F. Cafagna Coordinatore Nazionale



Il dominio "ONLINE" di PPS si adatta perfettamente all'attività abituale e alle competenze del gruppo: DAQ/Trigger/Clock

Composizione del Gruppo (invariata)

Ricercatori	%
V. Berardi	30
F. Cafagna	70
M.G. Catanesi	30
E. Radicioni	60

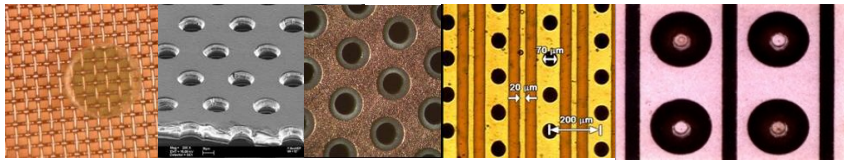
Tecnologi	%
F. De Leonardi	30
V. Passaro	50

Totale FTE: 2.7 (2019: 2.6)

Richieste (e attività 2020)

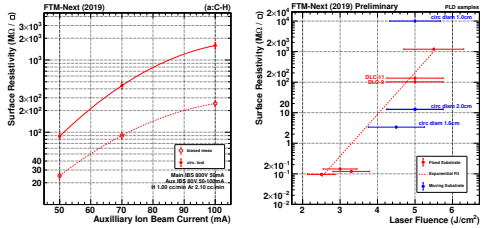
- richieste di servizi (includono RD51):
  - 1 mese accesso camera pulita (senza supporto tecnico)
  - 0.5 mu progettazione elettronica
  - 0.5 mu officina meccanica
  - 0.5 mu tecnico elettronico
- Nei prossimi anni le richieste rifletteranno gli ambiti di attività del gruppo: manutenzione del sistema di DAQ TOTEM/PPS, consolidamento del sistema di timing (diamanti e clock) di PPS.
- Per il 2020 prevediamo:
  - ~ 1k per nuova sorgente (clock)
  - ~5k per rinnovo computer DAQ TOTEM (tender CMS)
  - ~ 10-15k per upgrade readout timing diamanti
- M&O funds 2020 secondo RRB 2019; come al solito saranno meglio definiti a ottobre e comunicati alla CSN1.

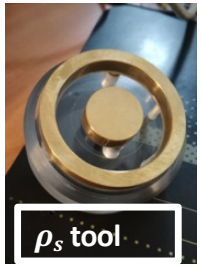
RD51 related Activities

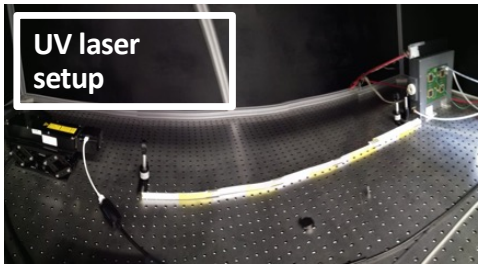


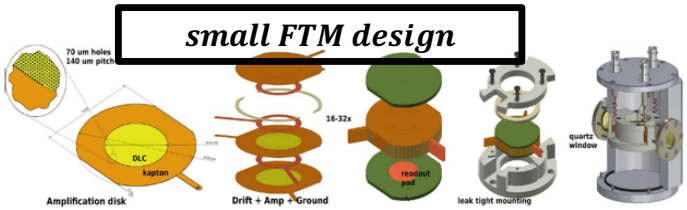
- **2 sigle in CSN-V: FTM-Next & MPGD_FaTimA_UV (Grant 73)**
  - Diamond Like Carbon w/ Ion Beam Deposition (UniBA) & Pulsed Laser Deposition (UniSAL)
  - Development of Test-Stand with UV-laser
- **«Development of Diamond Like Carbon for the Fast Timing MPGD»** at MPGD19 La Rochelle
- **«Resistive Coatings for Gaseous Detectors»** at Bari, May 13-14
  - 35 participants, int. Experts on DLC & Detectors

IBS & PLD Diamond Like Carbon



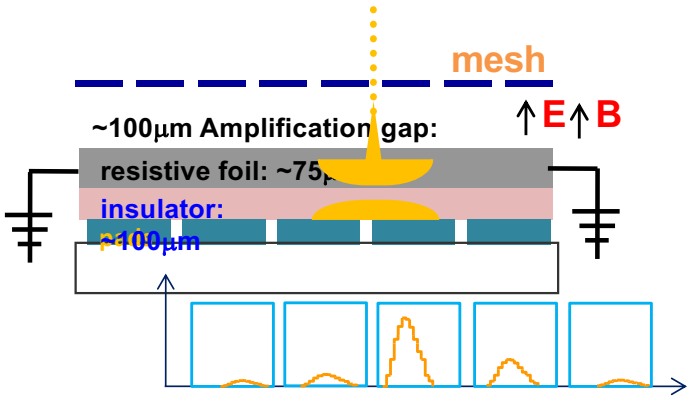


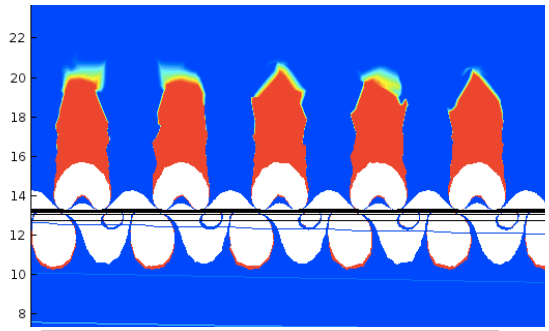


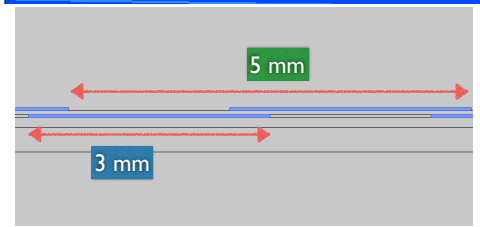


R&D per nuove TPC T2K

- R&D e simulazioni per costruire field-cages a minimo ingombro (geometrico & radiation length) --> costruiti strip foils & field-cage prototype, ora in test
- Resistive MicroMegas: test-beam 2018 svolto con successo, in corso test 2019 con resistività ottimizzata







$$\rho(r,t) = \frac{RC}{2t}\exp[-\frac{-r^2RC}{4t}]$$

R- surface resistivity
C- capacitance/unit area

Summary RD51

- Attività con MPGD
  - fast-timing MPGDs (P. Verwilligen)
  - CMS GEMs
  - nuove TPC per T2K (field-cages + resistive micromegas)
- Responsabile locale: G. Catanesi
- Responsabilità di rilievo nella collaborazione:
  - P. Verwilligen: co-convener per la simulazione
  - E. Radicioni: Management Board
- Richieste finanziarie
  - come tutti gli anni: 6k€ su missioni

LHCb

Responsabile locale: M. De Serio

Il gruppo LHCb-Bari è coinvolto nelle seguenti attività:

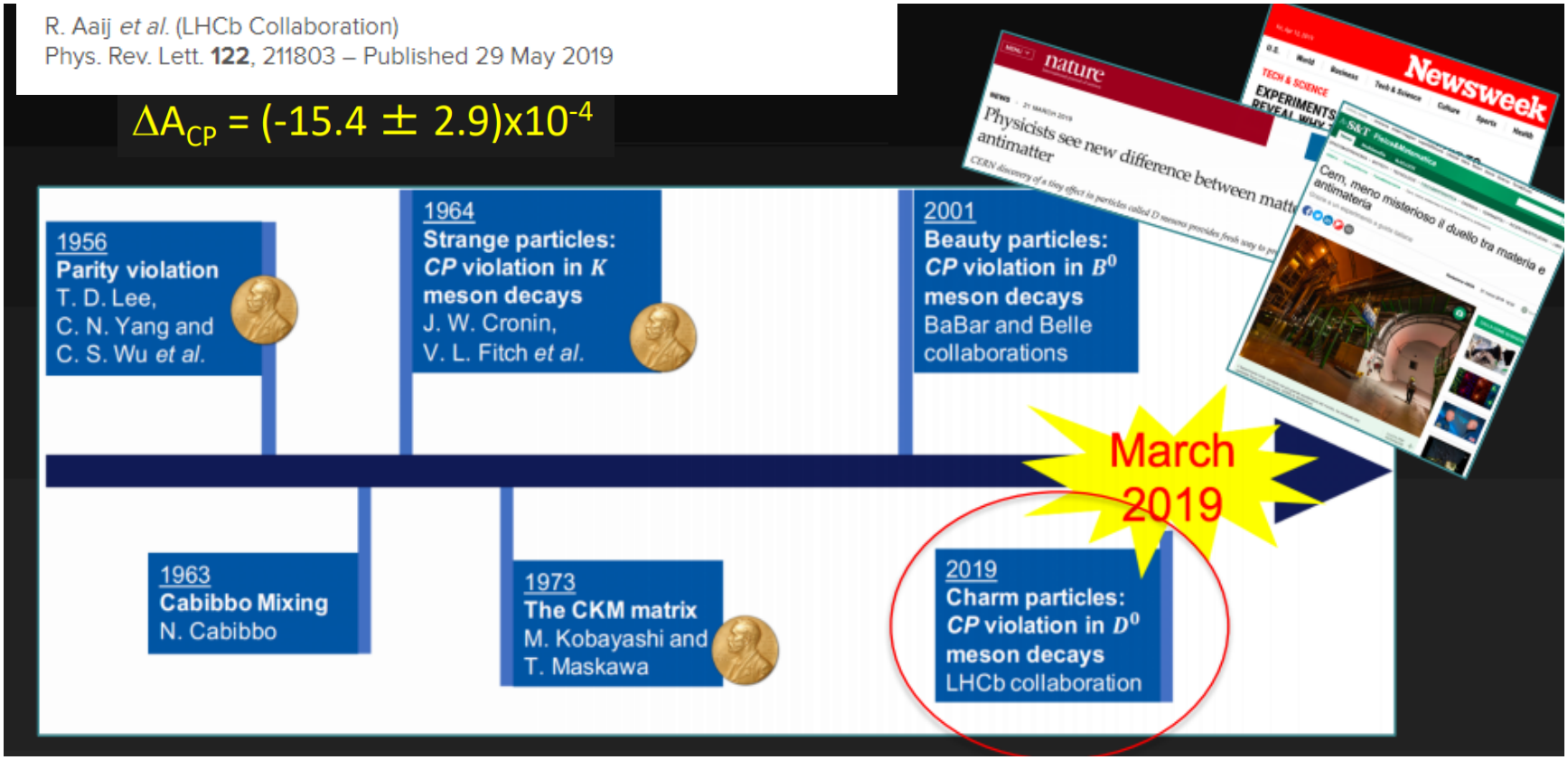
- **Sviluppo del sistema di acquisizione dati del rivelatore di muoni per l'upgrade di fase 1;**
- **Studi di spettroscopia di mesoni e barioni charmati;**
- **Ricerca di segnali di violazione dell'universalità leptonica.**

LHCb: alcuni highlights 2019

Observation of CP Violation in Charm Decays

R. Aaij *et al.* (LHCb Collaboration)
Phys. Rev. Lett. **122**, 211803 – Published 29 May 2019

$\Delta A_{CP} = (-15.4 \pm 2.9)\times10^{-4}$

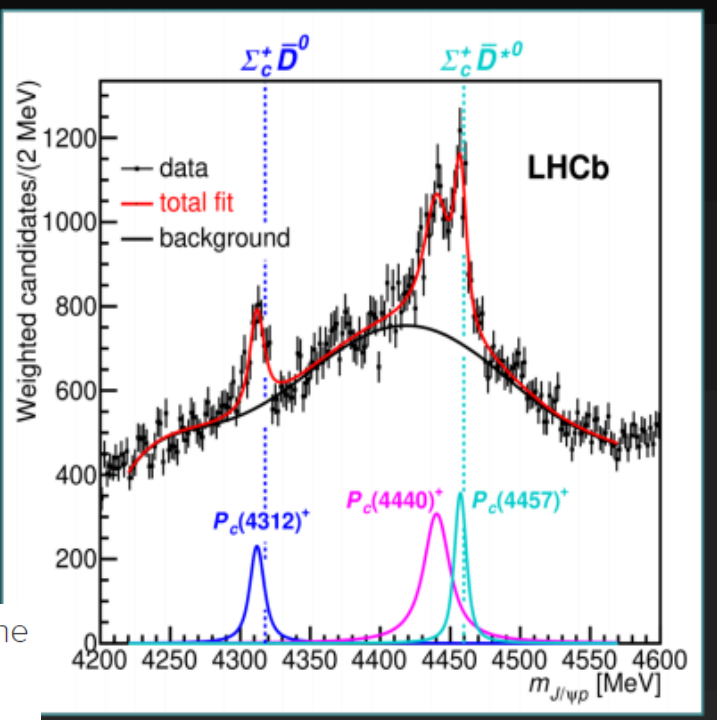


LHCb: alcuni highlights 2019

Observation of new pentaquark states

- Update by LHCb using full Run 2 statistics
- A new peak now emerges from background! $P_c(4312)$
- In addition, the $P_c(4450)$ reveals now a more complex structure with two different peaks
- Further confirmation of the previous pentaquark discovery

Full run 1 + Run 2 sample!



Observation of a Narrow Pentaquark State, $P_c(4312)^+$, and of the Two-Peak Structure of the $P_c(4450)^+$

R. Aaij *et al.* (LHCb Collaboration)
Phys. Rev. Lett. **122**, 222001 – Published 5 June 2019

Attività LHCb-Bari 2019: analisi

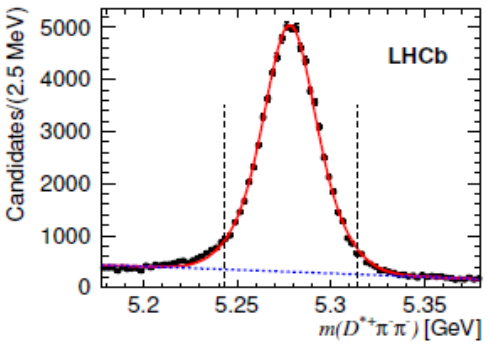
Dalitz plot analysis of the $B^- \to D^{*+}\pi^-\pi^-$ decay

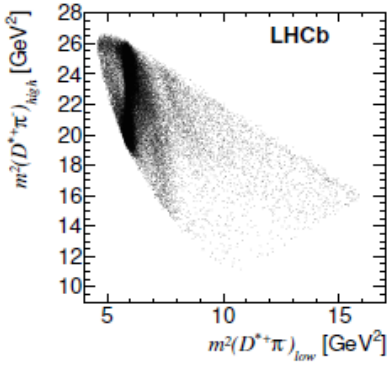
□ To be submitted to Phys. Rev. D.

Antimo Palano, Maurizio Martinelli

Approval-to-go-to-PAPER, June 4, 2019

□ 79120 B^- events.





□ Study of charmed meson spectroscopy decaying to $D^{*+}\pi^-$.

□ The decay is dominated by the presence of $D_1(2420)$, $D_1(2430)$ and $D_2^*(2450)$, together with several other resonant contributions.

□ Resonances parameters are measured and the quantum numbers of $D_0(2550)$, $D_1^*(2600)$, $D_2(2740)$ and $D_3^*(2750)$ established.

□ Measurement of the $J^P = 1^+$ mixing angle and phase.

Attività LHCb-Bari 2019: analisi

IN PROGRESS

- Partial wave analysis of $B \to K^0_s\ K\ K\ \pi$

  A. Palano, M. Martinelli

- Dalitz plot analysis of $B^0 \to D^*(2010)\ K^0_s\ \pi$

  M. De Serio, M. Martinelli, A. Palano, A. Pastore

- Measurement of the $B_s \to D_s\ \tau\ \nu_\tau$ branching fraction using 3 prong τ decays

  R.A. Fini + Ferrara

LHCb upgrade fase I

Very intense activity at LHCb site!

- Activities to dismantle the old sub-detectors progressing very well and on schedule
- Preparation of infrastructure also progressing well
- Prepare for the first installations in summer

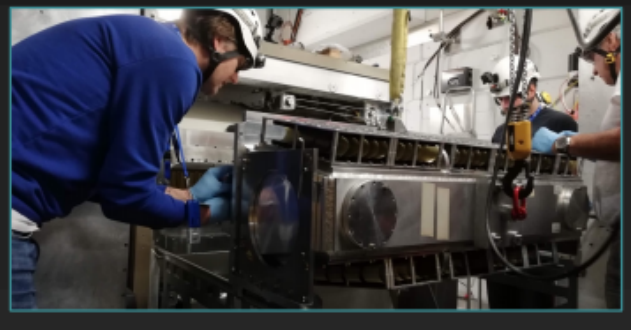
Removing outer tracker stations

Opening the shielding wall

HLT farm containers

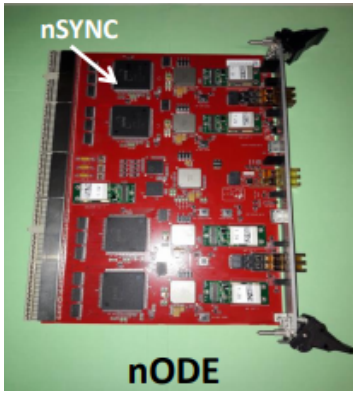
Dismantling of M1 muon station

Removing the old VELO



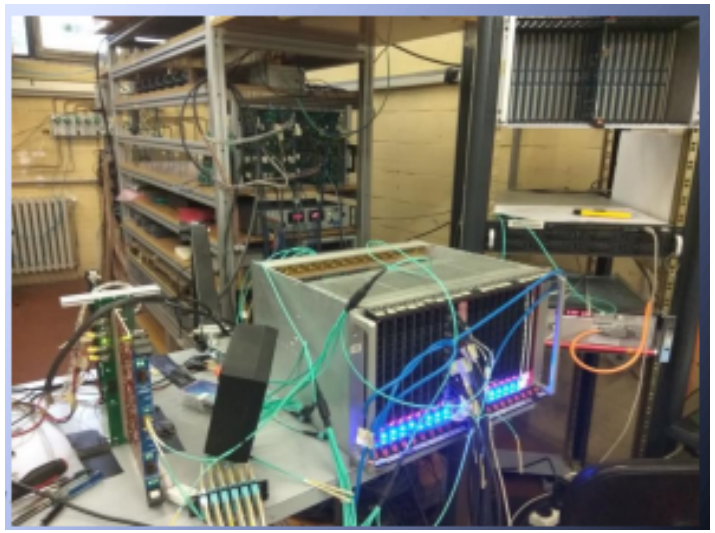
Removing the beam pipe

LHCb upgrade fase I: Muon detector



Data readout at 40MHz: nODE boards, equipped with nSYNC ASIC (4 per Board)

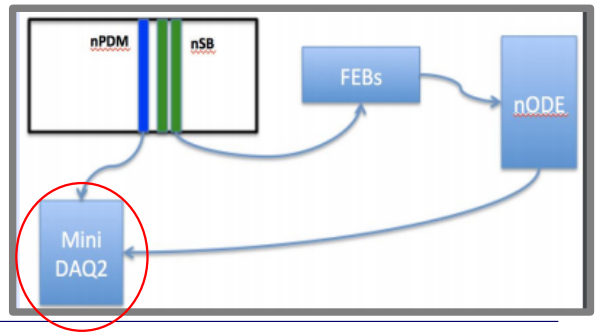
Pre-production boards now under test at LNF



Full chain test setup in preparation in Roma1

Firmware developed in Bari and Roma2

Full chain test with final firmware in preparation



Anagrafica e attività prevista nel 2020

Ricercatori

M. De Serio (resp. loc.)	70%
R.A. Fini	70%
A. Palano	0%
A. Pastore	70%
S. Simone	70%
Totale FTE	2.8

Richiesta servizi: 1 m.p. Servizio elettronico

Attività prevista:

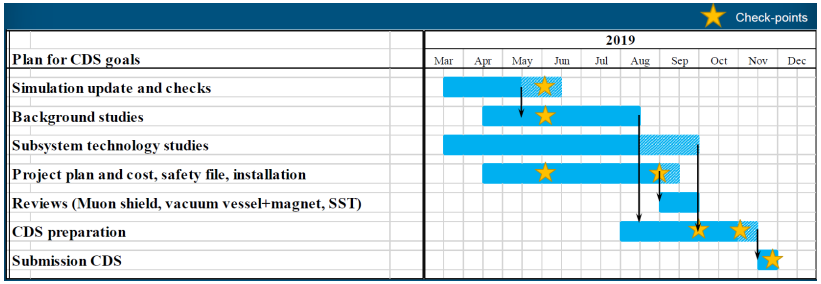
- Completamento test catena elettronica ed installazione
- Completamento analisi in corso 2019

Stato attivita' SHIP
e piani per il 2020 SHIP-Bari

Responsabile locale: S. Simone

Stato attività SHIP

SHiP CDS report: plan

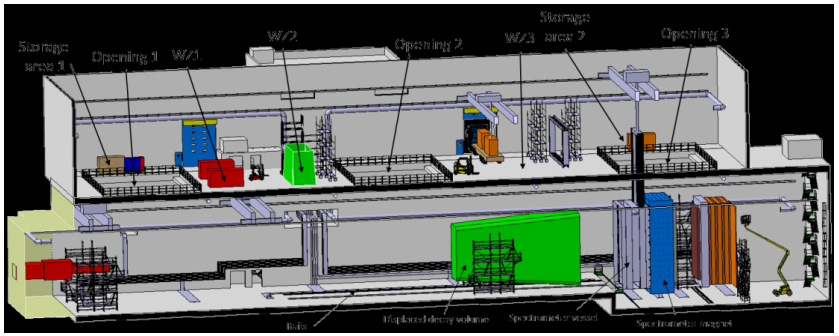


2 Published papers + 5 in preparations

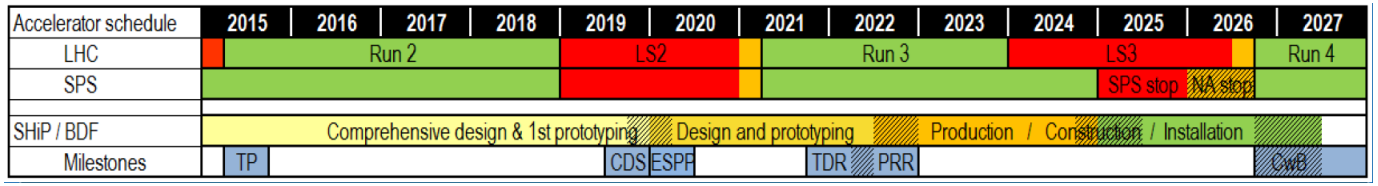
4. **Sensitivity of the SHiP experiment to Heavy Neutral Leptons**
SHiP Collaboration (C. Ahdida (CERN) *et al.*). Nov 2, 2018. 22 pp.
Published in **JHEP 1904 (2019) 077**
DOI: 10.1007/JHEP04(2019)077
e-Print: **arXiv:1811.00930 [hep-ph] | PDF**
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server; ADS Abstract Service; Link to Article from SCOAP3
Detailed record - Cited by 10 records

5. **The experimental facility for the Search for Hidden Particles at the CERN SPS**
SHiP Collaboration (C. Ahdida (CERN) *et al.*). Oct 16, 2018. 21 pp.
Published in **JINST 14 (2019) no.03, P03025**
DOI: 10.1088/1748-0221/14/03/P03025
e-Print: **arXiv:1810.06880 [physics.ins-det] | PDF**
References | BibTeX | LaTeX(US) | LaTeX(EU) | Harvmac | EndNote
CERN Document Server; ADS Abstract Service; Link to Fulltext from Publisher
Detailed record - Cited by 3 records

Infrastructure studies

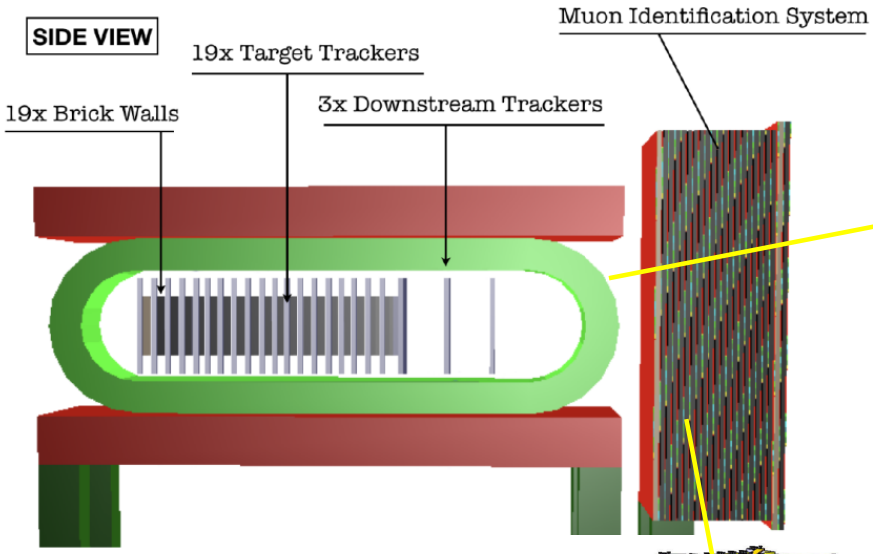


Project plan

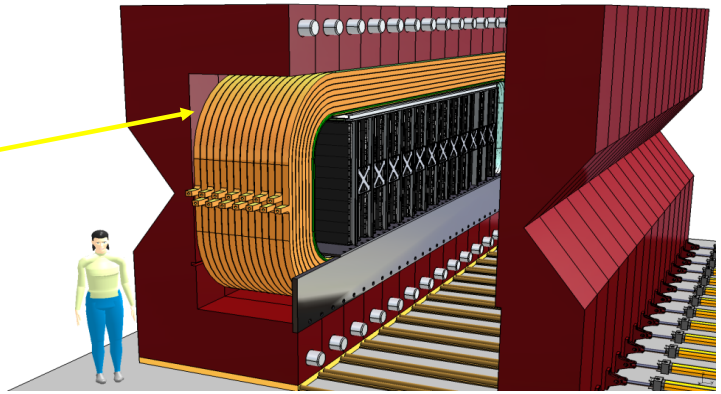


Stato attivita' SHIP – SND Scattering and Neutrino Detector

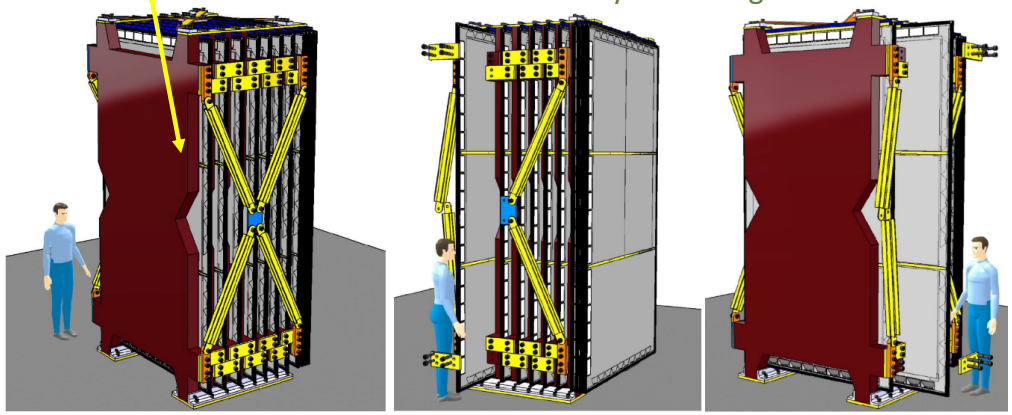
SHiP Progress Report
CERN-SPSC-2019-010 / SPSC-SR-248



Improved magnet design



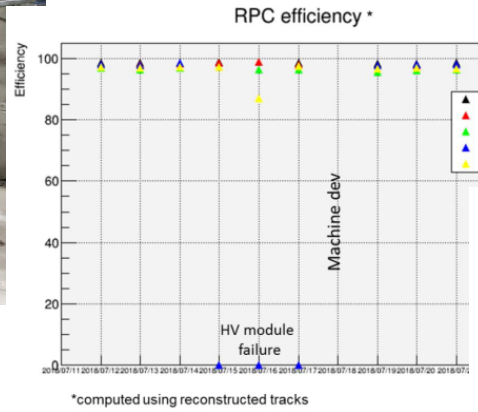
Modified Muon ID System design

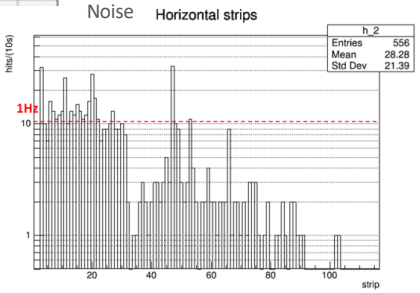


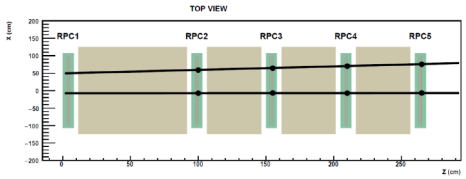
Progress on SND design

attività SHIP – SND @ Bari

In 2018, a small-scale Muon Id System instrumented with 5 RPCs (new design + new electronics) has been exposed to H4 beam.

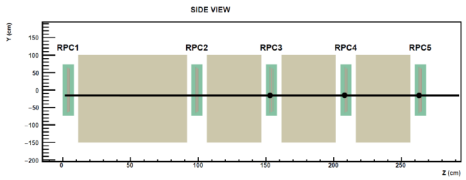







```
Run 2793
Spill1f22ae29
Trigger 21

X1 58.97 cm
Y1 -15.40 cm
sx  0.1005
sy  0.0005
```




```
Run 2793
Spill1f22ae29
Trigger 21

X1 -7.44 cm
Y1 -15.40 cm
sx  0.0019
sy  0.0005
```

- Internal note CERN-SHiP-NOTE-2019-001:
  Alignment of the muon flux spectrometer in FairShip using the survey measurements

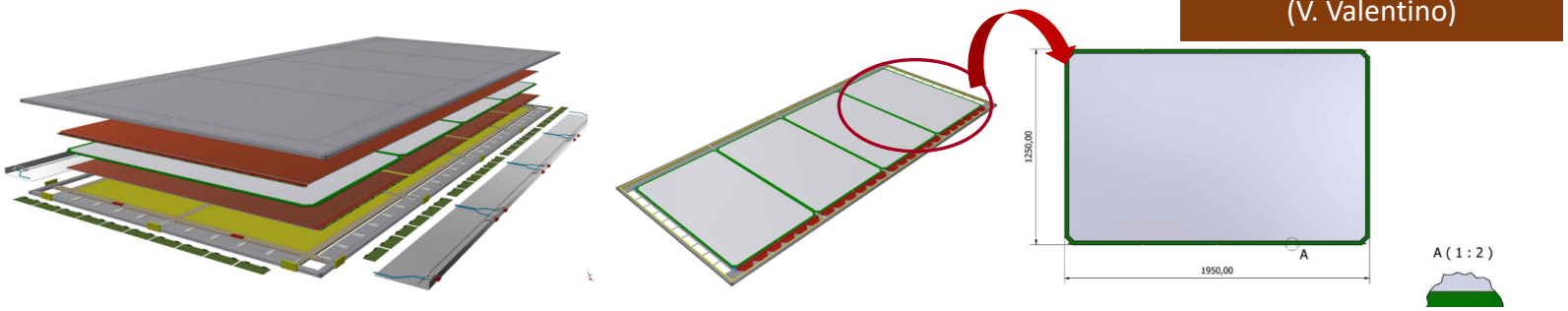
- Analysis of July 2018 RPC data for the muon flux and charm measurements @CERN H4 beam

attività SHIP – SND @ Bari

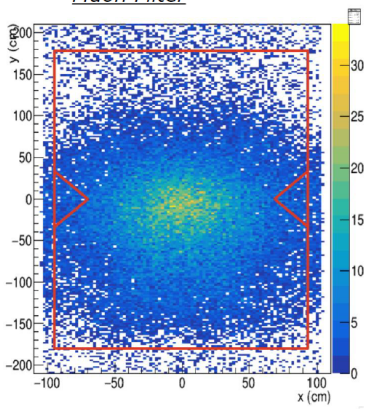
Tasks for the Muon ID System:
RPC Mechanical Structure , Electronics , DAQ

- Optimisation of the Muon ID System structure:

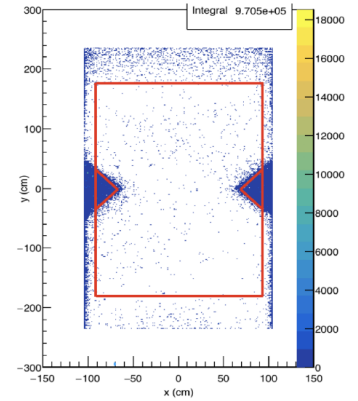
CAD meccanico INFN Bari
(V. Valentino)

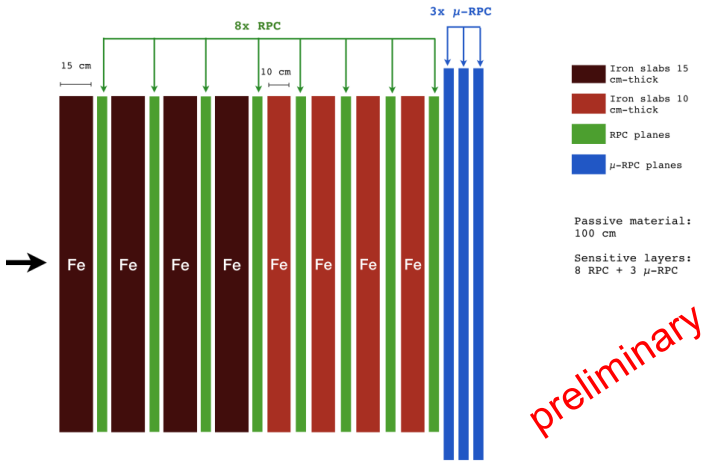


Map of primary muons entering Muon Filter



Map of backgound muons in RPC1



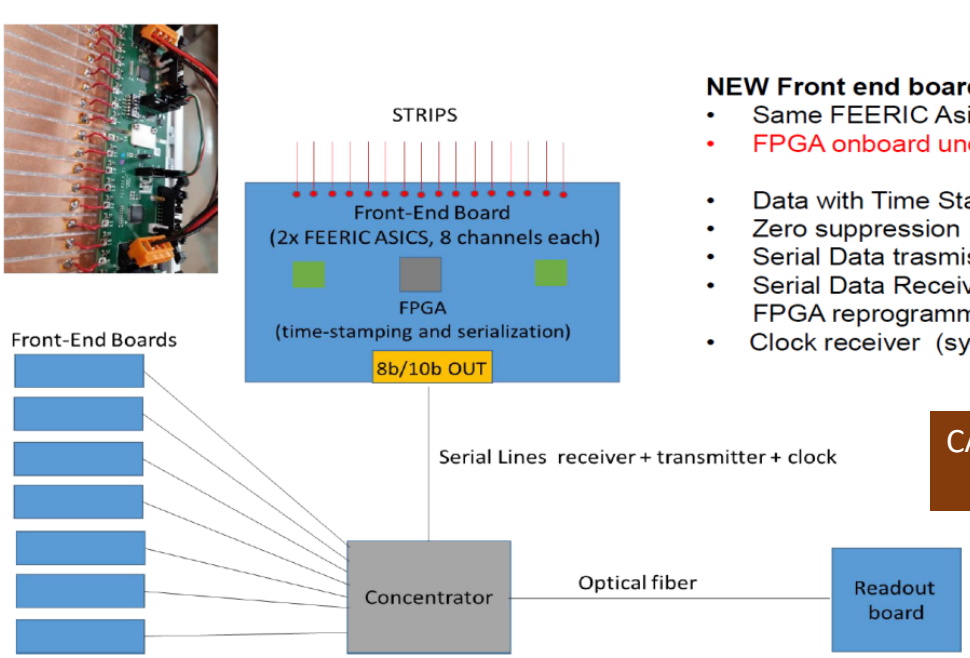


preliminary

attività SHIP – SND @ Bari

Tasks for the Muon ID System:
RPC Mechanical Structure , Electronics , DAQ

- Electronics:



NEW Front end board

- Same FEERIC Asics
- FPGA onboard under development

UNDER DEV

- Data with Time Stamp @160MHz
- Zero suppression
- Serial Data trasmission (8b/10b)
- Serial Data Receiver: self trigger, FPGA reprogramming, slow control
- Clock receiver (syncronization)

CAD elettronico INFN Bari
(G. De Robertis)

40 FE boards/plane, 2 concentrators / plane

- GREEN/GRANT 73 (Gas mixtures for RPC's Eco friEndly operatioNs) :
trasportato un RPC in sede per test (con telescopio RPC-OPERA)
potenziamento linee di gas, con centralina dedicata al flussaggio di eco-gas (HFO 1234-ze)

attività 2020 SHIP – SND @ Bari

Anagrafica 2020:
M. De Serio (30%), R.A. Fini (30%), G. Iaselli (10%), A. Marrone (10%), A. Pastore (30%), S. Simone (30%) , G. De Robertis (10%)

- Attività di R&D su meccanica, elettronica e DAQ per il Muon ID System del SND
- Realizzazione di prototipi per l'elettronica
- Disegno e realizzazione del prototipo di un piano di RPC (≈ 2x5 m^2)

- Richieste Servizi:
  2 m.p. CAD elettronico
  3 m.p. Officina Meccanica (1.5 CAD, 1.5 officina)

- Coinvolgimento del personale tecnico nei seguenti ambiti:
  - attività di test su/con emulsioni nucleari ed RPC
  - sistema di scanning e gestione della strumentazione DAQ

- **SHiP Collaboration Meeting, Bari, 24-26 Giugno 2020**

Futuri acceleratori: attività nella sezione INFN-Bari e richieste finanziarie

N. De Filippis
Politecnico/INFN Bari,
e LPC-FNAL Batavia

per il gruppo RD_FA

Bari
Luglio 2019

Future accelerators

Collider	Type	$\sqrt{s}$	$\mathscr{P}$ [%] $[e^-/e^+]$	N(Det.)	$\mathscr{L}_{\text{inst}}$ $[10^{34}]$ cm^{-2}s^{-1}	$\mathscr{L}$ [ab^{-1}]	Time [years]	Refs.	Abbreviation
HL-LHC	pp	14 TeV	-	2	5	6.0	12	[10]	HL-LHC
HE-LHC	pp	27 TeV	-	2	16	15.0	20	[10]	HE-LHC
FCC-hh	pp	100 TeV	-	2	30	30.0	25	[1]	FCC-hh
FCC-ee	ee	M_Z	0/0	2	100/200	150	4	[1]	
		$2M_W$	0/0	2	25	10	1-2		
		240 GeV	0/0	2	7	5	3		FCC-ee$_{240}$
		$2m_{top}$	0/0	2	0.8/1.4	1.5	5		FCC-ee$_{365}$
							(+1)	(1y SD before $2m_{top}$ run)	
ILC	ee	250 GeV	±80/±30	1	1.35/2.7	2.0	11.5	[3, 11]	ILC$_{250}$
		350 GeV	±80/±30	1	1.6	0.2	1		ILC$_{350}$
		500 GeV	±80/±30	1	1.8/3.6	4.0	8.5		ILC$_{500}$
							(+1)	(1y SD after 250 GeV run)	
CEPC	ee	M_Z	0/0	2	17/32	16	2	[2]	CEPC
		$2M_W$	0/0	2	10	2.6	1		
		240 GeV	0/0	2	3	5.6	7		
CLIC	ee	380 GeV	±80/0	1	1.5	1.0	8	[12]	CLIC$_{380}$
		1.5 TeV	±80/0	1	3.7	2.5	7		CLIC$_{1500}$
		3.0 TeV	±80/0	1	6.0	5.0	8		CLIC$_{3000}$
							(+4)	(2y SDs between energy stages)	
LHeC	ep	1.3 TeV	-	1	0.8	1.0	15	[9]	LHeC
HE-LHeC	ep	1.8 TeV	-	1	1.5	2.0	20	[1]	HE-LHeC
FCC-eh	ep	3.5 TeV	-	1	1.5	2.0	25	[1]	FCC-eh

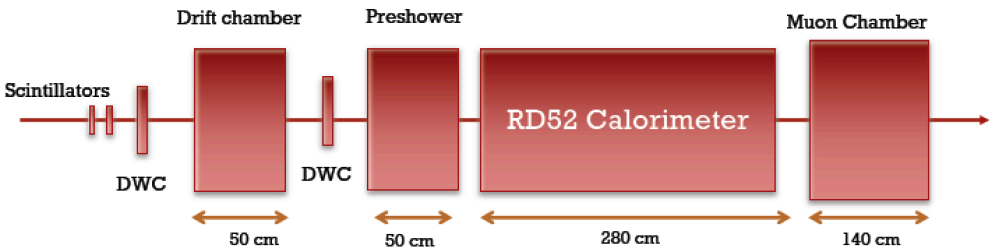
Organizzazione

- **Diverse aree di interesse ed attività:**
  - Misure di precisione per acceleratori e^+e^- (FCC-ee, CepC)
  - Misure di precisione per acceleratori pp (FCC-hh) e SppC
  - Misure per muon collider
  - Misure per electron ion collider
  - Prospettive di scoperta di nuova fisica
  - Generatori MC, simulazione del rivelatore
  - Infrastruttura di calcolo (BARI Tier 2 for RD_FA)
- **Sono coinvolti fisici teorici e sperimentali**
- **Contributi per CDR per CepC (2018) e a FCC per EU Strategy (2018)**
- **Anagrafica Bari 2018/2019:**
  - Nicola De Filippis (prof. ass. poliba: 10%)
  - Marcello Abbrescia (prof. ass., uniba): 10%
  - Reham Aly (phd student: 10%)
  - Angela Taliercio (master student: 10%)
- **Fondi RD_FA per missioni confluiti su INFN Pisa nel 2018 e 2019**

Nessuna vera decisione dal workshop della **European Strategy for Particle Physics 13-16 May 2019 – Granada**

Test beam 2018 al CERN

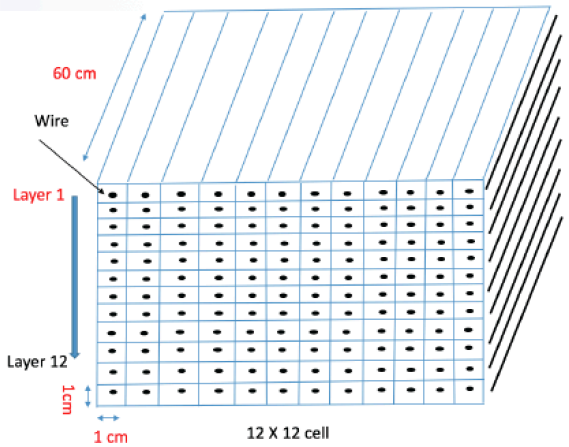
Test beam 2018 al CERN: area H8



- Trigger with 2 scintillators in coincidence + 1 veto (if needed)
- 2 DWC (Delayed Wire Chamber)
- CEDAR (Differential Cherenkov detector)
- Drift Chamber Prototype
- Preshower with GEM
- Few different Dual Readout prototypes
  - RD52 calorimeter with PMT readout
  - RD52 calorimeter with longitudinally displaced fibers
  - Small calorimeter module with SiPM readout
- Muon chamber 1 layer GEM + 2 layers μRWell

I nostri interessi: Camera a deriva

- The chamber consists of 12 x 12 cell
- Each cell is 1 cm x 1 cm
- the wire length is 60 cm
- The voltage applied to each wire is about 1475V (depends by the runs)
- The gas used is 90% He 10 % i-C4H10

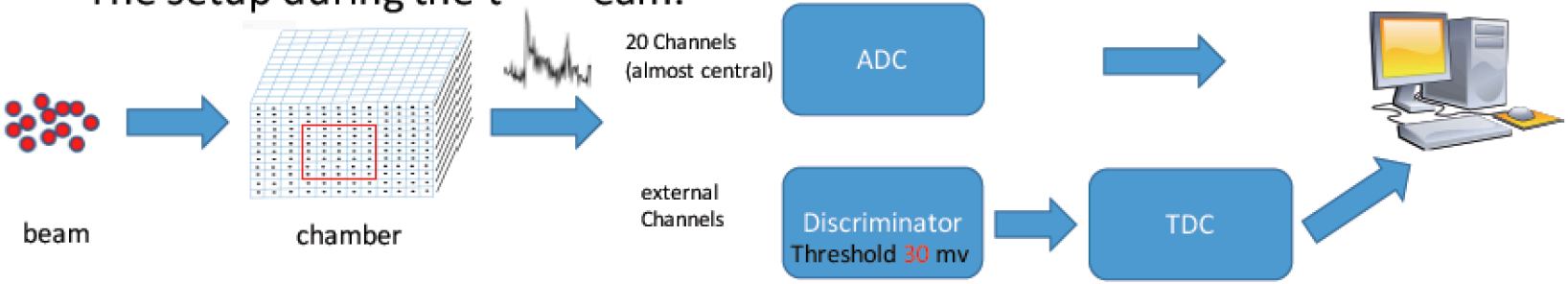


Schematic Diagram

Rivelatore costruito e testato a INFN Lecce

I nostri interessi: Setup per camera a deriva

- The chamber is exposured to different types of beams (Muon , Electron, Pion and Kaon) with energy 20-60GeV
- The setup during the test beam:



- During the test beam:
  - We read just 20 cells in the central core (Layer 7 was broken).
  - Data are available via rdfa virtual organization accessible via grid tools in the path: srm://storm-se-01.ba.infn.it:8444/srm/managerv2?SFN=/rfda/TestBeam

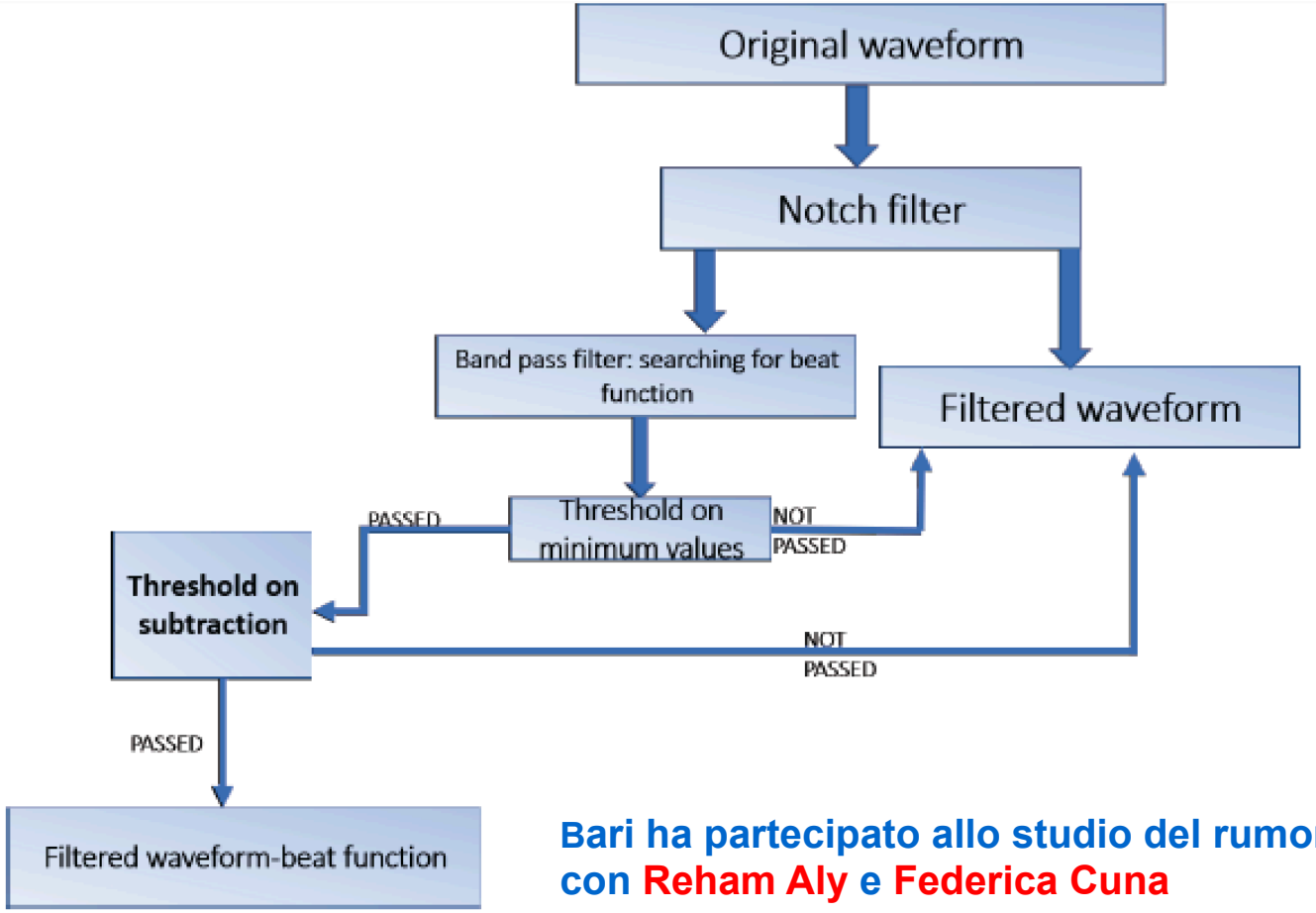
Le misure previste

Derive performance of the chamber in terms of potential for particle tracking and particle ID

- This is the request:
  - Goal: Pion / kaon separation at different energies
  - External detector for particle ID (CEDAR)
  - Beam Energies: 6, 10, 20, 40, 50, 60, 100
  - 10k events per particle type and energy
- Measurement with 2 gas mix for 2 energies
- High Voltage scan for one energy

Il team barese ha partecipato a tutte le fasi dell'analisi che è ancora in corso.

Trattamento del rumore



Bari ha partecipato allo studio del rumore con Reham Aly e Federica Cuna

Calcolo per RD_FA

- E' stata creata una "virtual organization" **rdfa** per attività RD_FA in GRID:
  - una coda del CNAF associato alla VO e 10TB di disco

- Il centro ReCaS Bari è il primo Tier2 che supporta la VO rdfa quanto:
  - ci sono le risorse per ospitare le simulazioni per RD_FA
  - c'è il know-how su strumenti di calcolo
  - Il ranking come Tier2 di CMS (ed Alice) è buono

- I dati del testbeam del 2018 sono storati a Bari ed accessibili via grid da chiunque sia sottoscritto alla VO rdfa

Partecipazione a progetti

Proposal for Call: H2020-MSCA-RISE-2019 – approved

- "Future Experiments seek Smart Technologies (FEST)"
  - N. De Filippis – 4months, R. Aly – 4 months, I. Margjeka – 4 months, W. Elmetenawee – 4 months, F. Cuna – 4 months

Proposal for CREMLIN+ submitted

- "Development and design of Particle Identification and tracking systems"

Proposals for AIDA++:

with INFN Lecce

- "Cluster Counting/Timing: data reduction and pre-processing of drift chamber signals sampled at high rates"
- " A prototype of an ultra-light drift chamber with new materials for the next generation of lepton colliders"
- "Development of innovative planar gaseous detectors with high time and spatial resolution and improved rate capability for FCC"
- "Innovative neutron gaseous detectors with solid converters and imaging capabilities "

Monitor chamber: numbers

Stato dell'arte:

test in letteratura dimostrano che un continuo monitoraggio della velocità di drift al livello del **$\pm 1\times 10^{-3}$** in tempi dell'ordine di poche decine di secondi consente di apprezzare:

- variazioni di campo elettrico di 2V/cm;
- variazioni relative di contenuto di isobutano del 4.3×10^{-3};
- variazioni della pressione della miscela di 0.8 mbar;
- variazioni di contenuto di vapori d'acqua di $_{-150}^{+80}$ ppm.

Goal:

si intende contriuire alla realizzazione di una camera di monitoring presso i laboratori INFN-Lecce, per poi installarla e testarla presso INFN Bari e Lecce per gli studi del rivelatore IDEA per FCC-ee

Anagrafica FCC 2020

INFN- Bari	2020
N. De Filippis (Assoc. Prof.)	20%
M. Abbrescia (Assoc. Prof.)	10%
R. Aly (PhD)	20%
I. Margjeka (PhD)	10%
W. Elmetenawee (PhD)	10%
A. Colaleo (INFN)	10%
M. Maggi (INFN)	10%
TOT	**0.9 FTE**

Anagrafica e richieste per MUON Collider 2020

INFN- Bari	2020
S. My (Assoc. Prof.)	10%
L. Silvestris (INFN)	10%
P. Verwilligen (INFN)	10%
A. Colaleo (INFN)	10%
M. Maggi (INFN)	10%
TOT	**0.5 FTE**

Si richiedono 4k euro per missioni (partecipazione ai meeting)