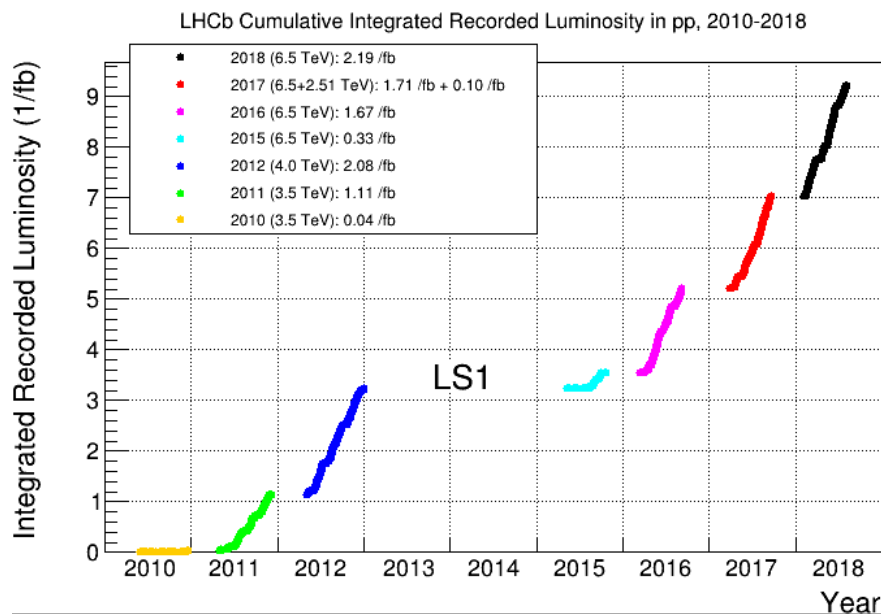




# Attività e anagrafica LHCb



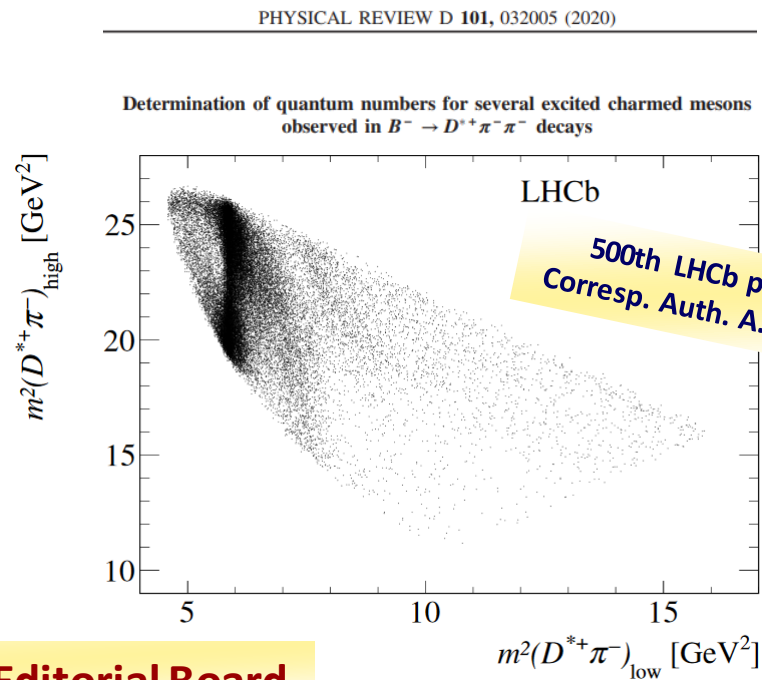
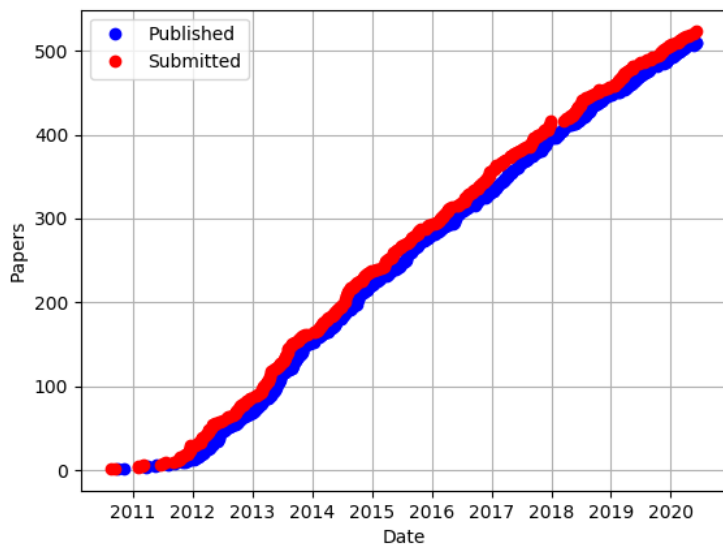
plus several datasets of proton-lead, lead-lead collisions as well as fixed target datasets: pNe, pHe, pAr, PbAr

## LHCb detector currently undergoing major upgrade:

- All sub-detectors updated, many sub-detectors overhauled or replaced
- Completely new trigger strategy (purely software)



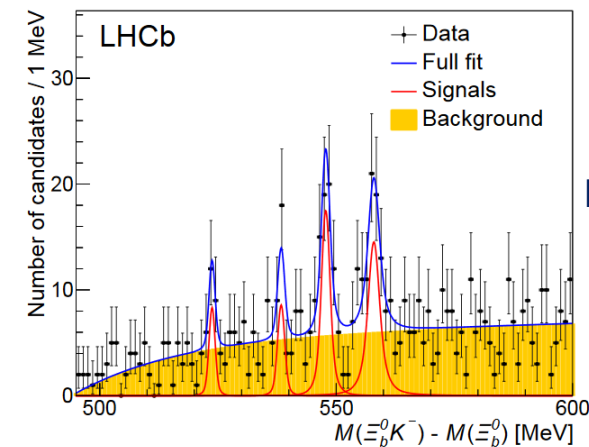
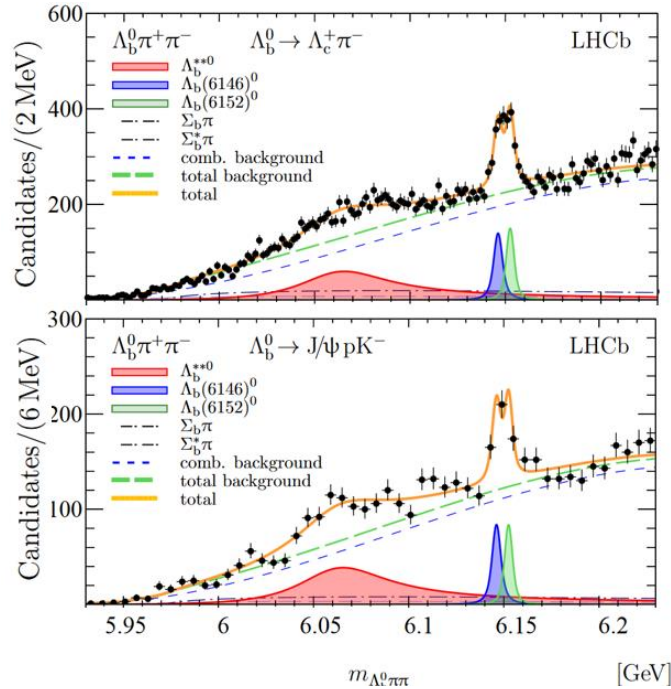
More than 500 published papers!



A. Palano recently nominated Member of the Editorial Board

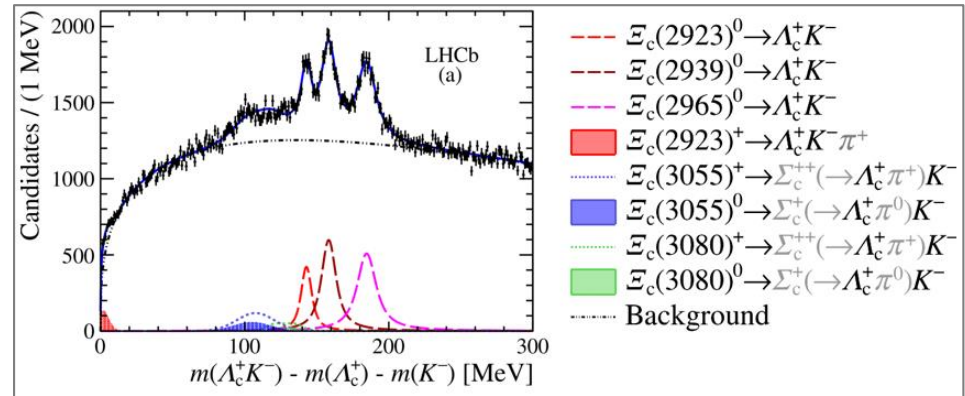


## Observation of a new beauty baryon particle



## First observation of excited $\Omega_b^-$ states

## Observation of new $\Xi_c^0$ baryons



LHCb  $B^+ \rightarrow \chi_{c1}(3872)K^+$

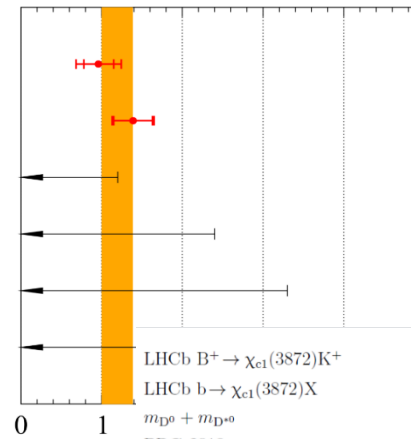
LHCb  $b \rightarrow \chi_{c1}(3872)X$

Belle  $B \rightarrow \chi_{c1}(3872)K$

BES III  $e^+e^- \rightarrow \chi_{c1}(3872)\gamma$

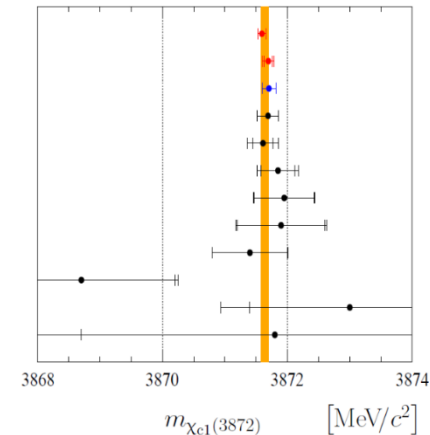
BaBar  $B \rightarrow \chi_{c1}(3872)K$

BaBar  $B \rightarrow \chi_{c1}(3872)K$



## Study of the $\chi_{c1}(3872)$ state

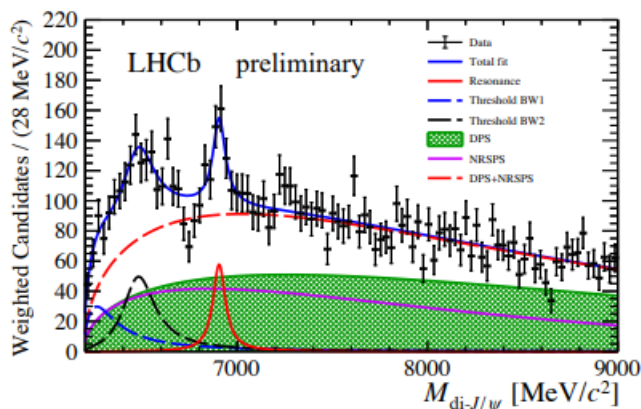
LHCb  $B^+ \rightarrow \chi_{c1}(3872)K^+$   
 LHCb  $b \rightarrow \chi_{c1}(3872)X$   
 PDG 2018  
 CDF  $p\bar{p} \rightarrow \chi_{c1}(3872)X$   
 Belle  $B \rightarrow \chi_{c1}(3872)K$   
 LHCb  $pp \rightarrow \chi_{c1}(3872)X$   
 BES III  $e^+e^- \rightarrow \chi_{c1}(3872)\gamma$   
 BaBar  $B^+ \rightarrow \chi_{c1}(3872)K^+$   
 BaBar  $B^0 \rightarrow \chi_{c1}(3872)K^0$   
 BaBar  $B \rightarrow (\chi_{c1}(3872) \rightarrow J/\psi \omega) K$   
 D0  $p\bar{p} \rightarrow \chi_{c1}(3872)X$





Latest results on exotic hadrons (seminar at CERN on June 16<sup>th</sup>, 2020)

## $J/\psi$ -pair mass spectrum (I)



## Observation of structures in the $J/\psi$ pair mass spectrum

- $J/\psi$  mass and pointing-to-PV constraints applied
- $J/\psi$ -pair invariant mass spectrum shows
  - ✓ A broad structure next to threshold ranging from 6.2 to 6.8  $\text{GeV}/c^2$
  - ✓ A narrower structure at about 6.9  $\text{GeV}/c^2$
  - ✓ Hint for another structure around 7.2  $\text{GeV}/c^2$
  - ✓ No evidence for further structures above 7.2  $\text{GeV}/c^2$

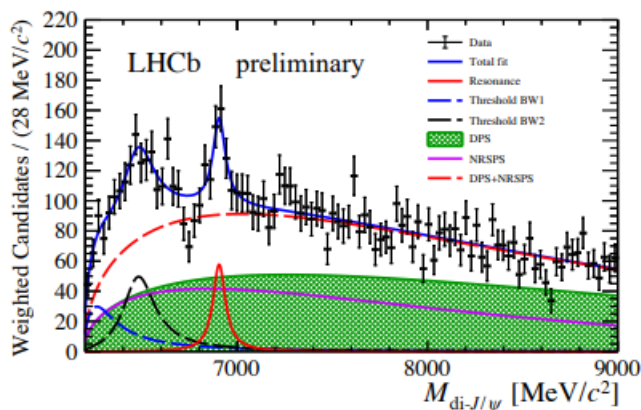
- The  $J/\psi$ -pair invariant mass spectrum is inconsistent with non-resonant SPS and DPS only hypothesis by more than  $5\sigma$  in the  $[6.2, 7.4] \text{GeV}/c^2$  mass region
- A narrow peaking structure matching the lineshape of a resonance and a broader structure close to the threshold are found
- The structures are consistent with predicted  $T_{cc\bar{c}\bar{c}}$  states
- Assuming the 6.9  $\text{GeV}/c^2$  structure is a resonance with Breit-Wigner lineshape
  - ✓ Based on no-interference fit
    - $M = 6905 \pm 11(\text{stat}) \pm 7(\text{syst}) \text{MeV}/c^2$
    - $\Gamma = 80 \pm 19(\text{stat}) \pm 33(\text{syst}) \text{MeV}/c^2$
  - ✓ Based on the simple model with interference
    - $M = 6886 \pm 11(\text{stat}) \pm 11(\text{syst}) \text{MeV}/c^2$
    - $\Gamma = 168 \pm 33(\text{stat}) \pm 69(\text{syst}) \text{MeV}/c^2$

Preliminary!



**Latest results on exotic hadrons (seminar at CERN on June 16<sup>th</sup>, 2020)**

## $J/\psi$ -pair mass spectrum (I)



- $J/\psi$  mass and pointing-to-PV constraints applied
- $J/\psi$ -pair invariant mass spectrum shows
  - ✓ A broad structure next to threshold ranging from 6.2 to 6.8 GeV/c<sup>2</sup>
  - ✓ A narrower structure at about 6.9 GeV/c<sup>2</sup>
  - ✓ Hint for another structure around 7.2 GeV/c<sup>2</sup>
  - ✓ No evidence for further structures above 7.2 GeV/c<sup>2</sup>

**Observation of structures  
in the  $J/\psi$  pair mass spectrum**

**Paper submitted on July, 1st**

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH (CERN)



CERN-EP-2020-115  
LHCb-PAPER-2020-011  
June 30, 2020

arXiv:2006.16957v1 [hep-ex] 30 Jun 2020

**Observation of structure  
in the  $J/\psi$ -pair mass spectrum**

LHCb collaboration<sup>†</sup>

### Abstract

Using proton-proton collision data at centre-of-mass energies of  $\sqrt{s} = 7, 8$  and 13 TeV recorded by the LHCb experiment at the Large Hadron Collider, corresponding to an integrated luminosity of 9 fb<sup>-1</sup>, the invariant mass spectrum of  $J/\psi$  pairs is studied. A narrow structure around 6.9 GeV/c<sup>2</sup> matching the lineshape of a resonance and a broad structure just above twice the  $J/\psi$  mass are observed. The deviation of the data from nonresonant  $J/\psi$ -pair production is above five standard deviations in the mass region between 6.2 and 7.4 GeV/c<sup>2</sup>, covering predicted masses of states composed of four charm quarks. The mass and natural width of the narrow  $X(6900)$  structure are measured assuming a Breit-Wigner lineshape.

Submitted to Science Bulletin



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
- Proposta di un rivelatore di muoni per la fase 2
- Studi di spettroscopia di mesoni charmati

Partial wave analysis of  $B \rightarrow K_s^0 K K \pi$

A. Palano, M. Martinelli (Milano Bicocca)

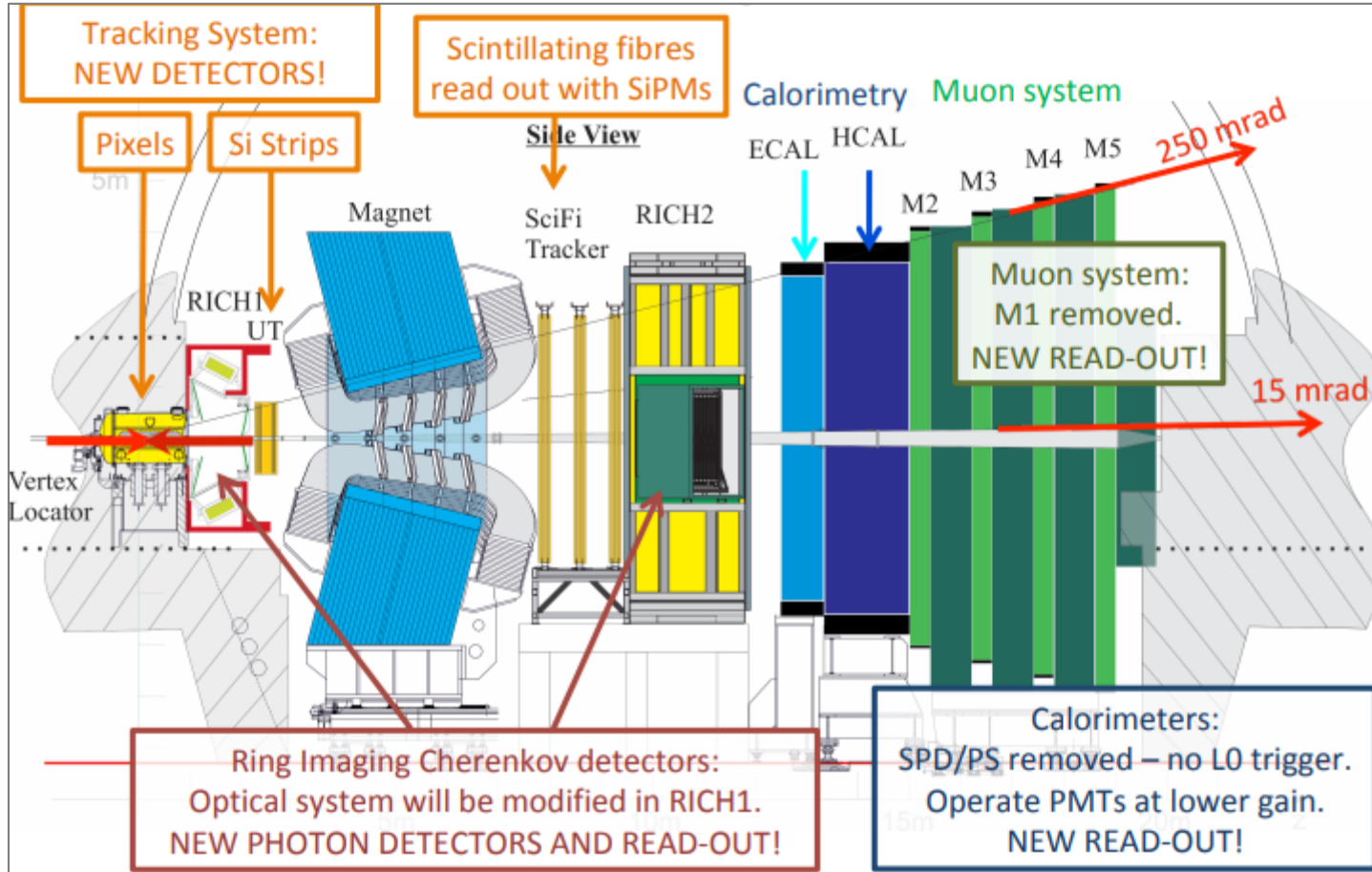
Dalitz plot analysis of  $B^0 / B_s^0 \rightarrow D^*(2010) K_s^0 \pi$

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

- Ricerca di segnali di violazione dell'universalità leptonica

Measurement of the  $B_s \rightarrow D_s \tau \nu_\tau$  branching fraction using 3 prong  $\tau$  decays

R.A. Fini (in collaborazione con INFN Ferrara et al.)





# LHCb upgrade phase I: Status



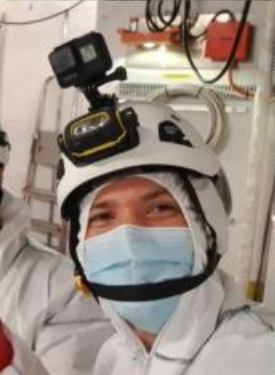
First activities at the LHCb experimental site and in CERN labs re-started in early May 2020 after the stop due to Covid-19, **almost all projects re-started now**



HCAL Beam Plug installation



Muon electronics installation

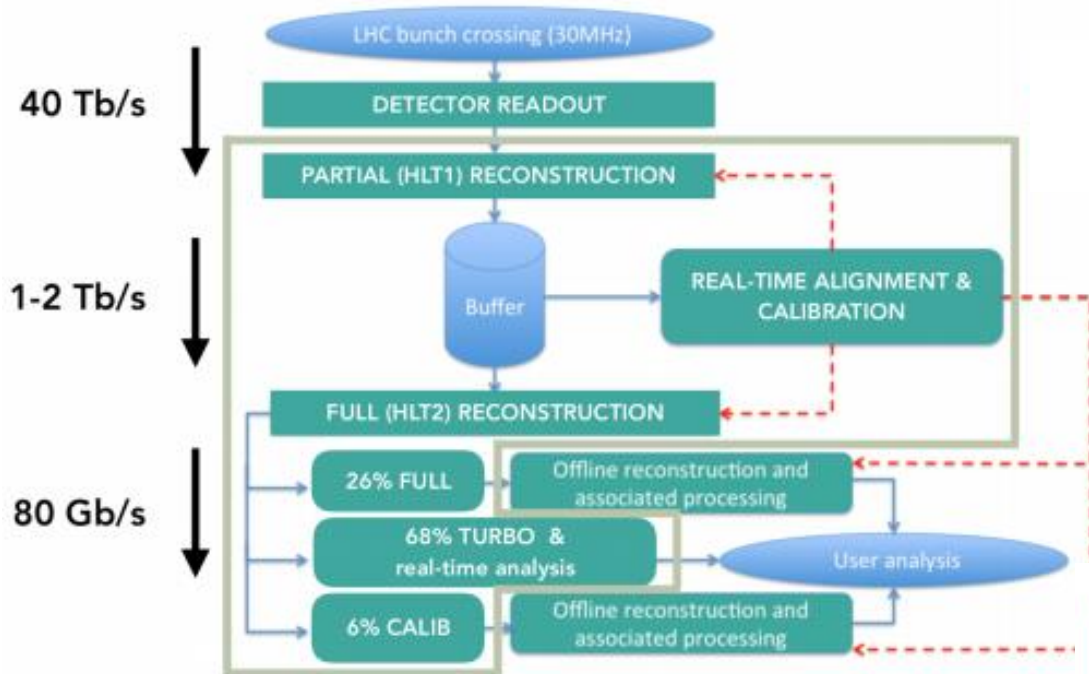


RF foil installation



Installation of EB servers



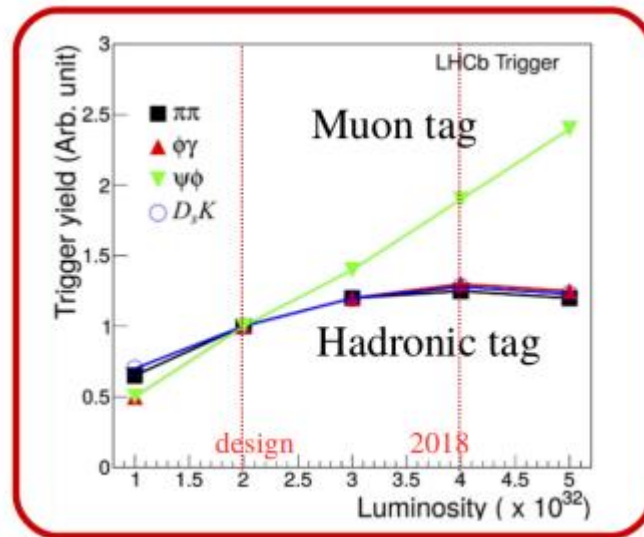


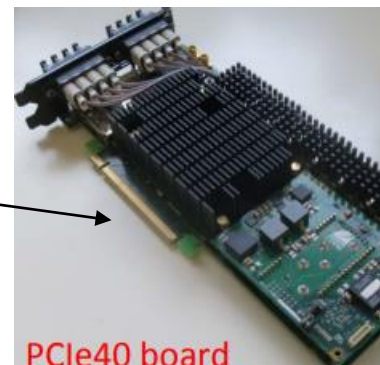
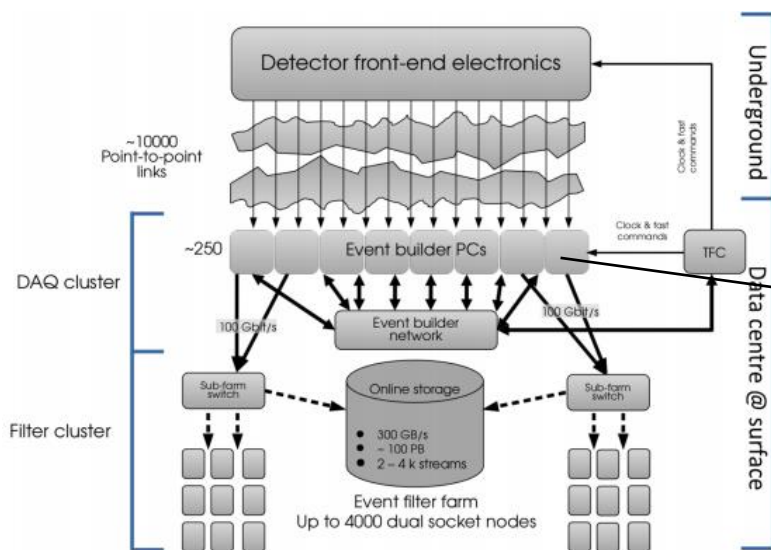
Remove the hardware trigger, detector readout at 30 MHz

Perform partial reconstruction and selection to reduce data flow from 40 Tb/s to 1-2 Tb/s: HLT1

Align and calibrate the detector in real time

Perform full reconstruction with offline quality in real time: HLT2





## Muon detector specific firmware of the new readout board (TELL40) developed by Bari and Roma2 groups

Commissioning delayed

### LHCb Upgrade Muon TELL40 Data Processing

**Technical Note**

Issue:	Draft
Revision:	1.1
Reference:	EDMSXXXXXXXX
Created:	June 5, 2018
Last modified:	April 14, 2020
Prepared by:	M. De Serio <sup>a</sup> , E. Santovetti <sup>b</sup> , A. Satta <sup>b</sup>
	<sup>a</sup> INFN Bari
	<sup>b</sup> INFN Roma Tor Vergata



- **LHCC September 2018**

“The LHCC recommends the LHCb collaboration for successfully preparing the physics case report for running beyond LS4 and supports the activities of the LHCb collaboration in planning for HL-LHC running through the preparation of TDRs”

- **Briefing book for the 2020 European Strategy**

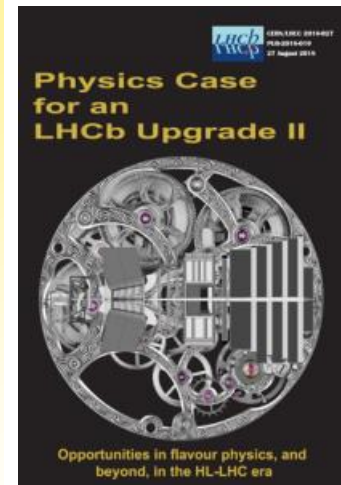
Particle Physics (<http://cds.cern.ch/record/2691414>)

Many supportive comments including:

“The LHCb Upgrade II... will enable a wide range of flavor observables to be determined at HL-LHC with unprecedented precision”

- **CERN Research Board September 2019**

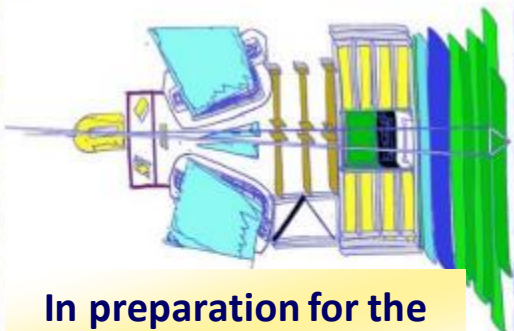
“The recommendation to prepare a framework TDR for the LHCb Upgrade-II was endorsed, noting that LHCb is expected to run throughout the HL-LHC era. “





## 5th WORKSHOP ON LHCb UPGRADE II

30.03.2020 - 01.04.2020  
Barcelona



In preparation for the  
Framework TDRs

## Towards a Muon Phase II Detector

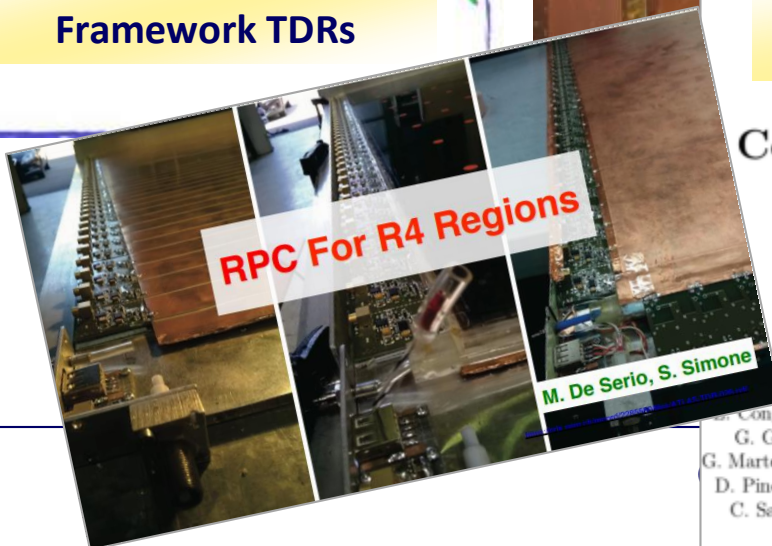


LHCb-INT-2020-007  
March 27, 2020

Bari group involved in the discussions  
for the future Muon Detector

## Considerations on Muon detector upgrade II

Albicocco<sup>1</sup>, W. Baldini<sup>2</sup>, G. Bencivenni<sup>1</sup>, B. Bochin<sup>3</sup>, N. Bondar<sup>3</sup>, D. Brundu<sup>4</sup>,  
Meddu<sup>4</sup>, A. Cardini<sup>4</sup>, M. Carletti<sup>1</sup>, L. Casu<sup>4</sup>, A. Chubykin<sup>5</sup>, P. Ciambrone<sup>1</sup>,  
Congedo<sup>5,6</sup>, M. De Serio<sup>5,6</sup>, P. De Simone<sup>1</sup>, G. Felici<sup>1</sup>, M. Gatta<sup>1</sup>, M. Giovannetti<sup>1</sup>,  
G. Graziani<sup>12</sup>, P. Griffith<sup>2</sup>, D. Ilin<sup>3</sup>, M. Korolev<sup>11</sup>, S. Kotriakhova<sup>3,7</sup>, O. Maev<sup>3,8</sup>,  
G. Martellotti<sup>7</sup>, G. Morello<sup>1</sup>, M. Palutan<sup>1</sup>, G. Passaleva<sup>8,12</sup>, A. Pastore<sup>5,6</sup>, M. Poli Lener<sup>1</sup>,  
D. Pinci<sup>7</sup>, R. Santacesaria<sup>7</sup>, M. Santimaria<sup>1</sup>, A. Saputi<sup>1,8</sup>, E. Santovetti<sup>13</sup>, A. Sarti<sup>7,9</sup>,  
C. Satriano<sup>7,10</sup>, A. Satta<sup>13</sup>, B. Schmidt<sup>8</sup>, T. Schneider<sup>8</sup>, B. Sciascia<sup>1</sup>, S. Simone<sup>5,6</sup>,  
A. Vorobyev<sup>3</sup>



RPC For R4 Regions

M. De Serio, S. Simone

# Anagrafica e richieste LHCB 2021

M. De Serio (resp. loc.)	80%
R.A. Fini	80%
<i>A. Palano</i>	<i>0%</i>
M. Pappagallo	90%
A. Pastore	80%
S. Simone	80%
L. Congedo (PhD)	80%
TOT FTE	4.9

Deputy Physics Coordinator (da 1/7/2020)

## Richiesta servizi (LHCb + SHiP):

**3 m.p. Servizio elettronico**

**3 m.p. Servizio meccanico**

Backup slides

