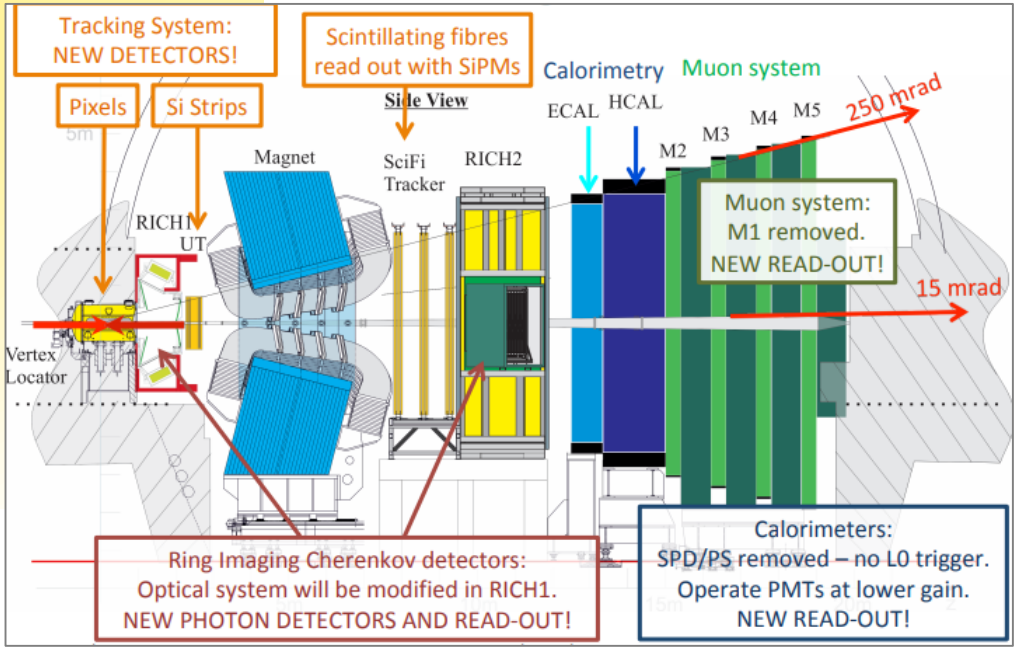
Attività, anagrafica e richieste servizi LHCb

Status of LHCb: upgrade phase I

LHCb detector undergoing major upgrade for Run 3

Notable progress in all projects:

- **Infrastructure work completed**
- **VELO, UT, RICH1, SciFi installation in progress**
- **RICH2, ECAL, MUON, Event Builder now in commissioning phase**

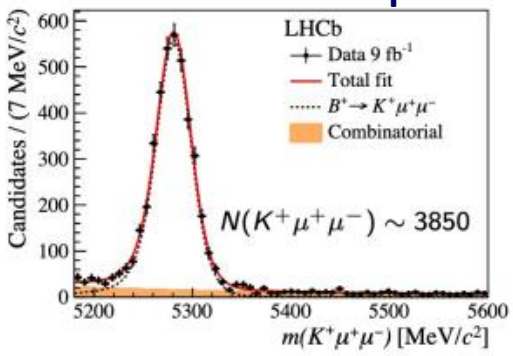


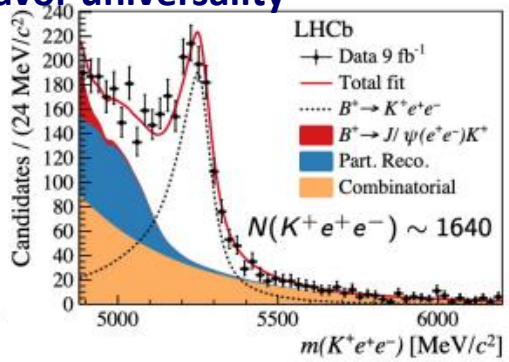
Status of LHCb: some physics highlights

M. Pappagallo Deputy Physics Coordinator

A. Palano Member of the Editorial Board

Test of Lepton flavor universality

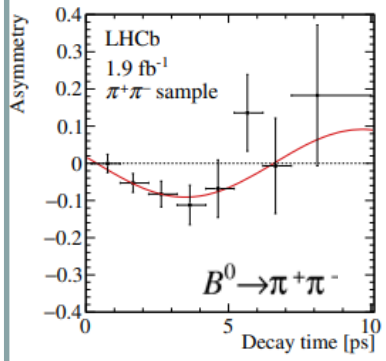


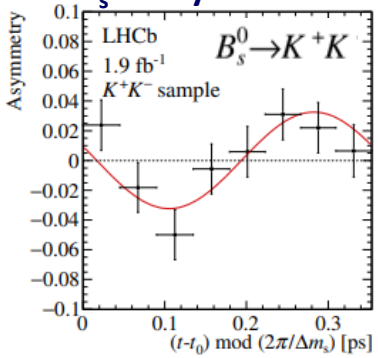


$$R_K = \frac{\int_{1.1\,\mathrm{GeV}^2}^{6.0\,\mathrm{GeV}^2} \frac{\mathrm{d}\mathcal{B}(B^+\to K^+\mu^+\mu^-)}{\mathrm{d}q^2}\mathrm{d}q^2}{\int_{1.1\,\mathrm{GeV}^2}^{6.0\,\mathrm{GeV}^2} \frac{\mathrm{d}\mathcal{B}(B^+\to K^+e^+e^-)}{\mathrm{d}q^2}\mathrm{d}q^2}$$

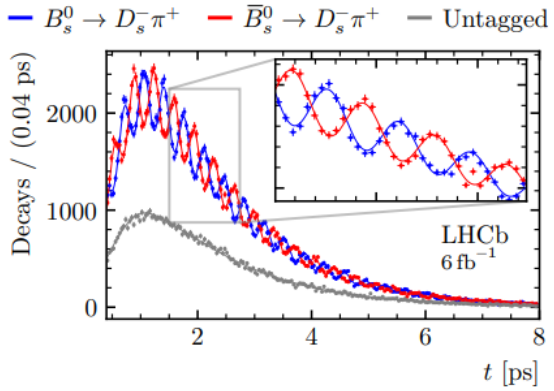
$R_K = 0.846\ ^{+0.042}_{-0.039}\ (\mathrm{stat})\ ^{+0.013}_{-0.012}\ (\mathrm{syst})$

First observation of time-dependent CP violation in B^0_s decays

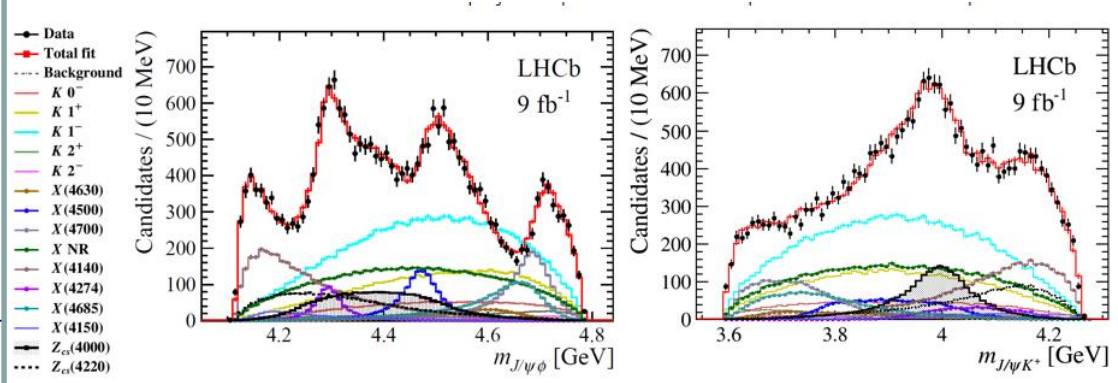




Precise determination of the B^0_s - anti B^0_s oscillation frequency

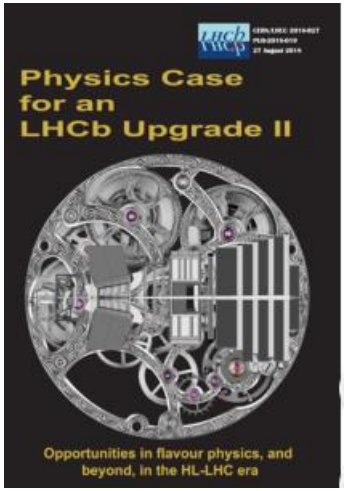


Observation of new resonances decaying to J/ψK+ and J/ψϕ



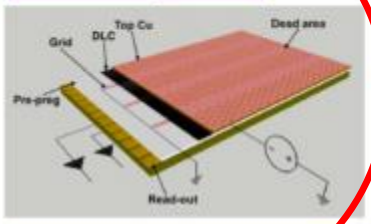
LHCb upgrade phase II

- **Expression of Interest (2017)**
- **Physics case (2018)**
- **Strong support in European Strategy (2020)**
- **Framework TDR in progress**
  Detector options to achieve physics program, initial cost estimates
  Finalization of the document in progress
  (to be completed by beginning of September)

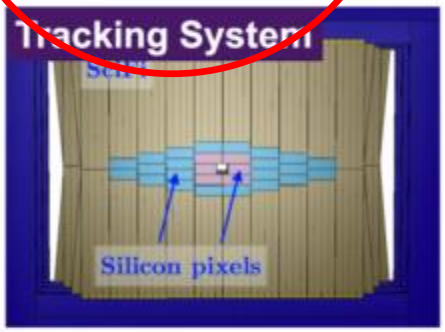


LHCb upgrade phase II

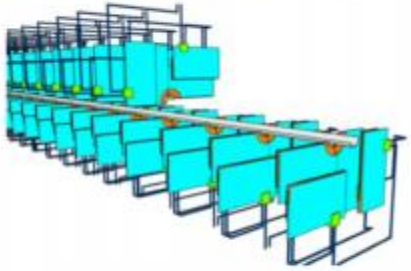
Muon system



Tracking System

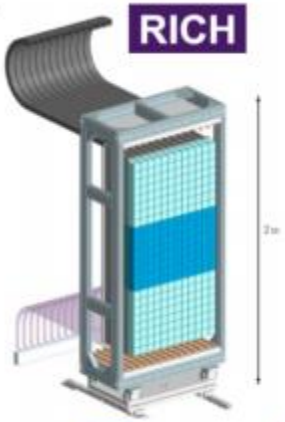


Vertex Detector (VELO)

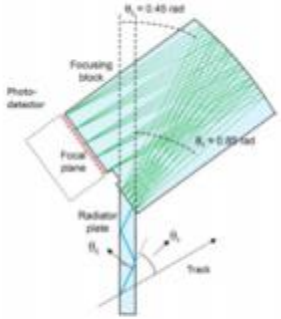


Electromagnetic Calorimetry

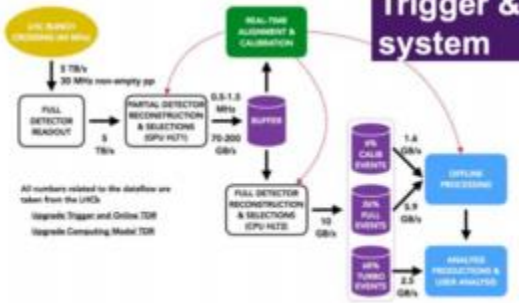
RICH



TORCH ToF



Trigger & DAQ system



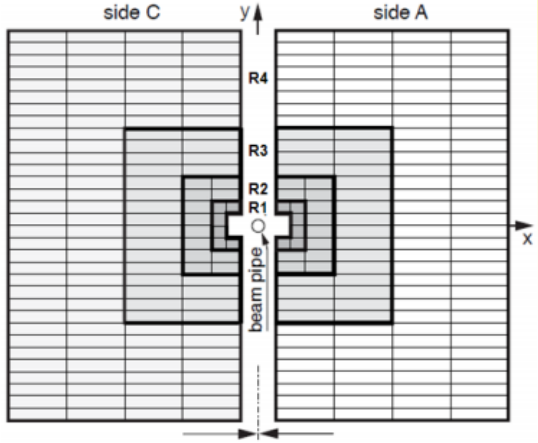
LHCb upgrade phase II

Muon detector baseline option (stations M2-M5):

- Inner regions (R1-R2): µRWell, 23 m^2, max rate: ~ 1 MHz/cm^2
- Outer regions (R3-R4): MWPCs (present + new higher granularity), 364m^2, max rate: ~ 10kHz/cm^2
- New FE Electronics

Other options for outer regions:

- RPCs and/or Scintillating Tiles

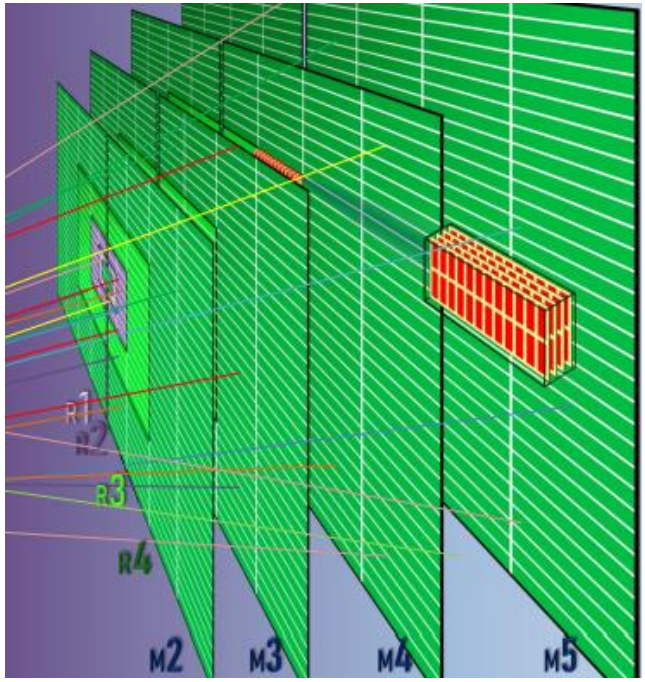


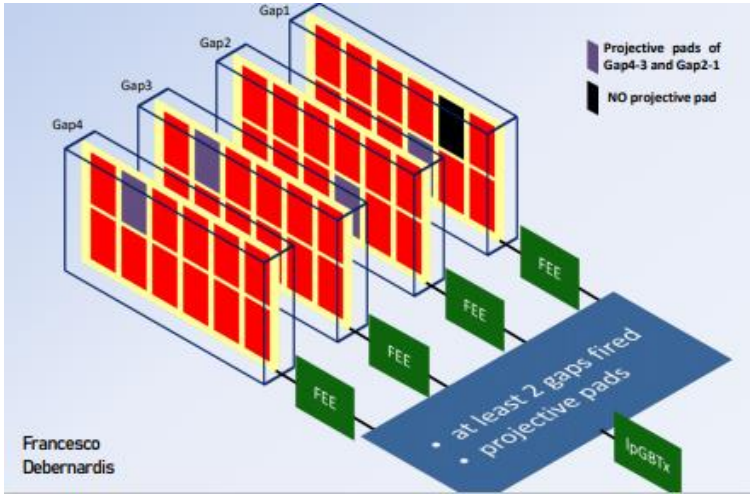
LHCb upgrade phase II @Bari

- **Simulation of the Muon detector**
- **Development of new FE electronics**
- **R&D on new-generation RPCs**

LHCb upgrade phase II @Bari

- **Simulation of the Muon detector**:
  optimization of the readout scheme and pad geometry (FTDR);
  requirements on improved time resolution





LHCb upgrade phase II @Bari

G. Derobertis, F. Licciulli, F. Loddo

- **Development of new FE electronics**

Requirements:
the new FEE should cope with a wide range of rates, pad density and capacitance (about a factor 100 between inner and outer regions), as well as be *back-compatible* (MWPCs in the outer regions)

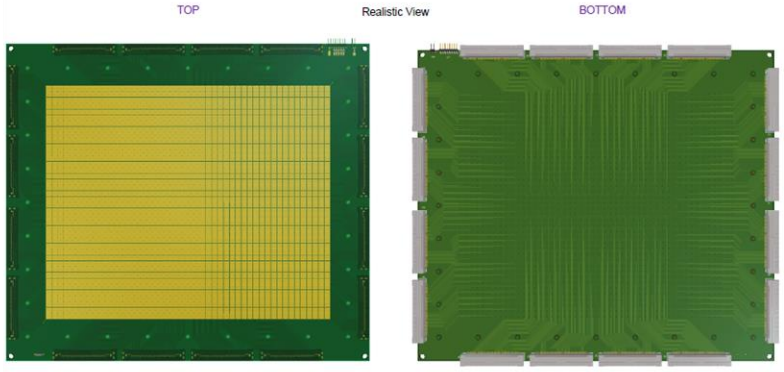
Upgraded version of FATIC2 ASIC (developed in Bari) as a possible option

LHCb upgrade phase II @Bari

G. Derobertis, F. Licciulli, F. Loddo

- **Development of new FE electronics**

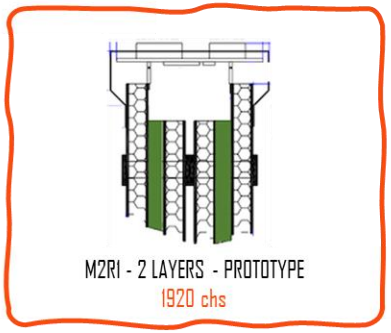
TEST PROTOTIPO μRWELL M2R1 + FATIC

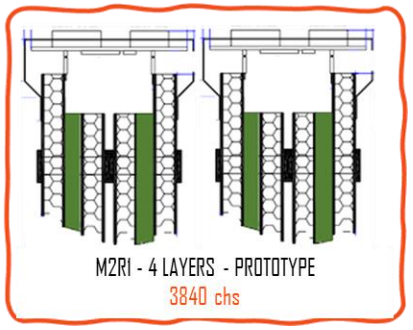


Layout prototipo M2R1:

- Dimensioni: 25x30 cm^2
- Numero di pads: 1920
- Numero di canali: 960
  (lettura coppie di pads)

LETTURA BiGap o QuadriGap

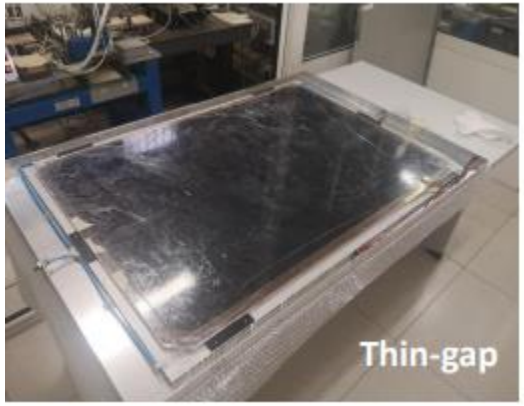




- Test catena DAQ
- Misure funzionali su banco (stabilità, S/N, soglie di lavoro)
- Presa dati con setup cosmici
- Presa dati con setup RX
- Test Beam (H8C beam area at CERN, 0tt-Nov 22)

LHCb upgrade phase II @Bari

- **R&D on new-generation RPCs:**
  design of an RPC triplet prototype with *thin* gap / electrodes operated with eco-friendly gas mixtures (studies ongoing)



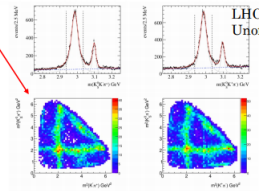
Physics analysis@Bari

A. Palano, M. Martinelli

Amplitude Analysis of $B^+ \to (K^0_S K\pi)K^+$

Plan of the work

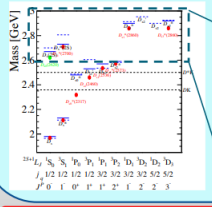
- Precise measurements of the charmonium resonances parameters
- Measurement of the partial $B^+ \to (c\bar{c})K^+$ branching fractions.
- Dalitz plot analysis of the $\eta_c \to K^0_S K\pi$ decay.
- Amplitude analysis of the $K^0_S K\pi$ system in the threshold region.



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

Study of $B_{(S)}{}^0 \to D^*(2010)^- K^0_S \pi^+$ decay channel

- The production of D_s^{**} in $B_{(s)}{}^0$ decays can help understanding the nature of these states
- Dalitz analyses involving DK final states have been also performed in $B_s{}^0$ decays:



Excited charm-strange states above the $D^*_{s0}(2573)$ seen in D(*)K spectra in collisions BaBar e⁺e⁻ and LHCb

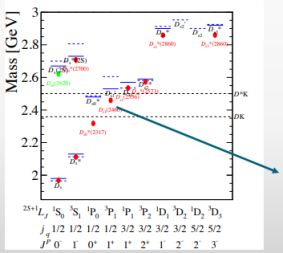
State	Mass	Width	Comment
		BaBar	
$D^*_{s1}(2700)^-$	$2710 \pm 2^{+12}_{-7}$	$149 \pm 7^{+39}_{-52}$	Seen in DK and D^*K
$D^*_{sJ}(2860)^-$	$2862 \pm 2^{+5}_{-2}$	$48 \pm 3 \pm 6$	Seen in DK and D^*K
$D_{sJ}(3040)^-$	$3044 \pm 8^{+30}_{-5}$	$239 \pm 35^{+46}_{-42}$	Seen in D^*K only
		LHCb	
$D^*_{s1}(2700)^-$	$2709.2 \pm 1.9 \pm 4.5$	$115.8 \pm 7.3 \pm 12.1$	Seen in DK and D^*K
$D^*_{sJ}(2860)^-$	$2866.1 \pm 1.0 \pm 6.3$	$69.9 \pm 3.2 \pm 6.6$	Seen in DK and D^*K
$D^*_{s1}(2860)^-$	2859 ± 12	159 ± 23	From $B^0_s \to \overline{D}^0 K^- \pi^+$
$D^*_{s3}(2860)^-$	2860.5 ± 2.6	53 ± 7	From $B^0_s \to \overline{D}^0 K^- \pi^+$

Now investigating D*K final states in $B_{(s)}{}^0$ decays …

F. Debernardis, A. Pastore, M. Pappagallo

Search for $D_{S1} \to D_S\,\mu\mu$ Decays

Search for Dalitz decays of $D_{s1}(2460)$ by using the CF decay mode: $D_s^+ \to K^+K^-\pi^+$ (5.45 ± 0.17)%



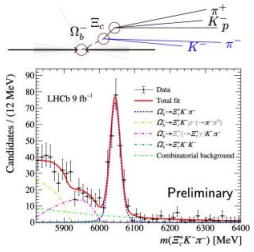
$D_{s1}(2460)^+ \to D_s^+ \mu^-\mu^+$

$J^P = 1^+$ $J^P = 0^-$ $J^P = 1^-$

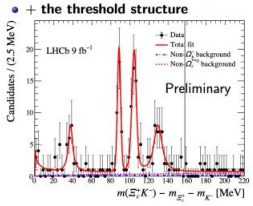
S. Mitchell, M. Pappagallo, M. Mikhasenko

First Exclusive Observation of Ω_c^{**0} in $\Omega_b^- \to \Xi_c^+ K^- \pi^- \pi^-$ Decays

[LHCb-PAPER-2021-012, in preparation]



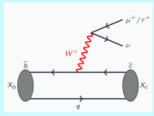
- Strict exclusivity cut ⇒ No feed down!
- Same four peaks (no clear fifth)
- + the threshold structure



R. Fini et al.

R(D_s): Lepton Flavour Universality

Test of lepton flavour universality using the transitions $b \to c\tau\nu$ transitions



Study of the semileptonic $B_s^0 \to D_s^- \ell^+ \nu_\ell$ decay ratio

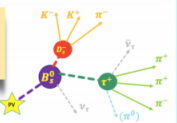
$$R(D_s) = \frac{\mathcal{B}(B_s^0 \to D_s^- \tau^+ \nu_\tau)}{\mathcal{B}(B_s^0 \to D_s^- \mu^+ \nu_\mu)}$$

$D_s^- \to K^+K^-\pi^-$

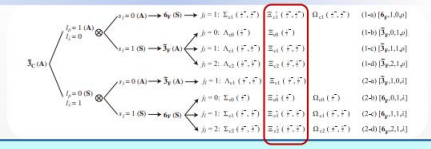
HADRONIC

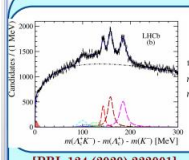
$\tau^+ \to \pi^+\pi^-\pi^+(\pi^0)\bar{\nu}_\tau$

RUN1 and RUN2 data



Ξ_c Spectroscopy





$m(\Omega_c(3050)^0) - m(\Xi_c(2923)^0) \simeq 125$ MeV,
$m(\Omega_c(3065)^0) - m(\Xi_c(2939)^0) \simeq 125$ MeV,
$m(\Omega_c(3090)^0) - m(\Xi_c(2965)^0) \simeq 125$ MeV.

[PRL 124 (2020) 222001]

E. Gabriel, M. Pappagallo, F. Muheim

$\Xi_c^{**0} \to \Xi_c^0 \pi^+ \pi^-$

L. Lagrange, M. Pappagallo, F. Muheim

$\Xi_c^{**+} \to \Xi_c^+ \pi^+ \pi^-$

R. O'Neil, M. Pappagallo, M. Williams

$\Xi_c^{**+} \to \Lambda_c^+ \pi^+ K^-$

F. Oliva, M. Pappagallo, M. Williams

See M. Pappagallo's talk @ Congresso Sezione INFN Bari 21-22/6/2021

Anagrafica LHCb-Bari 2021

M. De Serio (resp. loc.)	80%
R.A. Fini	80%
G. Galati (RTDa)	70%
A. Palano	*0%*
M. Pappagallo	90%
A. Pastore	70%
S. Simone	80%
L. Congedo (PhD)	100%
F. Debernardis (PhD)	100%
G. De Robertis	10%
F. Licciulli	10%
F. Loddo	10%
TOT FTE	**4.9 → 7.0**

Richiesta servizi

Servizio elettronico:

- Disegno schede con ASIC FATIC per lettura μRWELL
- Disegno schede di interfaccia con RO

Servizio meccanico:

- Disegno e realizzazione struttura meccanica per tripletto RPC

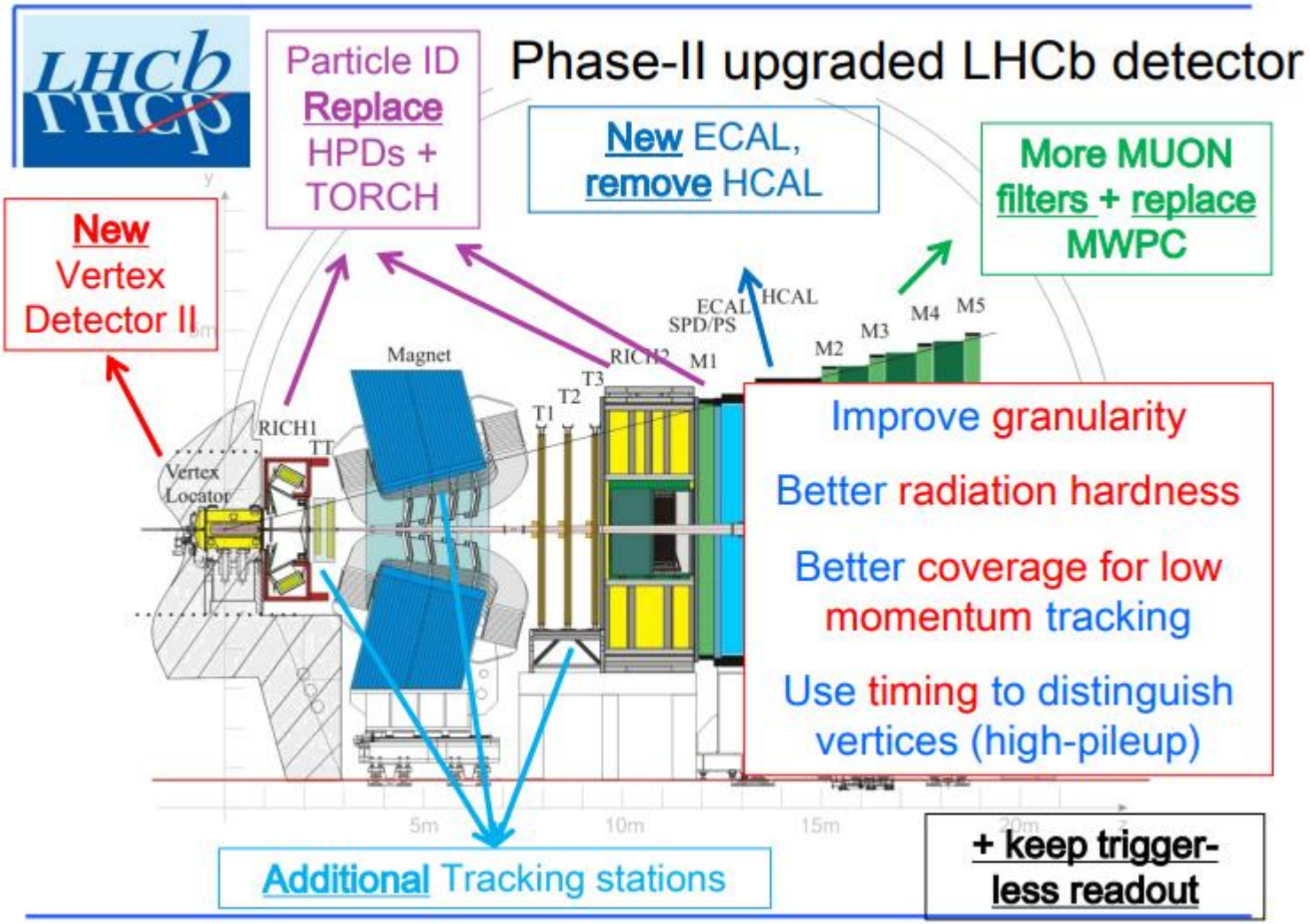
Assegni di ricerca

1 assegno di durata biennale su fondi INFN da 1/11/2022:

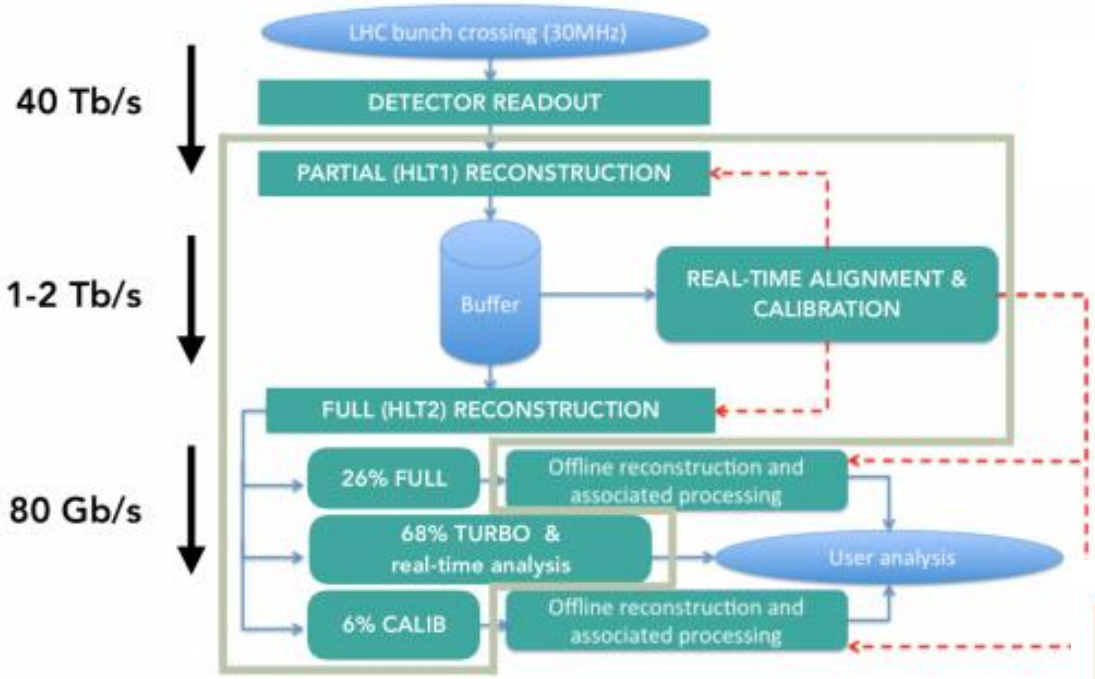
Sviluppo di rivelatori a gas per l'upgrade del muon detector dell'esperimento LHCb

Backup slides

LHCb upgrade phase II



LHCb upgrade phase I

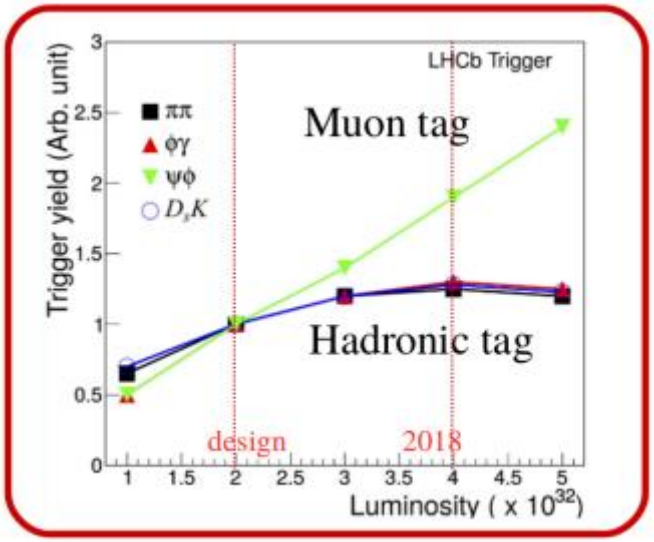


Remove the hardware trigger, detector readout at 30 MHz

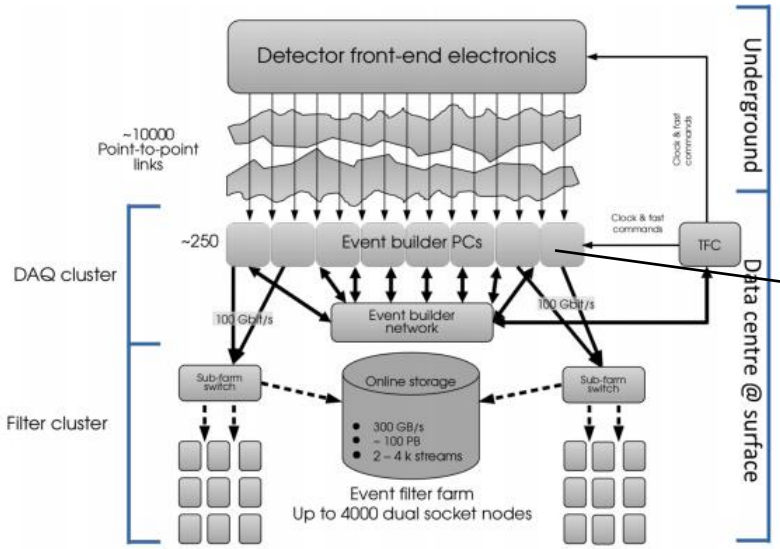
Perform partial reconstruction and selection to reduce data flow from 40 Tb/s to 1-2 Tb/s: HLT1

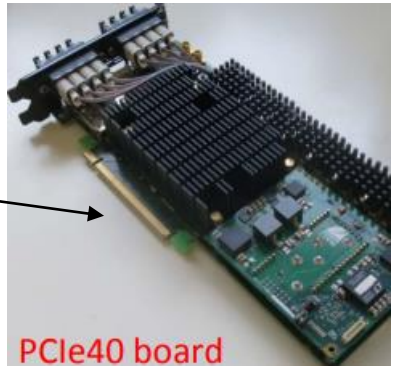
Align and calibrate the detector in real time

Perform full reconstruction with offline quality in real time: HLT2



LHCb upgrade phase I





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

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[a], E. Santovetti[b], A. Satta[b]
	[a]INFN Bari
	[b]INFN Roma Tor Vergata