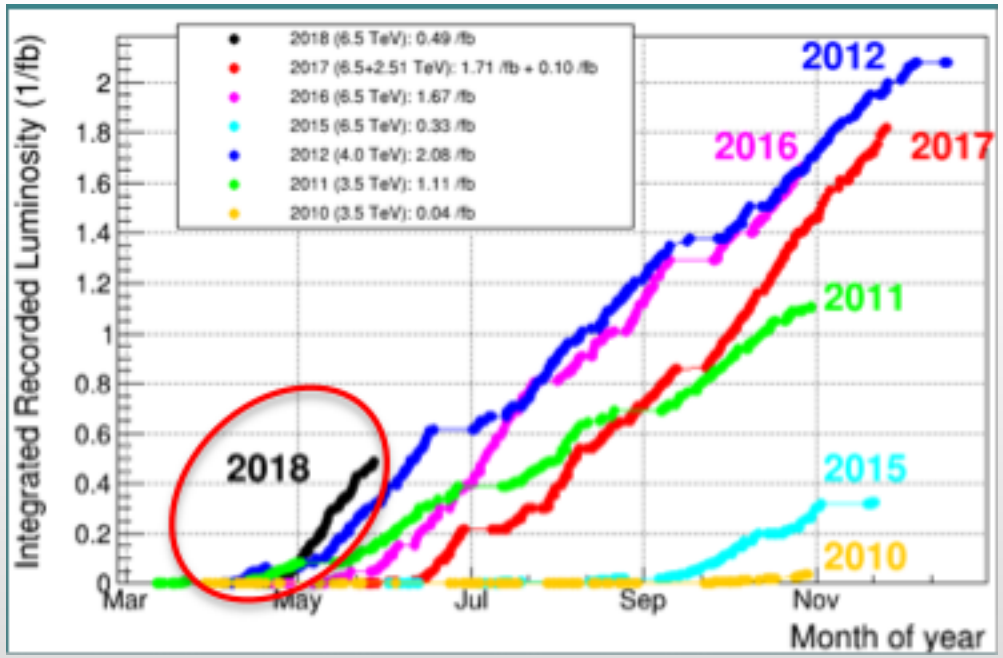
LHCb
Consiglio di sezione INFN 10 luglio 2018

Donatella Lucchesi

LHCb 2018 Data taking

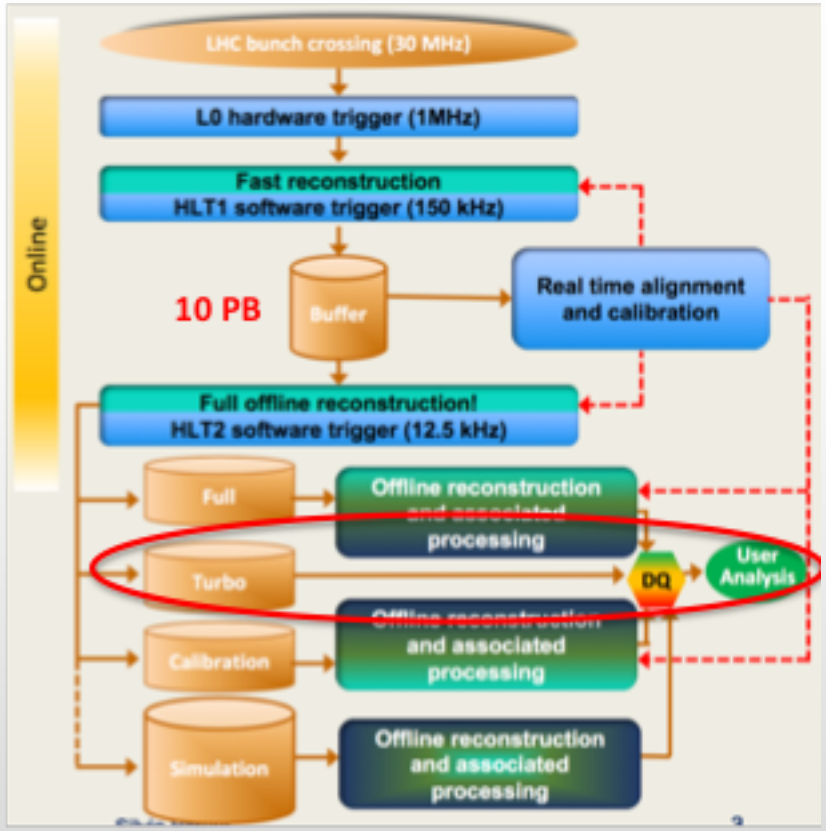
Excellent performances:

- Collected 7.6 fb^{-1} in Run1+Run2
- 0.6 fb^{-1} up to now in 2018



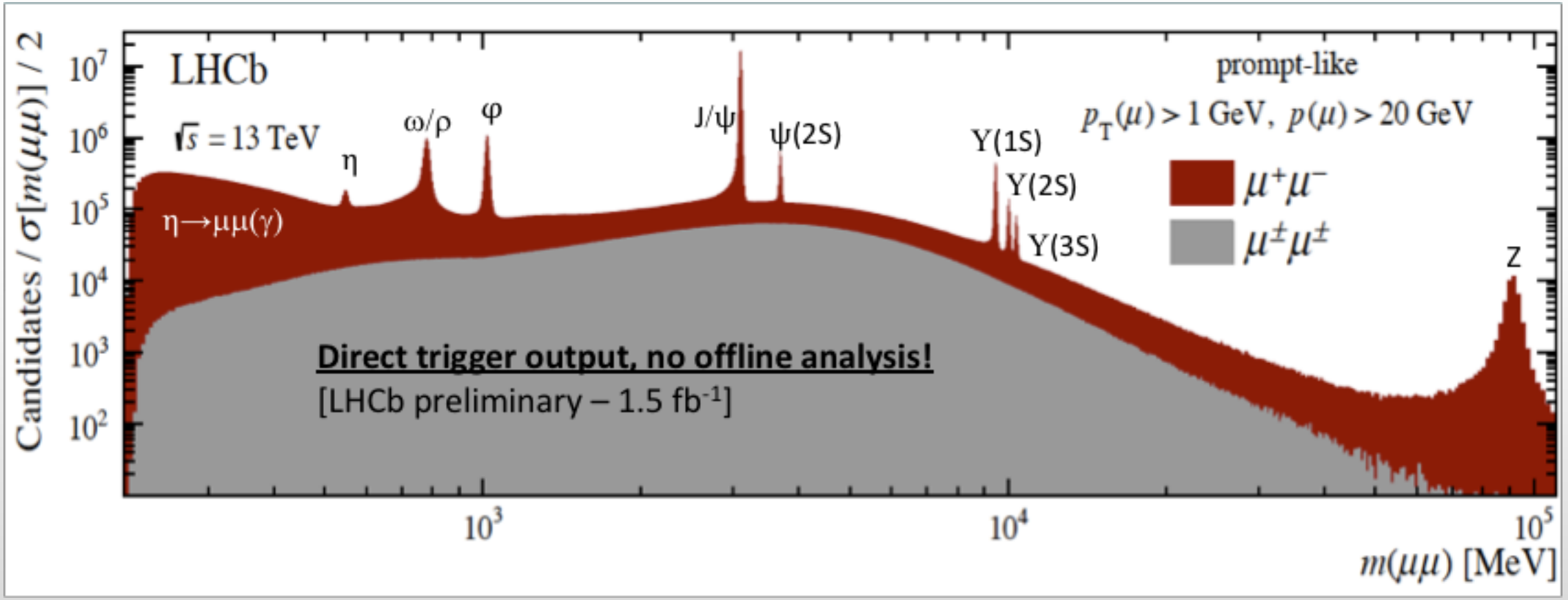
Turbo was optimized in 2017:
Selected data saved in a format ready for the analysis
no offline reconstruction

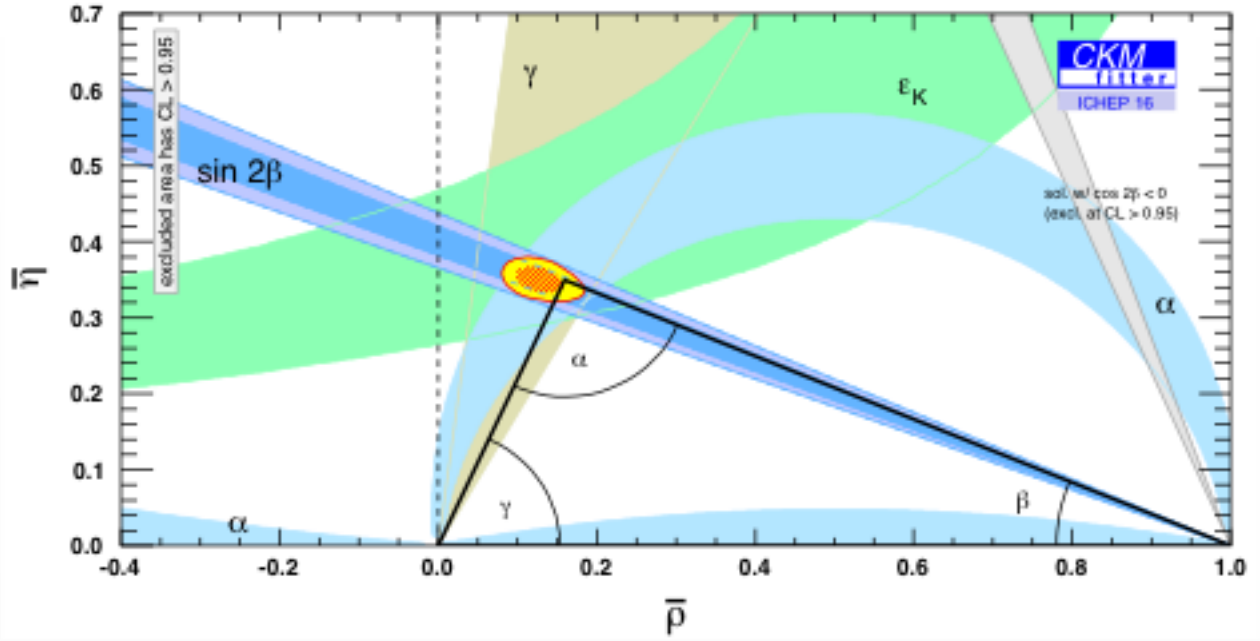
An anticipation of the upgrade trigger

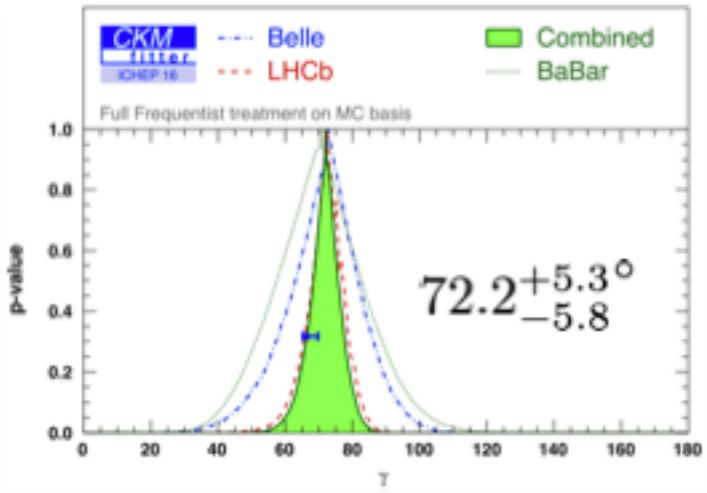


An application of turbo: search for dark photon $A \rightarrow \mu^+ \mu^-$

There is a dedicated trigger in the turbo stream



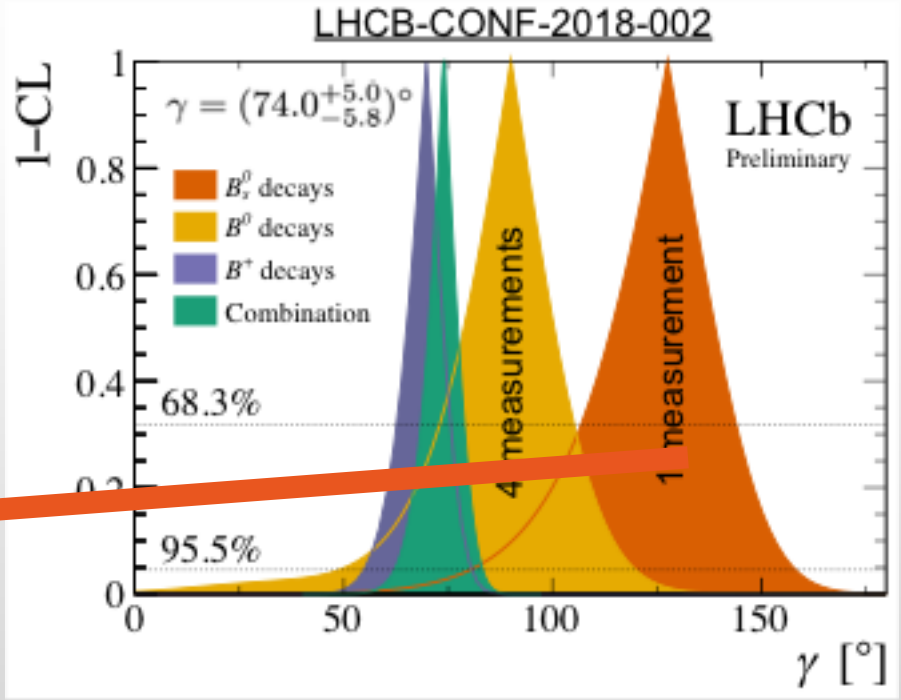




LHCb

Recently 4 update and 3 new measurements
Combination of 16 measurements in LHCb

$$\gamma = (74.0\,^{+5.0}_{-5.8})^\circ$$



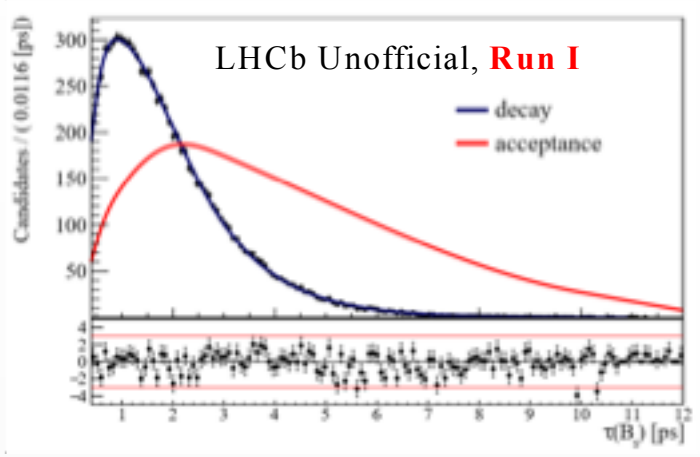
CP Violation

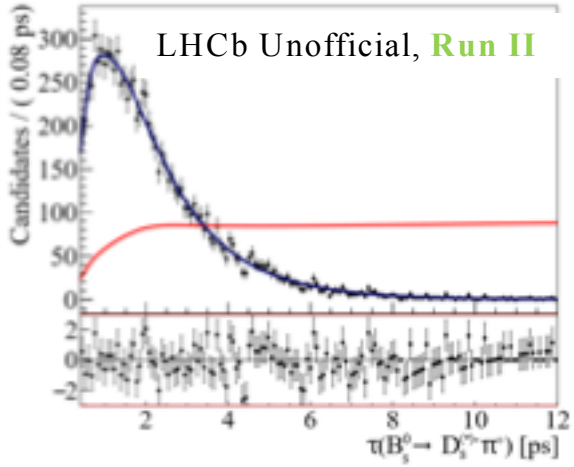
Padova contributes by studying the time dependent asymmetry folded with γ

can we cross check the $B^0_s \to D_s K$ result ?

Bertolin Gallorini

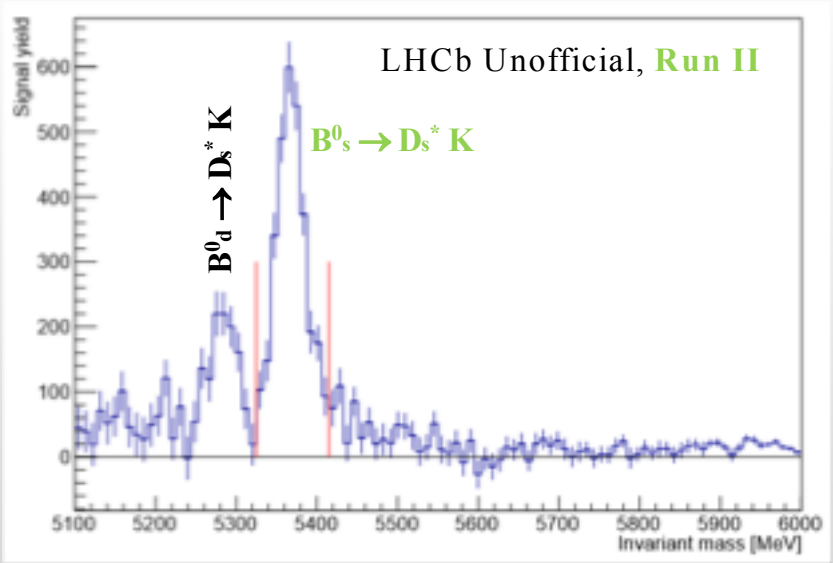
Padova as the leading role on: CKM γ from $B^0_s \to D_s^* K$, $D_s^* \to D_s \gamma$





algorithms improved to achieve a flat acceptance as a function of the B^0_s decay time

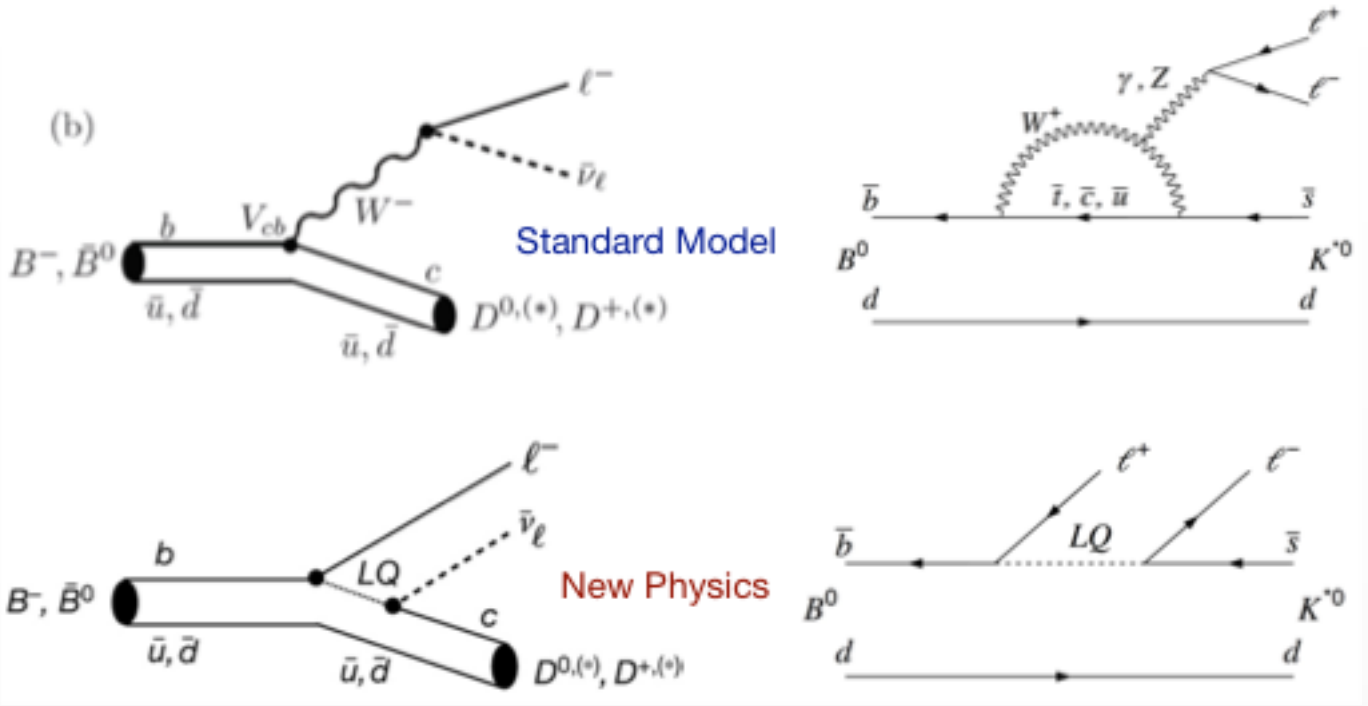
many other improvements w.r.t. Run I



back of the envelope estimated signal yield in Run II (2015-2017, ~ 3.2 fb^{-1}): ~ 3100 events

Run I (3 fb^{-1}): 1025 +- 71 events
from the LHCb observation paper JHEP06 (2015) 130

recent bachelor theses:
CAVINATO Samuele (end of Sep. 2017) B^0_s folded asymmetry studies in the $D_s^* \pi$ and $D_s^* K$ decay modes



Anomalies at tree level

⇓

$$R(D^*) = \frac{BF(B \to D^* \tau \nu)}{BF(B \to D^* \mu \nu)}$$

Anomalies in penguin

⇓

$$R_K = \frac{BR(B^+ \to K^+ \mu^+ \mu^-)}{BR(B^+ \to K^+ e^+ e^-)}$$

Lepton Flavor Universality

Lupato, Simi

R (Λ_c^*) is the first attempt to check lepton universality with baryons where the sensitivity to New Physics would be different.

Run I measurement lead by Padova

$$R(\Lambda_c^*) = \frac{\mathcal{B}(\Lambda_b^0 \to \Lambda_c^* \tau^- \bar{\nu}_\tau)}{\mathcal{B}(\Lambda_b^0 \to \Lambda_c^* \mu^- \bar{\nu}_\mu)} = \frac{N(\Lambda_b^0 \to \Lambda_c^* \tau^- \bar{\nu}_\tau)}{N(\Lambda_b^0 \to \Lambda_c^* \mu^- \bar{\nu}_\mu)} \frac{\epsilon_\mu}{\epsilon_\tau} \frac{1}{\mathcal{B}(\tau^- \to \mu^- \bar{\nu}_\mu \nu_\tau)}$$

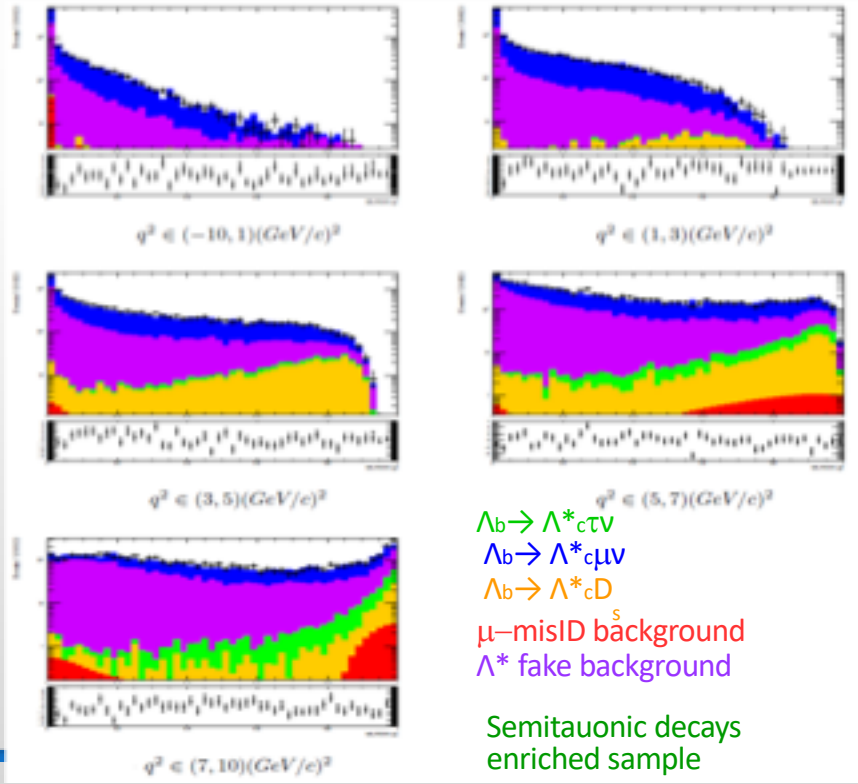
An extended maximum likelihood fit is performed simultaneously on the NN output variable distributions in 5 bins of transferred momentum and in 2 bins of isolation.

$$R(\Lambda_c^*) = R_{RAW}(\Lambda_c^*) \frac{\epsilon_\mu}{\epsilon_\tau} \frac{1}{\mathcal{B}(\tau^- \to \mu^- \bar{\nu}_\mu \nu_\tau)}$$

From MC

$$R(\Lambda_c^*) = 0.238 \pm 0.108(stat) \pm 0.058(syst)$$

First measurement of the R(Λ_c^*) ratio, consistent with the Standard Model expectation(LHCB-ANA-2018-026)



Lepton Flavor Universality with Λ

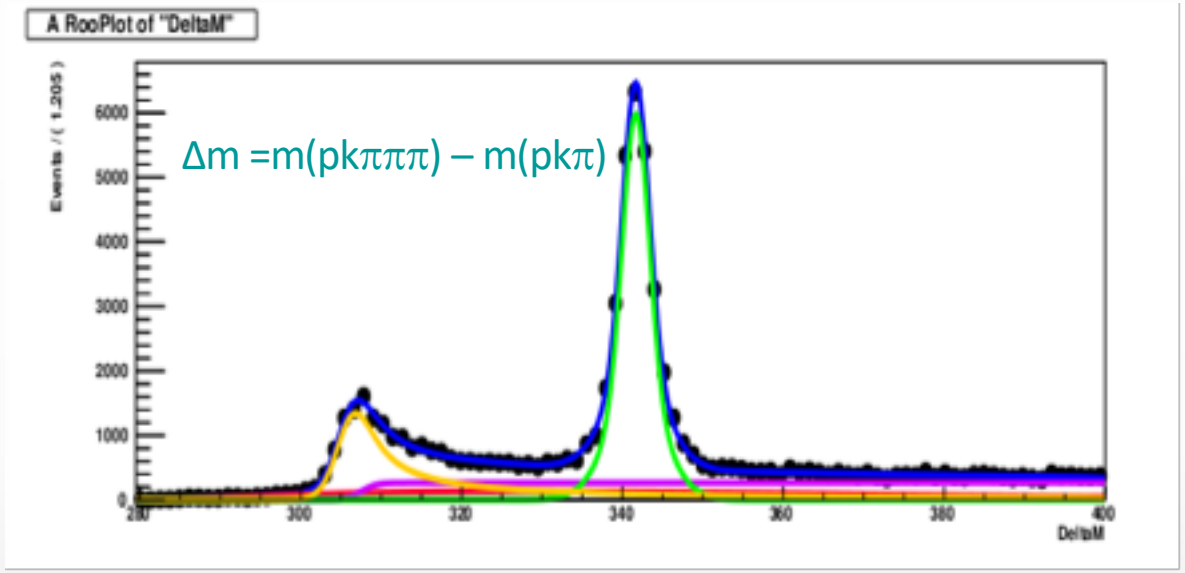
With Run II data several improvements are foreseen

Lupato, Simi

- Include $\Lambda_c(2593)$, signal extracted by fitting Δm
  Blechman et al. phenomenology model implemented
  [10.1103/PhysRevD.67.074033]

- Constrain $\Lambda_b \rightarrow \Lambda_c^* D_s$ background, use multivariate based selections
  bachelor thesis: Argenton Pietro

- $\Lambda_b \rightarrow \Lambda_c^* \mu\nu$ form factors measurement, additional result of the analysis



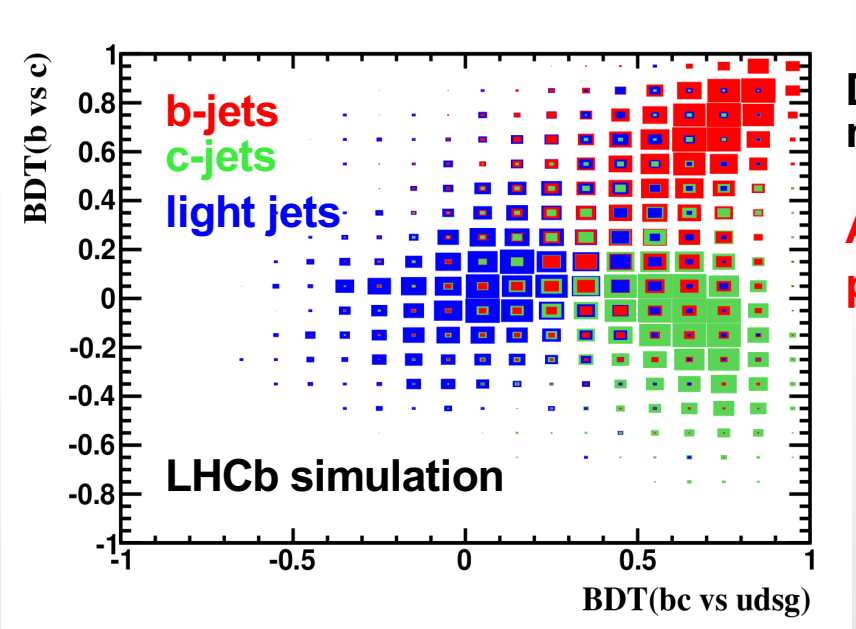
Lepton Flavor Universality with Λ

A jet is identified to be generated from a **b** or **c** quark (**b-jet** or **c-jet**) if a **Secondary Vertex** is reconstructed within the jet cone **ΔR <0.5**

Two **Boosted Decision Trees** are used to identify b and c jets, input observables are related to the SV.

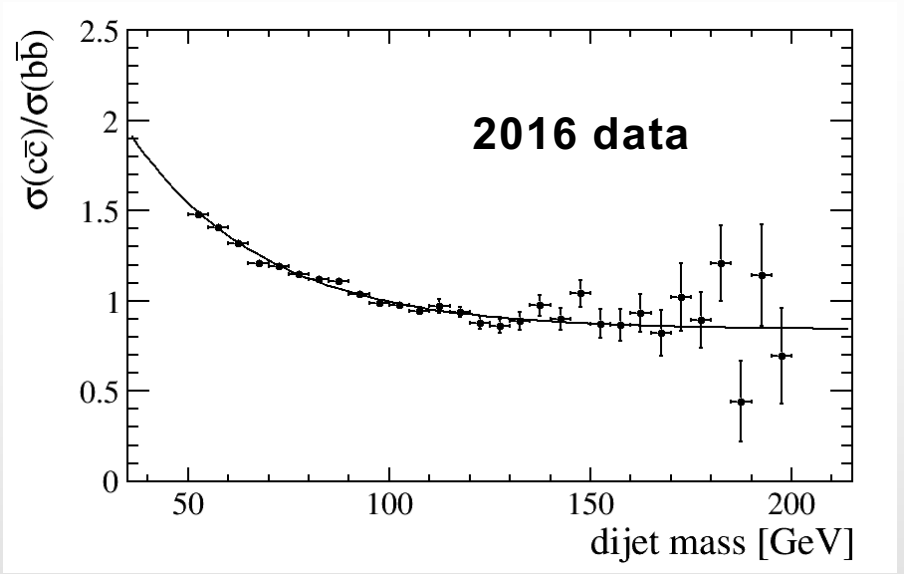
BDT(bc|udsg) Separate **heavy flavour** jets from **light** jets

BDT(b|c) Separate **b-jets** **c-jets**



Distributions normalized to 1

A good discrimination power is achieved!

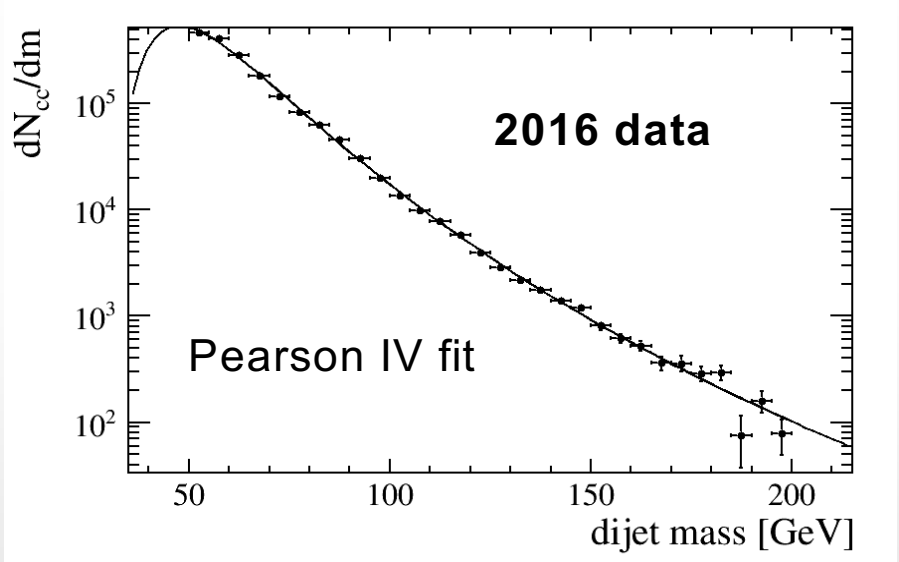


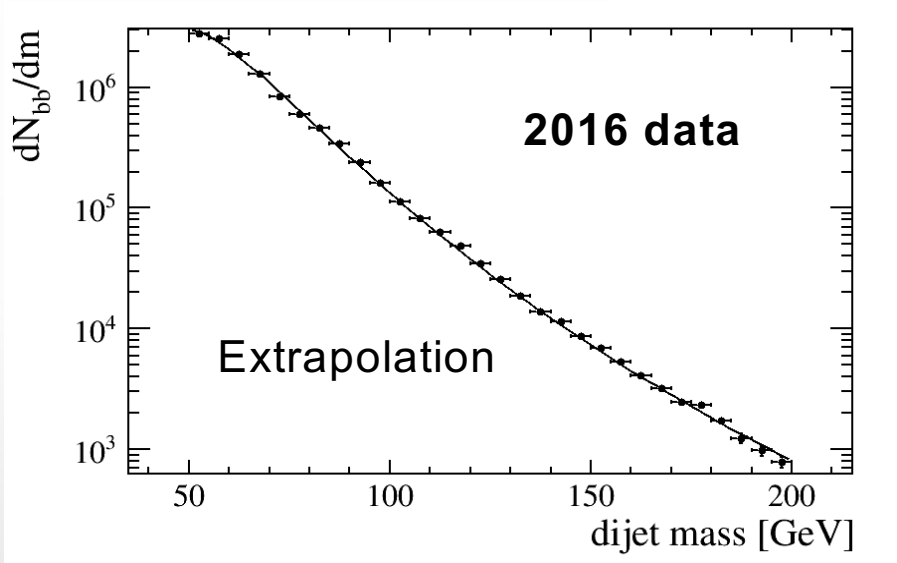
Measurement of $\sigma \rightarrow cc\ /\sigma \rightarrow bb$

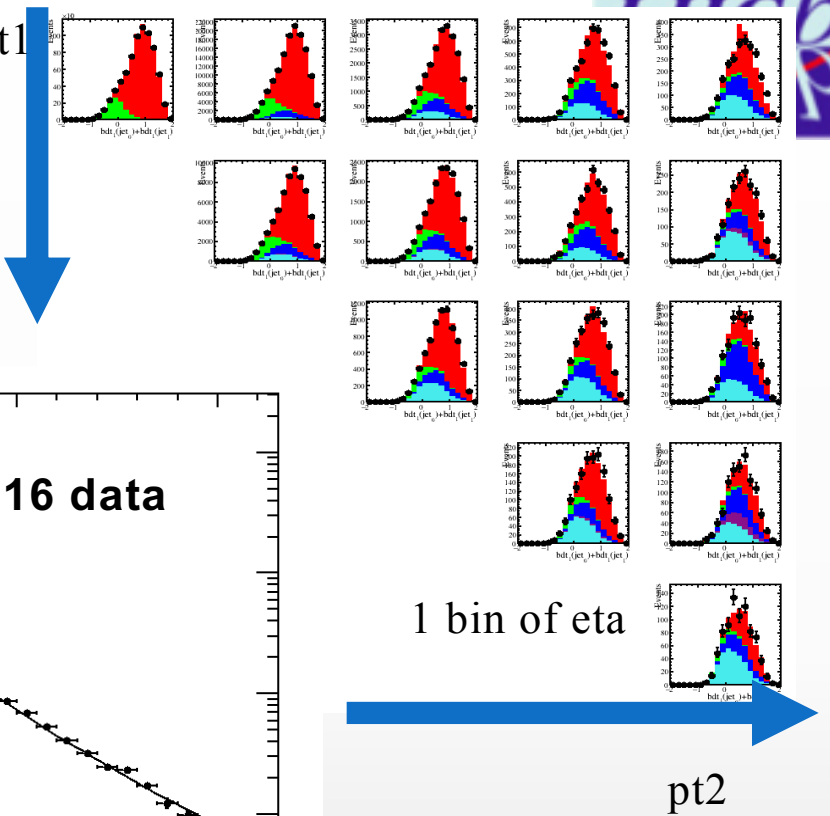
Sestini, Michielin leading the analysis

Fit to BDT observables to determine the flavor composition in bins of kinematics variables

Determination of signal and background distribution for each invariant mass bin
Any resonance is searcheable!







The bb and cc invariant mass distribution can be use to search for $H \to bb$ and $H \to cc$

Search for inclusive $H \to bb$ and $H \to cc$

Sestini, Michielin, Lucchesi

Sestini, Michielin, Gianelle
Lucchesi
Arcelia Hermosillo Ruiz
(DOE summer student)

DNN_Tag uses all the jets constituents selected by the Particle Flow as inputs:

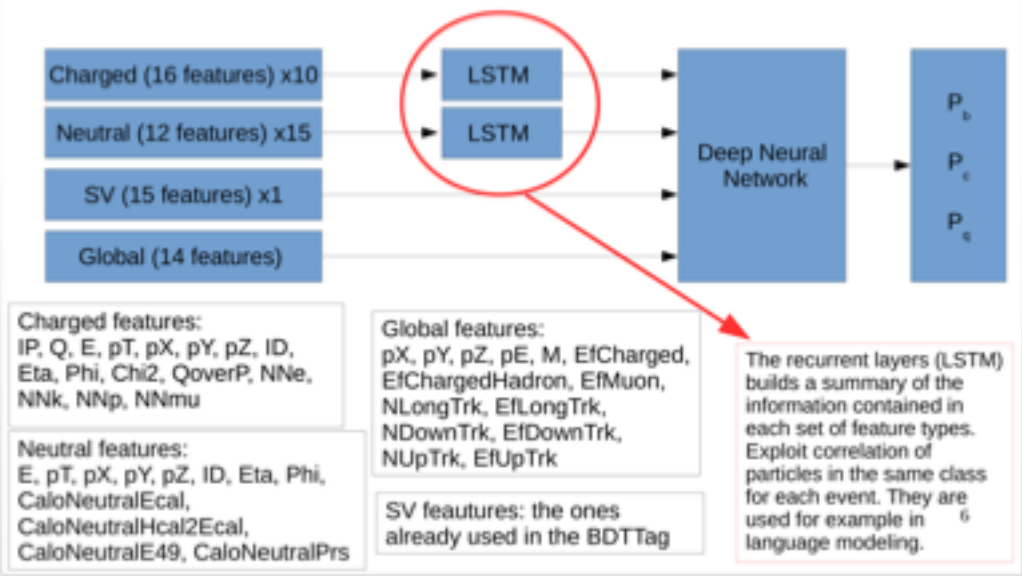
- Charged particles
- Neutral particles
- Secondary vertices
- Global jet observables

For each particle many observables are used: track parameters, Particle Identification quantities from RICHes, energy deposits in HCAL and ECAL etc.

A matrix with more than 300 elements is used in input to the DNN!

The training is performed with the high performance GPGPU

Gianelle contribution is essential for the implementation and the optimization of the code!



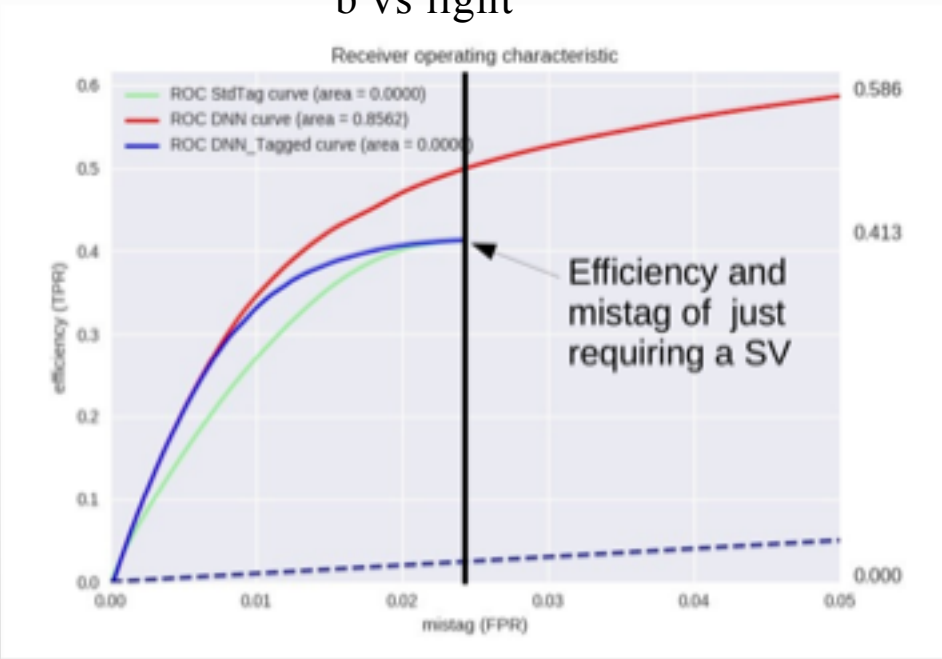
Deep Neural Network tagging algorithm

Sestini, Michielin, Gianelle
Lucchesi
Arcelia Hermosillo Ruiz
(DOE summer student)

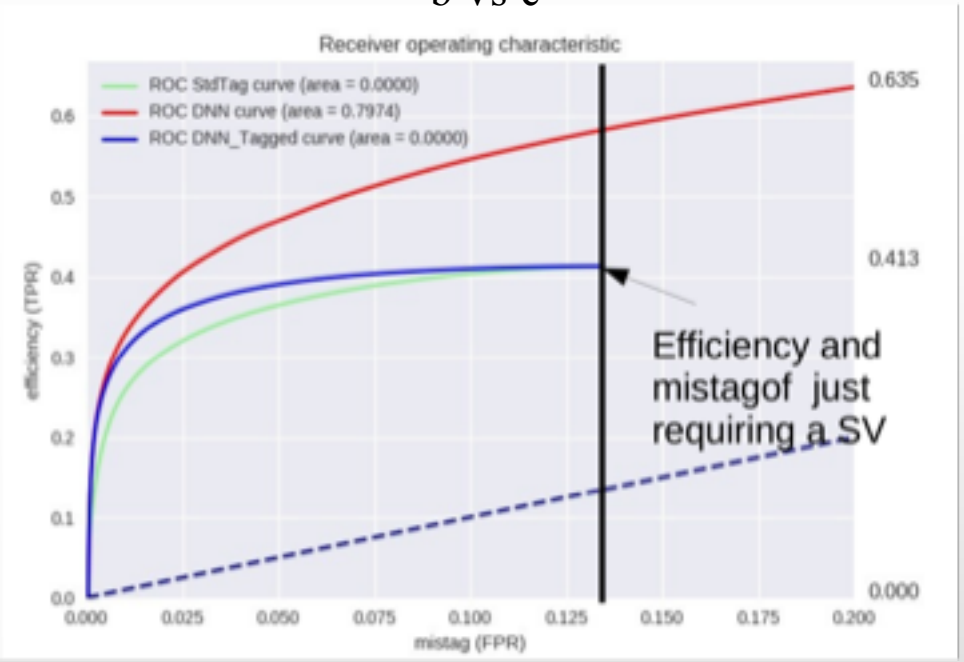
Impressive efficiency improvements, from 20% to 40%, depending on the case.

Jets without a secondary vertex reconstructed can be tagged with low light quark mis-identification, too!!

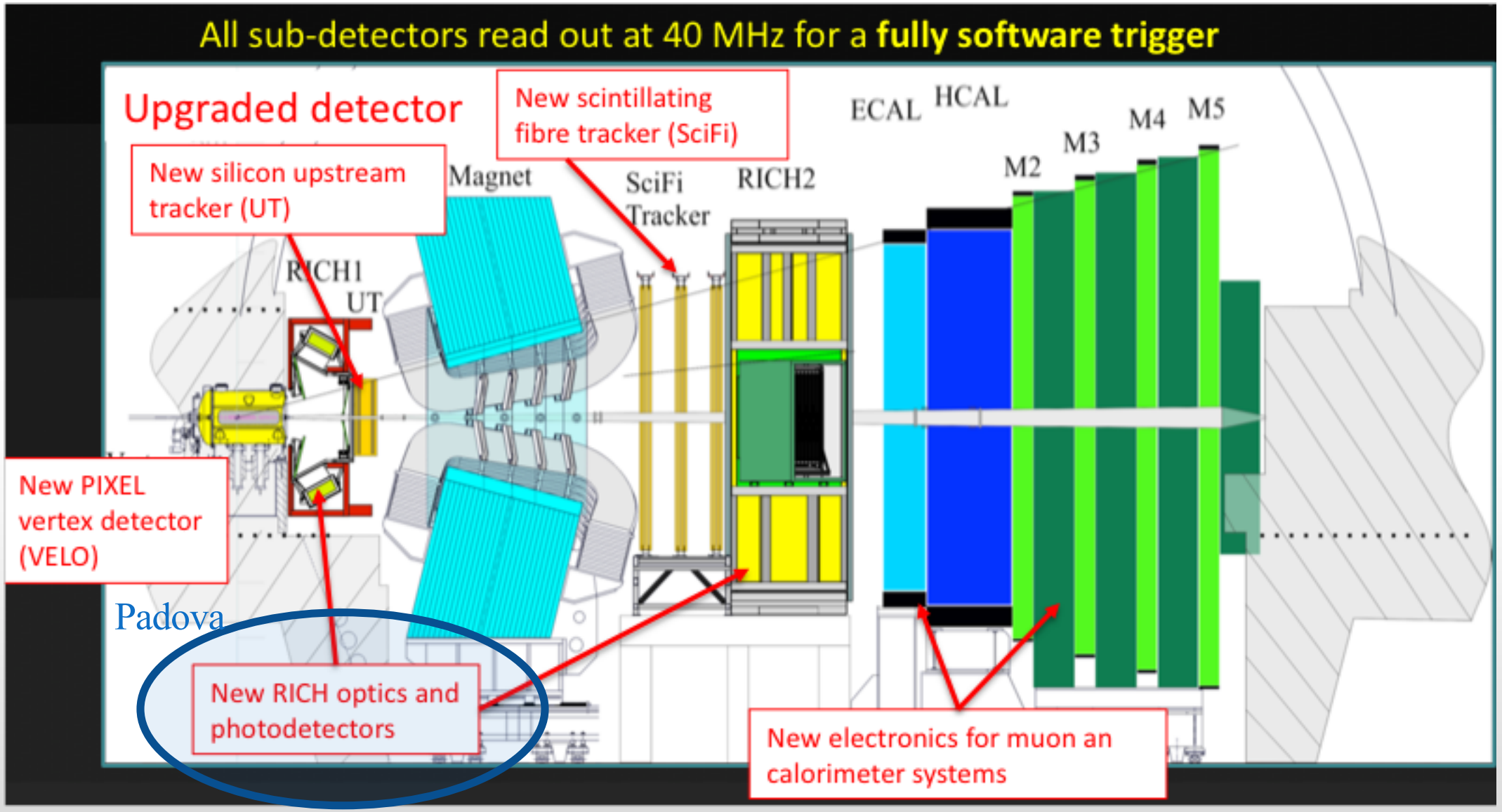
b vs light



b vs c



Deep Neural Network tagging algorithm


All sub-detectors read out at 40 MHz for a fully software trigger
Upgraded detector
New scintillating fibre tracker (SciFi)
New silicon upstream tracker (UT)
Magnet
SciFi Tracker
RICH2
ECAL
HCAL
M2
M3
M4
M5
RICH1
UT
New PIXEL vertex detector (VELO)
Padova
New RICH optics and photodetectors
New electronics for muon an calorimeter systems

The forgotten…

90% distributes CPU goes on Monte Carlo use of HPC can mitigate requests

Factor of 2 recovered improving code: multi-process, ram usage, vectorization, …

Nevertheless , more resources are needed!

- No turbo: output bandwidth 24GB/s
- Turbo with RunII strategy 17 GB/s
- Turbo: no raw data is written, reduce to one replica of data

	CPU			Disk			Tape		
	kHS06	FCB	AYG	PB	FCB	AYG	PB	FCB	AYG
Baseline by end of Run3 (2023)	2797	1.7	2.0	300	2.2	1.8	345	1.6	1.6
Baseline by end of LS3 (2025)	3676	1.1	1.3	312	2.3	1.4	351	1.5	1.3

- 2nd and 3rd columns are factor of "constant budget" (FCB) and average yearly growth (AYG) from 2021 until the given year

1	Bertolin Alessandro		Dipendente	Ricercatore	CSN I	70
2	Busetto Giovanni		Associato	Prof. Ordinario	CSN II	30
3	Collazuol Gianmaria		Associato	Prof. Associato	CSN II	0
4	Gallorini Stefano		Dipendente	Assegno di Ricerca	CSN I	70
5	Lucchesi Donatella		Associato	Prof. Associato	CSN I	70
6	Lupato Anna		Associato	Assegnista	CSN I	70
7	Morandin Mauro		Dipendente	Dirigente di Ricerca	CSN I	70
8	Sestini Lorenzo		Associato	Assegnista	CSN I	70
9	Simi Gabriele		Associato	Prof. Associato	CSN I	50
				Numero Totale Ricercatori	9	FTE: 5.0

	Nome	Età	Contratto	Qualifica	Aff.	%
1	Benettoni Massimo		Dipendente	Primo Tecnologo	CSN I	40
2	Gianelle Alessio		Dipendente	Tecnologo	CSN I	70
				Numero Totale Tecnologi	2	FTE: 1.1

Padova Anagrafica

	K€
Missioni	69.5
Consumo – metabolismo	10.0
Consumo – dischi cloud PD	5.0
Consumo – miscellanea RICH@CERN	5.0
Consumo – dischi backup dati test PMT	1.0
Consumo – totale	21.0
Apparati – riconversione stazione test	2.0

Responsabilita'

Alessandro Bertolin:

- sub-convener di B to Open Charm, Time-Dependent Measurements

Anna Lupato:

- Stripping liason dei semileptonici

Lorenzo Sestini:

- sub-convener Higgs & Exotica LHCb
- sub-convener di Higgs Exotic Decays LHC working group

Richieste servizi:

Progettazione meccanica: 2m.u. disegnatore per disegni esecutivi finali

Officina meccanica: 3m.u. per installazione strutture Meccaniche al cern

Elettronica: 1m.u. per riconversione di una delle stazioni di test PMT in stazione di test celle elementary

Padova Richieste