

# Fisica agli acceleratori

## Attività sperimentali e teoriche del'INFN a Roma Tre



M. Biglietti, INFN Roma Tre



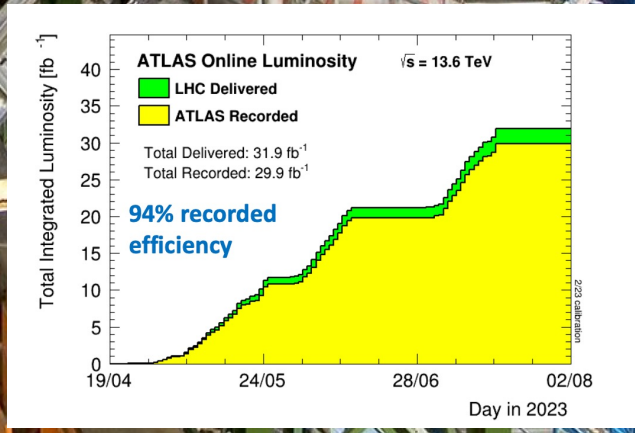
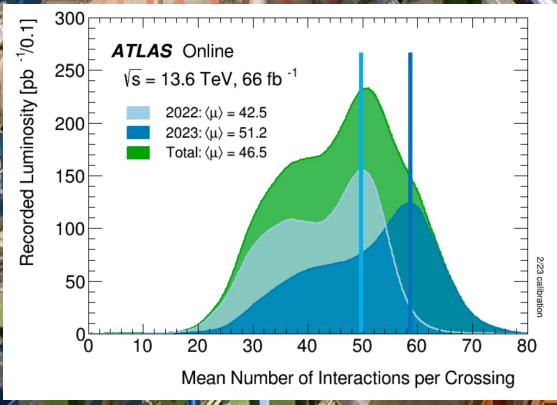
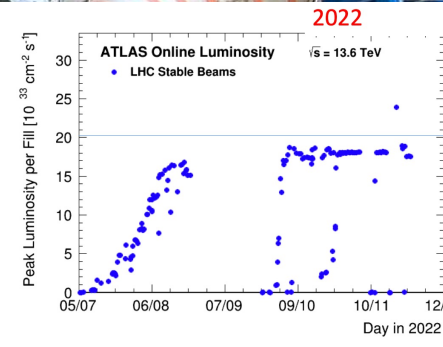
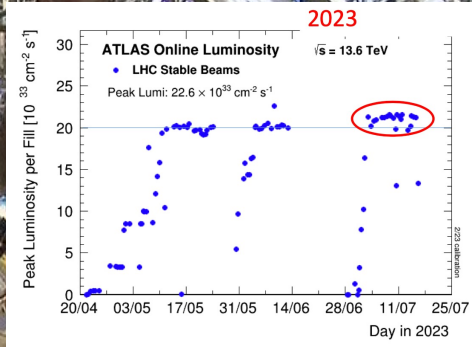
# LHC/ATLAS RUN3



RUN3 started in May 2022 with the main upgrade (the NSW) installed in both endcap

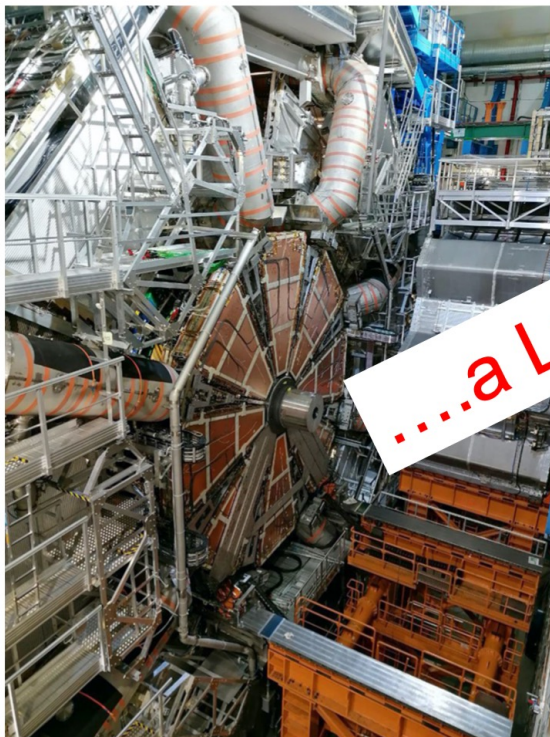
Unprecedented peak luminosity reached!

Pushing the limits of the detector, trigger and data acquisition to efficiently collect data from high intensity beams delivered by LHC

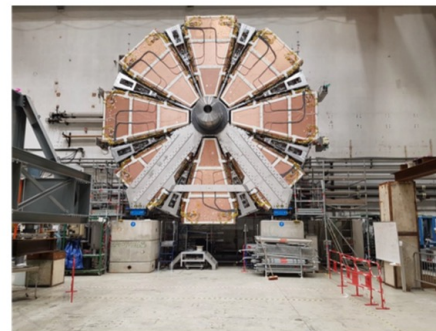
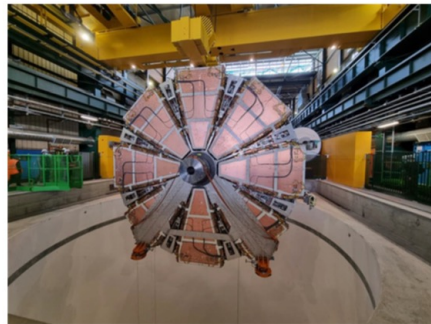




# Le New Small Wheel entrambe installate in ATLAS !



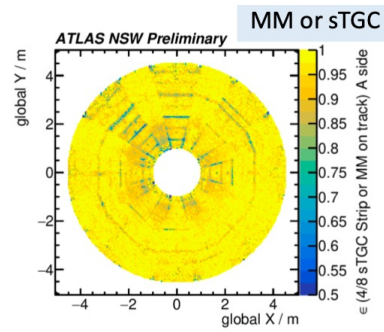
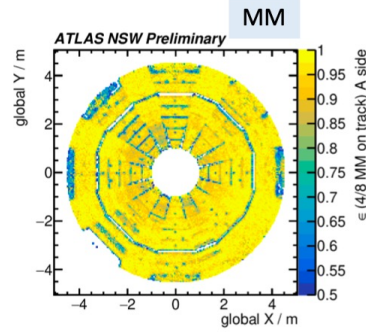
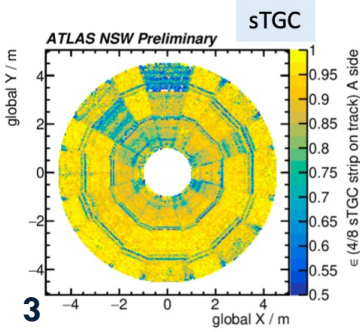
...a Luglio 2022



Sin dall'inizio el progetto (2013) un GRANDE contributo di Roma Tre al progetto, alla costruzione, all'intergrazione ed al commissioning dei RIVELATORI MICROMEGAS



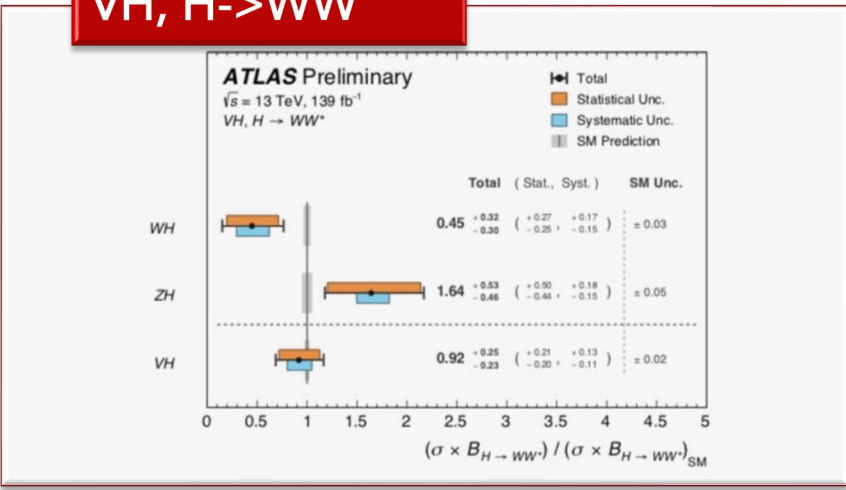
READY FOR COLLISIONS !



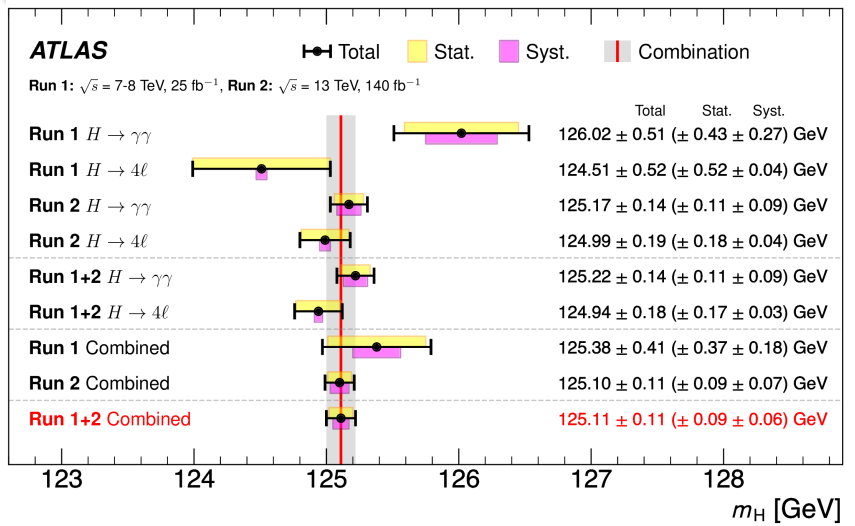
Studi di prestazioni/data quality/calibrazione dello spettrometro a muoni (ed in particolare NSW)

# ATLAS – Attivita` di Analisi in corso

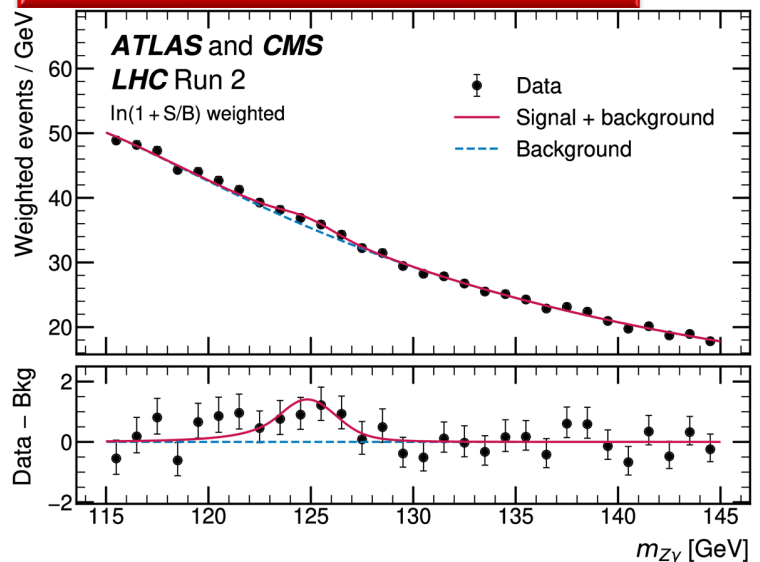
## VH, H->WW



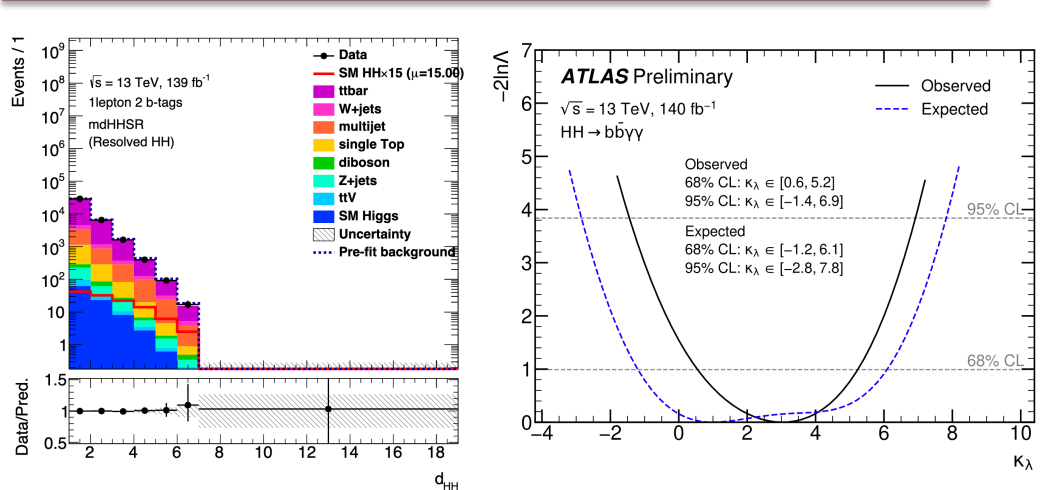
## Higgs boson mass measurement



## Evidence for the Higgs to $Z\gamma$



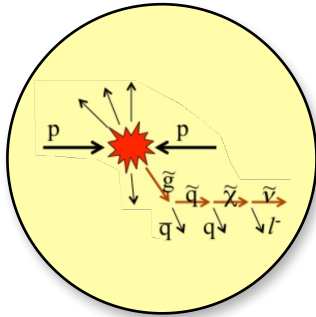
## hh → WWbb → lνqqbb and hh → γγbb





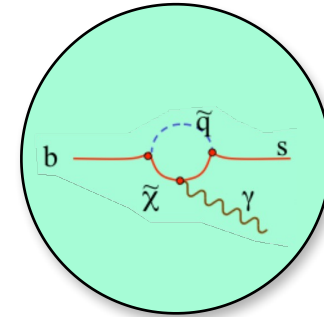
# Complementary Pathways to New Physics

## Energy frontier

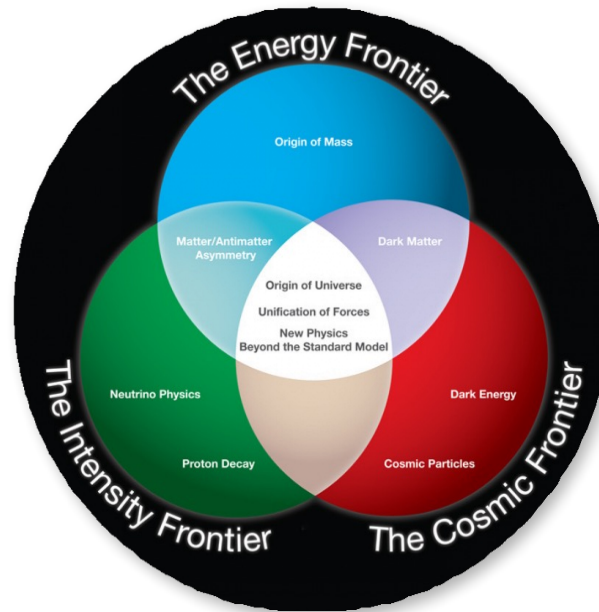


**Direct** production of new particles

## Intensity frontier



**Indirect** sensitivity through loops

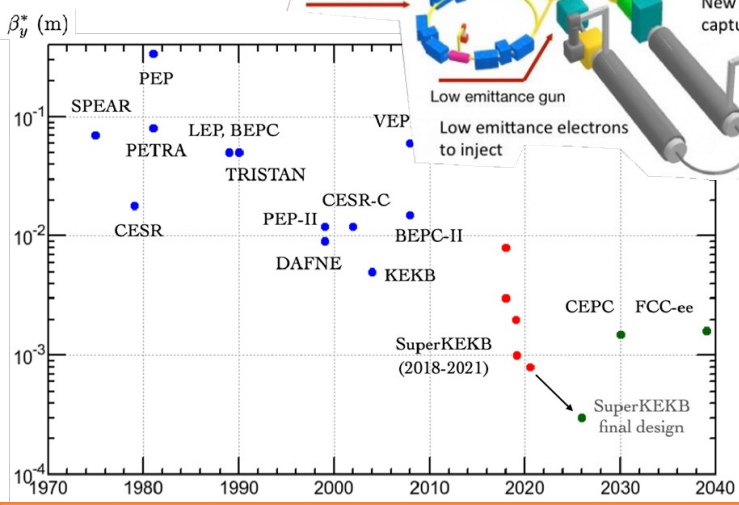
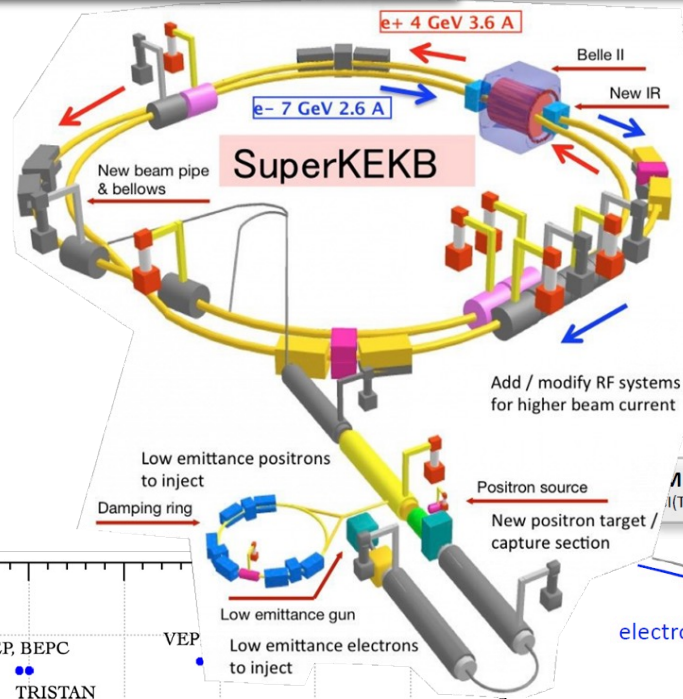


- Presently no unambiguous evidence for Beyond Standard Model (BSM) physics at the high energy frontier
- Intensity frontier offers indirect sensitivity to very high scales



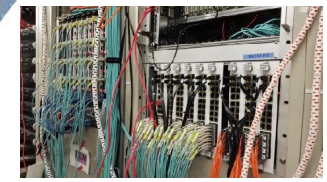
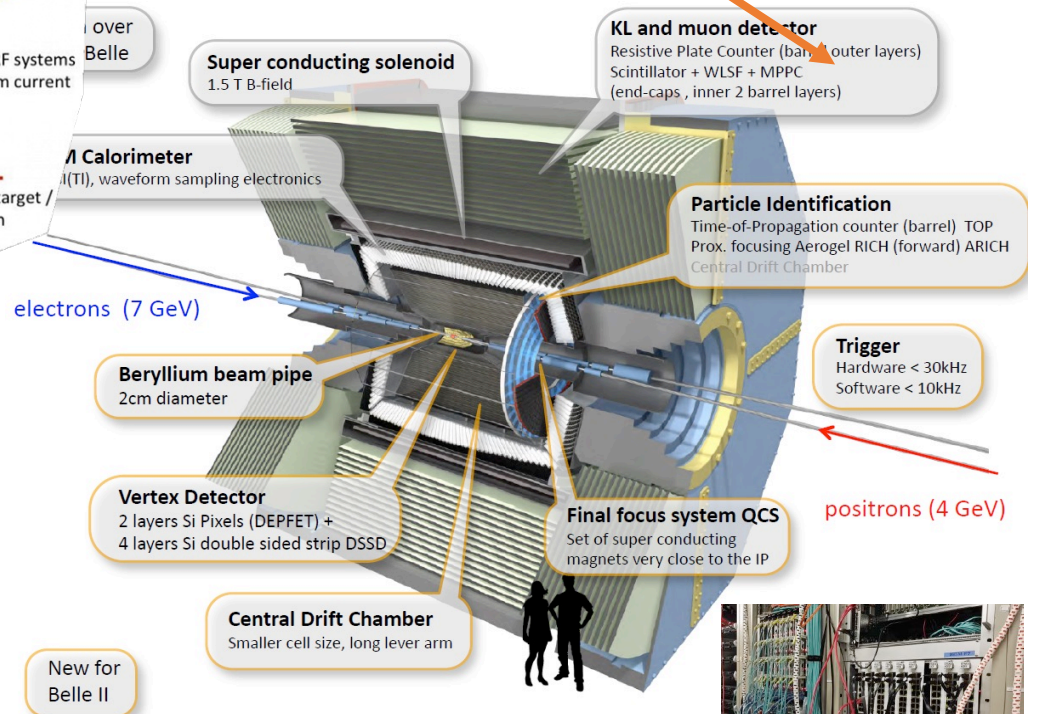
# The SuperKEKB project

# & The Belle II detector



*contributi Roma Tre*

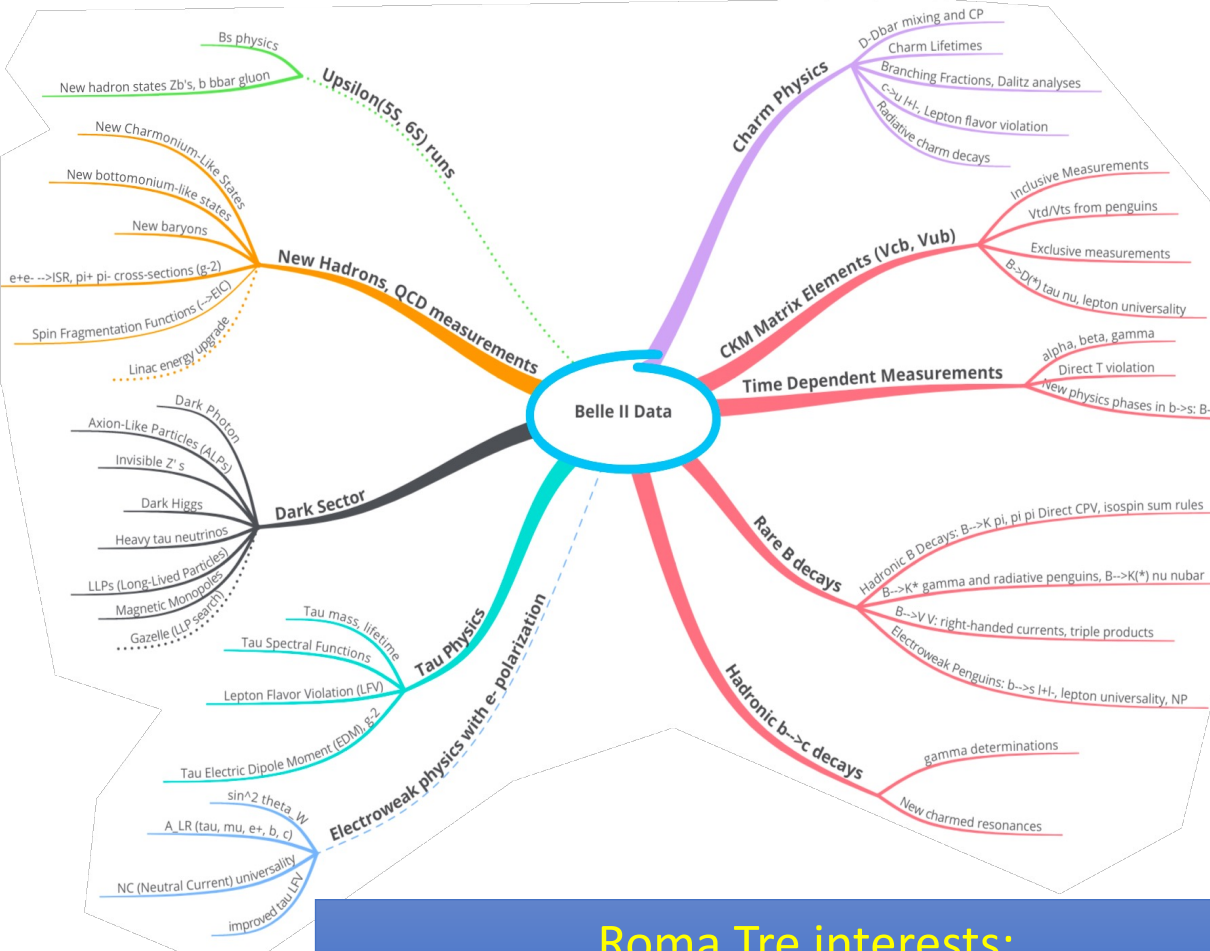
- RPC front-end
- muon-ID
- Klong ID



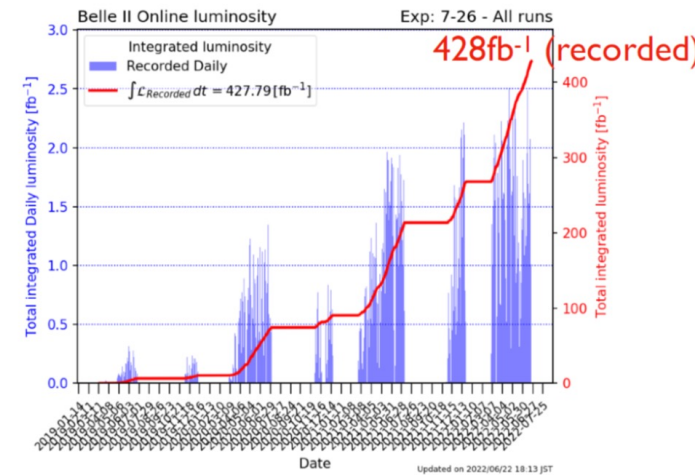
Despite the challenging problems encountered for machine ramping up, vertical beta function has already been squeezed below 1 mm and **world record** reached in instantaneous luminosity of  $4.7 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$



# Belle II : a wide physics program



The Belle II Physics Book  
 Prog. Theor. Exp. Phys. 2019, 123C01  
[arXiv:1808.10567](https://arxiv.org/abs/1808.10567)



- Roma Tre interests:**
- Dark sector searches
  - Lepton flavour violation and taus
  - Time dependent CP violation

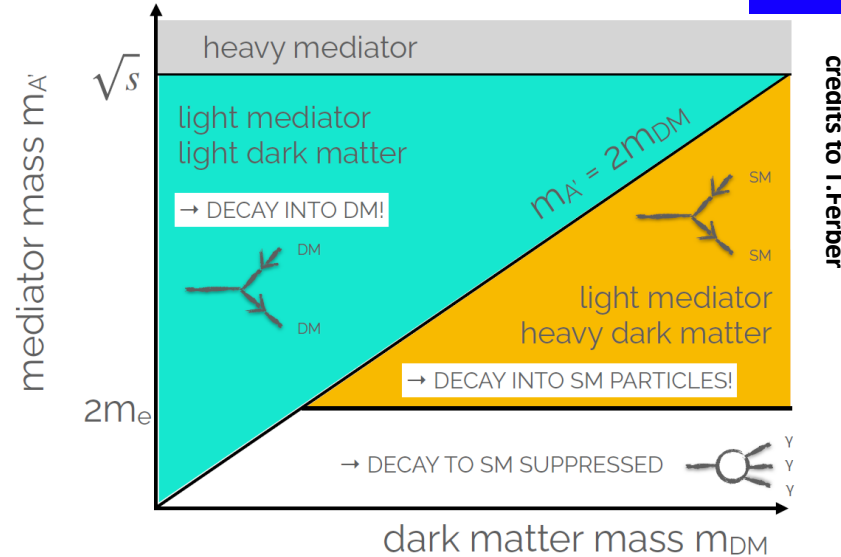


# Dark sector searches @ Belle II



Depending on masses of DM particles and mediators different topologies are expected. Mediator's decay and/or missing energy signatures can be searched for.

Typical advantages of B factories very useful also for dark sector quest.



**Many different models and possible channels can be investigated @ Belle II also with limited statistical samples.**

Two papers already published with very first data set:

- Search for  $Z'$  decay in invisibles [PRL 124 \(2020\) 141801](#)
- Search for axion like particles (ALPs) strahlung [PRL 125 \(2020\) 161806](#)

A number of other analyses in preparation....

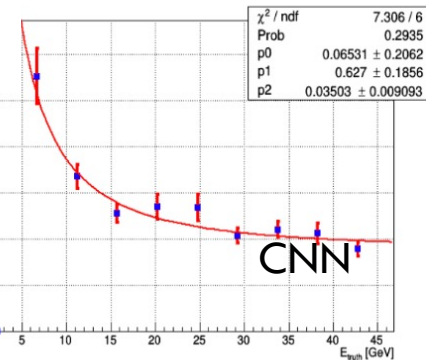
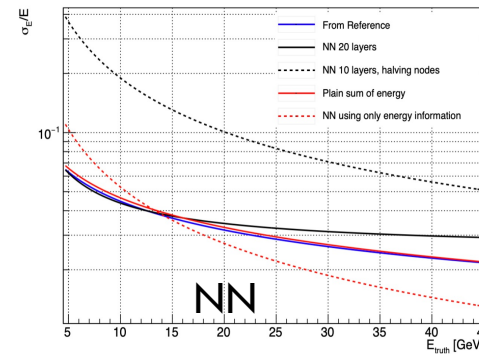
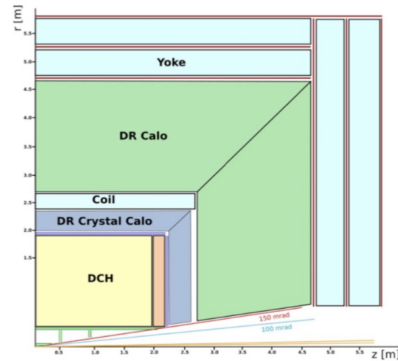
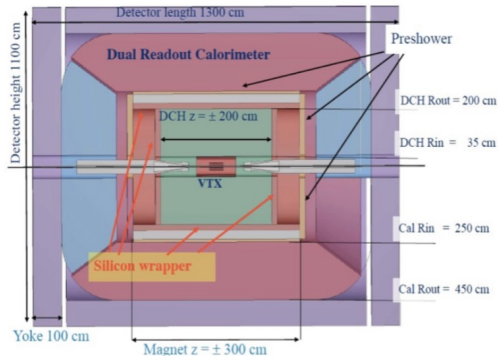
Looking for future!



# FCC : Future Circular Colliders

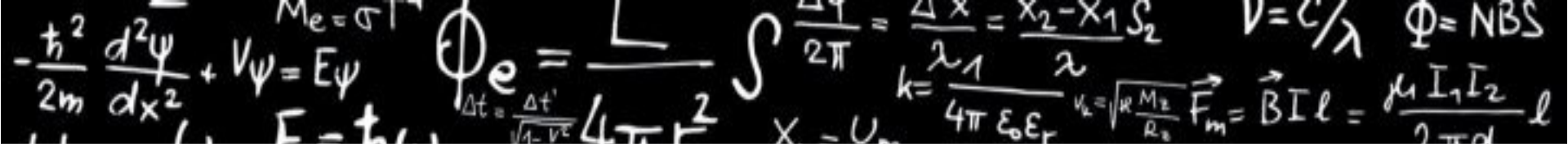
## IDEA Detector

innovative general-purpose detector for future  $e^+e^-$  circular colliders



dual read-out hadronic calorimeter:  
study of particle flow algorithms (PFAs)  
using Machine Learning techniques (DNN  
and CNN).





# Recenti Studi Teorici sui Collider a Roma Tre



**Sicuramente il Modello Standard non basta**

**... non contiene la Materia Oscura! (e tante altre cose)**

**Possiamo scoprire la Materia Oscura?**

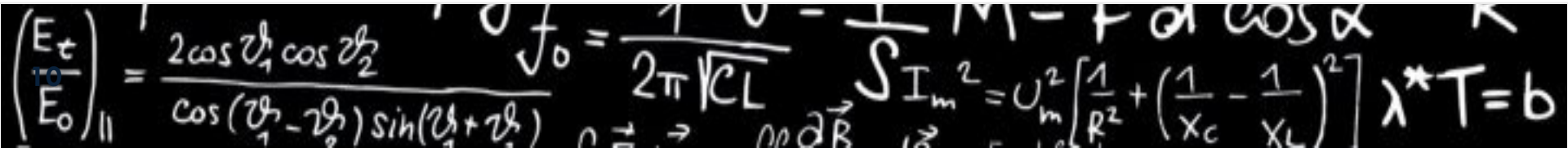
ricerche di nuova fisica ai collider LHC, Belle2

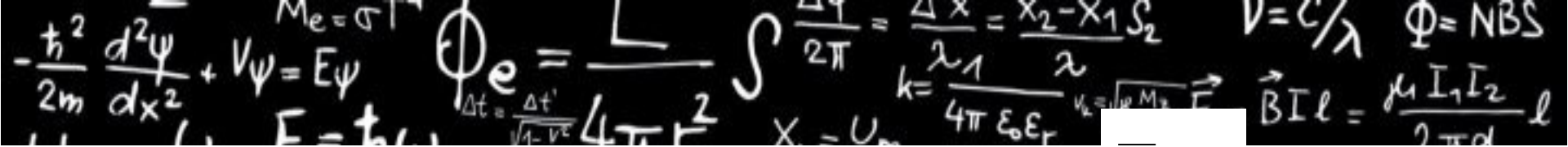
ricerca di nuova fisica a collider futuri FCC, Muon Collider

**... tuttavia funziona benissimo**

**Testiamolo più da vicino!**

predizioni di precisione per osservabili misurabili ai collider



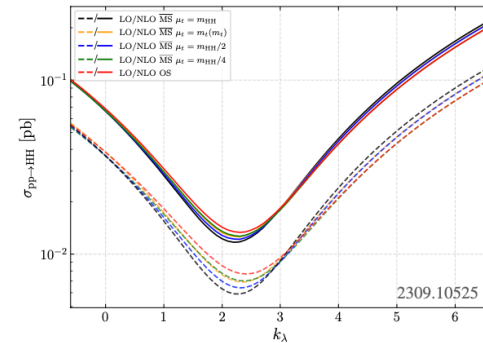
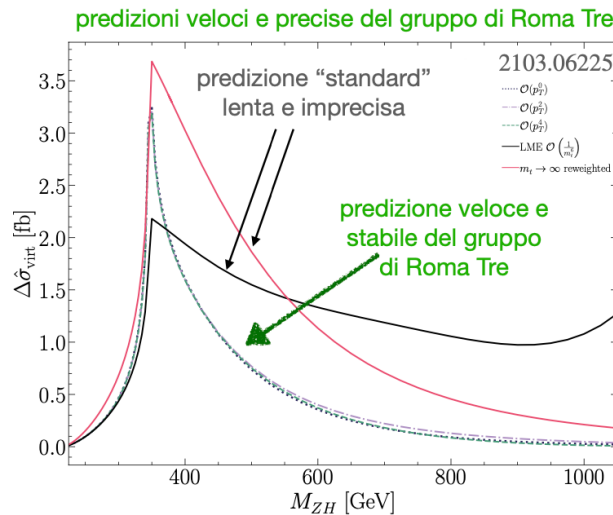
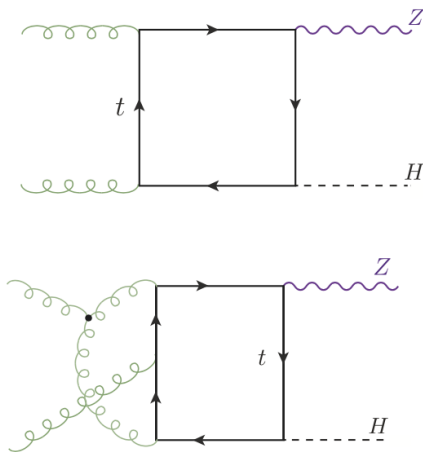


# Recenti Studi Teorici sui Collider a Roma Tre

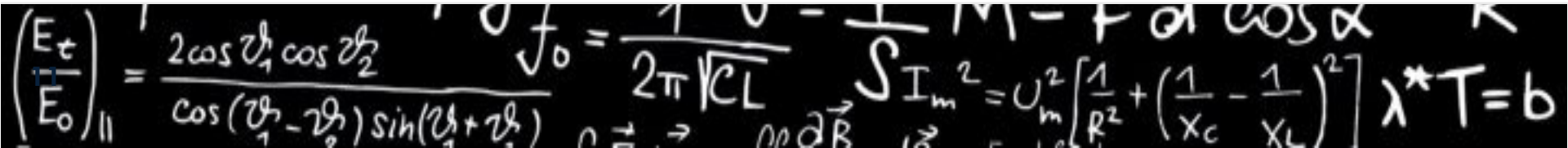
Testiamo il Modello Standard più da vicino!

## predizioni di precisione per osservabili misurabili al collider LHC

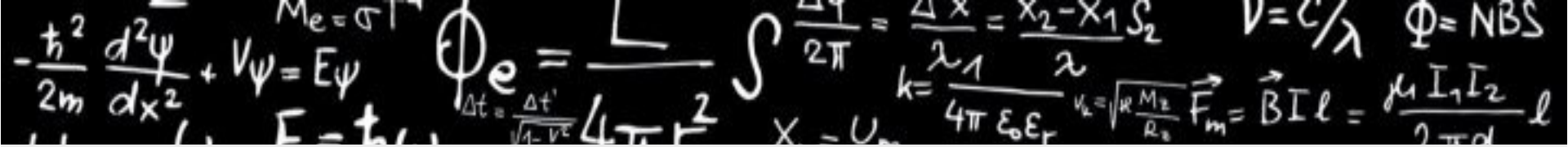
prime predizioni semi-analitiche per la produzione rara di bosoni di Higgs  $pp \rightarrow hh$  e  $pp \rightarrow Zh$



**possibilità di testare estensivamente e velocemente il settore di Higgs oltre il Modello Standard**





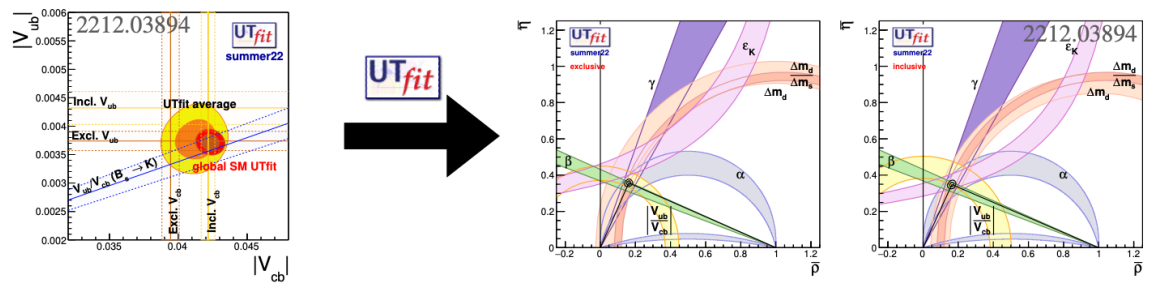


# Recenti Studi Teorici sui Collider a Roma Tre

Testiamo il Modello Standard più da vicino!

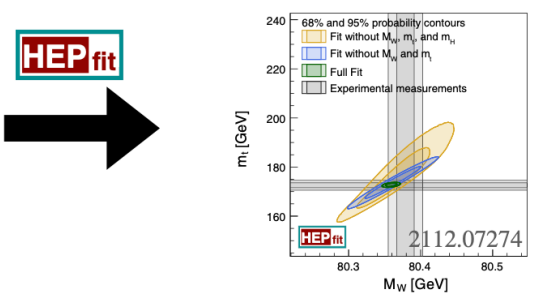
calcoli di precisione per osservabili di sapore (misure a LHC e Belle II)

predizioni di quantità adroniche e analisi globale dei dati del gruppo di Roma Tre (collaborazione UTfit)

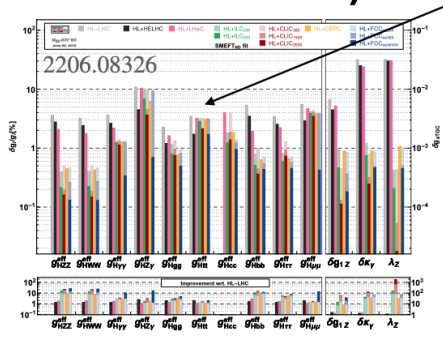


potenziale di scoperta dei collider ( $e^+e^-$ ,  $\mu^+\mu^-$ ,  $pp$ )

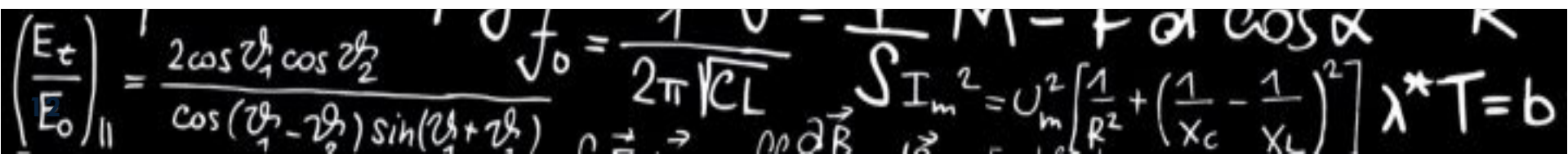
analisi globale di misure elettrodeboli e di Higgs del gruppo di Roma Tre (collaborazione HEPfit)

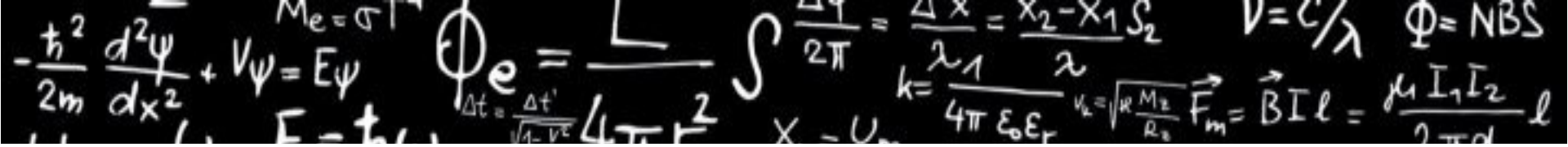


moltissimi lavori basati su HEPfit, proiezioni di analisi globali per future colliders per Snowmass, European Strategy for Particle Physics ...



Precisione sui coupling EW e Higgs ai future collider

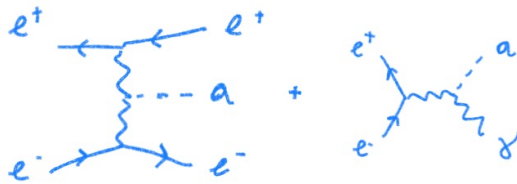




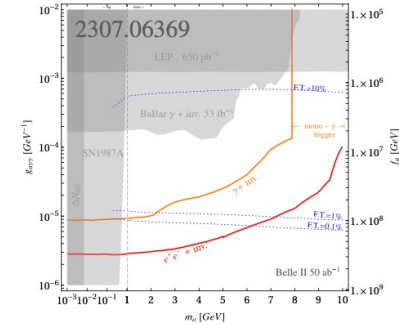
# Recenti Studi Teorici sui Collider a Roma Tre

Possiamo scoprire la Materia Oscura?

## ricerche di nuova fisica ai collider LHC, Belle II

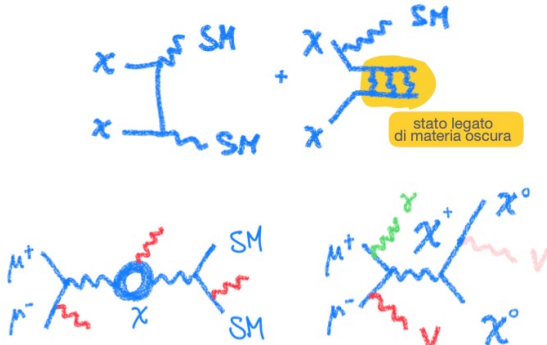


**a Belle II é possibile sondare nuovi regimi della materia oscura Axion-Like!**



nuovi canali di ricerca di assioni a Belle II

## ricerca di nuova fisica a collider futuri FCC, Muon Collider



ricerca indiretta (produzione in loop)

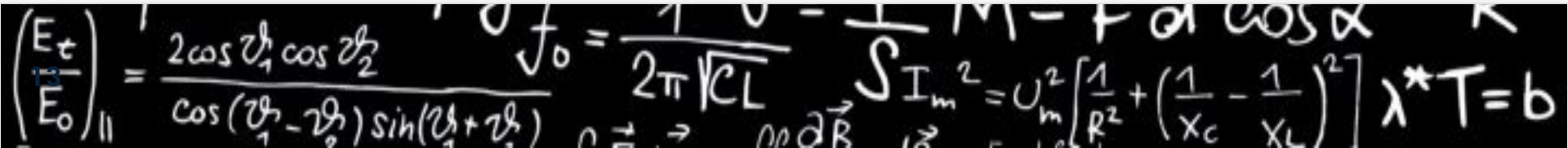
ricerca diretta nuove segnature

più preciso calcolo della massa della materia oscura (stati legati)

stima della potenzialità di scoperta delle WIMP ai collider



**al muon collider é possibile scoprire la materia oscura WIMP nel suo intero intervallo di masse (fino a una frazione di 1000 TeV) !**





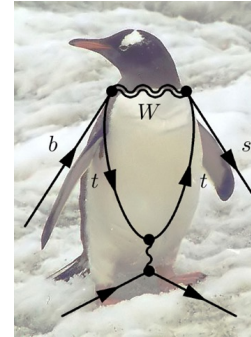
Grazie per l'attenzione!

# Backup



A recent interesting result @ Belle II:

# First evidence for the decay: $B^+ \rightarrow K^+ \nu \bar{\nu}$



- Reliable theoretical predictions  
 $\mathcal{B}(B \rightarrow K \nu \bar{\nu}) = (5.58 \pm 0.38) \times 10^{-6}$  [arxiv:2207.13371]  
 Branching fraction gets increased by leptoquarks, axions, etc.
- $B^+ \rightarrow K^+ \nu \bar{\nu}$  has never been experimentally observed

3.6  $\sigma$  away from null hypothesis

2.8  $\sigma$  away from SM prediction

