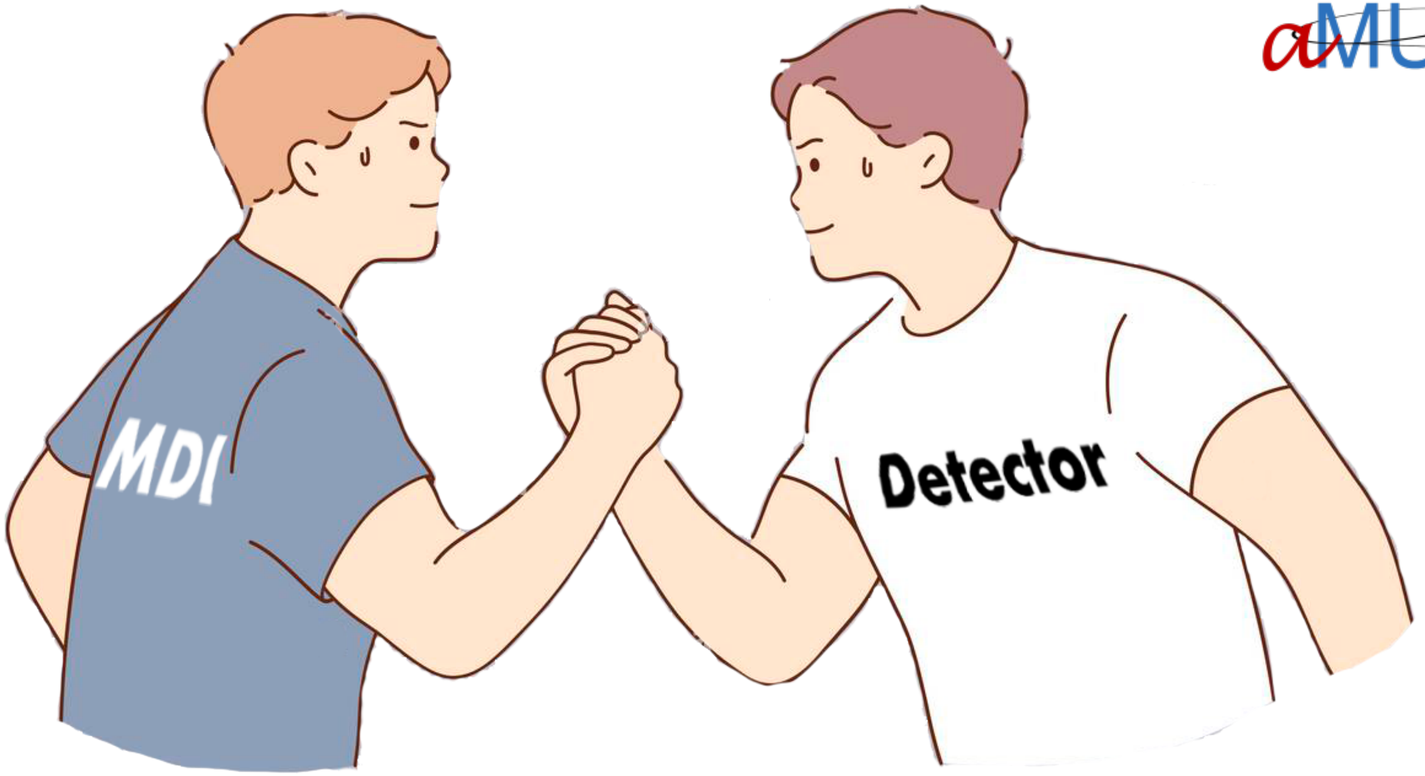
IMCC Annual Meeting



The detector seen by MDI

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IJCLAB, ORSAY – 21/06/2023

Introduction

SLIDES BY C. AIMÈ

SLIDES BY L. BUONINCONTRI

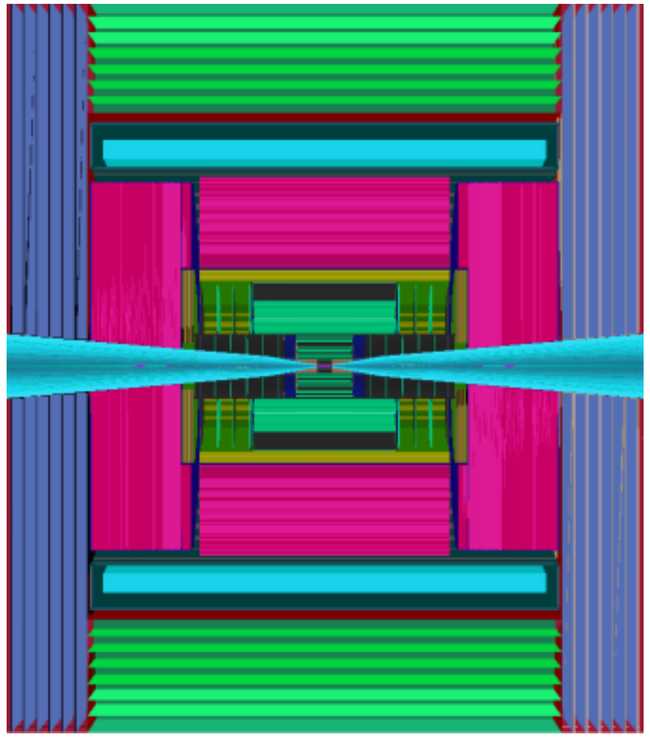
- So far, the detector and MDI have been optimised for 3 TeV signal and **1.5 TeV BIB**
- When going to 3/10 TeV or more, we need to understand what the **detector requirements are from MDI point of view**
- This talk presents “problems” and open questions, which should prompt **fruitful discussions**
  - Unfortunately, no solutions yet but everything **WIP**

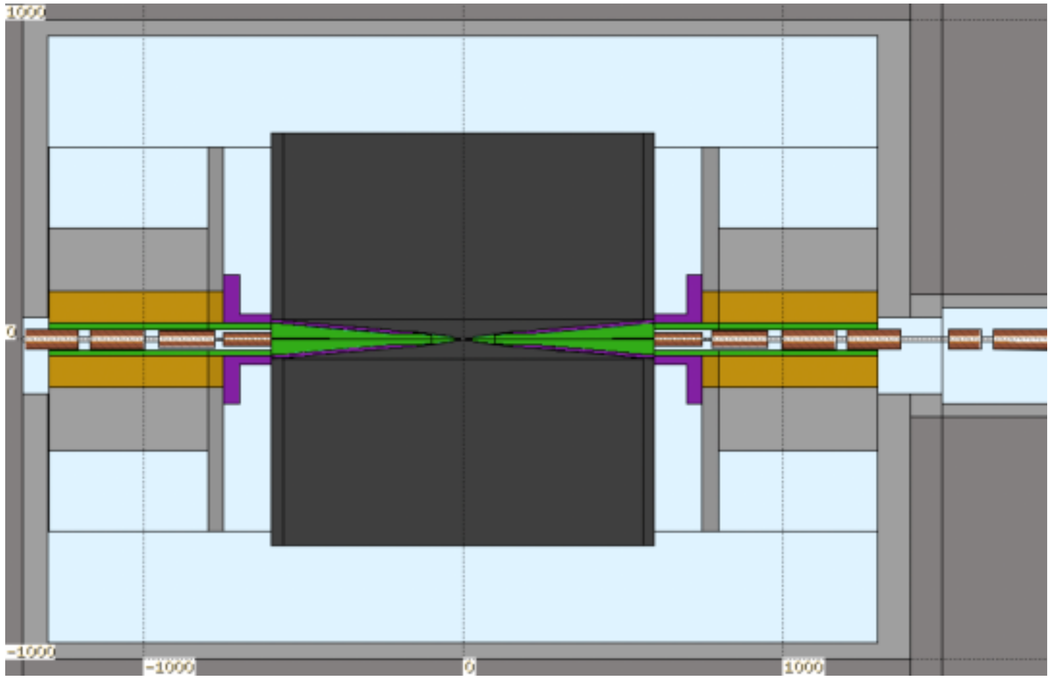
Status of the IR optics design for the 10 TeV Muon Collider	*Kyriacos Skoufaris*
Salle 101 - B. 200 - IJCLab Orsay	10:30 - 10:50
Status of the background and forward muon studies for the 10 TeV collider	*Daniele Calzolari*
Salle 101 - B. 200 - IJCLab Orsay	10:50 - 11:20
Studies at 3 TeV	*Dr Francesco Collamati et al.*
Salle 101 - B. 200 - IJCLab Orsay	11:20 - 11:50
The detector seen by MDI	*Davide Zuliani*
Salle 101 - B. 200 - IJCLab Orsay	11:50 - 12:10
Round-table discussion on MDI studies	
Salle 101 - B. 200 - IJCLab Orsay	12:10 - 12:30

Get ready for discussion!

TOWARDS A MUON COLLIDER

Detector and MDI





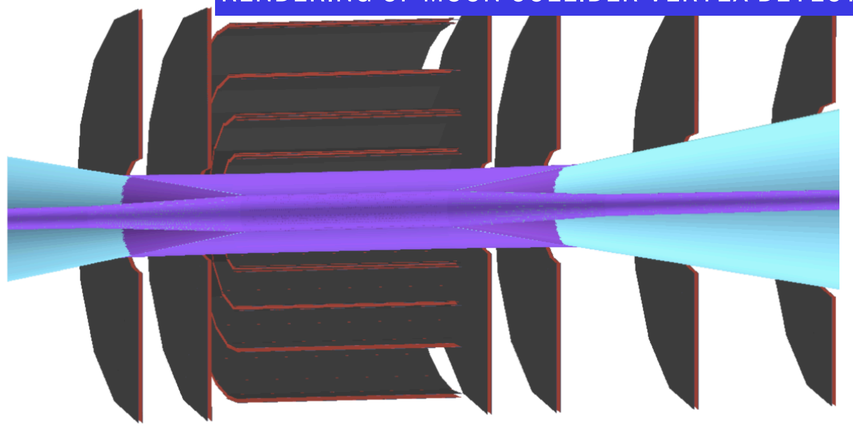
- Standard detector structure from CLIC
- Good p_T (tracker) and energy (calorimeters) resolution
- Studied with FLUKA+LineBuilder
- Nozzles to mitigate BIB

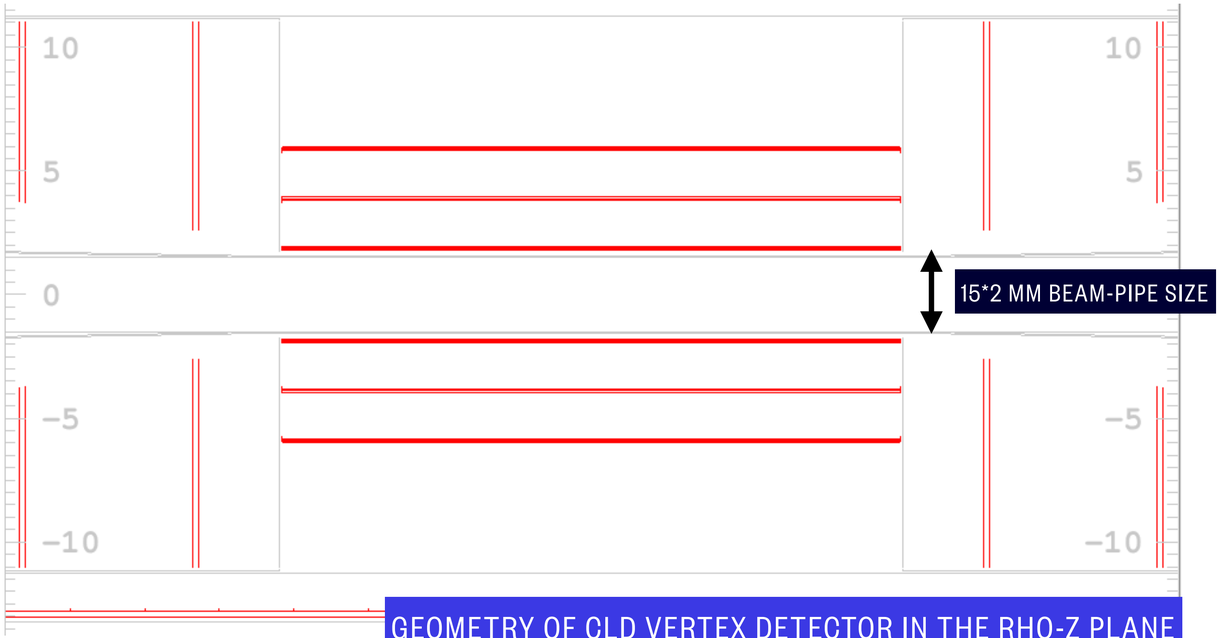
Size of the beam-pipe

- Mainly driven by the **size** of the **beam** at the interaction point
- It defines the **position** of the **first vertex layer**
  - Fundamental to achieve good performance for tracks' **impact parameter**
- Some rough numbers for typical beam-pipe radii:

	Beam-pipe size	First VXD layer
LEP	50 mm	~60 mm
LHC	29 mm	~40/50 mm
CLD/FCCee	15 mm	17.5 mm
Muon Collider (v1)	22.8 mm	30 mm

RENDERING OF MUON COLLIDER VERTEX DETECTOR



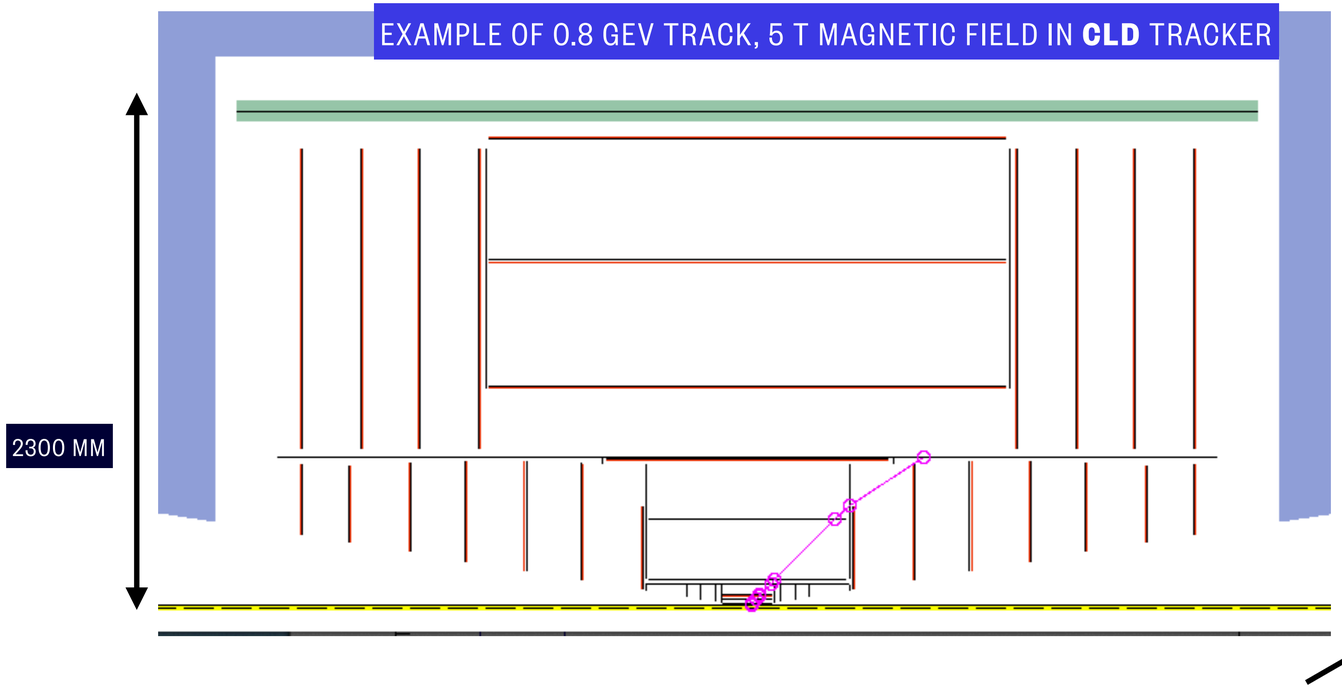


GEOMETRY OF CLD VERTEX DETECTOR IN THE RHO-Z PLANE

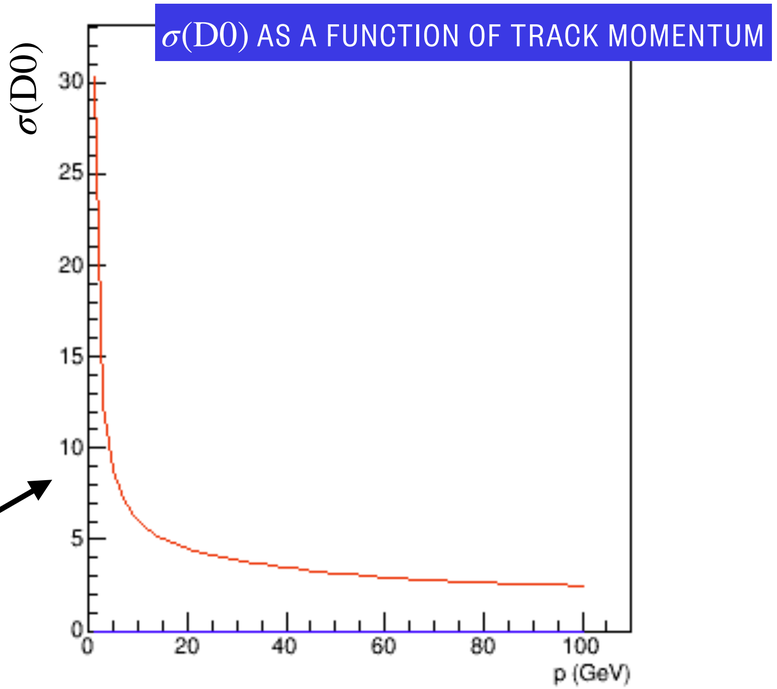
Size of the beam-pipe

- A quick study has been performed using a **parametric simulation** of the **tracking system**
  - Possibility to quickly change:
    - Position of tracker and vertex layers
    - Materials, layers thickness, sensitivity
    - Magnetic field

EXAMPLE OF 0.8 GEV TRACK, 5 T MAGNETIC FIELD IN **CLD** TRACKER



σ(D0) AS A FUNCTION OF TRACK MOMENTUM

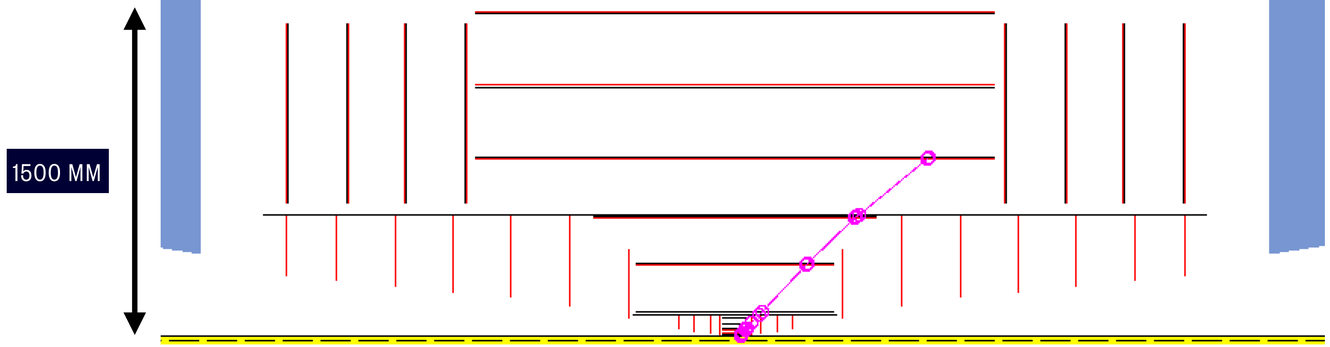


- Performance evaluation for several parameters

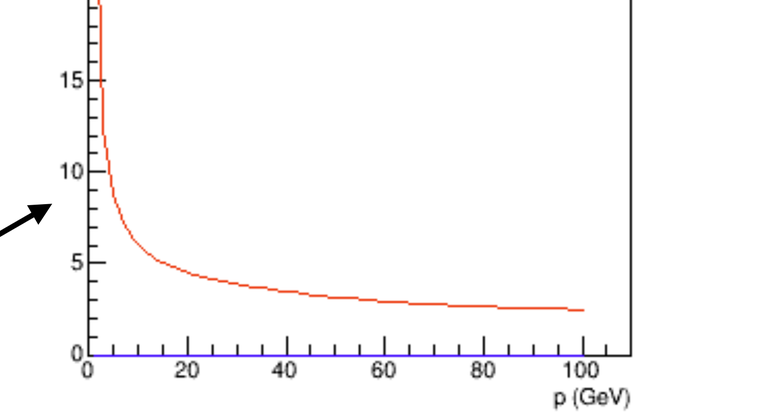
Size of the beam-pipe

- A quick study has been performed using a **parametric simulation** of the **tracking system**
  - Possibility to quickly change:
    - Position of tracker and vertex layers
    - Materials, layers thickness, sensitivity
    - Magnetic field

EXAMPLE OF 0.8 GEV TRACK, 3.57 T MAGNETIC FIELD IN **MUON COLLIDER** TRACKER



σ(D0) AS A FUNCTION OF TRACK MOMENTUM

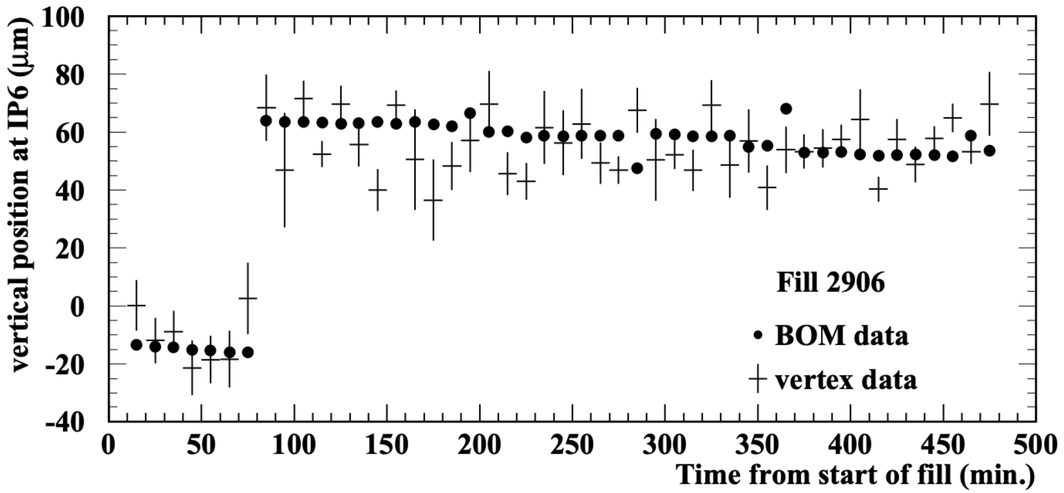


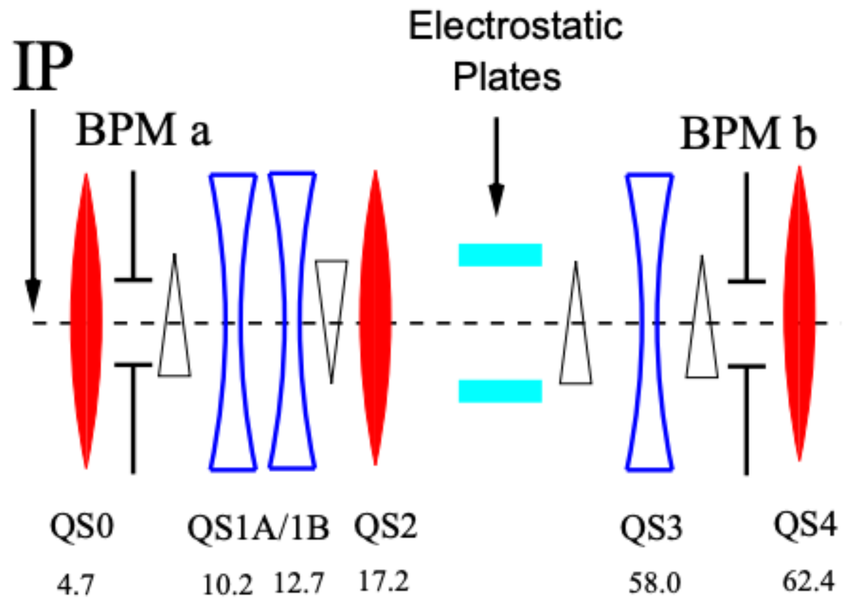
- Performance evaluation for several parameters

BEAM SPOT MEASUREMENT AT LEP

Knowledge of PV position

- Fundamental to distinguish PV from SV (e.g. to have high-performance flavour tagging)
- **Harder at lepton colliders** wrt hadron colliders (**fewer tracks** to use for fitting)
  - e.g. LEP2 used the LEP **Beam Orbit Measurement**
  - Necessary to monitor position of beam focusing magnets closest to the interaction region



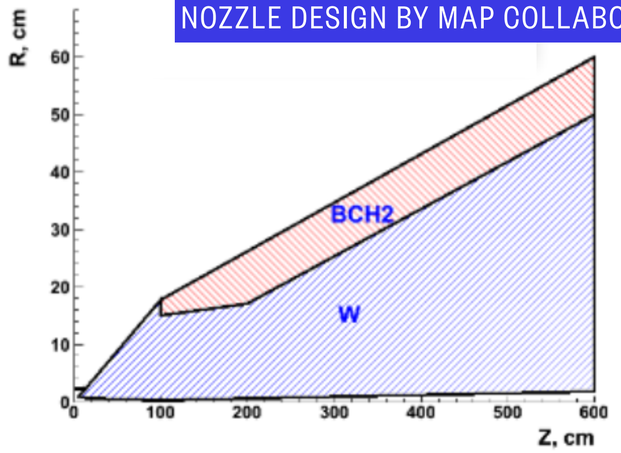


- Is it possible to do something similar here?

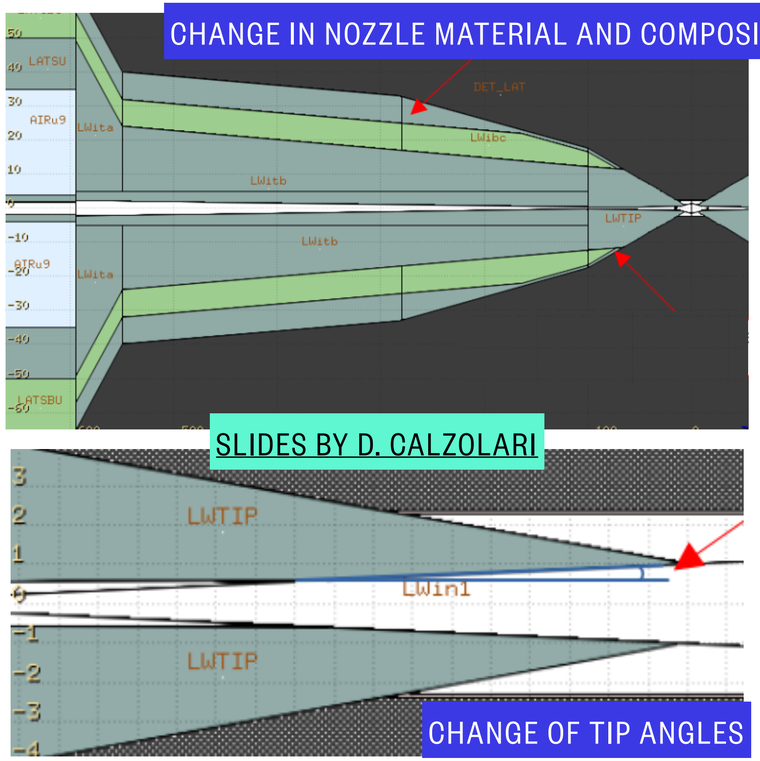
Nozzles dimensions

- Nozzles have been optimised to mitigate BIB at 1.5 TeV
- A first attempt has been already performed at 10 TeV
  - Reduce the **background levels** inside the detector

NOZZLE DESIGN BY MAP COLLABORATION

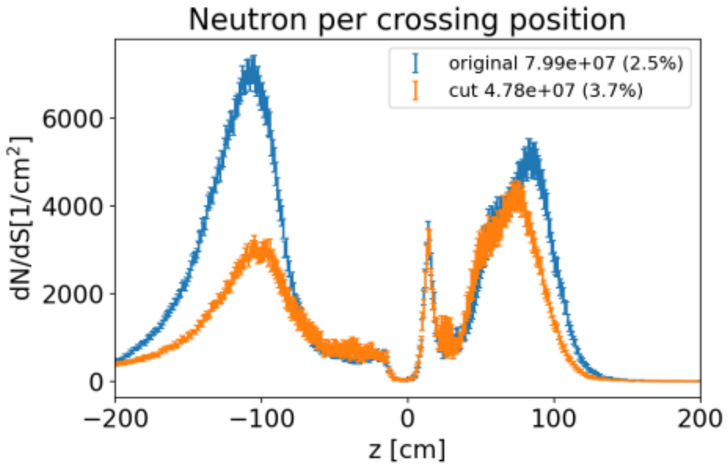


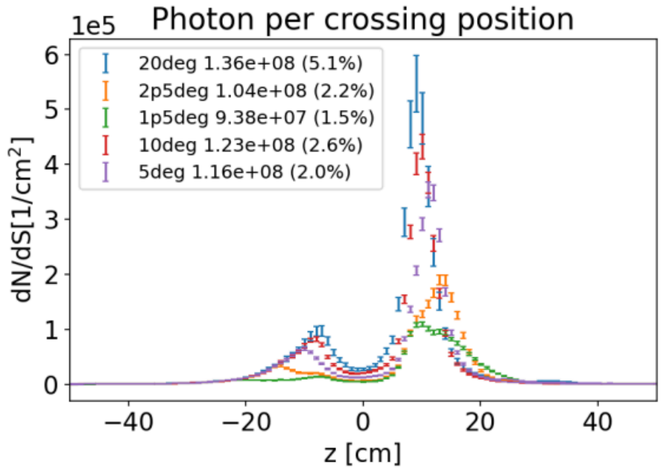
CHANGE IN NOZZLE MATERIAL AND COMPOSITION



SLIDES BY D. CALZOLARI

CHANGE OF TIP ANGLES



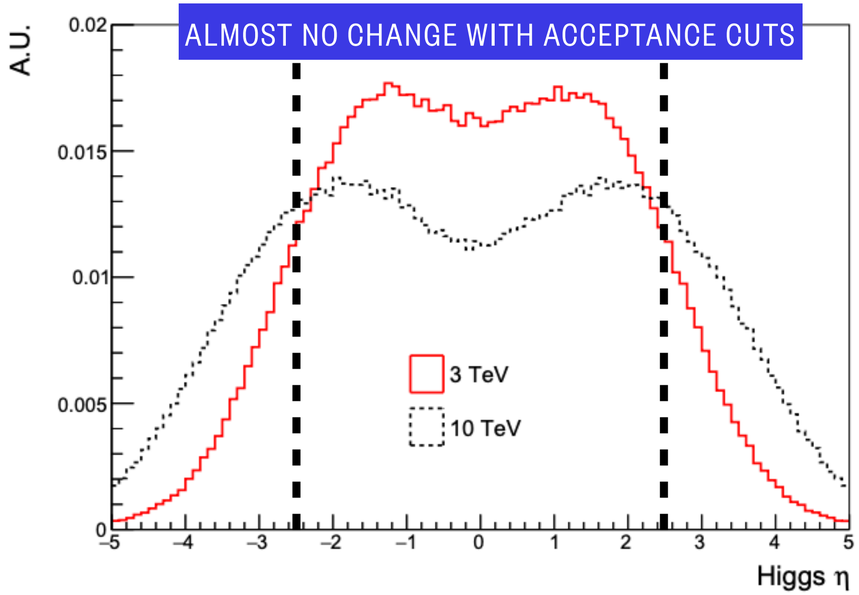


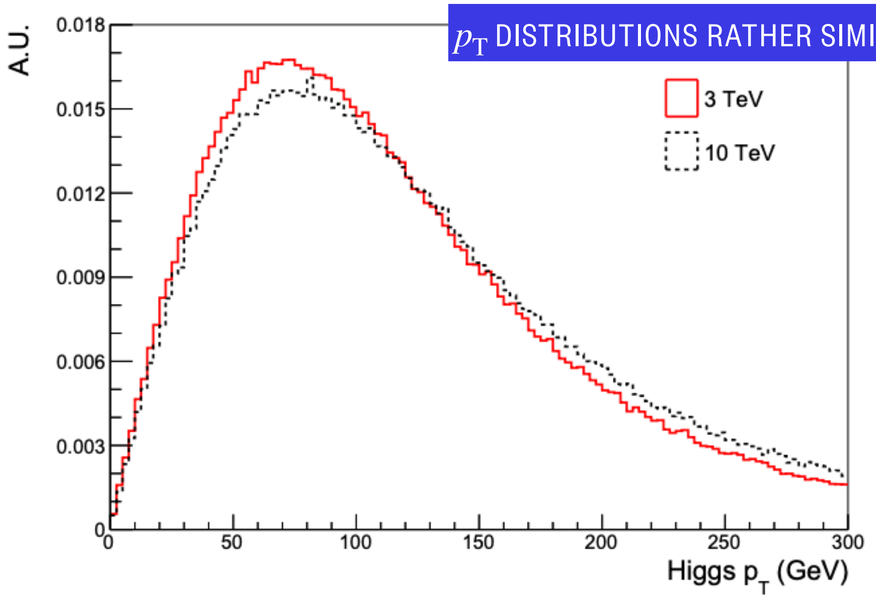
- What about acceptance?

PAPER MY P. MAEDE AND M. FORSLUND

Nozzles dimensions

- Indeed, going to 10 TeV the **acceptance** of some physics processes **might change**
  - e.g.: $\mu^+\mu^- \to H(\to b\bar{b})\nu_\mu\bar{\nu}_\mu$ at 3 and 10 TeV

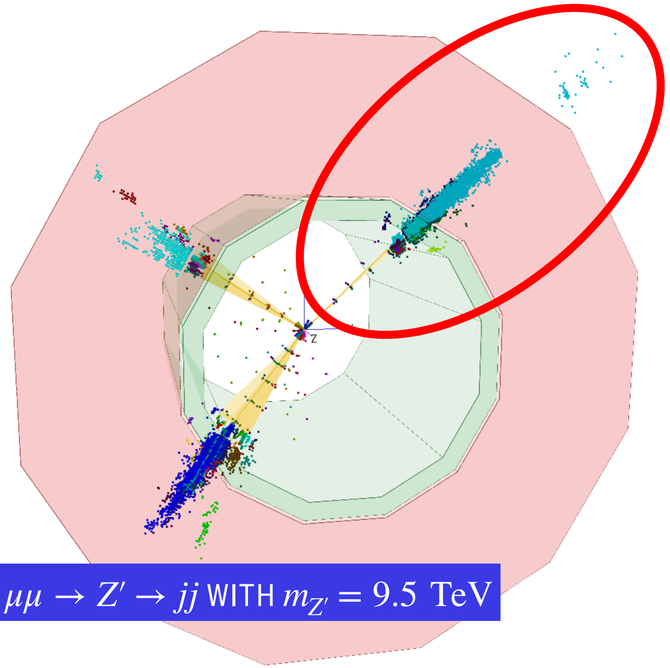




- Can we use a “wider” detector acceptance to exploit the angular features of these processes?

Detector dimensions

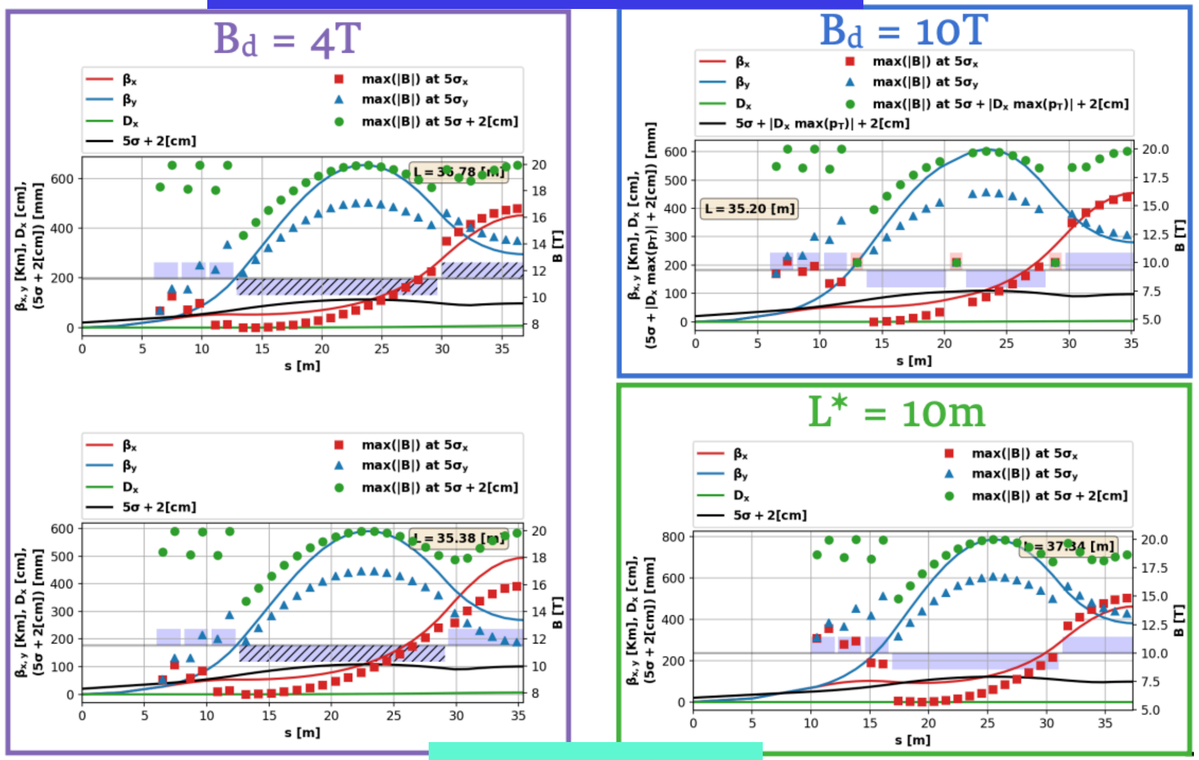
- Going to 10 TeV means that some very high-energetic processes might appear
  - Problem: **dimensions** of **tracking system** and **calorimeters**



EVENT DISPLAY OF $\mu\mu \rightarrow Z' \rightarrow jj$ WITH $m_{Z'} = 9.5$ TeV

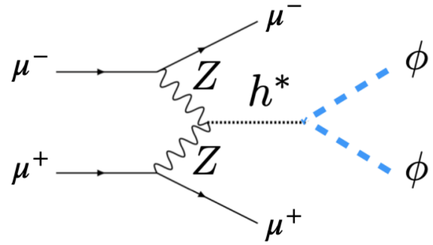
- Is a longer detector possible? Can we increase L*?

STUDY FOR DIFFERENT FINAL FOCUSING SCHEME

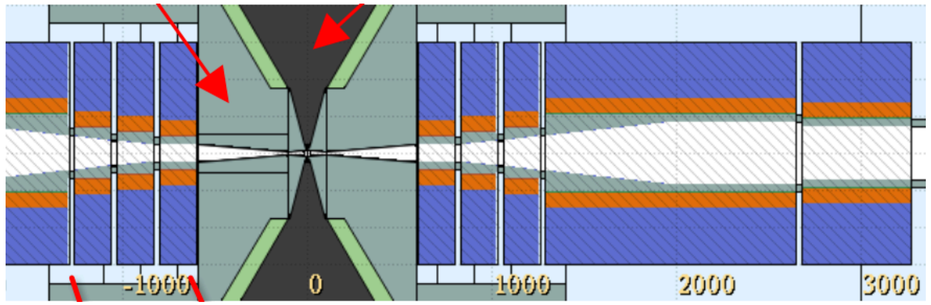


SLIDES BY K. SKOUFARIS

Nozzles instrumentation

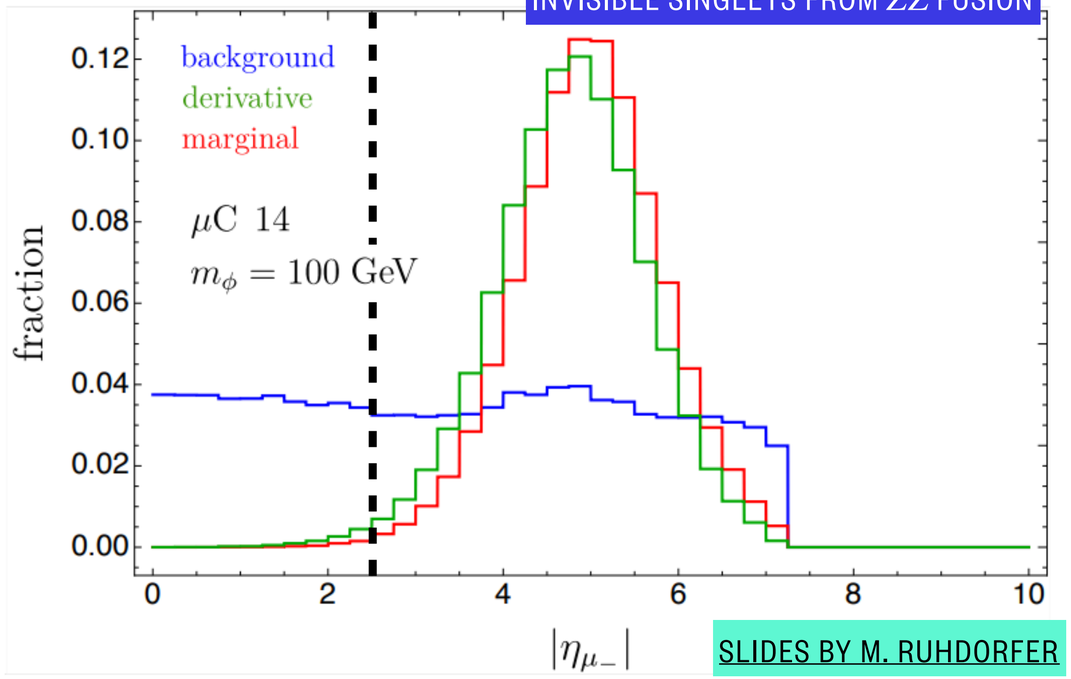


- Several studies showing the importance of **tagging forward muons**
- Two possibilities:
  - Forward detector outside the main detector
    - Difficult due to focusing scheme



  - **Instrumentation** of the **nozzles**
    - Is it possible? How this affects MDI?

INVISIBLE SINGLETS FROM ZZ FUSION



SLIDES BY M. RUHDORFER

Conclusions

- Lots of **questions** and **open points** to discuss:
  - Size of the beam-pipe → track and vertices reconstruction
  - Knowledge of PV position → fundamental for tagging SV
  - Nozzle and detector dimensions → acceptance of physics processes
  - Nozzle instrumentation → important for forward physics
  - …
- Important **effort** and **synergies** between detector and MDI

Thank you for your attention,
and let's discuss!