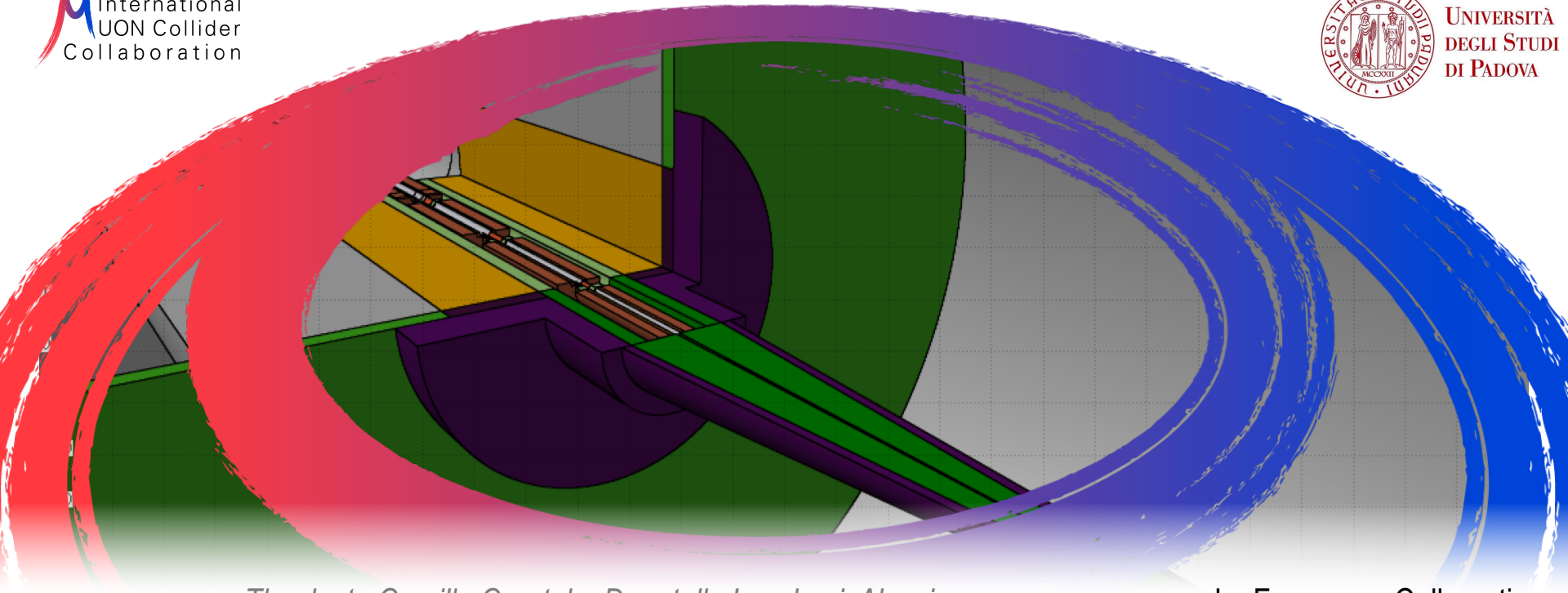
BIB Studies @1.5-3 TeV with FLUKA

International MUON Collider Collaboration

INFN

Università degli Studi di Padova



Thanks to Camilla Curatolo, Donatella Lucchesi, Alessio Mereghetti, Nikolai Mokhov, Mark Palmer, Paola Sala

by Francesco Collamati
INFN Rome
20 05 2021

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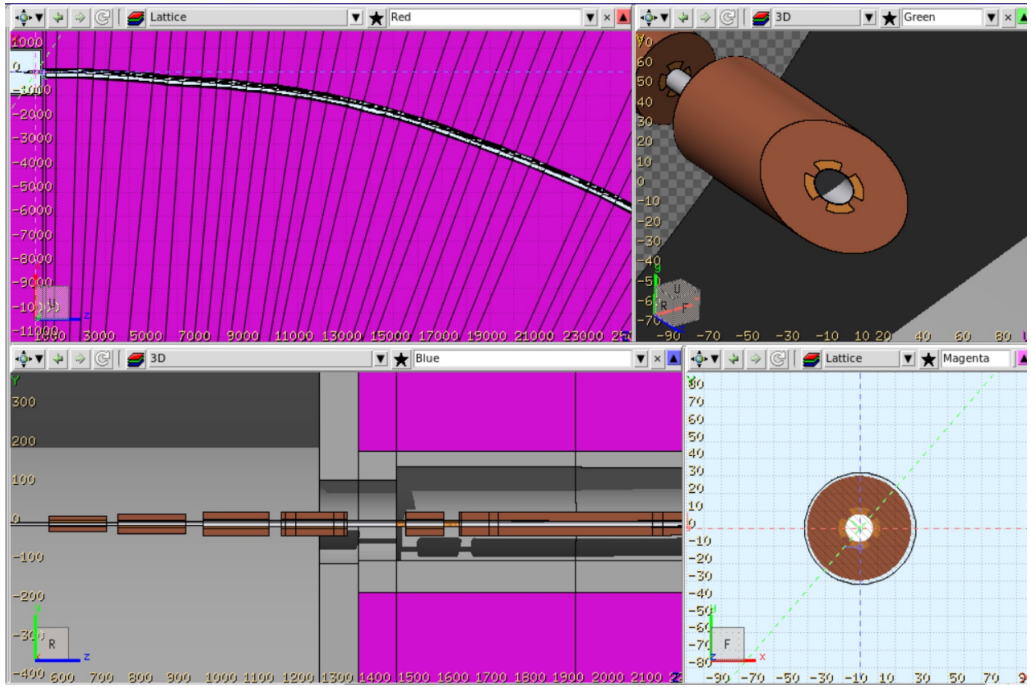
WHAT WE WANTED:

- Leveraging on the massive work by MAP, develop a new, flexible tool to simulate Beam Induced Background (BIB) in a Muon Collider
  - Build geometry starting from machine optics
  - Easily change machine configuration

WHAT WE DID:

- ☒ Use of *LineBuilder* + **FLUKA** to reconstruct MC geometry from optics file
- ☒ Benchmark the tool in the already studied **1.5TeV** case
- ☐ Use the tool to study the **3TeV** case

The 1.5TeV case benchmark



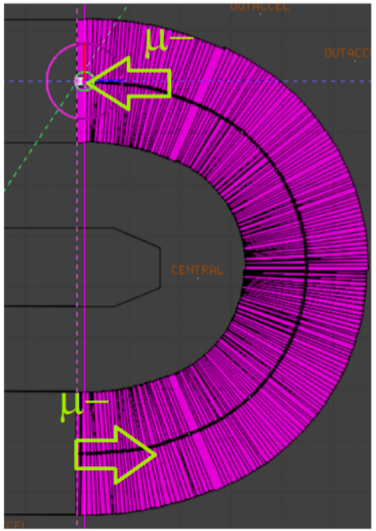
- Optics files and MARS results provided by *MAP*
- MDI *passive elements* retrieved by MAP publications
- Energy cuts:
  - 200keV for γ and e+/-
  - 100keV for neutrons
  - 1MeV for proton & μ
- Only μ decays within 25m from IP considered for the comparison
- Realistic beam of 2×10^{12} μ^-

The 1.5TeV case benchmark

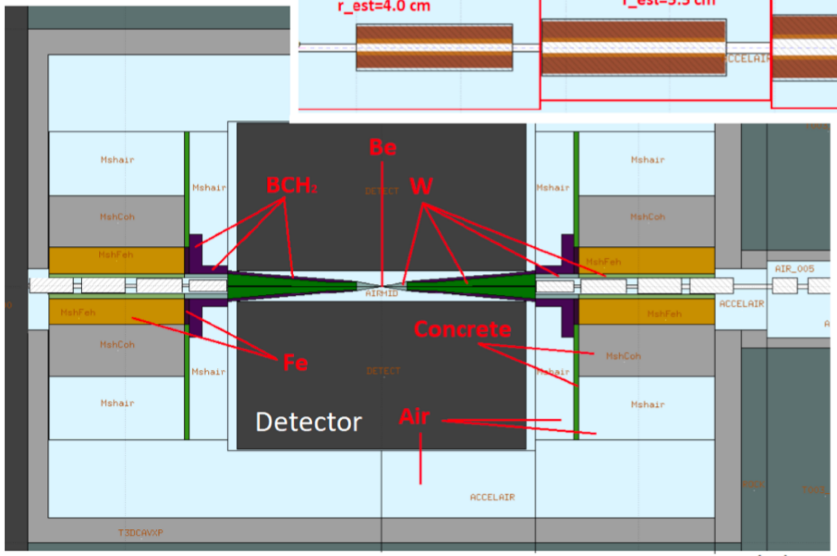
MDI Layout Description

Simulation tool: **LineBuilder + FLUKA**
Data analysis: **Python**

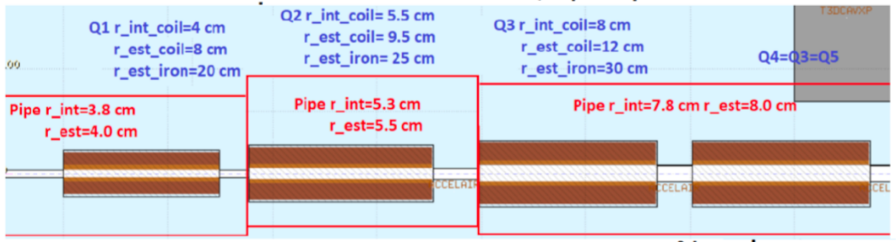
750 GeV muon beam travels half ring to IP



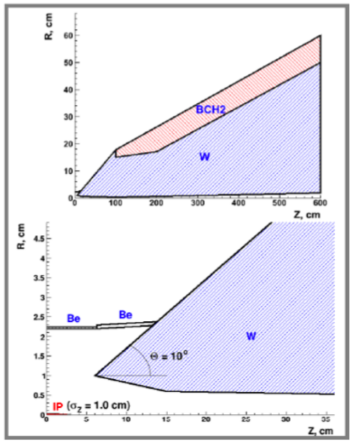
IR



IR Quadrupoles



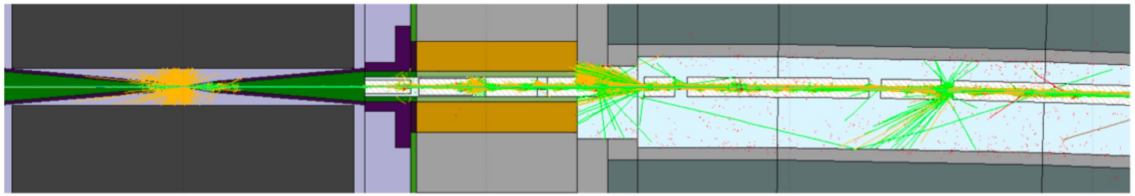
Nozzle



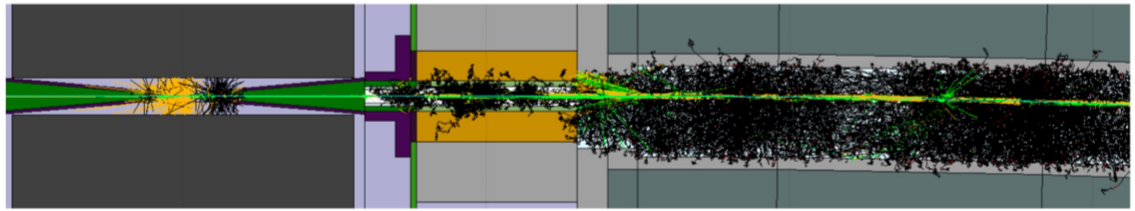
The 1.5TeV case benchmark

Sample Event

FLUKA tracking without neutrons

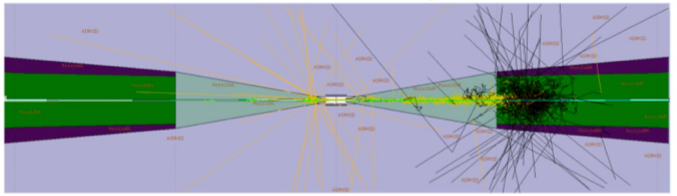


FLUKA tracking with neutrons

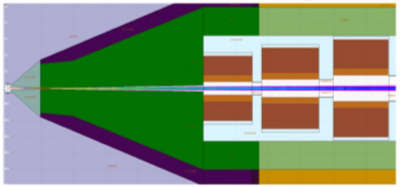


Photon
Neutron
Electron/Positron
Proton
Pion
Muon

zoom on a selected decay

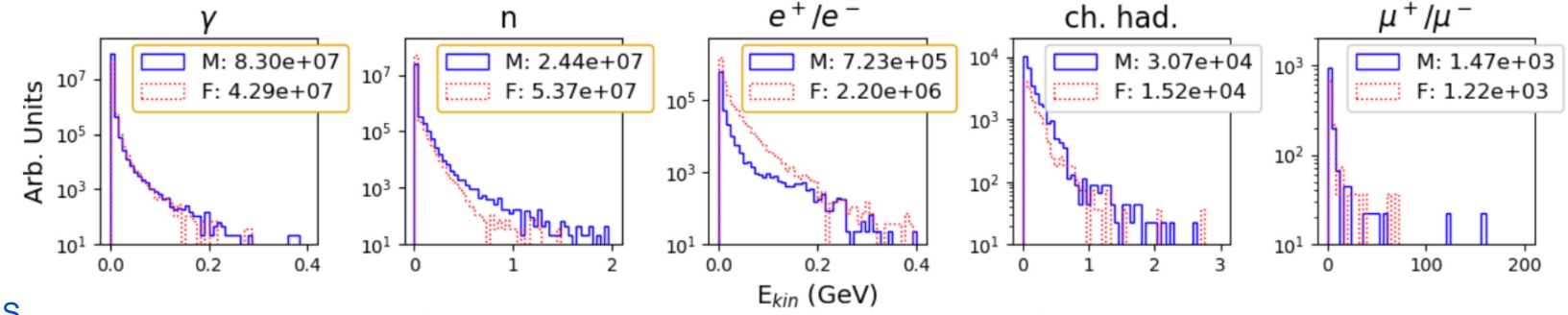


muon beam focusing at IP

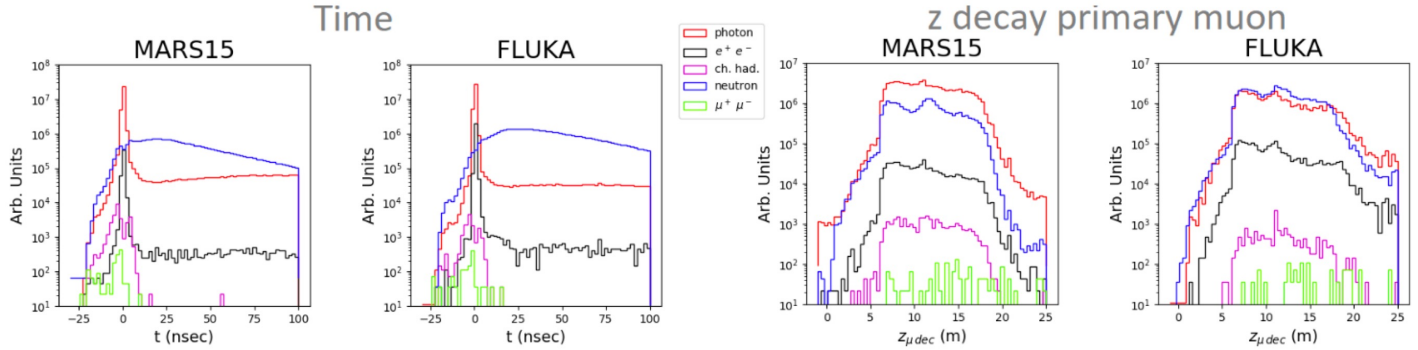


The 1.5TeV case benchmark

MARS-FLUKA Results Comparison



MARS
FLUKA

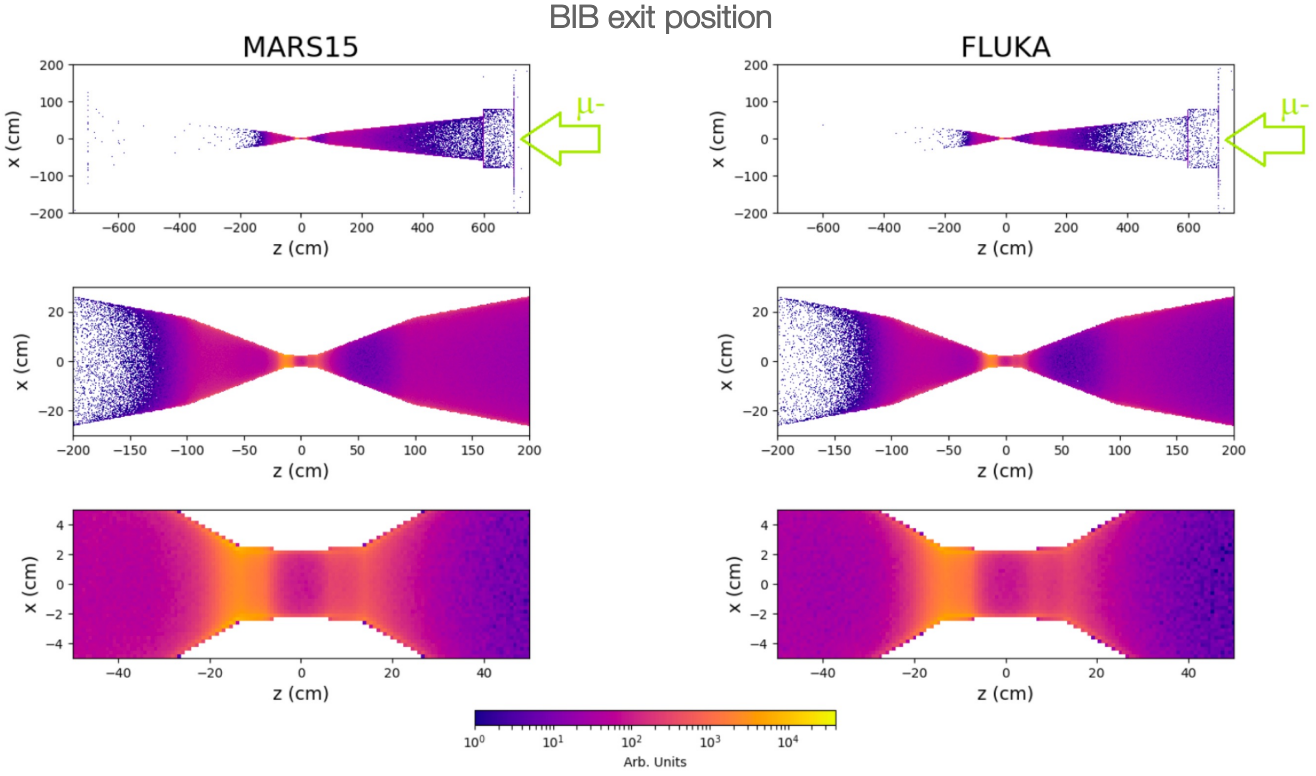


Residual discrepancies in **particles time and energy distribution**:

- Minor layout differences (passive elements, absorbers)
- Intrinsic differences between codes

The 1.5TeV case benchmark

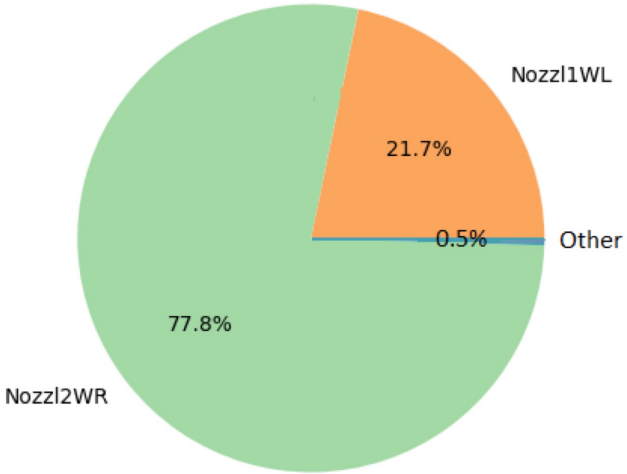
MARS-FLUKA Results Comparison



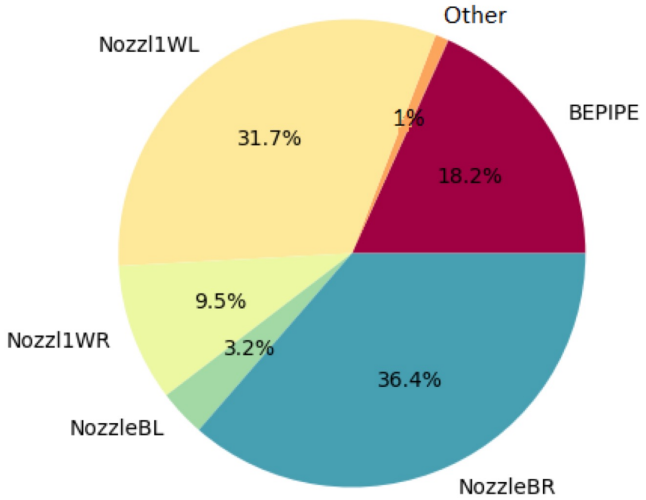
The 1.5TeV case benchmark

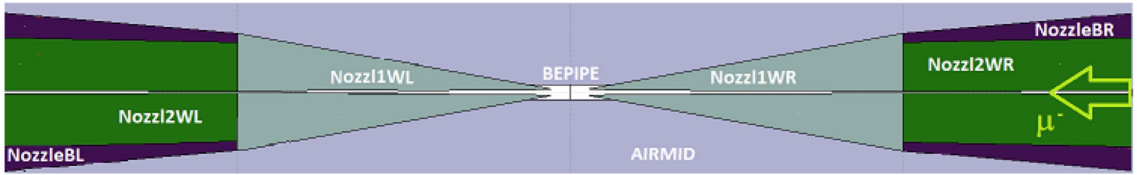
MARS-FLUKA Results Comparison

where first interactions occur after muons decay



where particles exit the ring

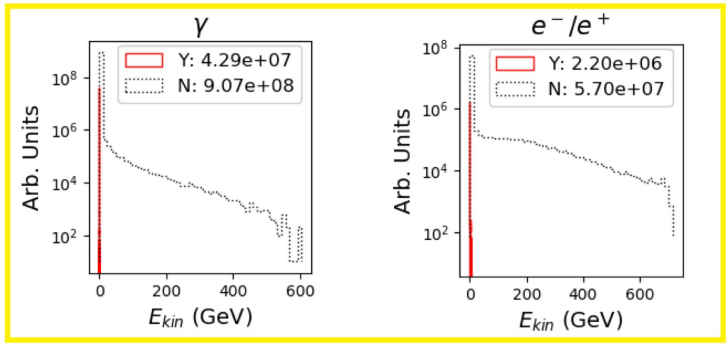


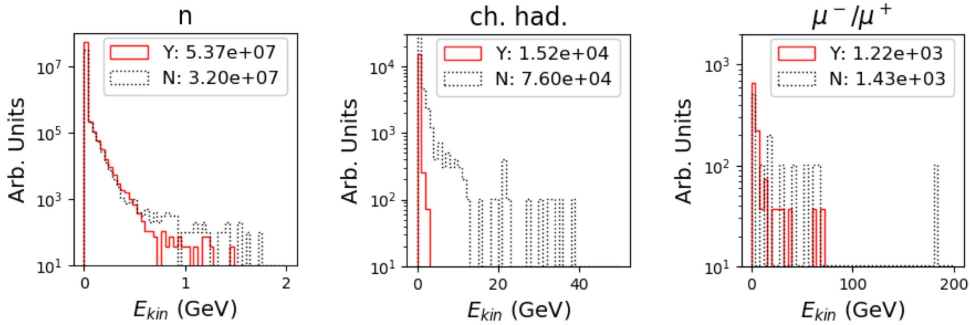


The 1.5TeV case benchmark

MARS-FLUKA Results Comparison

The role of the Nozzle:



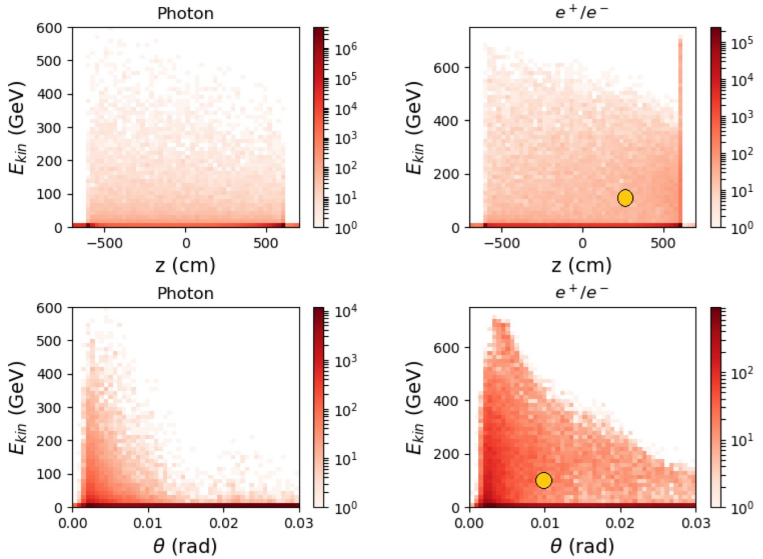


The 1.5TeV case benchmark

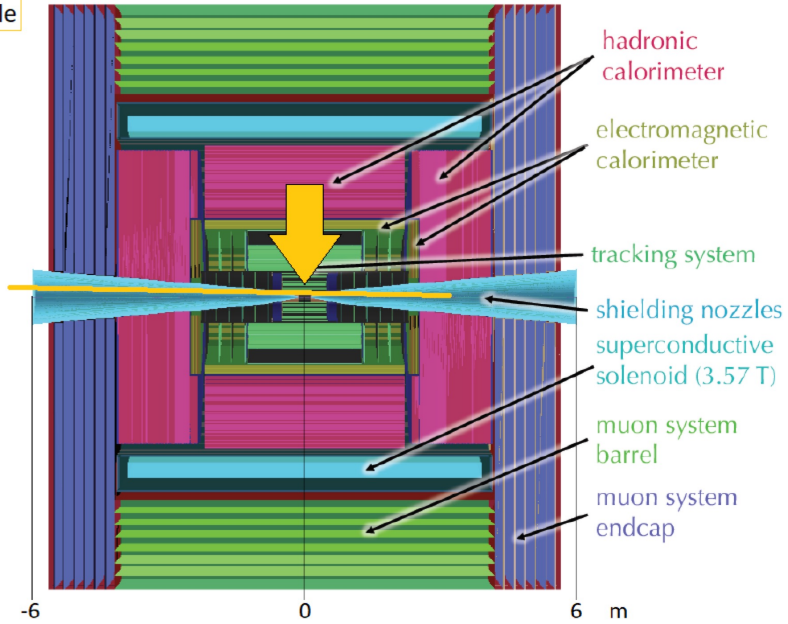
MARS-FLUKA Results Comparison

The role of the Nozzle:

Ex: 100 GeV electron exit at 3 m with 0.01 rad angle



reaches the inner layers of the tracking system



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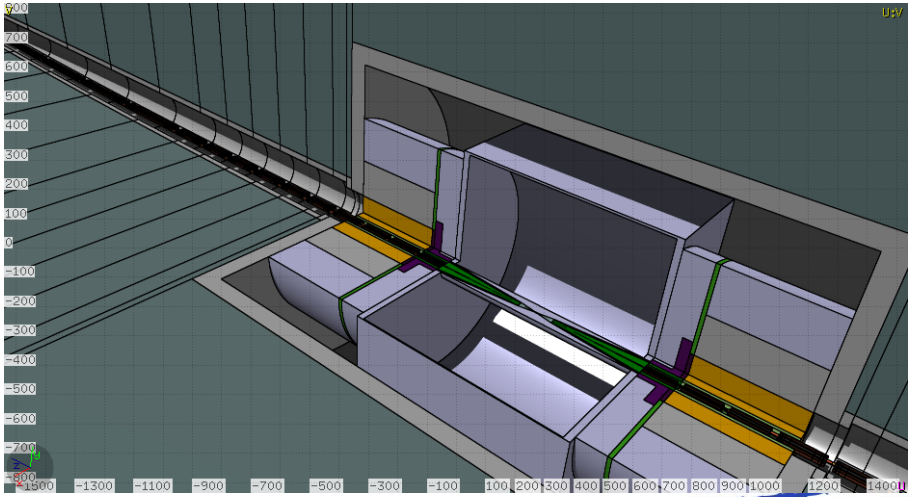
Sum Up

- Basing on optics files from MAP, we used our **new FLUKA based tool** to simulate BIB in the **1.5TeV** case
  - **Good agreement** has been found with MARS15 results
    - Residual differences are probably due to imperfect geometry reproduction (passive elements..)
  - The tool has been used also to study BIB *without the nozzle*
    - Gives important information to possible alternative and novel mitigation strategies
- Results are in **publication** *(arXiv:2105.09116)*
- The study of the **3TeV** is already **started**



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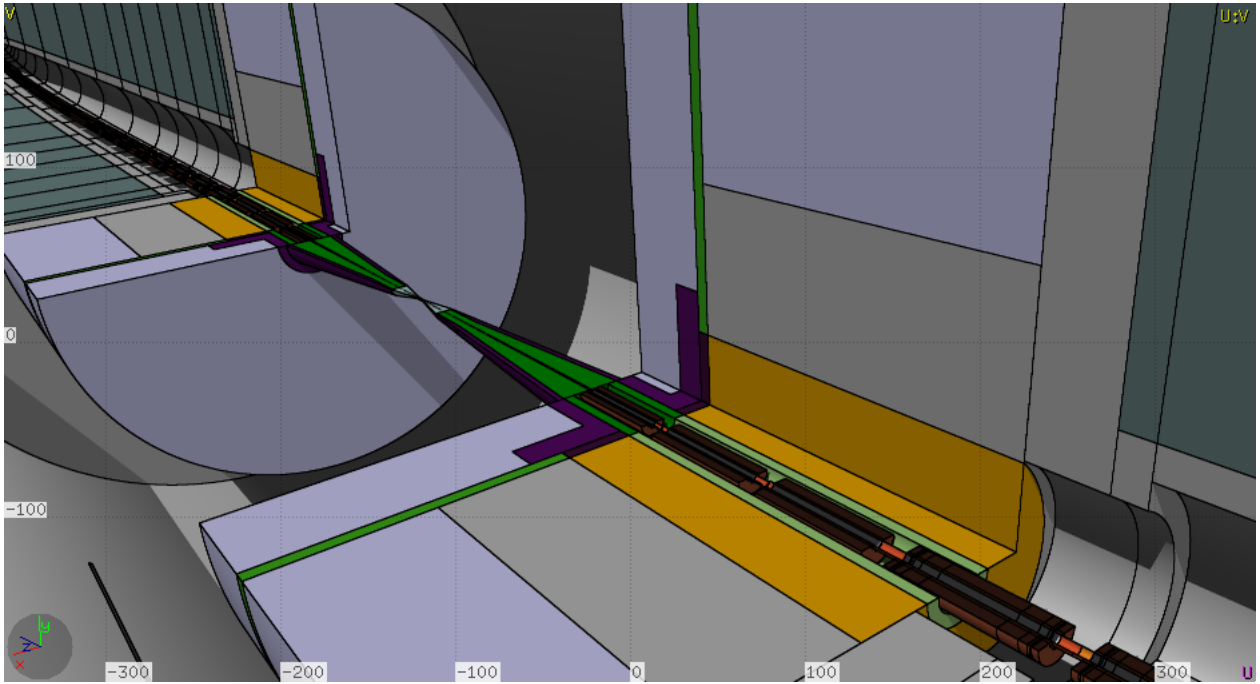
CERN

Thank you
for attention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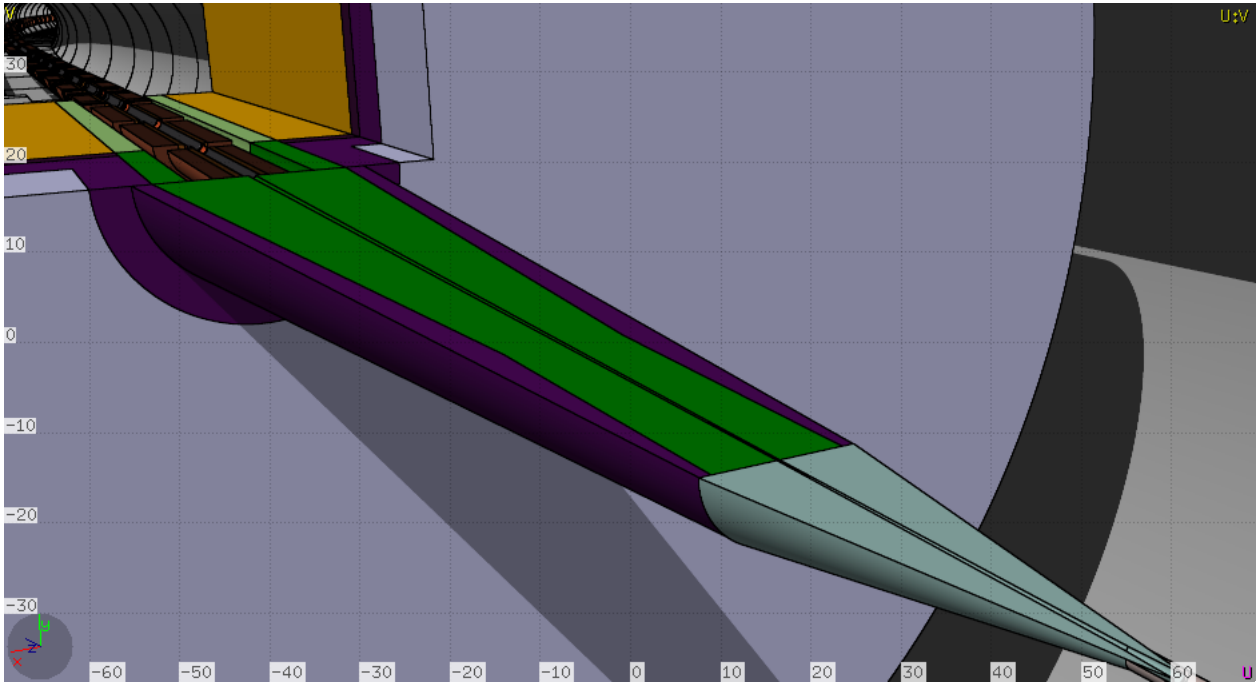
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