WP2: Physics and Detector Requirements

Donatella Lucchesi University of Padova
for the WP2 coordination group

MuCol EU Kick-off Meeting

International MUON Collider Collaboration

28 March 2023
Zoom
Europe/Zurich timezone

MuCol

WP2 Physics and Detector Requirements: Beneficiaries and Participants

Table 3.1b.2:   WP2 - Workpackage description

Work package number	2		Lead beneficiary			UNIPD			
Work package title	Physics and Detector Requirements								
Participant number	8	1	6	5	2	18	10		
Short name of participant	UniPD	CERN	INFN	CEA	DESY	UOS	LIP		
Person months per participant:	24	0	12	12	12	12	12		
Start month	1								

Institution	Contact Person
University of Padova	Donatella Lucchesi
CERN	Maurizio Pierini
INFN	Massimo Casarsa
CEA	Fabrice Balli
DESY	Federico Meloni
University of Sussex	Alex Cerri
LIP	Michele Gallinaro
University of Pavia	Cristina Riccardi
Iowa State University	John Hauptman
Sun Yat-sen University	Jian Tang

Personnel funds

Objectives

WP2 will study the beam-induced background effects on the de
define its optimal configuration which will include the shielding
developed to exploit 5D information in order to additionally mi
particular the irreducible part. The last objective is the detector

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WP2 Physics and Detector Requirements: ectives

Objectives

WP2 will study the beam-induced background effects on the detector with different interaction region design to define its optimal configuration which will include the shielding. Event reconstruction algorithms will be developed to exploit 5D information in order to additionally mitigate the beam-induced background effects, in particular the irreducible part. The last objective is the detector performance evaluation by using the most relevant SM measurements and New Physics reaches.

Description of work

WP2 will be coordinated by **UNIPD**, with the participation of **INFN, CEA, DESY, UOS, LIP, CERN, ISU, SYSU, UNIPV.**

Task 2.1 Design of detector configurations at √s=3 TeV and √s=10 TeV with the optimised interaction regions (UNIPD,)

This task will study the beam-induced background effects on the detector components produced with different interaction region configurations. Feedbacks will be given to WP5, high energy complex , where the IR is designed to optimise background fluxes and the shielding configuration. This will be done in an iterative way until an optimised IR is defined and the relative detector configuration proposed.

Task 2.2 Design and implementation of event reconstruction algorithms in 5D at √s=3 TeV and √s=10 TeV

relevant SM measurements and New Physics reaches.

WP2 Physics and Detector Requirements: Activities

Description of work

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Task 2.2 Design and implementation of event reconstruction algorithms in 5D at √s=3 TeV and √s=10 TeV (DESY)

This task will focus on developing reconstruction algorithms exploiting 3D position, energy, and timing measurements to mitigate beam-induced background and perform tracking and calorimetry clustering. Leveraging on the developments made for future colliders, this task will explore machine learning solutions and parallel computing, both for real-time event processing and for offline analysis, taking into account the specific challenges of a muon collider (e.g., particle tracking in the forward region).

Task 2.3 Evaluate detector performance at different collision energies by using major physics processes (INFN)

This task will explore the detector performance of a muon collider operating at different collision energies. Exploiting an optimal design of the interaction region (Task1) and advances in event reconstruction (Task2), the detector performance will be determined by evaluating the reach of major physics processes for Standard Model measurements, and for searches for physics beyond the Standard Model.

Deliverables (brief description and month of delivery)

WP2 Physics and Detector Requirements: General Organization

✱ Physics & Detector group general meeting every two weeks via zoom ➡ MuCol WP2 meetings

✱ The P&D indico page will be use if it is OK, we can add on the banner MuCol WP2 meeting

✱ Short reports by people in charge of the tasks are foreseen

✱ Once per month an MDI joint meeting WP2 and WP5 (last Friday of the month at 5PM CET) a better date/time can be found if necessary

✱ Software developed within the project will be part of the IMCC software managed and distributed as it is up to now

✱ Simulated Data will be stored at CERN and made available to all the participants (See later)

This task will explore the detector performance of a muon collider operating at different collision energies. Exploiting an optimal design of the interaction region (Task1) and advances in event reconstruction (Task2), the detector performance will be determined by evaluating the reach of major physics processes for Standard Model measurements, and for searches for physics beyond the Standard Model.

Deliverables (brief description and month of delivery)

D2.1: beam-induced background files and related detector Configurations available for Open Access publication- M30
D2.2 Report on detector performance at different collision energies for given physics processes as contribution to the European Strategy process – M36

September 2025

March 2026

Work package number	3			Lead beneficiary		ESS
Work package title	Proton Complex					
Participant number	11	12	1			
Short name of participant	ESS	UU	CERN			
Person months per participant:	33	2	0			
Start month	1			End month	48	

Objectives

This work package aims to define the most promising scheme for the linac, accumulator and compressor

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WP2 Physics and Detector Requirements: Milestones

Table 3.1d: **List of milestones**

Mileston e number	Milestone name	Related work package(s)	Due date (in month)	Means of verification
M1.1	Website Available	1	2	Website online
M1.2	Kick-off meeting	1	3	Indico site
M1.3	Tentative parameters available	1	6	Database
M1.4	First annual meeting	1	15	Indico site
M1.5	Preliminary parameters	1	18	Database
M1.6	Second annual meeting	1	27	Indico site
M1.7	Consolidated parameters	1	30	Database
M1.8	Third Annual meeting	1	39	Indico site
M2.1	Training on detector design and physics performance tools	2	6	Training material
M2.2	Workshop on MDI and IR design	2, 5	13	Indico site
M2.3	Release of simplified detector performance model (DELPHES card or/and similar format)	2	18	Model published on the website
M2.4	Workshop on detector design and physics performance with a public lecture on Muon Collider	2	25	Indico site
M2.5	Publication of report of detector performance with major physics process at several E_{CM}	2	48	Article ready for submission
M3.1	Update for the proton complex parameters and review with WP4	3/4	13	Report
M3.2	Preliminary report on the linac and accumulator work	3	33	Report
M4.1	Initial Assessment of Target radiation load on	4	11	Report

WP2 Physics and Detector Requirements: First milestone

Training on detector design and physics performance tools

Two days training meeting at CERN **July 5th afternoon - July 6th lunch time** being organized
First half day, presentations on:
- Status of physics and detector studies
- Status of beam-induced background production and studies in the detector
- Software and computing

Second half day:
- Hands-on

Blocking issue: people not affiliated to any CERN-recognized activity can not access resources
Two possible solution:
1. IMCC becomes an official CERN project and people being part of the collaboration can ask for CERN account
2. People not CERN users can be registered under External participant in an EU project. PI of the project signs and approves under his responsibility for each account request.

It must be solved asap to allow every MuCol participant to take part to the training

That's all !