10 Muons *(Ugo Gasparini, Darin Acosta)*

The goal of this task is twofold: the development and integration in the CMS software environment of the simulation, reconstruction and analysis tools needed to fully exploit the capabilities of the CMS experiment in producing physics results using muons in the event final state; the detailed study of these capabilities and the definition of the strategies to obtain the optimal response in the various physics channels of interest, in close coordination with the other PRS tasks dealing with different physics objects.

10.1 Muon Detector Simulation *(Coordinator name)*

This item covers the simulation issues specific to the muon sub-systems, assuring the implementation and integration of the relevant code in the OSCAR simulation program. In particular, the proper simulation in the GEANT4 framework of the physics processes involved in the muon detection, including multiple scattering, muon showering and δ-ray production, neutron background parameterization and punchtrhough effects, must be cross-checked against test-beam available data and already existing GEANT3 simulation results.

Deliverable:	**10.1-i Hit simulation in muon detector.**
Description:	Mantenance of existing simulation code in CMSIM and its porting in OSCAR/GEANT4.
Responsible:	MUON
Client/Sponsor:	CMS
Completion:	Continous
Risks/Resources:	*Describe constraints, assumptions and risks.*

Deliverable:	**10.1-ii Verification of simulation model.**
Description:	Study of muon showering modelling, δ-ray production, punchthrough effects.
Responsible:	MUON
Client/Sponsor:	PRS
Completion:	*A date, or "before xxx", or "after yyy".*
Risks/Resources:	*Describe constraints, assumptions and risks.*

Deliverable:	**10.1-iii Neutron background parameterization.**
Description:	Provide neutron parameterization in CSC,DT and RPC chambers, according to latest shielding geometry.
Responsible:	MUON
Client/Sponsor:	PRS
Completion:	Sept.2001
Risks/Resources:	*Describe constraints, assumptions and risks.*

Deliverable:	**10.1-iv Fast simulation**
Description:	Provide parameterization of muon showering and δ rays production in CSC,DT and RPC chambers. Code porting and mantenance in FAMOS program.
Responsible:	MUON
Client/Sponsor:	PRS
Completion:	Dec.2001
Risks/Resources:	*Describe constraints, assumptions and risks.*

10.2 Muon Detector Response Simulation and Reconstruction *(Coordinator name)*

This item covers the reconstrution issues specific to the muon sub-systems, assuring the implementation and integration of the relevant code in the ORCA program. In particular the maintenance of already existing hit digitization and reconstruction, L1 trigger simulation and local track reconstruction code in the Drift Tubes, RPC and CSC muon systems must be guaranteed, as well as further developments to improve the code performance and to allow transparent usage of the code at the following stages of the reconstruction, including integration with other detectors and studies of alignment and calibration issues.

Deliverable:	**10.2-i Digitization in ORCA.**
Description:	Mantenance and update of hit digitization code in CSC, DT and RPC systems. Implementation of neutron background effects.
Responsible:	MUON
Client/Sponsor:	PRS
Completion:	*A date, or "before xxx", or "after yyy".*
Risks/Resources:	*Describe constraints, assumptions and risks.*

Deliverable:	**10.2-ii Muon L1 trigger simulation in ORCA.**
Description:	Mantenance and update of L1 trigger primitive generation in CSC, DT and RPC systems. Global Muon Trigger simulation code.
Responsible:	MUON
Client/Sponsor:	PRS
Completion:	*A date, or "before xxx", or "after yyy".*
Risks/Resources:	*Describe constraints, assumptions and risks.*

Deliverable:	**10.2-iii Local track reconstruction in muon system.**
Description:	Mantenance and update of muon track candidates reconstruction code in muon system.
Responsible:	MUON
Client/Sponsor:	PRS
Completion:	*A date, or "before xxx", or "after yyy".*
Risks/Resources:	*Describe constraints, assumptions and risks.*

10.3 Muon Detector Alignment, Calibration, and Databases *(Coordinator name)*

The aim of this sub-task is the development of the software tools needed for the alignment and calibration studies in the muon system. In particular, the interface of existing muon alignment software with the ORCA reconstruction, together with the development of general software tools to displace/rotate in ORCA the muon subdetector units, is mandatory to study mis-alignment effects at different reconstruction/selection stages (L1 trigger, HLT, off-line) , to link the muon and the tracker alignment systems and to develop strategies for aligment corrections using the event data. As far as calibration is concerned, the simulation of realistic trigger syncronization data and specific behaviour of electronic-channels to be recorded in the Calibration Database must be provided, and strategies for calibration updating using event data must be studied. Finally, tools for converting the existing geometry detector database developed within CMSIM to a GENT4/OSCAR format, including recent and possible future updates, also from engineer drawings, must be developed.

Deliverable:	**10.3-i Geometry database.**
Description:	*Elaborate on purpose and functionality.*
Responsible:	MUON
Client/Sponsor:	PRS, Alignment group
Completion:	*A date, or "before xxx", or "after yyy".*
Risks/Resources:	*Describe constraints, assumptions and risks.*

Deliverable:	**10.3-ii ORCA interface to muon alignment software.**
Description:	*Elaborate on purpose and functionality.*
Responsible:	MUON
Client/Sponsor:	PRS, Alignment group
Completion:	*A date, or "before xxx", or "after yyy".*
Risks/Resources:	*Describe constraints, assumptions and risks.*

Deliverable:	**10.3-iii Tools for alignment studies in ORCA and strategy for aligment with tracks.**
Description:	*Elaborate on purpose and functionality.*
Responsible:	*Responsible person*
Client/Sponsor:	*Who wants the deliverable? As specific as possible.*
Completion:	*A date, or "before xxx", or "after yyy".*
Risks/Resources:	*Describe constraints, assumptions and risks.*

Deliverable:	**10.3-iv Calibration database and tools for trigger syncronization.**
Description:	*Elaborate on purpose and functionality.*
Responsible:	*Responsible person*
Client/Sponsor:	*Who wants the deliverable? As specific as possible.*
Completion:	*A date, or "before xxx", or "after yyy".*
Risks/Resources:	*Describe constraints, assumptions and risks.*

10.4 Muon Detector Online and Control software *(Coordinator name)*

This item has to provide and mantain transparent and user-friendly interface of muon test-beam data to the event object database of CMS, allowing the usage of reconstruction code developed in the ORCA framework in the test-beam analysis activities. Tools for online software (e.g. event monitoring) and forthcoming combined test-beam activities (e.g DT+RPC , CSC+RPC) must be provided as well. Development of slow and fast controls software for the muon systems.

Deliverable:	**10.4-i DAQ software for muon test-beams.**
Description:	*Elaborate on purpose and functionality.*
Responsible:	*Responsible person*
Client/Sponsor:	*Who wants the deliverable? As specific as possible.*
Completion:	*A date, or "before xxx", or "after yyy".*
Risks/Resources:	*Describe constraints, assumptions and risks.*

Deliverable:	**10.4-ii Interface of muon test-beam data to CMS ODBMS.**
Description:	*Elaborate on purpose and functionality.*
Responsible:	*Responsible person*
Client/Sponsor:	*Who wants the deliverable? As specific as possible.*
Completion:	*A date, or "before xxx", or "after yyy".*
Risks/Resources:	*Describe constraints, assumptions and risks.*

Deliverable:	**10.4-iii Muon test-beam monitoring.**
Description:	*Elaborate on purpose and functionality.*
Responsible:	*Responsible person*
Client/Sponsor:	*Who wants the deliverable? As specific as possible.*
Completion:	*A date, or "before xxx", or "after yyy".*
Risks/Resources:	*Describe constraints, assumptions and risks.*

Deliverable:	**10.4-iv Muon reconstruction in test-beam data with ORCA.**
Description:	*Elaborate on purpose and functionality.*
Responsible:	*Responsible person*
Client/Sponsor:	*Who wants the deliverable? As specific as possible.*
Completion:	*A date, or "before xxx", or "after yyy".*
Risks/Resources:	*Describe constraints, assumptions and risks.*

Deliverable:	**10.4-v Common software for combined Test-beams.**
Description:	*Elaborate on purpose and functionality.*
Responsible:	*Responsible person*
Client/Sponsor:	*Who wants the deliverable? As specific as possible.*
Completion:	*A date, or "before xxx", or "after yyy".*
Risks/Resources:	*Describe constraints, assumptions and risks.*

Deliverable:	**10.4-vi Slow control software for the muon systems**
Description:	*Elaborate on purpose and functionality.*
Responsible:	*Responsible person*
Client/Sponsor:	*Who wants the deliverable? As specific as possible.*
Completion:	*A date, or "before xxx", or "after yyy".*
Risks/Resources:	*Describe constraints, assumptions and risks.*

Deliverable:	**10.4-vii Fast control software for the muon systems**
Description:	*Elaborate on purpose and functionality.*
Responsible:	*Responsible person*
Client/Sponsor:	*Who wants the deliverable? As specific as possible.*
Completion:	*A date, or "before xxx", or "after yyy".*
Risks/Resources:	*Describe constraints, assumptions and risks.*

10.5 Muon High Level Triggers and Physics Objects *(Coordinator name)*

The goals of this sub-task are the muon identification at the different stages of the reconstruction and event selection (L2 and L3 triggers, off line), the definition of algorithms to identify and select interesting events for the different Physics channels with muon(s) in the final state, the development of benchmark physics analyses using the full detector simulation and reconstruction chain developed in the OSCAR and ORCA frameworks. Tools for common issues with other sub-detectors (e.g. muon-tracker matching, energy isolation algorithms, minimum ionizing particle definition) must be developed in close collaboration with other PRS groups. The setting-up of Monte Carlo productions, including the configuration of MC generators and the definition of relevant samples needed for bacgkround rejection and benchmark signal studies, is a crucial part of this sub-task activity.

Deliverable:	**10.5-i Muon L2 trigger selection.**
Description:	Reduction of data rate from L1 trigger using Muon (L2.1) and calorimetric (L2.2) information. Seeding of L3 reconstruction.
Responsible:	PRS
Client/Sponsor:	CMS
Completion:	June 2001
Risks/Resources:	Realistic L1 simulation needed. Working L2 scheme by May 2001.

Deliverable:	**10.5-ii Muon L3 trigger selection.**
Description:	Reduction of data rate from L2 trigger to O(100) Hz using tracker data. Definition of physics selection strategies.
Responsible:	PRS
Client/Sponsor:	CMS
Completion:	End 2001
Risks/Resources:	

Deliverable:	**10.5-iii Tools for muon identification.**
Description:	Develop tools to define muon physics objects to be used at various level of selection (L2, L3, off-line). Define muon quality categories (tight, standard, loose), study matching and isolation criteria. Matching with m.i.p. deposits in calorimeters.
Responsible:	PRS
Client/Sponsor:	CMS
Completion:	*A date, or "before xxx", or "after yyy".*
Risks/Resources:	*Describe constraints, assumptions and risks.*

Deliverable:	**10.5-iv Configuration of MC productions for HLT, Physics TDR and specific detector studies.**
Description:	Define and provide MC configurations of relevant datasets in low luminosity and high luminosity scenarios for High Level Trigger studies and off-line physical analyses involving muons in the final state. Provide tools for fast cross-check of MC productions.
Responsible:	PRS
Client/Sponsor:	CMS, MUON
Completion:	Continous
Risks/Resources:	*Describe constraints, assumptions and risks.*

Deliverable:	**10.5-v Analysis tools and benchmark channels studies.**
Description:	Develop analysis tools to study detector functionality and performance, testing them on different benchmark channels. Efficiency and background rejection optimization.
Responsible:	PRS
Client/Sponsor:	CMS, MUON
Completion:	*A date, or "before xxx", or "after yyy".*
Risks/Resources:	*Describe constraints, assumptions and risks.*

Deliverable:	**10.5-vi HLT rate and efficiency tables**
Description:	Develop HLT analysis scenario down to 0(100)HZ level, providing trigger rate and signal efficiency for all discovery channels involving muons.
Responsible:	PRS
Client/Sponsor:	CMS, MUON
Completion:	*A date, or "before xxx", or "after yyy".*
Risks/Resources:	*Describe constraints, assumptions and risks.*