WP.11.n

1. **Not moveable equipment - beamline mechanical setup, magnets, cryo-setups**
2. **Moveable equipment: daq, dcs, trigger, telescopes, etc**
3. **Areas and fixed equipment: preparation and post-treatment areas including cooling**

General introduction to WP (refer to other WPs, beamlines, experiments)

Installation and operation of prototype detector elements in particle beamlines (using for example the facilities described in WPs 6-7) provide the ultimate test-ground for performance verification and improvements of new detector technologies. In many cases such tests are carried out using detectors irradiated (see WPs 8-9) to the doses expected in their future user environment to increase the realism of the tests. Testbeam measurements are very demanding as they require substantial infrastructures also beyond the primary beamline - as mechanical supports, cooling and thermal control, reference beam telescopes, readout and control systems, monitoring and offline analysis capacities. On the other hand, since the detector elements are tested in such realistic environments, testbeam measurements are generally considered as the most critical and useful tool in detector technology development, and all detectors technologies used in modern detector systems have usually been through several iterations of testbeam measurements.

This work-package describes the infrastructures needed and foreseen to be developed to allow efficient testing of the key detector technologies planned to be used in SLHC experiments, Neutrino experiments and for Super B detector development in Europe. For completeness, the linear collider testbeam infrastructures are described in WP10. The bulk of the beamlines used are at CERN (WP6), but also beamlines at DESY (WP7) and Frascati will be used. It is considered that the operation of the beamlines and particle beam themselves are largely covered by the missions of these laboratories, and the infrastructures discussed here are therefore the additional equipment needed to install, operate and make efficient and meaningful measurements of detector elements in these beamlines, including preparatory work and measurements carried out on the samples in connected laboratories. With these infrastructures in place most the detector R&D foreseen for these major projects over the coming 4 years can be carried out related to major testbeam programs. Some of this infrastructures are moveable such that it can be moved from one beamline to another as needed.

The infra-structures are divided into three subgroups; basic infrastructures as mechanics, magnets for testing in magnetic fields, cryogenics equipment, particle ID system, trigger chambers and timing equipment that allow the timing between asynchronous beam-particles and the readout systems clock to better than a nanosecond (task 1), specific support equipment for operation as daq, reference telescopes control system and readout (task 2), and finally more general support facilities that allow also pre and post measurements in surrounding lab areas to take place, the primary example are cooling and thermal performance evaluation (task 3). The typical detector elements that will be tested are silicon detector system, new gas detector system for Inner Detectors and Muon systems, and calorimeter systems. The measurements cover efficiencies, noise, time, space and energy resolutions – basically all the critical performance parameters for new detector systems. The measurements are carried out with beam conditions are close as possible to those the detectors will see in their final implementation.

WP.11-Task.1 – Basic infrastructures in the testbeams

1. General description of the task activities

(Give a short introduction to the general context and objective aimed for in about 1/4 of a page. Please note that, in the final proposal this text will be merged into a single ~½ page text for the work package as a whole. The text shall be understandable by an outsider. Avoid using too many acronyms.)

The beamlines at CERN have been used 2000-2006 to test detector parts for LHC. The beamlines therefore have the basic infrastructures needed to test also the detector parts for SLHC. These are beam monitoring and particle ID equipment, basic trigger systems, magnets and control systems. This task therefore includes those changes and improvements needed to test inner detector system (main detector R&D focus of SLHC) and parts for neutrino experiments, beyond the existing basic infrastructure. These changes covers mechanical support, timing and triggering systems. Testing of muon systems and calorimeters for SLHC is expected to be covered by existing infrastructure, enhanced by the increased capabilities of the GIF+ facility (WP9). A particular concern is access to low energy beams for neutrino detector testing, where additional infrastructure development is needed, both to provide such a beam and for particle ID in this low energy beam. Linear collider experiment infrastructure is described in WP10, while Super B will use mainly the Frascati beamlines where similar new develops are needed, improved mechanical support, beam monitoring and beam energy calibrations systems for low energy beams. The basic infrastructures in the DESY beamline are sufficient and no changes are needed .

2. Organization participation (ignore – will import from resource sheet)

Participant acronym						
Estimated person-months per participant:						

3. Objectives

(Bullet-style, 1 or 2 lines per objective, 1 objective per sub-task)

- Mechanical support tables for detector testing, allowing to position, scan and rote the DUTs (Devices Under Test).
- Improved triggering and timing systems (move to task 2 ?)
- TOF, Cherenkov, and a SciFi tracker for particle ID in low energy beam.
- Beam monitor and beam calibration system at LNF BTF, and setup of Tagged Photon Beam.

4. Description of work

(~1/2 page, describe the work in the context of the objectives. possibly broken into sub-tasks, indicate for each sub-task the purpose of it, the participants involved in it and their role. If really indispensable, you can divide into subtasks.)

Will rewrite the following two paragraphs at the end to make one coherent text.
Beam line setups at CERN (SPS and PS)

The following new/improved infrastructures are needed in these beamlines:

- Mechanical support tables for SLHC ID testing, allowing to position, scan and rote the DUTs.
- Improved triggering and timing systems (include CMS PIXEL module development)
- TOF, Cherenkov, and a SciFi (why – is this an excuse for development of these detectors? – if yes probably ok) tracker for particle ID in low energy beams.

Distribution on interested groups not yet made.

Beam line setup at LNF BTF (must shorten)
The following infrastructural improvements for this beamline:

- Mechanics to remotely control the mechanical position of the DUT. Approximate requirements: 100cm usable area, 50-100kg load, 30-40cm travel (can be less), about 1mm positioning accuracy, vibration isolation. Interested parties: LNF (Name?)
- Beam monitor and profiler: continuosly monitor the beam quality, position, width. Implementation can be done with GEM chambers with a resolution of about 3-400um in xy. Interested parties: LNF (Bencivenni)
- Beam energy calibration. There are two issues: 1) Measure the actual beam energy resolution, which has never been done especially at low energy; and 2) correct for non-linearity and hysteresis of the momentum selection magnet in an energy scan.
    - Build a small and precise calorimetry system to measure energy resolution both on electrons and tagged photons. We need to understand whether Babar style CsI(Tl) crystals that will be used for some of the SuperB tests have the required performance. Interested parties: LNF (Miscetti), PG (Cecchi)
    - Install magnetic field probes in the momentum selection magnets. This requires a clear motivation from the planned detector test (2nd priority) Interested parties: LNF (Mazzitelli)
- Tagged photon beam. The setup is currently a bit homemade and unstable. Requires engineering, spare boards, development into an user facility. It is essential to reduce the background by a factor 10-100 especially at low energy

List of Deliverables for the task
(typically 1 per task per year)

Deliverables of task 1	**Person month estimate**	**Description/title**	**Nature**[1]	**Delivery month**[2]
wp.t.1		Mechanical support tables for detector tests	Other	12
wp.t.2		Triggering and timing system for particle beam (SLHC development – move to task 2)	Other	36
		Low energy beam system, control and monitoring for SPS	Other	24
		Particle ID systems for low energy beamline	Other	30
		Beam monitoring, calibration and photon beam setup for LNF, BTF	Other	24

List of Milestones for the task (currently not specified)

Milestones	**Description/title**	**Tasks involved**	**Delivery month**[2]	**Means of verification**

wp.t.1	Related to Mechanical support tables for detector tests			
wp.t.2	Related to Triggering and timing system for particle beam (move to task 2)			
	Related to Low energy beam system, control and monitoring for SPS, included particle ID			
	Related to Beam monitoring, calibration and photon beam setup for LNF, BTF			

[1] Nature: R=Report, P=Prototype, D=Demonstrator, O=Other
[2] Counted from the starting date

WP.11-Task.2 – Moveable equipment: DAQ, DCS, trigger, telescopes, trigger modules belong to experimental setup, etc

1. General description of the task activities

(Give a short introduction to the general context and objective aimed for in about 1/4 of a page. Please note that, in the final proposal this text will be merged into a single ~½ page text for the work package as a whole. The text shall be understandable by an outsider. Avoid using too many acronyms.)

To read out and control the detector elements being developed during testbeam operation a significant amount of surrounding support equipment is needed. This equipment is generally build up and maintained in a specific beamline, suitable for the bulk of the tests for a specific component, but the equipment can in most cases be moved to other beamlines if special tests are needed - for example with a different beam (different energy range or timing structure). Specific support equipment for operation the detector in the beamlines are data acquisition systems (DAQ) and off detector readout systems, reference telescopes, detector control systems (DCS), some special trigger modules, computers for detector monitoring and offline checks. Additionally, gas and cooling systems are needed as discussed in task 1 and task 3 respectively (add something about gas in task 1?).

2. Organization participation (ignore for the time being – will import from resource sheet)

Participant acronym						
Estimated person-months per participant:						

3. Objectives

(Bullet-style, 1 or 2 lines per objective, 1 objective per sub-task)

- Development of DAQ and readout systems
- Development of reference telescope systems
- Development of triggering and timing systems
- Develop detector control system and monitoring in beamlines

4. Description of work (need to be coherently written)

(~1/2 page, describe the work in the context of the objectives. possibly broken into sub-tasks, indicate for each sub-task the purpose of it, the participants involved in it and their role. If really indispensable, you can divide into subtasks.)

DAQ and readout for stand-alone tests:
Develop DAQ systems for the SLHC systems compatible with the SLHC reaodut parameters, including monitoring functions. Include readout of beam telescopes such that full rate tests are possible. Develop DAQ and readout system for neutrino detector testing. Develop user-friendly DAQ system for BTF, based on standard boards available from LNF electronics pool or widely available .

Trigger modules: Include real development of trigger modules as for CMS? – currently also in task 1 – have to see where it really belongs.

DCS systems: Develop Detector Control Systems, include real development of improved ELMB boards for SLHC.

Beam telescopes: Improve beam telescopes used for SLHC testing and make compatible with high rate readout. Low material telescope made with straw tube, designed for tracking applications, in particular the SuperB DCH, with resolution <100um (to check ??) in one view only.

Data collection and monitoring: Development of monitoring and data-analysis systems for detector testing.

List of Deliverables for the task
(typically 1 per task per year)

Deliverables of task 1	**Person month estimate**	**Description/title**	**Nature**[1]	**Delivery month**[2]
wp.t.1		Development of DAQ and readout systems	Demonstrator	18
wp.t.2		Develop trigger PIXEL modules for SLHC tracker tests	Prototype	36
		Development of DCS and monitoring systems	Prototype	30
		Development of reference telescope systems	Other	18
		Development of triggering and timing systems in beamlines	Other	24

List of Milestones for the task

Milestones	**Description/title**	**Tasks involved**	**Delivery month**[2]	**Means of verification**
wp.t.1	Related to Development of DAQ and readout systems			
wp.t.2	Related to Develop trigger PIXEL modules for SLHC tracker tests			
	Related to Development of DCS and monitoring systems			
	Related to Development of reference systems			
	Related to Development of triggering and timing systems			

[1] Nature: R=Report, P=Prototype, D=Demonstrator, O=Other
[2] Counted from the starting date

WP.11-Task.3 – Related infrastructures for preparation and post measurements

1. General description of the task activities

(Give a short introduction to the general context and objective aimed for in about 1/4 of a page. Please note that, in the final proposal this text will be merged into a single ~½ page text for the work package as a whole. The text shall be understandable by an outsider. Avoid using too many acronyms.)

The thermal performance of detectors is one of the most critical parameters in modern detector system. With increased granularity, stringent speed requirements, high packaging density, and irradiation damage, advanced low mass cooling systems are critical for the detector system, and thermal performance is among the most crucial parameters that need to be tested and verified for new detector systems. Task 3 describes the cooling infrastructures needed to test detector systems in the lab and to carry out detailed measurements there, and also in the testbeams where the system need to be cooled during operation and the effect of different temperatures studied.
(point out that the detectors cannot be operated – in some cases even stored – without cooling)

2. Organization participation (ignore – will extract from resource table later)

Participant acronym						
Estimated person-months per participant:						

3. Objectives

(Bullet-style, 1 or 2 lines per objective, 1 objective per sub-task)
Build cooling systems and equipment for thermal testing of detector modules, to be used in lab and during testbeam operation.

4. Description of work

(~1/2 page, describe the work in the context of the objectives. possibly broken into sub-tasks, indicate for each sub-task the purpose of it, the participants involved in it and their role. If really indispensable, you can divide into subtasks.)

Develop cooling plants and test (beam) box(es) which can be operated at low temperatures of -40C or even lower, for detailed testing of SLHC ID systems.
Develop a thermohydraulic testbench for the thermal and fluid dynamical characterization of tracker modules and subsystems for SuperB. Initial specs: 500-1000W of cooling power, -30 – 20 C temperature range. Including measurement of temperature, flux.

List of Deliverables for the task

(typically 1 per task per year)

Deliverables of task 1	Person month estimate	Description/title	Nature[1]	Delivery month[2]
wp.t.1		Cooling system(s) development	Demonstrator	36
wp.t.2		Thermal testbenches and environmental chambers	Other	24

List of Milestones for the task

Milestones	Description/title	Tasks involved	Delivery month[2]	Means of verification
wp.t.1	Related to Cooling system(s)			
wp.t.2	Related to Thermal testbenches and environmental chambers			

[1] Nature: R=Report, P=Prototype, D=Demonstrator, O=Other
[2] Counted from the starting date