Summary of WBS requirements and quality control.

WBS-1 Detector Frames and Support Table

Requirements:

Rotary stage position reproducible to about 0.5 mil or 10 um, corresponding to angular repeatability of < 0.1 mr.
Translation stage movement distance known to 1 mm, with angle changes less than 0.1 mr horizontal x 1 mr vertical.
Supports detectors.

Quality Control:

Careful mechanical construction
Survey
laser pointing

WBS-2 SciFi Detector

Requirements:

Timing resolution better then 1ns per fiber (becomes better than ~700ps when demanding 2 planes).
Position resolution – Fiber size 2mm.
Efficiency better then 95%/plane (better than 99% when demanding 2/3 planes).

Quality Control:

Resolution and timing:

Cosmics tests at TAU.
Beam tests at PSI.

Efficiency:

Cosmics tests at TAU.
Online testing at PSI.

WBS-3 Beam Cerenkov Detectors

Requirements:

Timing resolution better then 0.1 ns.
Efficiency about 99% or better for muons.

Quality Control:

Timing resolution:

Cosmic and beam tests at PSI, with respect to fact scintillator.
Vary angle of Cerenkov wrt beam.

Efficiency:

Beam testing at PSI, with tracking or scintillator stack.

WBS-4 Straw Tube Tracker

Requirements:

150 um position resolution on hit straws (giving a 1mr angular resolution with 2 chambers).
At least 95% efficiency (giving better than 99.999% efficiency for 3 out of 5).
Time resolution not critical.
Position repeatability of the chamber to within 10 um

Quality Control

Resolution:

Test individual straws with a radioactive source.
Test multiple planes with source.
Test chambers at PSI with GEM tracking.

Efficiency:

Test straws/planes with cosmics.
Online testing at PSI.

Repeatability:

Tests at PSI with GEMs/Frames.

WBS 5 – Cryo Target

Requirements

Cylindrical liquid hydrogen target with length of 4 cm and diameter of 4 cm.

WBS 6 – Electronics/DAQ/Analysis

Requirements

3 KHz data acquisition rate.

WBS 7 – Scintillator

Requirements:

- Average detection efficiency $\varepsilon > 0.95$.
- Average time resolution, $\sigma < 70$ ps.

Quality Control

- BC-404 Scintillators are inspected for damages, inclusions, and refraction index inhomogeneities
- Hamamatsu R9779 PMTs are tested for signal integrity, signal-to-noise ratio, gain, HV requirements, and magnetic field shielding
- Counter Pre-Check: Counters are inspected for void-free glued PMT-to-scintillator transition and light tightness, set to final gain-balanced HVs
- Counter Full-Check: With Three-Bar-Method position dependent and overall time resolutions, effective speed of light, left and right attenuation lengths (BAL and TAL) are programmatically analyzed and automatically stored
- Database: All acquired information is stored and retraceable

WBS-8 GEM

Requirements:

1. <100 um position resolution (giving better than 1mr angular resolution with 3 GEMs). Achieved 75 um at OLYMPUS.
2. At least 95% efficiency (has been established with OLYMPUS, investigations are ongoing). Can use any-2-of-3 to define track for higher efficiency.
3. No time information; GEMs require external trigger
4. GEM track to provide reference direction for scattering angle measurement
5. Readout speed of 2 kHz at 20% deadtime, corresponding to 200 usec readout time per event

Steps to achieve fast readout:

Currently 400 Hz readout rate has been established for two telescopes, where the readout time per event has been 1.8ms. A 200 us readout per event is needed to achieve 2 kHz at 20% deadtime.

One can gain a factor 2 by implementing block transfer of 32-bit words, and another factor 2 by using only one telescope, i.e. 500 usec. However, another factor 2.5 is needed.

With the existing system design, one can gain another factor 3 by using three VME crates with three CPUs and MPD FPGA boards, respectively, i.e. by adding another two. Hampton has one spare VME crate with CPU and MPD from OLYMPUS still available. Reading out with one VME crate per GEM will require a slight reconfiguration of the telescope cabling. The cost for this approach is included in this WBS.

Alternatively, it has been discussed to avoid the VME bus limitation by employing a UDP protocol via PCI bus. This option will be explored further but requires R&D and hence involves certain risks. It would be desirable to establish the required readout speed with the GEM telescope as soon as possible, therefore the funds are requested in the first year.

One telescope along with one MPD is now on its way from PSI back to Hampton, where one set of VME crate and CPU is available. The additional two sets of VME crate with CPU and MPD will be set up and tested at Hampton University in fall 2014 before the new electronics are shipped to PSI.