WP Number	1	1-48
WP Title	Hadron Sector Detectors (Research, Develop, Training)	
Lead Beneficiary	INFN	

Objectives: Commissioning and operate the upgraded CLAS12 detectors and develop triggers to collect physics and calibration datasets. Comissioning, performance optimization and operation of the upgraded BigBite/SBS spectrometers in Hall A. Develop and operate detectors (HPS and BDX) for light dark matter searches.

Description of Work and Role of Specific Beneficiaries / Partner Organisations

T4.1: Commission CLAS12 RICH detector and reconstruction software and quantify detector performance (INFN, DU, UCONN, GWU, DUKE, JLAB). Upgrade the CLAS12 detector with a ring-imaging Cherenkov detector. Develop algorithms of particle identification. Study, prepare and validate the various configurations needed for the approved experiments. Study the match between forward and central detectors, i.e. between current and target fragmentation region covering. Study efficiency as a function of the background rejection. Integrate the measurements with a small-angle calorimeter.

T4.2: Optimally operate upgraded BigBite and new SBS spectrometers at JLab Hall-A (UNIROMA, INFN, UNICT, Glasgow University, JLab, University of Virginia, Hampton University, Carnegie Mellon University, Kharkov Institute of Physics and Technology-da, Resarm Engineering Plastics Belgium). Upgrade the BigBite and SBS spectrometers to provide a flexible experimental facility in Hall A for high luminosity polarized electron-nucleus/nucleon/pion scattering experiments offering good spatial, angular and momentum resolutions, at moderate acceptance, with polarimeter capability. Develop, test and optimize by data from calibration and physics runs, the alignment (<100 um resolution) procedures of the hybrid charged particle tracker (Silicon strip + GEM) and the working conditions in high background (up to few 100 MHz/cm2 particle flux). Optimize the timing hodoscope calibration. Finalize the real-time trackers data reduction to sustain the expected trigger rate, also properly combining the information from the timing hodoscope and HCAL-J calorimeter. Review the lesson learnt on the BigBite operation in GMn/GEn experiments to improve the detectors when installed in the SBS spectrometer and to prepare for the more demanding experiments. Port the developed solutions to the new SBS spectrometer.

T4.3: Commissioning of light dark matter detectors (INFN, JLAB, ….).
Design and build an high-density crystals-based electromagnetic calorimeter to be used as active interaction volume for light dark matter searches. Design a high efficiency and hermetic veto system to identify and reject cosmogenic background. Design, deploy and and operate a prototype of BDX detector at Jefferson Lab in similar conditions of the experiment. Design deploy and operate a MINI-BDX detector to be exposed to the beam to study beam-related background. Develop and validate a Monte Carlo simulation framework to study the SM interaction of 10.6 GeV, 10E22 Electron-On-Target with the beam-dump. Operate and calibrate the HPS PbWO electromagnetic calorimeter in the dark photon search.

T4.4: Develop high-performance polarized targets and super-conductive bulk magnets (INFN, JLAB, UNIFE, UNIROMA2). Optimize the procedures to purify and characterize sample of HD gas to be freezed in high-magnetic fields. Study the tolerance to the charged beam irradiation of a solid HD target in frozen-spin mode. Develop bulk magnets of high-temperature super-conductive material to serve as active shields or holding magnets depending on the external field experienced at the super-conductive transition. Optimize the preparation procedure of such magnets for use in very compact systems without the need of external currents leads, pre-form wiring, or normal-conductive mass for quench dumping.

T4.5 Study a streaming read-out data acquisition at the intensity frontier (INFN, MIT, JLAB**).** Design a data-acquisition architecture based on digitizers working in streaming readout mode. Develop the hardware components (fADC, front-end, networking, computer farm back end) necessary to sustain the high rates expected in high luminosity (CLAS12, EIC) and accelerator-RF asynchronous (BDX) experiments. Develop the framework to implement high-level software triggers. Instrument an electromagnetic calorimeter with a full streaming RO DAQ system. Test and validate the triggerless DAQ against a standard FPGA-based triggered DAQ to demonstrate advantages of the streaming scheme.

T4.6: Feasibility study of next generation Cherenkov detectors (INFN, JLAB, UGA, HAWAII, Weeroc, Omega). Study physics prospects and innovative technological solutions for single-photon detection over large areas. Develop compact readout architectures with integrated cooling and temperature control systems to operate silicon photo-multipliers in a single-photon regime. Study mitigations to increase radiation tolerance of silicon photo-multipliers.

Description of Deliverables:

D4.1 (M36): Technical papers on performance of the CLAS12 detectors and triggers.
D4.2 (M36): Technical papers on performance of the upgraded BigBite/SBS spectrometers.
D4.3 (M48): Report on the design of beam-dump experiments.
D4.3 (M48): Report on technical solution for polarized targets and holding magnets.
D4.3 (M48): Report on implementation and performance of a streaming readout DAQ