



Welcome

Joint CFNS & RBRC Workshop on Physics and Detector
Requirements at Zero-Degree of Colliders

24-26 September 2019

Stony Brook University

Zero-degree workshops

- HESZ
 - 2013 in Nagoya
 - Workshop on high-energy scattering at zero degree
 - 2015/2017 in Nagoya
 - Combined with Forward Physics WS
 - Workshop on forward physics and high-energy scattering at zero degrees
 - to be held in 2021
- Forward Physics WS
 - 2018 in Stony Brook
 - CFNS workshop on forward physics and instrumentation from colliders to cosmic rays
 - 2019 (Nov. 18-21) in Guanajuato, Mexico
 - Workshop on forward physics and QCD at the LHC, the future Electron Ion Collider and cosmic ray physics





Zero-degree physics

- HERA
 - Leading proton/neutron
- LHC/RHIC
 - Roman pot and more tracking
 - ZDC: EM+Hadron
 - Polarimeters @ RHIC
- EIC
 - Polarized e+p/d/3He
 - e+A
 - Short Range Correlation and EMC effect, ...
 - and more physics
 - Hadron spectroscopy, ...
- Cosmic-ray and neutrino reaction

Zero-degree physics

- DVCS measurement for access to GPDs to learn about the transverse spatial distribution (of gluons) inside the proton
- Spectator neutron and proton tagging in $e+d/3\text{He}$ collisions
- Neutron structure as a function of the neutron momentum in the np wavefunction of the deuteron
- np pairs in a highly correlated short distance interaction and the EMC effect in nuclei dominated by the high-momentum np pairs in nuclei
- Forward neutrons sensitive to the path length of the parton and fragmentation of the colliding nucleon along the virtual photon direction in the nucleus
- Breakup veto for exclusive processes on nuclei to distinguish between coherent (nucleus intact) and incoherent (nucleus decays) diffractive scattering
- Separation of beam and target fragments for hadronic kinematic reconstruction
- Tagging of very forward-going nuclear isotopes
- Energy flow in very forward region in hadron and $e+p/A$ colliders for high-energy cosmic ray/neutrino shower evolution
- Forward and very forward transverse-spin asymmetry measurement
- Application for luminosity monitors and polarimetry

Zero-degree detectors

- EIC detector requirements and R&D handbook

EIC Detector Requirements

η	Nomenclature		Tracking			Electrons		$\pi/K/p$ PID		HCAL	Muons						
			Resolution	Allowed X/X_0	Si-Vertex	Resolution σ_E/E	PID	p-Range (GeV/c)	Separation	Resolution σ_E/E							
-6.9 – -5.8	↓ p/A	Auxiliary Detectors	low- Q^2 tagger	$\delta\theta/\theta < 1.5\%$; $10^{-6} < Q^2 < 10^{-2} \text{ GeV}^2$													
...																	
-4.5 – -4.0				Instrumentation to separate charged particles from photons													
-4.0 – -3.5	Central Detector	Backwards Detectors			TBD	2%/√E	π suppression up to $1:10^4$	$\leq 7 \text{ GeV/c}$	$\sim 50\%/\sqrt{E}$								
-3.5 – -3.0			$\sigma_p/p \sim 0.1\%xp+2.0\%$														
-3.0 – -2.5																	
-2.5 – -2.0																	
-2.0 – -1.5			$\sigma_p/p \sim 0.05\%xp+1.0\%$														
-1.5 – -1.0																	
-1.0 – -0.5																	
-0.5 – 0.0																	
0.0 – 0.5			Barrel	$\sigma_p/p \sim 0.05\%xp+0.5\%$								$\sim 5\%$ or less	$\sigma_{xyz} \sim 20 \mu\text{m}$, $d_0(z) \sim d_0(r\phi) \sim 20/p_T \text{ GeV } \mu\text{m} + 5 \mu\text{m}$	$\leq 5 \text{ GeV/c}$	$\geq 3\sigma$	TBD	TBD
0.5 – 1.0																	
1.0 – 1.5	Forward Detectors			TBD	(10-12)%/√E		$\leq 8 \text{ GeV/c}$	$\sim 50\%/\sqrt{E}$									
1.5 – 2.0		$\sigma_p/p \sim 0.05\%xp+1.0\%$															
2.0 – 2.5																	
2.5 – 3.0		$\sigma_p/p \sim 0.1\%xp+2.0\%$															
3.0 – 3.5																	
3.5 – 4.0	↑ e	Auxiliary Detectors	Instrumentation to separate charged particles from photons														
4.0 – 4.5																	
...																	
> 6.2			Proton Spectrometer	$\sigma_{\text{intrinsic}}(t)/ t < 1\%$; Acceptance: $0.2 < p_T < 1.2 \text{ GeV/c}$													

+ ZDC (EM+Hadron)

Zero-degree detectors

- What are requirements for tagging or vetoing very forward particles from
 - Physics
 - Experimental condition
 - Technology
- Calorimeter
 - EM + hadron
 - Neutral particles (neutron, photon, neutral hadrons, ...)
- Roman pot & tracking
 - Proton, ...
- IR design

- RHIC
 - STAR
 - sPHENIX
- EIC detector proposal