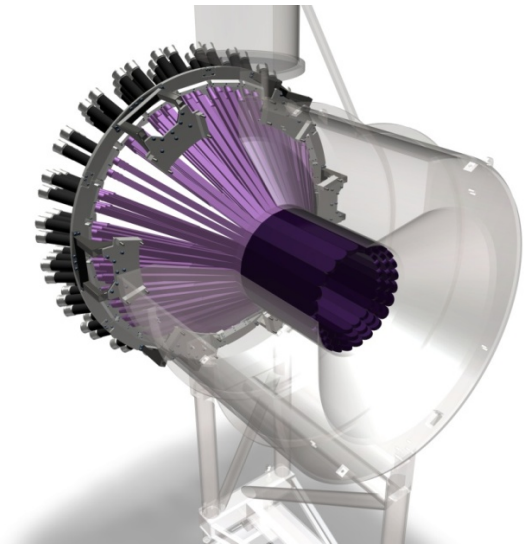
CLAS12 – CND

The detection of the recoil neutron in nDVCS and in other exclusive reactions of electroproduction on deuterium targets is one of the necessary steps towards a complete understanding of nucleon structure in terms of Generalized Parton Distributions. For this task, the CLAS12 Central Detector will be equipped with a scintillator barrel, placed between the CTOF and the magnet, which will allow the detection of neutrons between 0.2 and 1 GeV/c of momentum, identifying them via the measurement of their time of flight and hit position. The Central Neutron Detector (CND) is made of three layers of scintillator paddles (48 paddles per layer), coupled two-by-two at the front with semi-circular light guides and read at the back by photomultipliers placed outside of the high magnetic-field region and connected to the bars via 1.5-m-long bent light guides.

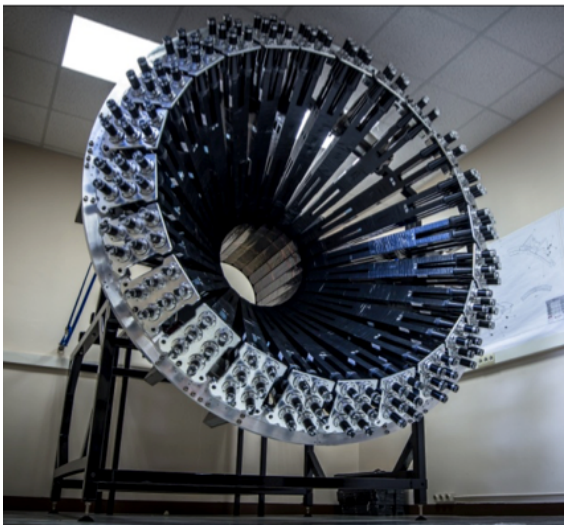


Detector - TECHNICAL PARAMETERS

PARAMETER	**DESIGN VALUE**
Detector type	Barrel of scintillators
Angular coverage	40^o to 120^o
Number of radial layers	3
Number of azimuthal segments	48
Number of scintillator bars	144
Scintillator kind	Plastic (ELJEN 200), trapezoidal shape
Scintillator cross-sections	~3x3 cm^2 (different for each layer)
Scintillator length	~70 cm (different for each layer)
Light guides upstream	144, 1.2 m long, with a 30° bend
Light guides downstream	72, « u-turn » shaped
Readout	144 PMTs, Hamamatsu R10533, upstream
Shielding for PMTs	1mm μ-metal foil, 5mm mild steel
Expected Performance	**VALUE**
Neutron detection efficiency	~10%
Time resolution	~130 ps
Polar angle resolution	$\Delta\theta = 2°$
Azimuthal angle resolution	$\Delta\phi = 2°$
Momentum range for neutron ID	0.2 – 1 GeV/c

- **Construction Strategy and Project Leadership:**
  - The project is lead by the Institut de Physique Nucléaire (IPN) d'Orsay, France (lead scientist S. Niccolai)
  - All R&D, design, prototyping, and testing of the detector took place at IPN
  - The construction of the 24 modules composing the CND and of its mechanical support structure was carried out in Orsay, while the final assembly will take place at JLab, inside of the CLAS12 solenoid

- **Significant Dates:**
  - Simulations and R&D started in 2008
  - LOI for nDVCS@CLAS12 endorsed by PAC34 (2009)
  - Proposal for nDVCS@CLAS12 approved by PAC37 and rated by PAC38 (2011)
  - CND project presented at Conseil Scientifique of IN2P3, obtained full funding (Paris, fall 2011)
  - JLab review of the CND in February 2012; R&D finalized the same year
  - Detector delivered to JLab in June 2015
  - ERR at JLab in June 2016



- **Project Status:**

- All components of the detector and of the mechanical structure have been purchased by IPN Orsay.
- Construction began in December 2013, completed in February 2015.
- Each block has been tested in cosmic rays after assembly to check time resolution and do calibrations.
- Mechanical structure assembled and tested by installing all 24 blocks in it.
- Work on reconstruction and calibration software is under completion.
- Tests in cosmic rays at JLab, to test the CND blocks with the CLAS12 electronics, were done in the spring 2016. Confirmed time resolutions measured in Orsay. The recommendations of the ERR were all addressed.

IPN ORSAY

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