Hall C Reference

Description of the Hall C Raster Systems

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Abstract

A brief description of Hall C two raster systems (target raster and polarized target raster) is summarized.

1 History

The Lissajour pattern target raster system has been used for about 8 years since 1994. The operation is based on power resonance loop. Lissajous pattern is generated from two independent sinusoidal current signals. Its simplicity makes the system very reliable. No major maintenance was performed during past 8 years.

The major problem of Lissajous raster is the uniformity of the raster pattern. Along the boundaries of raster pattern, there is density enhancement produced by slowdown behavior of sinusoidal waveform at turning point. This large increase in deposited beam energy in these areas eventually causes overheating of the target material. By experimental measurements - a luminosity scan with HMS, we found the luminosity decreases gradually by increase of beam curent. That indicates that local overheating effect near the boundaries and the corners of Lissajous pattern contributes an uncertainty in the target length which, in turn, effects the acuracy of the experimental data.

Therefore, besides upgrade target circulation system - increase stream velocity, generation of uniform raster density is the first requirement of new raster system design.

2 Operational principle

Based on an H-bridge technique, four branches of power HexaFETs form a two by two switch. The raster air-core magnet is located at the center of H-bridge. A high voltage power supply powers the two far rails of the switch. By switching the HexaFETs in the right order and at the right frequency, a triangular current waveform is generated. The timing property of the switch is determined by the H-Bridge controller. The magnetic field of the raster magnets follow the shape of the current waveform and this steers the beam using a triangular waveform rather than a sinusoidal waveform.

3 Major specification

Raster frequency in kHz	24.96/25.08
Maximum peak-to-peak current in Ampere	82
Maximum rigidity in GeV/c)	$20/\Delta x_{1/2}$ for Hall C
	$35/\Delta x_{1/2}$ for G_0
Maximum bending power in mr	0.97/p[GeV/c] for Hall C
	1.70/p[GeV/c] for G_0
Shape of raster pattern	rectangular
Shape of raster trace	triangular
Dwelling time at vertex in ns	50
Dwelling/half period in %	0.25
Trace linearity in %	98.2
Density uniformity in %	95
Operational mode	free run
	helicity synchronization
	line synchronization
Pattern on-line display	current probe 2D or 3D
	field pickup 2D or 3D

4 Special feature of the system

4.1 Rule of raster frequency selection

Two raster ferequencies are selected in this way: the two numbers are integer of 416×60 and 418×60. These two frequencies are close enough to generate a very fast rolling picture. It ensures the beam can travel as long as possible distance at unit time. The two frequencies can also be easily locked at single signal source such as line or helicity frequencies.

4.2 Sweeping properties

Compared with Lissajous raster, the H-bridge raster driver provide highly homogeneous density distribution with 98% linearity and 95 % uniformity that approaches theoretical limits. The linear sweep velocity is a constant at 1000 m/s. The return time at the raster peak is about 50 ns, the dwelling time is almost negligible. The maximum rigidity allows operation at 11 GeV/c in the near future.

4.3 Rastered beam position

The system is equipped with phase-lock module. Under phase-lock option, the two initial beam positions (in both x and y) will exactly start at the front edge of external signals. The relatively broad range of phase-lock function have made full success to synchronize helicity signals during G_0 experiment in 2002. By proper digitizing either current or filed pickup signals, users will get full knowledge about instant bean location.

4.4 Dual control system

The system is equipped with dual control systems - manual controller and EPICS control. Manual controller is installed in counting house. Users can operate the system and set up demand parameters as a stand-alone unit. When the EPICS control is runing, the manual controller automatically display the setting parameters as monitor.

4.5 On-line raster pattern display

Chris Slominski developped a on-line raster pattern display program[1]. It can provide 2D and 3D histigram display with calibrated scale. Users could use this feature to correlate with data stream as instant beam position flags. This program is available in the accounts `cvxwrks@cdaqh1` or `cdaq@cdaqs1/2/3`

[1] `http://devsrv.acc.jlab.org/controls_web/LLAPPS/AppDoc/beamRaster/gui/doc/manuals/user.html`

by clicking the left mouse button and selecting “Raster Pattern Display”. see Hall C logbook.

5 Operation

Users call MCC to ask them to set right raster size. The raster control screen display in Hall C counting house is passive. Users could check raster status, verify raster size from the parameters of the screen.

6 Polarized traget raster

The polarized target experiments ask a round shape 2.5 cm in diameter spiral raster pattern on polarized target cell. The original raster system was based on the power resonance driver. The resonance loop gives a high Q value that limits bandwidth very much. The resultant modulation ferequency is 1 Hz. Also the uniformity of the raster pattern is not satisfied by experiments.

The new design (pulse width modulation amp) will solve the problem. It will provide 100 Hz fundamental and 30 Hz modulation with absolutely density uniformity. The commissioning of new system will be scheduled at the end of 2003.

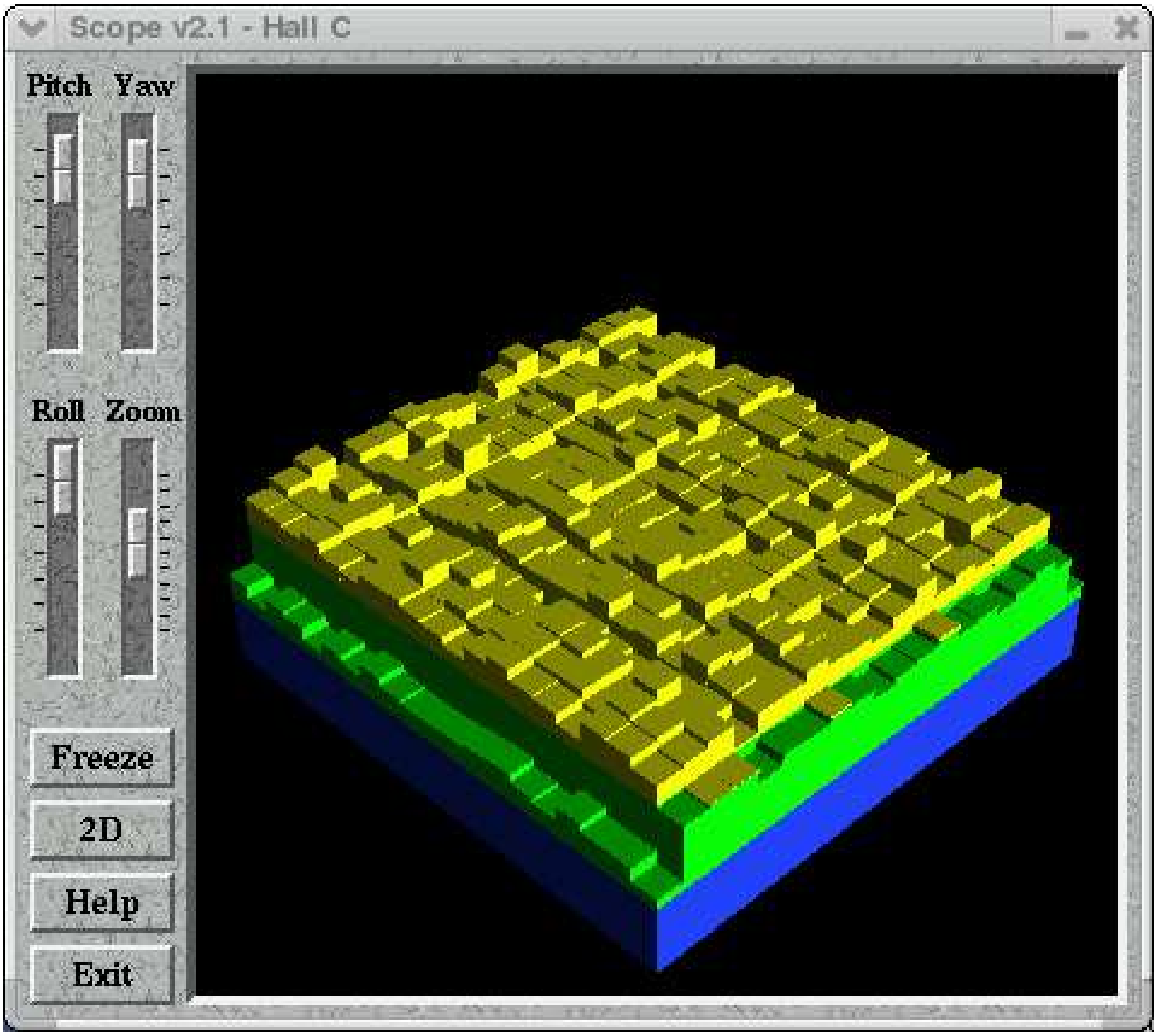

Figure 1: Raster display program