

# Polarimetry

## 1-28-2015

n<sup>3</sup>He Experiment

# Review of Initial Polarimetry Studies

## **Initial Attempts at Polarimetry:**

Performed polarimetry measurements on 12/19/2014 just before beam off. Performed polarimetry again on 01/23/2015 and 01/26/2013 following return of beam.

Initial data from 12/19 determined approximate values of SFR versus the voltage  $V$  applied to the Spin flipper circuit. Voltage is proportional to the amplitude of the magnetic field inside the spin flipper oscillating at  $f=26.655$  kHz. Voltages were varied from 10 mV to 3 volts. Maximum SFR obtained was 5.1 at 2.5 -3 Volts using the M4 beam monitor. An AFP flip at the end of the polarimetry measurements de-polarized the cell.

For polarimetry measurements on 01/23/2015 and 01/26/2015 the ion chamber was used as the beam monitor. Estimates of SFR from the DAQ computer showed a maximum spin flip ratio of about 1.5-1.6. Problems with SF electronics and high voltage supply interfered with data acquisition. Replaced D-75A audio amplifier with NPDG D-75 audio amplifier which solved the electronics problem. Re-connected HV supply.

# Polarimetry on 1-28-2015

Problem with low SFR on previous polarimetry dates was traced to faulty set-up of polarimetry apparatus on beam-line. Relatively large volume of ion chamber was absorbing neutron flux outside the limits of the polarized He-3 cell. To solve the problem the doors of the 4-Jaw collimator were closed to only allow beam flux transmitted thru the He-3 cell. Settings on the doors of the collimator from center(closed) are:

Top.....16.7 cm	Beam left .....17.2 cm
Bottom..... 13.3 cm	Beam Right.....13.7 cm

These settings will be required for all future polarimetry measurements. Neutron Background for polarimetry measurements should also be performed using these door settings.

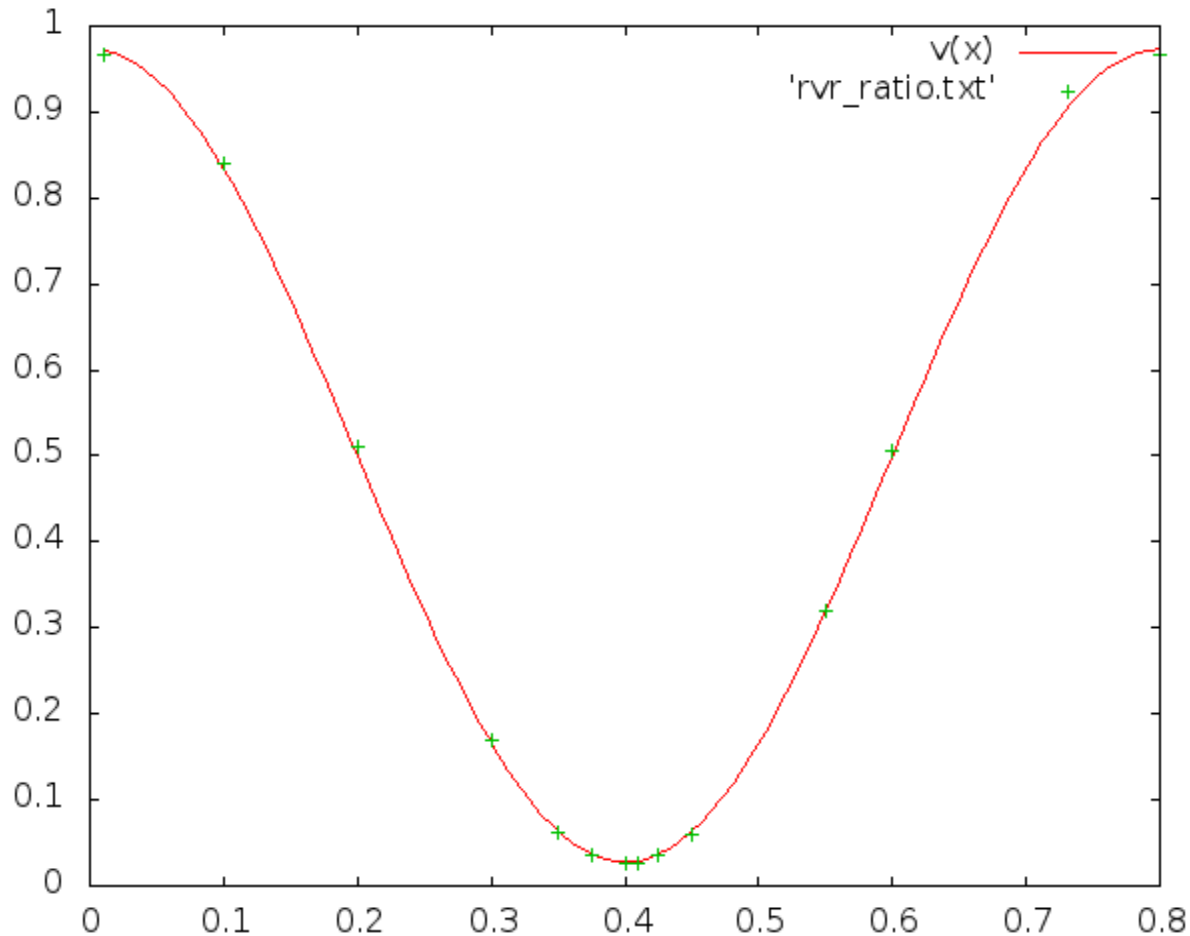
After attending to the systematic issues, spin flip ratios in excess of 30 were measured on selected ion chamber channel (25).

Plot of the inverse spin flip ratio as a function of voltage is shown below along with table of data points. Plot was made using a guide field setting at  $B=9.085$  Gauss as measured by the SF magnetometer. The plot normalizes the SFR to the maximum value which occurs at a setting of  $V = 400$  mV on the AFG 3022 function generator. The corresponding voltage amplitude being applied to the SF is about 17 Vpp. Fit to a cosine curve matches expectations with a minimum occurring at a neutron spin rotation of  $\pi$  radians.

# Data Runs for 1-28-2015

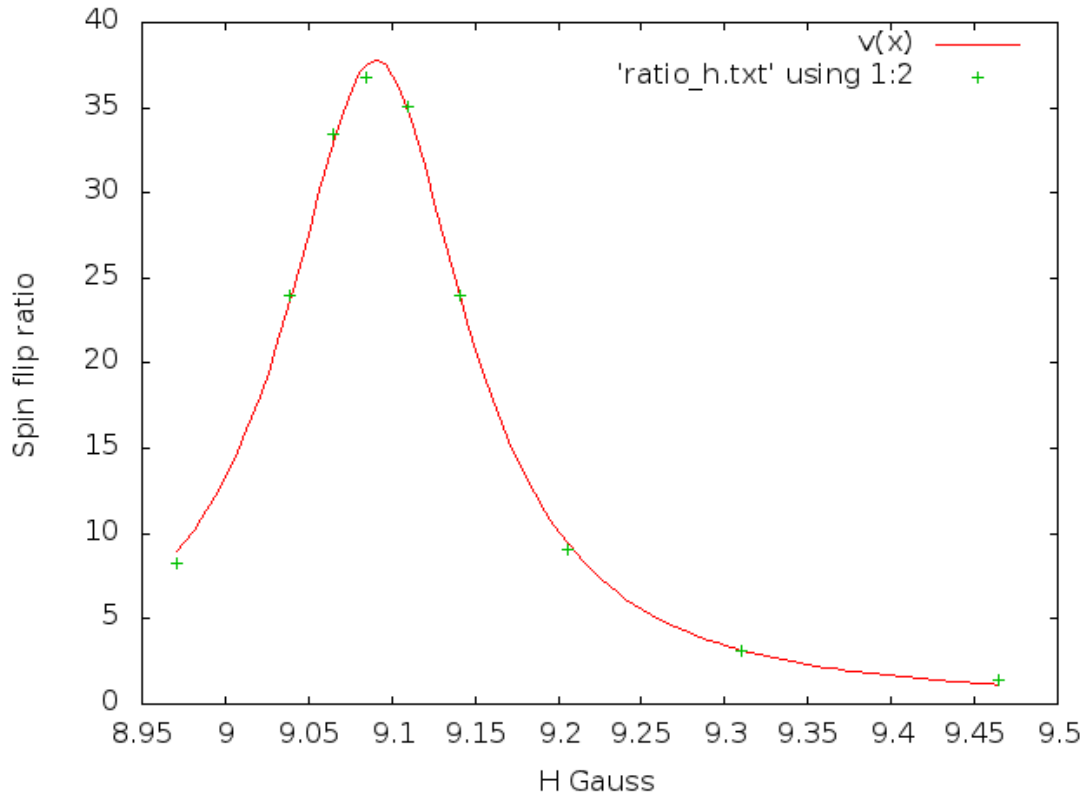
<i>Date</i>	<i>Item</i>	<i>By2</i>	<i>Run Numbers</i>	<i>Description</i>	<i>Spin</i>	<i>Current</i>	<i>FGV</i>	<i>Notes</i>
1/28/2015	1	9.085	3407-3414	Polarized Cell	up		500	Single Li Cover over Polarimetry aperture
1/28/2015	2	9.085	3415-3419	Polarized Cell	up		500	Double Li Cover over Polarimetry aperture
1/28/2015	3	9.085	3420-3424	Polarized Cell	up		500	No Li Cover
1/28/2015	4	9.085	3425-3430	Polarized Cell	up		400	
1/28/2015	5	9.085	3431-3435	Polarized Cell	up		300	
1/28/2015	6	9.085	3436-3440	Polarized Cell	up		200	
1/28/2015	7	9.085	3441-3445	Polarized Cell	up		100	
1/28/2015	8	9.085	3446-3450	Polarized Cell	up		10	
1/28/2015	9	9.085	3451-3455	Polarized Cell	up		600	
1/28/2015	10	9.085	3456-3460	Polarized Cell	up		800	
1/28/2015	11	9.085	3461-3465	Polarized Cell	up		450	
1/28/2015	12	9.085	3466-3471	Polarized Cell	up		350	
1/28/2015	13	9.085	3472-3476	Polarized Cell	up		375	
1/28/2015	14	9.085	3477-3481	Polarized Cell	up		425	
1/28/2015	15	9.085	3482-3486	Polarized Cell	up		410	
1/28/2015	16	9.085	3487-3491	Polarized Cell	up		550	
1/28/2015	17	9.085	3492-3496	Polarized Cell	up	22.00	700	
1/28/2015	18	9.465	3497-3502	Polarized Cell	up	23.00	400	
1/28/2015	19	9.31	3503-3508	Polarized Cell	up	22.60	400	
1/28/2015	20	9.206	3509-3514	Polarized Cell	up	22.32	400	
1/28/2015	21	9.11	3515-3519	Polarized Cell	up	22.10	400	
1/28/2015	22	9.141	3520-3523	Polarized Cell	up	22.16	400	
1/28/2015	23	9.039	3524-3538	Polarized Cell	up	21.90	400	
1/28/2015	24	8.971	3539-3544	Polarized Cell	up	21.72	400	
1/28/2015	25	9.065	3545	Polarized Cell	up	21.94	400	
1/28/2015	26	9.072	3550-3552	Polarized Cell	up		400	Before AFP
1/28/2015	27	9.072	3553-3554	Polarized Cell	down		400	AFP flip
1/28/2015	28	9.072	3555-3559	Polarized Cell	down		400	
1/28/2015	29	9.072	3564-3565	De-polarized Cell	x		400	

# SFR versus Voltage on Function Generator



Voltage	Inverse SF Ratio
0.3	0.1692
0.2	0.511
0.1	0.839
0.01	0.966
0.6	0.506
0.8	0.966
0.45	0.06
0.35	0.063
0.375	0.036
0.425	0.035
0.41	0.026
0.55	0.321

Plot and data table below fits spin flip ratio as a function of the guide field to a Lorentzian (Rabi curve). The plot includes a maximum SFR of 37.79 located at 9.09 Gauss and a FWHM of 0.13 Gauss

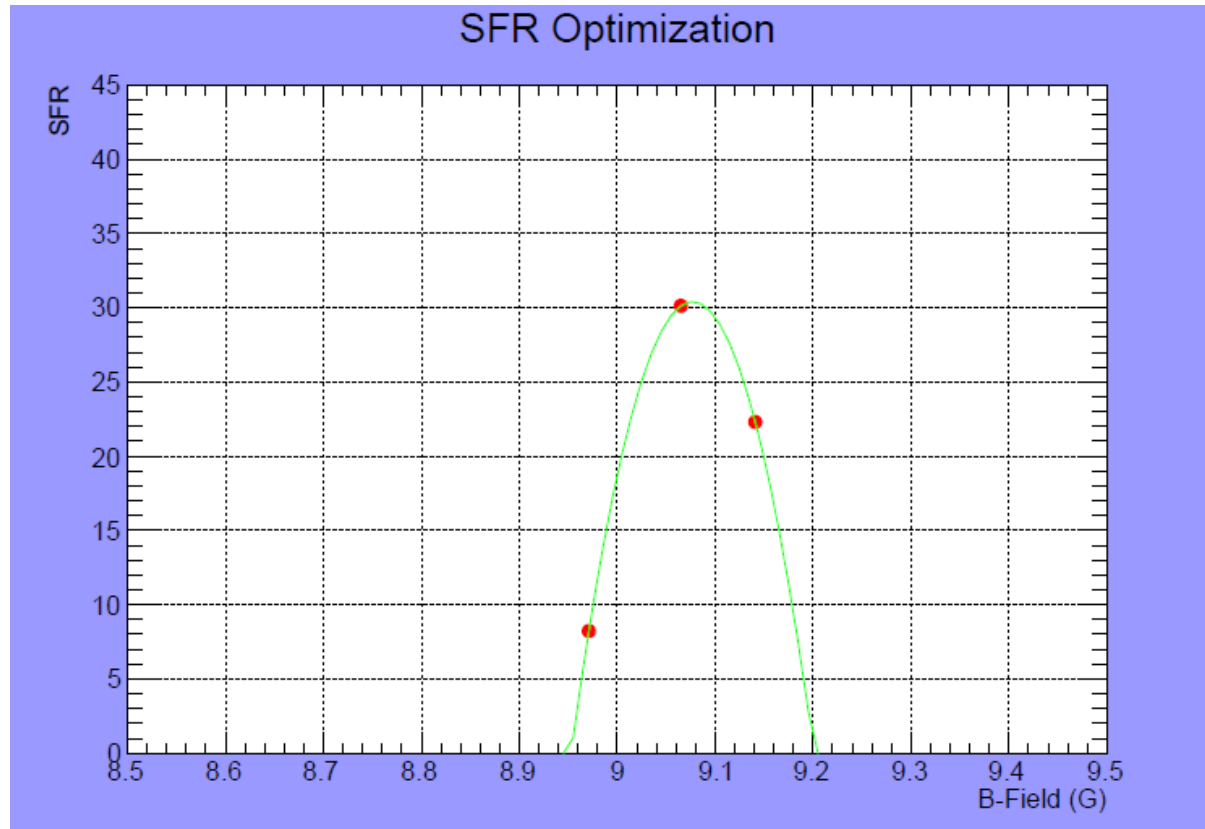


Field	Ratio
9.085	36.8
9.31	3.14
9.465	1.45
9.206	9.08
9.11	35.08
9.141	24
9.039	24.02
8.971	8.28
9.065	33.46

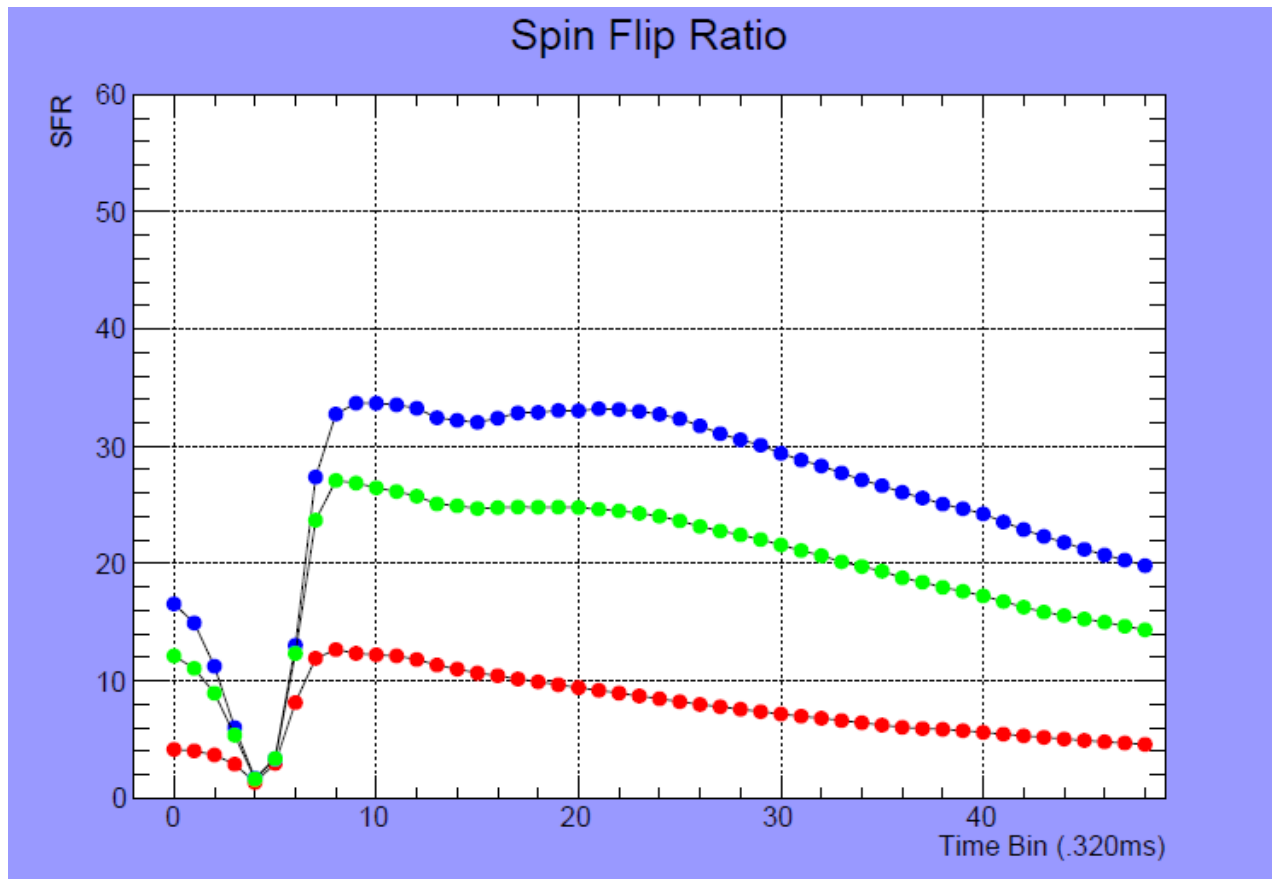
Note that a spin flip ratio of 20 corresponds to a spin flipper efficiency in excess of 97%. At SFR~37 this should give an efficiency close to 1. The parameters of the nHe3 experiment call for a minimum value for spin flipper efficiency of 98%. AFP spin flip failed again during 1/28 measurements. Problem was traced to B-field coil mounted backward on equipment.

# SFR Optimization

Plots on this page show SFR vs guide field and SFR vs Time bin drawn from ROOT programs. There were no data runs collected to measure background neutron flux so plots could not be made with the removal of background.



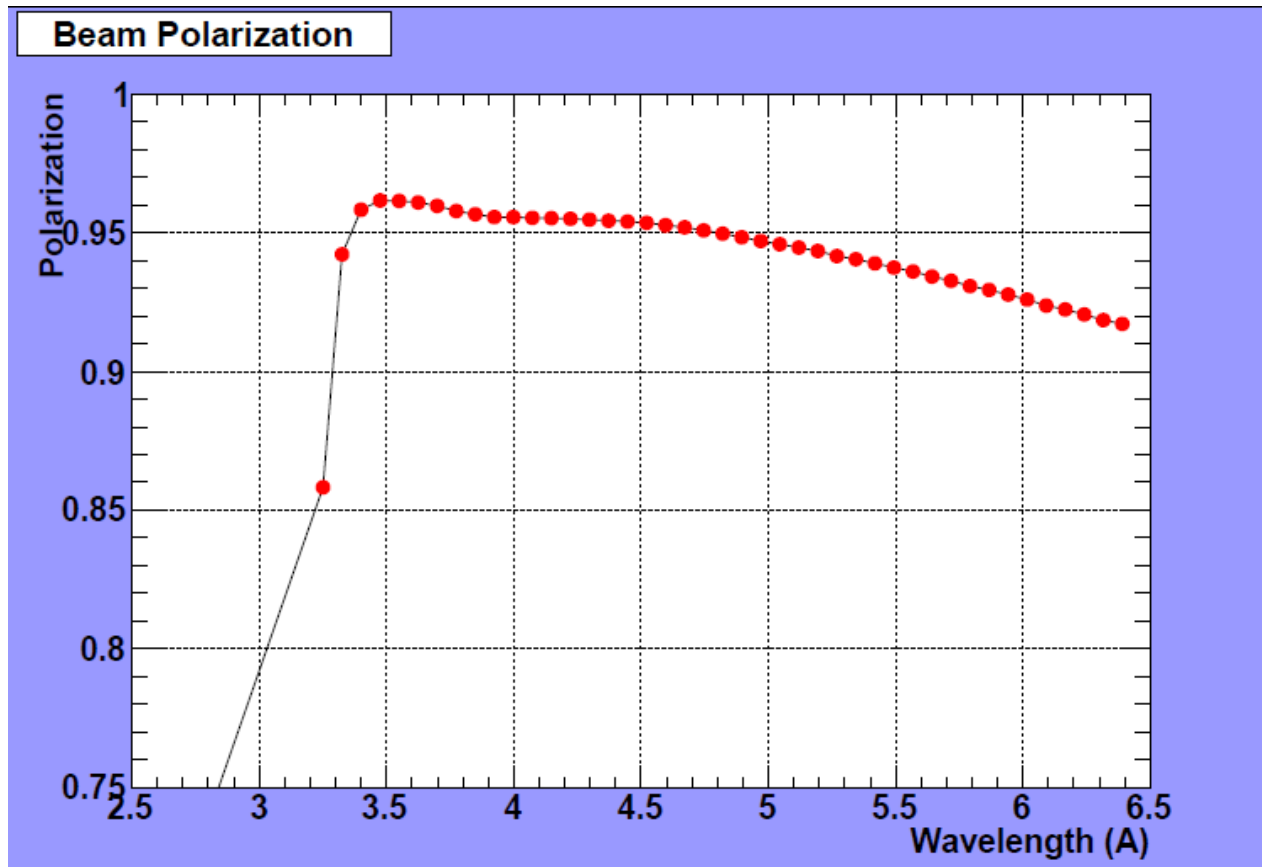
# SFR curves for Guide field optimization



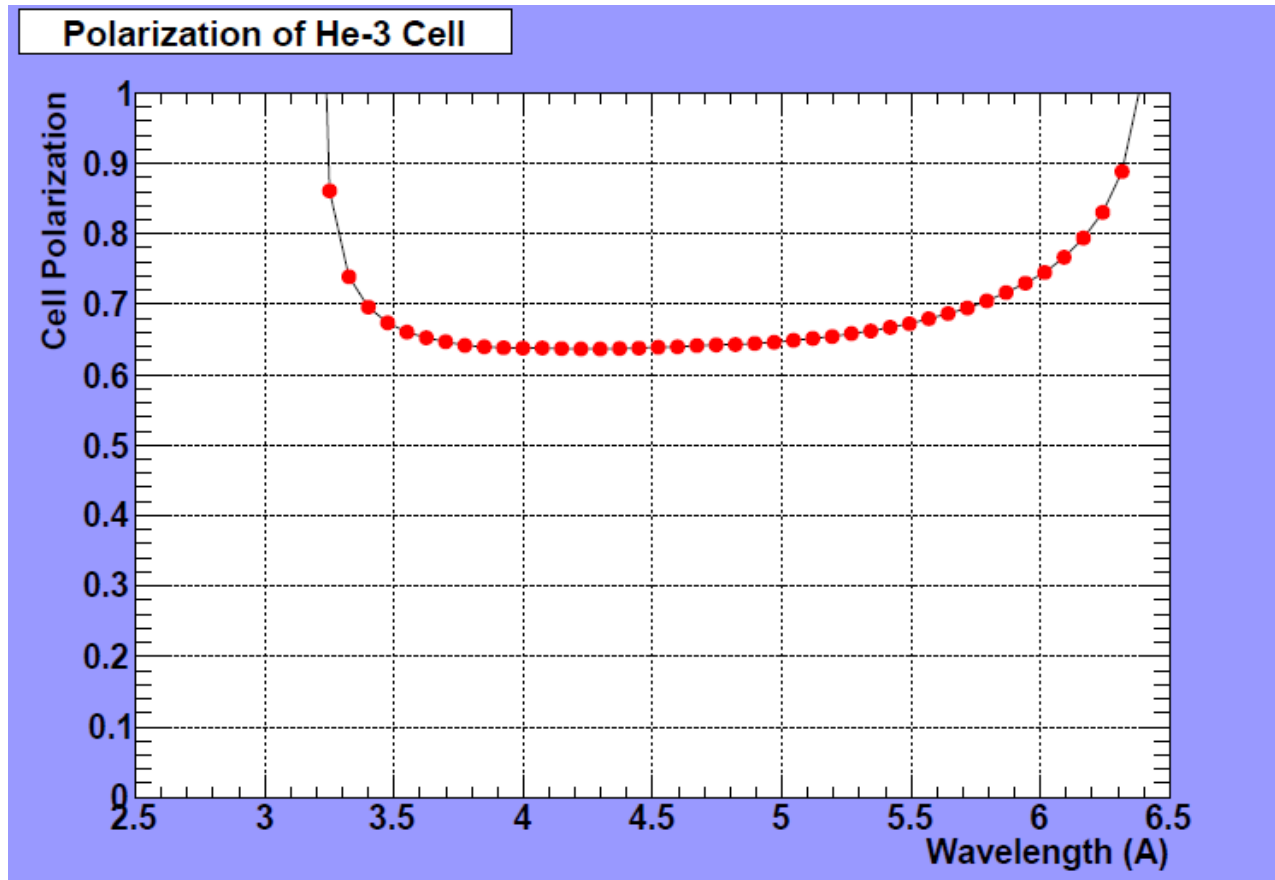


# Beam Polarization

Plots of beam polarization and cell polarization versus neutron wavelength. Both plots do include the removal of the background signal. Horizontal axes also may be slightly inaccurate since precise correspondence between time bins and wavelength is not known.



# He-3 Cell Polarization



Cell Polarization is about 63%. Upturn of polarization at large and small wavelengths may be traced to the presence of background signal.