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Control a McPherson spectrometer via scan controller

These instructions will work for almost every McPherson monochromator. They have as standard equipment a linear wavelength drive and wavelength display. These instructions are useful for any of the instruments specifically mentioned as well as a few other (older) McPherson models.

These instructions will not work for:

- Model 315, 310, 247 or 248 all these are grazing incidence models with non-linear positioning (can work with grating equation; see Instruction Manuals for the specific instruments)
- Model 303 prism model with non-linear positioning (requires external calibration / lookup table due to index of refraction)
- Model 251, 251MX fixed geometry spectrographs that do not scan their gratings

What good is a linear wavelength drive? A counter?

A linear wavelength drive is good because it uses mechanical components to convert grating angle (wavelength) to motor rotation. It allows simplified control. There is a constant rate of wavelength change per motor revolution.

For example, the Model OP-XCT with 600g/mm grating has a drive that changes wavelength by 3 nanometers for every complete motor revolution. No matter if you scan around zero order or at 100 nanometers, the motor turns one revolution and changes wavelength position by 3 nanometers. In this instrument it will simply take (100-0)/3 = 33.33 revolutions to travel from 0 to 100 nm.

Altering grating groove density, to 300g/mm for example, also linearly scales. The pitch is then 6 nanometers per revolution with the coarser grating. The pitch scales as 600/300*3

The counter is great because it allows the user to easily confirm current position. Counters generally read correctly for 1200 g/mm gratings. If you wish to accommodate the maximum number of instruments an input field for *counter gearing* can be included

Current Position (nm)	*calculated*	Counter reading X grating gear factor
Model No.	Drop down menu, e.g. select 207	e.g. 272, 2035, 207 …
Grating groove density	Drop down menu, e.g. 1200	e.g. 1200g/mm object holds 4nm/rev data
Counter Reading (nm)	User input, e.g 435.6	nm value from instrument counter
Counter gearing (for g/mm)	User input, e.g. 1200	Gearing for counter (in Model 225 counter gearing is for 600g/mm)
Limit status	Electrical, pole the scan control	if limit has been exceeded, recalibrate
Home position (nm)	User input from manual, e.g. 502.56	**Home position available only on newer models*

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General parameters are:

1. Input the value currently shown on the wavelength counter, the starting point for relative moves
2. Determine nm/rev for your instrument (refer to table below). Note the list below has values only for 1200g/mm gratings, the rate of change
3. Input the groove density of the grating actually in the beam/installed in the spectrometer, a possible factor influencing rate of change
4. input the counter gearing
5. home position equivalent wavelength *newer models only

Specific parameters are:

5. the stepping motors we provide have 36000 micro steps per motor revolution and on lowest level we talk to the scan controller in steps

Programming Example (using a terminal program)

Object:	To scan a Model 207 monochromator with 1200 G/mm grating at a rate of 100 nM/minute over a range of 40 nM, then change direction and slew back to starting wavelength at a rate of 400 nM/minute.

*refer to the 789 scan control manual for details about Velocity parameter, nm/Motor Rev rate and more

Program Line	Command	Description
1	V15000	15,000 steps/sec. (100 nM/min)
2	+ 360000	40 nM wavelength scan (360,000 steps)
3	W1000	Wait 1000 milliseconds to change velocity
4	V60000	Change V to 60,000 steps/sec. (400 nM/min)
5	-396000	Change direction and return 396,000 steps
6	+36000	Change direction and increment 36000 steps. These last two steps eliminate mechanical backlash.

Home switch feature:

*For newer models of McPherson instruments a Homing feature is also available. An additional input field is required to set wavelength equivalence to mechanical Home position. The accuracy of electronic homing is much higher than that attained from mechanical counter.

Do not attempt to home your instrument if there is no home switch installed.

The “Home Switch” is disabled for routine scanning due to the LED portion emitting IR light, possibly causing issues in systems working in the IR. The “Home” switch is enabled by sending the ASCII command “A8” via the RS232 port to the 789A-4 Controller.

Sending the ASCII command "A24" prepares the controller for the final sequence of the homing procedure.

The homing procedure consists of several steps:

1) Determining if the current wavelength is above or below the "Home" wavelength
2) Setting the wavelength to the correct starting position (approx 1 to 2 motor revolution below Home).
3) Initiating the final homing sequence

After the homing procedure has completed, sending the command "A0" disables the "Home" switch.

A more detailed treatment of commands used during Homing may be found in the 789 scan control manual

Instrument parameters (complete listing in 789 scan control manual)

Model No.	Focal length (mm)	Included Angle (°)	nm / rev. (with 1200g/mm) (nm)	Wavelength range allowed with 1200g/mm (nm)
272	200	38	25 *1140g/mm	<0 - 1250
2035	350	26.8	12.5	<0 - 1300
205	500	26	4	<0 - 1300
207	667	25.24	4	<0 - 1300
2061	1,000	14.32	4	<0 - 1300
209	1,333	9.96	4	<0 - 1300
2062	2,000	6.2	4	<0 - 1300
Vacuum				
234/302	200	64	2	<0 - 550
218	305	22	4	<0 - 1000
219	500	32	4	<0 - 1200
235	500	70.25	4	<0 - 300
225	1,000	15	2.5	<0 - 300

Nm / step (with 1200G/mm) : 789 controller is normally operated at 36000 steps per revolution, therefore the nm increment per step is the value given / 36000

Mechanical backlash: always approach from one full (motor) revolution below the wavelength of interest

Included Angle: does not indicate which instruments are asymmetrical, and have different incident and diffracted angles

Standard Gratings Offered: 50, 75, 150, 300, 570, 600, 1140, 1200, 1710, 1800, 2280, 2400, 3600 grooves per mm.

Counter: All instruments have a mechanical counter for wavelength readout. A "counter" input field permits users to simply calibrate the x (wavelength) axis by entering the central wavelength, e.g. counter reading. The mechanical counter may be geared to read directly for different grating. A "counter gearing" input field helps accommodate more instruments (esp. older)

Limit switches: exist to protect the instruments mechanical parts and prevent "crashing". Normally an out of range move is prevented by (1) error message if out of bounds value is entered, and (2) limit switch is tripped. In case of (2) above, the Home sequence or other calibration is required.

General Observation: Alternate and unpredictable parameter values are occasionally required. Ideally .ini or .cfg file holds the instrument parameters in easily editable format. Alternately, all the menu values should be allowed to be forced, e.g. force groove density off a drop down menu and to specific value = 1201.6g/mm grating, or wavelength pitch = 2.9 nanometers per revolution.

General Observation II: Some other company makes it very difficult to calibrate x-axis in nanometers. We believe (but have not seen the code) that they calculate the x-axis values based on interpretation of direct drive grating position, a necessary evil for some. Accordingly, *for them*, calibrating x-axis as nanometers requires many known wavelength points and recursive analysis.

For McPherson instruments, x-axis is easily calibrated with the grating equation and solving a range of diffracted angles determined by CCD pixel size/pitch. DO NOT OVER COMPLICATE THIS!