

高场核磁共振仪 器维护

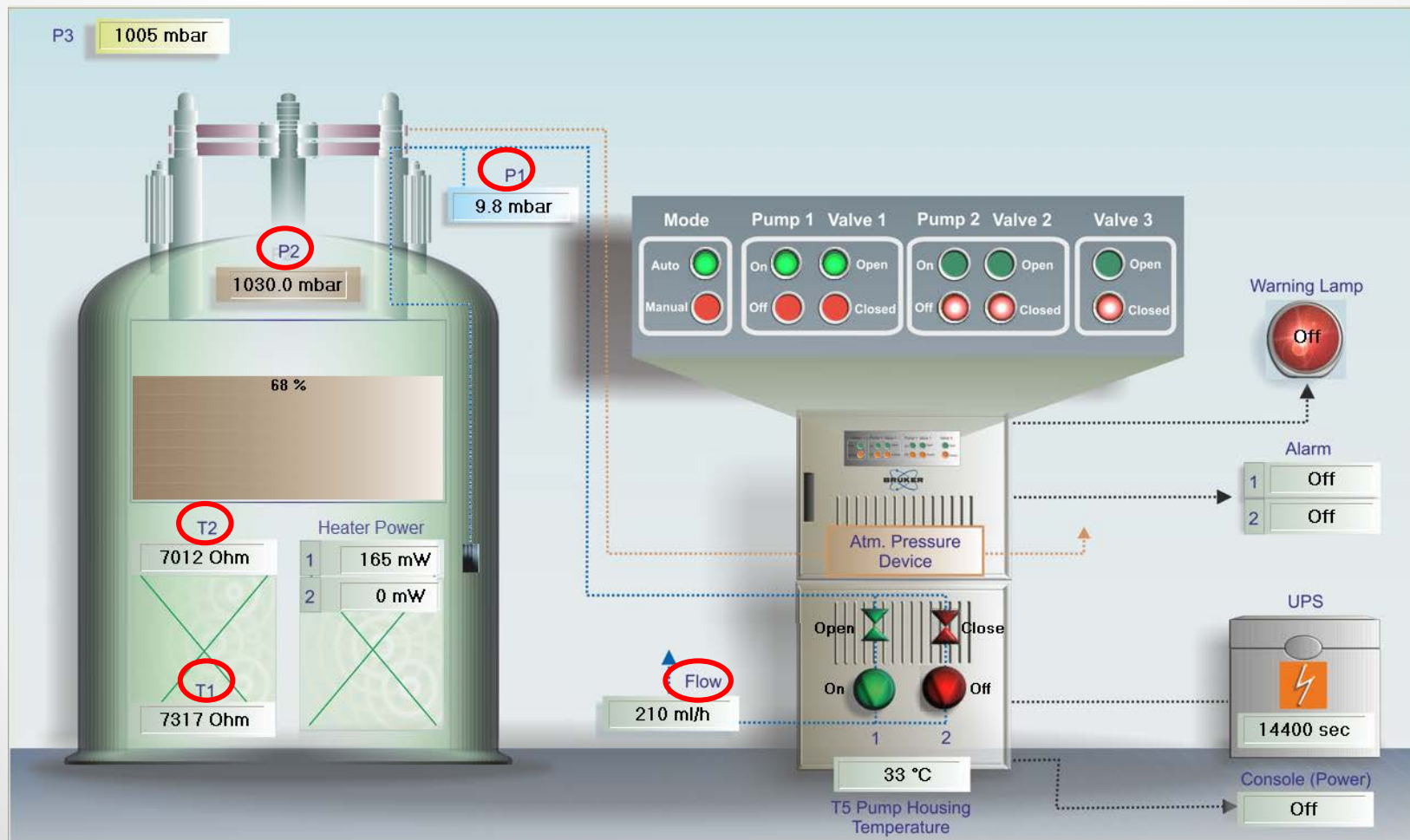
李红卫

2019年度北京波谱年会，2019-05-18

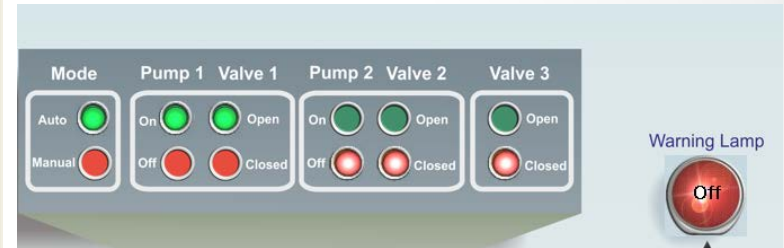
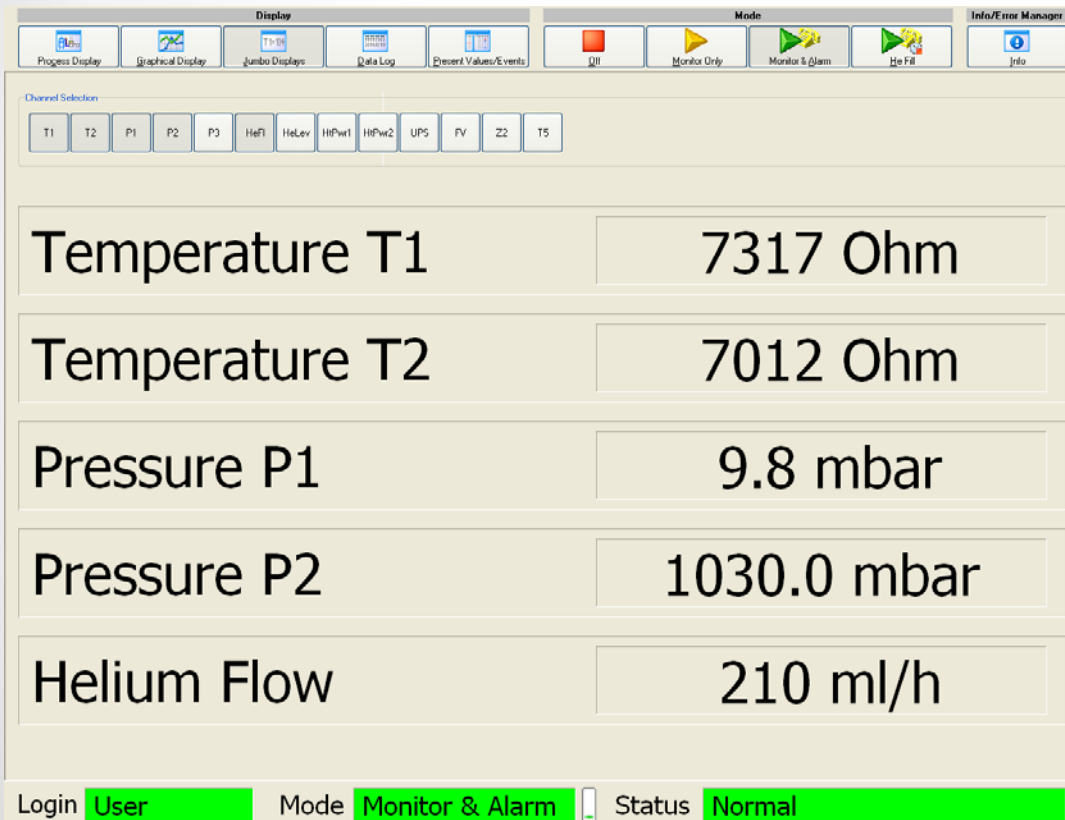
内容摘要

- BMPC (Bruker Magnet Pump Control) 系统
- 超低温探头系统
- 核磁共振仪器硬件性能测试

2K超导磁体及BMPC系统



BMPC系统维护



日常监测重要参数，
遇到问题及时排除，
定期更换真空泵的
机油和UPS的电池。



长时间停电时应将连接在容量更大UPS上的备用真空泵连接至管路，待UPS电池接近没电时启用第三路泵。

(T1: 7317, T2: 7012)

(T1: 7150, T2: 6850) min

超低温探头系统



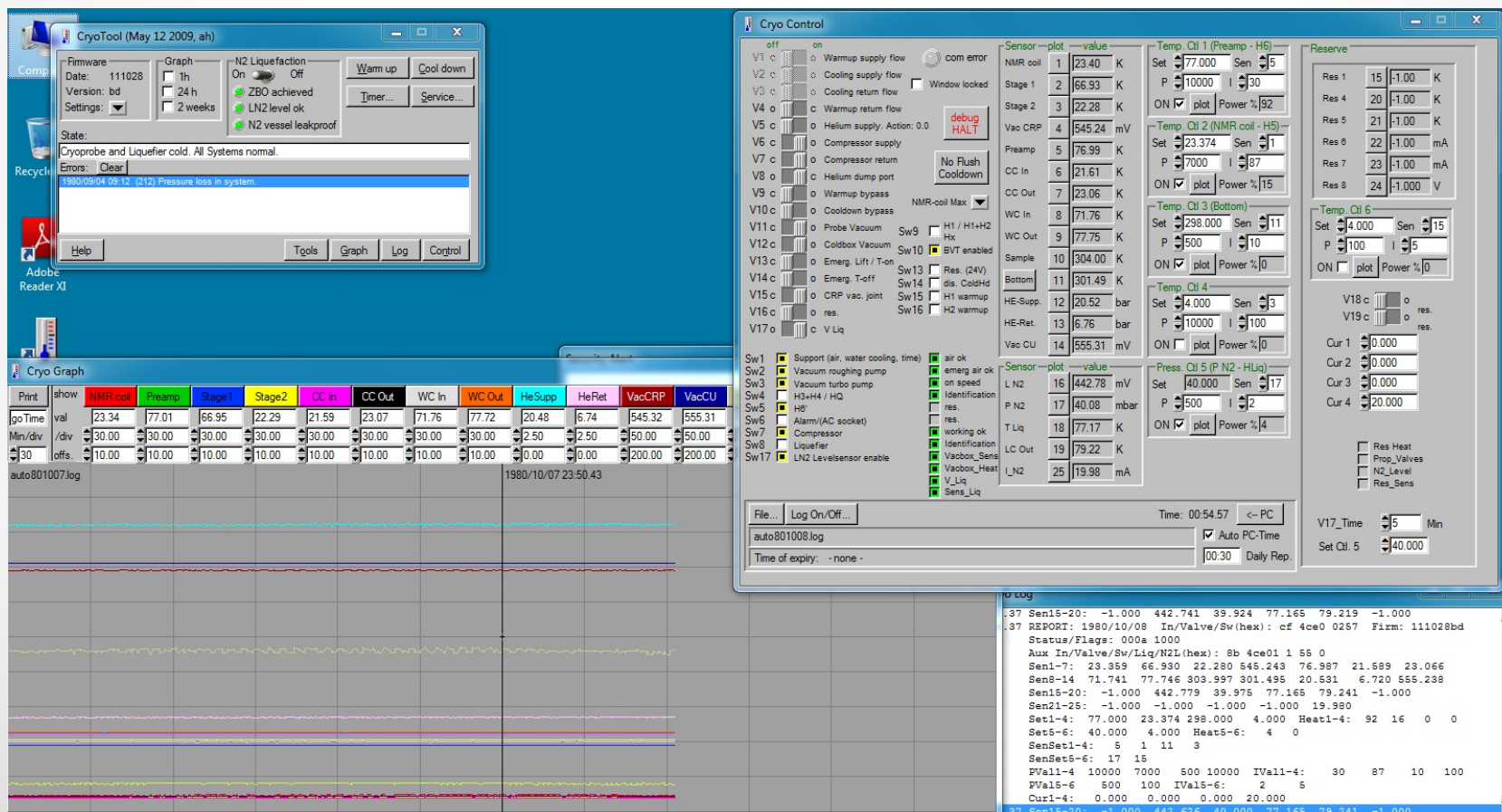
室内控制系统



室外压缩机

超低温探头系统维护

- 日常监测性能参数



CryoTool (May 12 2009, ah)

Firmware
Date: 111028
Version: bd
Settings: ▼

Graph
☐ 1h
☐ 24 h
☐ 2 weeks

N2 Liquefaction
On ☒ Off
☒ ZBO achieved
☒ LN2 level ok
☒ N2 vessel leakproof

Warm up Cool down
Timer... Service...

State:
Cryoprobe and Liquefier cold. All Sys

Cryo Control

Errors: Clear
1980/09/04 09:12 (212) Pressure loss

Help

off on
V1 ☒ Warmup supply flow com error
V2 ☒ Cooling supply flow Window locked
V3 ☒ Cooling return flow
V4 ☒ Warmup return flow
V5 ☒ Helium supply. Action: 0.0
V6 ☒ Compressor supply
V7 ☒ Compressor return
V8 ☒ Helium dump port
V9 ☒ Warmup bypass
V10 ☒ Cooldown bypass
V11 ☒ Probe Vacuum Sw9 ☐ H1 / H1+H2 Hx
V12 ☒ Coldbox Vacuum Sw10 ☒ BVT enabled
V13 ☒ Emerg. Lift / T-on Sw13 ☐ Res. (24V)
V14 ☒ Emerg. T-off Sw14 ☐ dis. ColdHd
V15 ☒ CRP vac. joint Sw15 ☐ H1 warmup
V16 ☒ res. Sw16 ☐ H2 warmup
V17 ☒ V Liq

debug HALT
No Flush Cooldown
NMR-coil Max ▼

Sw1 ☒ Support (air, water cooling, time) ☒ air ok
Sw2 ☒ Vacuum roughing pump ☒ emerg air ok
Sw3 ☒ Vacuum turbo pump ☒ on speed
Sw4 ☐ H3+H4 / HQ ☐ Identification
Sw5 ☒ H6 ☐ res.
Sw6 ☐ Alarm/(AC socket) ☐ res.
Sw7 ☐ Compressor ☒ working ok
Sw8 ☐ Liquefier ☒ Identification
Sw17 ☒ LN2 Levelsensor enable ☒ Vacbox_Sens
☒ Vacbox_Heat
☒ V_Liq
☒ Sens_Liq

Sensor plot value
NMR coil 1 23.40 K
Stage 1 2 66.93 K
Stage 2 3 22.28 K
Vac CRP 4 545.24 mV
Preamp 5 76.99 K
CC In 6 21.61 K
CC Out 7 23.06 K
WC In 8 71.76 K
WC Out 9 77.75 K
Sample 10 304.00 K
Bottom 11 301.49 K
HE-Supp. 12 20.52 bar
HE-Ret. 13 6.76 bar
Vac CU 14 555.31 mV

Temp. Ctl 1 (Preamp - H6)
Set 77.000 Sen 5
P 10000 I 30
ON ☒ plot Power % 92
Temp. Ctl 2 (NMR coil - H5)
Set 23.374 Sen 1
P 7000 I 87
ON ☒ plot Power % 15
Temp. Ctl 3 (Bottom)
Set 298.000 Sen 11
P 500 I 10
ON ☒ plot Power % 0
Temp. Ctl 4
Set 4.000 Sen 3
P 10000 I 100
ON ☐ plot Power % 0
Press. Ctl 5 (P N2 - HLiq)
Set 40.000 Sen 17
P 500 I 2
ON ☒ plot Power % 4

Reserve
Res 1 15 -1.00 K
Res 4 20 -1.00 K
Res 5 21 -1.00 K
Res 6 22 -1.00 mA
Res 7 23 -1.00 mA
Res 8 24 -1.00 V

Temp. Ctl 6
Set 4.000 Sen 15
P 100 I 5
ON ☐ plot Power % 0
V18 ☐ res.
V19 ☐ res.
Cur 1 0.000
Cur 2 0.000
Cur 3 0.000
Cur 4 20.000
☐ Res Heat
☐ Prop_Valves
☐ N2_Level
☐ Res_Sens
V17_Time 5 Min
Set Ctl. 5 40.000

File... Log On/Off...
auto801008.log
Time of expiry: - none -
Time: 00:54.57 <- PC
☒ Auto PC-Time
00:30 Daily Rep.

- Warm up和Cool down

Cryo Control

off on

V1 c ☐ Warmup supply flow ☐ com error

V2 c ☐ Cooling supply flow ☐ Window locked

V3 c ☐ Cooling return flow

V4 o ☐ Warmup return flow

V5 c ☐ Helium supply. Action: 0.0

V6 c ☐ Compressor supply

V7 c ☐ Compressor return

V8 o ☐ Helium dump port

V9 c ☐ Warmup bypass

V10 c ☐Cooldown bypass

V11 c ☐ Probe Vacuum

V12 c ☐ Coldbox Vacuum

V13 c ☐ Emerg. Lrt / T-on

V14 c ☐ Emerg. T-off

V15 c ☐ CRP vac. joint

V16 c ☐ res.

V17 o ☐ V Liq

Sw1 ☒ Support (air, water cooling, time)

Sw2 ☒ Vacuum roughing pump

Sw3 ☒ Vacuum turbo pump

Sw4 ☒ H2/N2 / H2

Sw5 ☒ H8'

Sw6 ☐ Alarm/(AC socket)

Sw7 ☐ Compressor

Sw8 ☐ Liquefier

Sw17 ☒ LN2 Levelsensor enable

Sw9 ☐ H1 / H1+H2 Hx

Sw10 ☒ BVT enabled

Sw13 ☐ Res. (24V)

Sw14 ☐ dis. ColdHd

Sw15 ☐ H1 warmup

Sw16 ☐ H2 warmup

debug HALT

No Flush Cooldown

NMR-coil Max

Sensor—plot—value

Sensor	plot	value
NMR coil	1	23.40 K
Stage 1	2	66.93 K
Stage 2	3	22.28 K
Vac CRP	4	545.24 mV
Preamp	5	76.99 K
CC In	6	21.61 K
CC Out	7	23.06 K
WC In	8	71.76 K
WC Out	9	77.75 K
Sample	10	304.00 K
Bottom	11	301.49 K
HE-Supp.	12	20.52 bar
HE-Ret	13	6.76 bar
Vac CU	14	555.31 mV
L N2	16	442.78 mV
P N2	17	40.08 mbar
T Liq	18	77.17 K
LC Out	19	79.22 K
I_N2	25	19.98 mA

Temp. Ctl 1 (Preamp - H6)

Set 77.000 Sen 5

P 10000 I 30

ON ☒ plot Power % 92

Temp. Ctl 2 (NMR coil - H5)

Set 23.374 Sen 1

P 7000 I 87

ON ☒ plot Power % 15

Temp. Ctl 3 (Bottom)

Set 298.000 Sen 11

P 500 I 10

ON ☒ plot Power % 0

Temp. Ctl 4

Set 4.000 Sen 3

P 10000 I 100

ON ☐ plot Power % 0

Press. Ctl 5 (P N2 - H Liq)

Set 40.000 Sen 17

P 500 I 2

ON ☒ plot Power % 4

Reserve

Res	Set	Sen	Unit
Res 1	15	-1.00	K
Res 4	20	-1.00	K
Res 5	21	-1.00	K
Res 6	22	-1.00	mA
Res 7	23	-1.00	mA
Res 8	24	-1.000	V

Temp. Ctl 6

Set 4.000 Sen 15

P 100 I 5

ON ☐ plot Power % 0

V18 c ☐ res.

V19 c ☐ res.

Cur 1 0.000

Cur 2 0.000

Cur 3 0.000

Cur 4 20.000

☐ Res Heat

☐ Prop_Valves

☐ N2_Level

☐ Res_Sens

V17_Time 5 Min

Set Ctl. 5 40.000

File... Log On/Off...

auto801008.log

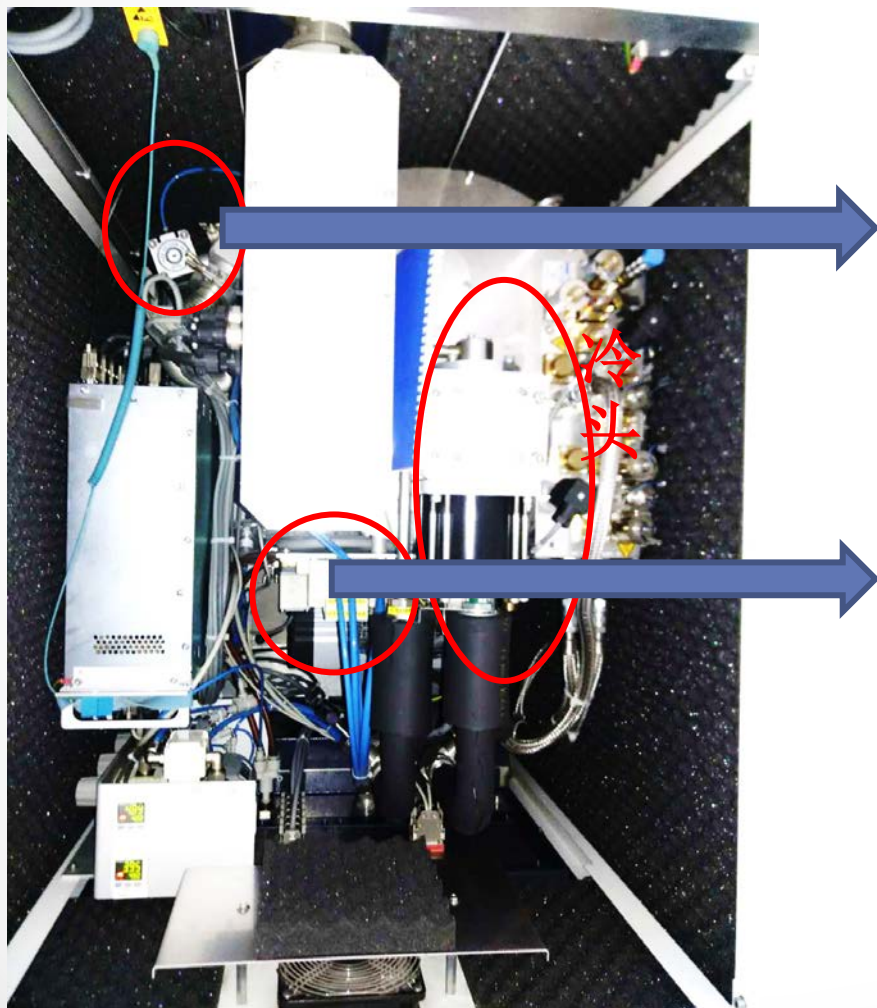
Time of expiry: - none -

Time: 00:54:57 <-- PC

☒ Auto PC-Time

00:30 Daily Rep.

- 定期做冷头维护和冲洗室外机



分子泵



机械泵

硬件性能测试 (hwt)



Acceptance Report NMR Spectrometer

Contract No: CN13906/13
Bruker No: 10120448
Equipment: AVIII800
Date: 15/Sep/2014
Page: 1(2)

Customer Information			
Customer Name (Responsible Person)	CHANGWEN JIN		
Company / Institution	Peking University		
Address / Street / Building / Room	No.5, Yiheyuan Road, Haidian District		
Postal Code / Town	100080 Beijing		
Phone	+86-10-62754782		Fax
Email			

Summary of Test Results

lineshape (ls) and Resolution (rs),							Resolution at 50% Linewidth at 0.55% / 0.11%											
Probe#	Serial #	Type	Options	Ø	Nuc	Sample①	Resolution(Hz)				Lineshape(Hz)				SSB(%)②			
							rotating		non-rot		rotating		non-rot		rotating		rotating	
							spec	ach	spec	ach	spec	ach	spec	ach	spec	ach		
Z119427	0010	CPTCI	ATM	5	1H	A	0.7	0.51	0.8	0.77	7/14	4.9/9.6	8/16	7.2/12.6	1	0.3		
Z119427	0010	CPTCI	ATM	5	13C	G	0.5	0.12			5/8	1.1/3.4			1	0.1		
			</															

① 1H

A 0.3% CHCl₃-600MHz
B 1%CHCl₃ 500-600MHz
C 3% CHCl₃ 200-400MHz
D 10% CHCl₃ 200-400MHz (2.5mm Probe)
E 2mM Sucrose 0.5mM DSS
F 0.1% EB (2ppm/200Hz)
G ASTM ~40% p-Dioxane in C₆D₆
I 10% EB in CDCl₃
H TPP~48.5mM Triphenylphosphate
L Form~90% Formamide (¹H decoupling)
K TBT~0.05% 1,3,5-Trifluorotoluene
M 0.1M CTDOH ¹³C, 0.1M Urea ¹⁵N

② Spinning Sidebands (SSB) & Transients

④ Wideline probes only



Acceptance Report NMR Spectrometer

Contract No: CN13906/13
Bruker No: 10120448
Equipment: AVIII800
Date: 15/Sep/2014
Page: 2(2)

Sensitivity(S/N)													
Probe#	Serial #	Type	Options	Ø	Nuc	Sample①	S/N		90° Pulse (µs)		Dead time(µs)②		Remarks
							spec	ach	spec	ach	spec	ach	
Z119427	0010	CPTCI	ATM	5	1H	F	8600	9047	8	7.9			9.3w, noise = 200Hz
Z119427	0010	CPTCI	ATM	5	1H	E	1200	1213	8	7.9			9.3w
Z119427	0010	CPTCI	ATM	5	13C	G	1550	1711	12	11.9			164w
Z119427	0010	CPTCI	ATM	5	13C	I		1693	12	11.9			164w
Z119427	0010	CPTCI	ATM	5	15N	M			32	31.9			215w

Copies of all spectra are in the customer's possession.

Customer Training according to Acceptance Test Procedure ZUEP0102

<input checked="" type="checkbox"/> Basic safety precautions	<input checked="" type="checkbox"/> Loading software	<input checked="" type="checkbox"/> Water suppression
<input checked="" type="checkbox"/> Posting magnetic field warning signs	<input checked="" type="checkbox"/> Basic operation	<input checked="" type="checkbox"/> 2D experiments
<input checked="" type="checkbox"/> Cryogenic handling, magnet refilling	<input checked="" type="checkbox"/> Software service tools	<input checked="" type="checkbox"/> GRASP-Equipment
<input checked="" type="checkbox"/> Helium/Nitrogen level	<input checked="" type="checkbox"/> System documentation	<input checked="" type="checkbox"/> Variable temperature
<input checked="" type="checkbox"/> Homogeneity/stability disturbance	<input checked="" type="checkbox"/> Explanation of warranty	<input checked="" type="checkbox"/> MAS and High power
<input checked="" type="checkbox"/> Hardware overview	<input checked="" type="checkbox"/> Customer support (Tel/Fax)	<input checked="" type="checkbox"/> Automation/sample changer
<input checked="" type="checkbox"/> Console ON/OFF operation & safety	<input checked="" type="checkbox"/> Maintenance	<input checked="" type="checkbox"/> Troubleshooting
<input checked="" type="checkbox"/> Tuning and matching	<input checked="" type="checkbox"/> RF power limits	<input checked="" type="checkbox"/> RF routing
<input checked="" type="checkbox"/> Handling/cleaning of Cryoprobe	<input checked="" type="checkbox"/> RF heating	

* He bottle exchange

(for Cryoprobes only)

Remarks/Exclusions

1. I agree that the above tests were performed during installation and are meeting the published or contractually agreed specifications.

2. In accordance with the terms of sale, the period of warranty will begin (exc.) on: 15/Sep/2014
Duration 36 months.

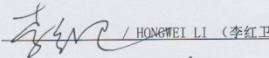
3. I accept that this installation is complete (exc.) as per the sales agreement and I authorise payment of the outstanding balance due for this system.

Place BEIJING

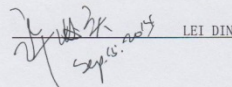
Date: 15/Sep/2014

Customer Representative:(signature/printed, same as 1st page)

Bruker Representative/Initials: (signature/printed)

 HONGWEI LI (李红卫)

Date Signed By Customer: 2014.9.15

 LEI DING

HWT

File Edit

List of available experiments:

use the left mouse button to move an experiment to the group
use the right mouse button to edit the experiment

1D

2D

Good

HWT
gen

HWT
mod

HWT
grad

Other

phase stability test (13 degree test)

amplitude stability test (90 degree)

amplitude stability test (30 degree)

phase cycling cancellation test

amplitude linearity test (0 - 59 dB in 1 dB steps)

amplitude linearity test (pulse length *2, power +6 dB)

quad image suppression test (4 * 1 scan, 4 * 4 scans)

receiver gain test (digital, 16fold oversampling)

B1 homogeneity test

turn on test - dante type

turn on test

B1 homogeneity test C-13

C-13 decoupler profile (chirp)

C-13 decoupler profile (garp)

C-13 decoupler profile (waltz)

glitch test : H-1 frequency

phase propagation test

phase shifting test

180 degree pulse calibration test (different phases)

pulse calibration test (different flip angles)

Add / modify experiments

current probe: 5 mm CPTC1 1H-13C/15N/D Z-GRD Z123212/0006

dataset name:

use sample changer: no

Group of selected experiments

ATP

GLP

HWT

SVT

filename of group:

Clear

```

1 Prep. Exp. for : phase stability test (13 deg
2 phase stability test (13 degree test)
3 amplitude stability test (90 degree)
4 amplitude stability test (30 degree)
5 phase cycling cancellation test
6 amplitude linearity test (0 - 59 dB in 1 dB s
7 amplitude linearity test (pulse length *2, po
8 quad image suppression test (4 * 1 scan, 4 *
9 receiver gain test (digital, 16fold oversampl
10 B1 homogeneity test
11 turn on test
12 B1 homogeneity test C-13
13 C-13 decoupler profile (chirp)
14 C-13 decoupler profile (garp)
15 C-13 decoupler profile (waltz)
16 glitch test : H-1 frequency
17 phase propagation test
18 phase shifting test
19 180 degree pulse calibration test (different
20 pulse calibration test (different flip angles
21 modulator linearity test (5 - 100% in 5% step
22 shaped pulse amplitude stability test
23 shaped pulse phase stability test
24 shaped pulse amplitude linearity test (pulse
25 shaped pulse comparison (rectangular, gaussia
26 shaped pulse modulator linearity test
27 excitation profile 1
28 excitation profile 2
29 z-gradient profile (positive)
30 z-gradient profile (negative)
31 amplitude stability test after gradient pulse
32 gradient recovery test
33 amplitude stability test after gradient echo
34 amplitude stability test after gradient echo
35 phase cycling cancellation test after gradien

```

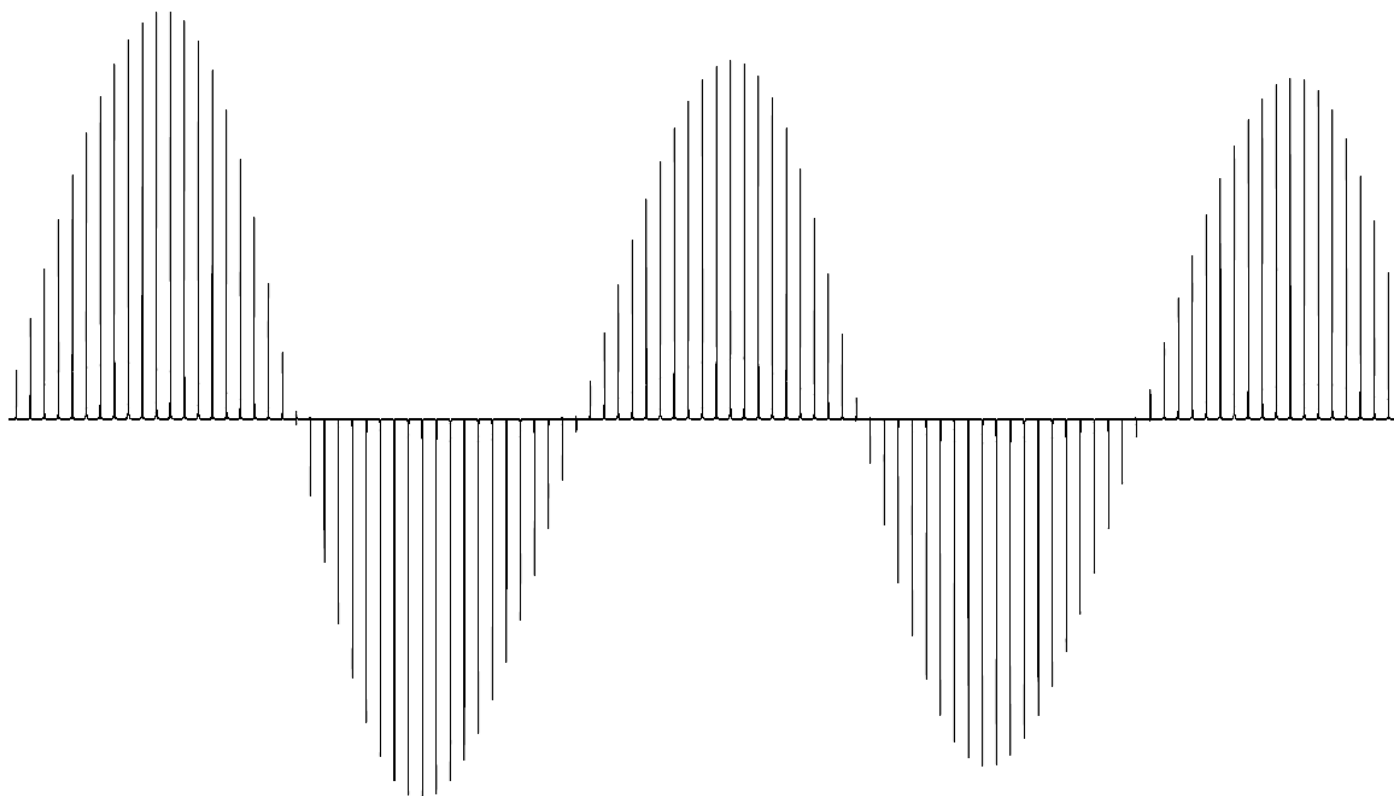
```

1
2 sysphas1st ne 32
3 sysamp1st factor 1.0
4 sysamp1st factor 0.33
5 syscancel
6 sysmultl1 ne 60
7 syspullin1 ne 8
8 sysquadim
9 sysrgtest
10 sysb1hom
11 systurnon plstart 0.0
12 sysb2hom
13 sysdecpro1 cpdprg chi
14 sysdecpro1 cpdprg gar
15 sysdecpro1 cpdprg wal
16 sysglitch
17 sysphasf1 pulsepr sys
18 sysphasf1 pulsepr sys
19 sys180fit1
20 sys180fit2
21 sysmodl1
22 sysamp1sp9 p11 16.0 s
23 sysphas1sp p11 16.0 s
24 syssspln1 p11 16.0 sh
25 syssoftp1 p11 16.0
26 sysmodls1 p11 16.0
27 syssexpro1 p11 6000.0
28 syssexpro1 p11 16.0 sh
29 sysgrzpro gradcnst 50
30 sysgrzpro gradcnst 50
31 sysgrstab ne 32
32 sysgreco1 p16 5000.0
33 sysgrecho p16 5000.0
34 sysgrecho p16 5000.0
35 sysgrcan

```

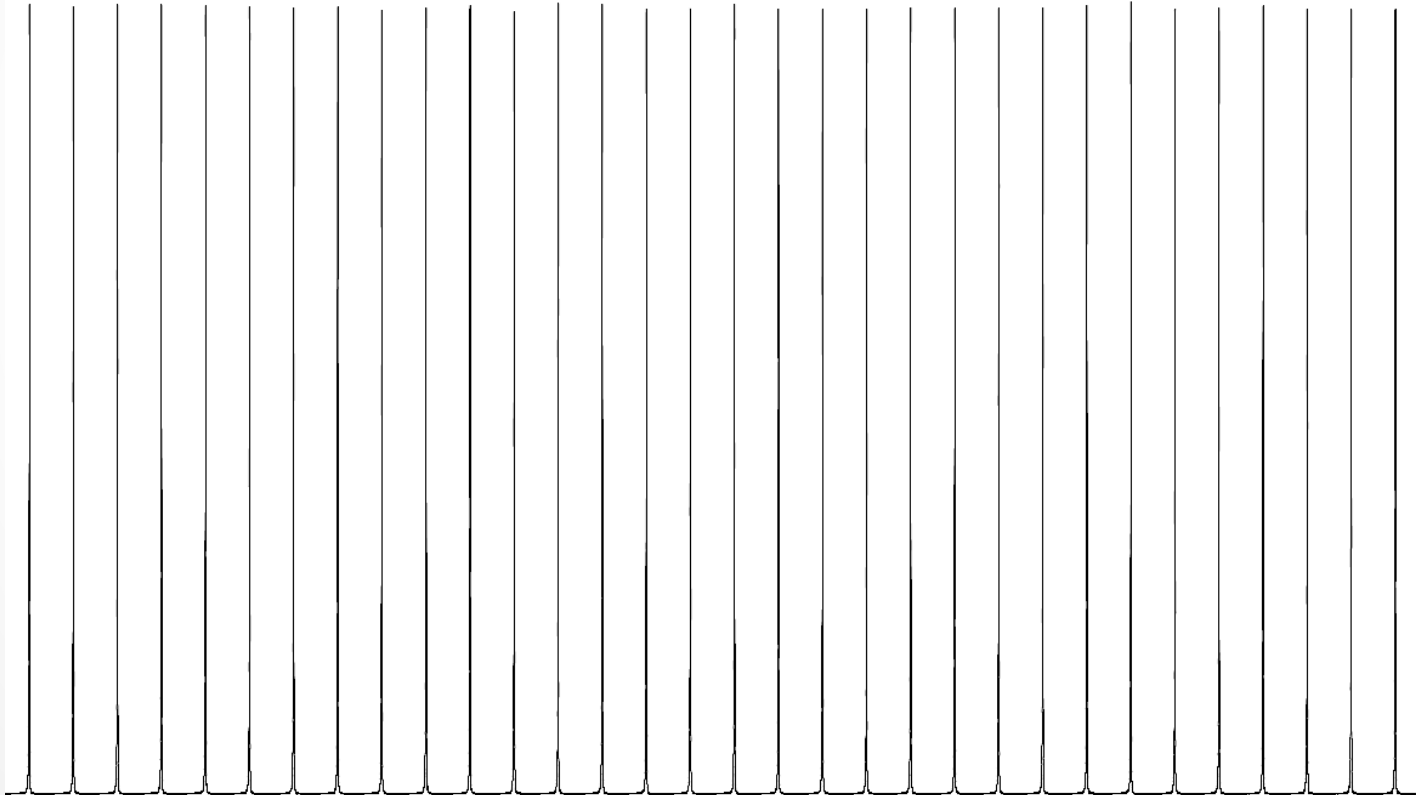

B1 均一性检测

HWT Suite with TOPSPIN3.2 patchlevel 7; Probehead 3 : 5 mm CPTCI 1H-13C/15N/D Z-GRD Z117768/0036
sysblhom - B1 homogeneity test
Order Number: 10104594;AVC600; Instrument: spect; Sample: D2O
100 experiments in 0.70 usec steps
Max[90] = 100.0%, Max[450] = 88.0%, Max[810] = 83.7%



90度功率稳定性检测

HWT Suite with TOPSPIN3.2 patchlevel 7; Probehead 3 : 5 mm CPTCI 1H-13C/15N/D Z-GRD Z117768/0036
sysphas1st - phase stability test (13 degree test)
Order Number: 10104594;AVC600; Instrument: spect; Sample: D2O
standard deviation: 0.247%; mean amplitude: 99.384%

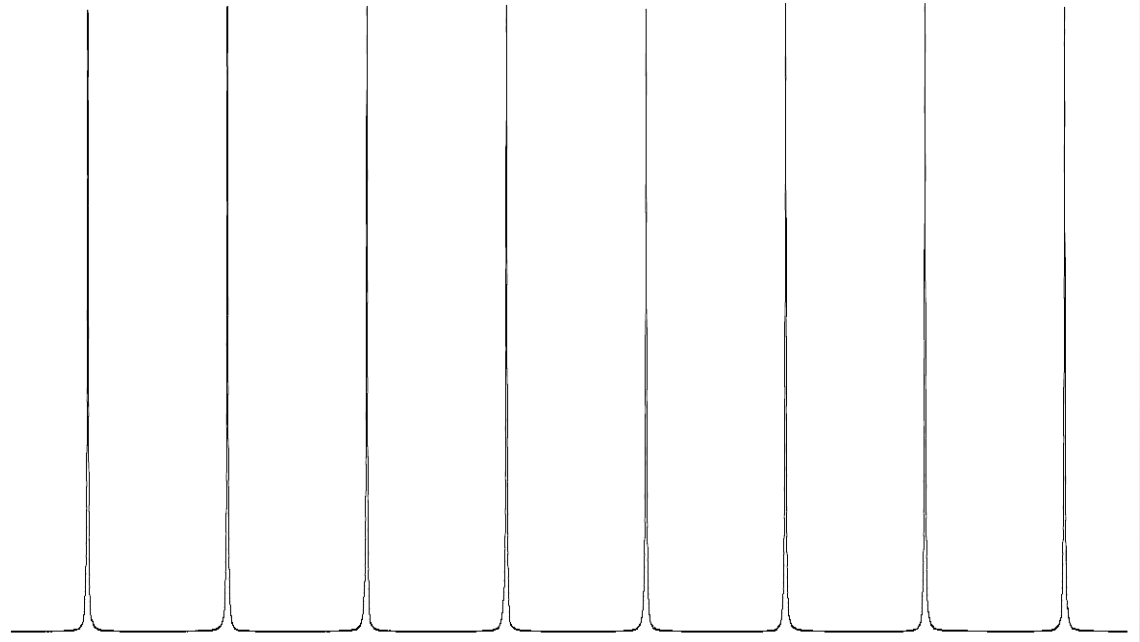


功率线性检测

amplitude linearity test (0 to 50 dB in 1 dB power level steps)

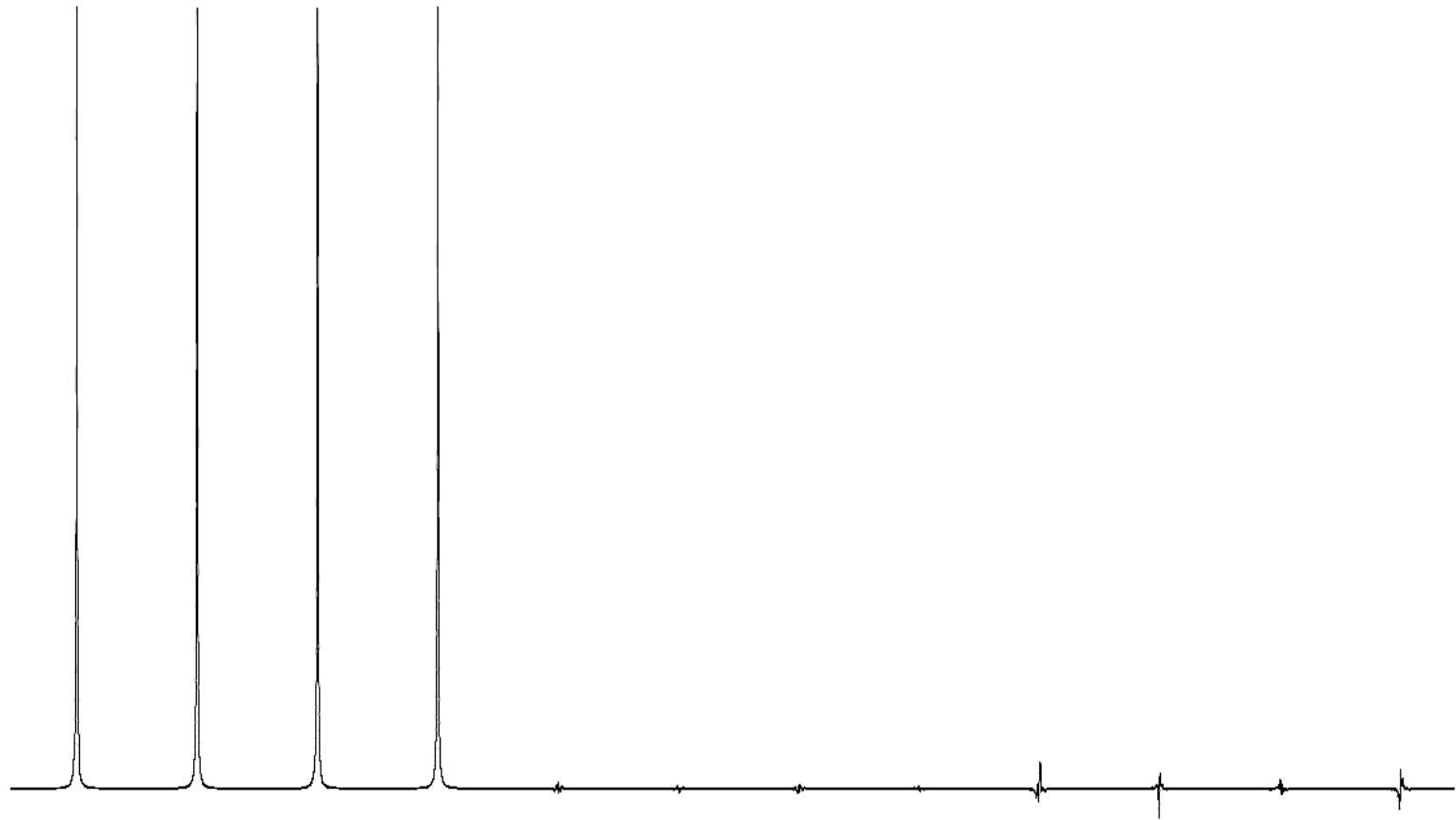
Power level [dB]	Attenuation [%]	Intensity
0	100.000	1000.000
1	89.090	910.309
2	79.370	814.452
3	70.711	725.499
4	62.996	654.674
5	56.123	579.516
6	50.000	519.906
7	44.545	465.858
8	39.685	414.716
9	35.355	372.695
10	31.498	328.540
11	28.062	292.924
12	25.000	261.780
13	22.272	232.921
14	19.843	207.658
15	17.678	188.196
16	15.749	167.691
17	14.031	149.884
18	12.500	133.721
19	11.136	118.714
20	9.921	106.079
21	8.839	94.722
22	7.875	84.160
23	7.015	74.900
24	6.250	67.108
25	5.568	59.785
26	4.961	52.968
27	4.419	47.397
28	3.937	42.231
29	3.508	38.050
30	3.125	33.160
31	2.784	30.226
32	2.480	26.915
33	2.210	24.066
34	1.969	21.259
35	1.754	18.964
36	1.563	16.773
37	1.392	14.978
38	1.240	13.466
39	1.105	11.928
40	0.984	10.612
41	0.877	9.368
42	0.781	8.487
43	0.696	7.579
44	0.620	6.636
45	0.552	5.911
46	0.492	5.296
47	0.438	4.781
48	0.391	4.115
49	0.348	3.655
50	0.310	3.373

HWT Suite with TOPSPIN3.2 patchlevel 7; Probehead 3 : 5 mm CPTCI 1H-13C/15N/D Z-GRD Z117768/0036
syspullini - amplitude linearity test (pulse length *2, power +6 dB)
Order Number: 10104594;AVC600; Instrument: spect; Sample: D2O
maximum: 100.000%; minimum: 98.866%



Phase cycling cancellation test

HWT Suite with TOPSPIN3.2 patchlevel 7; Probehead 3 : 5 mm CPTCI 1H-13C/15N/D Z-GRD Z117768/0036
syscancel - phase cycling cancellation test
Order Number: 10104594;AVC600; Instrument: spect; Sample: D2O



	A	B	C	D
1		800LS	800CP	950CP
2	phase stability/mean amplitude	93.527% ± 3.355%	98.745% ± 0.377%	96.175% ± 1.953%
3	amplitude stability(90 degree)/mean amplitude	99.772% ± 0.099%	99.780% ± 0.122%	99.077% ± 0.557%
4	amplitude stability(30 degree)/mean amplitude	99.788% ± 0.125%	99.813% ± 0.125%	99.056% ± 0.511%
5	phase cycling cancellation/rangle of residual signal	OK	OK	OK
6	amplitude linearity(0 to 50 dB in 1 dB power level steps)/standard deviation	0.14%	0.06%	0.14%
7	amplitude linearity(pulse length *2, power +6 dB)/range of amplitude	97.807%~100%	99.072%~100%	96.928%~100%
8	quad image suppression(4 * 1 scan, 4 * 4 scans)/residual signal	OK	OK	
9	receiver gain/standard deviation	0.04%	0.13%	0.08%
10	B1 homogeneity(1H)/90degree, 450degree. 810degree	100% 79.8% 66.3%	100% 92.1% 83.1%	100% 84.7% 73.6%
11	turn on (0.05-0.50 usec in 12.50 nsec steps) /standard deviation	0.09%	0.10%	0.21%
12	B1 homogeneity(13C)/0degree, 360degree. 720degree	100% 80.2% 67.7%	100% 85.2% 72.6%	100% 76.5% 65.6%
13	C13 decoupler profile/chirp, garp, waltz	OK	OK	OK
14	glitch-H1	OK	OK	OK
15	phase propagation	OK	OK	OK
16	phase shifting	OK	OK	OK
17	180 degree pulse calibration test (different phases)	OK	OK	OK
18	pulse calibration test (different flip angles)	OK	OK	OK
19	modulator linearity test (5 - 100% in 5% steps)/standard deviation	0.13%	0.04%	0.03%
20	shaped pulse amplitude stability/mean amplitude	99.676% ± 0.13%	99.84% ± 0.103%	99.916% ± 0.048%
21	shaped pulse phase stability/mean amplitude	95.206% ± 2.757%	99.19% ± 0.422%	99.119% ± 0.408%
22	shaped pulse amplitude linearity(pulse length *2, power level +6)/mean amplitude	98.508%~100%	97.656%~100%	96.564%~100%
23	shaped pulse comparison (rectangular, gaussian, eburpl)	97.984% 99.018% 100%	99.397% 99.589% 100%	98.074% 99.007% 100%
24	shaped pulse modulator linearity/standard deviation	0.04%	0.06%	0.05%
25	excitation profile	OK	OK	OK
26	z-gradient profile	OK	OK	OK
27	amplitude stability test after gradient pulse (1msec, 10G/cm)/mean amplitude	99.598% ± 0.199%	99.833% ± 0.112%	99.786% ± 0.11%
28	gradient recovery	OK	OK	OK
29	amplitude stability test after gradient echo 1/mean amplitude	99.706% ± 0.162%	99.832% ± 0.108%	99.752% ± 0.147%
30	amplitude stability test after gradient echo 2/mean amplitude	99.371% ± 0.325%	96.694% ± 3.932%	98.967% ± 0.96%
31	phase cycling cancellation test after gradient pulse	OK	OK	OK

谢谢!