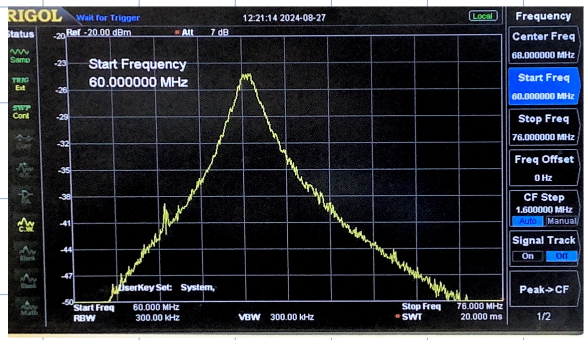
F47 Cyclotron frequency in a Penning trap

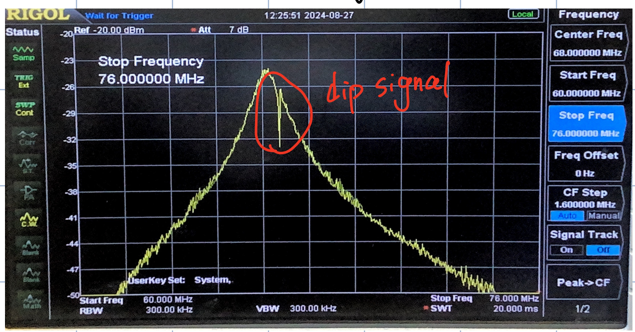
27. 08. 2024
9:00 ~ 18:00

Yulai Shi
Yuting Shi

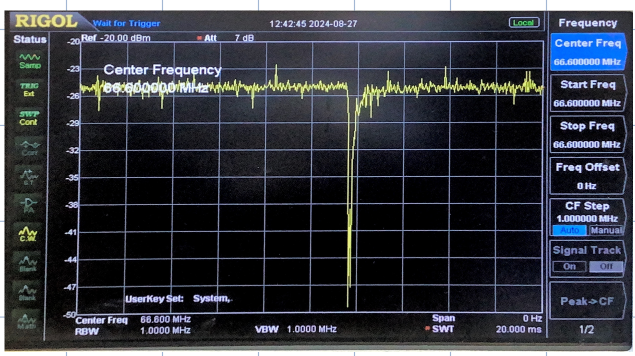
1. Finding the resonance and dip signal



- Stabilize the signal : center freq. 66 MHz, Start 60 MHz , Stop 76 MHz
- dip signal : voltage 49 V (ring electrode)



2. Excitation measure



Voltage range: 47.5 V ~ 50.5 V (ring)

ν_- : magneton , ν_+ : modified cyclotron

split electrode : ring voltage 49 V   8657A frequency (68 ± 2) MHz

3. Changing current , max, min ν_c, ν_-

$$\nu_z = \frac{1}{2\pi}\sqrt{\frac{q}{m} 2C_2 V_0} , \quad \nu_c = \frac{1}{2\pi}\frac{q}{m}B , \quad \frac{e}{m_e} = 1.7588 \cdot 10^{11}\ C \cdot kg^{-1}$$

$$\nu_- = \frac{1}{2}\left(\nu_c - \sqrt{\nu_c^2 - 2\nu_z^2}\right), \quad \nu_+ = \frac{1}{2}\left(\nu_c + \sqrt{\nu_c^2 - 2\nu_z^2}\right)$$

$I = 1.34\,A$, $V_0 = 48\,V$: theoretical $B = \frac{\mu_0 N I}{L} = \frac{1.2566 \cdot 10^{-6} \times 2400 \times 1.34}{0.246}$

$= 0.01643\ T$

ν_- min , ν_z min

$\nu_c = 460$ MHz $\quad \nu_- = 6.6$ MHz

$\nu_z = 77.38$ MHz $\quad \nu_+ = 453.4$ MHz

experimental	Frequency [MHz]	Amplitude [dBm]	Theoretical [MHz]
ν_-	5.5 ± 0.2	-10	6.6
ν_z	78.1 ± 0.1	$+17.0$	77.38
ν_+	451 ± 0.5	0	453.4
$\nu_+ - \nu_z$	470 ± 0.5	0	476
$\nu_z + \nu_-$	68 ± 1	-10	83
$2(\nu_z + \nu_-)$	135 ± 1	-10	/
ν_c	459 ± 2	0	460

$I = 1.1\,A$, $V_0 = 50.5\,V$ $\quad$ ν_- max , ν_z max

experimental	Frequency [MHz]	Amplitude [dBm]	Theoretical [MHz]
ν_-	7 ± 0.1	-10	8.534
ν_z	78.4 ± 0.5	$+14.0$	79.37
ν_+	367 ± 1	0	369.07
ν_c	375 ± 1	0	377.61
$\nu_+ - \nu_z$	288.6 ± 1.1	-10	
$\nu_z + \nu_-$	85.4 ± 0.5	-10	
$2(\nu_z + \nu_-)$	170.8 ± 1	0	

$I = 1.2\,A$, $V_0 = 50.5\,V$ $\rightarrow$ untersuchen

experimental	Frequency [MHz]	Amplitude [dBm]	Theoretical [MHz]
ν_-	6.8 ± 0.1	-10	7.794
ν_z	79.0 ± 1	$+15$	79.37
ν_+	402 ± 2	0	404.14
ν_c	410 ± 1	0	411.93
$\nu_+ - \nu_z$	323 ± 2.2	-10	
$\nu_z + \nu_-$	85.8 ± 1	-10	

$2(\nu_z+\nu_-)$	171.6 ± 2	0	

$I = 1.3A$, $V_0 = 50.5V$

experimental	Frequency [MHz]	Amplitude [dBm]	Theoretical [MHz]
ν_-	5.9 ± 0.2	-10	7.17
ν_z	75 ± 1	$+17$	79.37
ν_+	438.5 ± 0.5	$+10$	439.09
ν_c	445 ± 1	0	446.26
$\nu_+ - \nu_z$	363.5 ± 1.1	-10	
$\nu_z + \nu_-$	80.9 ± 1	-10	
$2(\nu_z+\nu_-)$	161.8 ± 2	0	

$$\nu_c = \left(\frac{1}{2\pi} \frac{q}{m} \cdot \frac{\mu_0 N}{L}\right) I$$

$$\frac{q}{m} = \frac{2\pi L}{\mu_0 N} \cdot K$$

4. Changing Voltage

$I = 1.34A$, $V_0 = 50.5V$

experimental	Frequency [MHz]	Amplitude [dBm]	Theoretical [MHz]
ν_-	5.7 ± 0.5	$+10$	6.902
ν_z	78.4 ± 0.5	$+17$	79.37
ν_+	452 ± 1	0	453.04
ν_c	459 ± 1	0	459.99
$\nu_+ - \nu_z$	373.6 ± 1.1	-10	
$\nu_z + \nu_-$	84.1 ± 0.71	-10	
$2(\nu_z+\nu_-)$	168.2 ± 1.4	0	

$I = 1.34A$, $V_0 = 49.4\,V$

experimental	frequency [MHz]	Amplitude [dBm]	Theoretical [MHz]
ν_-	5.6 ± 0.2	-10	6.87
ν_z	76.3 ± 0.5	$+17$	78.90
ν_+	451.3 ± 0.5	0	453.13
ν_c	458.5 ± 0.5	0	459.99
$\nu_+ - \nu_z$	375 ± 0.71	-10	
$\nu_z + \nu_-$	81.9 ± 0.54	-10	
$2(\nu_z + \nu_-)$	163.8 ± 1.1	0	

$I = 1.34A$, $V_0 = 49.3\,V$

experimental	frequency [MHz]	Amplitude [dBm]	Theoretical [MHz]
ν_-	5.55 ± 0.1	-10	6.784
ν_z	75.6 ± 0.5	$+17$	78.42
ν_+	451 ± 0.5	0	453.21
ν_c	457.5 ± 0.5	0	459.99
$\nu_+ - \nu_z$	375.4 ± 0.71	-10	
$\nu_z + \nu_-$	81.15 ± 0.51	-10	
$2(\nu_z + \nu_-)$	162.3 ± 1	0	

$I = 1.34A$, $V_0 = 48\,V$

experimental	frequency [MHz]	Amplitude [dBm]	Theoretical [MHz]
ν_-	5.5 ± 0.1	-10	6.60
ν_z	73.3 ± 0.5	$+17$	77.38
ν_+	451 ± 0.5	0	453.39
ν_c	458 ± 1	0	459.99

$\nu_+ - \nu_Z$	377.7 ± 0.71	-10
$\nu_Z + \nu_-$	78.8 ± 0.51	-10
$2(\nu_Z + \nu_-)$	157.6 ± 1	0