One to five photon microwave ionization of Li Rydberg atoms

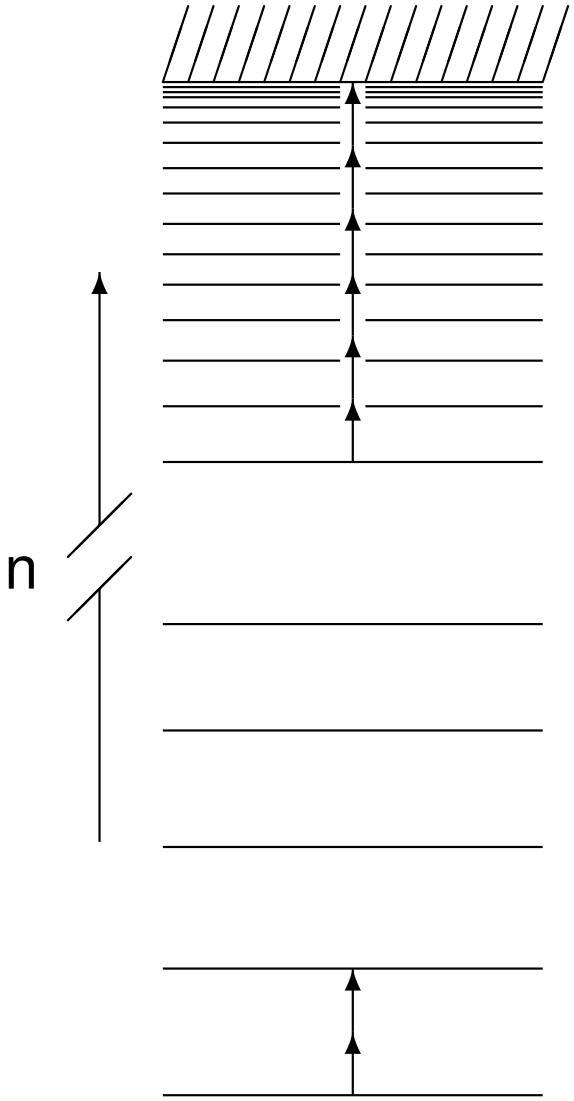
Joshua Gurian H. Maeda T. F. Gallagher

May 29, 2008

Outline

- A brief overview of microwave ionization
- Experimental Setup
- Microwave multiphoton ionization experimental results
- Simple theoretical comparison
- Experimental measurement of microwave ionization rates

Microwave Ionization



$\} \omega \rightarrow 1/n^2$

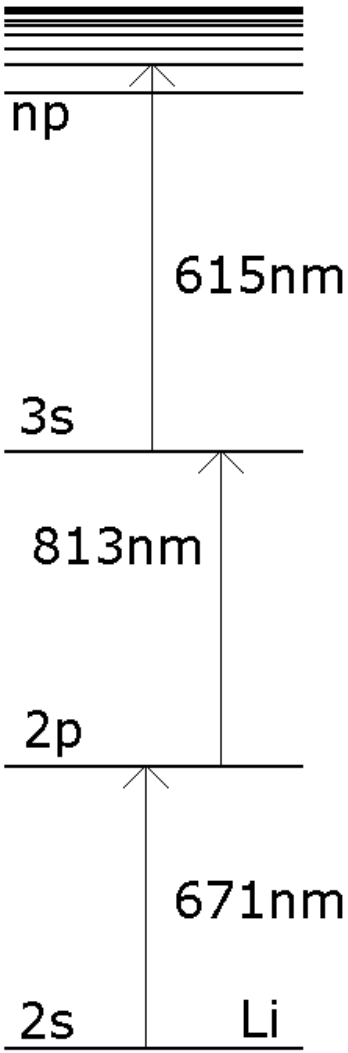
What happens as we approach the photoionization limit?

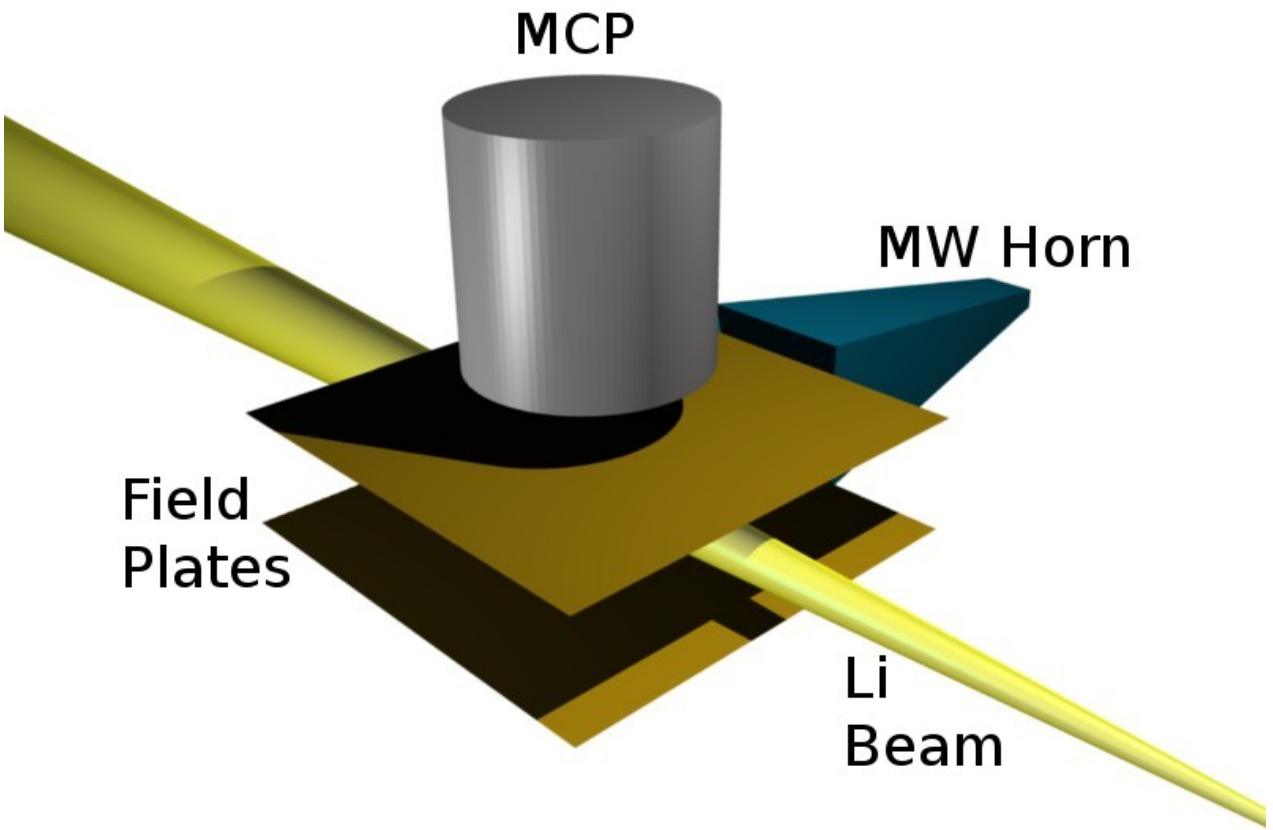
Field Ionization Process

$F = 1/3n^5$

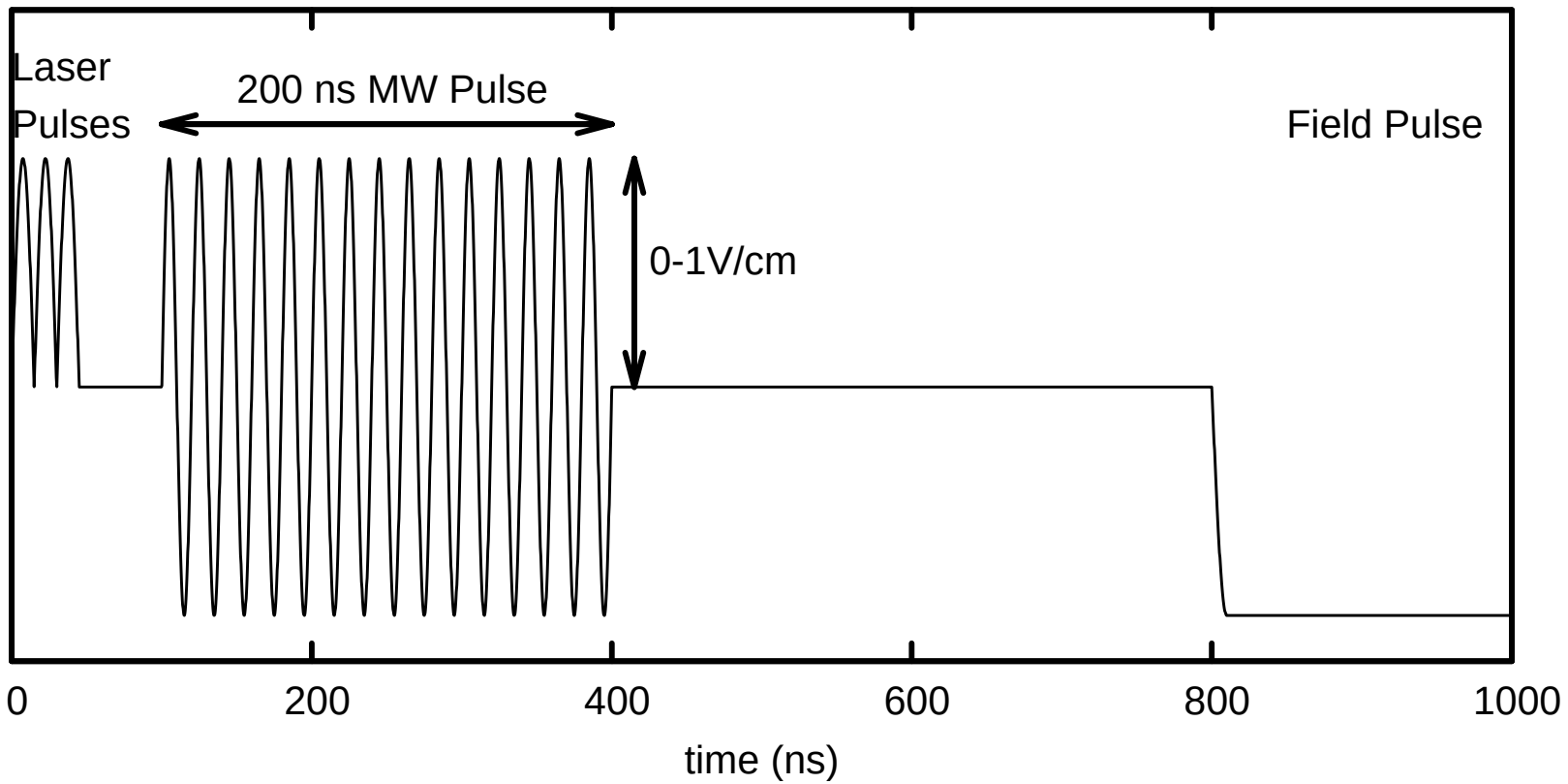
$\} \omega < 1/n^3$

Experimental Setup

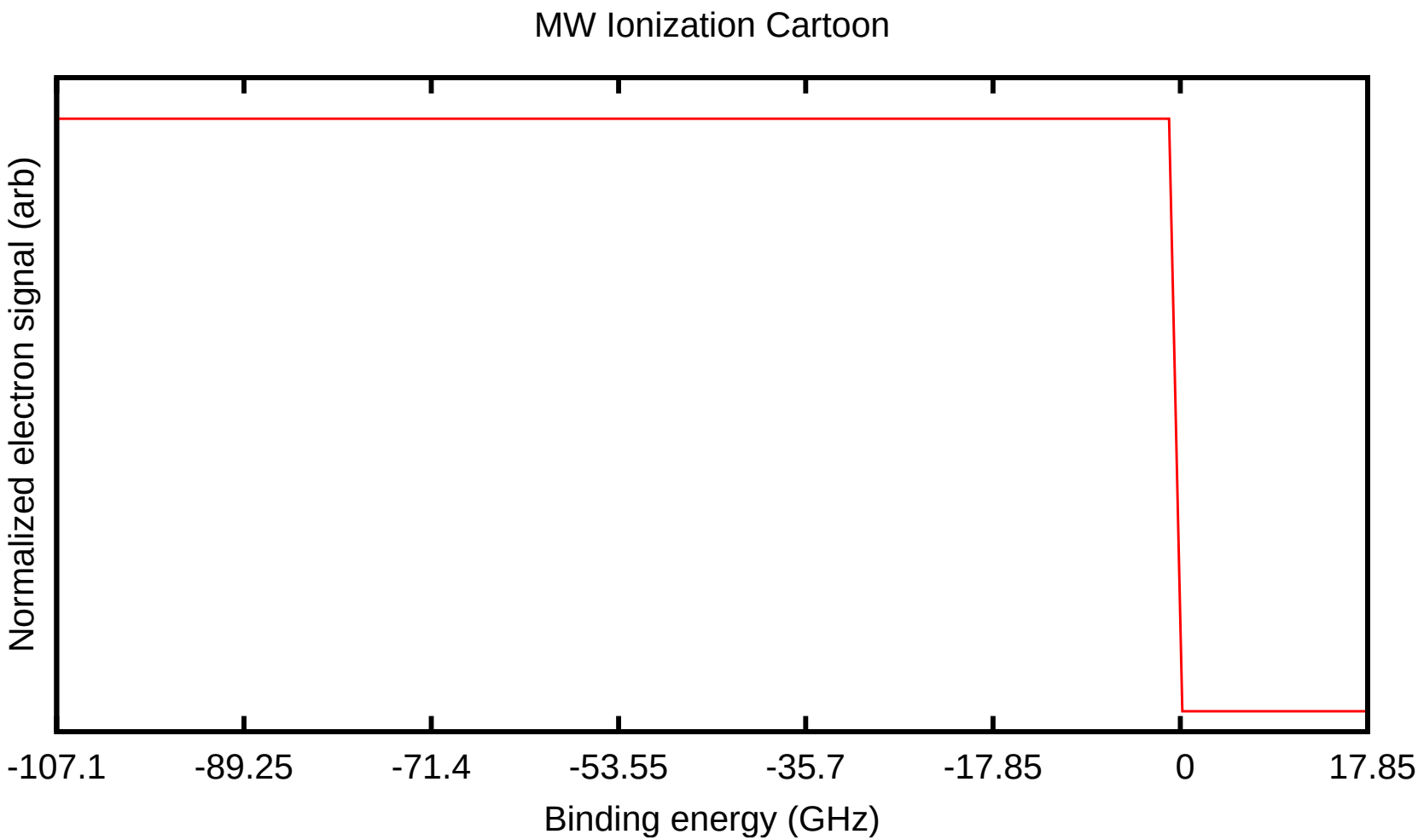




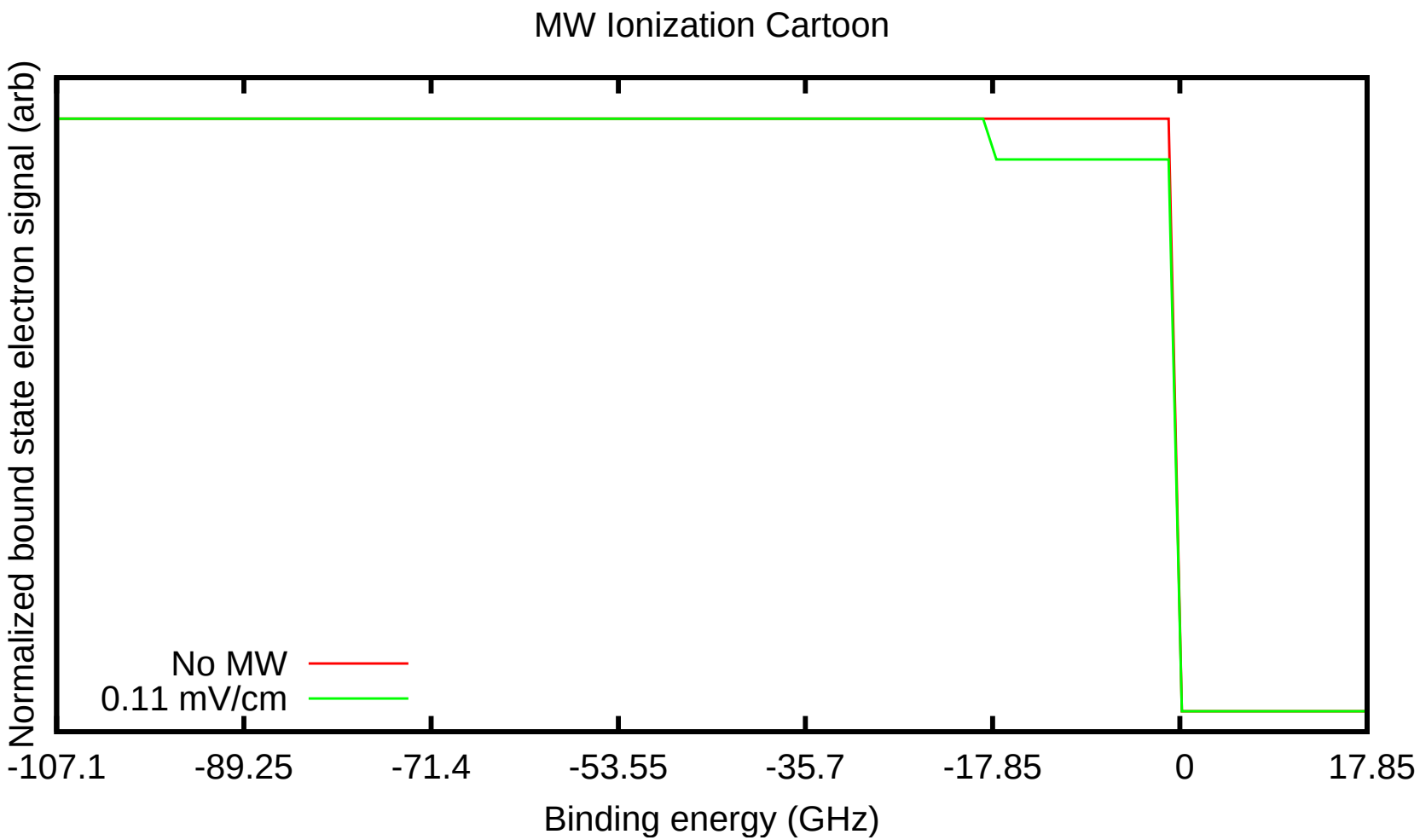
Timing


Laser
Pulses
200 ns MW Pulse
Field Pulse
0-1V/cm
0
200
400
600
800
1000
time (ns)

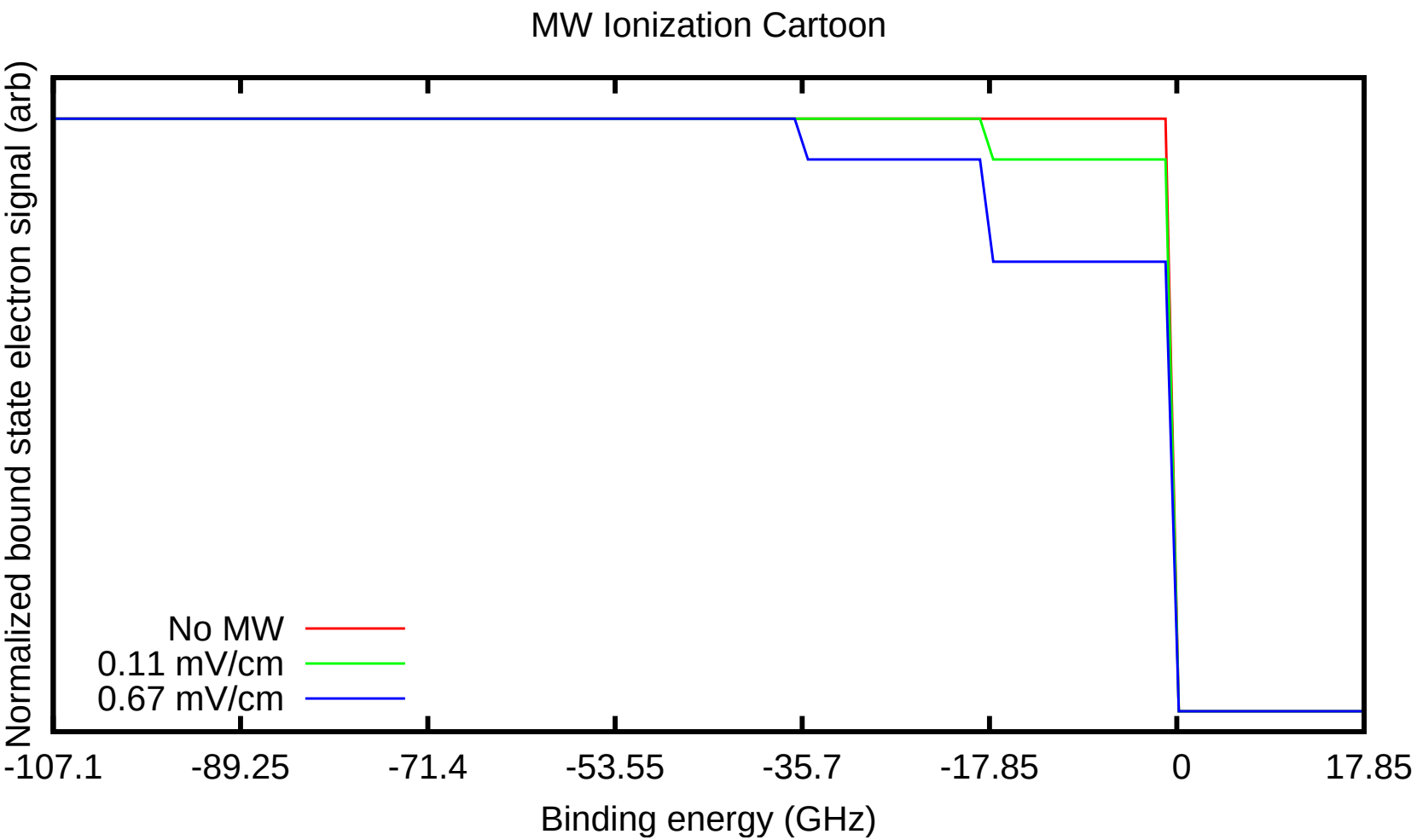
Cartoon


MW Ionization Cartoon
Normalized electron signal (arb)
-107.1
-89.25
-71.4
-53.55
-35.7
-17.85
0
17.85
Binding energy (GHz)

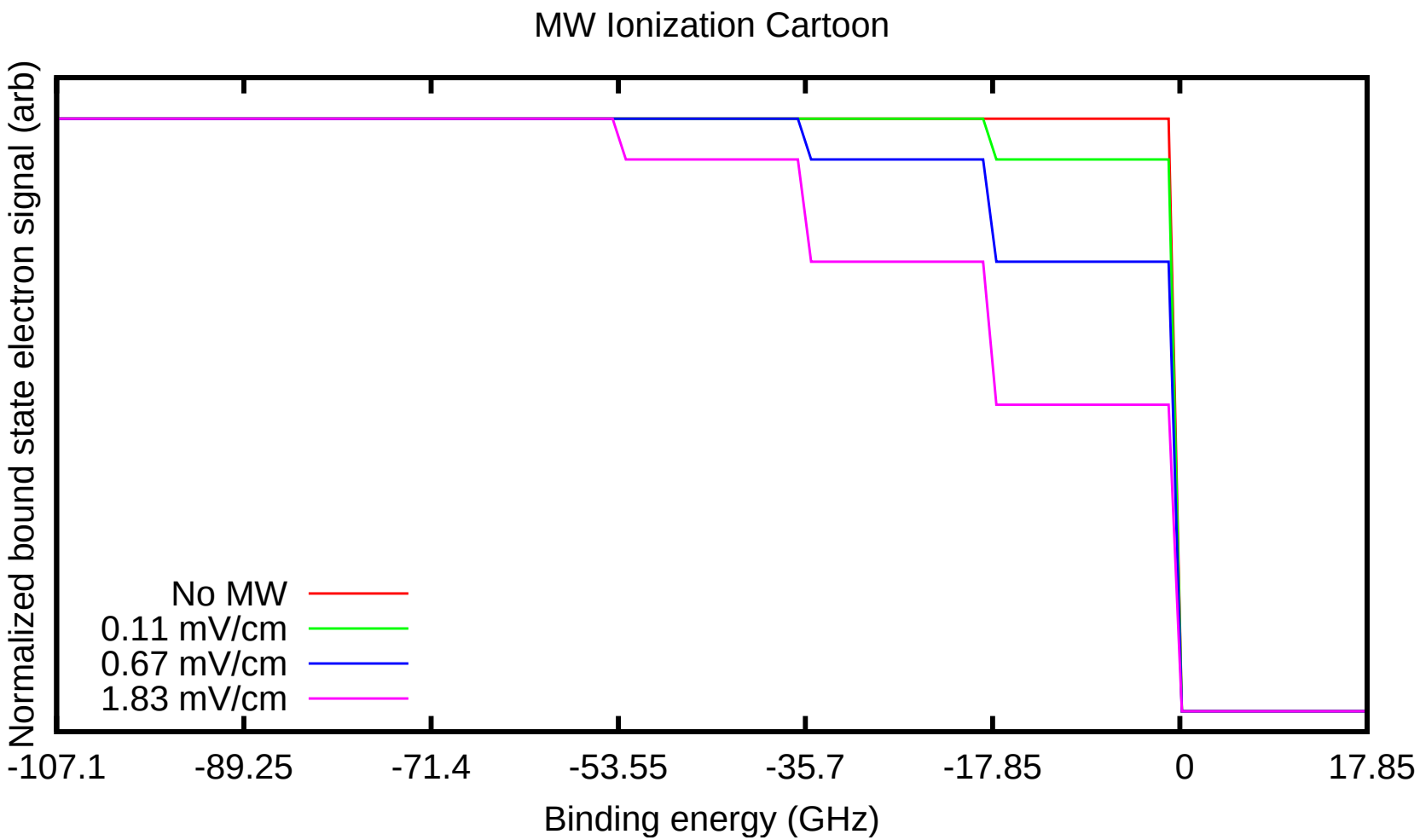
Cartoon


MW Ionization Cartoon
Normalized bound state electron signal (arb)
No MW
0.11 mV/cm
-107.1
-89.25
-71.4
-53.55
-35.7
-17.85
0
17.85
Binding energy (GHz)

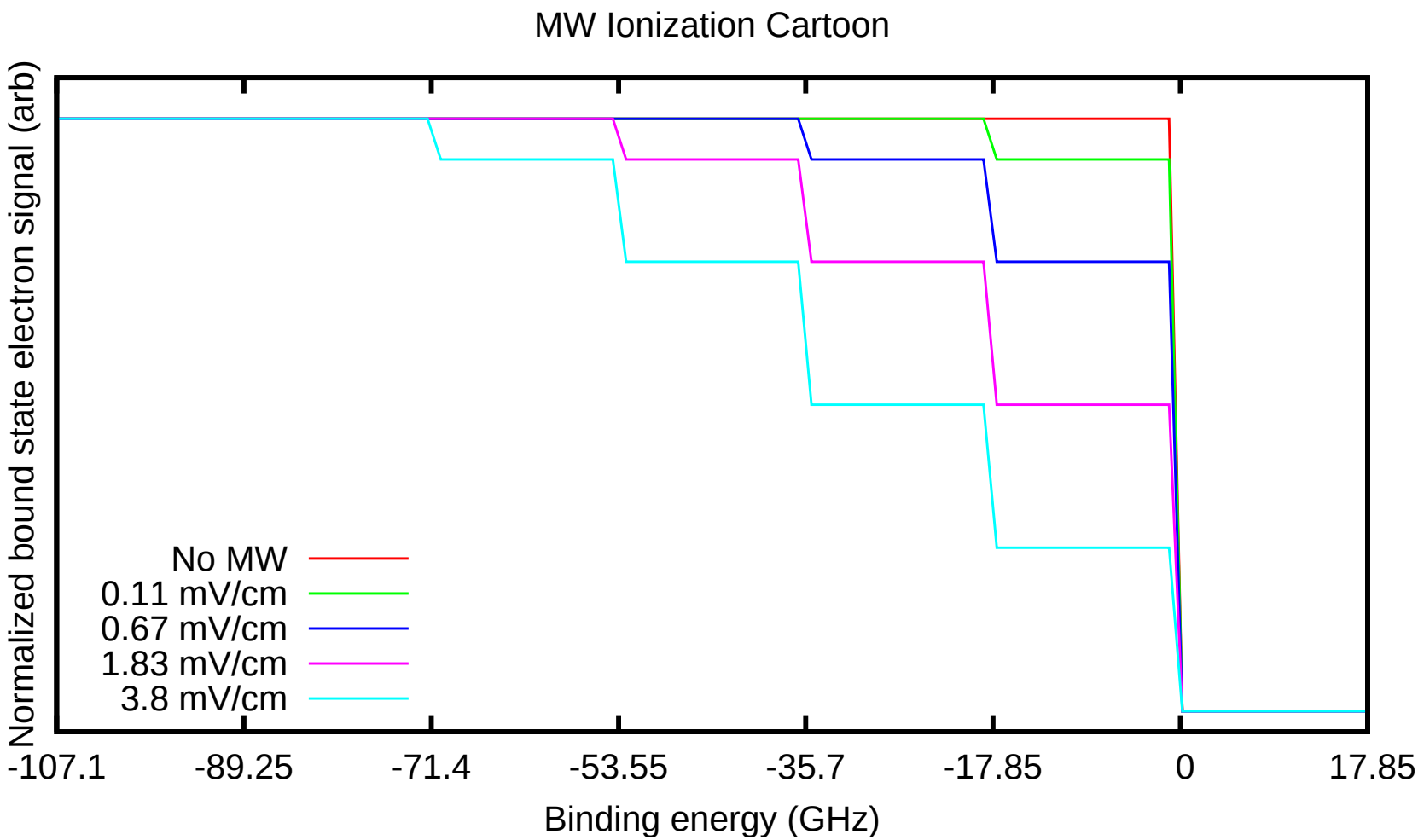
Cartoon


MW Ionization Cartoon
Normalized bound state electron signal (arb)
No MW
0.11 mV/cm
0.67 mV/cm
-107.1
-89.25
-71.4
-53.55
-35.7
-17.85
0
17.85
Binding energy (GHz)

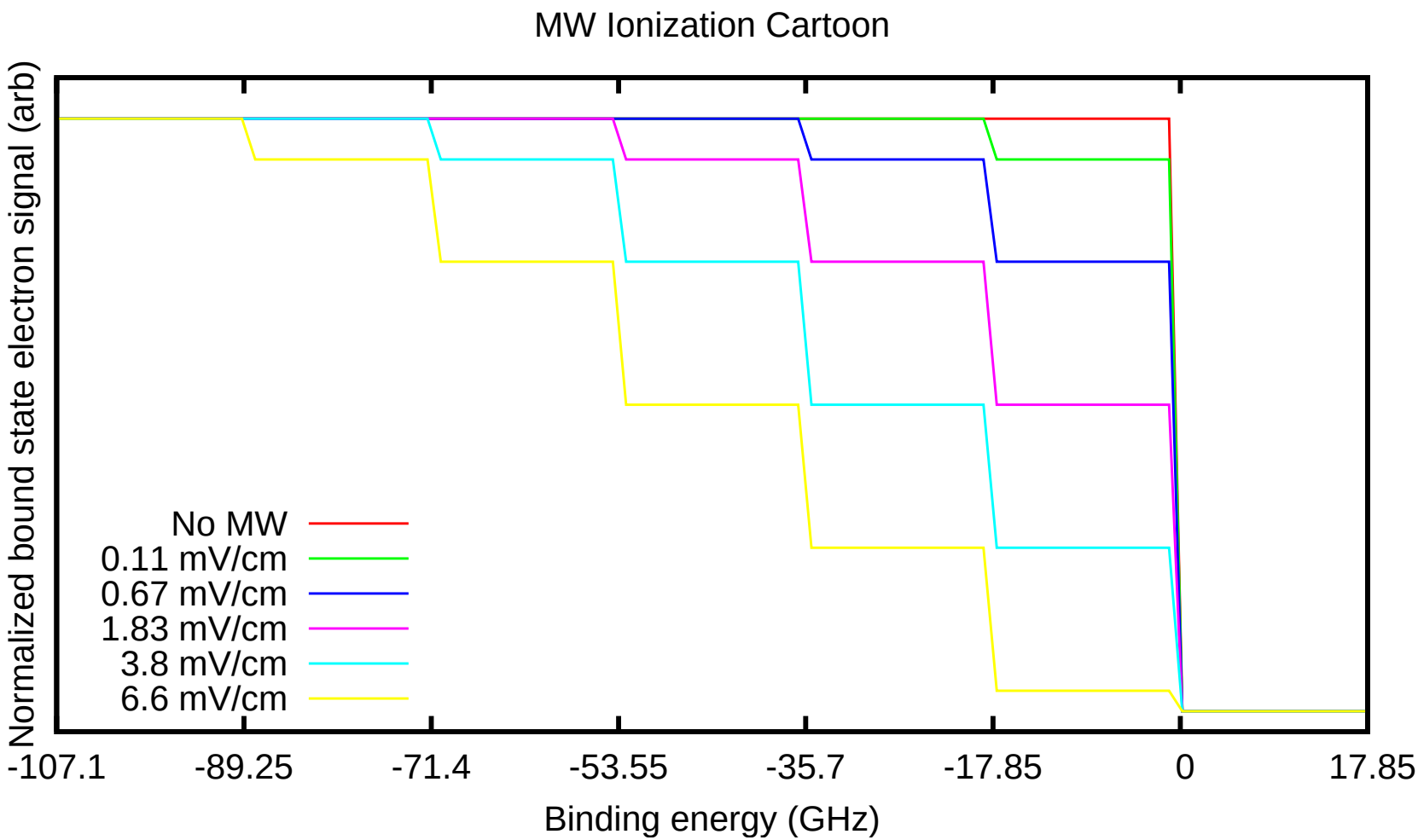
Cartoon


MW Ionization Cartoon
Normalized bound state electron signal (arb)
No MW
0.11 mV/cm
0.67 mV/cm
1.83 mV/cm
-107.1
-89.25
-71.4
-53.55
-35.7
-17.85
0
17.85
Binding energy (GHz)

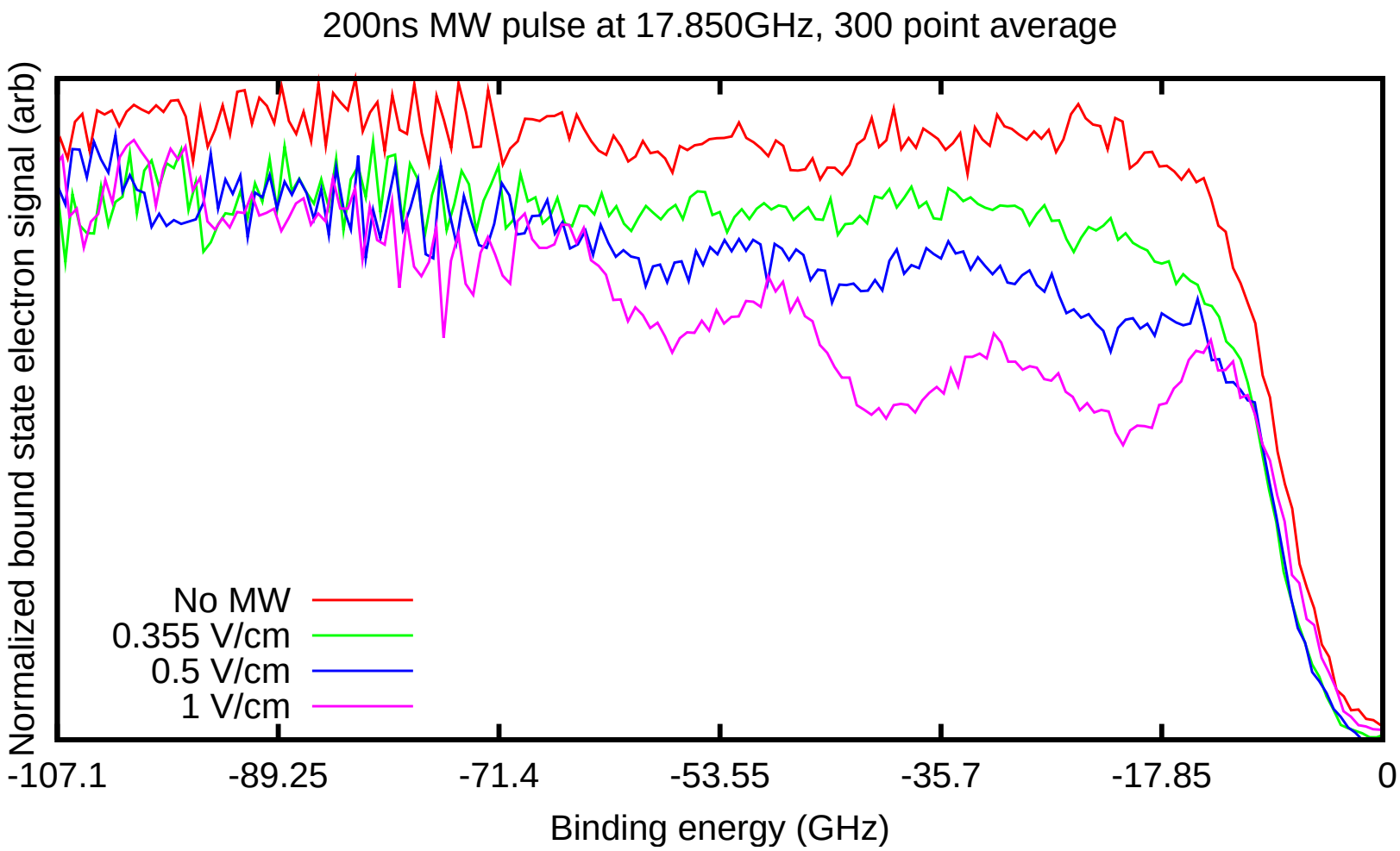
Cartoon


MW Ionization Cartoon
Normalized bound state electron signal (arb)
No MW
0.11 mV/cm
0.67 mV/cm
1.83 mV/cm
3.8 mV/cm
-107.1
-89.25
-71.4
-53.55
-35.7
-17.85
0
17.85
Binding energy (GHz)

Cartoon

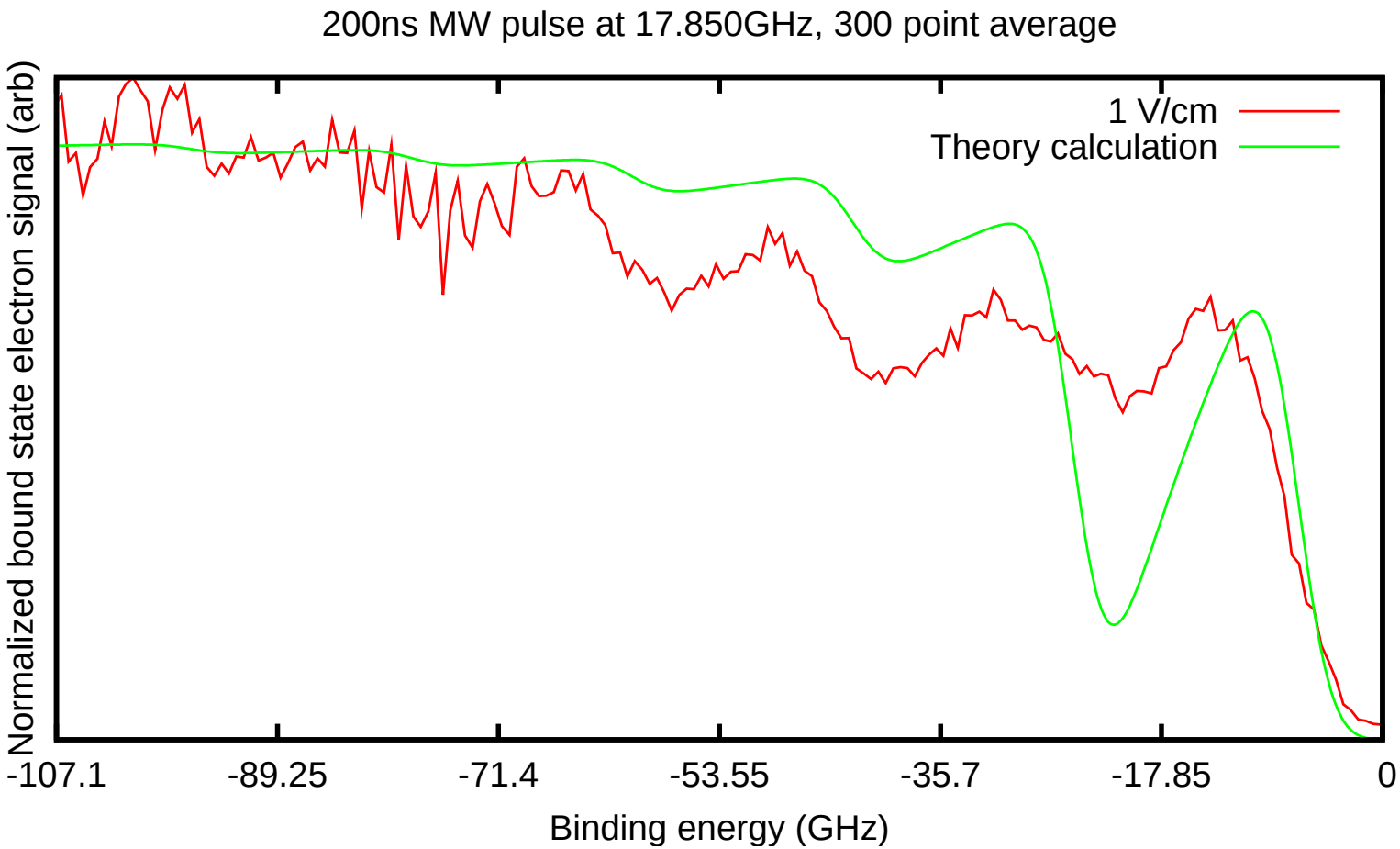

MW Ionization Cartoon
Normalized bound state electron signal (arb)
No MW
0.11 mV/cm
0.67 mV/cm
1.83 mV/cm
3.8 mV/cm
6.6 mV/cm
-107.1
-89.25
-71.4
-53.55
-35.7
-17.85
0
17.85
Binding energy (GHz)

Microwave Ionization Steps - Powers

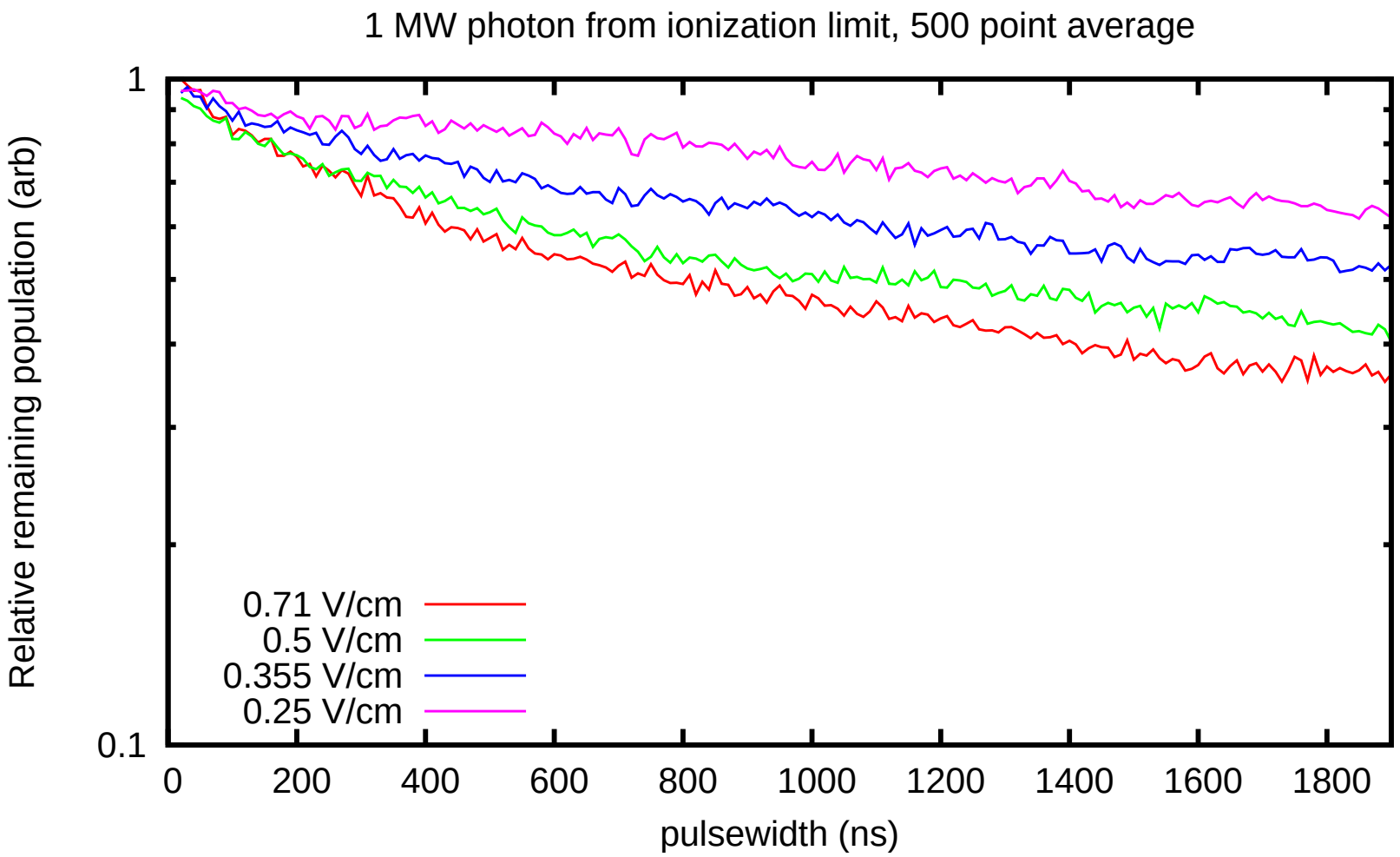


Theoretical comparison

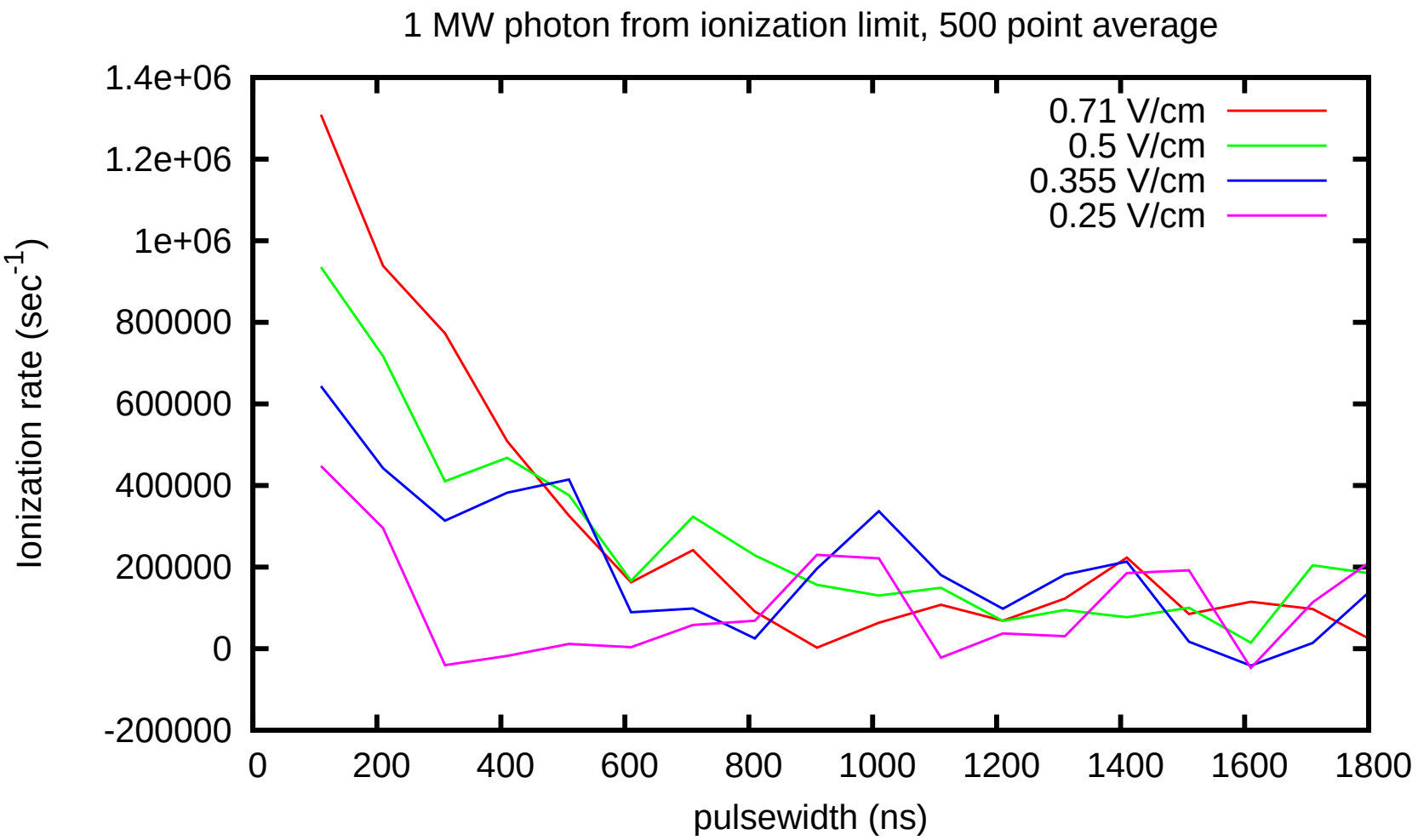
Delone et al., J. Phys. B (1994): $< n|r|\epsilon > \approx \frac{6^{2/3}\Gamma(\frac{2}{3})}{2\pi\sqrt{3}n^{3/2}\omega^{5/3}}$



Ionization Rate



Ionization Rate



Summary

- First experimental results of one to five photon microwave ionization near the photoionization limit
- Multiphoton microwave ionization nearly as efficient as single photon ionization
- Microwave ionization rates only scale with power for short pulsewidths