String design charts

Jim Woodhouse and Nicolas Lynch-Aird

January 23, 2019

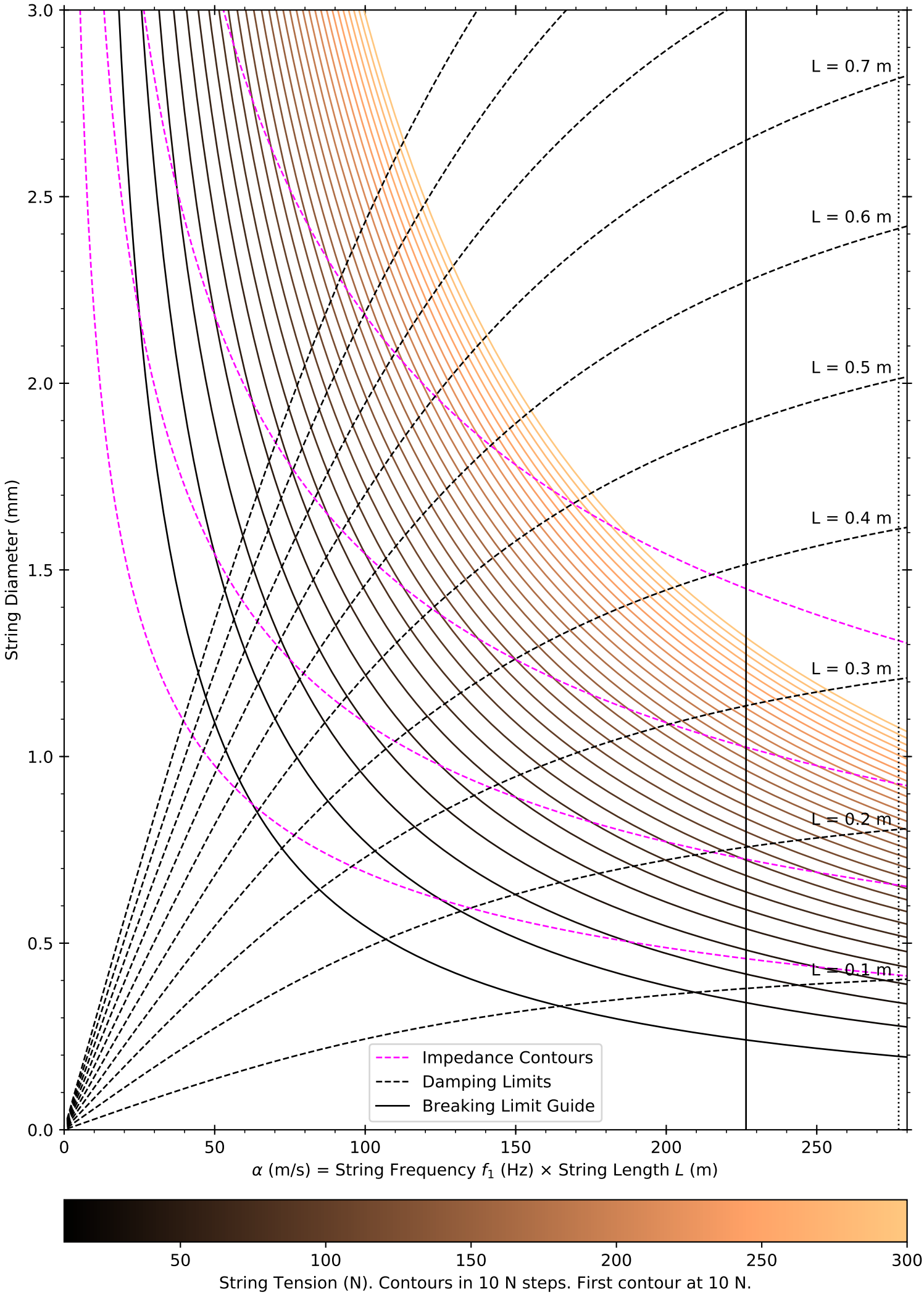
Design charts for monofilament strings of nylon, fluorocarbon and natural gut are given here, in large versions to allow direct use for designing string sets. For each string of interest, measure the length of the string (in m) and note the nominal tuned frequency (in Hz). Multiply these together, to get a value for the parameter α which appears on the horizontal axis of all the charts. The string length should be the unobstructed vibrating length of the string between the bridges or other supports. For an instrument such as the pedal harp, take care to ensure the frequency is properly matched to the string length. For example, if the open string length between the bridge pin and soundboard of a double-action pedal harp is used, then the nominal string frequency must be reduced by a semitone.

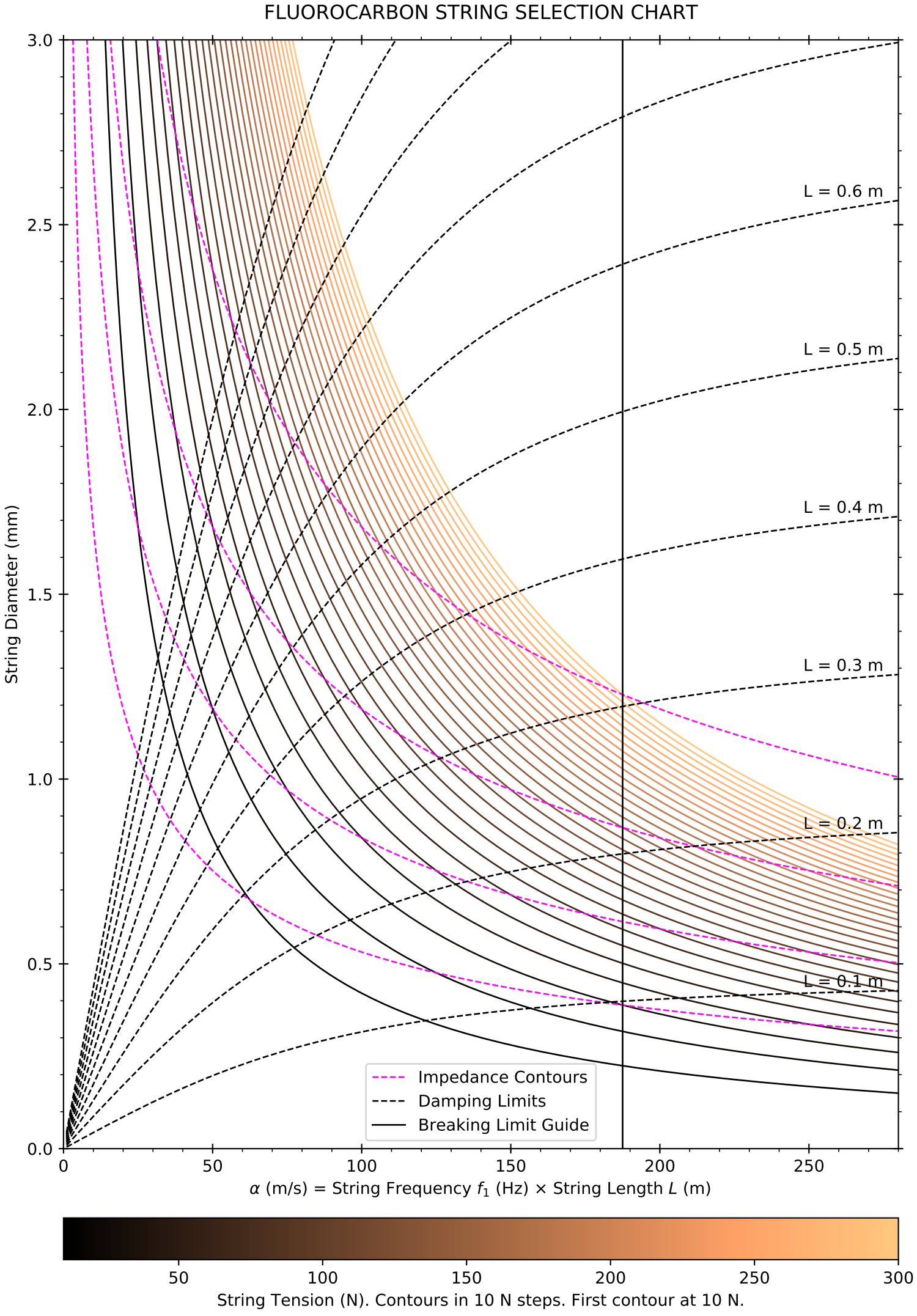
For each of the three candidate materials, damping limit curves are plotted for a set of string lengths at intervals of 0.1 m. Choose the closest, or interpolate between a pair to get a suitable limit curve for your particular instrument. For instruments with strings of different lengths, a separate damping limit curve may need to be chosen for each string.

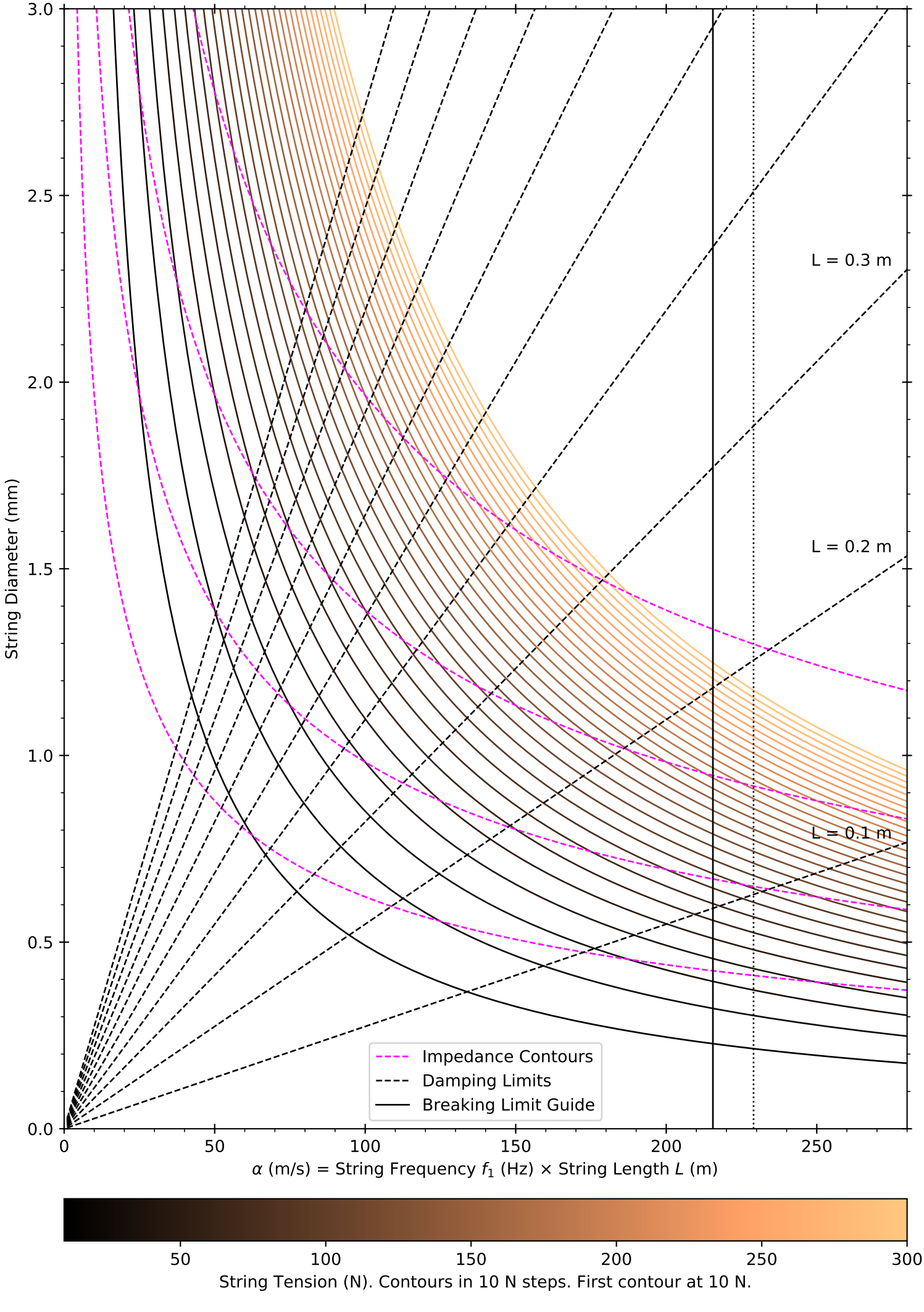
If you have no idea what kind of tension you are expecting to want for the instrument in question, look at the case studies in the accompanying paper: examples are given for guitar, lute and harp which should give good guidance for most plucked-string instruments. Higher tension will correspond to increased impedance and loudness, but may result in a duller sound due to the damping limit. Conversely lower tension will result in a quieter but brighter sound.

Look first at the highest and lowest desired values of α. High values may constrain the choice of material: nylon is usually best in this respect. The lowest value of α is likely to direct attention to the damping limit curve: this will identify the largest reasonable diameter of string that is likely to give an acceptable sound. To fill in a set of strings given these limiting cases, note that early plucked instruments often recommend constant-tension stringing, so follow the tension contours. Bowed instruments may use constant tension or constant impedance: impedance contours also appear on the charts. If using a mix of materials for a set of strings, pay attention to any jumps in impedance or tension at the transition points.

Python scripts for generating these charts are available at `https://github.com/lynchaird/string-selection-charts`.


NYLON STRING SELECTION CHART
String Diameter (mm)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
50
100
150
200
250
L = 0.7 m
L = 0.6 m
L = 0.5 m
L = 0.4 m
L = 0.3 m
L = 0.2 m
L = 0.1 m
Impedance Contours
Damping Limits
Breaking Limit Guide
α (m/s) = String Frequency f_1 (Hz) × String Length L (m)
50
100
150
200
250
300
String Tension (N). Contours in 10 N steps. First contour at 10 N.


FLUOROCARBON STRING SELECTION CHART
String Diameter (mm)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
50
100
150
200
250
L = 0.6 m
L = 0.5 m
L = 0.4 m
L = 0.3 m
L = 0.2 m
L = 0.1 m
Impedance Contours
Damping Limits
Breaking Limit Guide
α (m/s) = String Frequency f_1 (Hz) × String Length L (m)
50
100
150
200
250
300
String Tension (N). Contours in 10 N steps. First contour at 10 N.


GUT STRING SELECTION CHART
String Diameter (mm)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
50
100
150
200
250
L = 0.3 m
L = 0.2 m
L = 0.1 m
Impedance Contours
Damping Limits
Breaking Limit Guide
α (m/s) = String Frequency f_1 (Hz) × String Length L (m)
50
100
150
200
250
300
String Tension (N). Contours in 10 N steps. First contour at 10 N.