Doctoral Prospectus

Hans Fugal

Manuals, stops, and pipes.
Oh my!

The Pipes

Pipes - one for each note.
Ranks of pipes - aka stops
Length of pipes, 8', 16', etc.

The Console

Manuals
Pedalboard
Stops
Divisions
Swell pedal
Registration
motab has 6 divisions and 206 ranks (147 stops), 11,623 pipes. (not the largest organ)
the bigelow (pictured above) has 3 divisions, 7 ranks, probably abt 400 pipes.

Identify Registration of Organ Recordings

Motivation

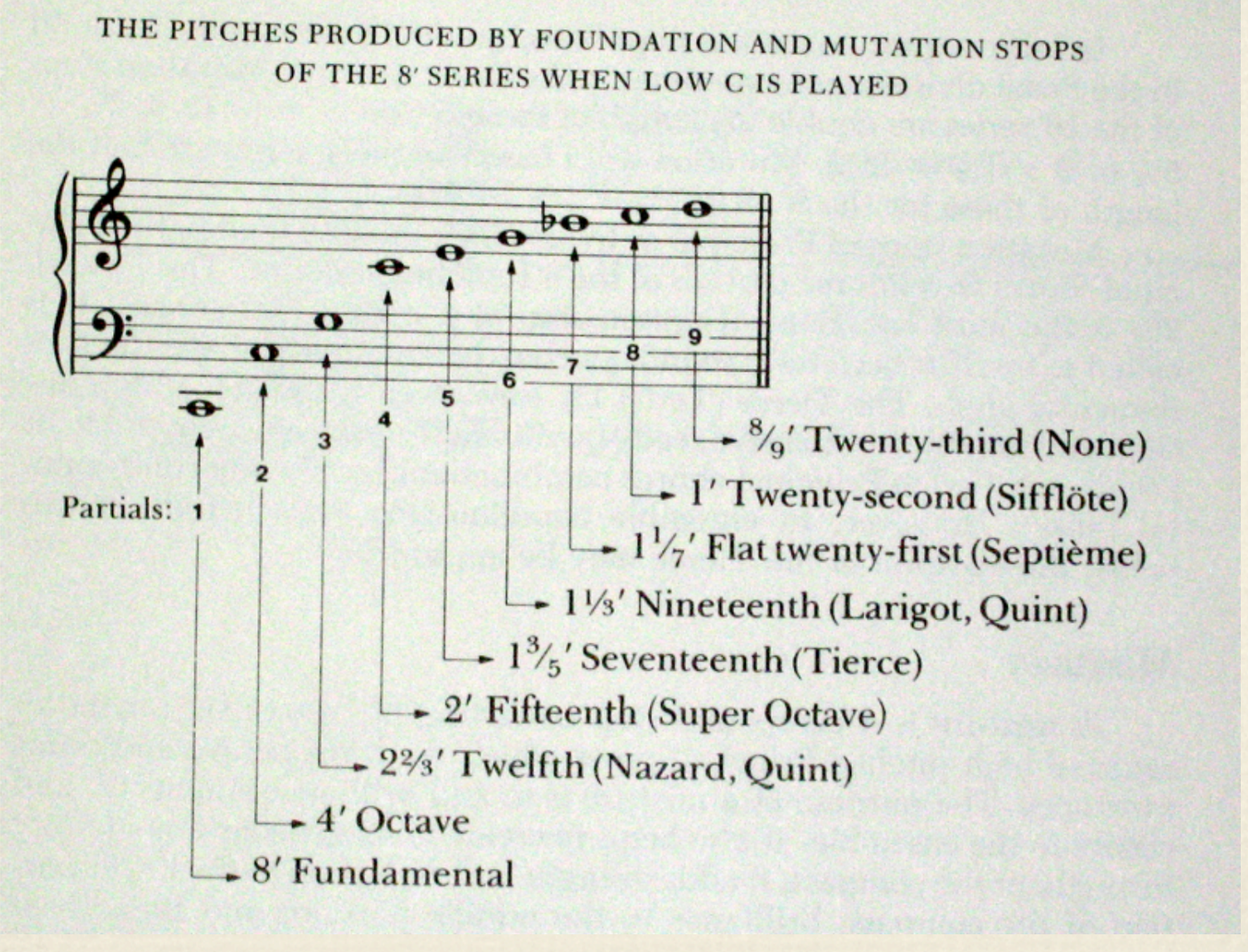
- Instrument Recognition: harder but easier
- Pedagogical
- Practical
- Because it's there

harder: real world recordings, reverb, polyphony, mixing of stops
easier: essentially constant spectrum, constant volume between and during notes, simultaneous attack, simple nature of organ sound
pedagogical: what stops did a master choose?
practical: what stops should I choose to sound like X? (train on my organ, test on X)

Organ Timbre

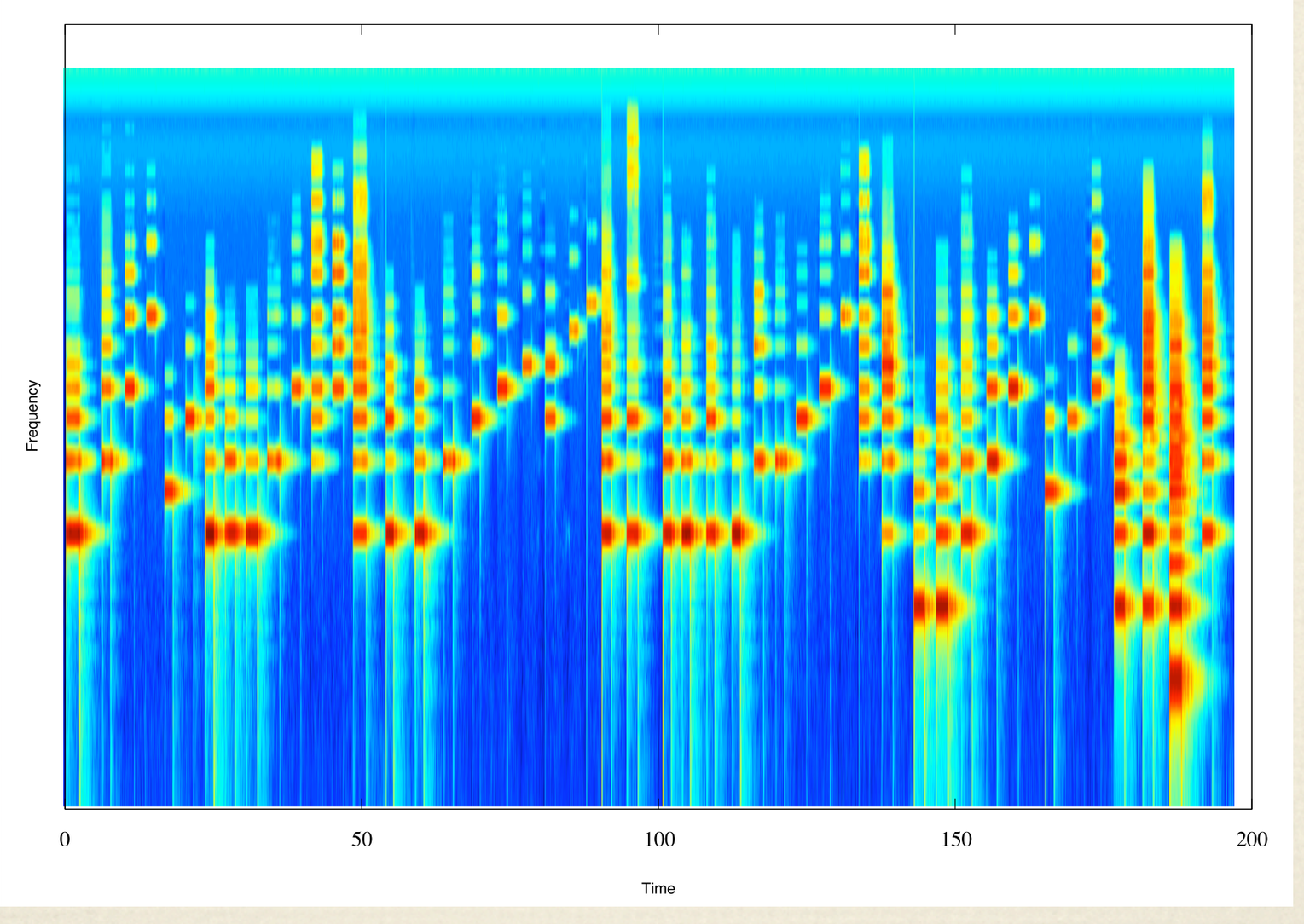
- Stable
- Predictable
- Each stop distinct
- Additive by combining stops

Harmonic Series



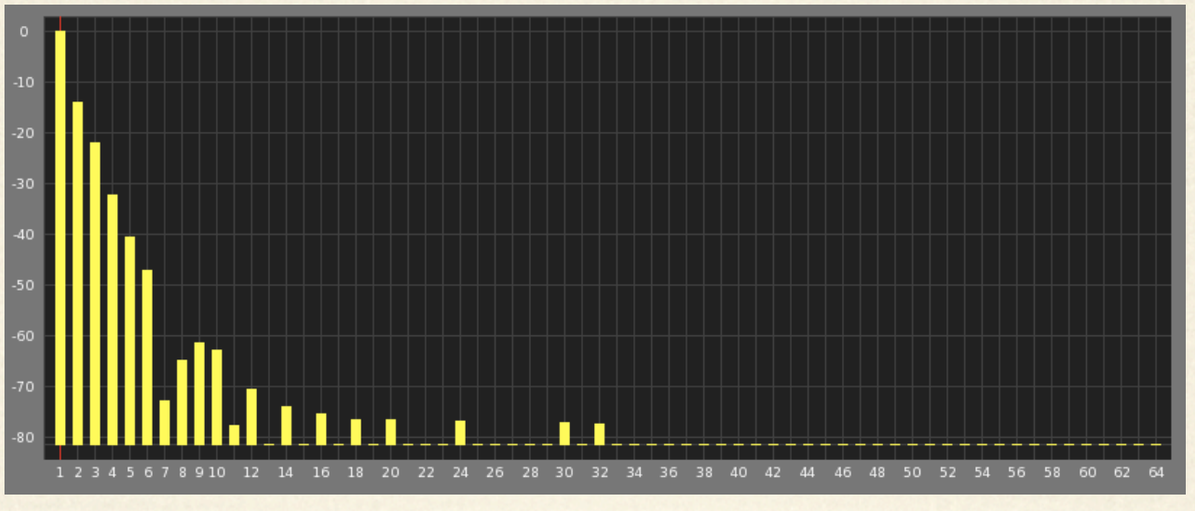
harmonic partials
mutation stops

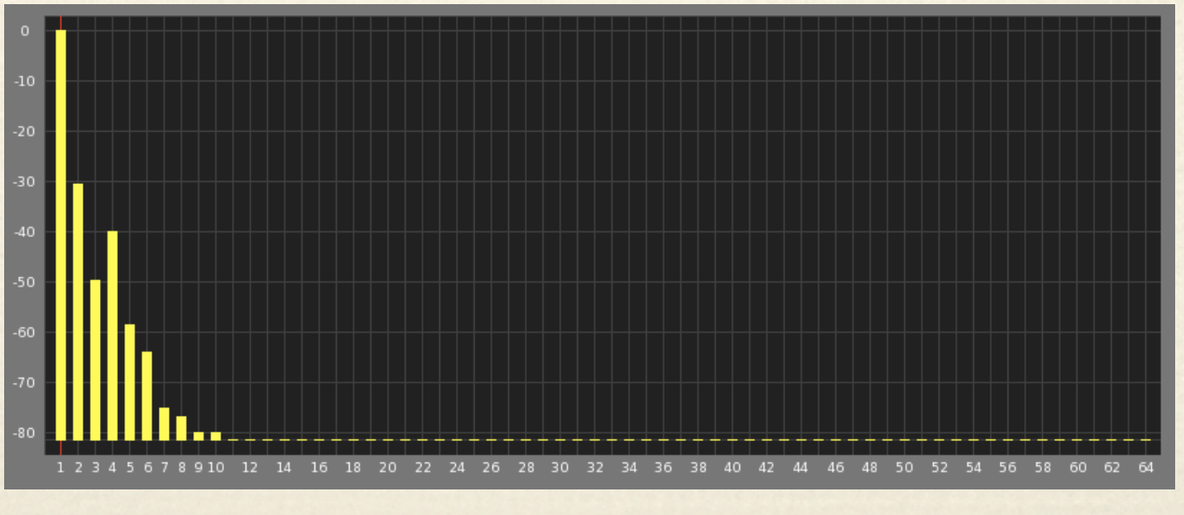
Aeolus Stops (Middle C)



log-frequency
distinct harmonic patterns
point out bombarde, which we'll see in 2 slides

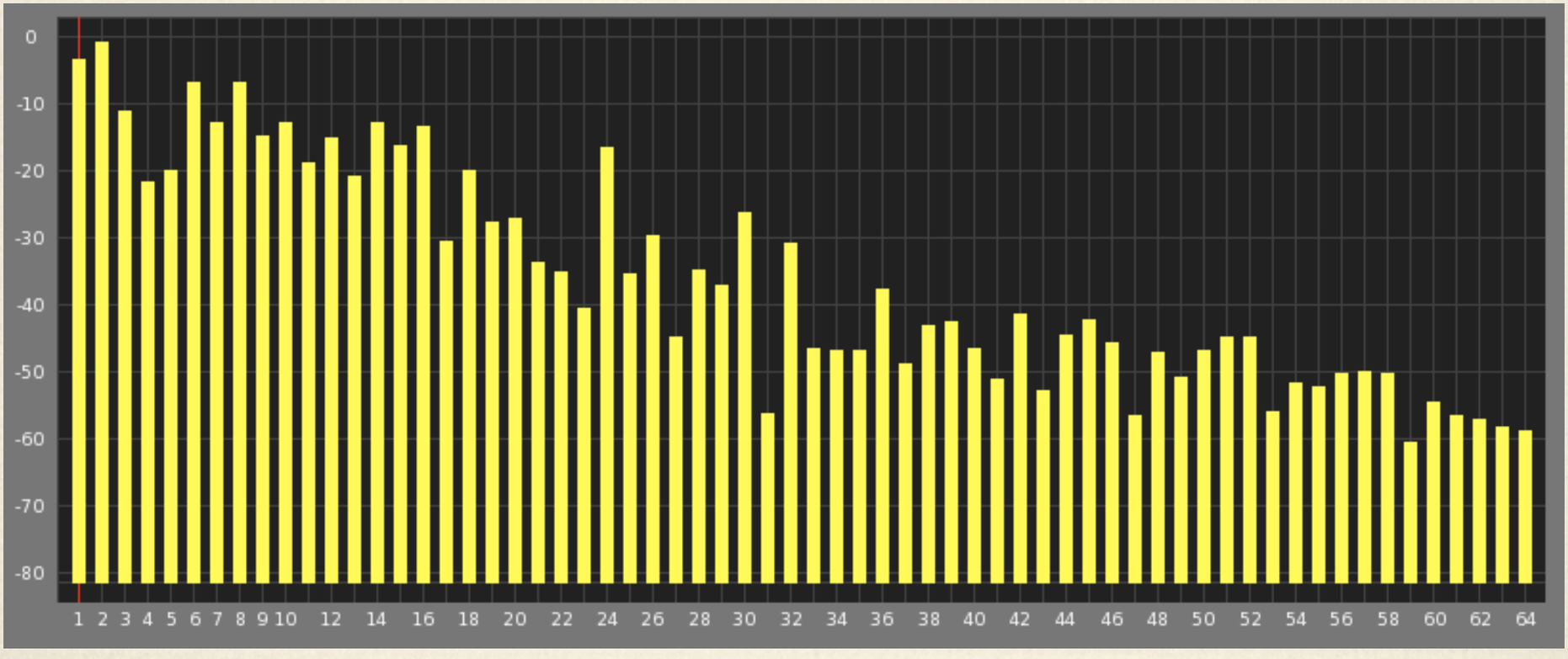
Principal 8’ and Flöte 8’





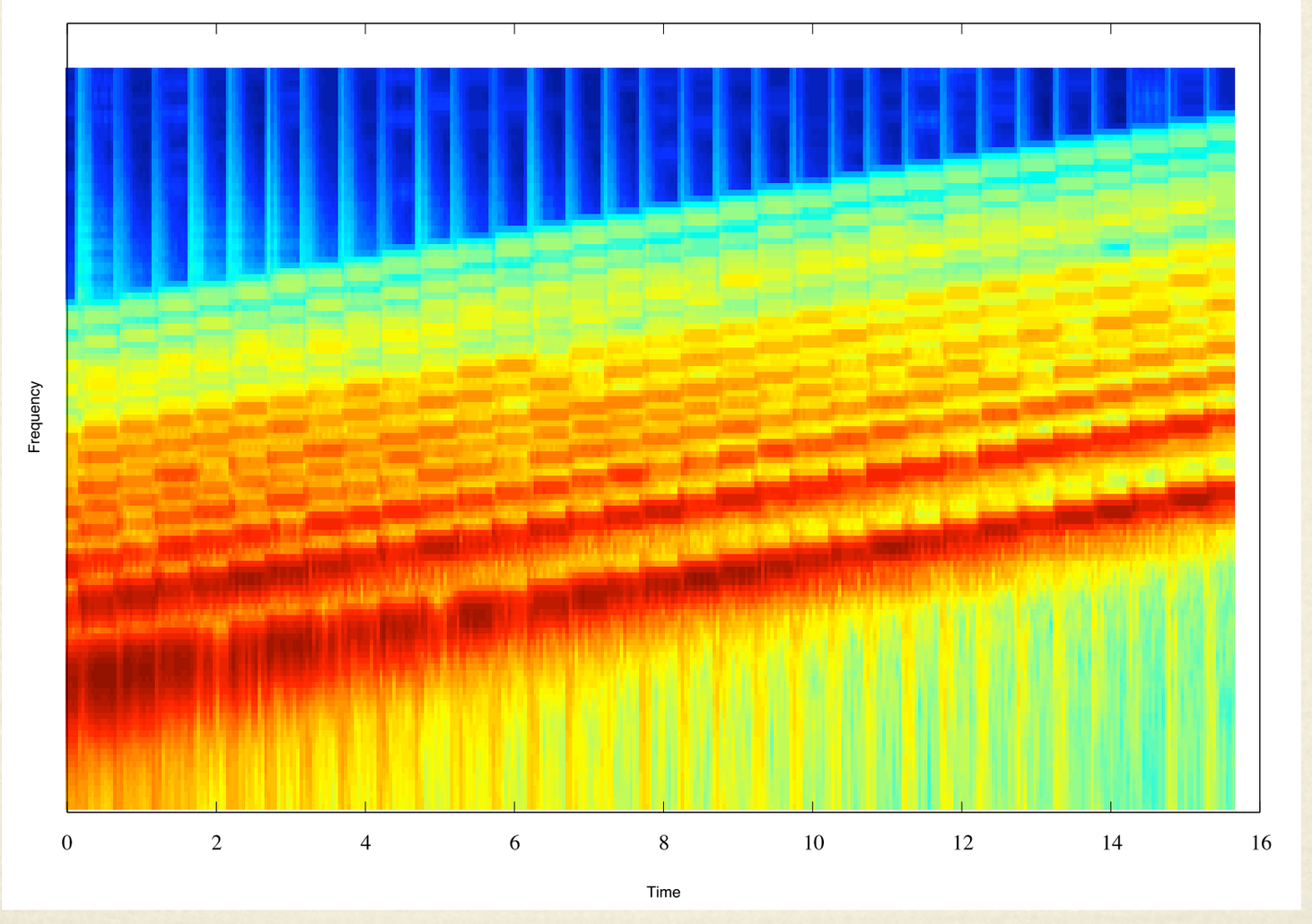
Aeolus synthesis parameters
harmonic level (dB)
cue bombarde

Bombarde 32’



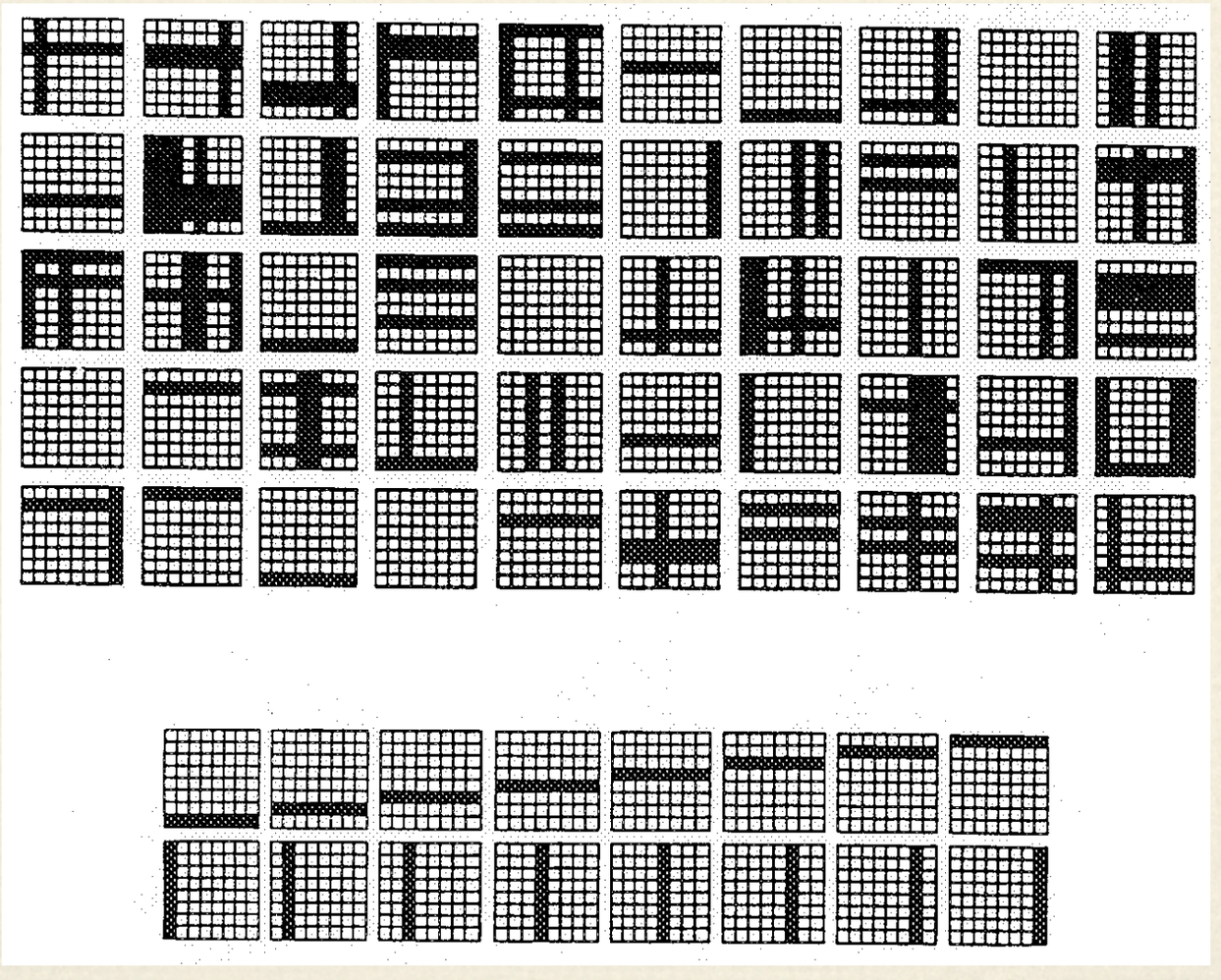
reeds - lots of harmonics

Spectrum Variation



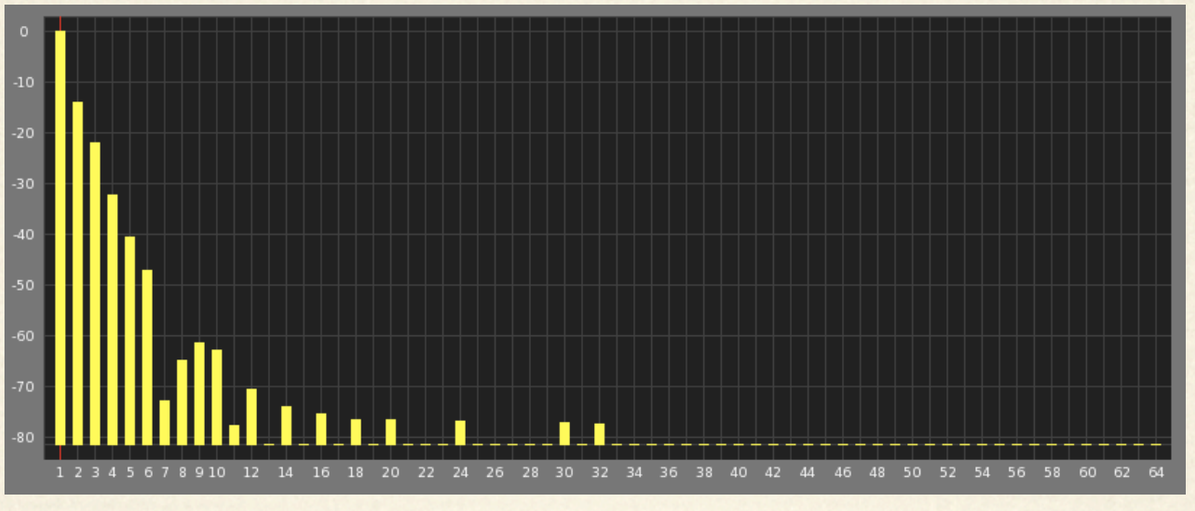
Remember, each pipe is a unique instrument
Note how things get more sparse in the upper register. probably because we hear high sounds louder, so for balance it would be voiced to have high notes be softer.
principal 8 iirc

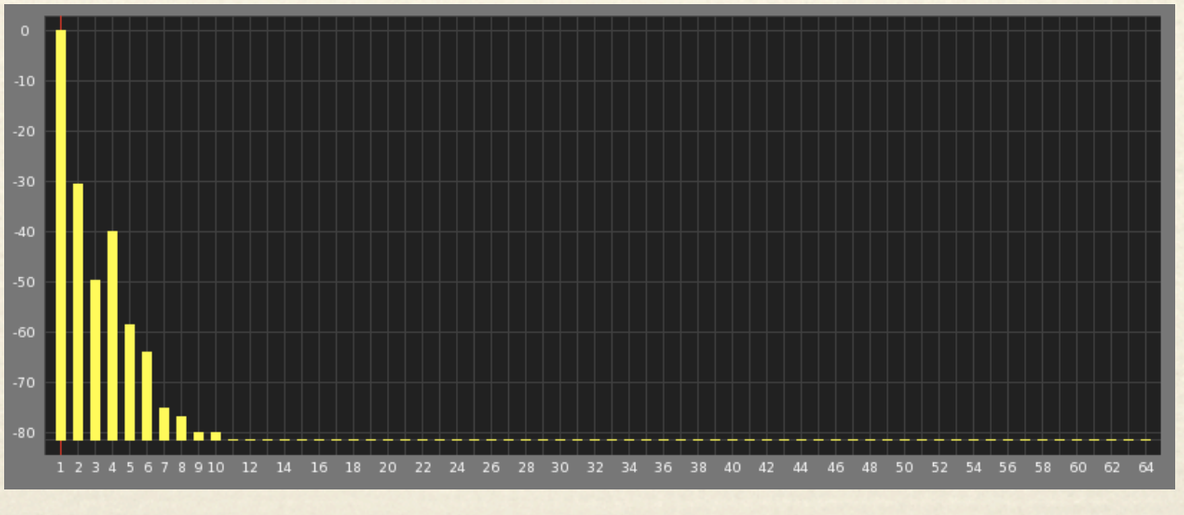
Multiple-Cause Mixtures



Bars problem: the bottom bases are combined to make the top. The cause of the top are multiple.

Principal 8’ and Flöte 8’

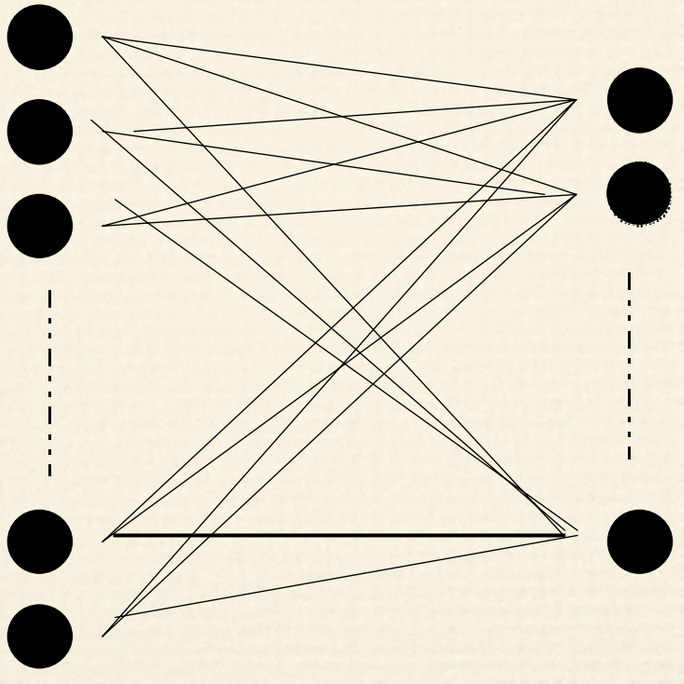




Imagine adding them together and the resultant harmonic spectrum

Neural Network

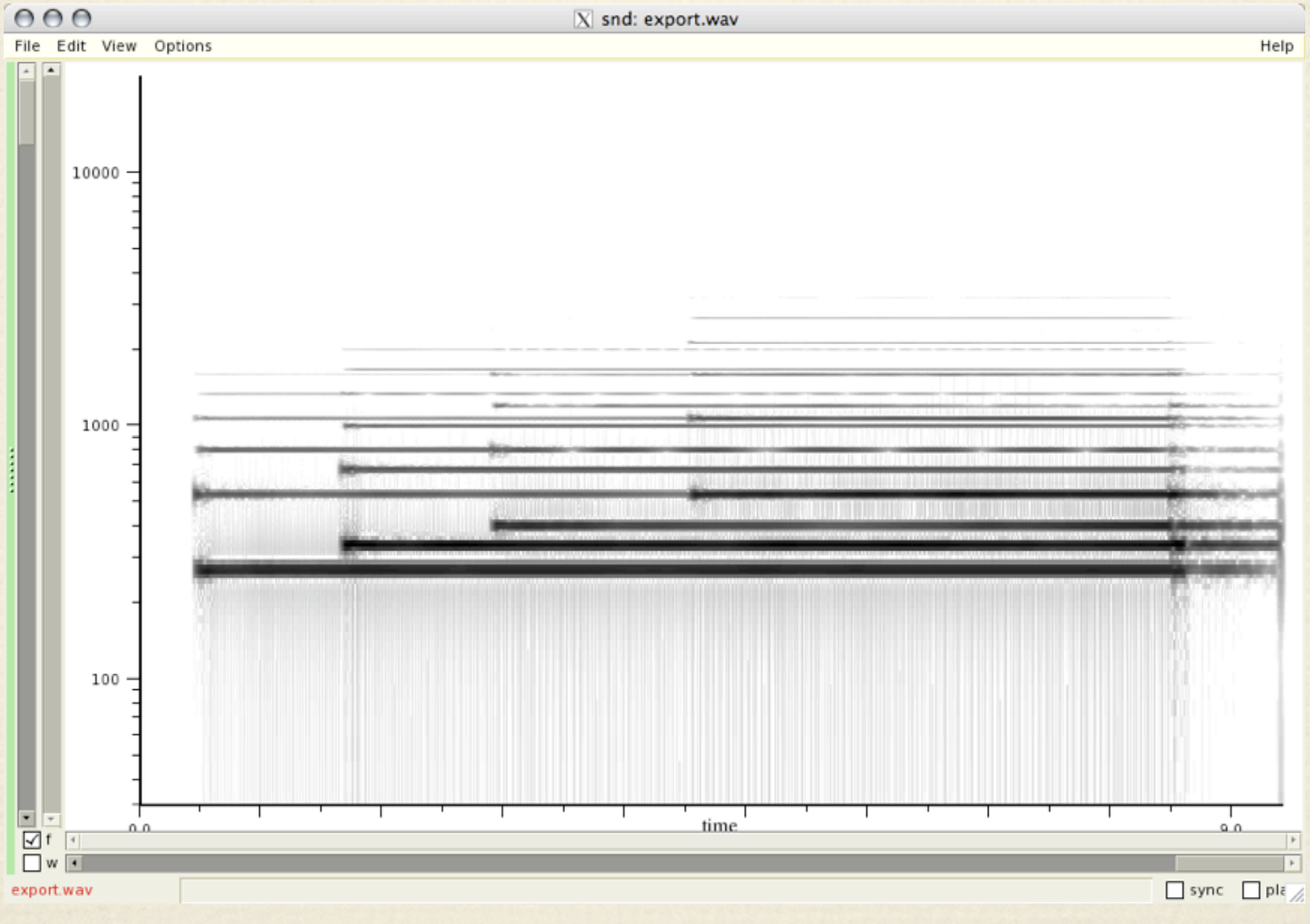
Harmonic Partials



Stops

This from klingseisen/saund.
Mine will be supervised instead of doing prediction (aka simple 2-layer neural network)
think it should work, but if not or if it doesn't seem optimal may be other ML techniques to explore.
But I don't know off-hand which one support multiple outputs like a NN

Polyphony



c, e, g, c’
e has little overlap with c (one harmonic)
g little overlap with c or e (one maybe two harmonics)
c’ has more overlap, but still many of _its_ partials are untouched.

Hypothesis

- Identify stops in isolation by modeling harmonic spectrum.
- Identify stops in mixture with neural network.
- Handle polyphony by picking fundamentals bottom up
- Belief “histogram”

Algorithm

- Train statistical models on isolated stops.
- Train neural network on random stop combinations generated from statistical models.
- Find fundamentals, identify stops, build belief histogram until convergence.

Steps 1 and 2 are one-time, Step 3 relatively fast, since no learning.

Potential Problems

- Multiple divisions
  (simultaneous hypotheses?)
- Registration Changes
- Sub/Octave Coupling
- Swell
- Tremolo
- Celestes

Data

- 10 seconds of each C, D#, F#, A in each stop
- Monophonic melodies in each stop in isolation
- Monophonic and Polyphonic music on one division with typical registration
- Polyphonic music on multiple divisions
- As many organs as possible

music pieces for testing, maybe a little training but without hoping to exhaust the possible combinations (random model-generated harmonics for that).

Roadmap

- Data gathered—July 26
- Stop models—August 2
- Stop mixtures—September 6
- Simple polyphony—Beginning of October
- Full polyphony—Middle of November
- Multiple divisions—December
- Dissertation/Defense—End of March