Granular Physics: Making Particles and Measuring the Angle of Repose

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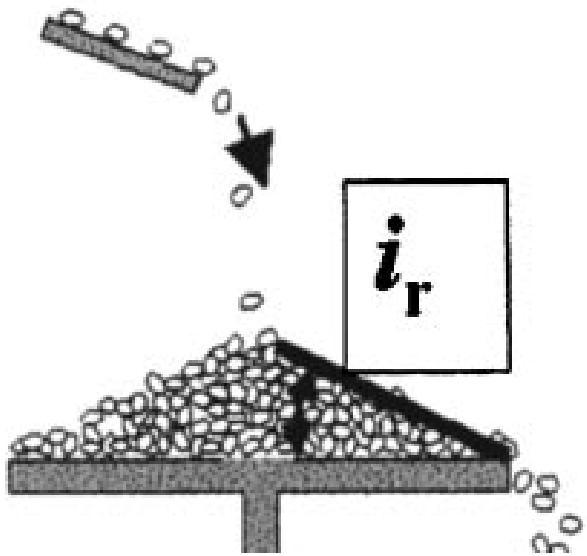
Overview

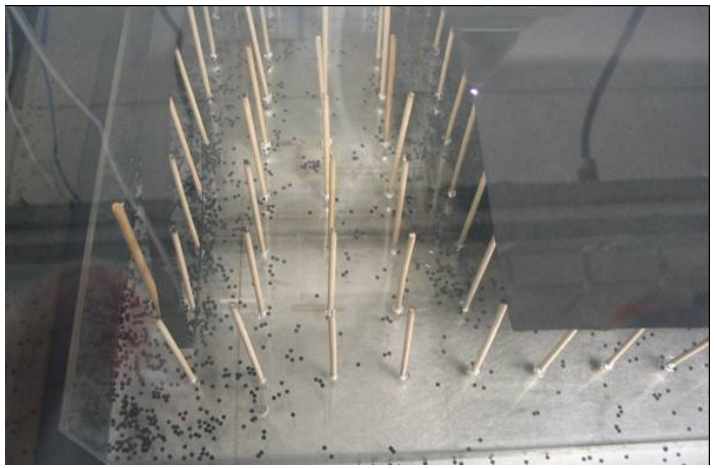
- What is Granular Physics?
  - Study of behavior of many small particles
  - Different from solid or liquid behavior
- Where is it used?
  - Applications in industry
  - Natural phenomena

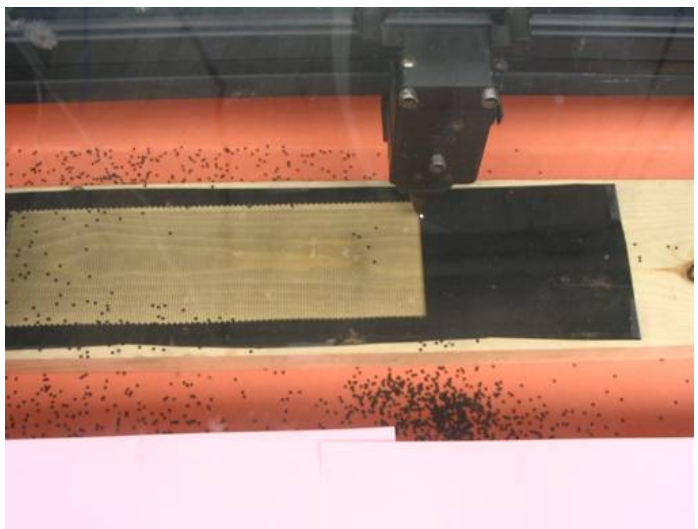
Project Outline

- Long term project
  - Flow and Angle of Repose
  - Shape, Size, Material, Effective Gravity
- This Summer
  - Method Improvement
  - Manufacturing Particles
  - Preliminary measurements



Accomplishments





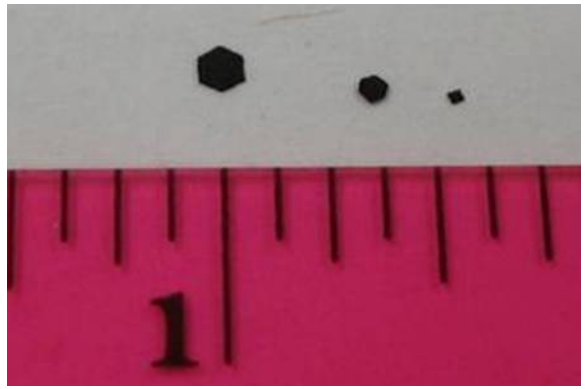
- Adjustment of method of production
  - Bed of Nails
  - Electrostatics
  - Simple platform
- Manufactured tens of thousands of identical particles
- Particle analysis

Hexagon with scalloped edges

Particle Data

Square with notch on corner

- Particles rough around the edges
- N particles = M/D/V
- Cutting method is still not optimal



L_1 = 0.0318”, L_2 = 0.019”, L_3 = 0.016”
(reference: 1/32 = 0.03125)

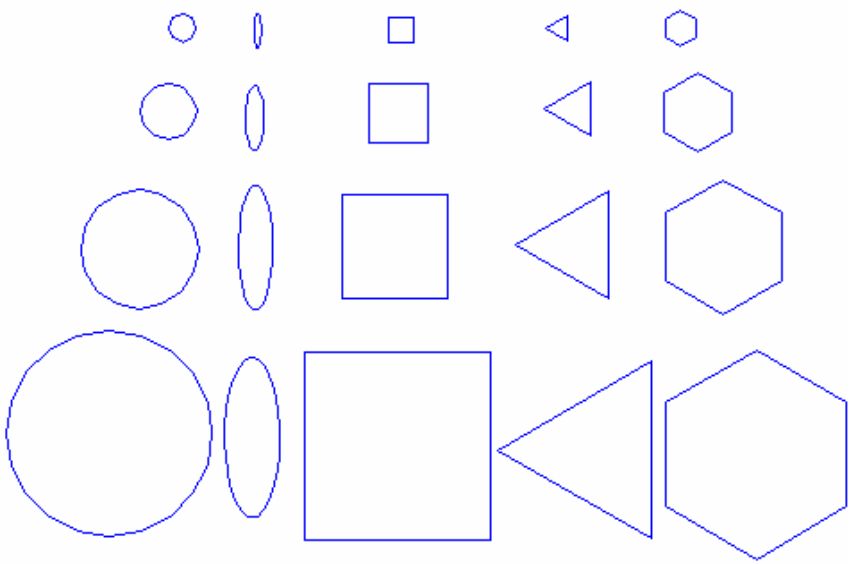
Mass Measurements used to calculate total number of collected particles							
Type	L (in)	Mass of Collection (g)	Volume per Particle (in^3)	Density (g/in^3)	N particles	N cut	% Error
Large Square	0.054	7.513	1.17E-05	19.44	33127	N/A	N/A
Large Triangle	0.073	N/A	9.23E-06	19.44	N/A	N/A	N/A
Small Square	0.016	0.923	1.02E-06	19.44	46357	64578	-39.3
Small Hexagon	0.019	7.680	3.75E-06	19.44	105282	119295	-13.3
Large Hexagon	0.032	6.922	1.06E-05	19.44	33453	35588	-6.38

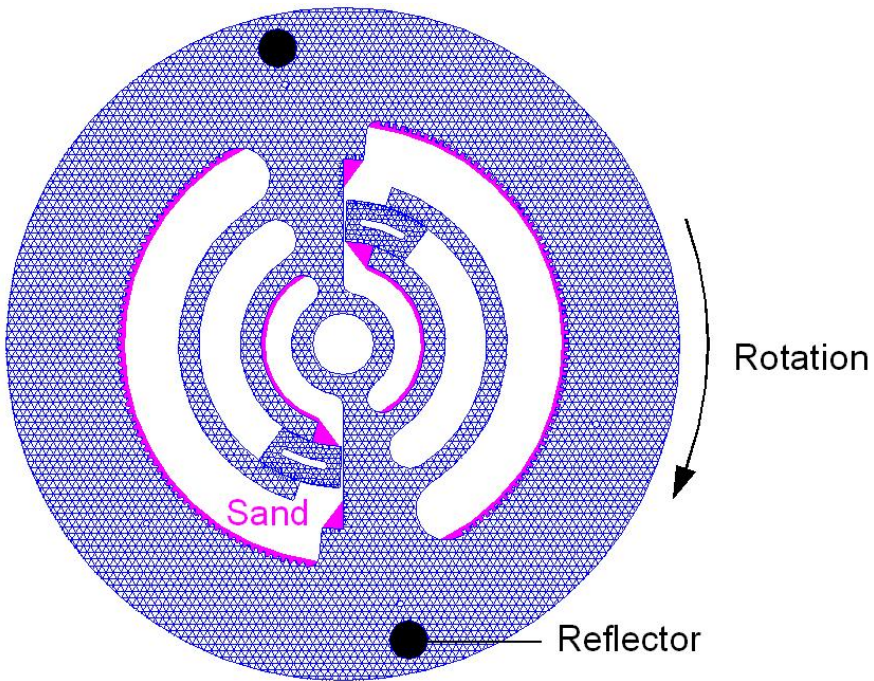
Angle of Repose Data

- Angle of Repose = $Tan^{-1}(h/r)$
- Carbon Paper Squares
  - Side width = 0.054 in
- Carbon Paper Triangles
  - Side width = 0.073 in

Particle Type	Carbon Paper Squares	Carbon Paper Squares	Carbon Paper Triangles	Carbon Paper Triangles
Surface Radius (cm)	1.237	2.497	1.237	2.497
Avg. Height (cm), Ten trials	1.26	2.25	1.33	2.22
Angle of Repose (deg)	45.5	42.0	47.2	41.7

Future Direction





- Suggestions
  - Make intermediate sizes
  - Cut circles and ovals
  - Reconsider the bed of nails
- A lot remains to be done
  - Different materials
  - Tens of microns down to nanometers
  - Increased gravity
  - poly-disperse collection of particles

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