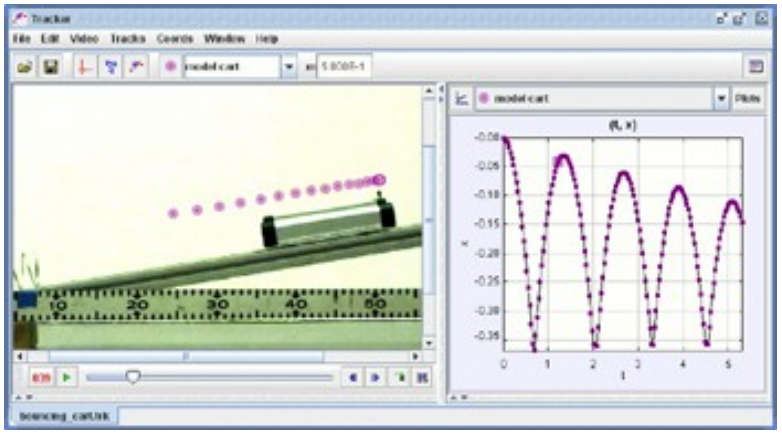
Tracker Video Analysis and Modelling Tool

What You Can Do with Tracker

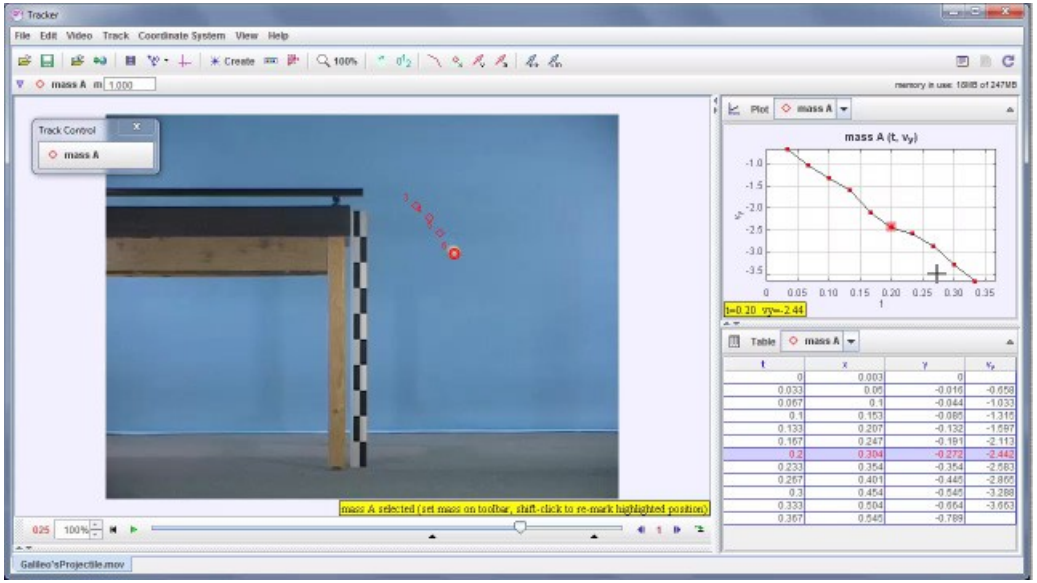


Public lecture
NUS LT-31
October 28, 2015

Organized by the Department of Physics, National University of Singapore; the Ministry of Education, Singapore; the National Institute of Education; Institute of Physics Singapore and funded by National Research Foundation

NUS National University of Singapore
Ministry of Education SINGAPORE
NIE National Institute of Education Singapore
Institute of Physics Singapore
National Research Foundation Prime Minister's Office Singapore
Research . Innovation . Enterprise

What is Tracker?

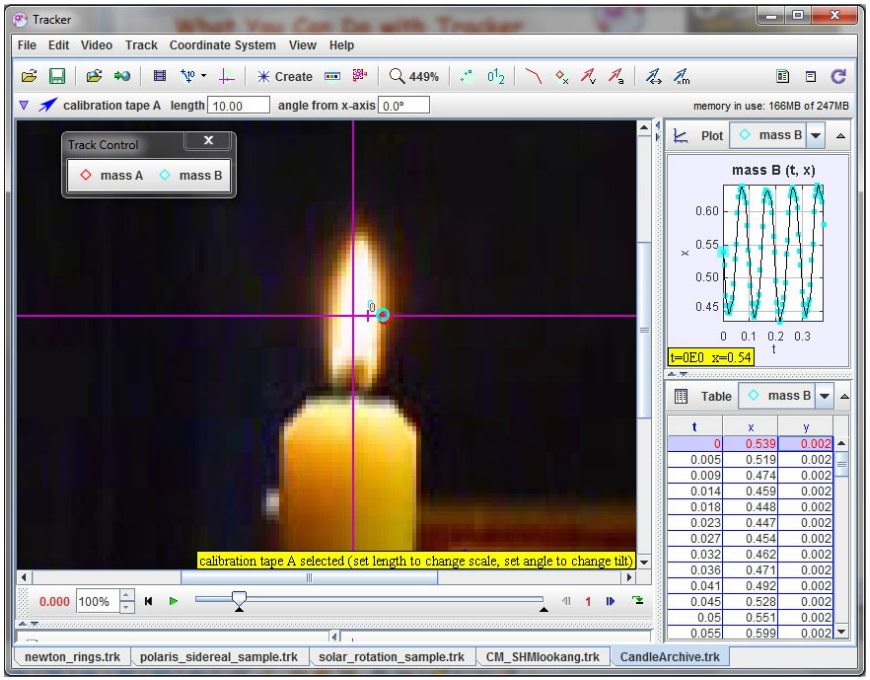


Tracker home: http://physlets.org/tracker/

OSP home: http://www.opensourcephysics.org/

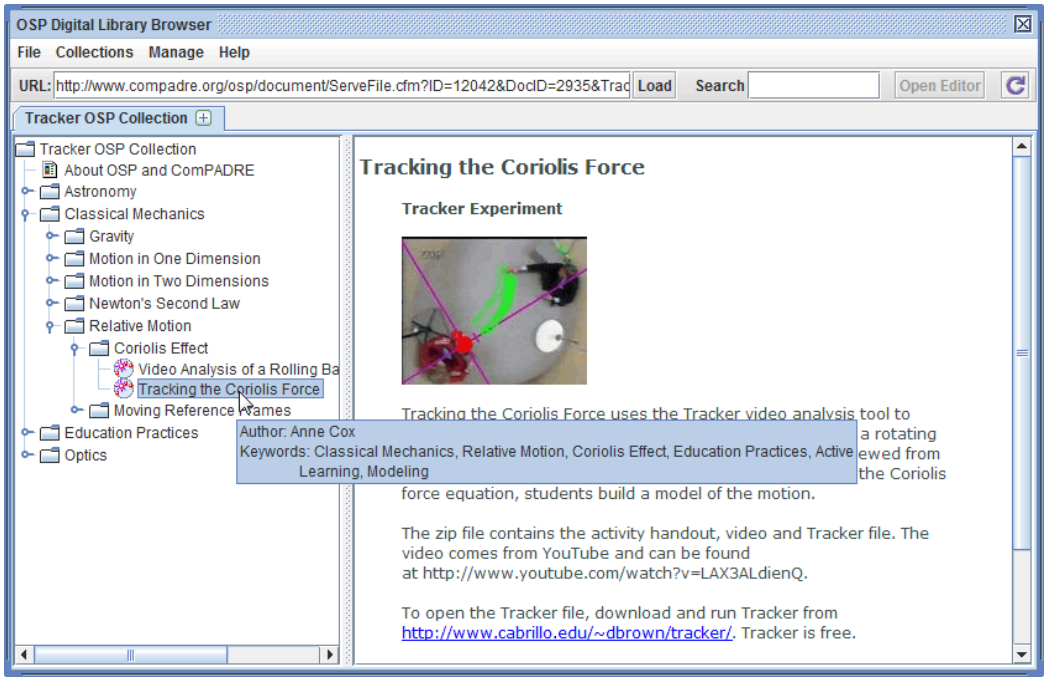
- *Free video analysis and modelling tool*
- *Project of Open Source Physics (OSP)*
- *Hosted by AAPT ComPADRE Digital Library*
- *Translated into 20 languages*

What can Tracker analyze?



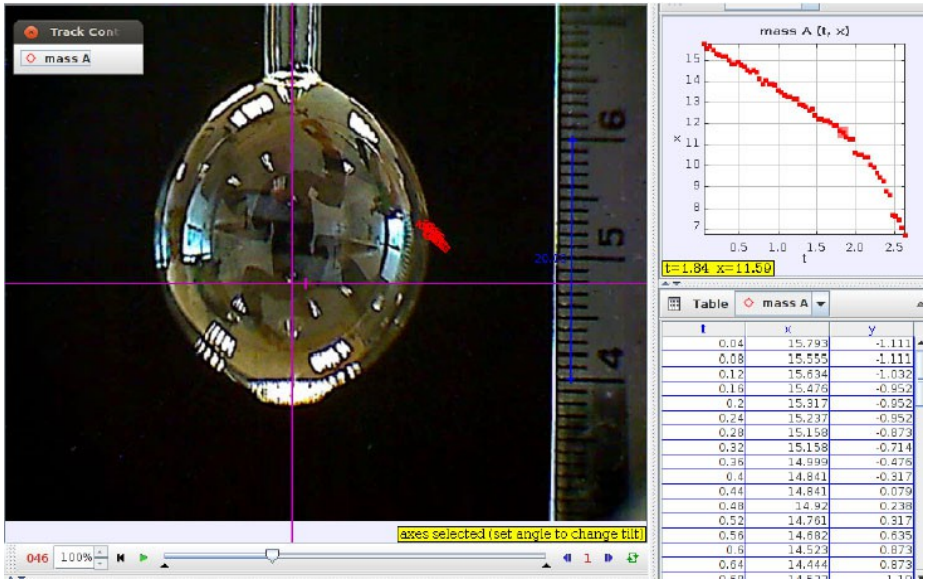
- *Motion and mechanics videos—of course!*
- ***But** there are many more possibilities: sound, fluids, optics, E&M, astronomy, fake videos, etc*
- *Videos are everywhere, easy to capture or download*

Tracker's Digital Library Browser



- *Collections of videos and Tracker experiments*
- *Open in Tracker with a double-click*
- *Searchable by keywords or metadata (e.g., author)*
- *Many collections on many servers, local too*

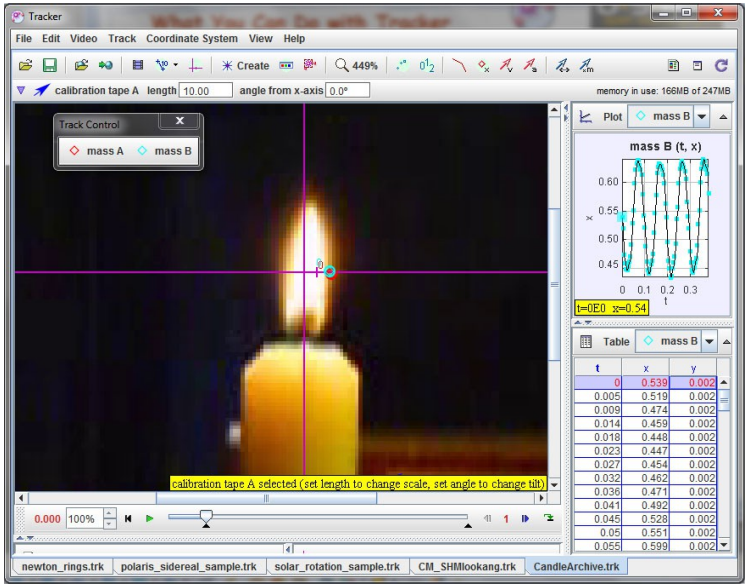
Deflating soap bubble



Digital library: “soap bubble”

- *Gregor Steele, Scotland*
- *Bubble deflates through capillary tube*
- *Prediction: r^4 vs t should be linear with negative slope*
- *Use Tracker's circle fitting tool to measure diameter*
- *Determine the viscosity of air*

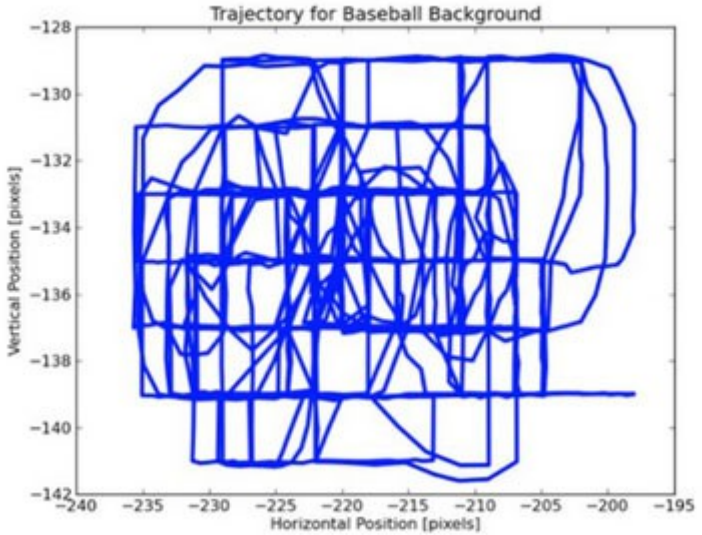
Candle sound waves



Digital library: “candle”

- *Paulo Carvalho et al, Brazil*
- *Candle flame moves with air in sound waves*
- *Measure frequency*

Fake videos

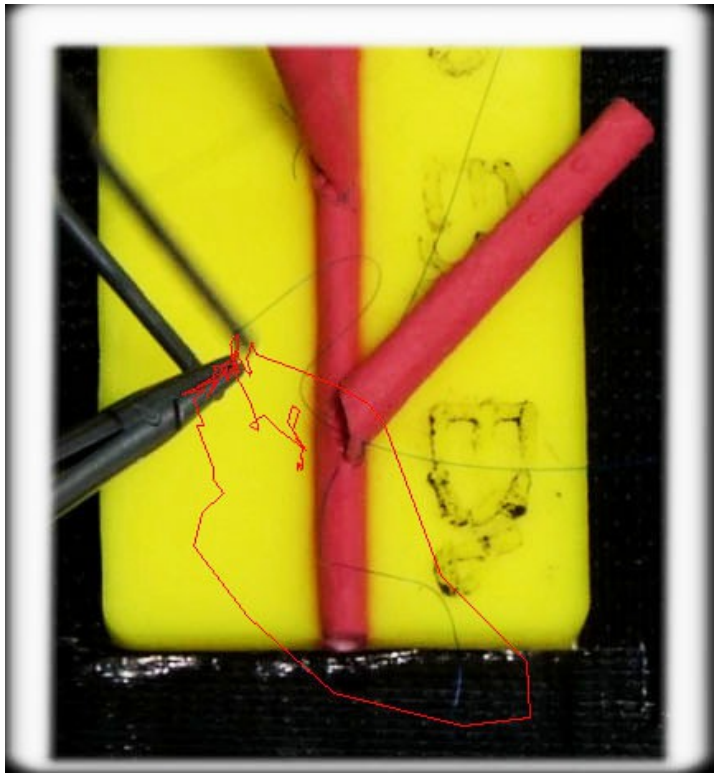


www.wired.com/2014/10/physics-fake-videos/

www.wired.com/2012/03/more-analysis-of-the-fake-birdman-video/

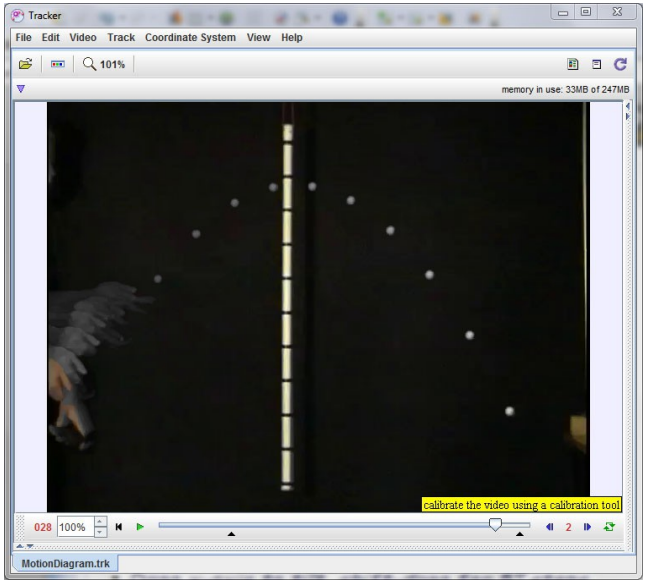
- *Rhett Allain, dot physics*
- *Movie scenes, YouTube videos*
- *Look for wrong physics, camera shake, etc*

Training surgeons



- *James Wood, Macquarie University*
- *Surgical trainees join simulated blood vessels together*
- *Compare with expert surgeons for economy of motion*

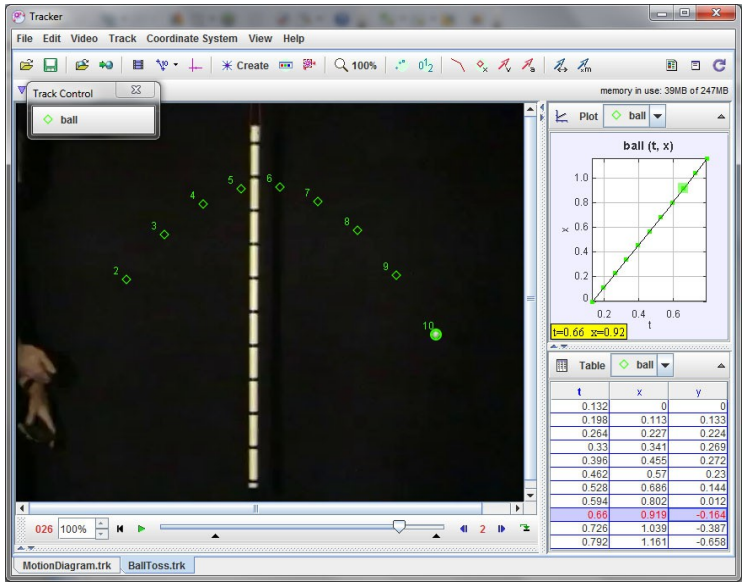
Motion diagrams



Digital library: “Motion diagram”

- *“Live” motion diagram*
- *Ghost video filter leaves fading trail*
- *Qualitative interpretation*

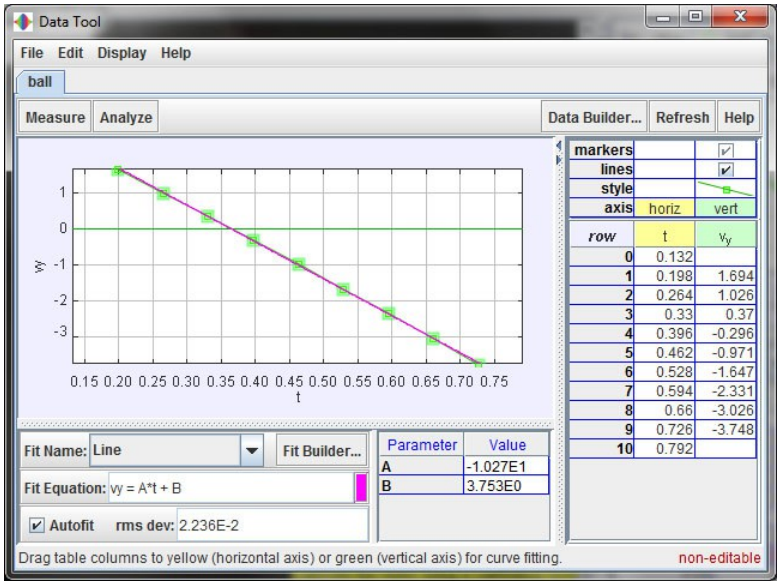
Video analysis: point mass track



Digital library: “Point mass track”

- *Calibrate the video, set the origin*
- *Mark positions with the mouse*
- *Quantitative data: position, velocity, acceleration, etc*
- *Plot and table views*

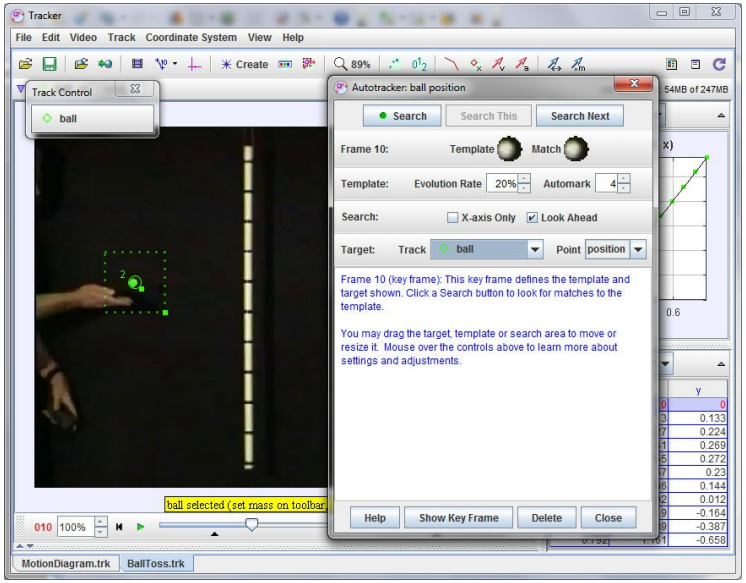
Tracker data analysis: Data Tool



Digital library: “Point mass track”

- *Opens directly from Tracker*
- *Slope and area measurements*
- *Curve fitting with fit builder*

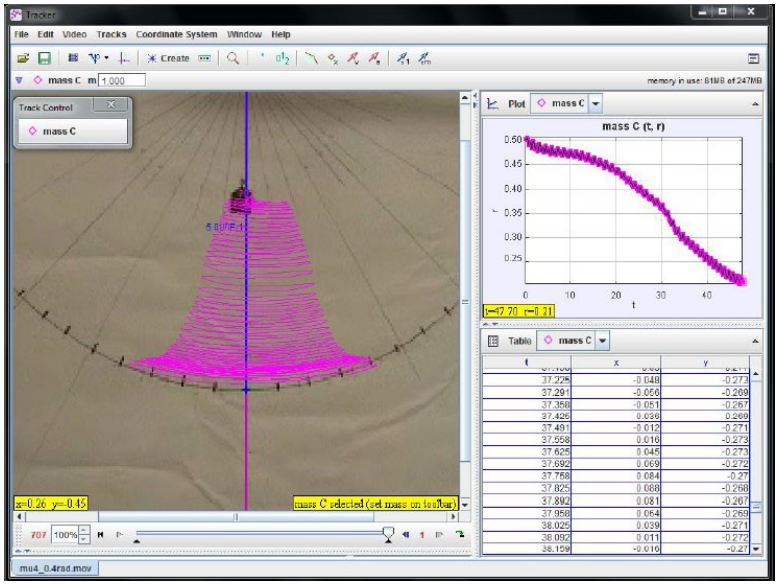
Video analysis: autotracker



Digital library: “Point mass track”

- *Matches images to track objects in successive frames*
- *Marks positions automatically if desired*
- *Evolves to accommodate changes in scene*

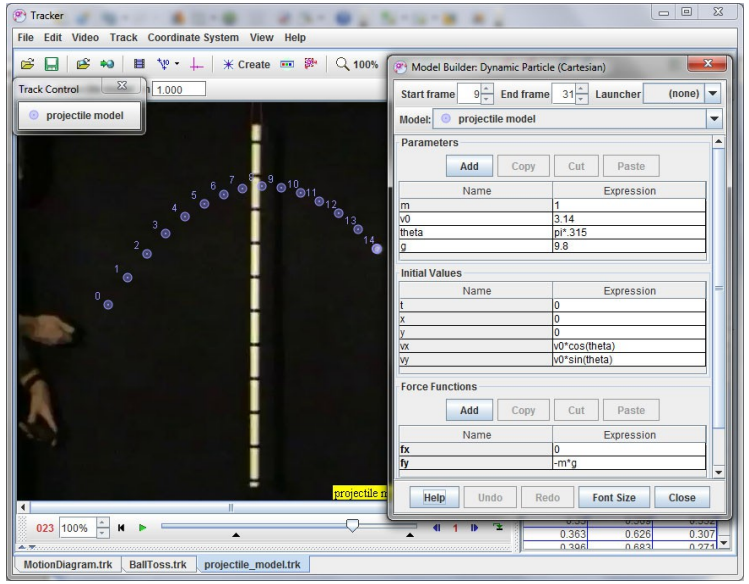
Pendulum on an Atwood machine



ComPADRE: “Tracker atwood”

- *Leah Ruckle, Davidson College*
- *Advanced student project*
- *10,000 data points (!) marked with autotracker*

Video modelling

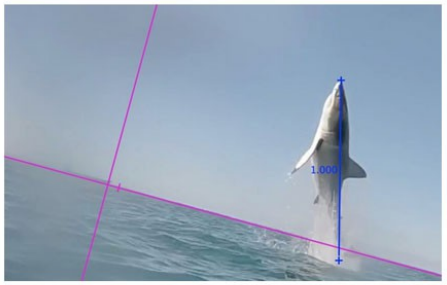


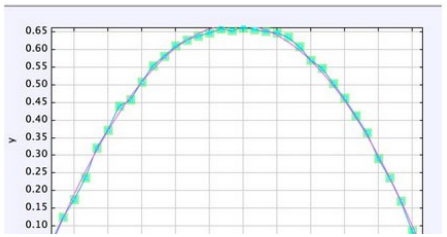
Digital library: “Projectile model”

- *Dynamic particle model uses ODE solver*
- *Enter force expressions and initial conditions*
- *Define parameters*
- *Powerful expression parser*

Free fall: sharks!

WATCH THIS LEAPING GREAT WHITE SHARK GET SOME SERIOUS AIR

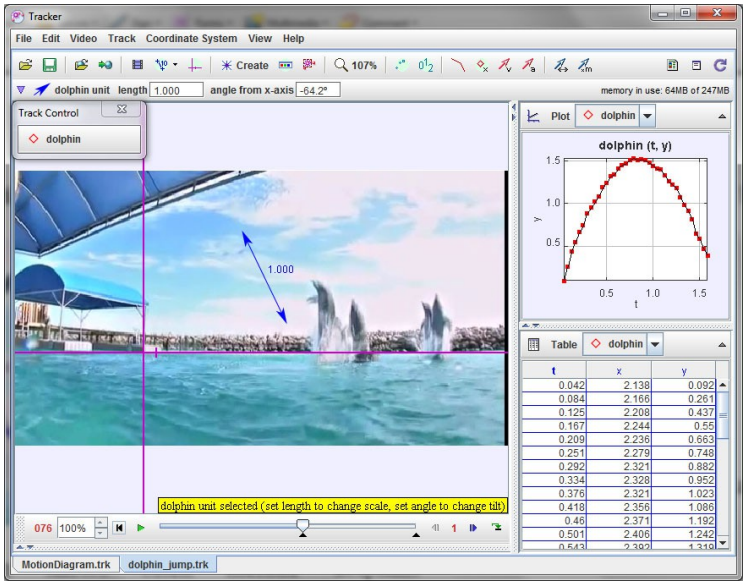




www.wired.com/2015/08/watch-leaping-great-white-shark-get-serious-air/

- *Rhett Allain, dot physics*
- *Exciting video*
- *Twist of treating shark length as unknown, finding it using known constant "g"*

Free fall: dolphins!



Digital library: “dolphin”

- *Anne Cox, Eckerd College*
- *Fun video*
- *PDF lesson materials included in zipped Tracker file*

Freefall: ball in accelerating elevator

RHETT ALLAIN SCIENCE 01.15.13 8:27 AM

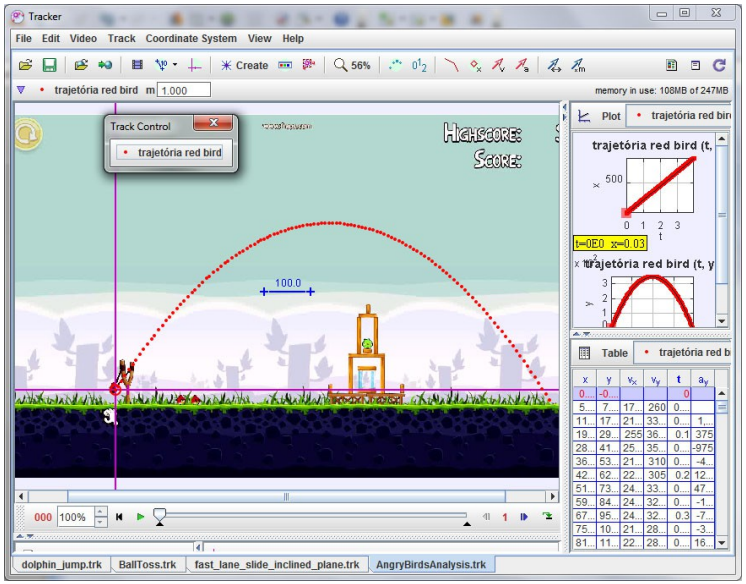
A BALL IN AN ACCELERATING ELEVATOR

Elevators in the Hyatt Regency New Orleans

www.wired.com/2013/01/a-ball-in-an-accelerating-elevator/

- *Rhett Allain, dot physics*
- *His own video taken at AAPT meeting*
- *Able to get good data and analyze it in Data Tool*
- *Accelerating reference frames*

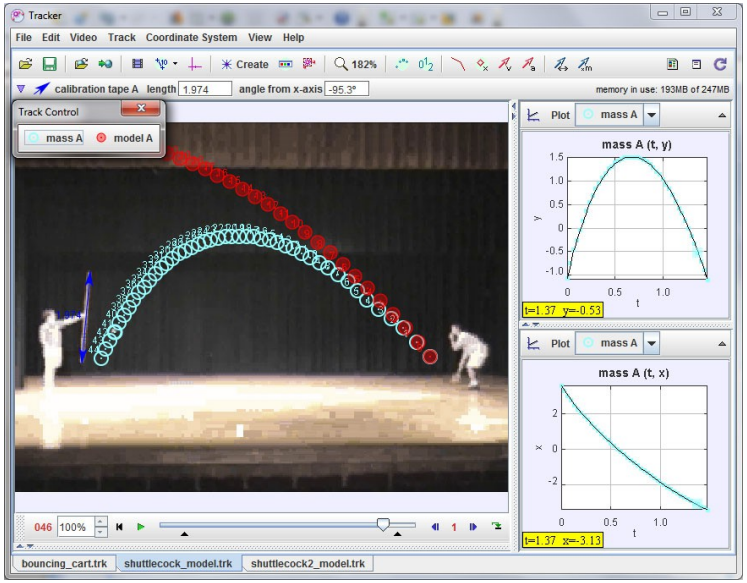
Freefall? Angry birds



Digital library: “Angry Birds”

- *Several contributors*
- *Video game screen capture video*
- *Alien world, unknown “g”, sometimes unknown physics*

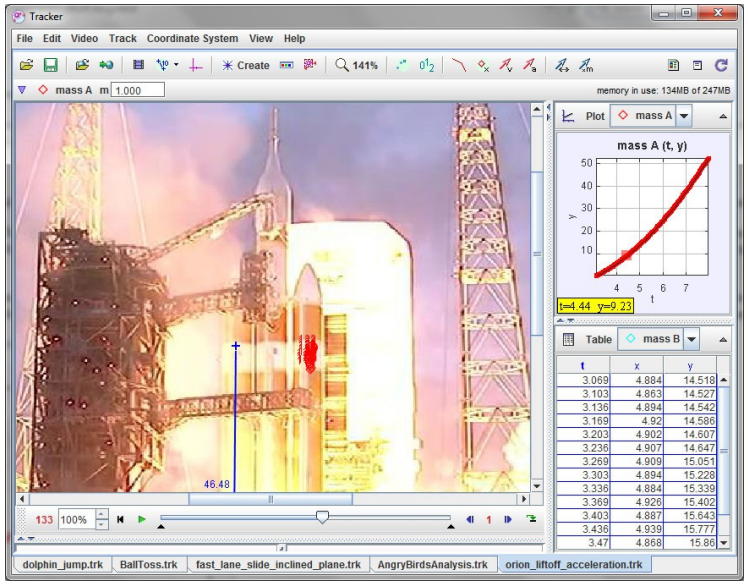
Air resistance: badminton shuttlecock model



Digital library: “badminton”

- *Loo Kang Wee, Singapore Tracker Digital Library*
- *Move beyond freefall*
- *Easy with dynamic modelling*
- *This is the real world!*

Orion liftoff



Digital library: “Orion Liftoff”

- *Rhett Allain, ComPADRE*
- *NASA video*
- *Measure acceleration*

Rocket car

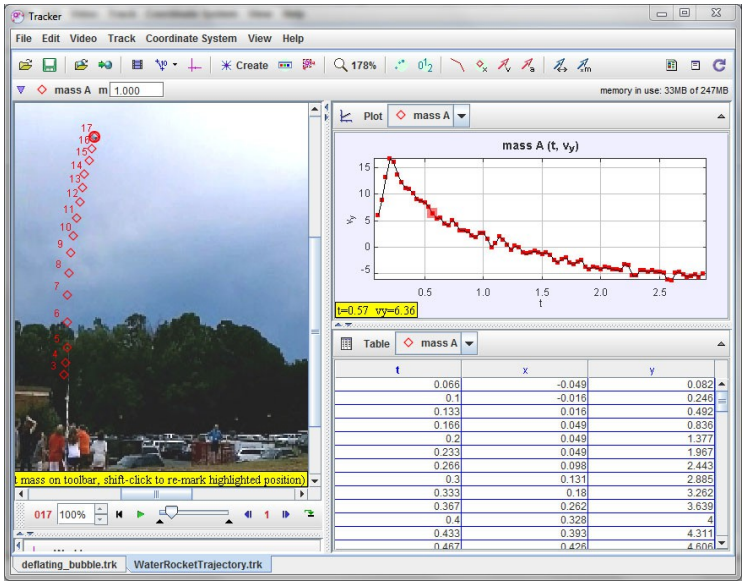
MYTHBUSTERS: WHY DID THE ROCKET CAR BREAK THE RAMP?

I HOPE YOU didn't miss the last MythBusters. Only the

www.wired.com/2013/05/mythbusters-why-did-the-rocket-car-break-the-ramp/

- *Rhett Allain, dot physics*
- *Mythbuster video*
- *Makes estimates and checks reasonableness*
- *Ties to force and momentum*

Water rocket



Digital library: “Water Rocket Experiment”

- *Wolfgang Christian, Davidson College*
- *Students aged 12-13 years*
- *Are they excited? Yes!!*

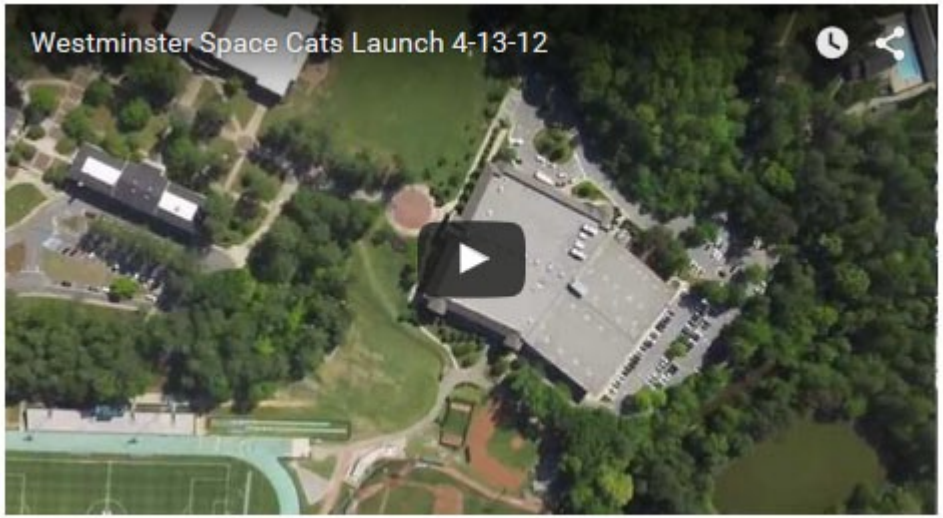
Skydiving without a parachute

##Reuters / EDDIE KEOGH

Digital library: “Skydiving without a parachute”

- *Rhett Allain, ComPADRE*
- *Skydiver wears a wingsuit, lands on cardboard boxes*
- *Determines speed on impact*

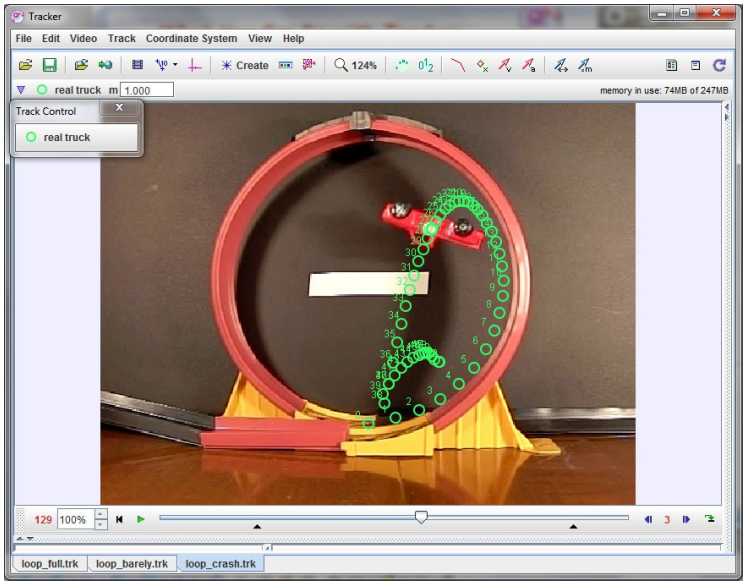
Height of a space balloon



www.wired.com/2012/05/angular-size-and-the-height-of-a-space-balloon/

- *Rhett Allain, dot physics*
- *Video from on-board camera*
- *Measure angular size of ground objects, determine h*
- *There's useful data in many videos!*

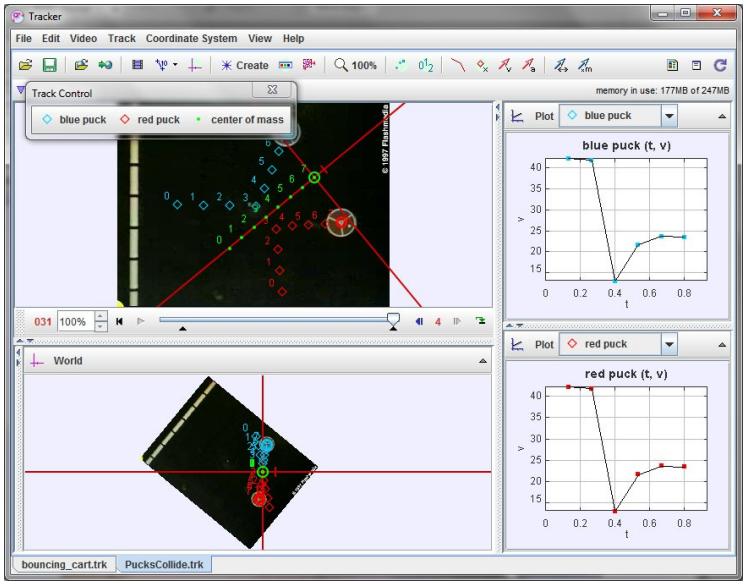
Hot wheels truck in a vertical loop



Digital library: “Hot Wheels Loop”

- *Douglas Brown, Tracker OSP collection*
- *Series of videos with different truck speeds*
- *Model forces acting on the truck*

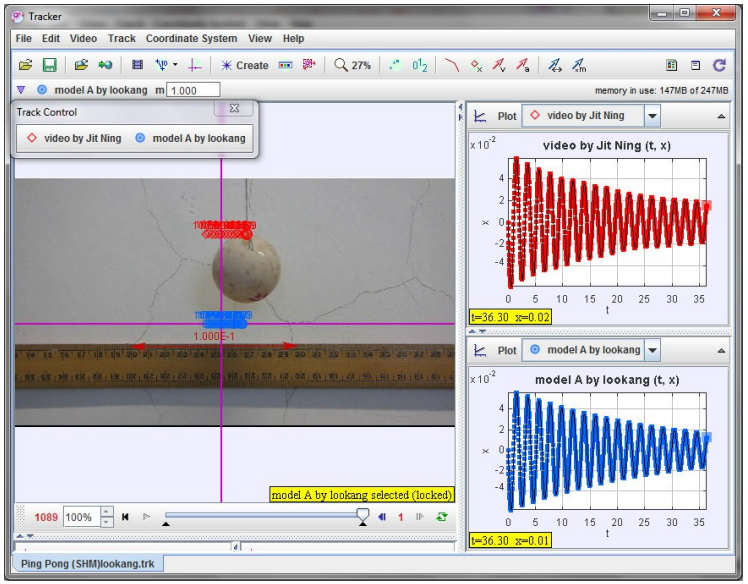
Collisions: center of mass



Digital library: “pucks collide”

- *Douglas Brown, Cabrillo College*
- *Center of mass moves at constant velocity*
- *World view enables you to observe the collision from the center of mass reference frame*

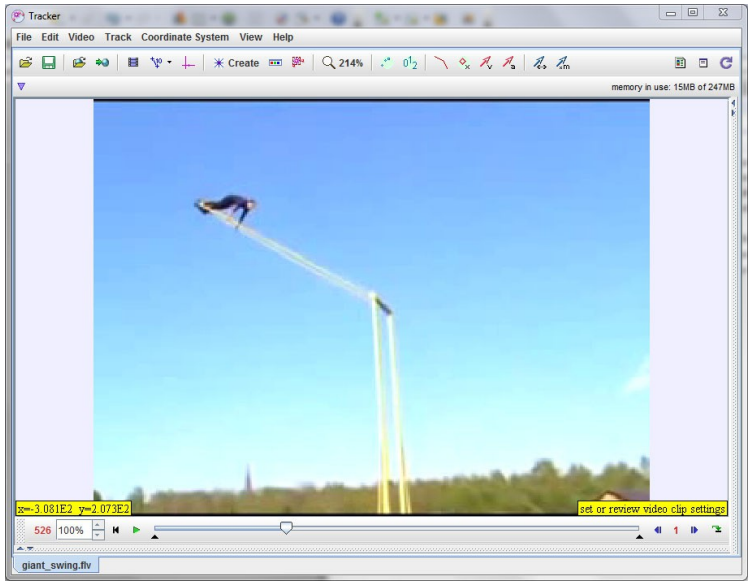
Pendulum motion



Digital library: “pendulum”

- *Loo Kang Wee, Singapore Tracker Digital Library*
- *Dynamic pendulum models enable students to explore large amplitude swings*

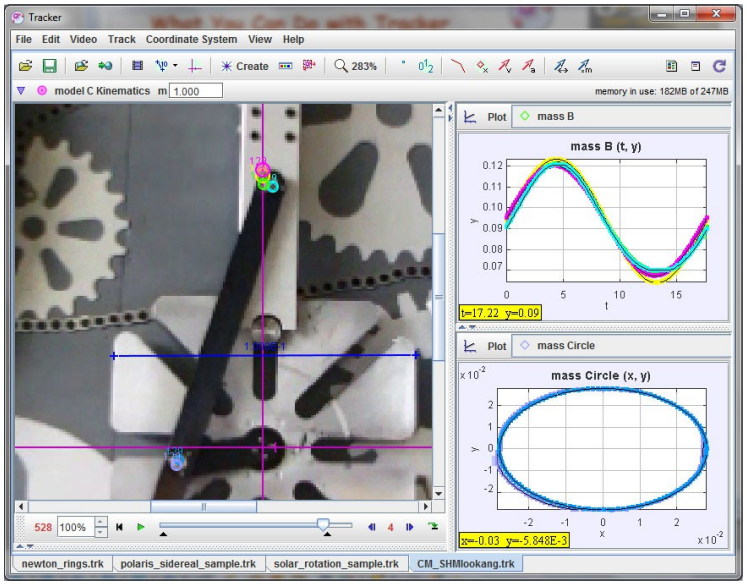
Giant swing!



YouTube: "Epic 360 rotation on giant swing"

- *Apply perspective filter to eliminate distortion*
- *Track moving origin to eliminate camera shake*
- *VERY large amplitude pendulum*
- *How to model the driving force?*

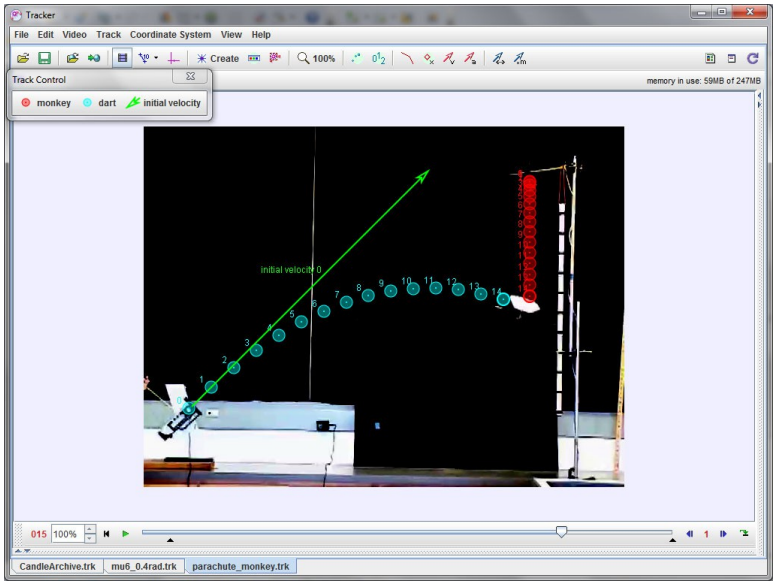
Gear and rod model

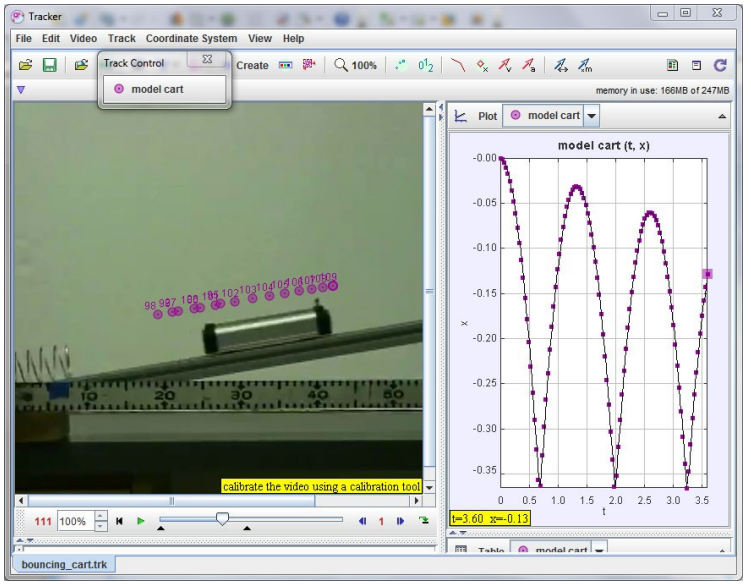


Digital library: “gear rod”

- *Loo Kang Wee, Singapore Tracker Digital Library*
- *Modelling shows rod does NOT undergo simple harmonic motion*

Student projects

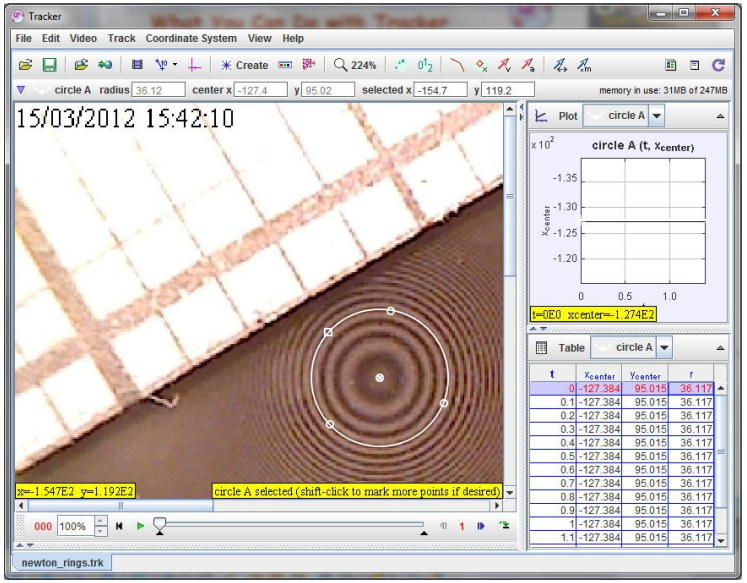




Digital library: “projects”

- *Students design experiment, capture videos, analyze or model the video, present results*
- *Appropriate at any level from middle school to university*

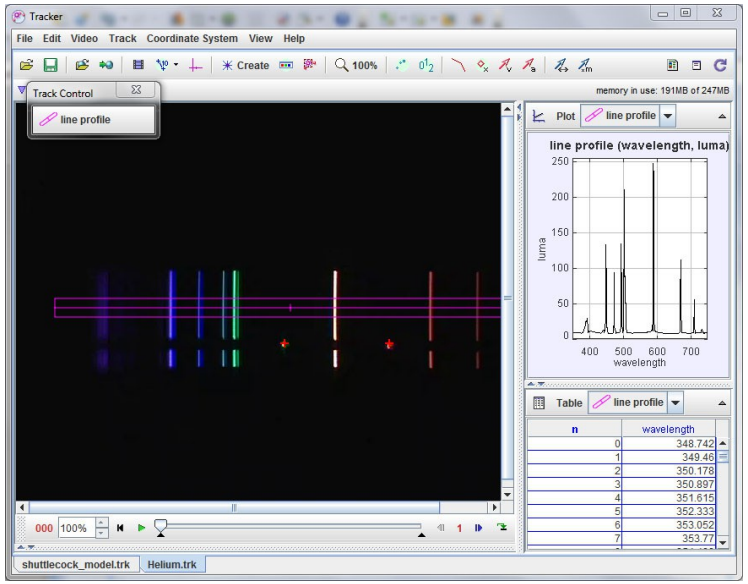
Newton's rings

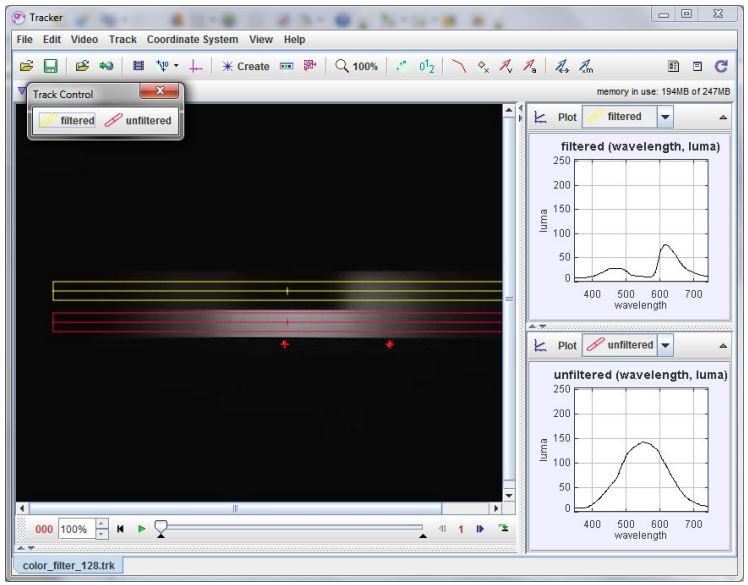


Digital library: “newton”

- *Gregor Steele, Scotland*
- *Light wave interference*
- *Measure radii with circle fitter*

Spectroscopy

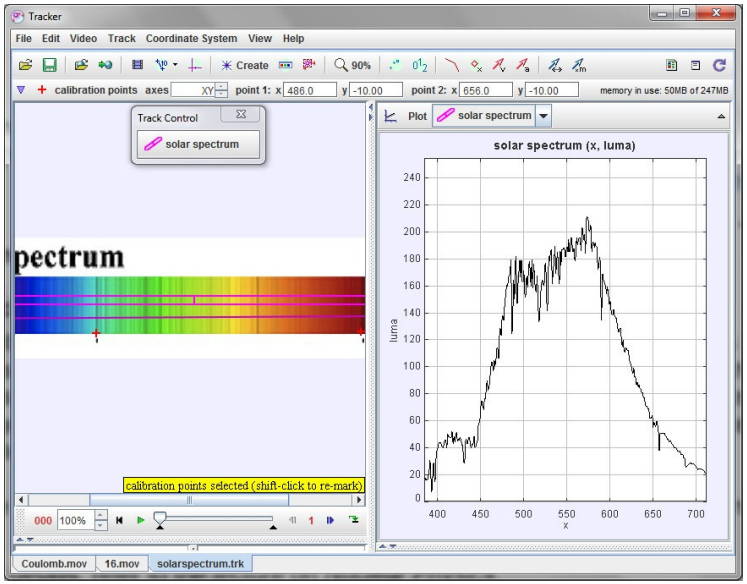




Digital library: “spectroscopy”

- *Douglas Brown, Cabrillo College*
- *Use laser spots to calibrate wavelength scale*
- *Measure spectrum with line profile tool*

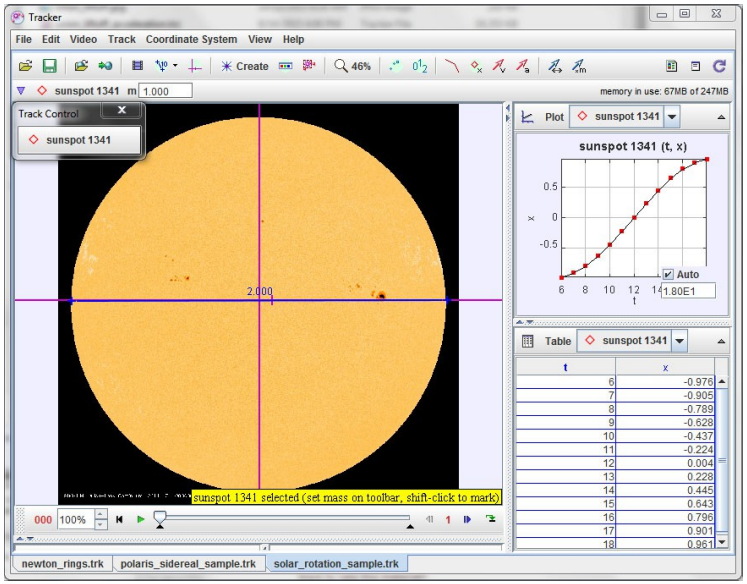
Solar spectrum



Digital library: “solar”

- *Loo Kang Wee, Singapore Tracker Digital Library*
- *Professionally captured spectrum*
- *Identify solar absorption lines*
- *Astronomy application*

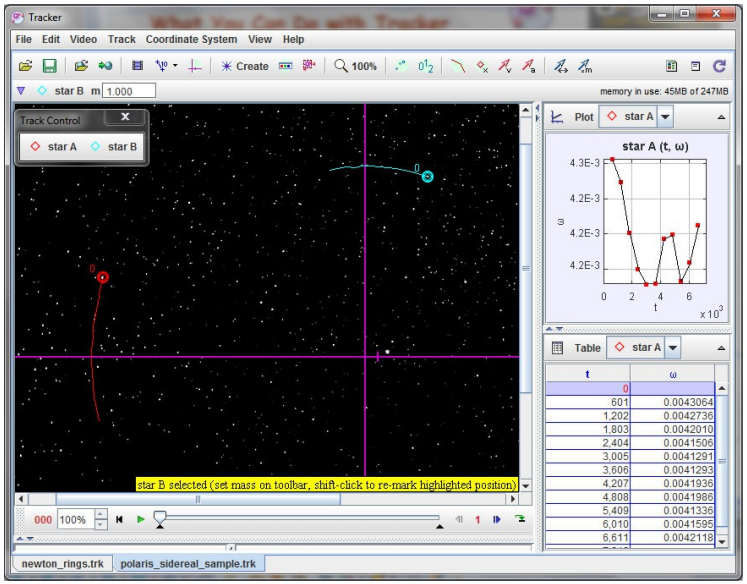
Solar sunspot rotation



Digital library: “sunspot”

- *Mario Belloni, Davidson University*
- *Still image sequences from NASA*
- *Measure rotation rate of sunspots*

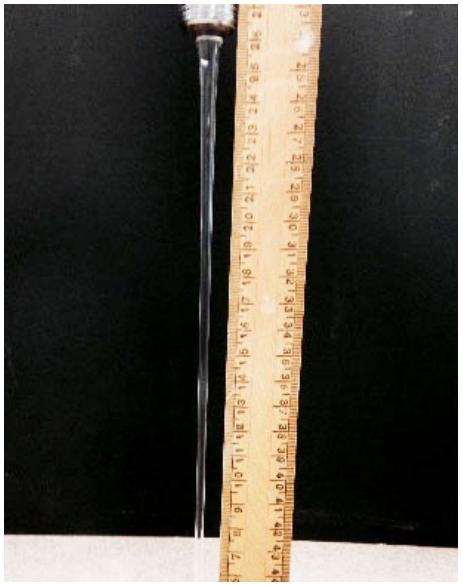
Measuring the siderial day



Digital library: “siderial”

- *Mario Belloni, Davidson University*
- *Student time-lapse videos*
- *Earth rotation*

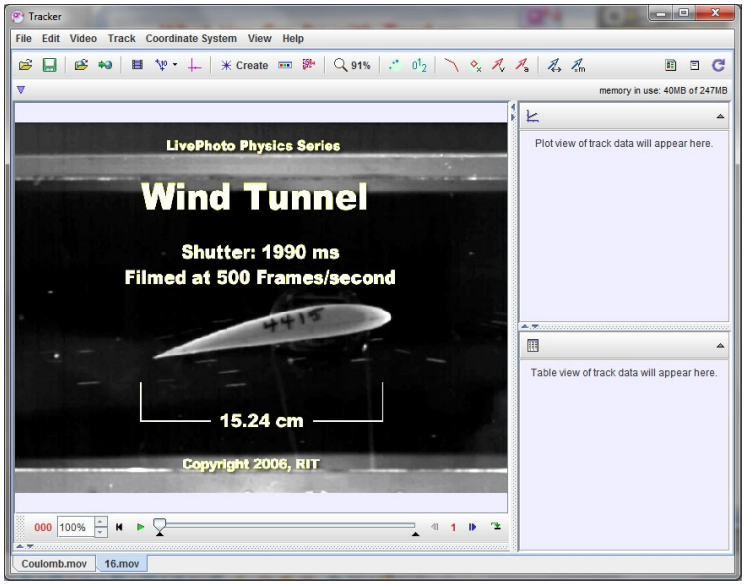
Determining "g" from water stream



Digital library: "Measuring g by Flow Rate"

- *Gregor Steele, Scotland*
- *Measure diameter of stream at different heights*
- *Use continuity equation to determine g*
- *Fluids*

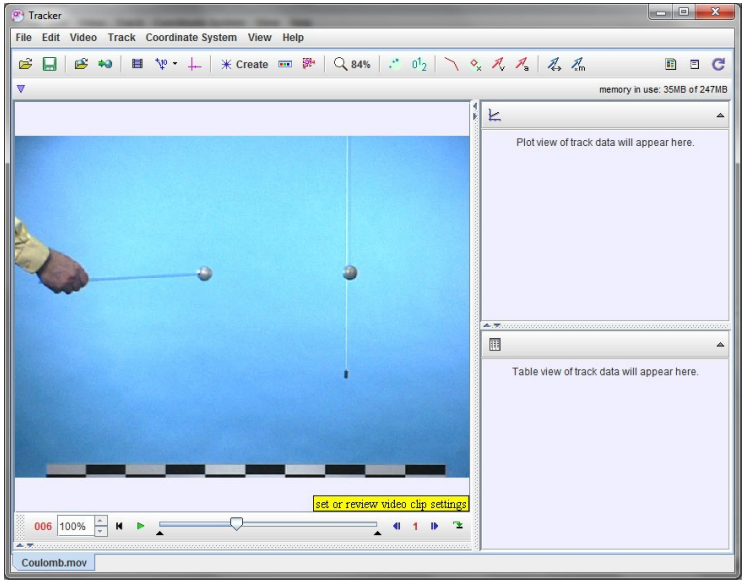
Wing in a wind tunnel



Digital library: “Wind tunnel”

- *LivePhoto video collection*
- *High-speed video*
- *Measure speeds of airborn particles over top and bottom*
- *Fluid dynamics*

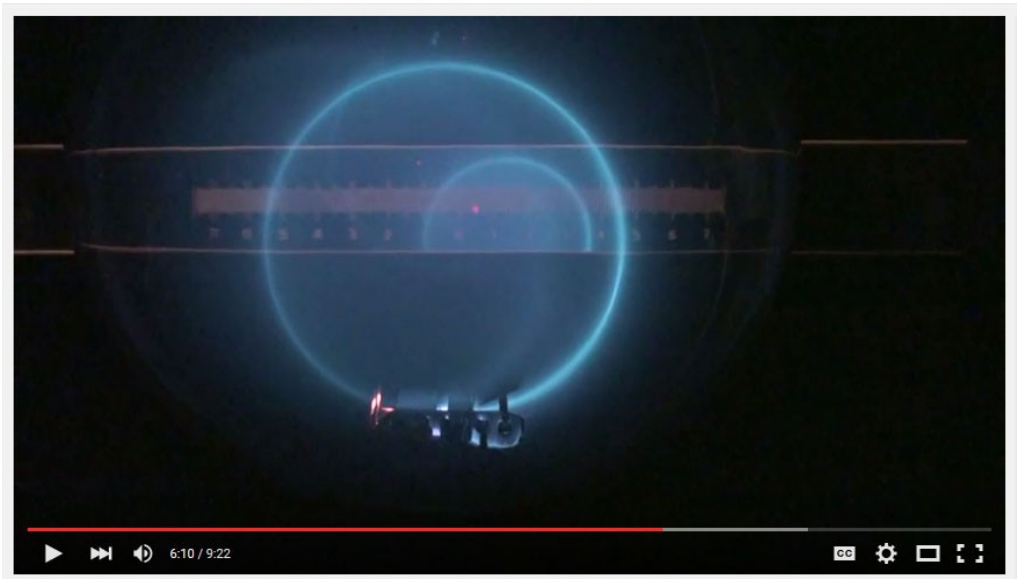
Coulomb repulsion



Digital library: “Coulomb”

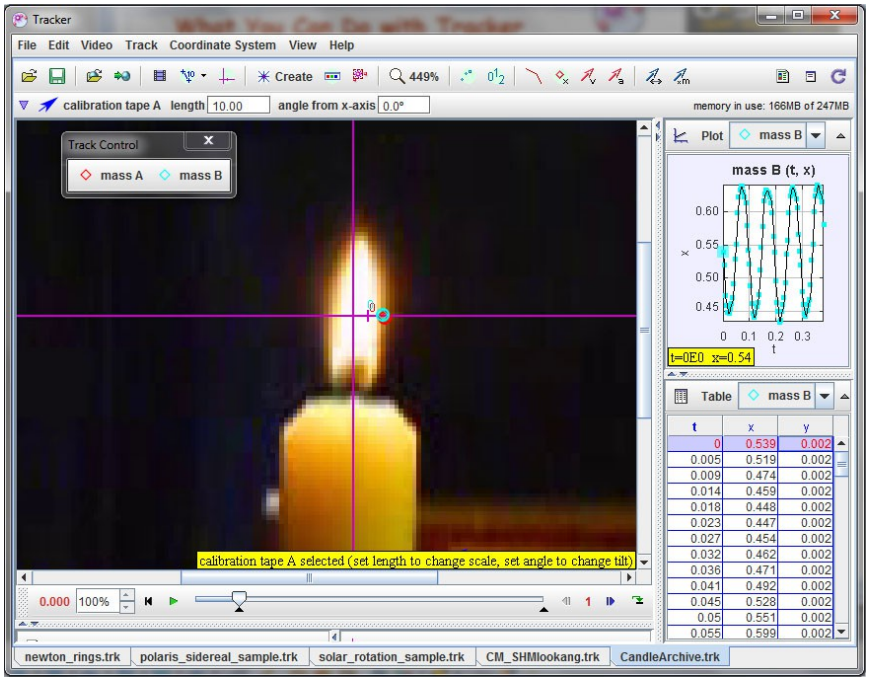
- *LivePhoto video collection*
- *Measure hanging angle vs distance apart*
- *Plot to test Coulomb's law*

Electron deflection in a magnetic field



- *Andy Johnstone, Scotland: <andy___@hotmail.com>*
- *Student videos*
- *Use Tracker circle fitter*
- *Electricity and magnetism*

What can you do with Tracker?



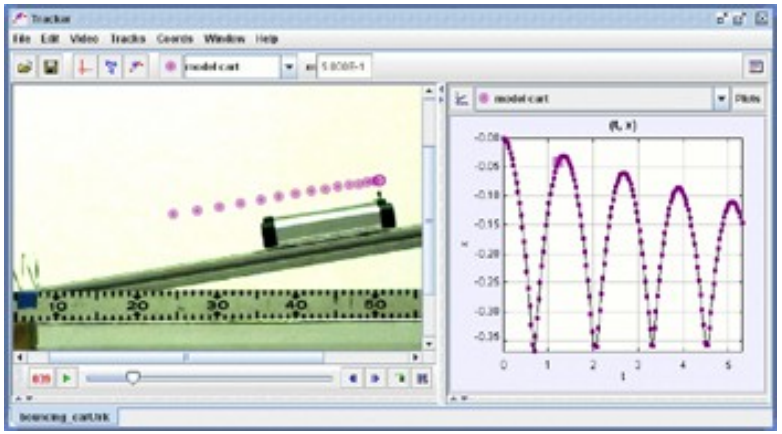
Much more than velocity and acceleration.

Search the collections.

Think outside the box!

Thank you!

Many thanks to hosts Loo Kang Lawrence Wee, Leong Tze Kwang, Ning Hwee Tiang, Tan Kim Kia, and Chan Him Nok



Tracker home: http://physlets.org/tracker/
OSP home: http://www.opensourcephysics.org/

Organized by the Department of Physics, National University of Singapore; the Ministry of Education, Singapore; the National Institute of Education; Institute of Physics Singapore and funded by National Research Foundation

NUS National University of Singapore
Ministry of Education SINGAPORE
NIE NATIONAL INSTITUTE OF EDUCATION SINGAPORE
Institute of Physics Singapore
NATIONAL RESEARCH FOUNDATION
PRIME MINISTER'S OFFICE
SINGAPORE
Research . Innovation . Enterprise