

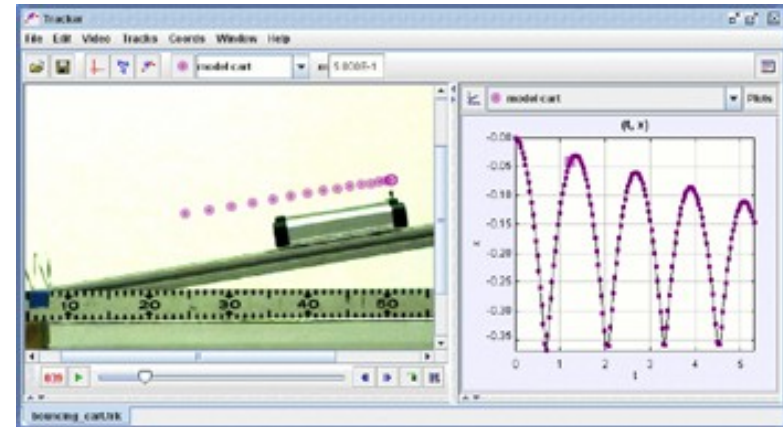


Tracker/EjsS/OSP Workshop for Singapore Teachers

2 Malan Road Block J, Level 4
eduLab@AST and IT Room 2

October 26-29, 2015

Leaders: Wolfgang Christian and Douglas Brown
Local Facilitators: Wee Loo Kang Lawrence, Leong Tze Kwang, Leong Tze Kwang, Ning Hwee Tiang, Tan Kim Kia, and Chan Him Nok
Sponsors: the National Research Foundation (NRF), Ministry of Education (MOE), and National Institute of Education (NIE).





Schedule day 1: 26 October 2015

09h00 - 09h45 *Introductions and overview of resources*

ComPADRE and OSP resources

OSP@SG resources

Tracker resources

09h45 - 10h15 *Introduction to Tracker*

10h15 - 10h45 *Participants analyze videos*

10h45 - 11h00 *Tea*

11h00 - 12h00 *Preparing videos for analysis*

12h00 - 13h30 *Lunch*

13h30 - 14h30 *Participants download/capture videos*

14h30 - 15h15 *Data analysis in Tracker*

15h15 - 15h30 *Break*

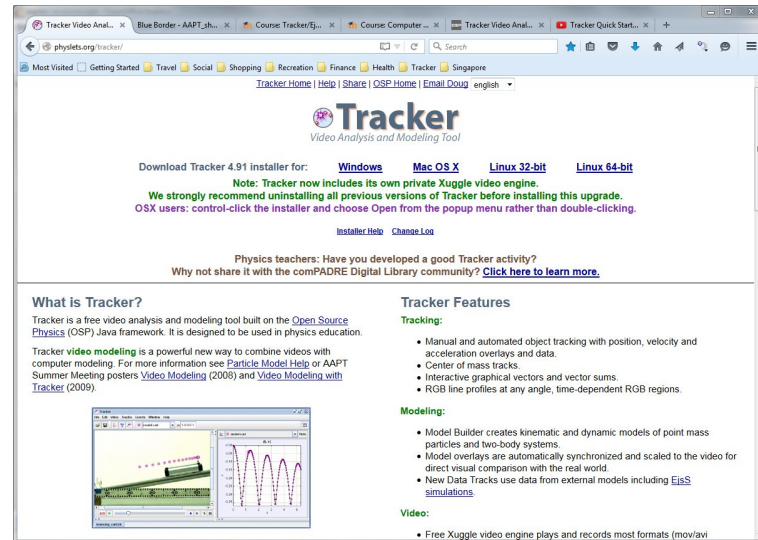
15h30 - 16h30 *Participants analyze data*

16h30 - 17h00 *Formulate personal curriculum development objectives*



Tracker Resources

Tracker web site



<http://physlets.org/tracker>

- *Installers for Windows, Mac, Linux*
- *Online help, video tutorials*
- *Video collections*



Tracker Resources

ComPADRE OSP web site

The screenshot shows a web browser window displaying the OSP website. The page title is "Tracker Video Analysis and Modeling Tool". The main content area includes a description of the tool, available languages (English, Spanish, Chinese, Danish, French, German, Italian, Portuguese, Greek, Czech, Arabic, Finnish, Korean, Swedish), and a list of installers for Windows, Mac OS X, and Linux. The left sidebar contains navigation links for SIMULATIONS, EJS MODELING, CURRICULUM, PROGRAMMING, TOOLS, BROWSE MATERIALS, RELATED SITES, DISCUSSION, and ABOUT OSP. The right sidebar features a "Save to my folders" button, social media icons, and sections for "Supplements" (Comments, Shared Folders), "Contribute" (Make a Comment, Relate this resource, Contact us), and "Related Materials" (Is the Basis For Tracker Video Analysis Demo Package, Is the Basis For OSP User's Guide Chapter 16: Tracker, Is the Basis For...).

<http://www.opensourcephysics.org>

- *Installers for Windows, Mac, Linux*
- *Video experiments*
- *EjsS models*



Tracker Resources

Digital Library Browser

The screenshot displays the OSP Digital Library Browser window. The title bar reads "OSP Digital Library Browser". The menu bar includes "File", "Collections", "Manage", and "Help". The address bar shows the URL "http://physlets.org/tracker/library/cabrillo_collection.xml" with "Load", "Search", and "Open Editor" buttons. Below the address bar are several tabs: "What you can do with Tracker", "Singapore Tracker Digital Library", "NTNU Videos", "LivePhoto Videos", and "College Ready". Under "Singapore Tracker Digital Library", there are sub-tabs for "Tracker Sampler", "Tracker OSP Collection", "Eckerd Tracker Collection", and "CSD Tracker DL". The "Tracker Sampler" sub-tab is active, showing a tree view with "Tracker Sampler", "Mechanics", "Spectroscopy", and "Student Modeling Projects". The main content area is titled "Tracker Sampler" and contains the text: "This collection includes examples of both video analysis and video modeling experiments." Below this text is a preview window for a Tracker experiment titled "bouncing_cart.tlk". The preview window shows a video frame of a cart on a ramp with a series of pink dots representing its position over time, and a plot window showing a graph of position x versus time t with a sinusoidal wave.

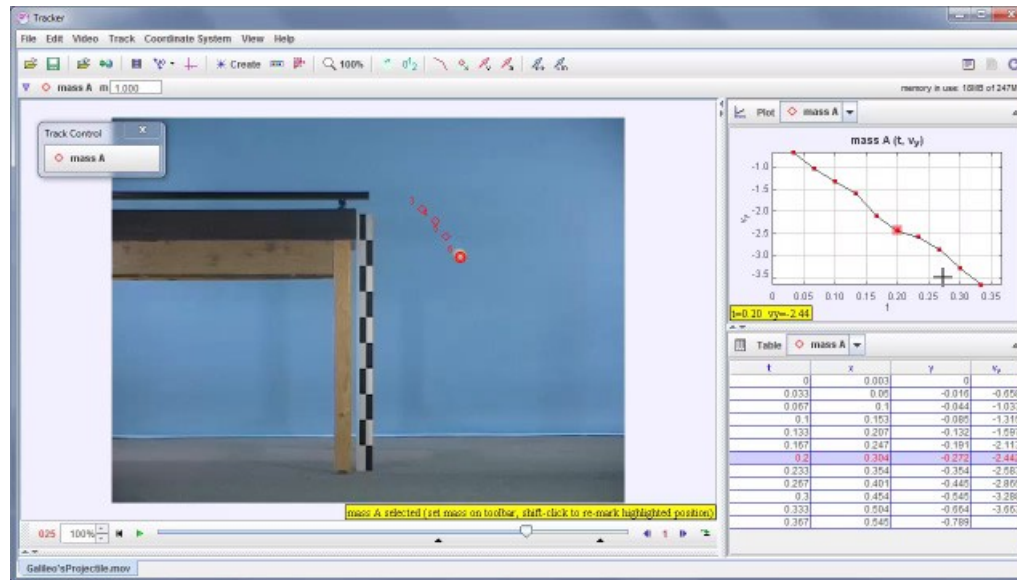
- *Collections of videos & experiments*

[Collections](#)|[Tracker Home Library](#)|[Singapore Workshop](#)



Introduction to Tracker

Tracking a falling ball to find "g"



Useful resources:

[Tracker Help: getting started](#)

[Quick Start video tutorial](#)

[Tracker video tutorial](#)



Introduction to Tracker

Quick Start video tutorial steps

Tracker Quick Start: freefall video analysis

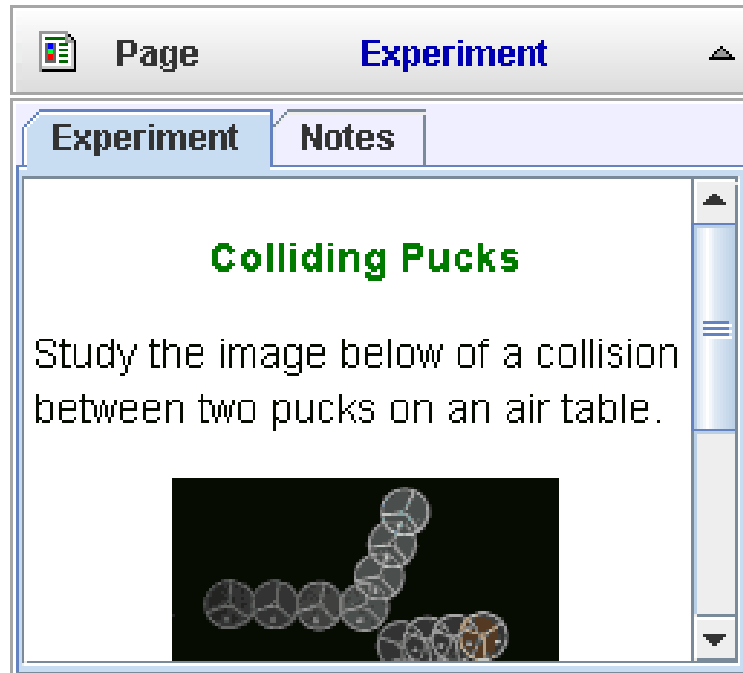
- 1. Open the video, select frames of interest*
- 2. Calibrate the video (set scale)*
- 3. Set the origin and coordinate axis tilt*
- 4. Track the ball as it falls*
- 5. Plot y-velocity versus time*
- 6. Double-click to open data in Data Tool*
- 7. Fit a straight line to the data, determine slope*

DL browser: [Galileo'sProjectile.mov](#)



Introduction to Tracker

Views



- *Plot view*
- *Data table view*
- *World view*
- *Page view*

Useful resources:

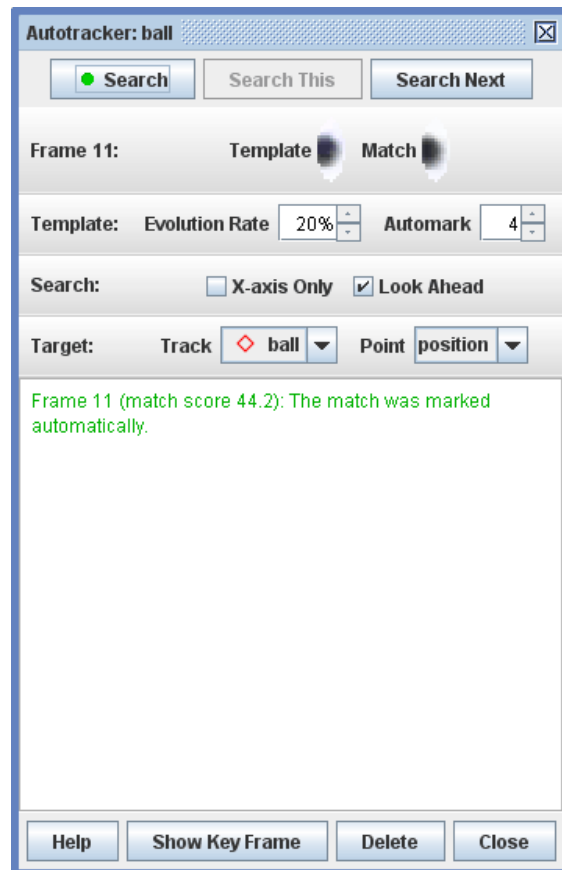
[Tracker Help: page view](#)

[DL browser: pageview.html](#)



Introduction to Tracker

Autotracker



Useful resources:

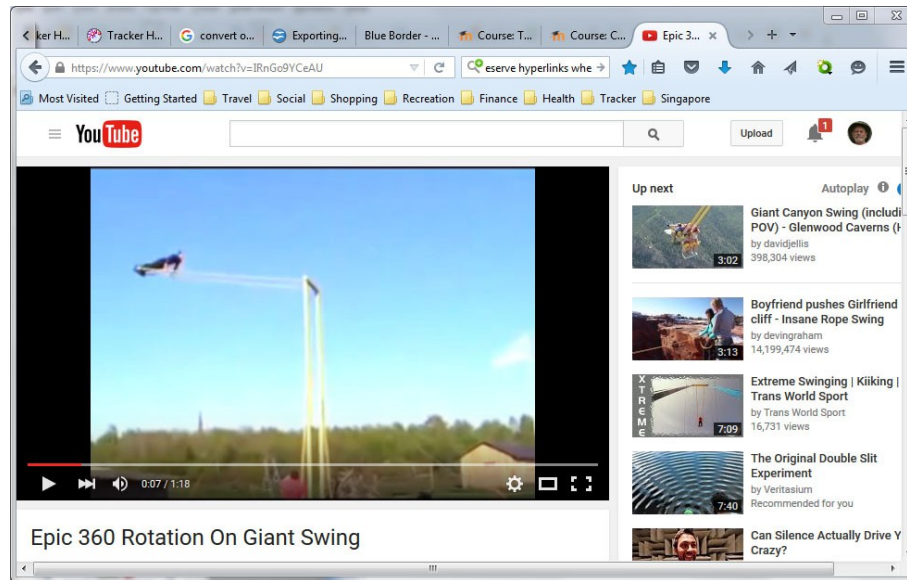
[Tracker Help: autotracker](#)

[Autotracker video tutorial](#)



Preparing Videos for Analysis

Download videos from web sites



Useful resources:

[YouTube](#)

[Clip Converter online video downloader](#)

[Freemake desktop video downloader](#)



Preparing Videos for Analysis

Recommended file formats

- *FLV, WMV, MP4, MOV*
- *GIF (may be animated), JPG, PNG*
- *Use a video converter to convert videos to one of these formats*
- *Trim/cut long videos for smaller files, faster loading*

Useful resources:

[Freemake desktop video converter](#)



Preparing Videos for Analysis

Record your own video: cameras

- *Look for high frame rate and time lapse capabilities, manual shutter*

Useful resources:

Suitable cameras: [Vernier](#), [Dot Physics](#)

Avoid rolling shutters: [LivePhoto](#)



Preparing Videos for Analysis

Record your own video: best practices

- *bright, uniform lighting*
- *uniform background, contrasting object*
- *fast shutter speed*
- *motion perpendicular to view*
- *narrow field of view*
- *steady camera (tripod if possible)*
- *calibration object at same distance*

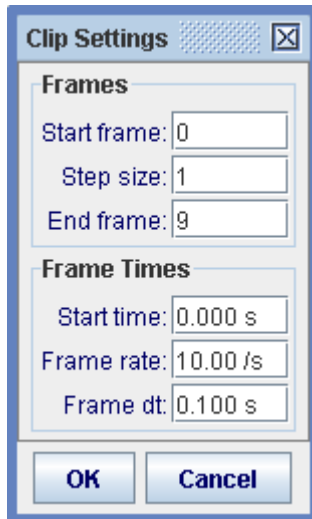
Useful resources:

[Vernier discussion](#)



Preparing Videos for Analysis

Video clip settings



- *Inspector or video player controls*
- *Start, end frames*
- *Step size*
- *Frame rate, frame dt*
- *Start time*

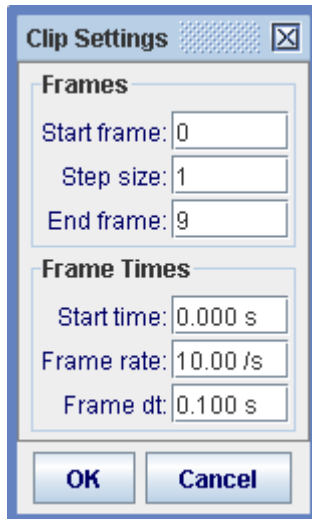
Useful resources:

[Tracker Help: videos](#)



Preparing Videos for Analysis

Video clip settings



- *Inspector or video player controls*
- *Start, end frames*
- *Step size*
- *Frame rate, frame dt*
- *Start time*

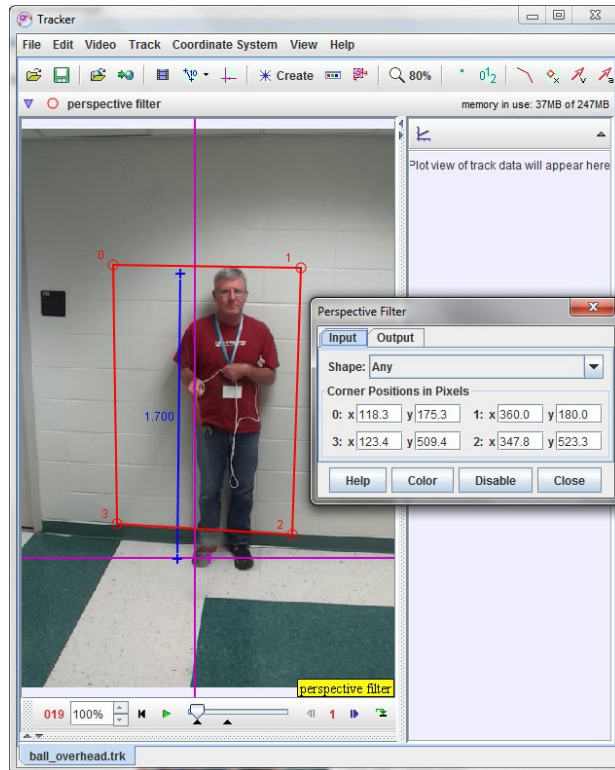
Useful resources:

[Tracker Help: videos](#)



Preparing Videos for Analysis

Video filters



- *Brightness, negative, grayscale*
- *Deinterlace*
- *Rotate, resize*
- *Distortion: perspective, fisheye*
- *Ghost filters: motion diagrams*
- *Baseline, sum*

Useful resources:

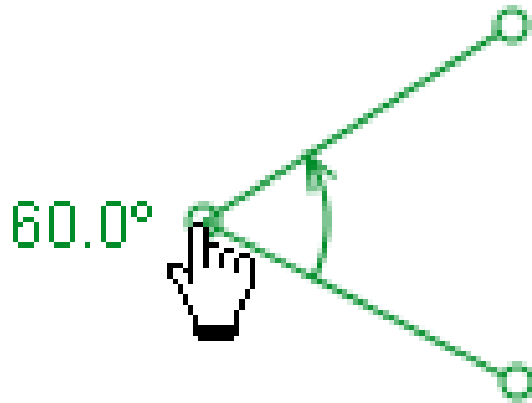
[Tracker Help: video filters](#)

DL browser: [ROLL583.mov](#), [BallToss.mov](#), [ballOnString.wmv](#)



Data Analysis in Tracker

Measuring tools



- *Tape measure*
- *Protractor*
- *Circle fitter*
- *Attach to points*

Useful resources:

[Tracker Help: tape measure](#)

[Tracker Help: protractor](#)

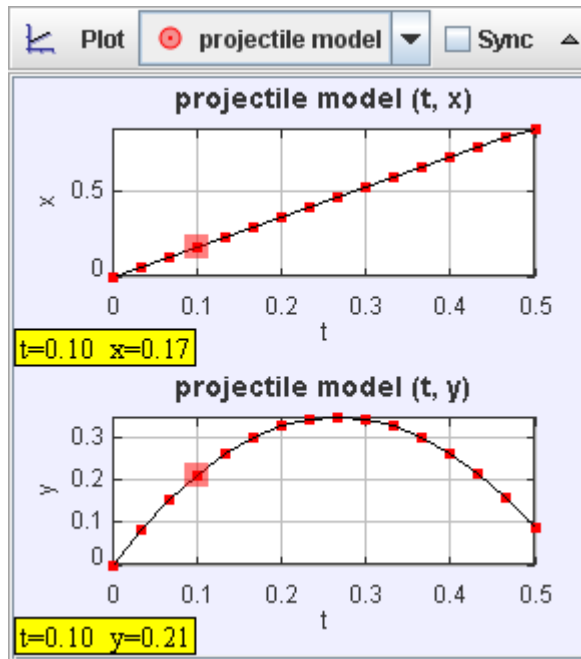
[Tracker Help: circle fitter](#)

[DL browser: Rotating fan.mp4](#)



Data Analysis in Tracker

Plot view



- *Plot variables & style*
- *Scaling*
- *Algorithms*
- *Synchronizing plots*

Useful resources:

[Tracker Help: plot view](#)



Data Analysis in Tracker

Data table view

t	x	y	v_x
0	4.178	-21.597	
0.133	7.998	-15.935	28.811
0.267	11.869	-10.387	29.034
0.4	15.748	-4.902	30.806
0.534	20.092	-7.337	32.715
0.667	24.481	-10.499	32.742
0.801	28.832	-13.538	32.537
0.934	33.166	-16.655	

- *Data columns*
- *Formatting*
- *Sorting*
- *Text columns*
- *Selecting data*
- *Exporting data*

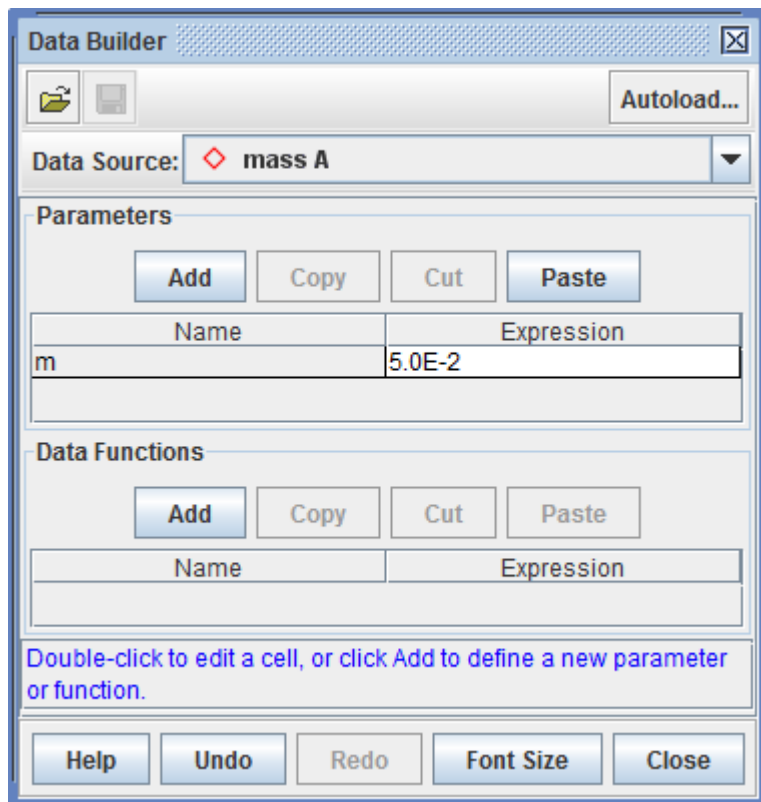
Useful resources:

[Tracker Help: datatable view](#)



Data Analysis in Tracker

Data Builder



- *Data functions*
- *Parameters*
- *Save, load*
- *Autoload*

Useful resources:

[Data Builder Help](#)

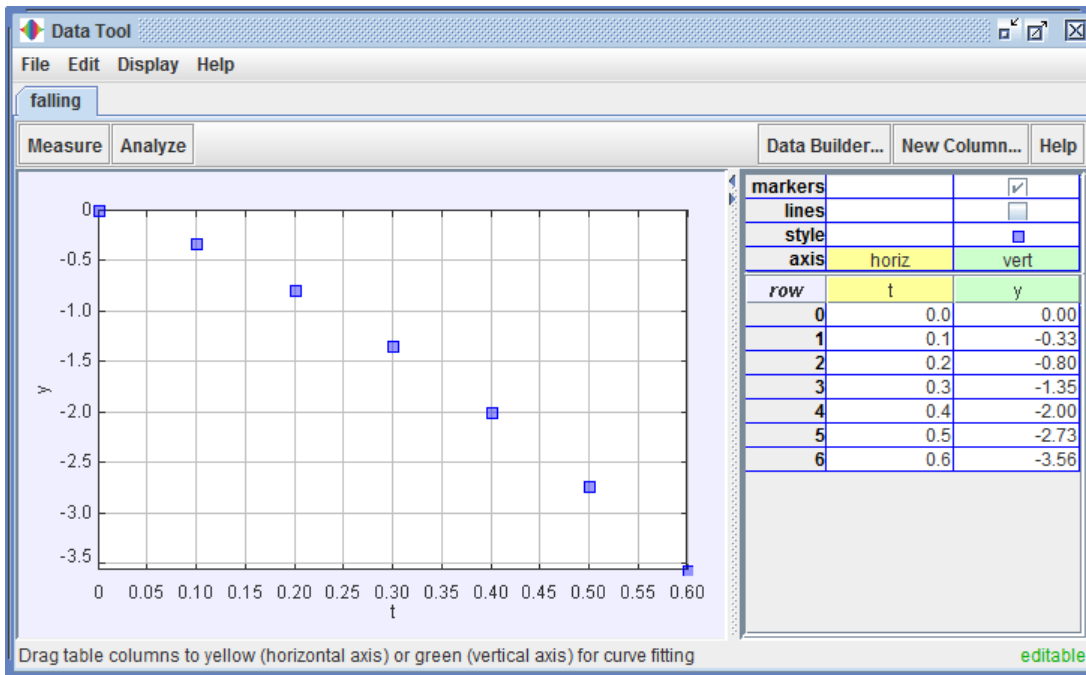
[Data Tool Help](#)

DL browser: [BallToss.mov](#)



Data Analysis in Tracker

Data Tool



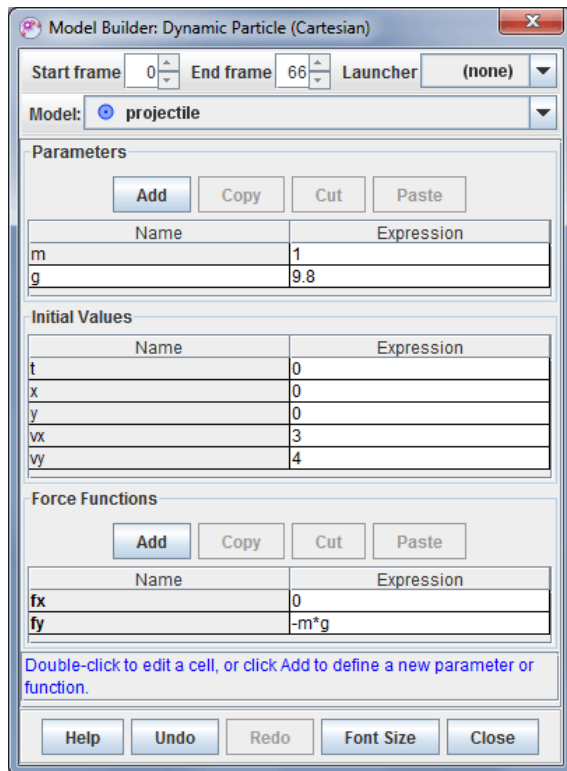
- *Curve fitting*
- *Statistics*
- *Slopes, areas*
- *Editable columns*
- *Data functions*
- *Fourier spectra*
- *Origin shifting*

Useful resources:
[Data Tool Help](#)



Tracker Particle Models

Dynamic models



Cartesian, polar coordinates
Model builder
Force equations
Parameters
Initial conditions
Start, end frames
Launching a model

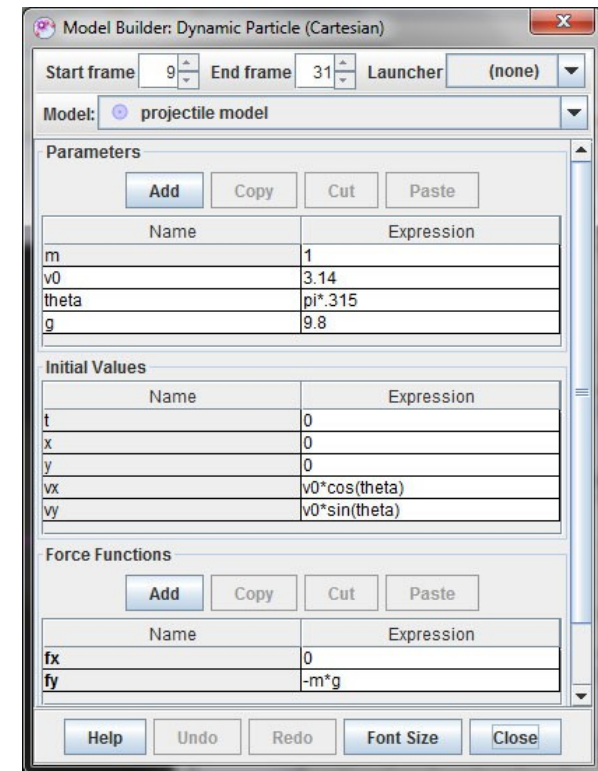
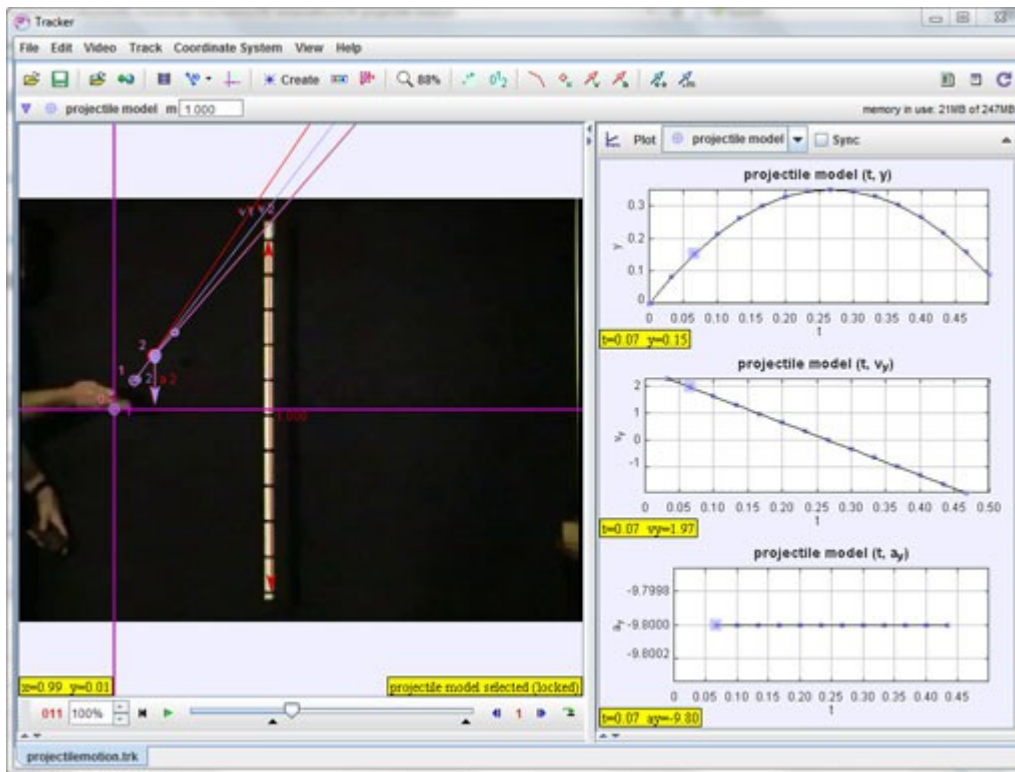
Useful resources:

[Tracker Help: particle models](#)



Tracker Particle Models

Dynamic model example: Projectile motion



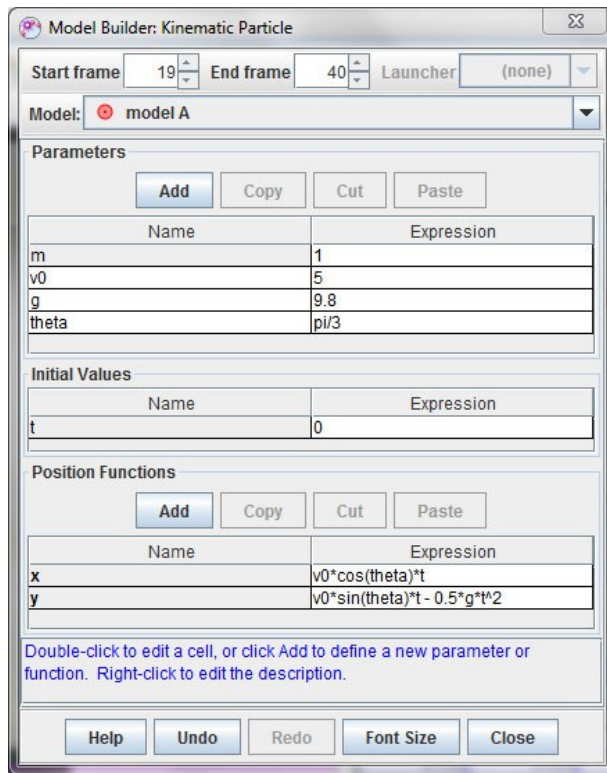
Useful resources:

[Projectile model TRZ](#)



Tracker Particle Models

Analytic models



- *Model builder*
- *Motion equations*
- *Parameters*
- *Initial time*
- *Start, end frames*

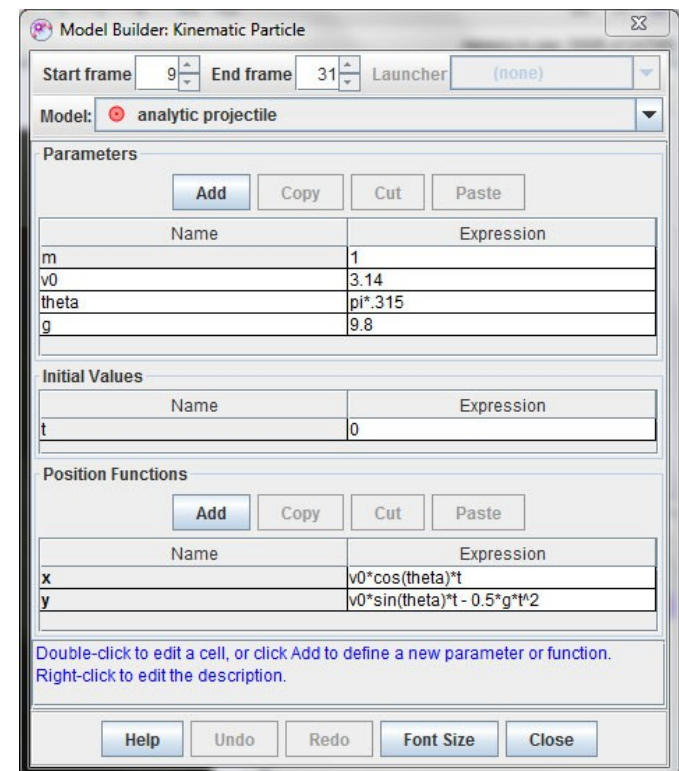
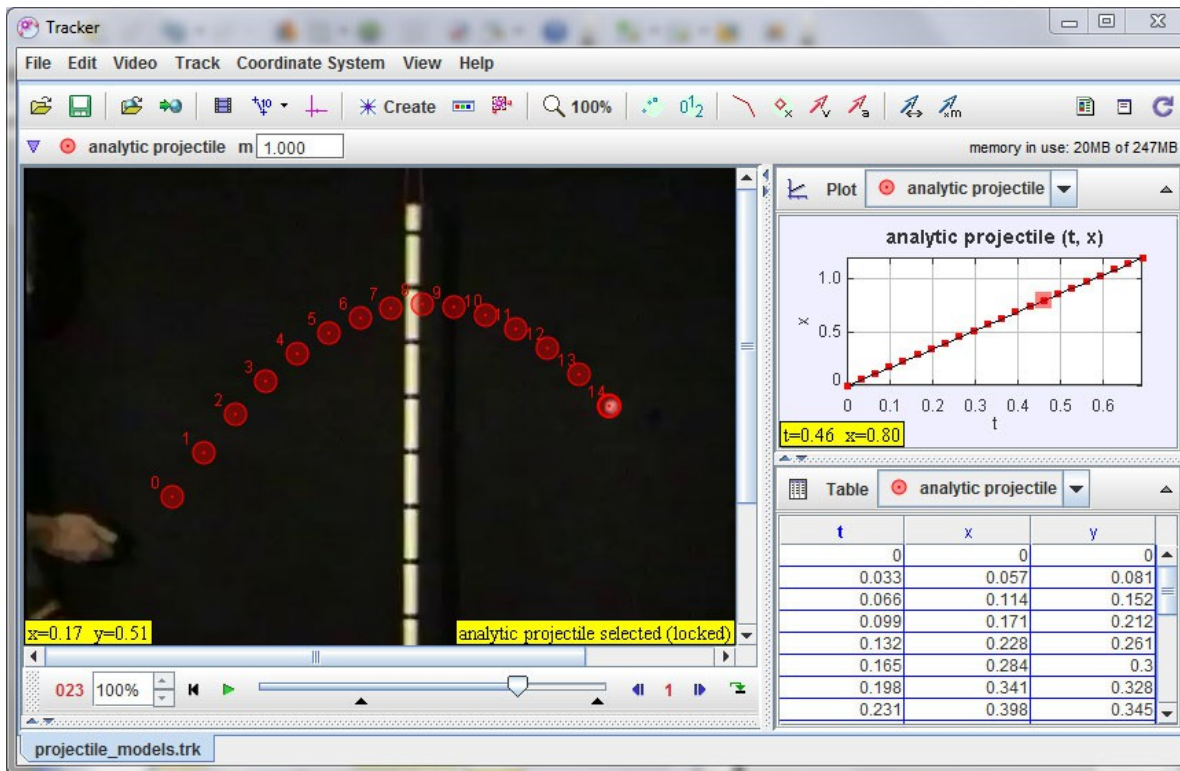
Useful resources:

[Tracker Help: particle models](#)



Tracker Particle Models

Analytic model example: Projectile motion



Useful resources:

DL browser: [projectile_models.trk](#)



Controlling the Coordinate System

Calibration options

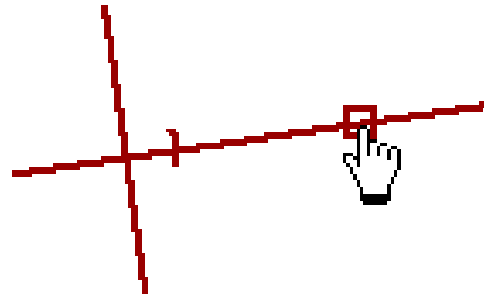
Coordinate axes
Calibration stick/tape
Offset origin
Calibration points
Circle fitter

Origin	Angle	Scale
X	X	
	X	X
X		
X	X	X
X		



Controlling the Coordinate System

Coordinate axes



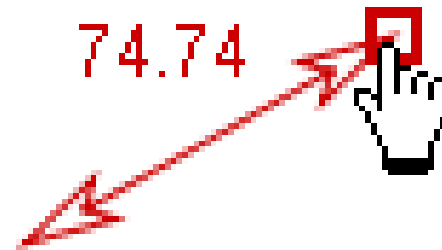
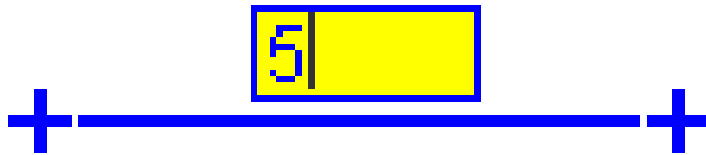
- *Most common way to set origin and angle*
- *Drag origin or nudge with arrow keys*
- *Set origin pixel position on toolbar*
- *Drag x-axis to tilt, shift-drag for 5° steps*
- *Set x-axis angle on toolbar*

[Tracker Help: coordinate axes](#)



Controlling the Coordinate System

Calibration stick and tape



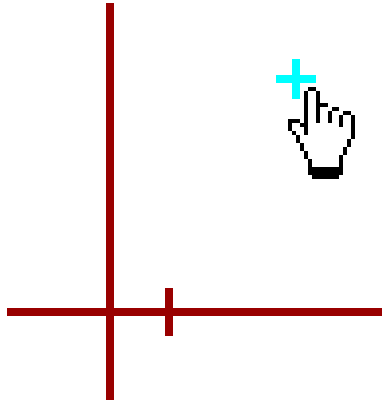
- *Most common way to set scale*
- *Drag either end or nudge with arrow keys*
- *Dbl-click length readout to set new value*
- *Set length value on toolbar*
- *Set x-axis angle on toolbar*
- *Stick and tape behave differently when dragging end*

[Tracker Help: calibration stick and tape](#)



Controlling the Coordinate System

Offset origin or single calibration point



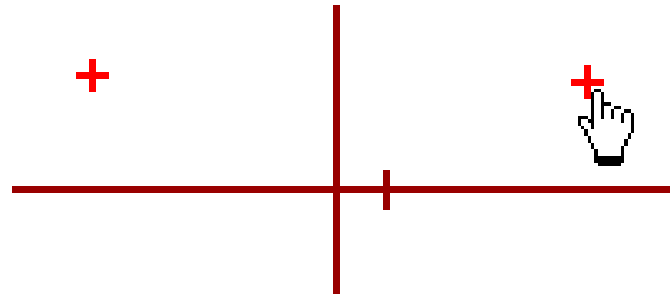
- *Handy when origin is off screen*
- *Drag or nudge to move origin*
- *Set coordinates on toolbar to move origin*

[Tracker Help: offset origin](#)



Controlling the Coordinate System

Calibration points (pair)



- *Most powerful calibration tool*
- *To use, position both points at known locations*
- *Set coordinates on toolbar to set origin, angle, tilt*
- *Drag or nudge either point to adjust*

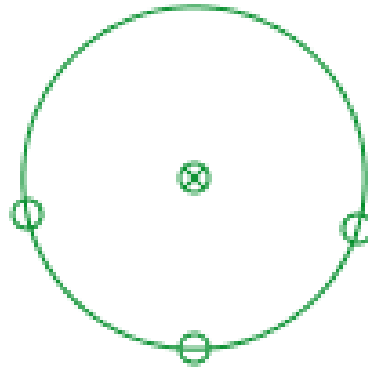
[Tracker Help: calibration points](#)

DL browser: [fluor_lamp_3000K.zip](#)



Controlling the Coordinate System

Circle fitter



- *Fit circle to 3+ points (may be point mass steps)*
- *Choose "move origin to center" from popup or track menu*
- *Useful for circular motion, esp when origin off screen*

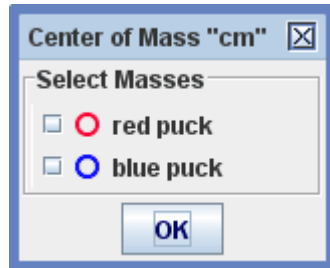
[Tracker Help: circle fitter](#)

DL browser: [Rotating fan.mp4](#)

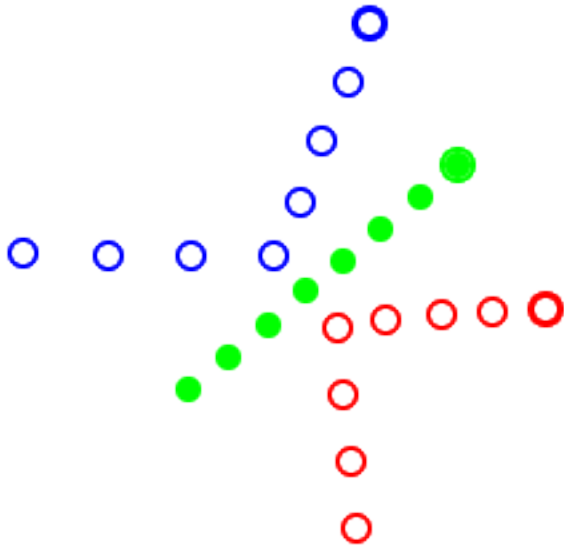


Multiple and extended objects

Center of mass



- *Multiple pointmass tracks*
- *Steps are determined by positions and masses of pointmass tracks*
- *Solid footprint*



Useful resources:

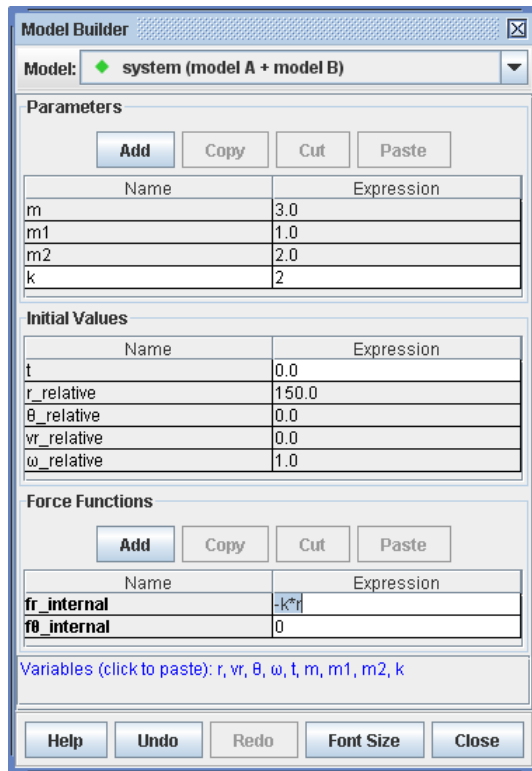
[Tracker Help: center of mass](#)

[Elastic collision TRZ](#)

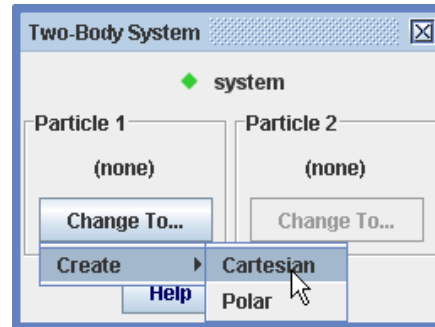


Multiple and extended objects

Two-body system models



- *Join two dynamic particle models*
- *Define internal forces*
- *Initial state = relative r , v_r , θ , ω*
- *System position = cm*



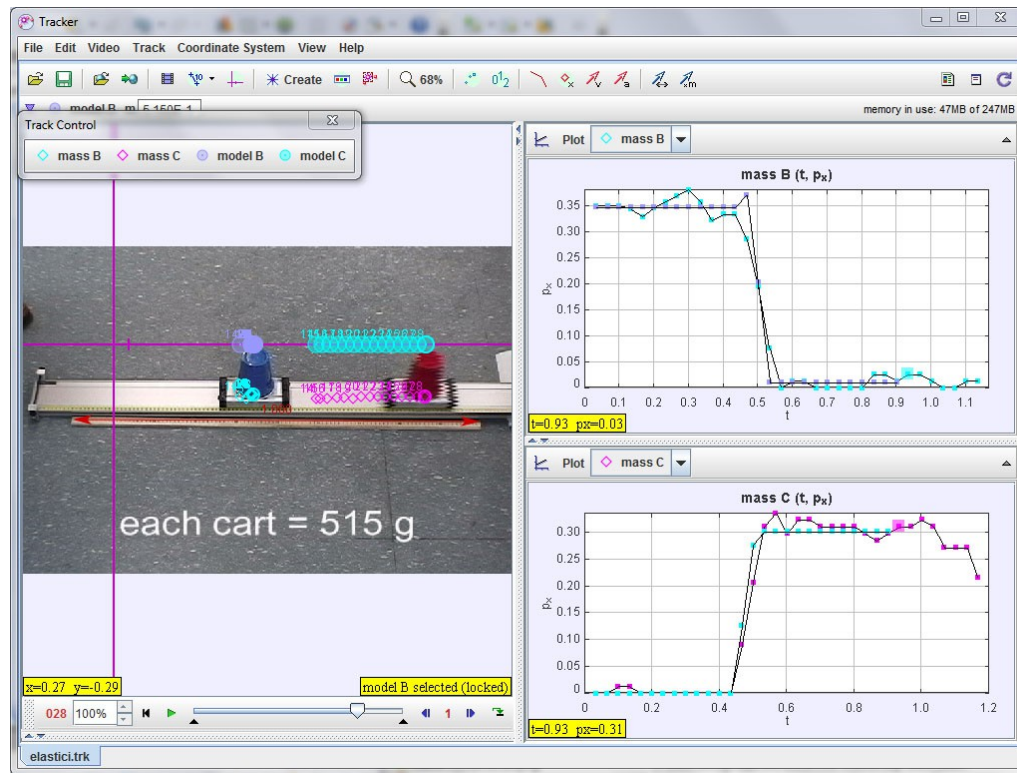
Useful resources:

[Tracker Help: particle models](#)



Multiple and extended objects

Collisions

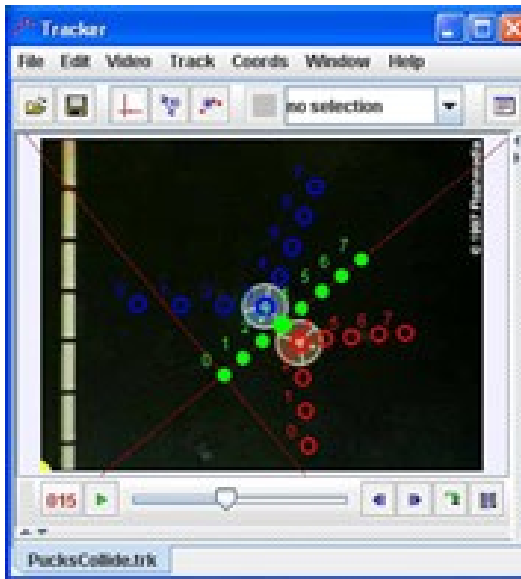


Useful resources:
[Collision force model TRZ](#)



Coordinate systems

Reference frames, world views



Useful resources:

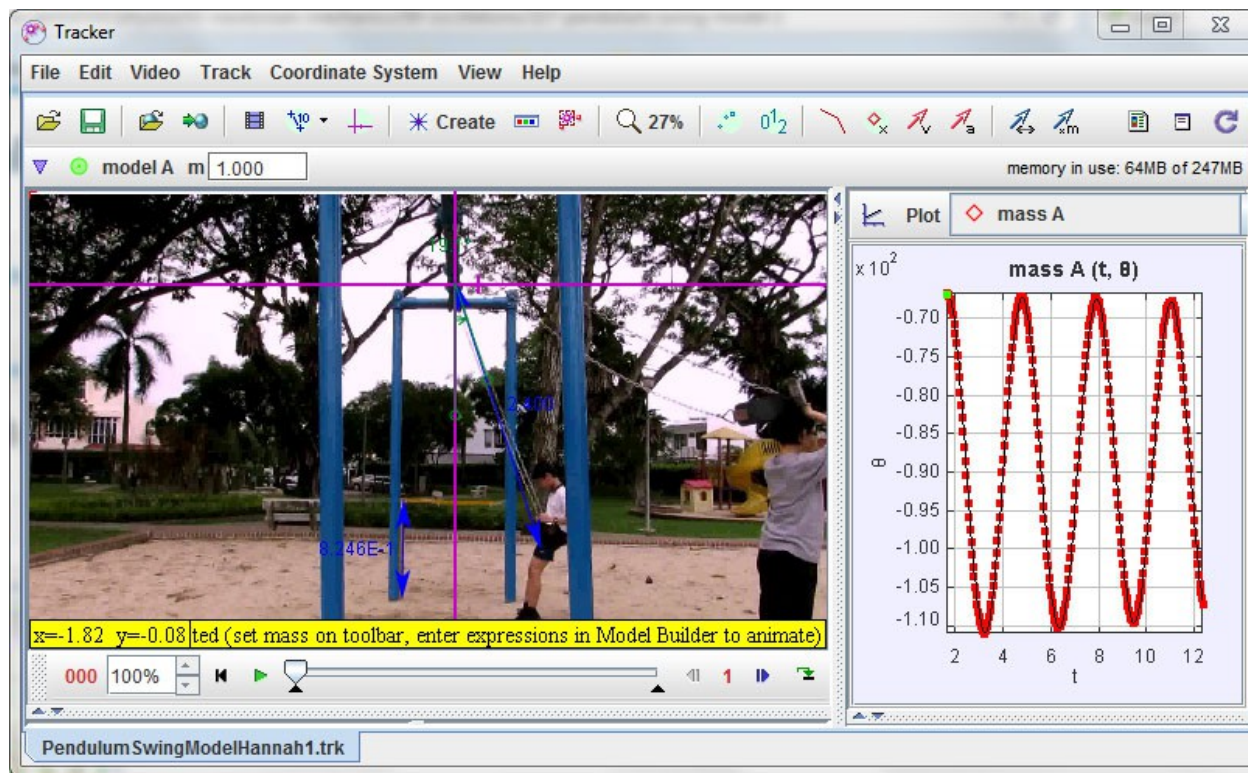
[Tracker Help: coordinate system](#)

[DL browser: PucksCollide.zip](#)



Coordinate systems

Polar coordinates

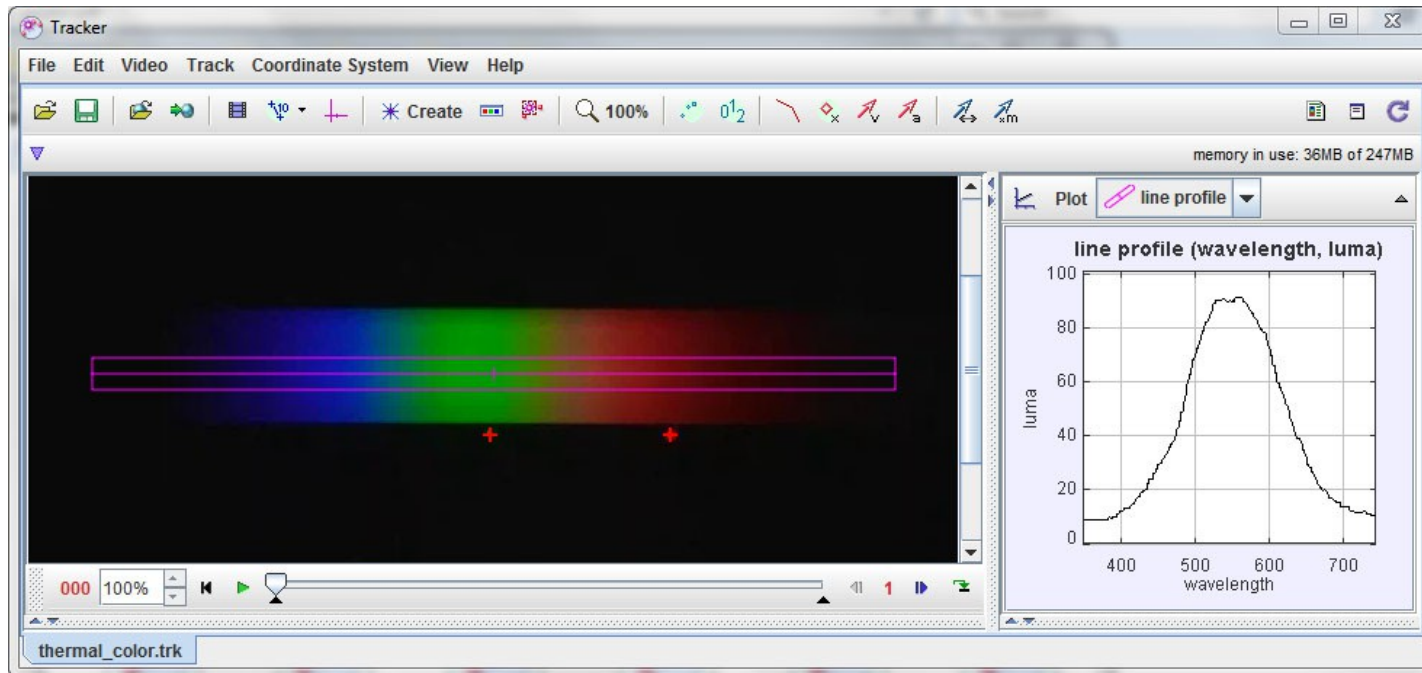


Useful resources:
[Pendulum swing model TRZ](#)



Tracker Spectroscopy

Line profiles



[Tracker Help: line profile](#)
[Spectroscopy poster \(AAPT\)](#)
DL browser: [color_filter_128.zip](#)



Useful Tracker Shortcuts

- Main view
- *Zoom with mouse wheel*
 - *Zoom to box after right-drag*
 - *Double-click zoom button to fit*

- Video player
- *Page-up to step, page-down back*
 - *Home to start, end to end*
 - *Right-click player to set start/end*

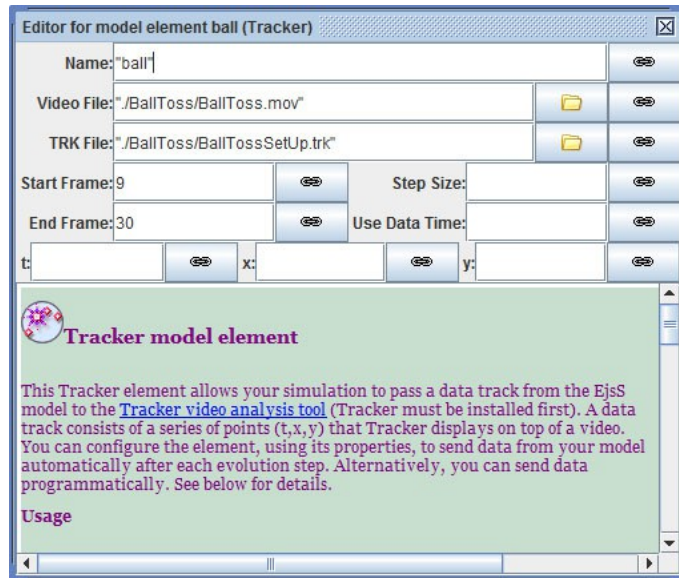
- View panes
- *Dbl-click toolbar to maximize/restore*

- Selected pts
- *Shift-arrow key to nudge X10*



EjsS Tracker Elements

Sending EjsS data to Tracker



- *In EjsS: Tracker element*
- *In Tracker: data track (automatic)*

Useful resources:

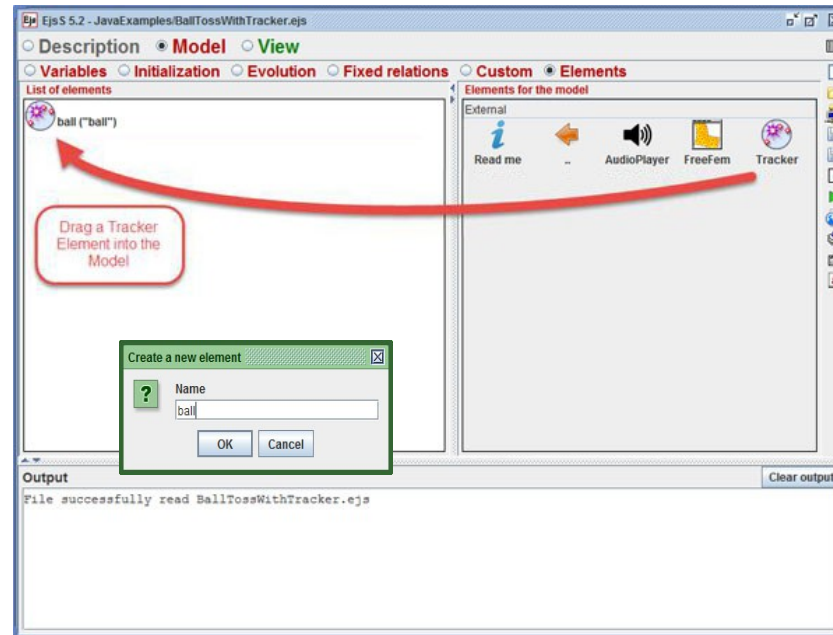
[Tracker Help: data track](#)

EjsS example: Ball Toss with Tracker



EjsS Tracker Elements

Create Tracker Element in EjsS



- *Model Elements page*
- *External models*
- *Drag icon to create element*
- *Assign a name to the element—in this case "ball"*



EjsS Tracker Elements

Enter a name for the data track

Editor for model element ball (Tracker)

Name:	"ball"	⛔
Video File:		📁 ⛔
TRK File:		📁 ⛔
Start Frame:		⛔
Step Size:		⛔
End Frame:		⛔
Use Data Time:		⛔
t:		⛔
x:		⛔
y:		⛔

- *Dbl-click the element to open property editor*
- *Name must be in quotes—here "ball"*
- *Name is assigned to the data track in Tracker*
- *Name may be same as element name*
- *Other properties will be set later*



EjsS Tracker Elements

Append initial data to element

```
//set initial conditions
t=0;
x=x0;
y=y0;
vx=vx0;
vy=vy0;

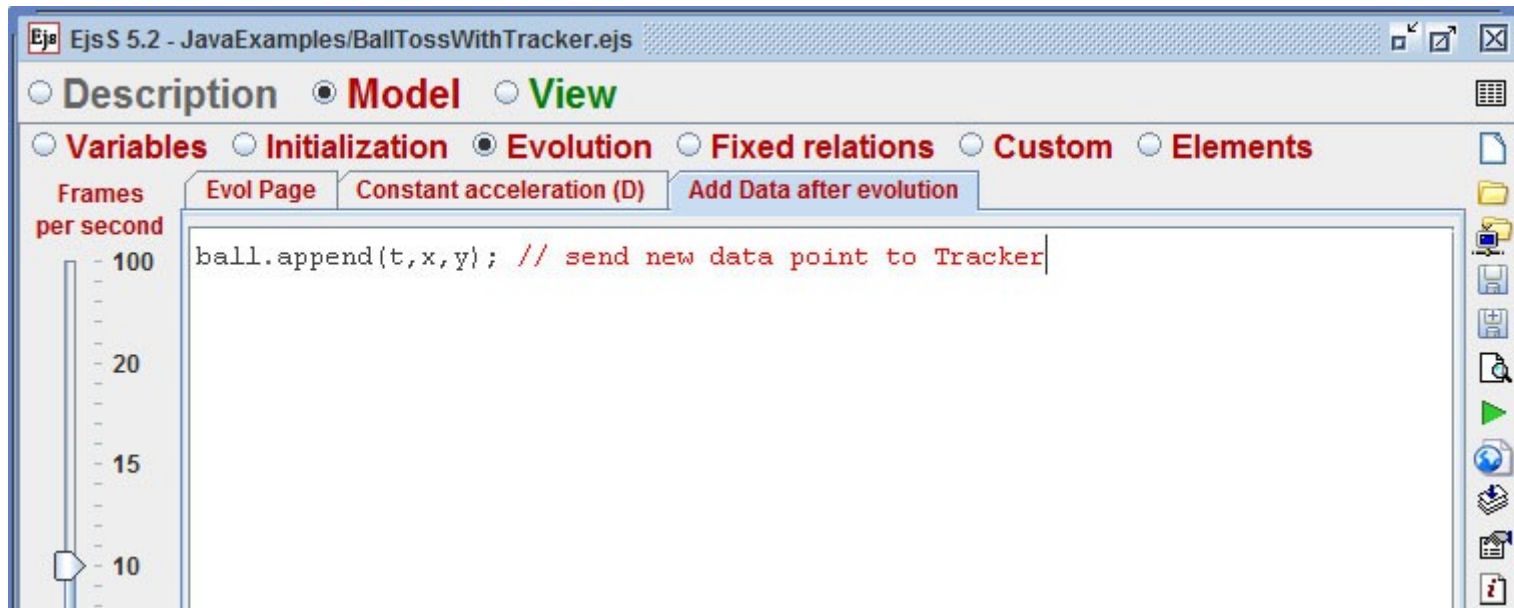
ball.append(t,x,y); // send first data point to Tracker
```

- *Click to add new page in Initialization if needed*
- *Call method `append(t, x, y)` on element "ball"*



EjsS Tracker Elements

Append data to element after ODE step

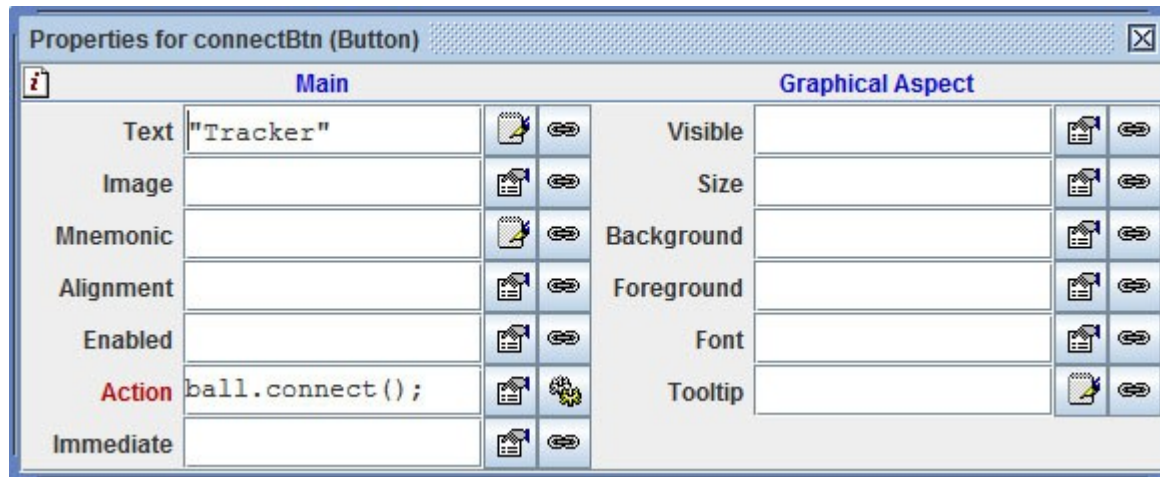


*Right-click to add new page in Model/Evolution
Call method `append(t, x, y)` on element "ball"*



EjsS Tracker Elements

Add button to connect to Tracker

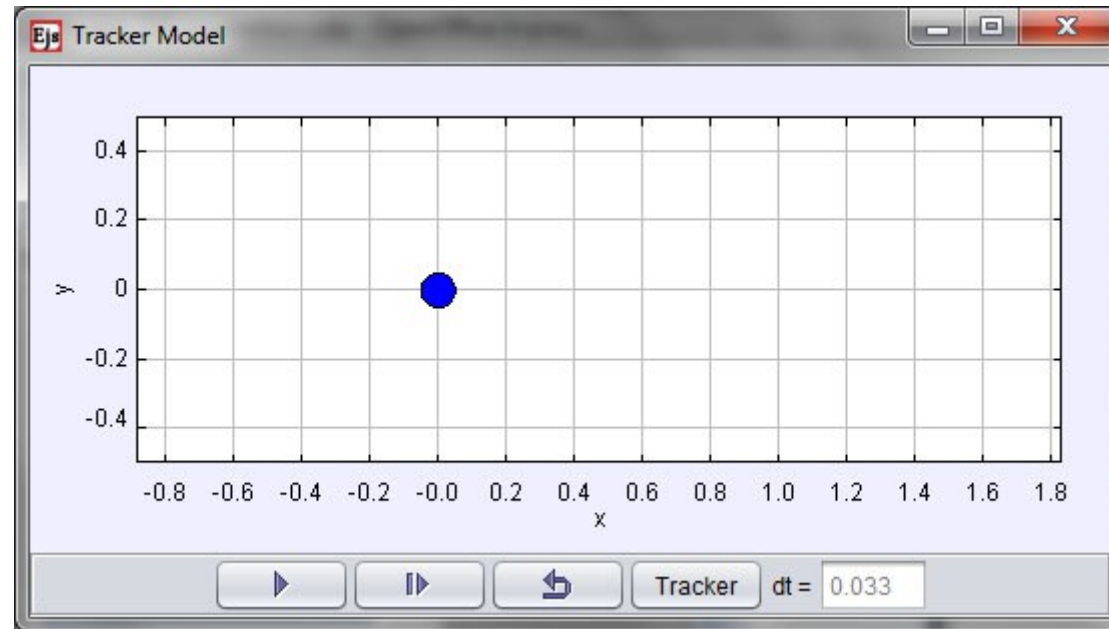


- *Create button in View page by dragging to a panel*
- *Dbl-click button to open property editor*
- *Button Text must be in quotes*
- *Button Action is connect() method*
- *Call connect() method on element "ball"*



EjsS Tracker Elements

Initial testing

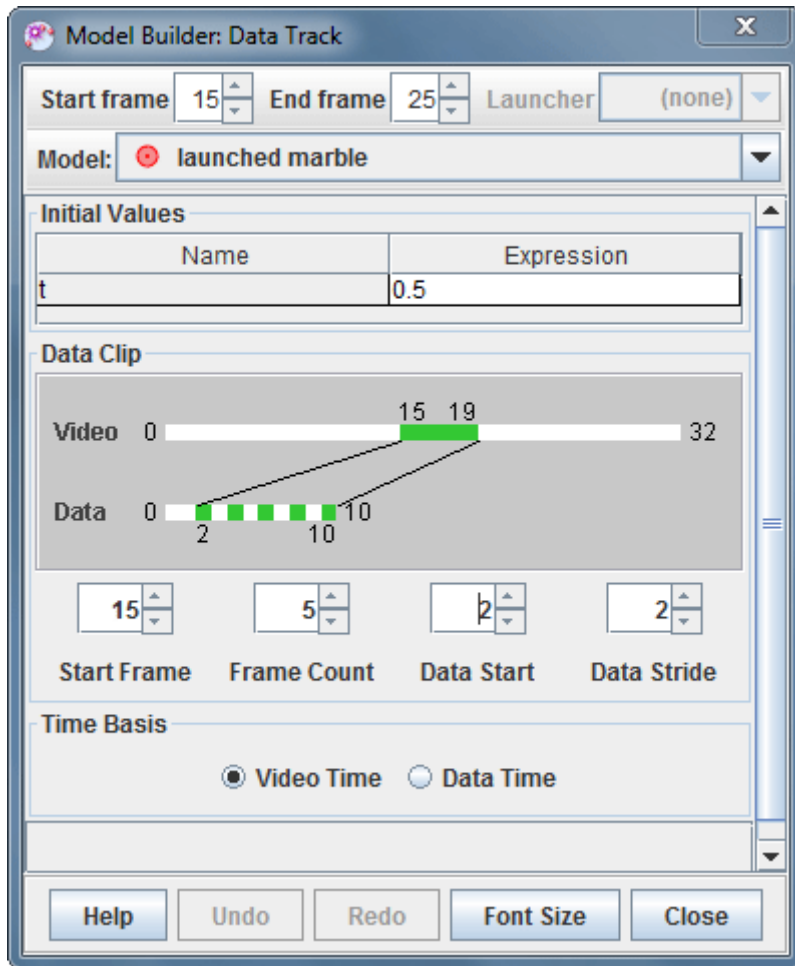


- *Connect button should create a data track in Tracker*
- *Step forward button should append data*
- *Play button should append more data*
- *Reset button should reset data track*



EjsS Tracker Elements

Data track settings



- *Video start frame*
- *Frame count*
- *Data start index*
- *Data stride*
- *Time basis*
- *Set in model builder*



EjsS Tracker Elements

Comparing data tracks with videos

- Video*
- *Calibrate scale*
 - *Set origin, adjust angle*
 - *Set clip start to first frame of interest*
 - *Set frame rate or frame dt*
 - *Set other clip properties if desired*

- Track*
- *Set properties in model builder*



EjsS Tracker Elements

Saving video settings in TRK file

- *Delete the data track before saving*
- *Save TRK file with same or similar name to EjsS model/element*
- *Undo in Tracker to restore data track if desired*



EjsS Tracker Elements

Using TRK and video in EjsS tracker element

The screenshot shows the 'Editor for model element ball (Tracker)' window. It contains the following fields and controls:

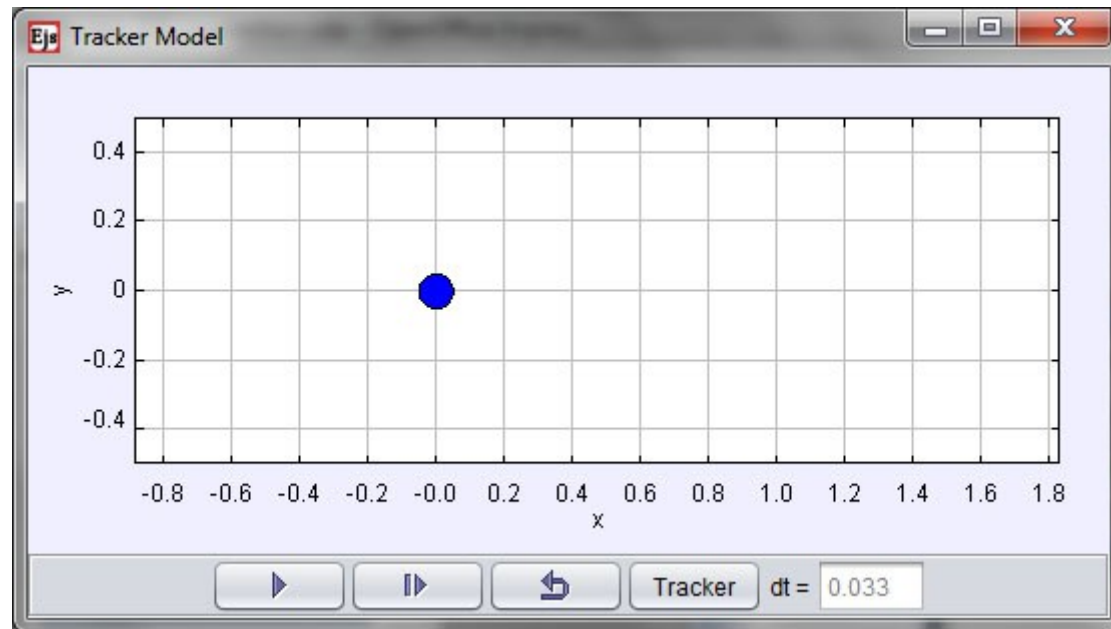
- Name: "ball" (with a lock icon)
- Video File: (empty field with a folder icon and a lock icon)
- TRK File: "/BallToss/BallTossSetUp.trk" (with a folder icon and a lock icon)
- Start Frame: 9 (with a lock icon)
- Step Size: (empty field with a lock icon)
- End Frame: 30 (with a lock icon)
- Use Data Time: (empty field with a lock icon)
- t: (empty field with a lock icon)
- x: (empty field with a lock icon)
- y: (empty field with a lock icon)

- *Copy both TRK file and video to EjsS source folder*
- *Check that copied TRK opens video*
- *Open tracker element in EjsS*
- *Use "open" button to set TRK file path*
- *Copy data track settings to EjsS element*
- *No need to enter video file path when using TRK*



EjsS Tracker Elements

Final testing



- *Connect button should open the calibrated video and create the data track*
- *Other buttons as before*