Virtual Atom Smasher

One example of an educational game in particle physics

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Background

- The Virtual Atom Smasher is a **pilot** project of the Citizen Cyberlab EU ICT project

  - Research Creativity and learning in on-line citizen science

  - In **addition** to helping scientists perform laborious tasks, it enable citizens to learn about science and actively take part

* You can learm more in http://citizencyberlab.eu/about/

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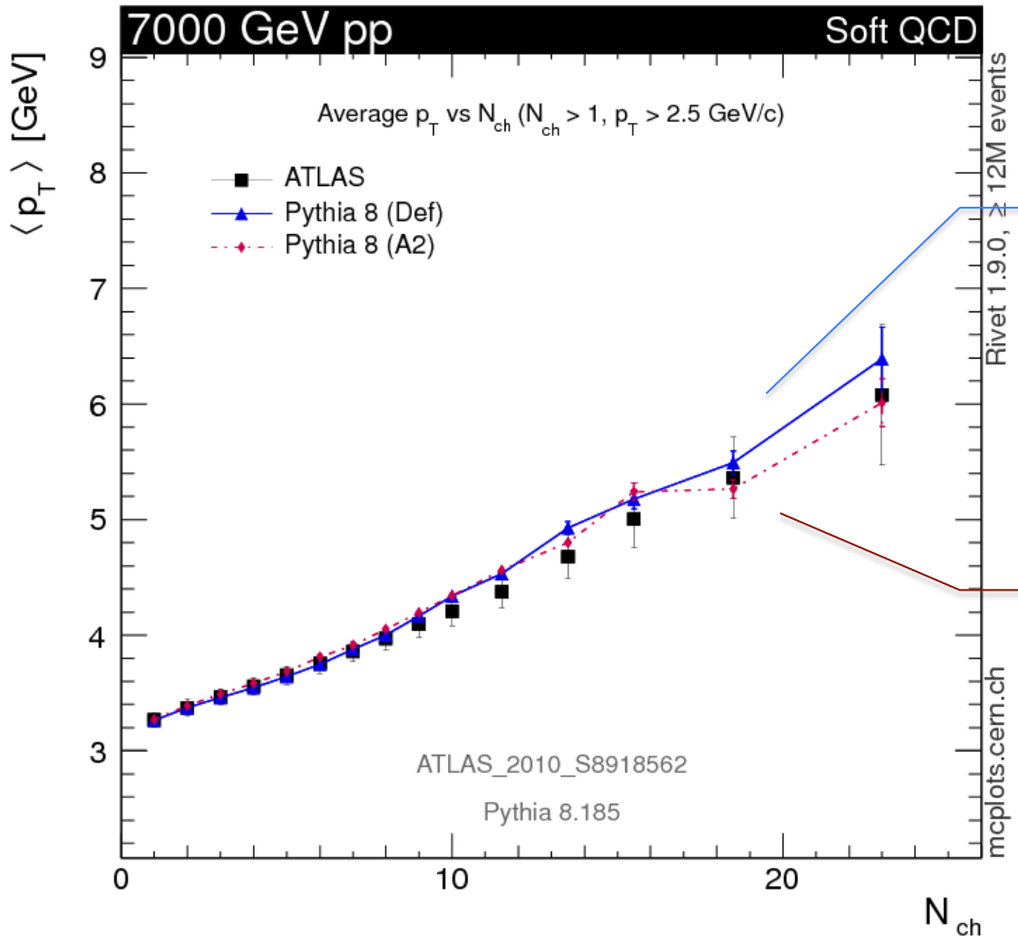
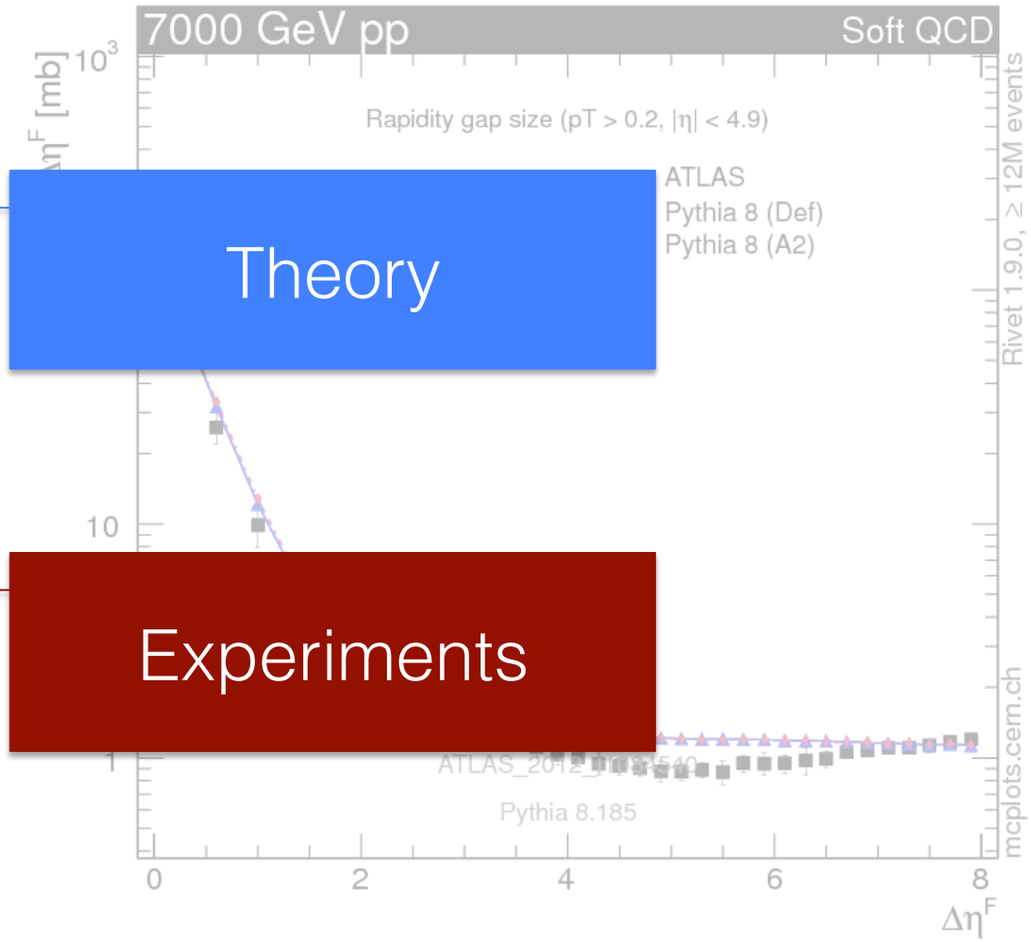
Theoretical Physics

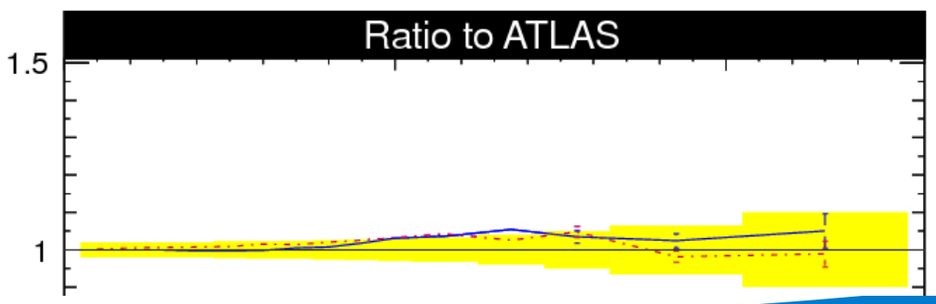
- In High-Energy Particle Physics the scientific discovery follows a particular pattern:

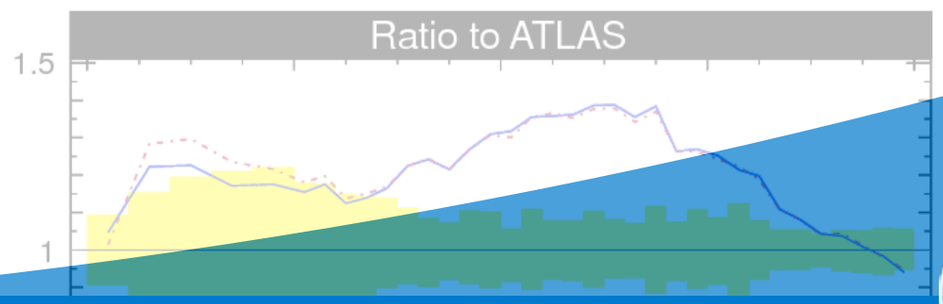
1. Create a theoretical model, applying the current knowledge and observation
2. Create a computer simulation that creates virtual collusions, just like the ones that happen in the big particle colliders (LHC, LEP..), using that model
3. Adjust the model until it matches the results from the experiments

A Theoretical Physics









Theory

Experiments

In Practice

- In practice we are using a couple of software for this purposes:
  - We are generating collisions with event generators *(such as pythia, sherpa, vincia, phojet, epos)*

    Reminder: *"event" = The products of a collision in a particle collider*
  - We are validating it's results by comparing them to theory using generator validators

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In Practice

- One of the most widely used event generator in HEP is Pythia
  - Use Monte-Carlo method for statistically solving the complex theoretical models
  - As a result: It needs to simulate thousands of events until the results are statistically correct (takes a lot of time)

http://home.thep.lu.se/~torbjorn/pythia81html/Welcome.html

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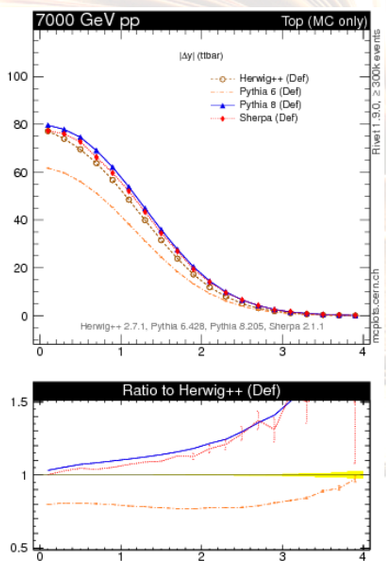
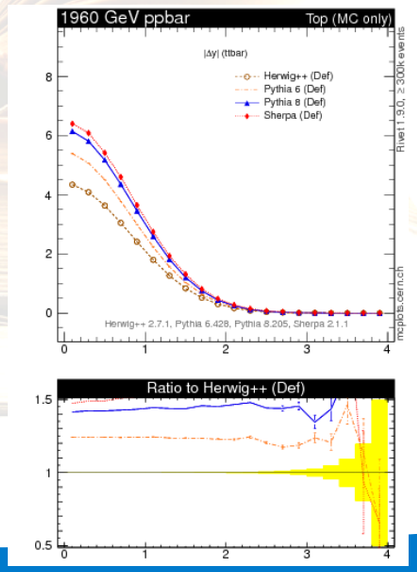
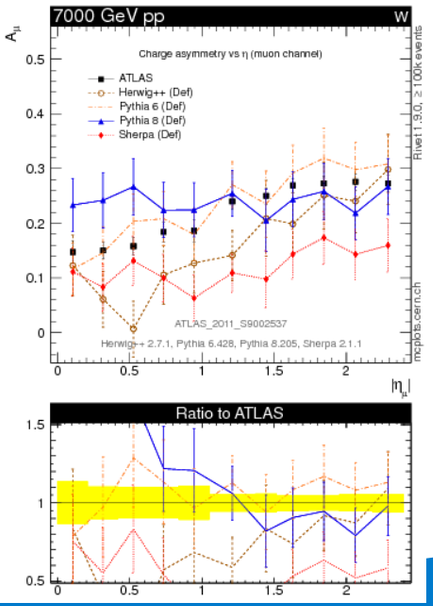
In Practice

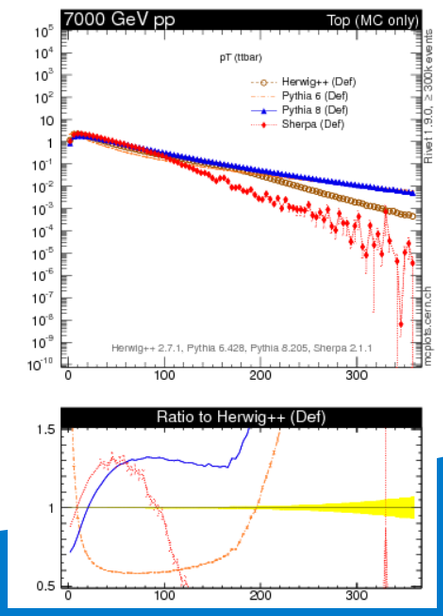
- One of the most widely used generator validator in HEP is Rivet

  - Compares the results from an event generator to the ones observed in experiments









https://rivet.hepforge.org/

So it's simple!

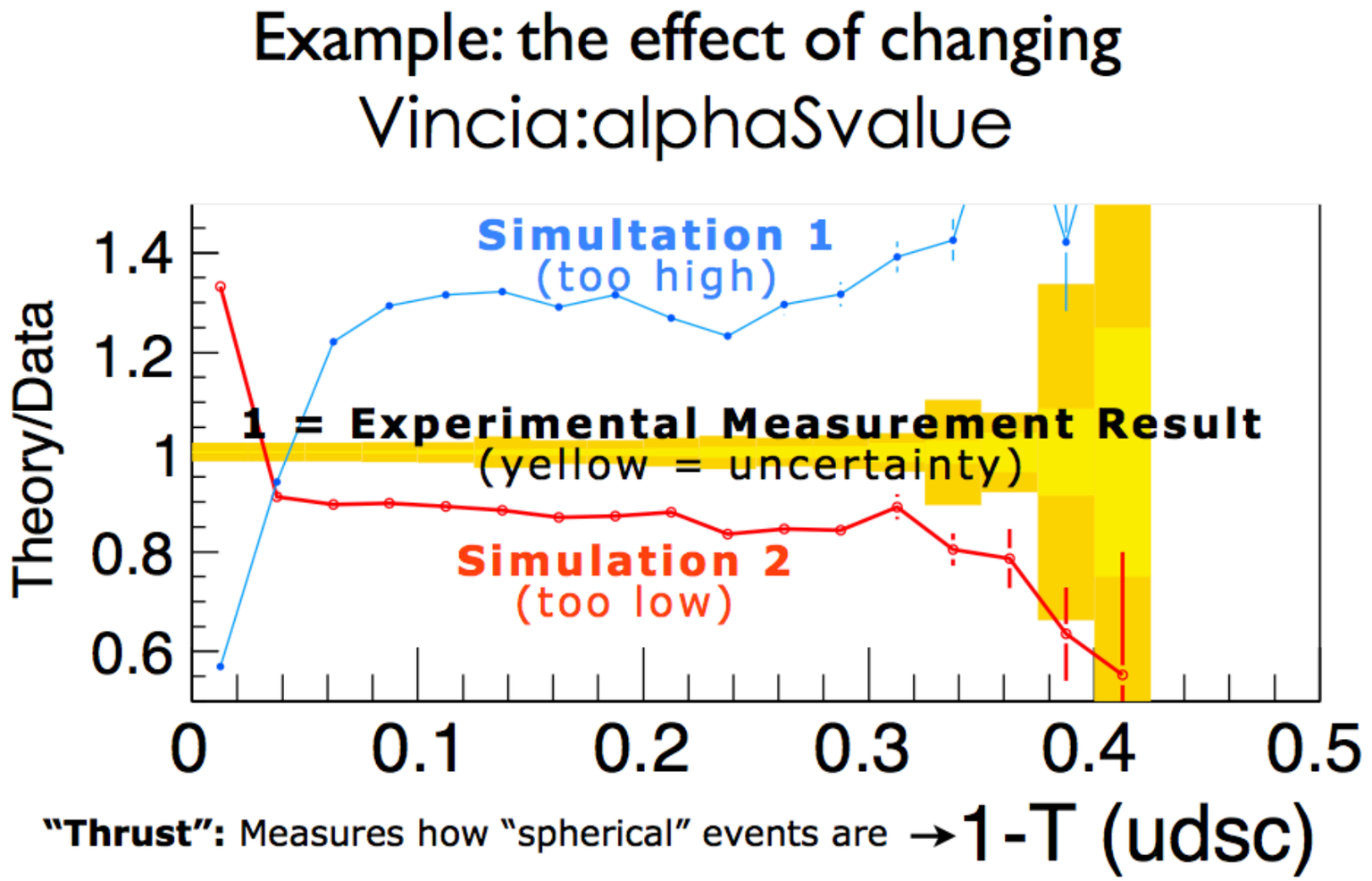
- We have all the software in place, so the 'tuning' process is quite simple, right?
  - Just change the following parameters:

```
! * Strong-force Coupling
Vincia:alphaSValue        = 0.138

! * Hadronic Energy Scale
Vincia:cutoffScale        = 0.45

! * String parameters
StringZ:aLund             = 0.38
StringZ:bLund             = 0.62
StringPT:sigma            = 0.26
```

```
! * Quark flavor parameters
StringFlav:probStoUD      = 0.21
StringFlav:mesonUDvector  = 0.35
StringFlav:mesonSvector   = 0.55
StringFlav:probQQtoQ      = 0.08
StringFlav:probSQtoQQ     = 1.00
StringFlav:probQQ1toQQ0   = 0.03
StringFlav:decupletSup    = 1.00
StringFlav:etaSup         = 0.60
StringFlav:etaPrimeSup    = 0.10
```

So it's simple!

- And make sure that results are getting better:



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So it's simple!

- Actually, a 15-y/o student did this in 2010
- Mikkel Jeppsson (Right) was an intern at CERN
- Peter Skands (Left) wrote a simple interface to these software
- We found the best results in use now!

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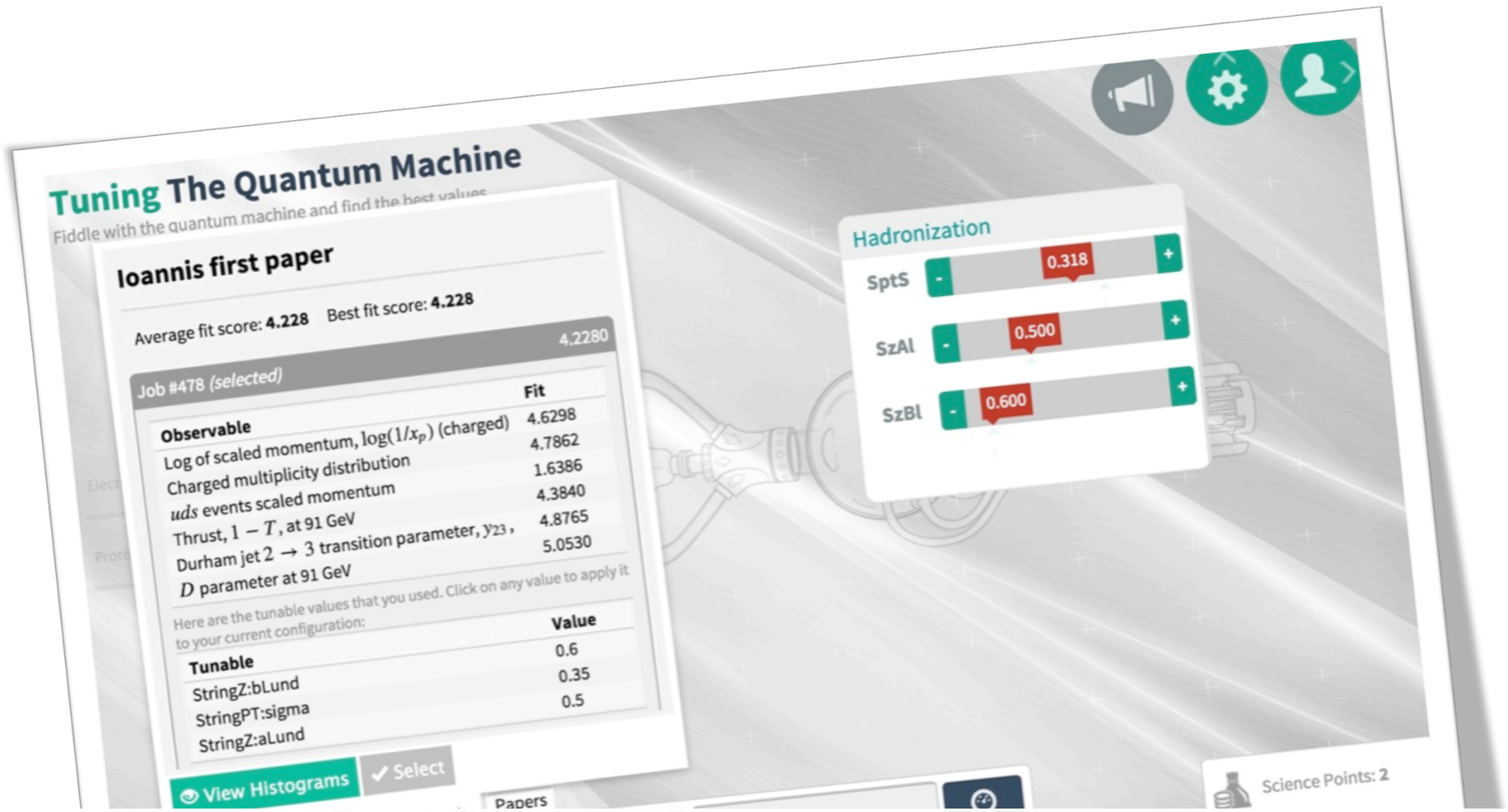
So it’s simple!

So, why not everyone?

B Virtual Atom Smasher

B Virtual Atom Smasher



A simplified, well-documented interface to the event generators

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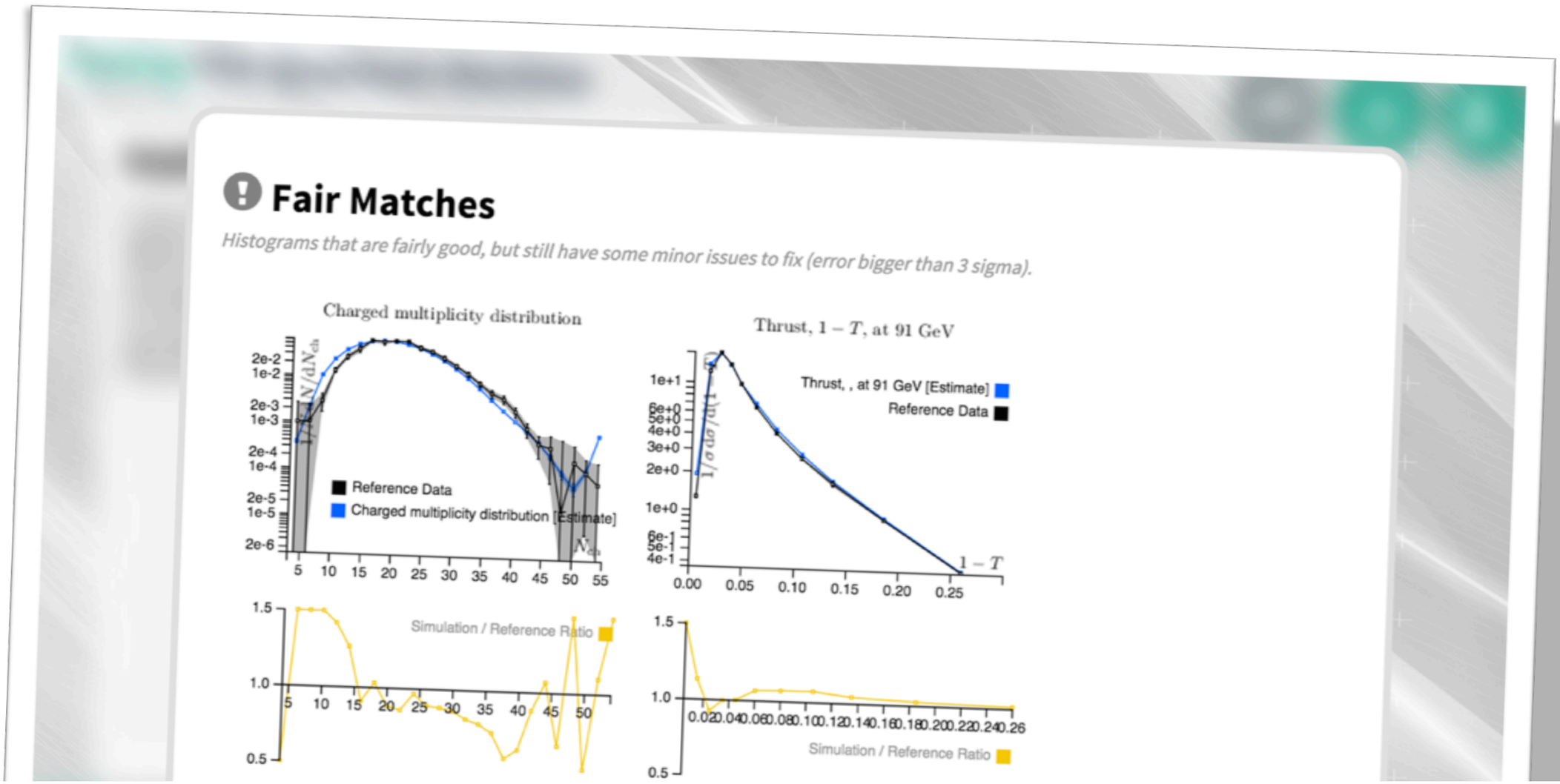

Integrated real-time plots from the generator validation

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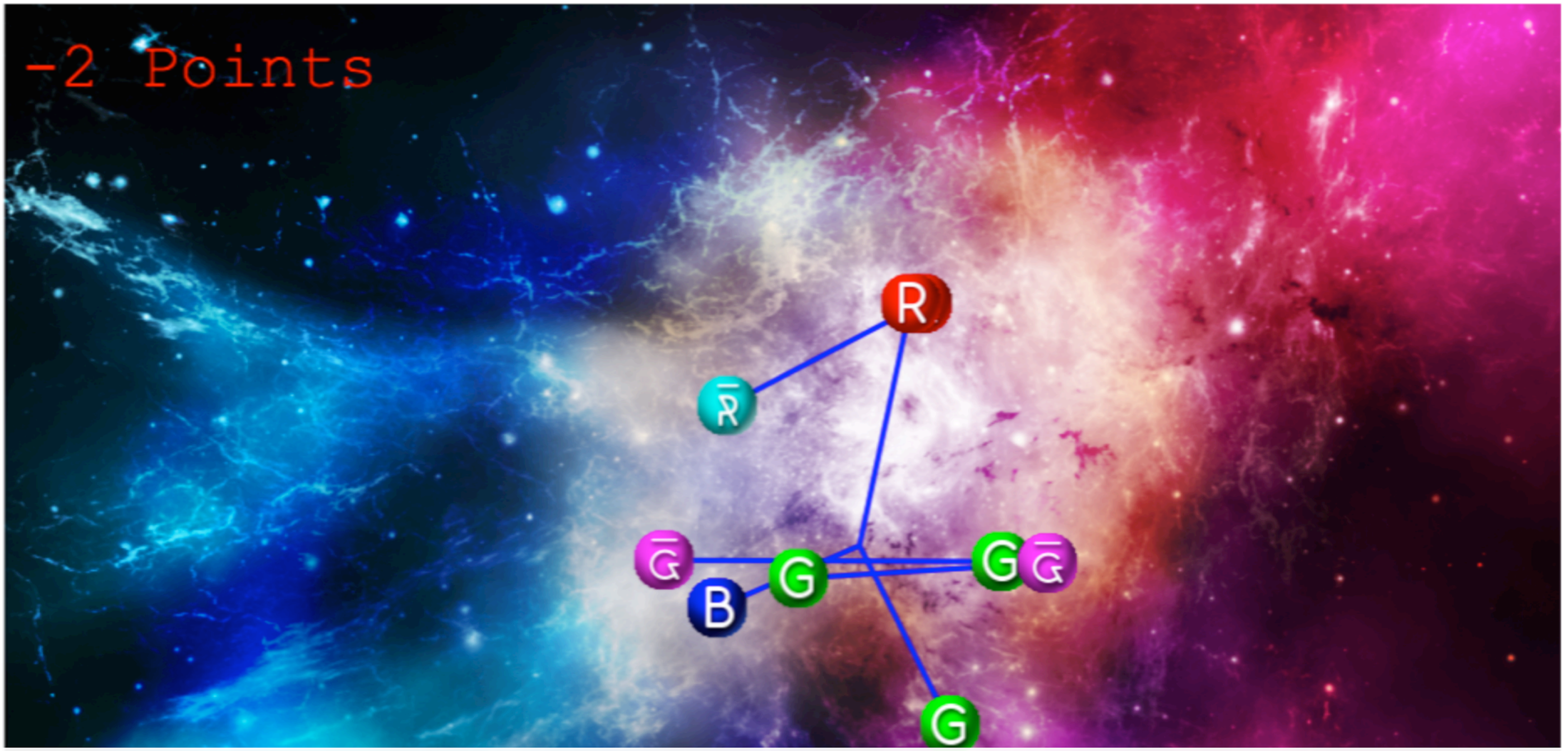
Integrated explanations for all the scientific terms found in the game

B Virtual Atom Smasher



Physics mini-games for understanding the more complex scientific topics

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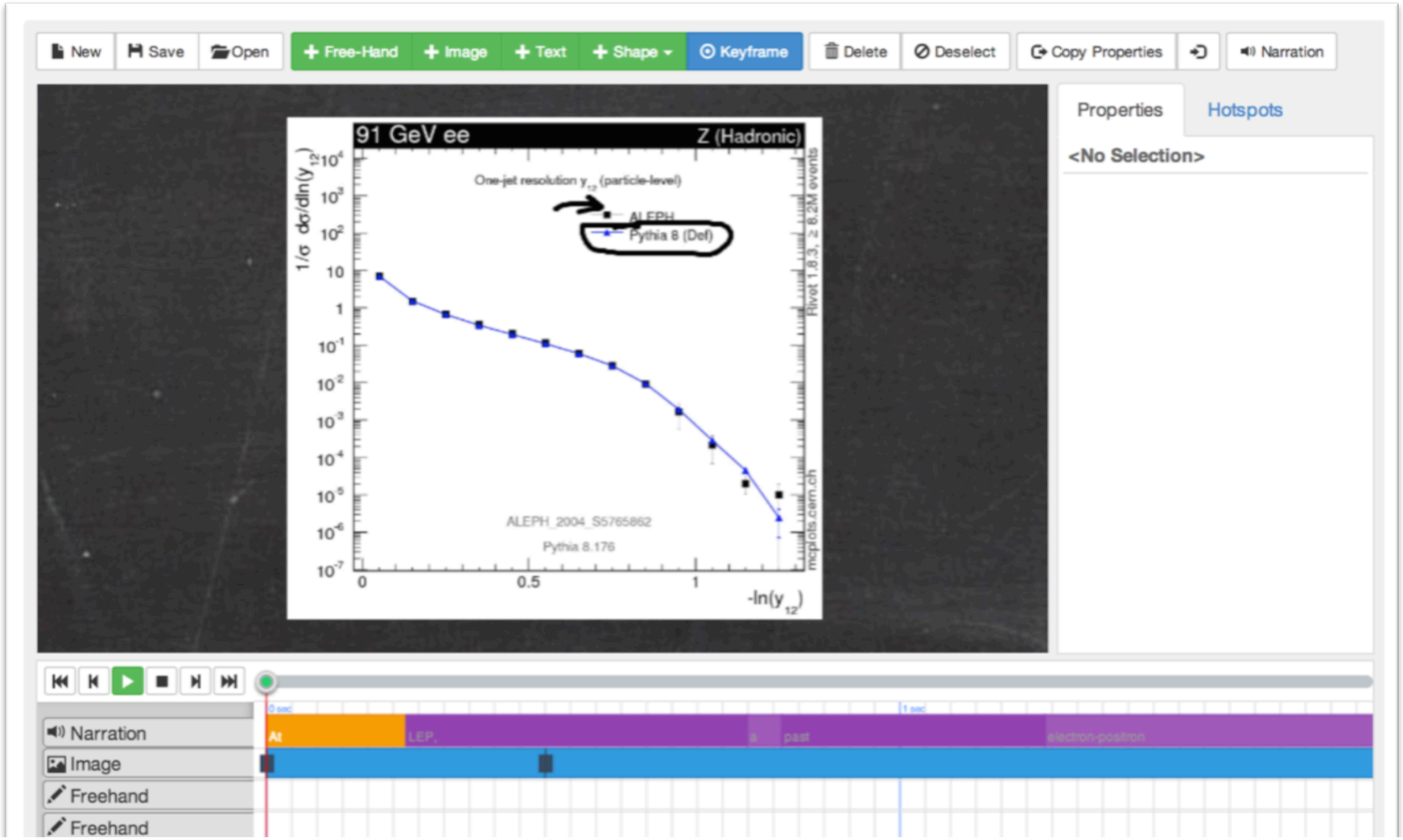

Editable, procedural presentations, using computer-generated background narration

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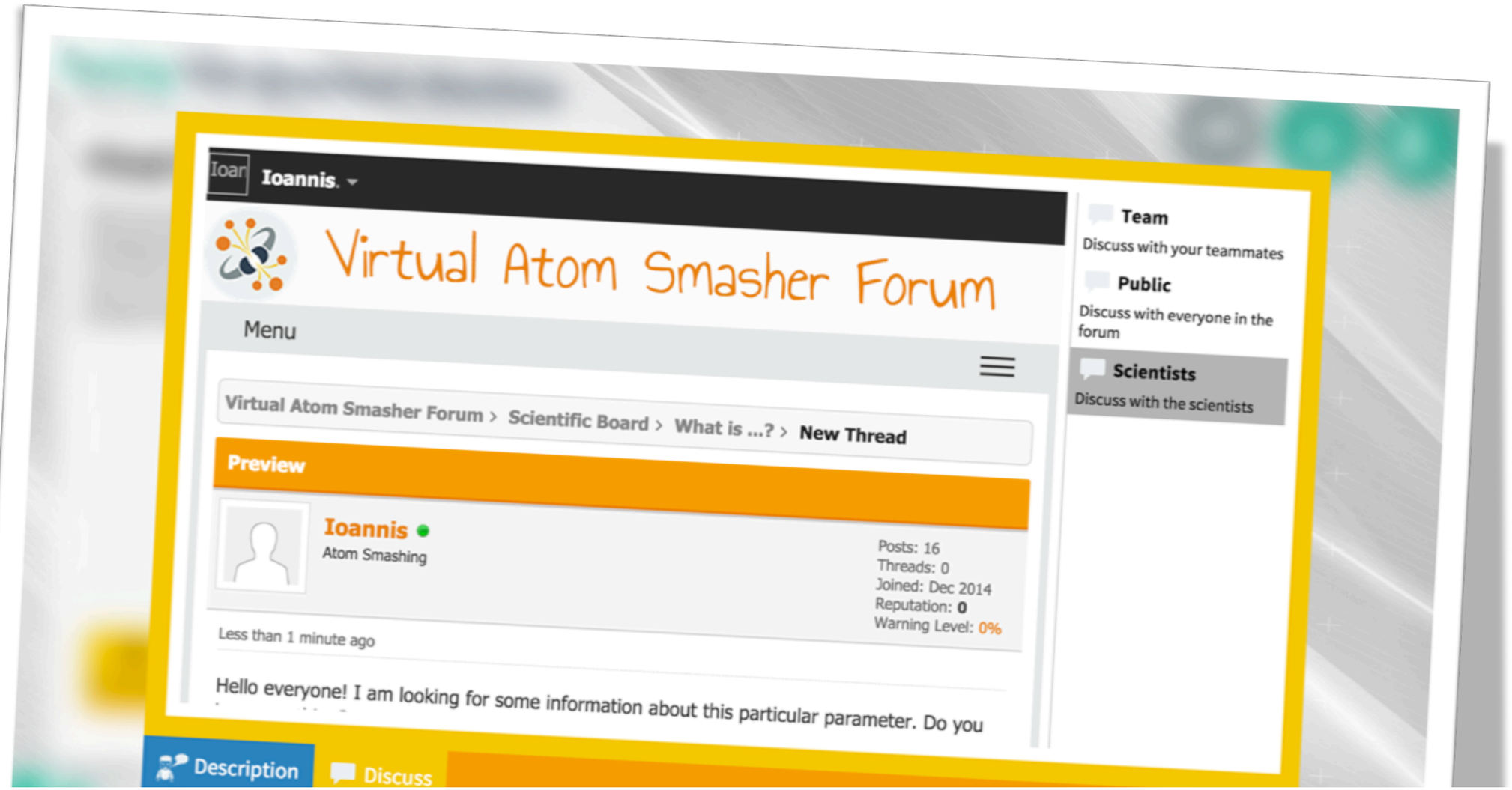
Virtual Atom Smasher



Of course, integrated forums between the teams and the scientists

B

Virtual Atom Smasher

On-line demo!

http://test4theory.cern.ch/vas

C Computing Resources

- There are distributed worker nodes, each one of them contributing to the simulation
  - The resources are grouped in teams (currently everyone joins the “newbies” team, with resources provided by CERN)
  - But you can create your own teams and use your own computing resources