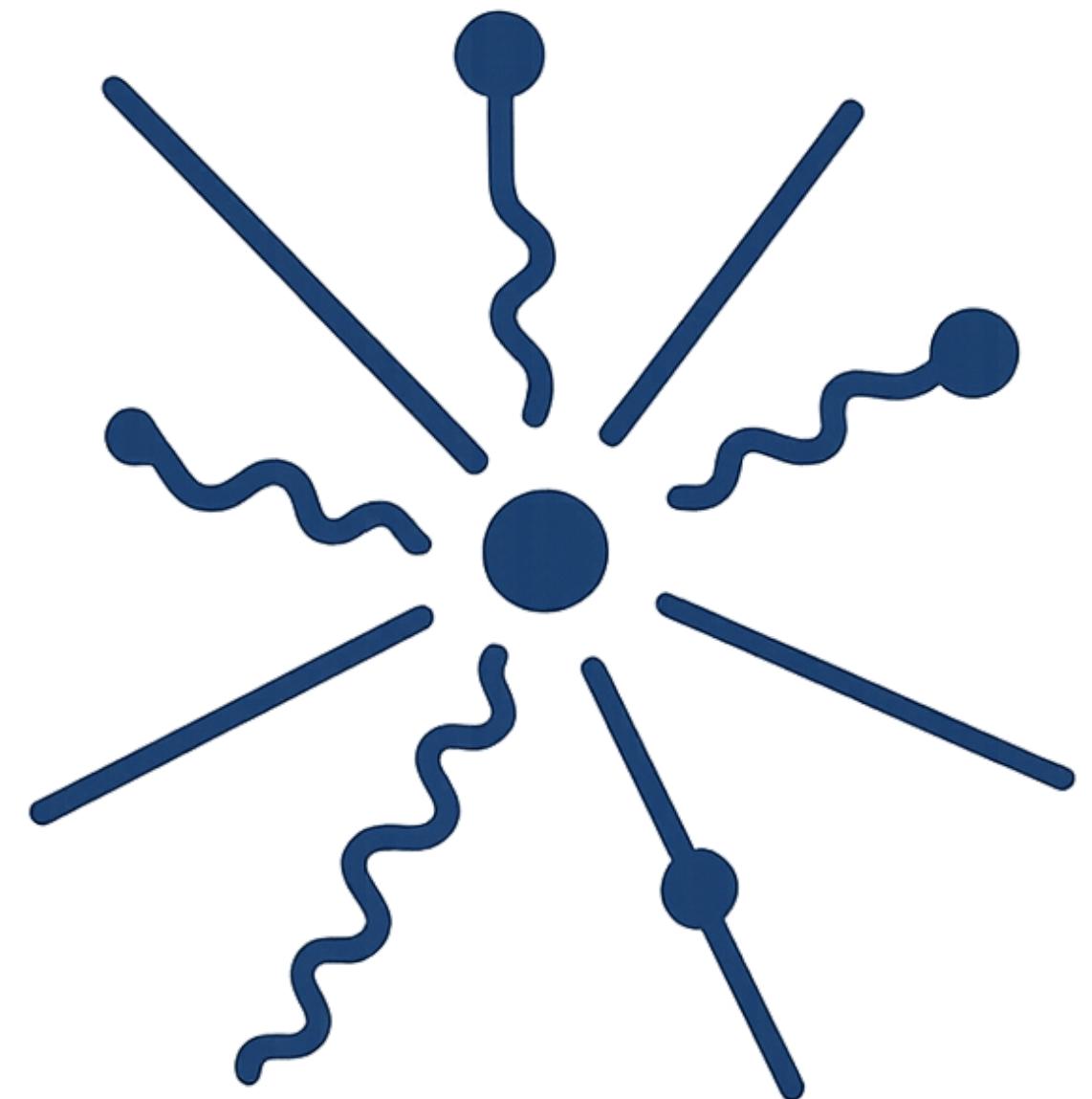
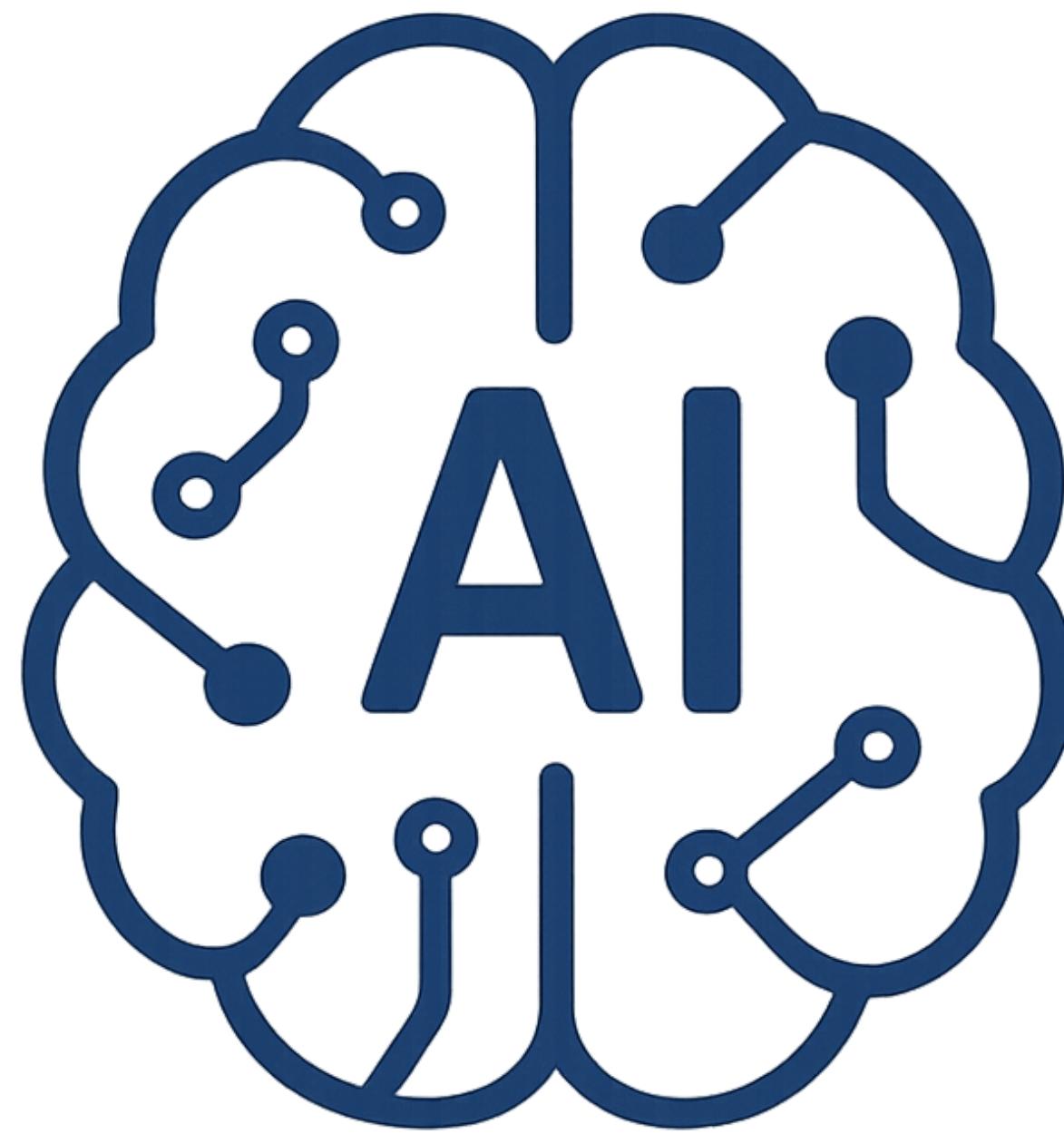
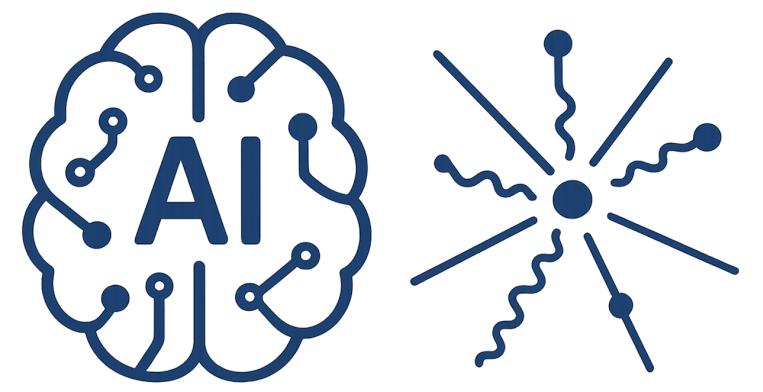


Introduction to

# AI-Driven HEP

S. A. Fard - School of Physics (IPM)



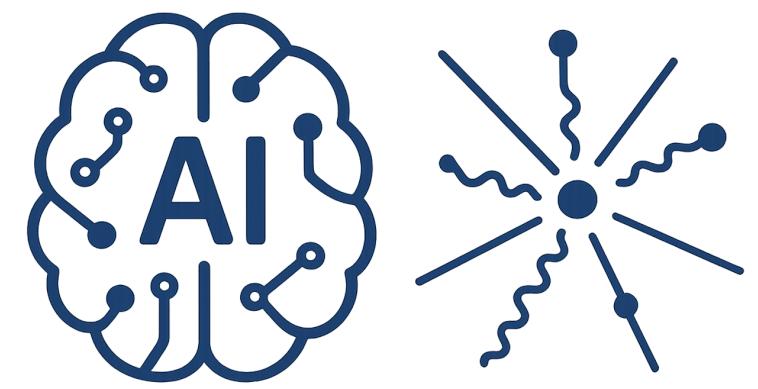


AI-Driven HEP 1



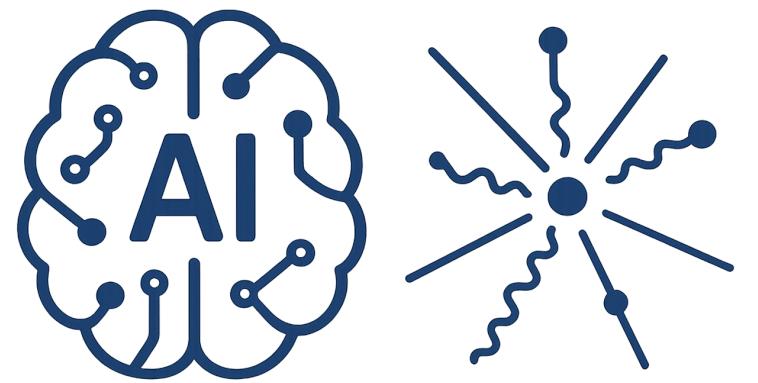
# Session 1

# Lost In the Forest



AI-Driven HEP 1

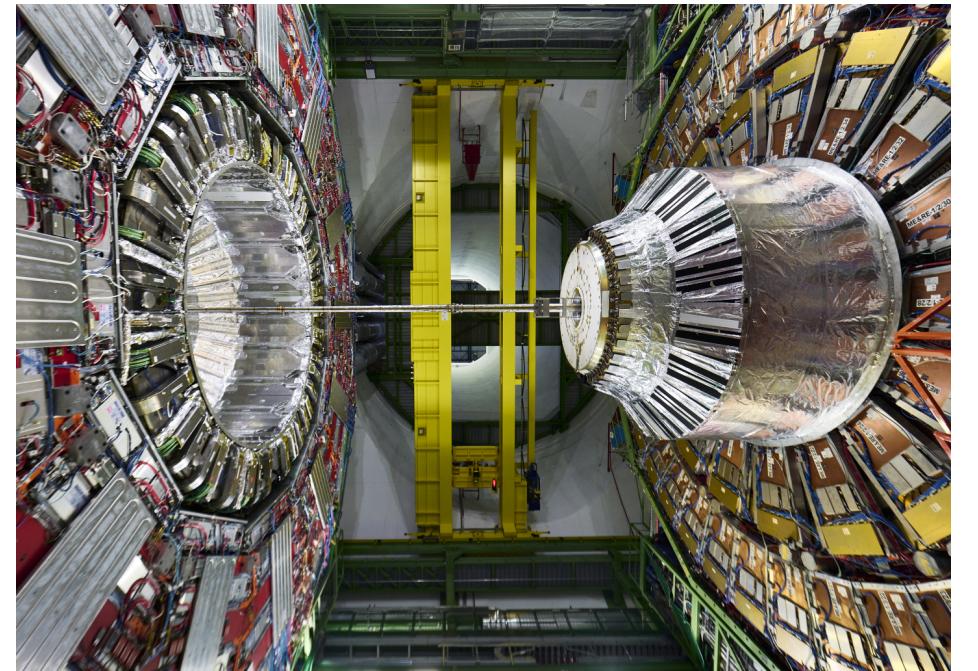
## What do we mean by High Energy Physics?



## AI-Driven HEP 1

# What do we mean by High Energy Physics?

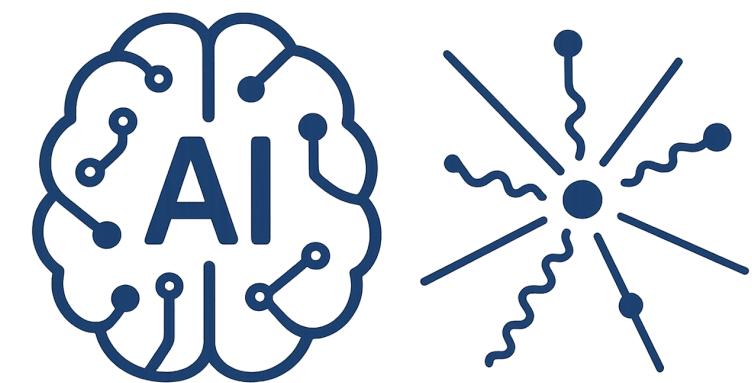
## Accelerators



Beam Dump      MicroBooNE

Colliders      LHC

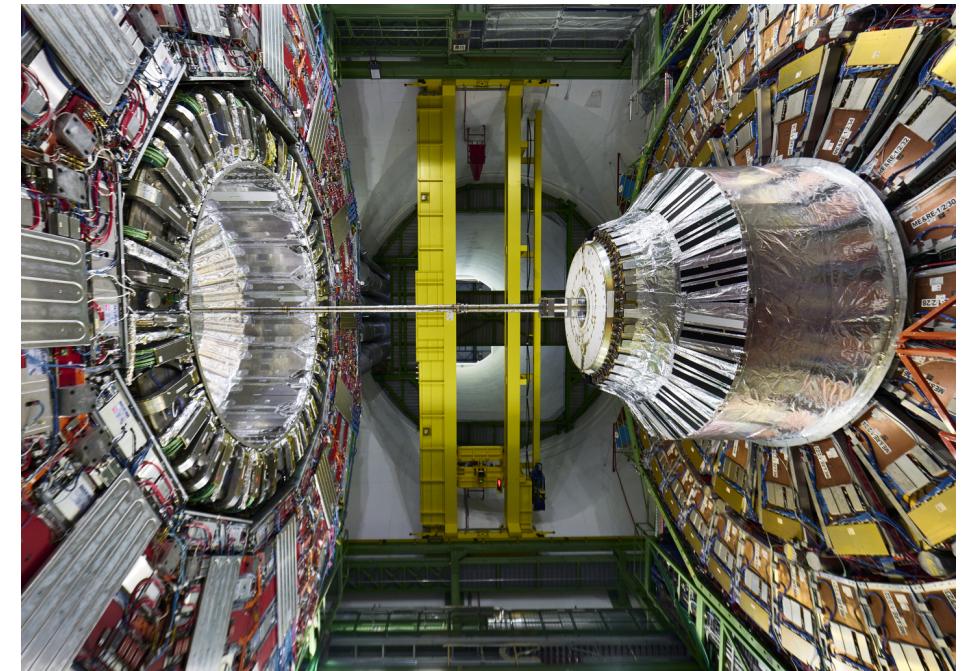
Reactors      KamLand



## AI-Driven HEP 1

# What do we mean by High Energy Physics?

Accelerators

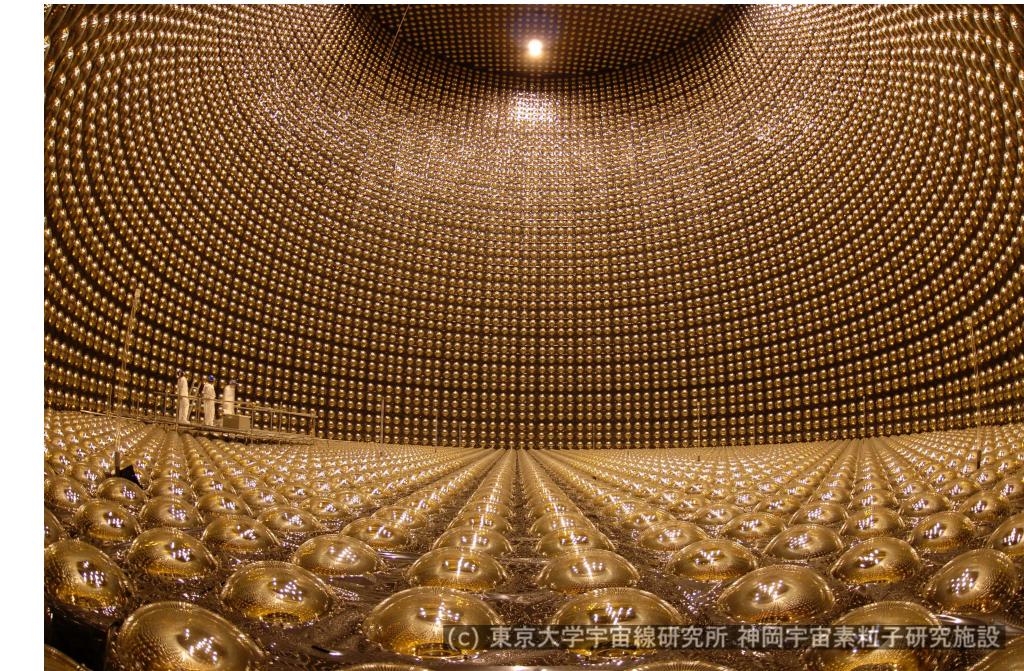


Beam Dump

Colliders

Reactors

Astroparticles



Cosmic Rays

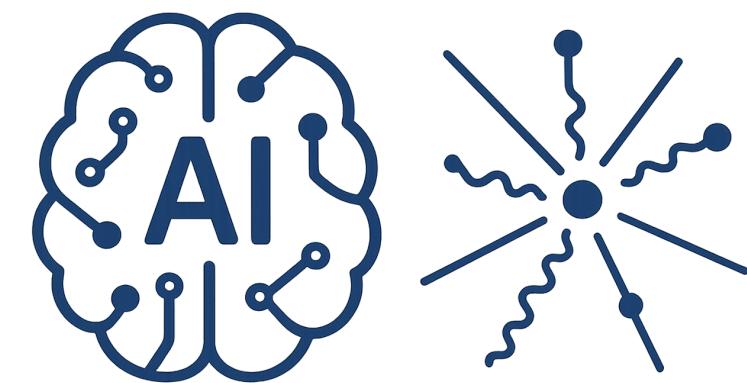
Sun

Earth

Fermi LAT

Super-K

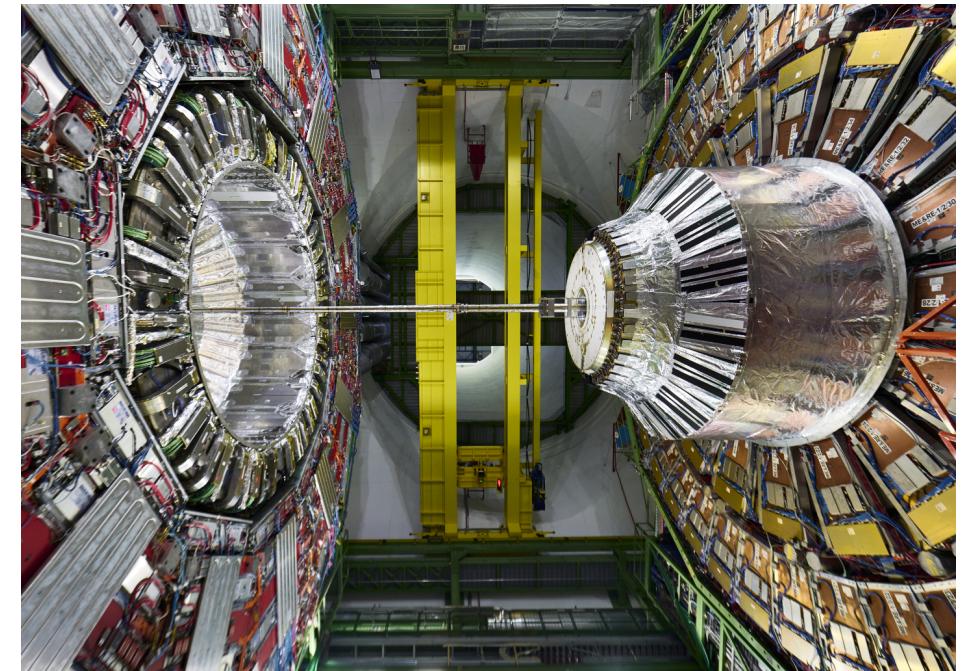
Borexino



## AI-Driven HEP 1

# What do we mean by High Energy Physics?

Accelerators

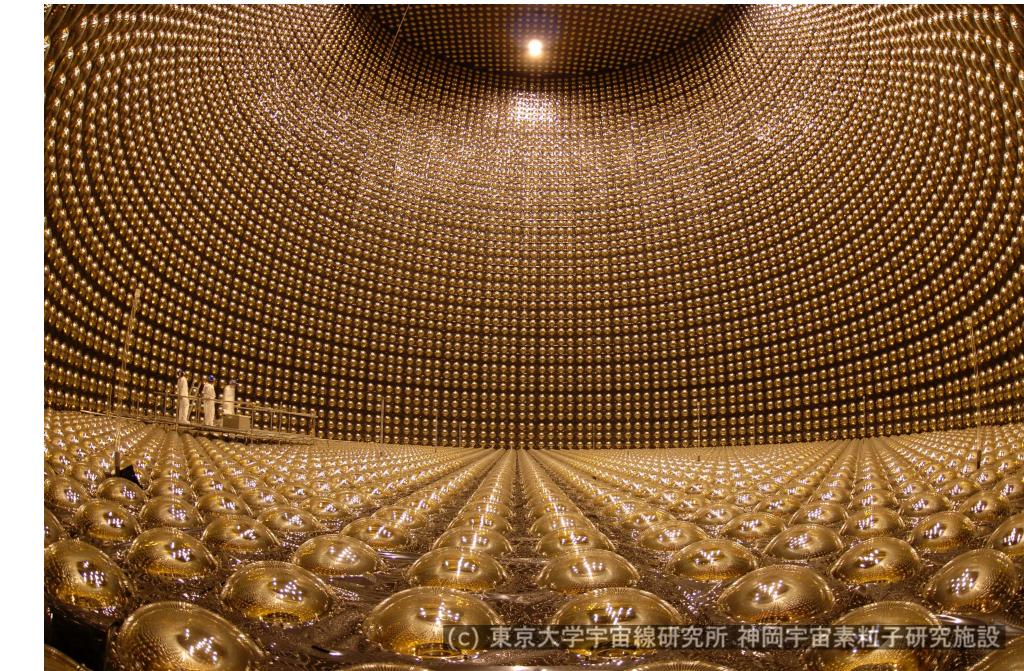


Beam Dump

Colliders

Reactors

Astroparticles

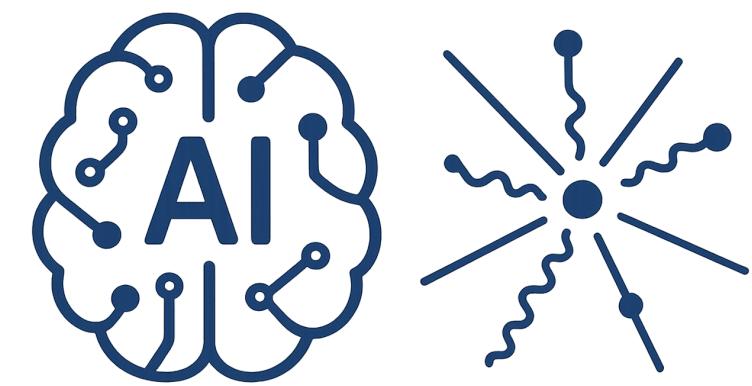


Cosmic Rays

Sun

Earth

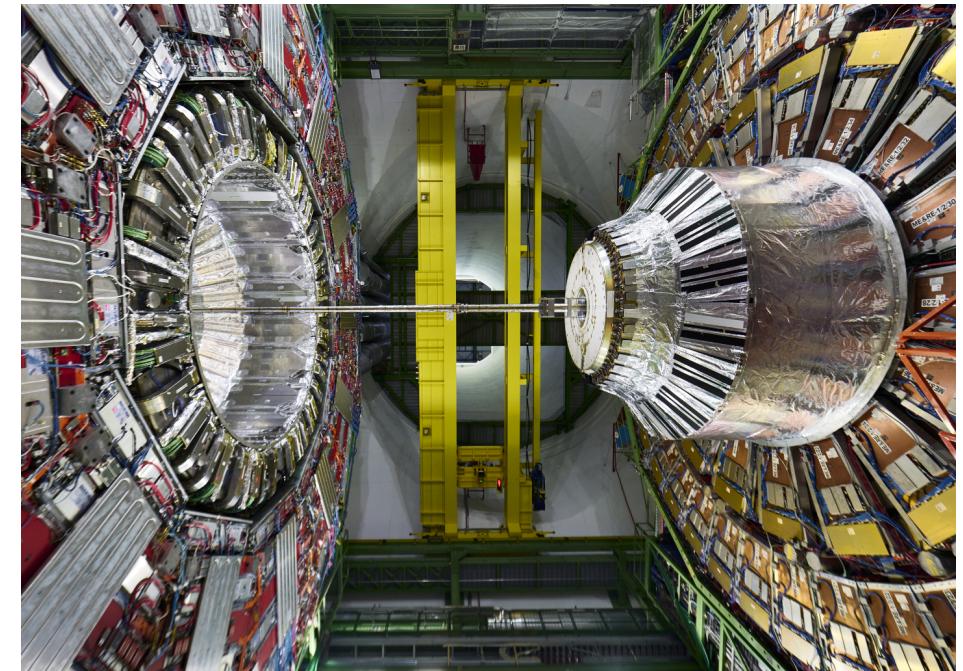




## AI-Driven HEP 1

# What do we mean by High Energy Physics?

Accelerators

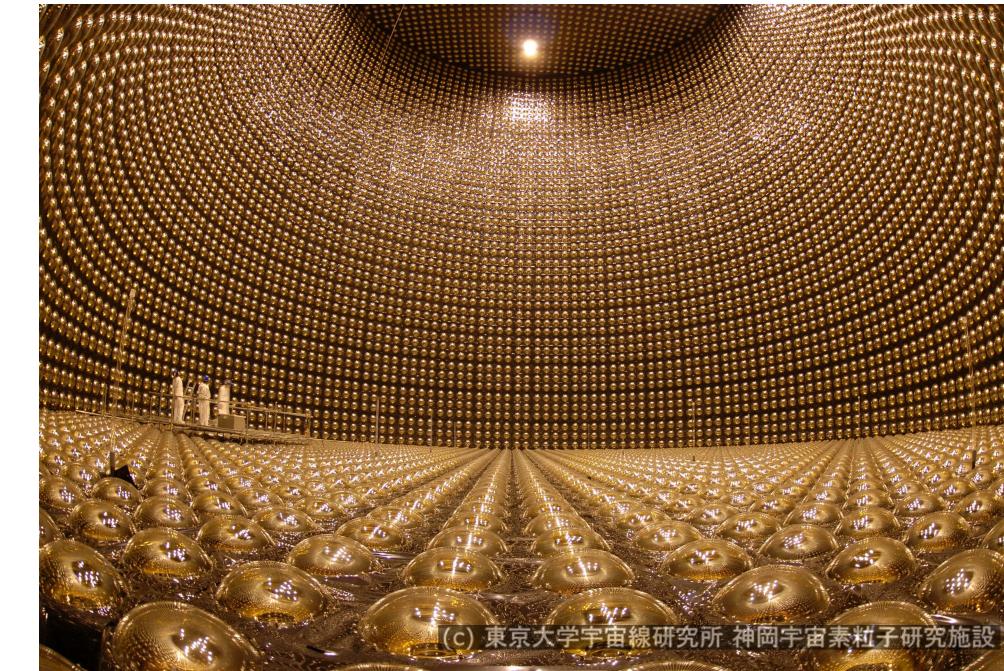


Beam Dump

Colliders

Reactors

Astroparticles



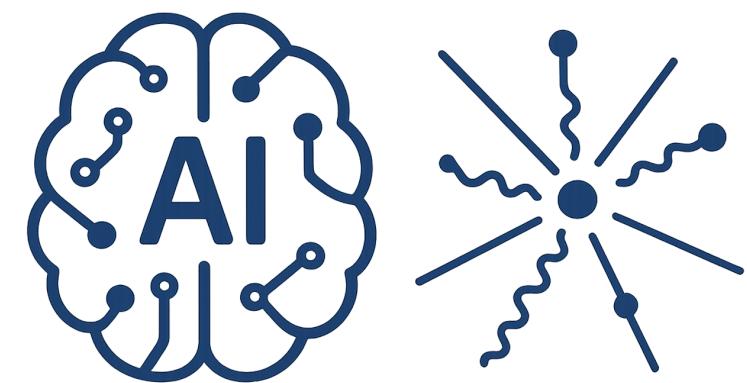
Cosmic Rays

Sun

Earth



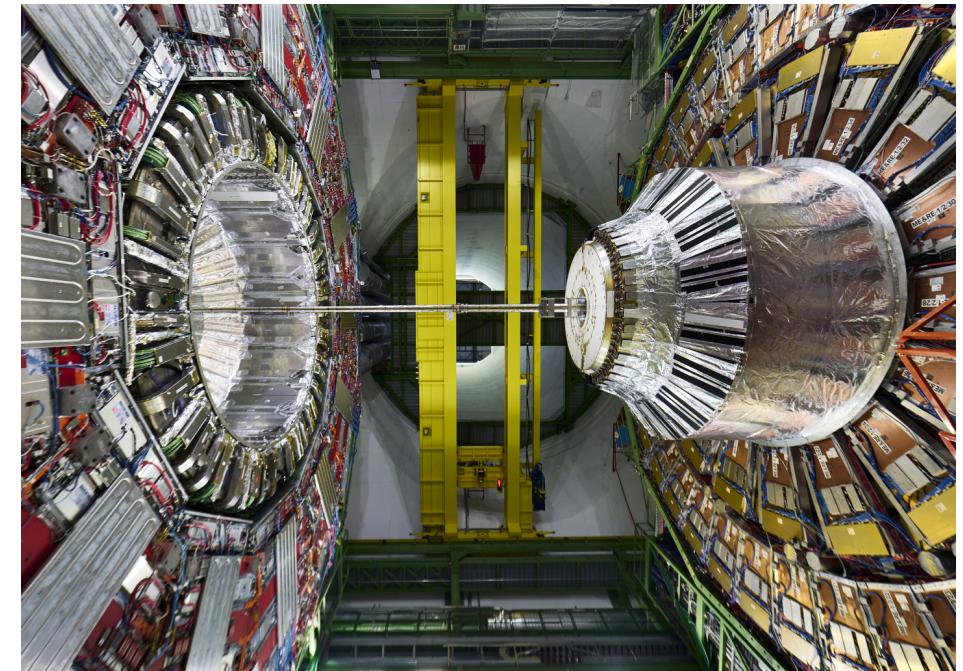
Exe 1-1: Design a detector for  
banana cargo at port?  
(Background free)



## AI-Driven HEP 1

### What do we mean by High Energy Physics?

Accelerators

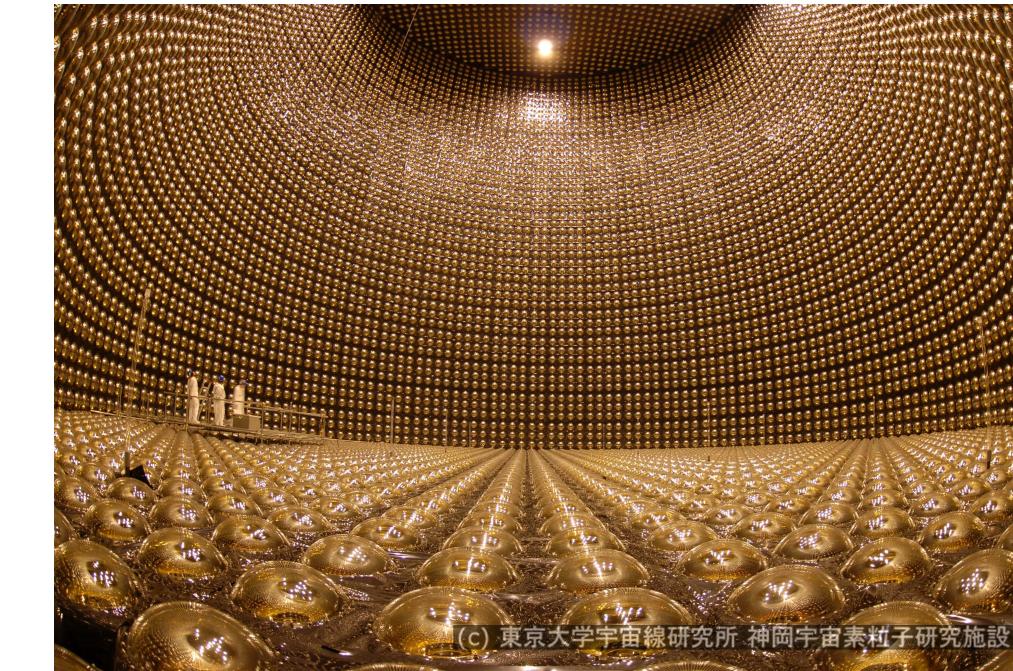


Beam Dump

Colliders

Reactors

Astroparticles



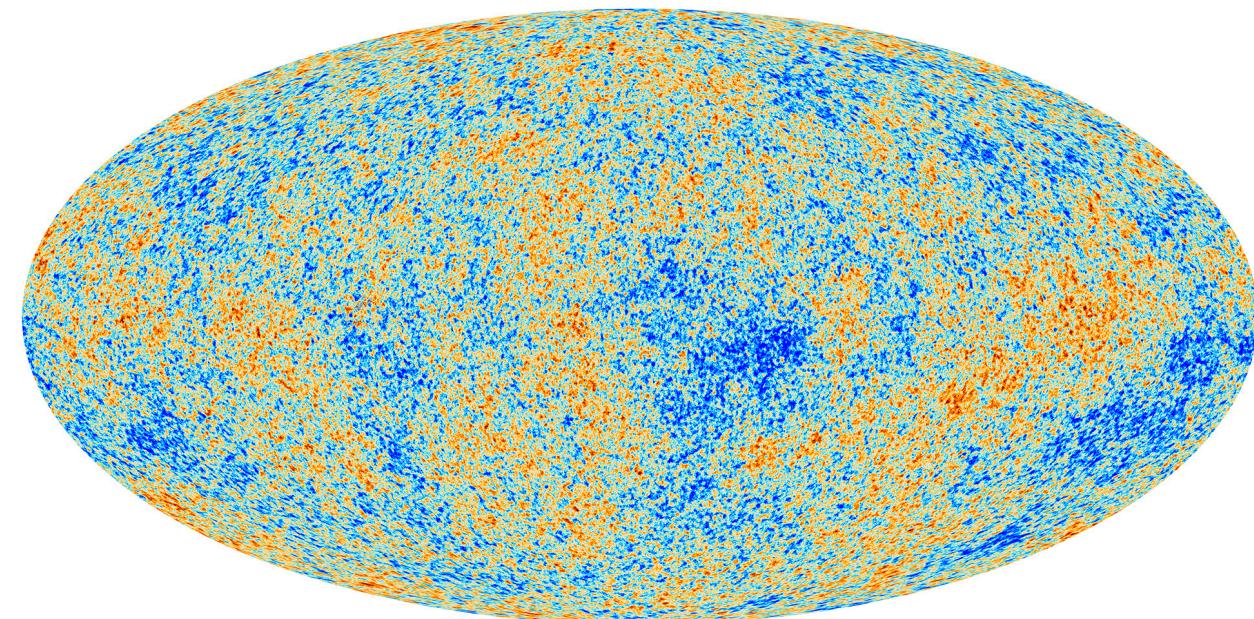
Cosmic Rays

Sun

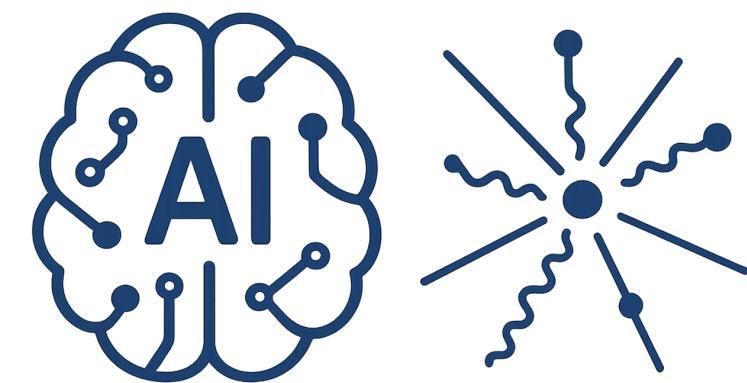
Earth



Cosmology



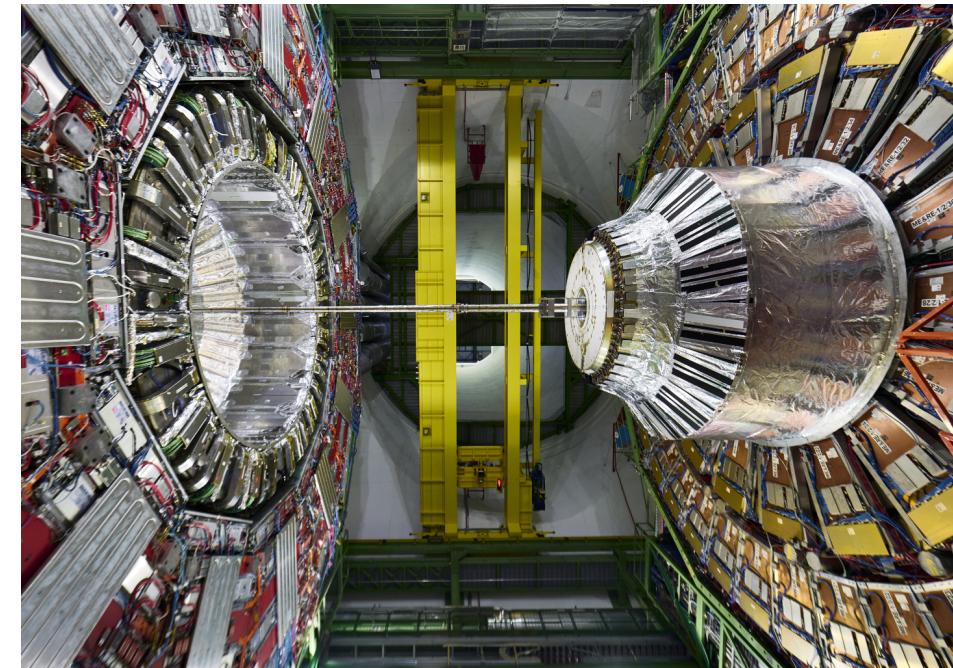
Planck



## AI-Driven HEP 1

### What do we mean by High Energy Physics?

Accelerators

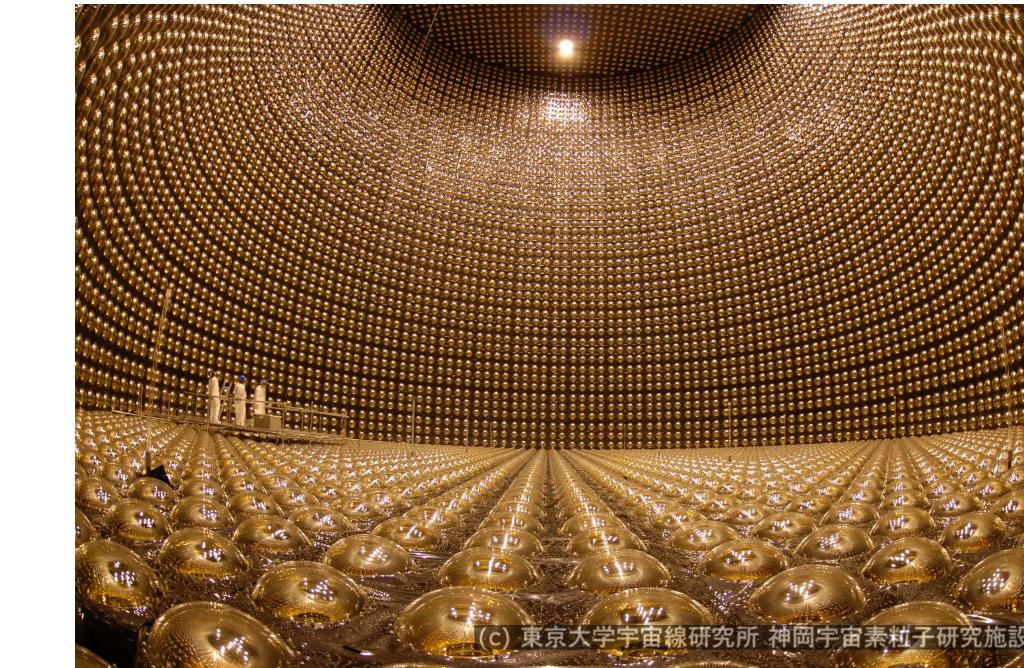


Beam Dump

Colliders

Reactors

Astroparticles



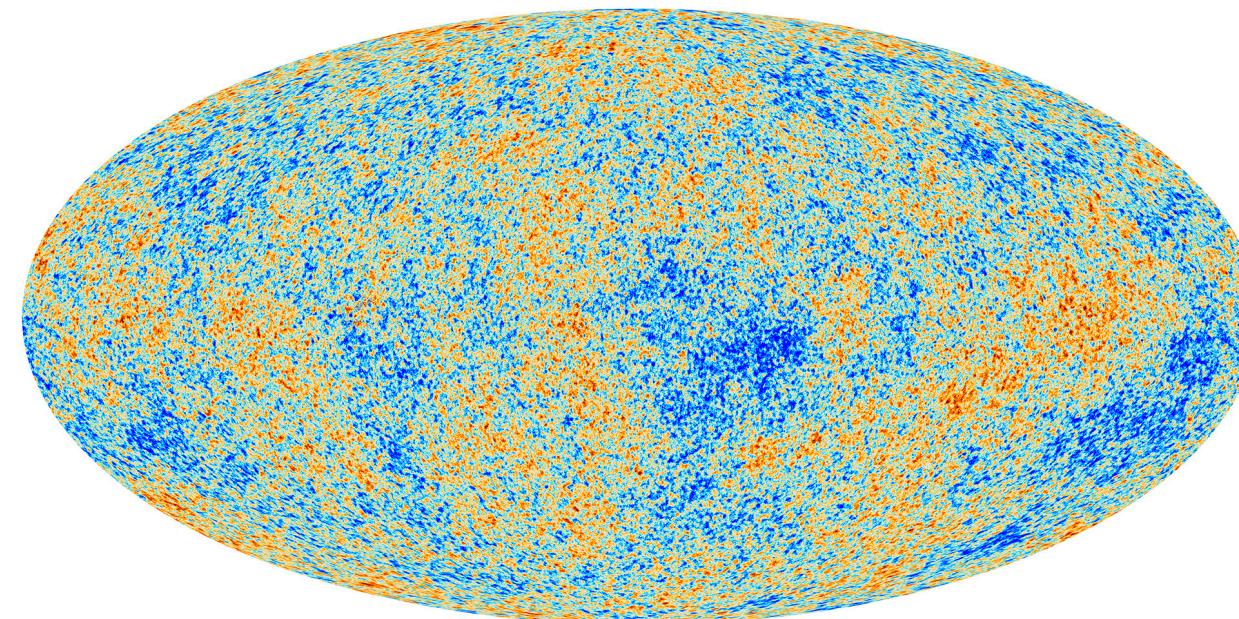
Cosmic Rays

Sun

Earth



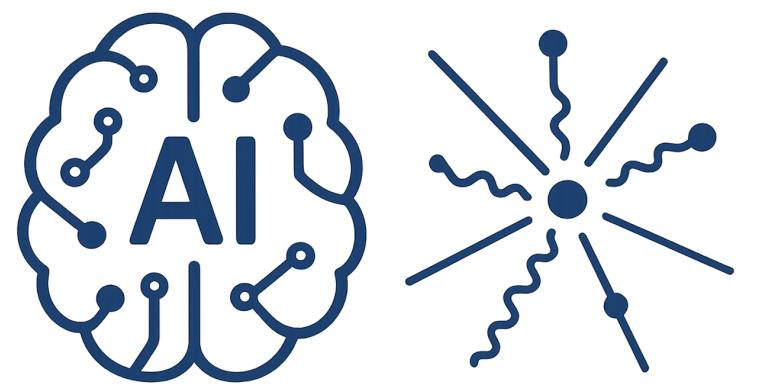
Cosmology



Gravitational Waves

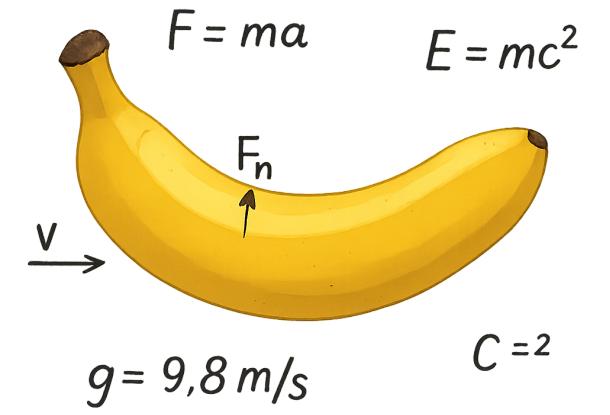


LIGO-Virgo

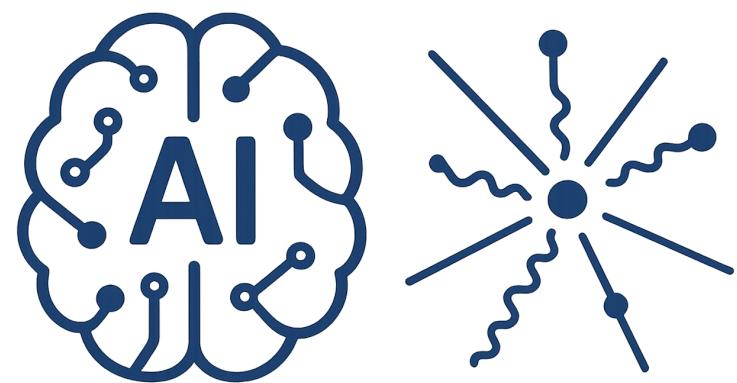


## AI-Driven HEP 1

### HEP how to use catalog

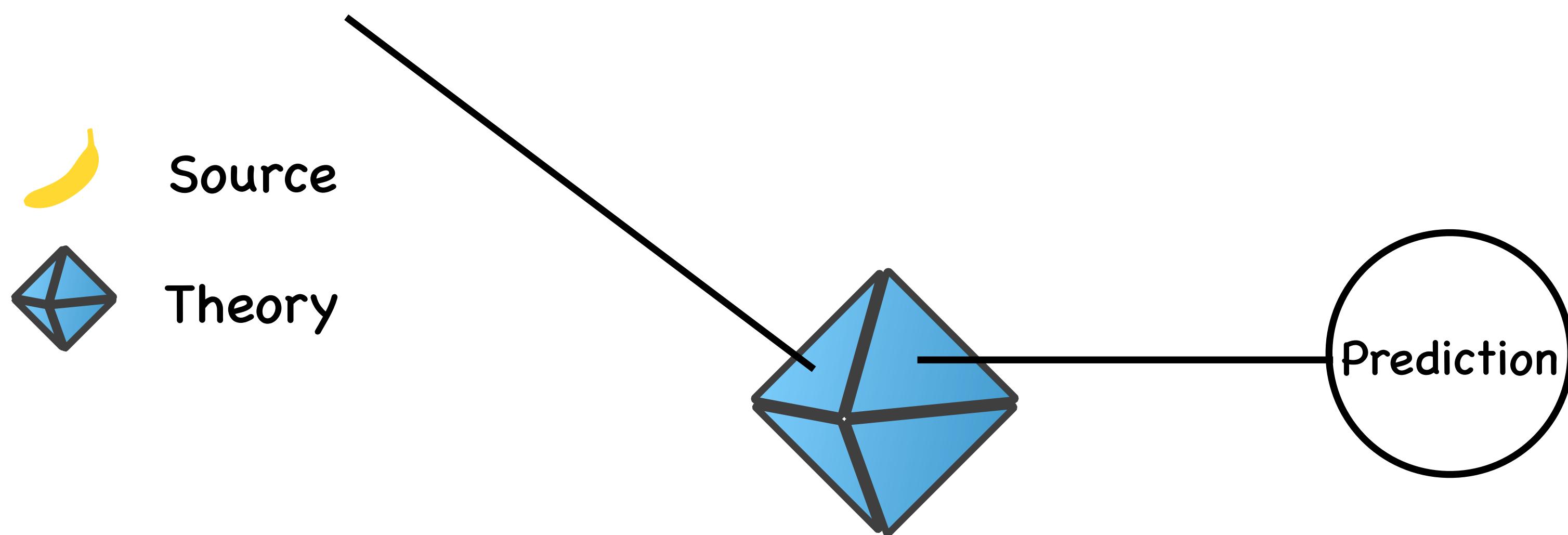
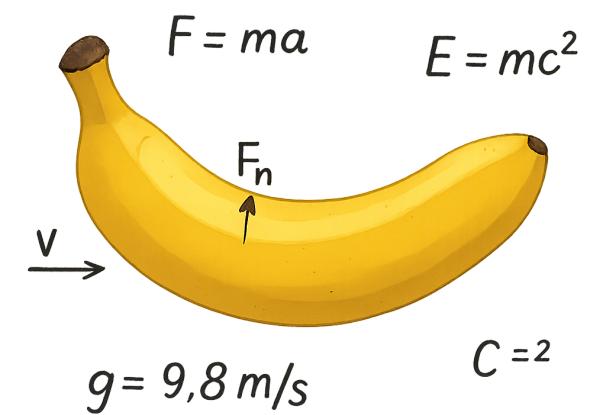


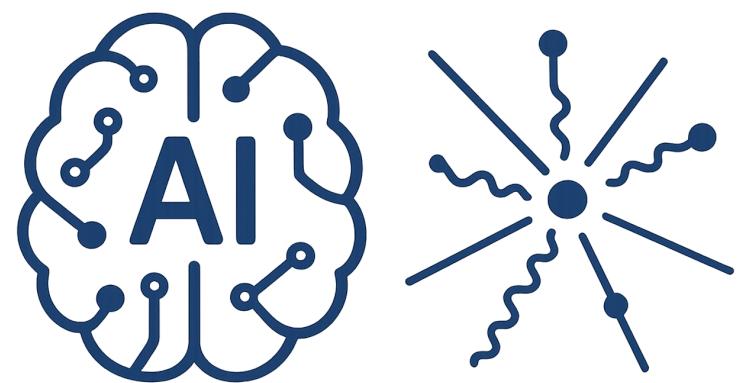
 Source



## AI-Driven HEP 1

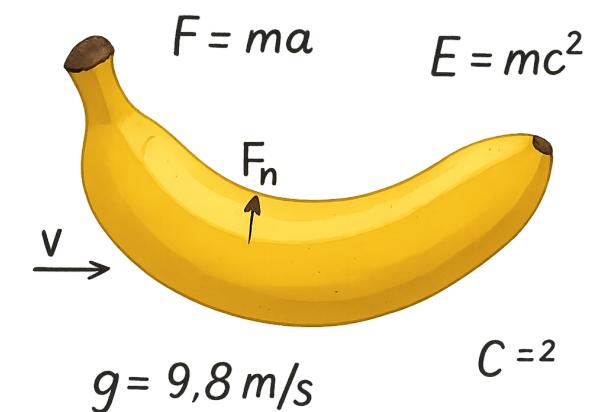
### HEP how to use catalog



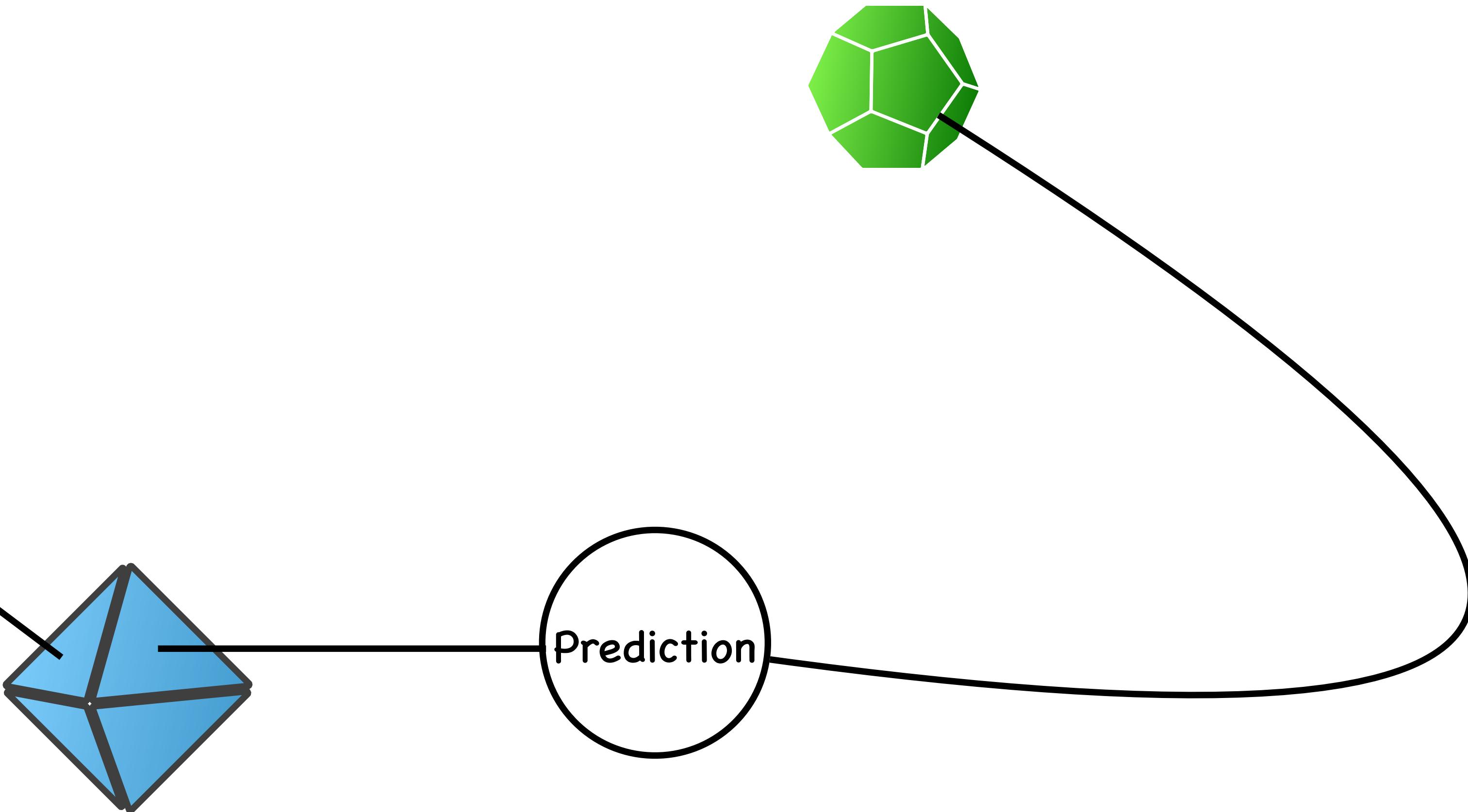


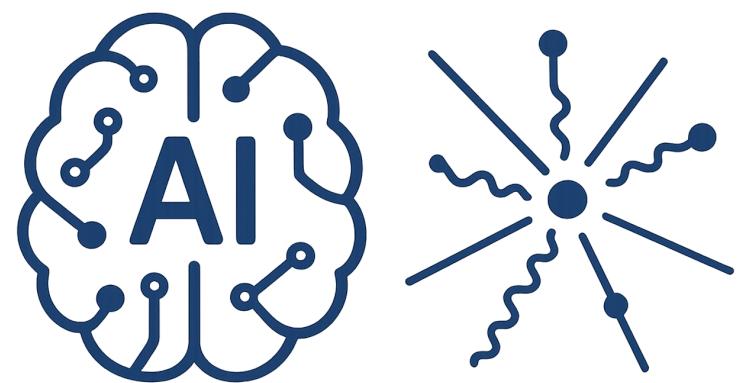
## AI-Driven HEP 1

### HEP how to use catalog



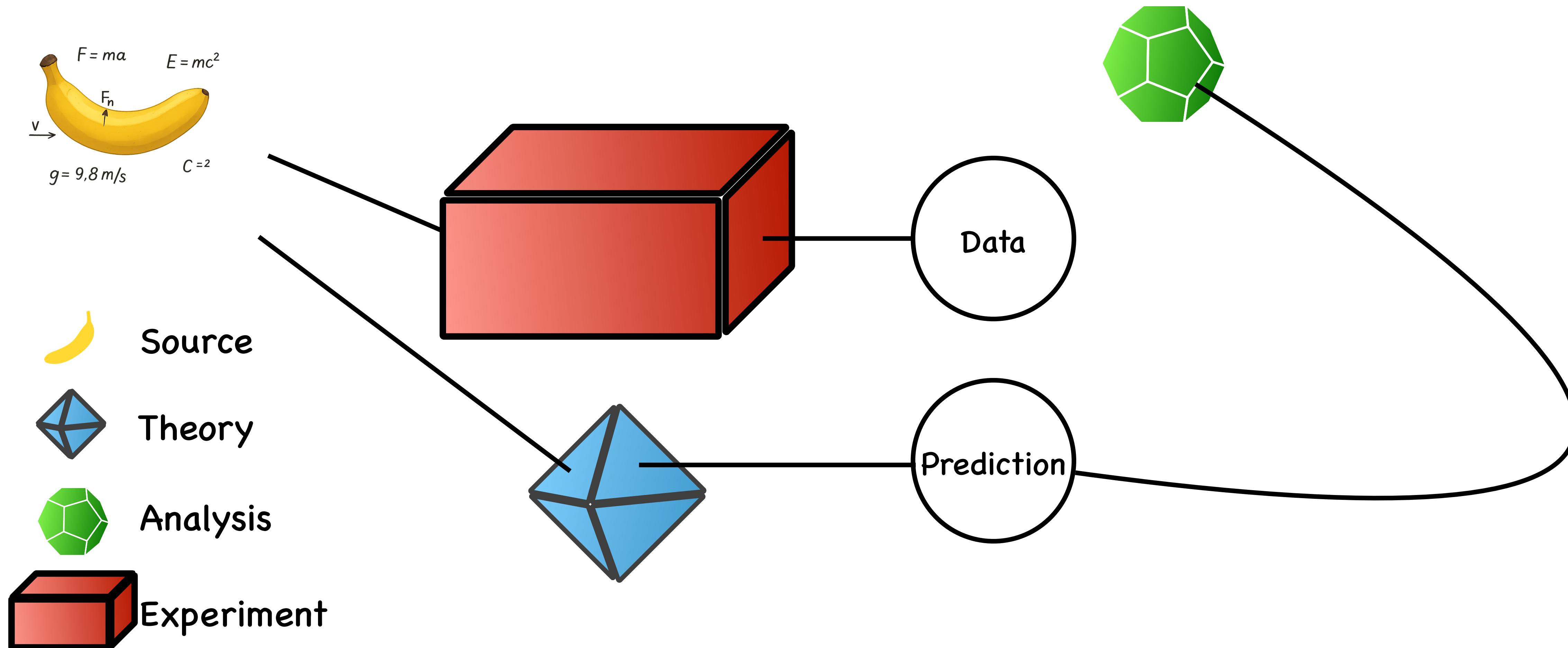
- Source (Banana icon)
- Theory (Blue diamond icon)
- Analysis (Green hexagon icon)

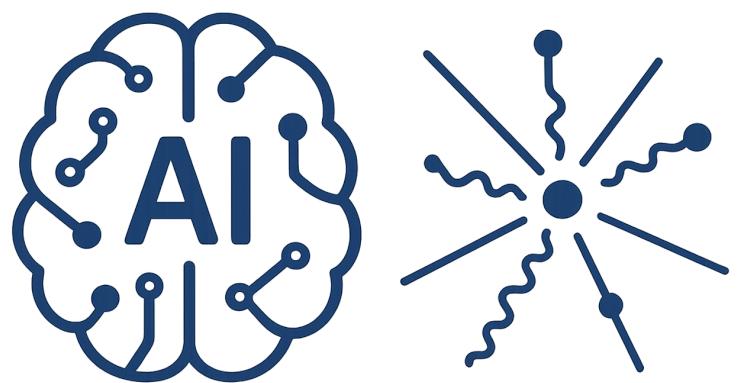




## AI-Driven HEP 1

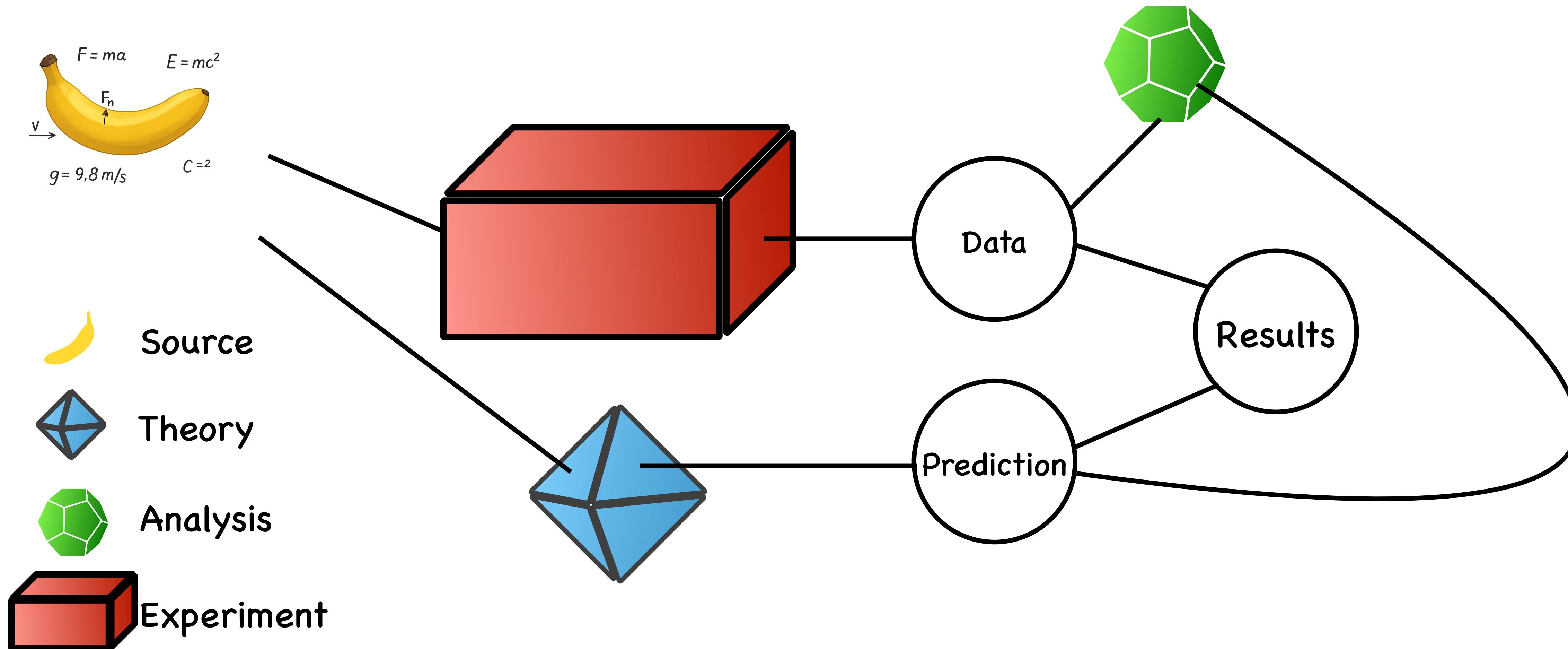
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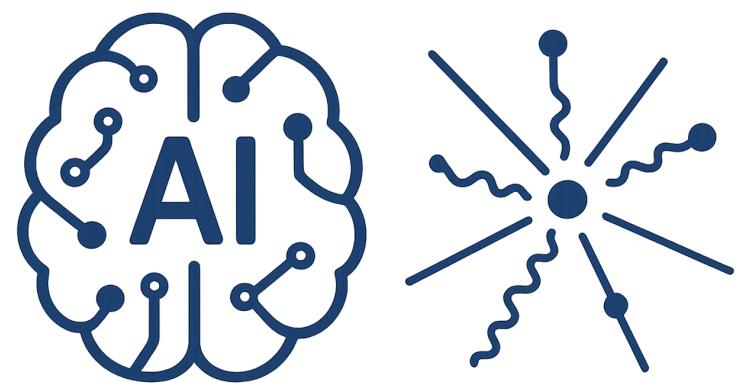




# AI-Driven HEP 1

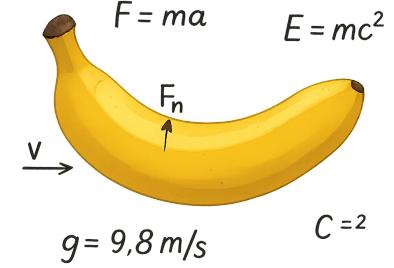
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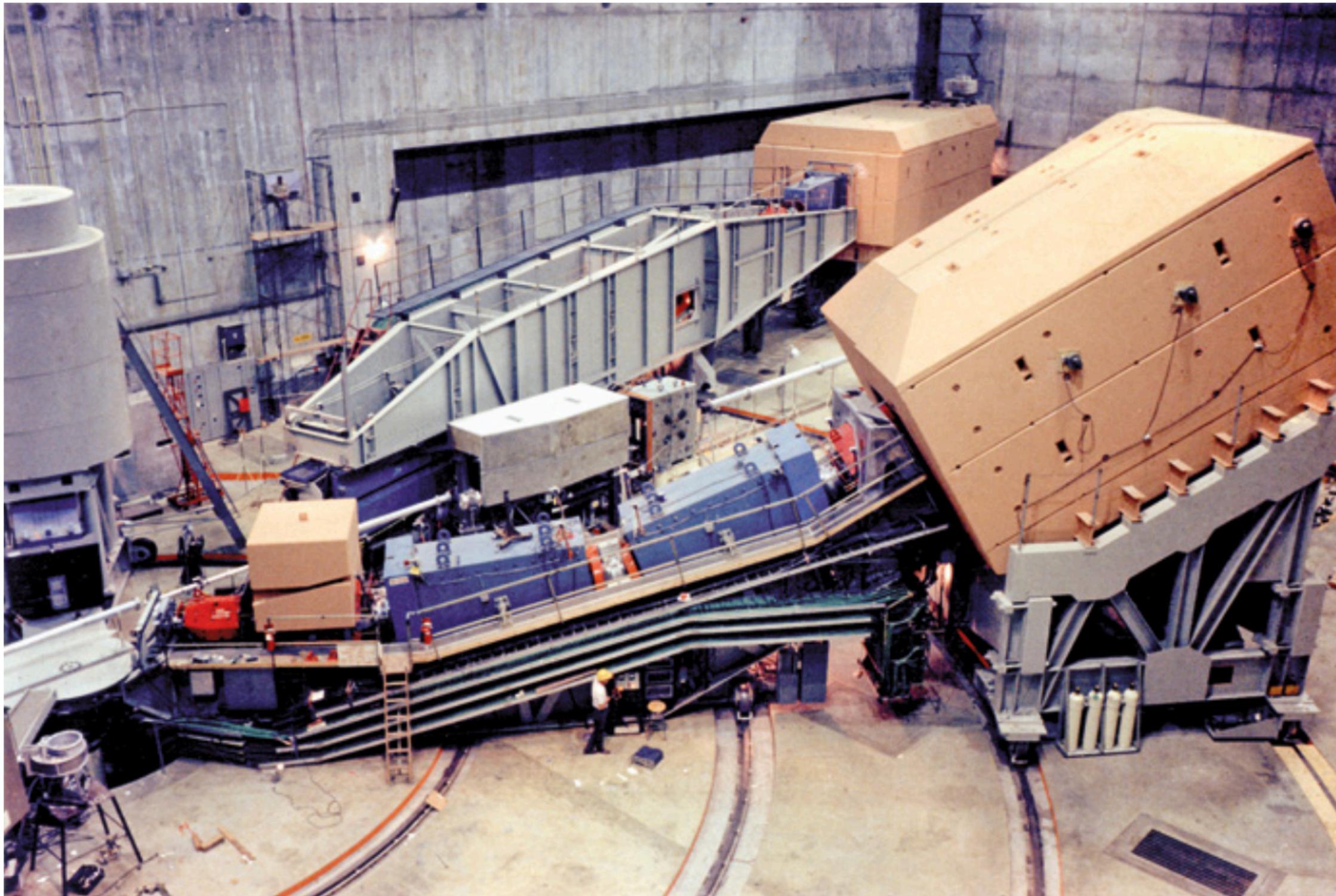


# AI-Driven HEP 1

## Classic Example



SLAC-MIT DIS



### HIGH-ENERGY INELASTIC $e$ - $p$ SCATTERING AT 6° AND 10° \*

E. D. Bloom, D. H. Coward, H. DeStaeler, J. Drees, G. Miller, L. W. Mo, and R. E. Taylor

Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305

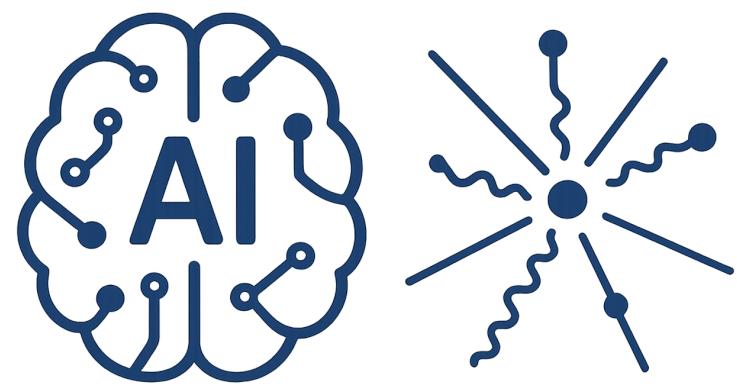
and

M. Breidenbach, J. I. Friedman, G. C. Hartmann, † and H. W. Kendall

Department of Physics and Laboratory for Nuclear Science,‡

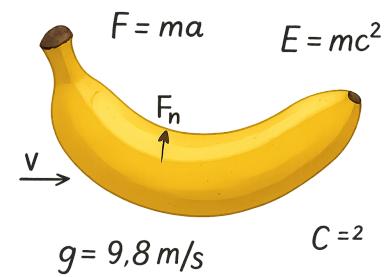
Massachusetts Institute of Technology, Cambridge, Massachusetts 02139

(Received 19 August 1969)



# AI-Driven HEP 1

## Classic Example

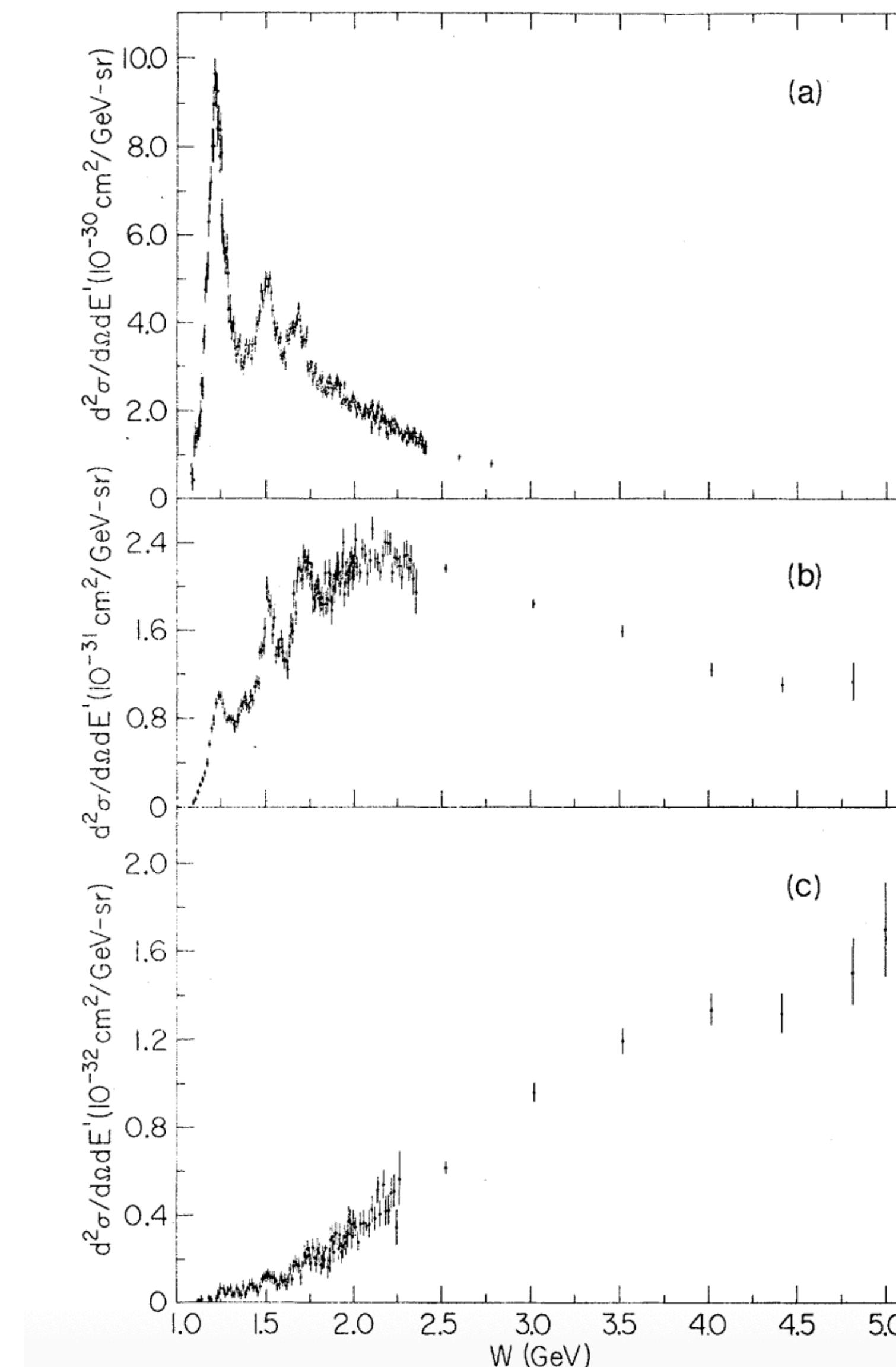


Pre-Process

Readout

Trigger

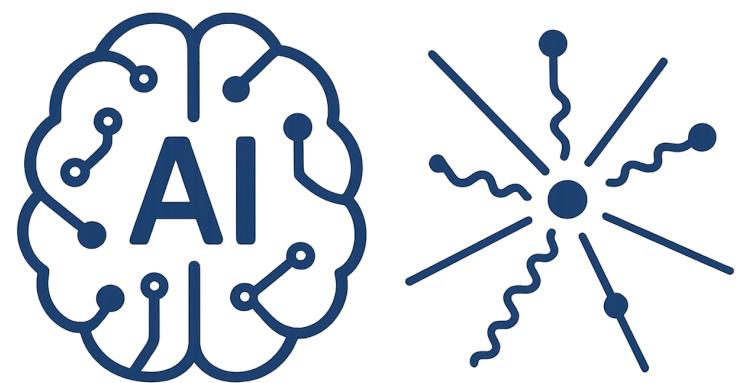
Veto



Post-Process

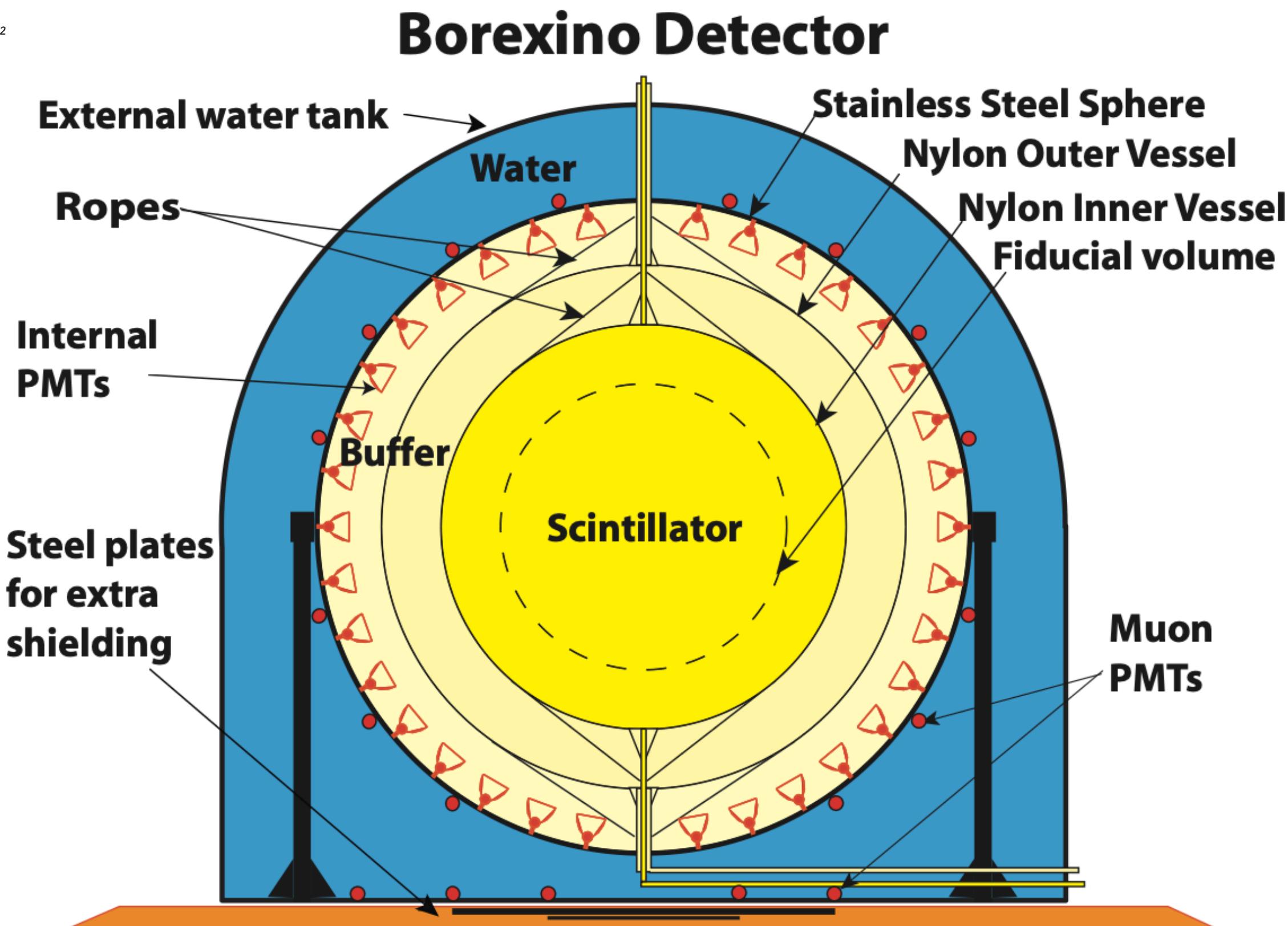
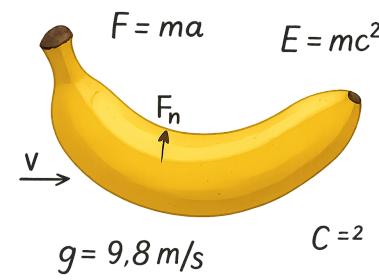
Parameter Estimation

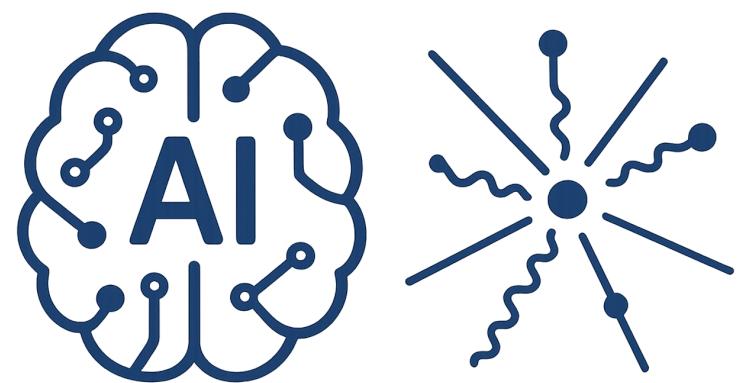
Hypothesis Testing



# AI-Driven HEP 1

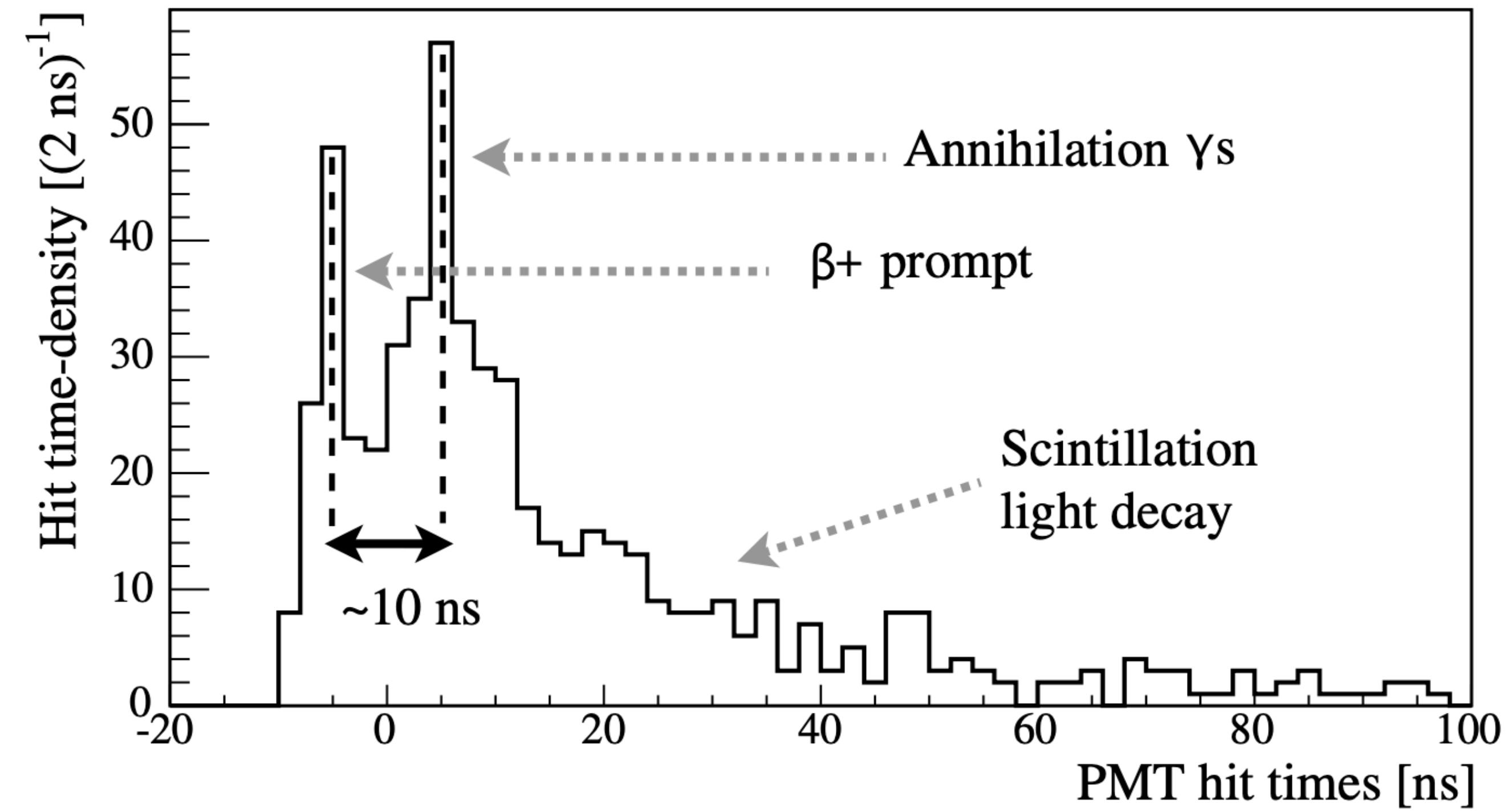
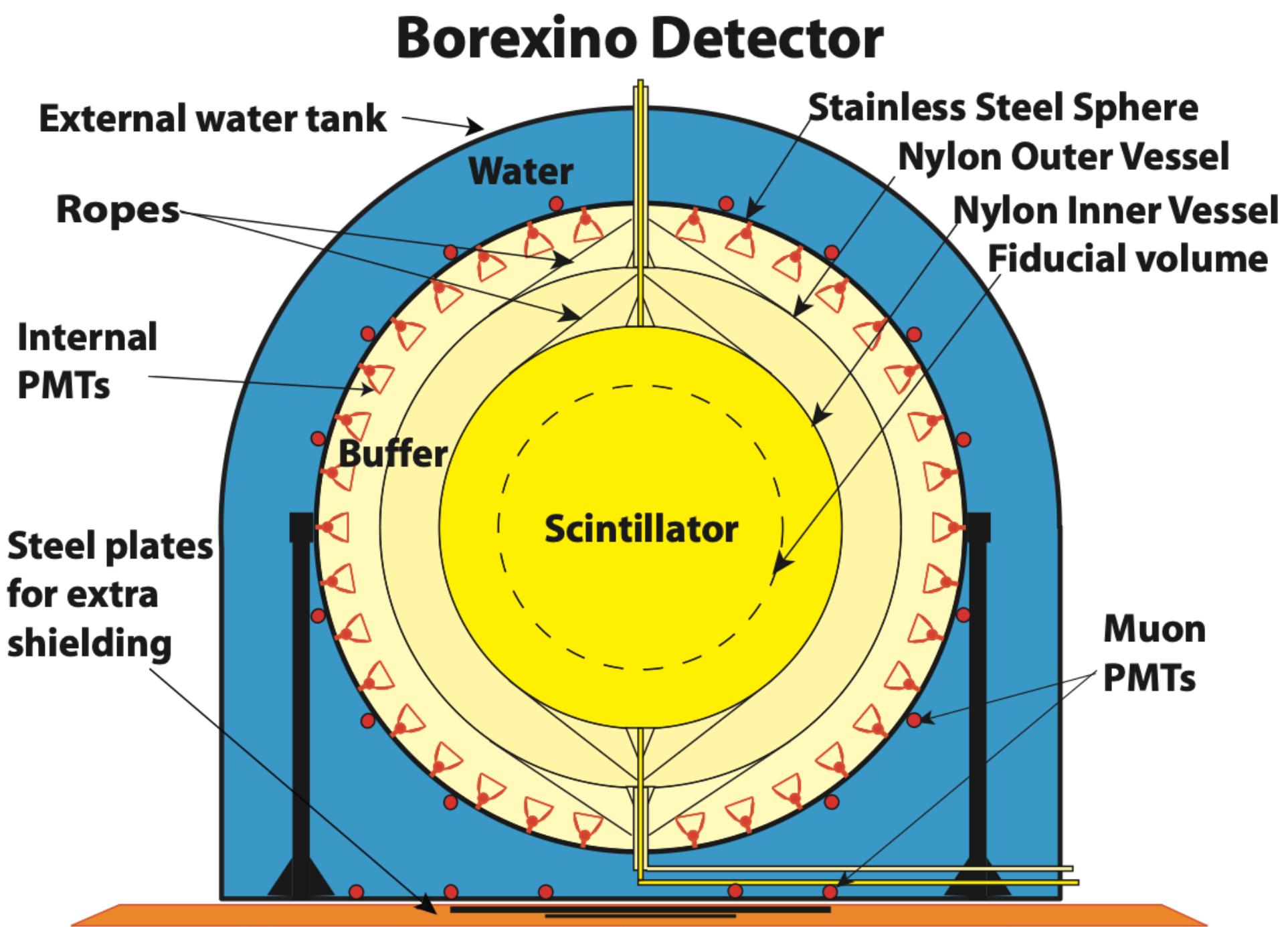
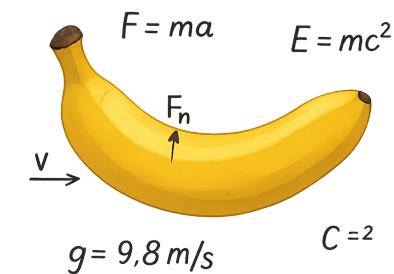
## Modern Example

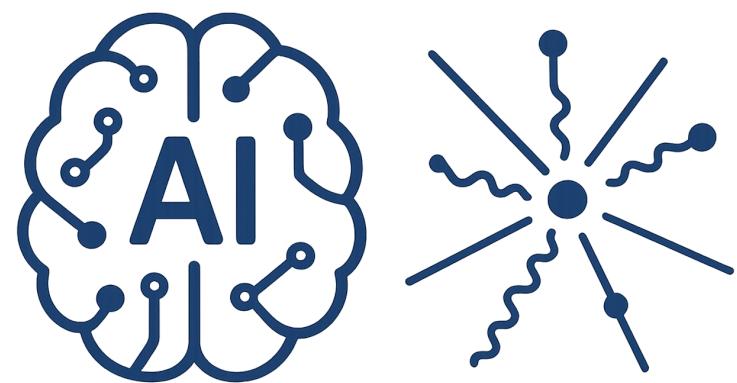




# AI-Driven HEP 1

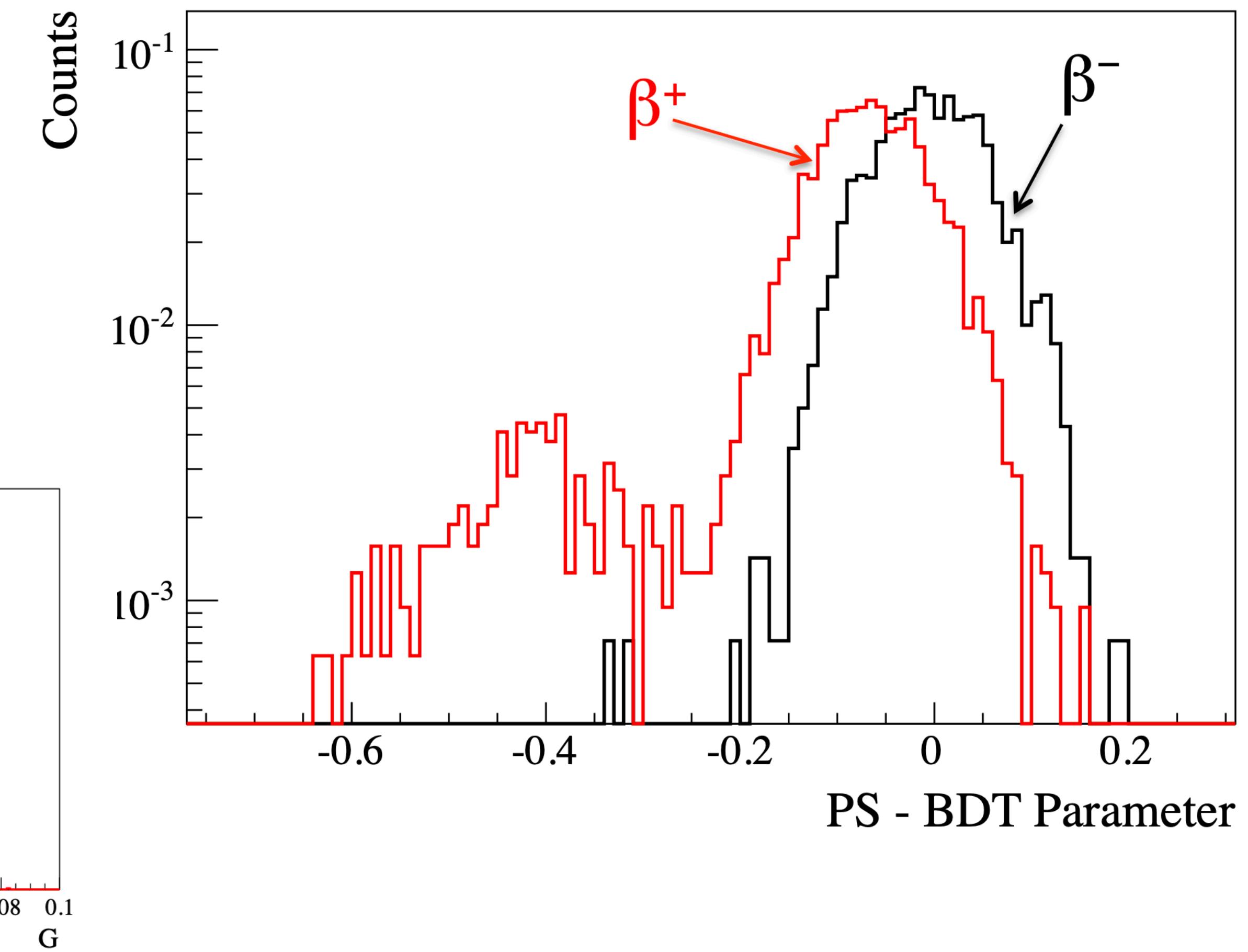
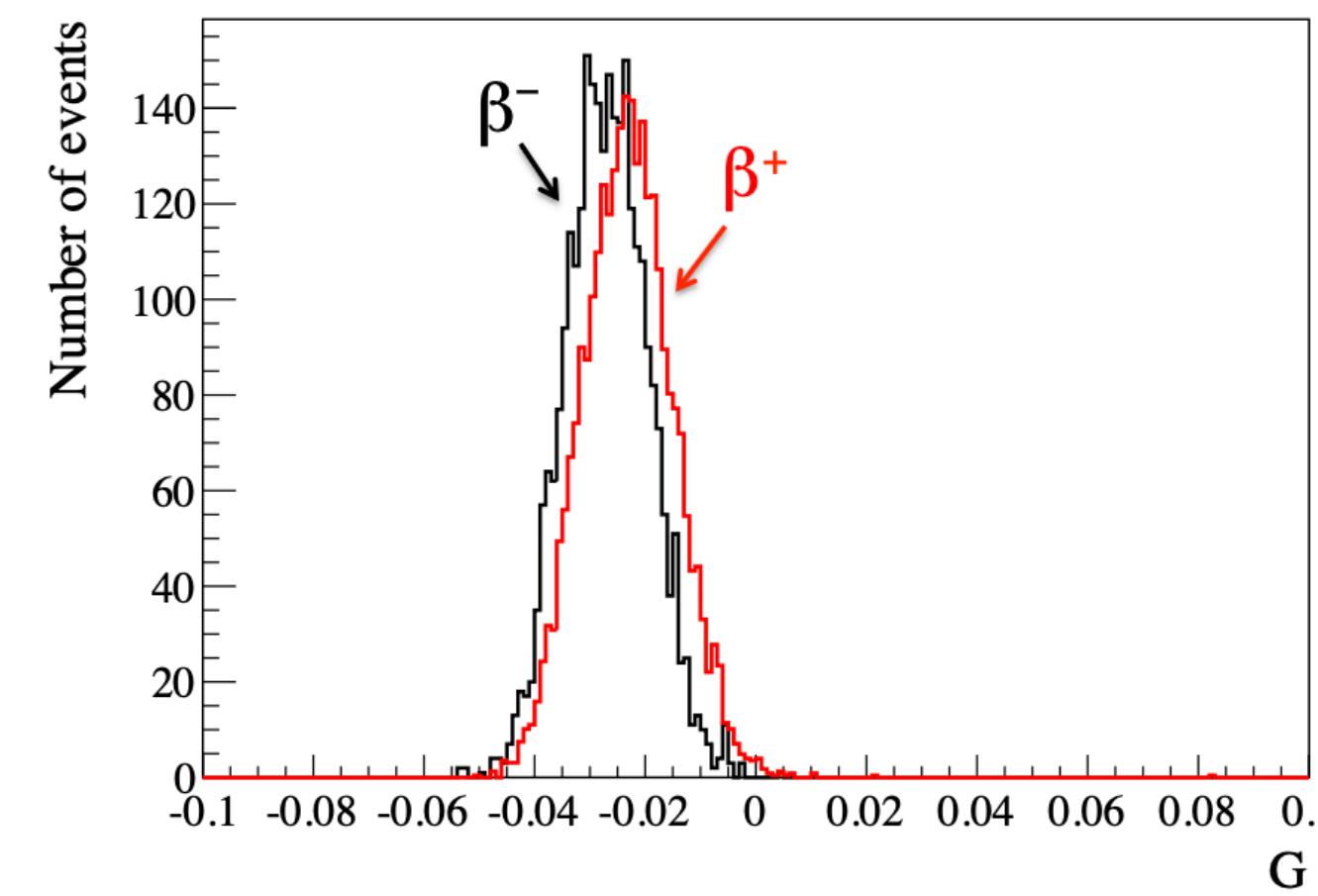
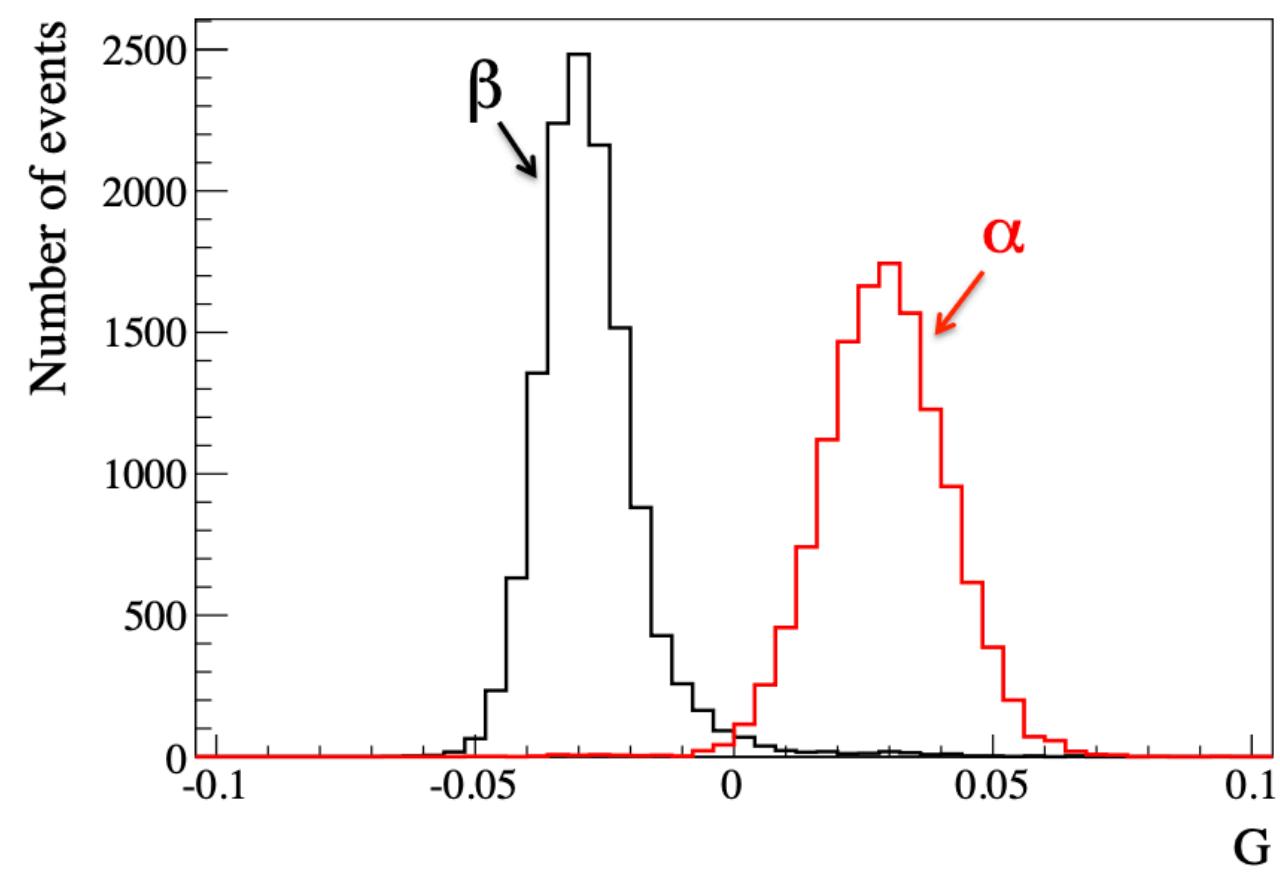
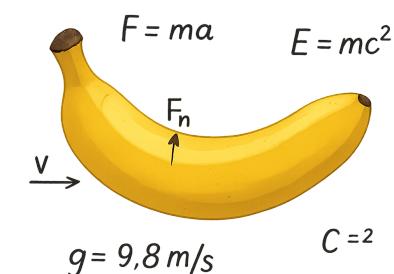
## Modern Example

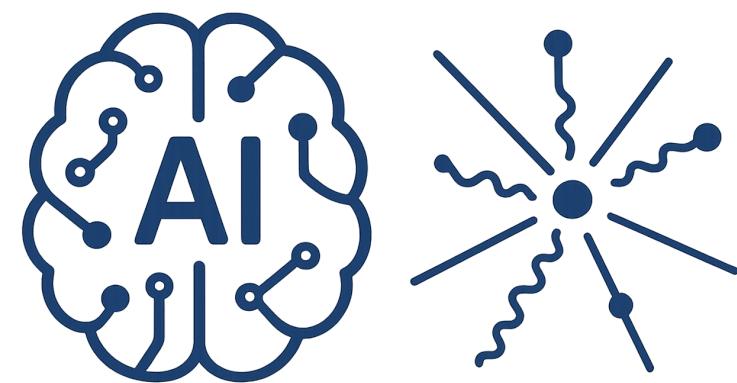




# AI-Driven HEP 1

## Modern Example





# AI-Driven HEP 1

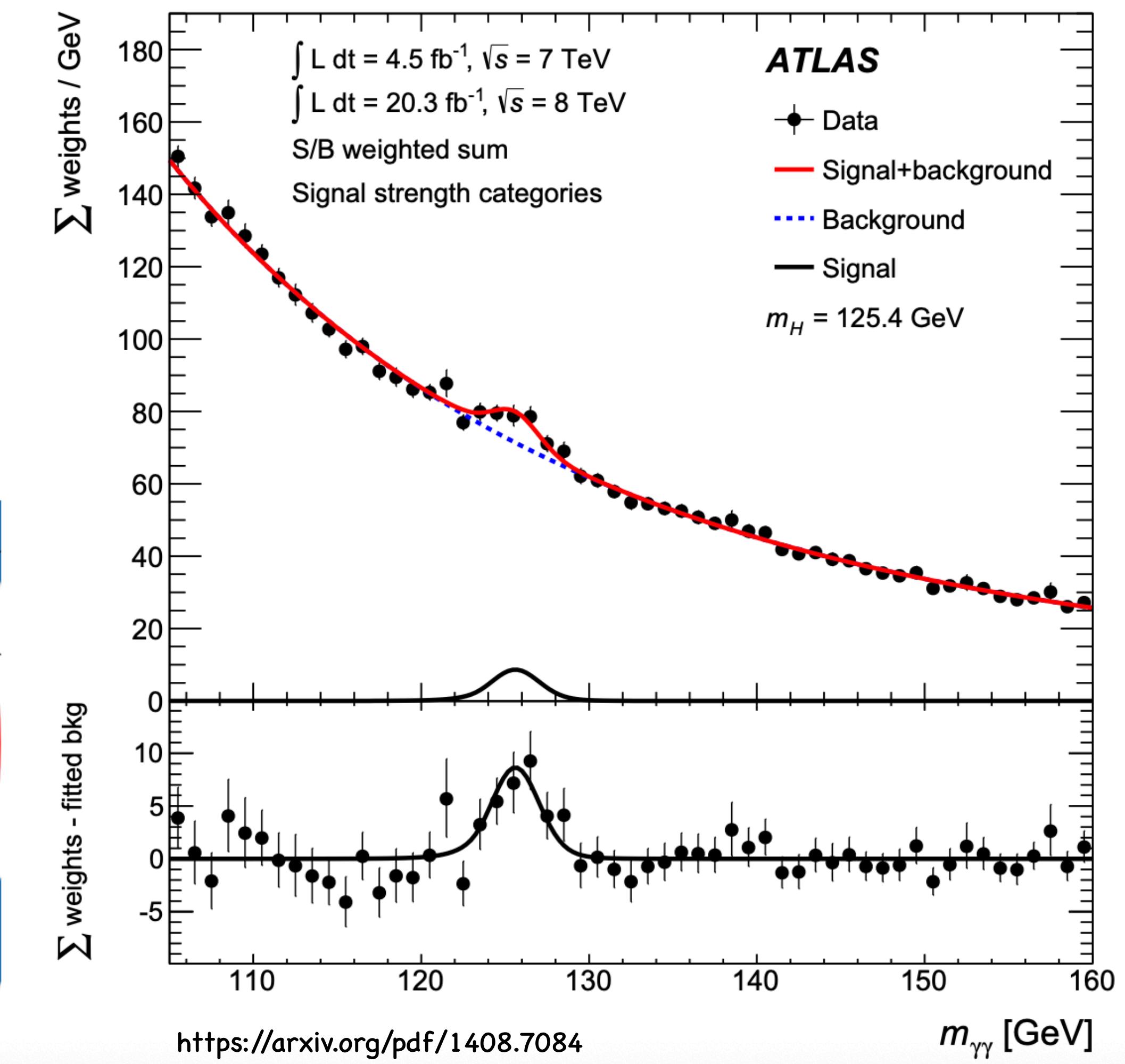
## Summary of Traditional Experiment Pipeline

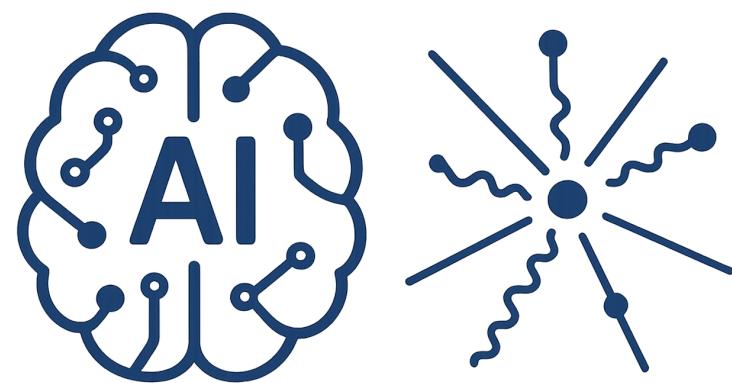
100 million sensor

100 billion collisions

1 sensitive observable

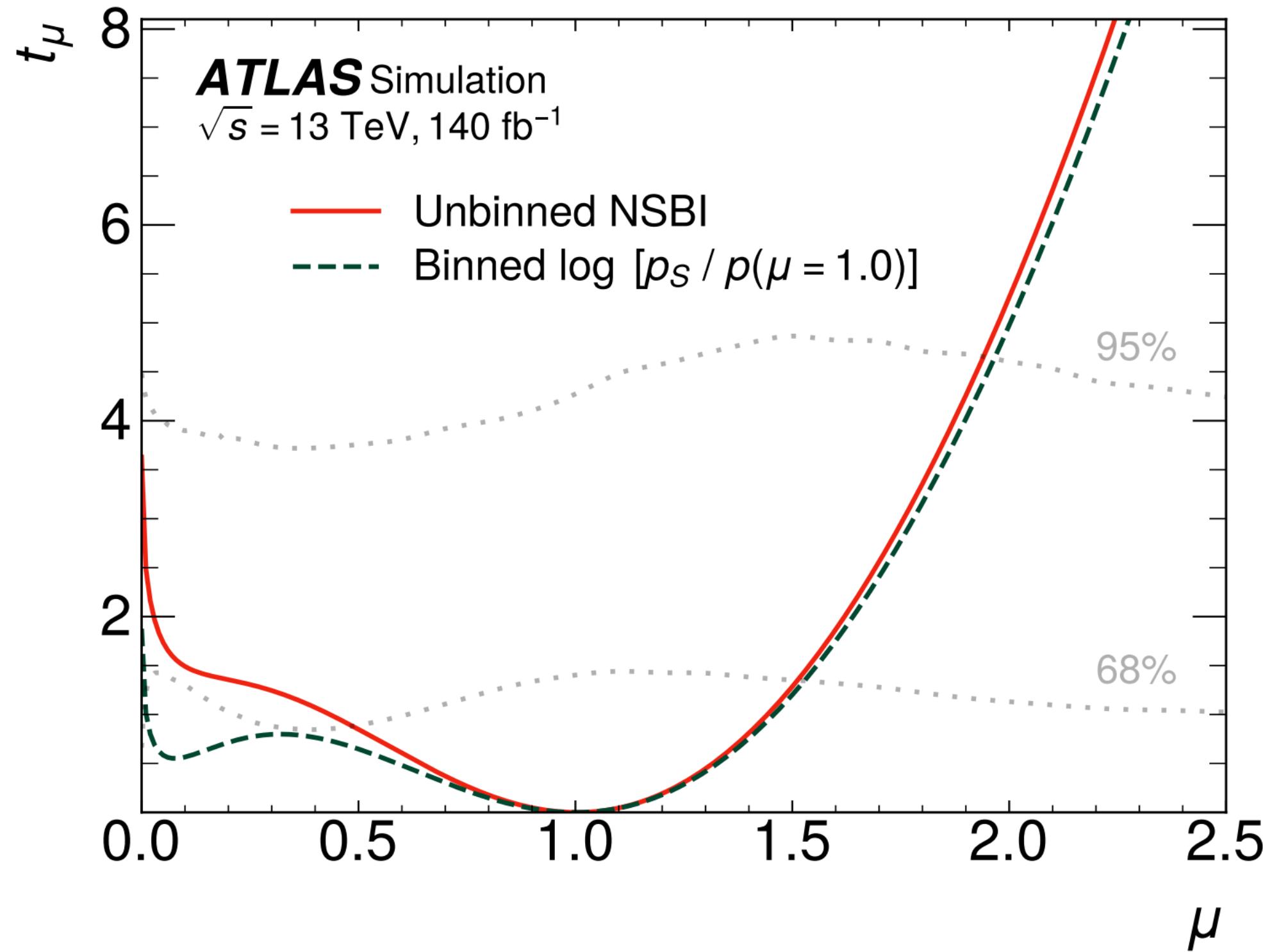
Reconstruction from raw data  
collected by sensor to a  
sensitive variable



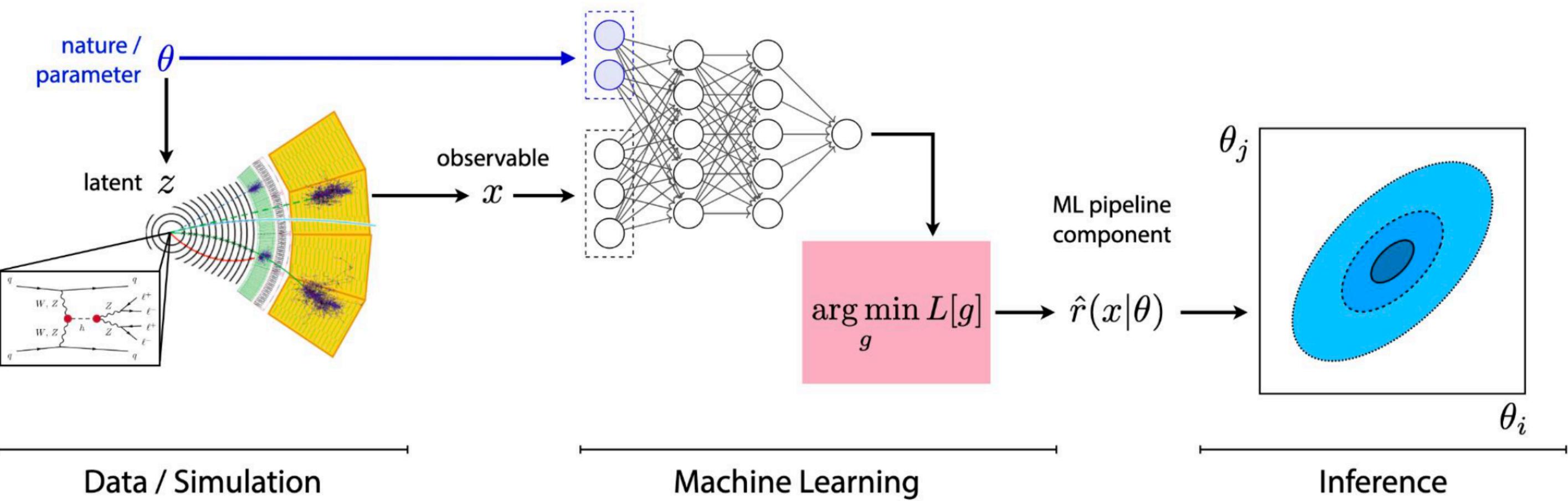


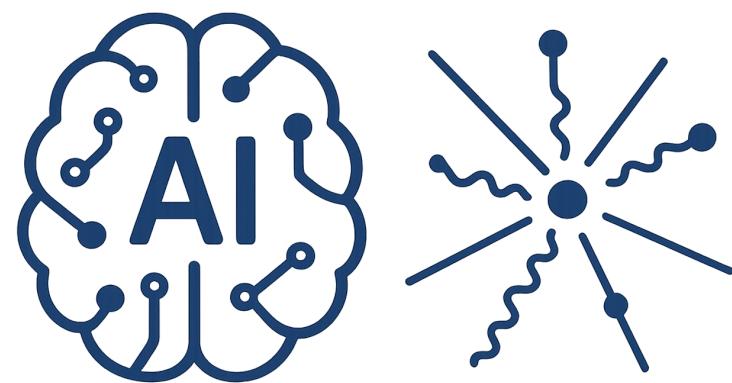
# AI-Driven HEP 1

## Bridging Technology of SBI



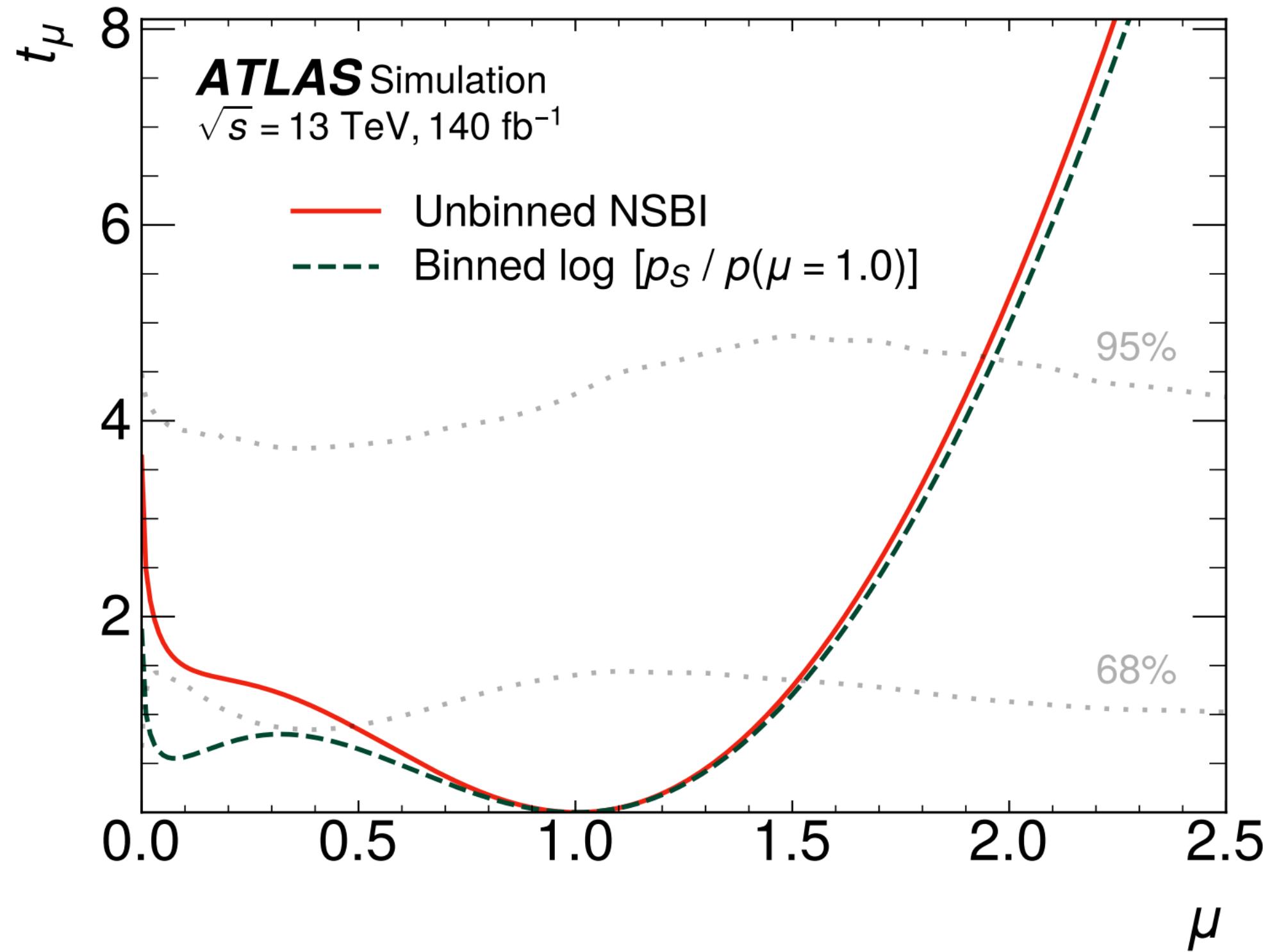
<https://arxiv.org/pdf/2412.01600>



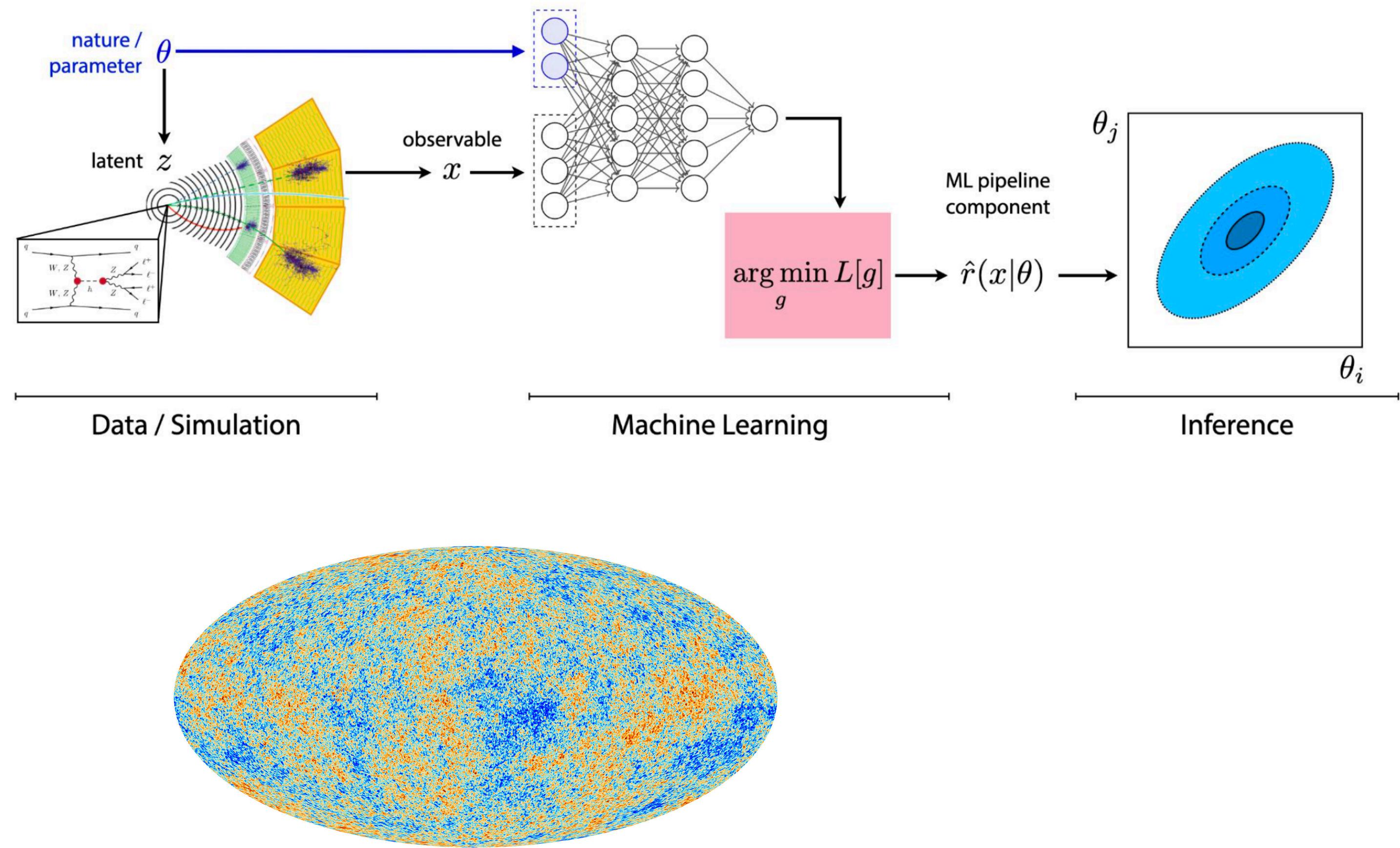


# AI-Driven HEP 1

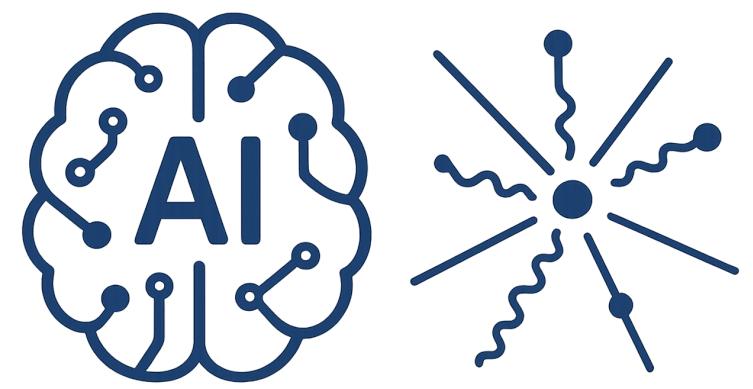
## Bridging Technology of SBI



<https://arxiv.org/pdf/2412.01600>

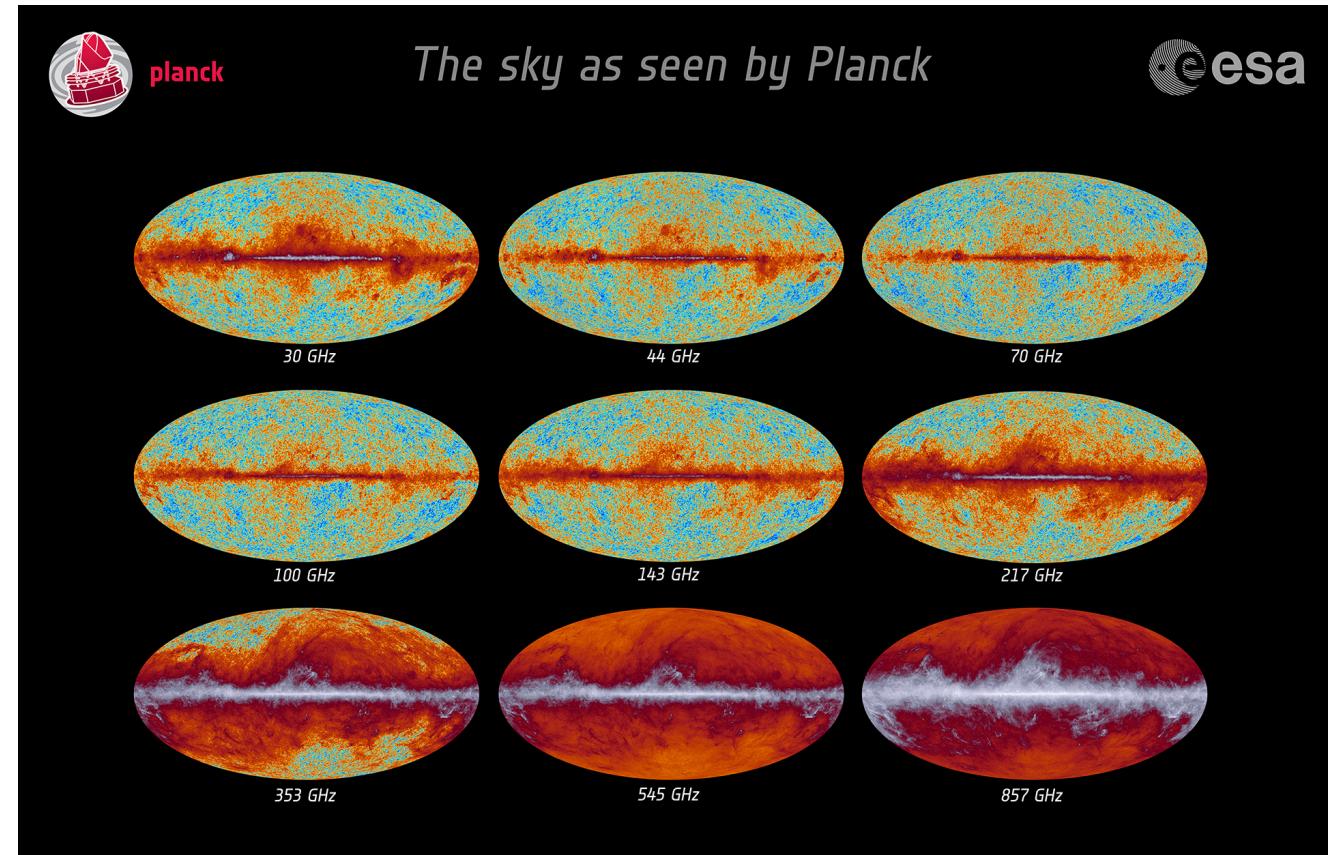
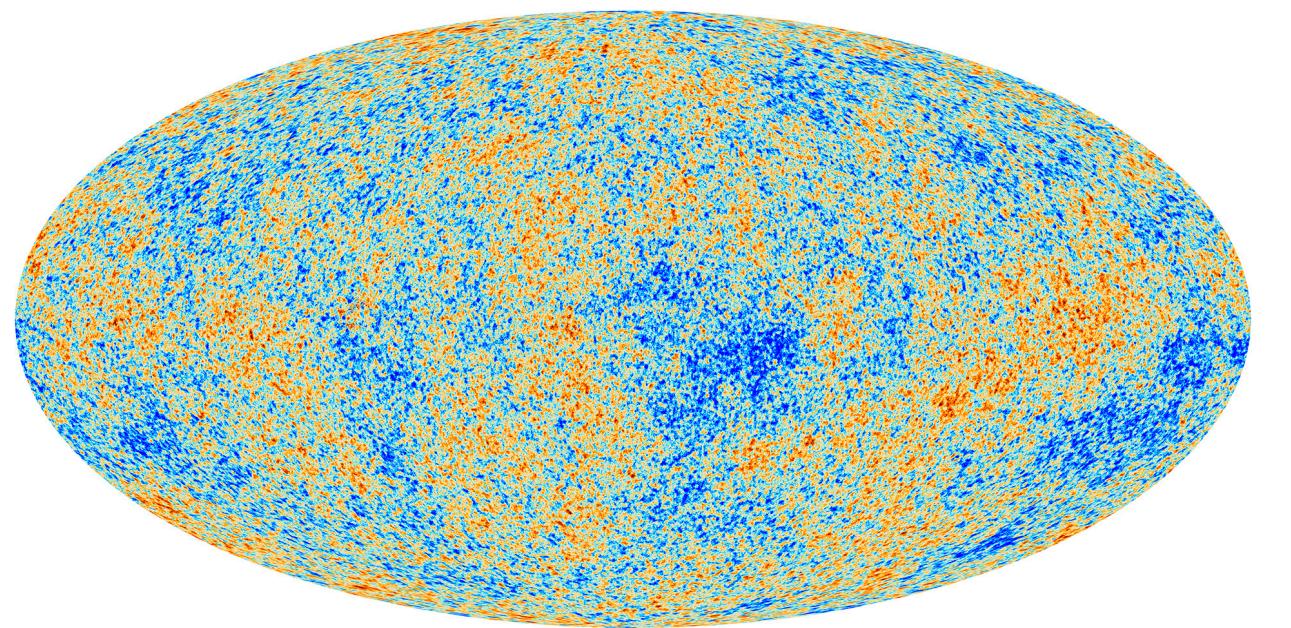


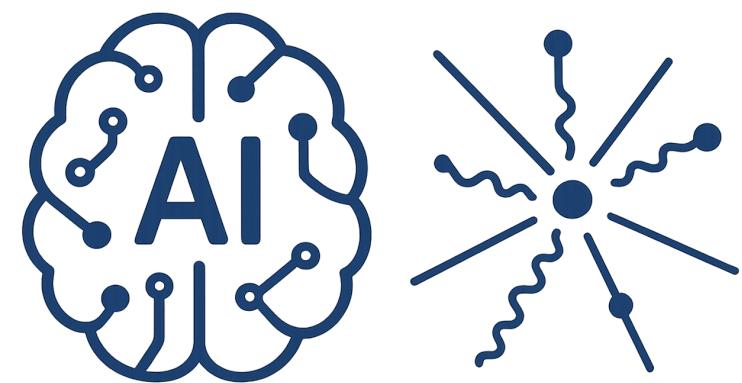
$$< \frac{\delta T}{T}(\theta) \frac{\delta T}{T}(\theta') >$$



## AI-Driven HEP 1

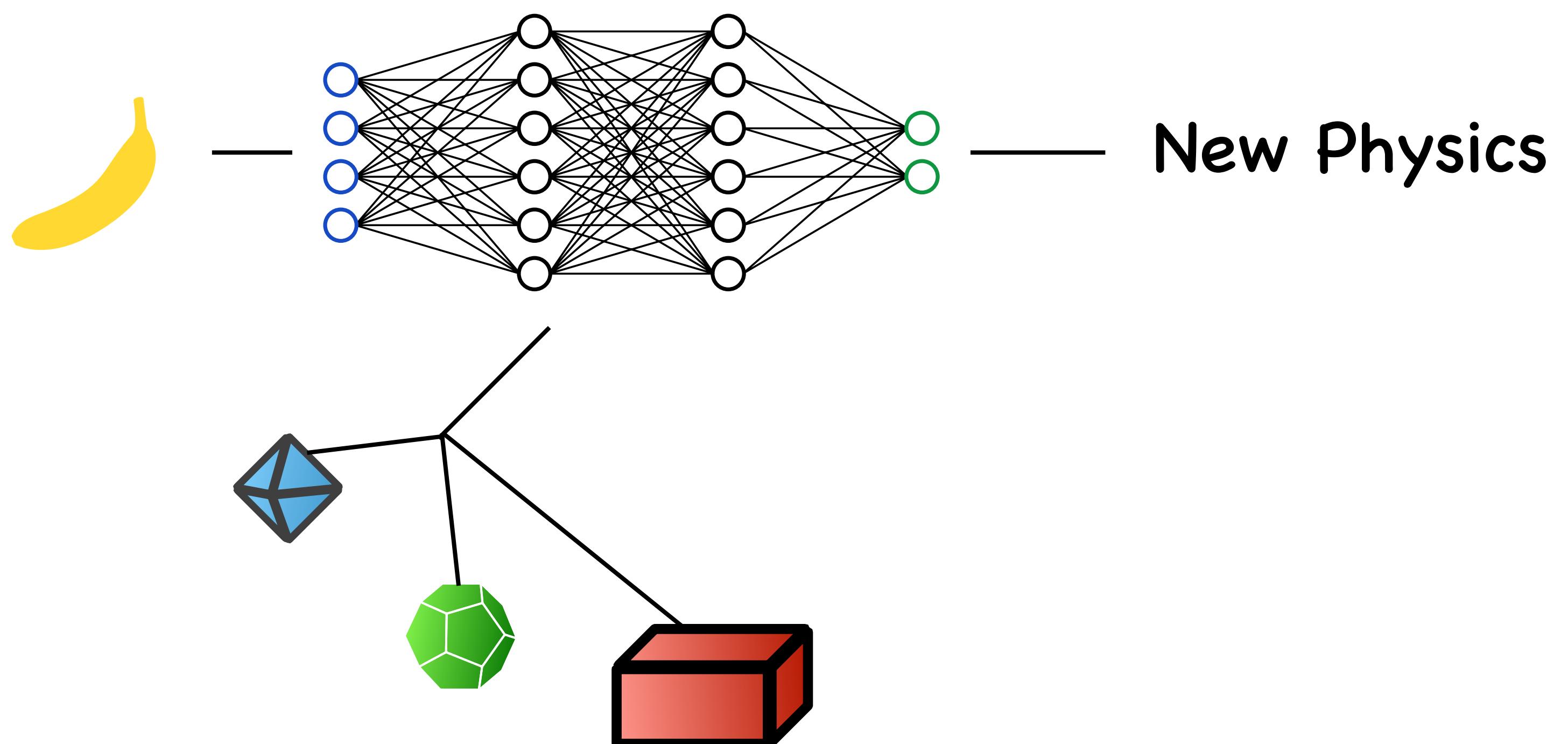
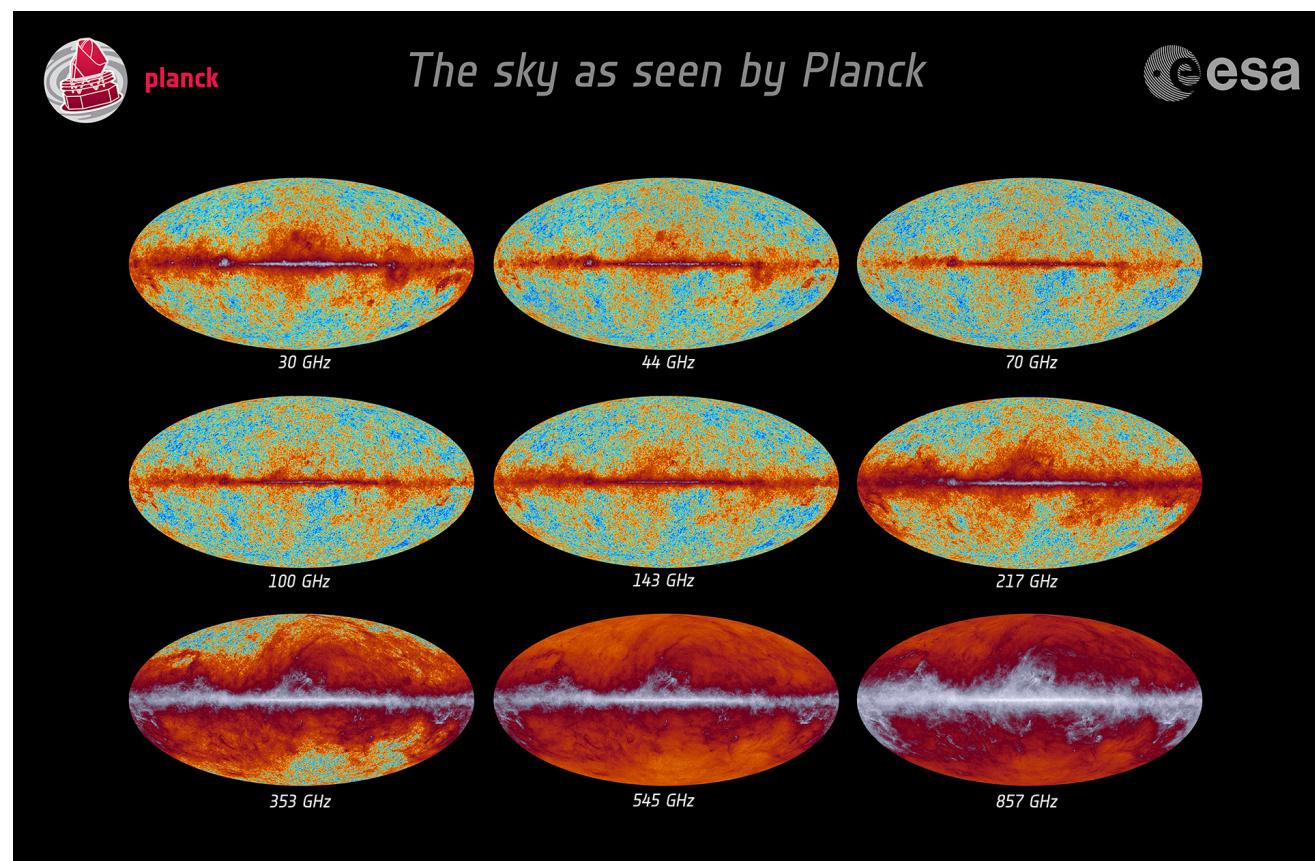
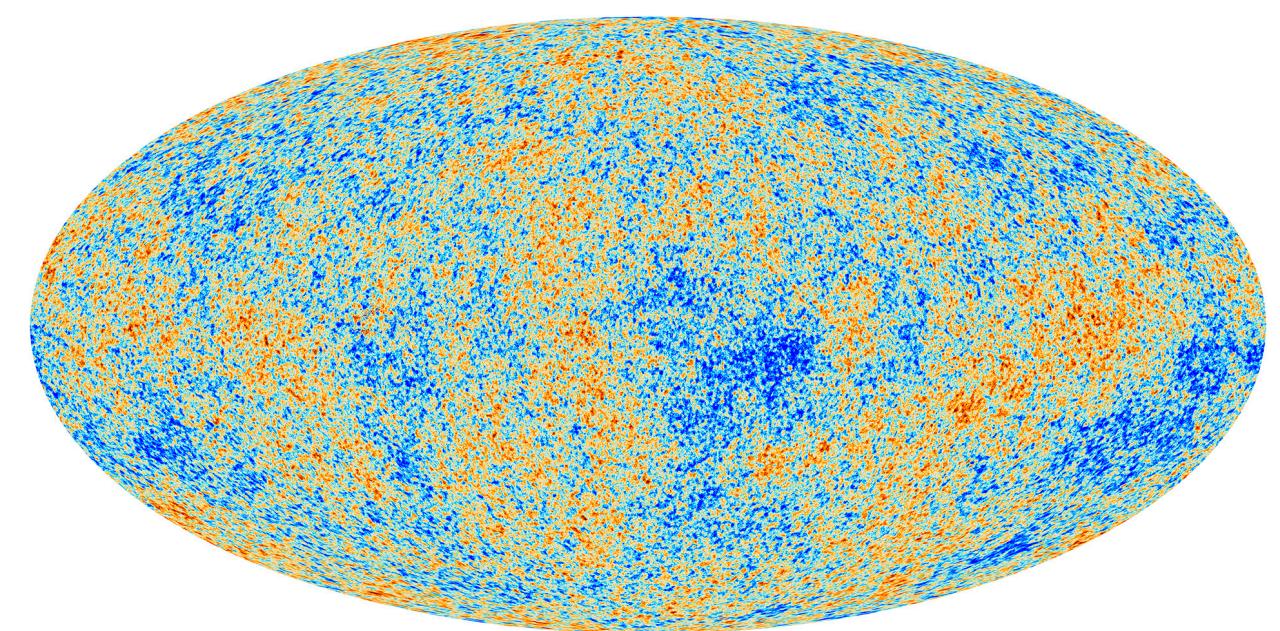
What if we reach to the Physics directly from raw Data

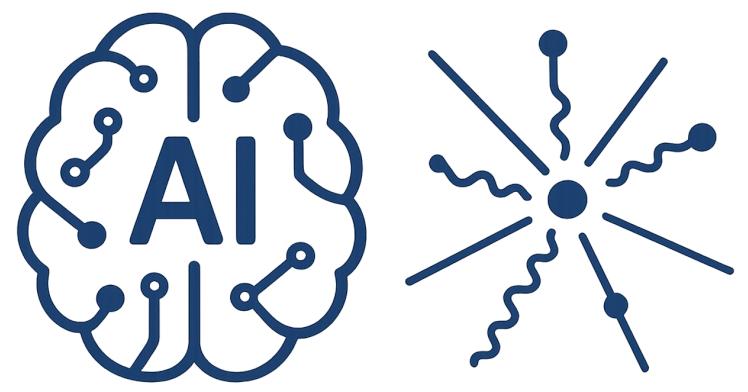




## AI-Driven HEP 1

What if we reach to the Physics directly from raw Data





## AI-Driven HEP 1

Welcome to the new era of  
AI-Driven HEP