Probing new physics at the LHC: searches for heavy top-like quarks with the ATLAS experiment

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Four questions, one dissertation

- **Why?** bother with "new physics"

Four questions, one dissertation

- **Why?** bother with "new physics"
- **Where?** is all happening

Four questions, one dissertation

- **Why?** bother with "new physics"
- **Where?** is all happening
- **What?** are we looking at

Four questions, one dissertation

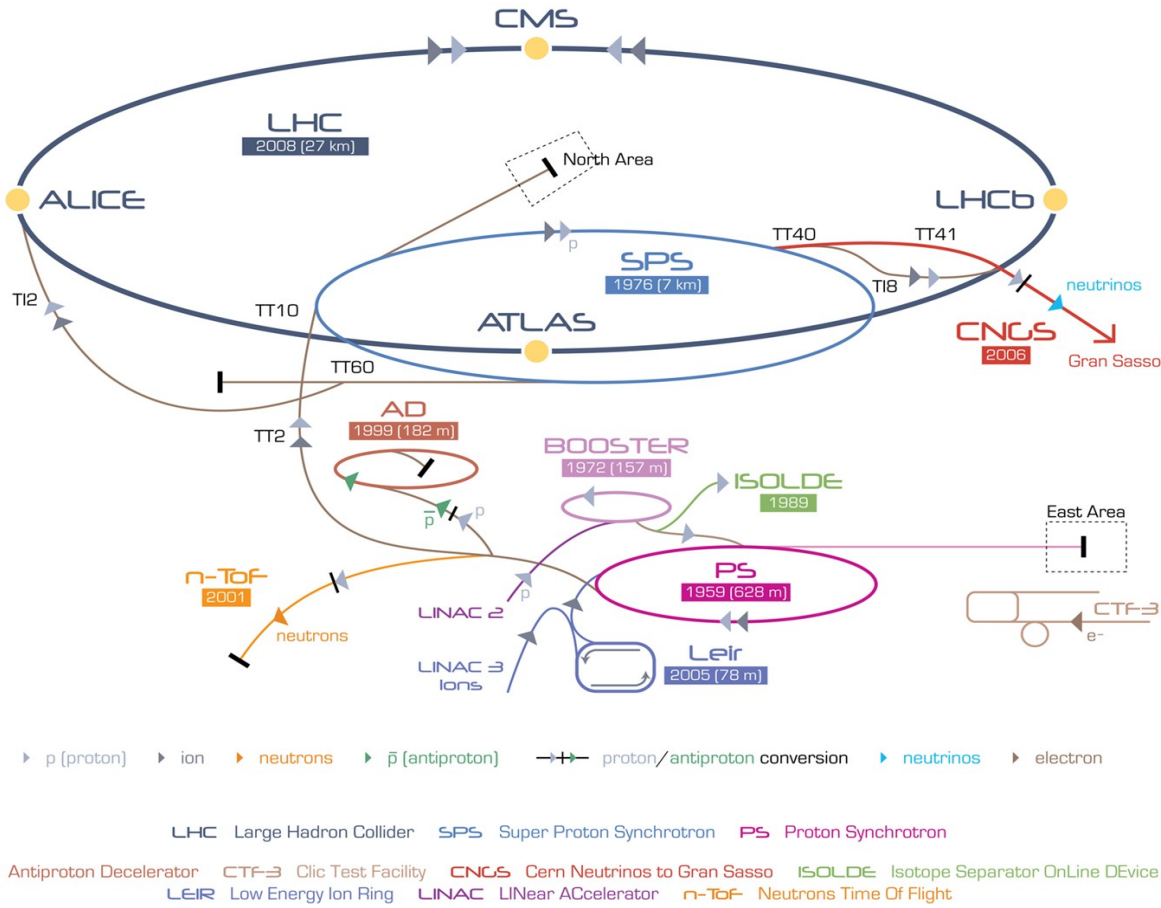
- **Why?** bother with "new physics"
- **Where?** is all happening
- **What?** are we looking at
- **How?**

Outline

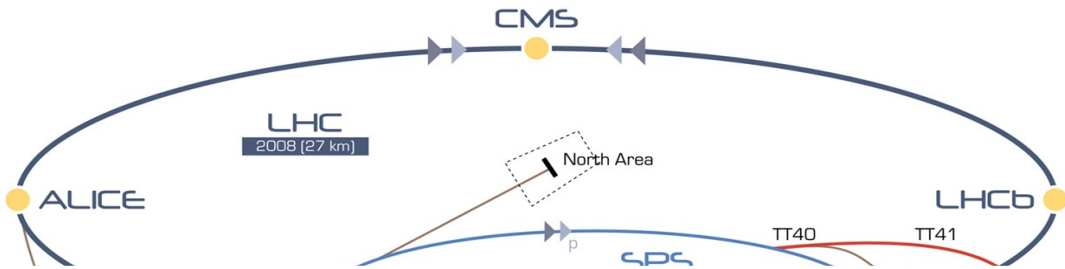
Standard Model as an effective theory

Outline

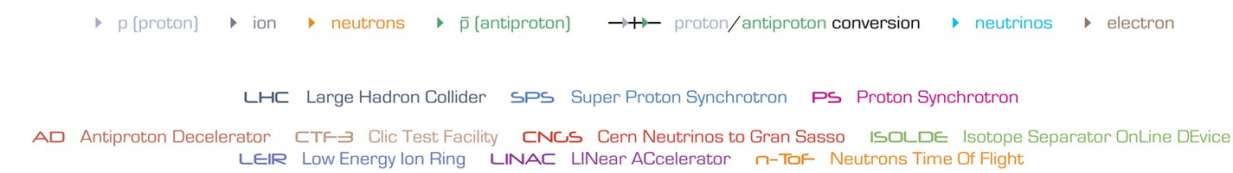
The LHC complex



The LHC complex



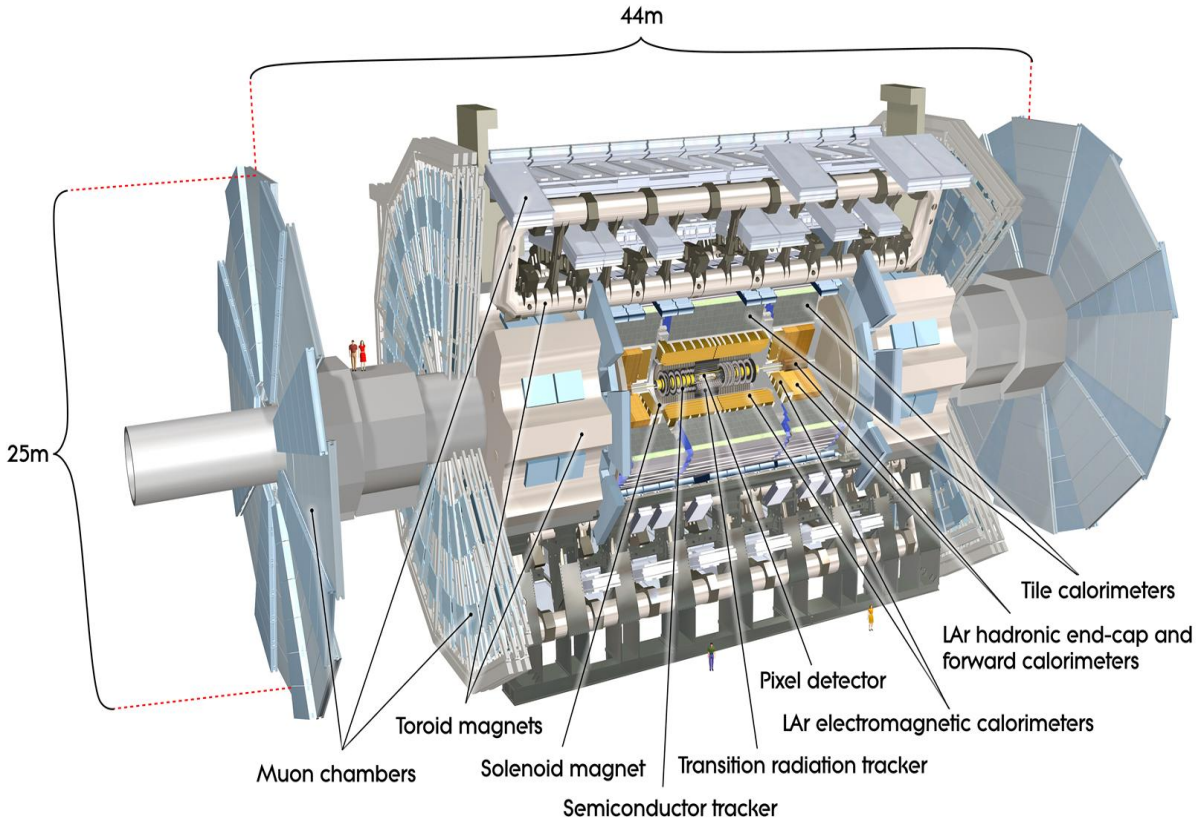
Parameter	designed	2012
Beam energy (TeV/c)	7	4
Beta function $\beta*$ (m)	0.55	0.6
Max. No. bunches/beam	2808	1380
Max. No. protons/bunch	1.15×10^{11}	1.7×10^{11}
Bunch spacing (ns)	25	50
Peak luminosity ($cm^{-2}s^{-1}$)	1×10^{34}	7.7×10^{33}
Emittance ε_n (μrad)	3.75	2.5
Max. $< \mu >$	19	37



The ATLAS Detector

A general purpose experiment

- vertex detector and central tracker
- superconducting solenoid
- electromagnetic and hadronic calorimeters
- muon spectrometer
- superconducting toroids
- high hermeticity (full ϕ and $|\eta| < 5$)



The ATLAS Detector

In 2012 21.7fb^{-1} collected at $\sqrt{s} = 8$ TeV!

A general purpose experiment

- vertex detector and central tracker
- superconducting solenoid
- electromagnetic and hadronic calorimeters
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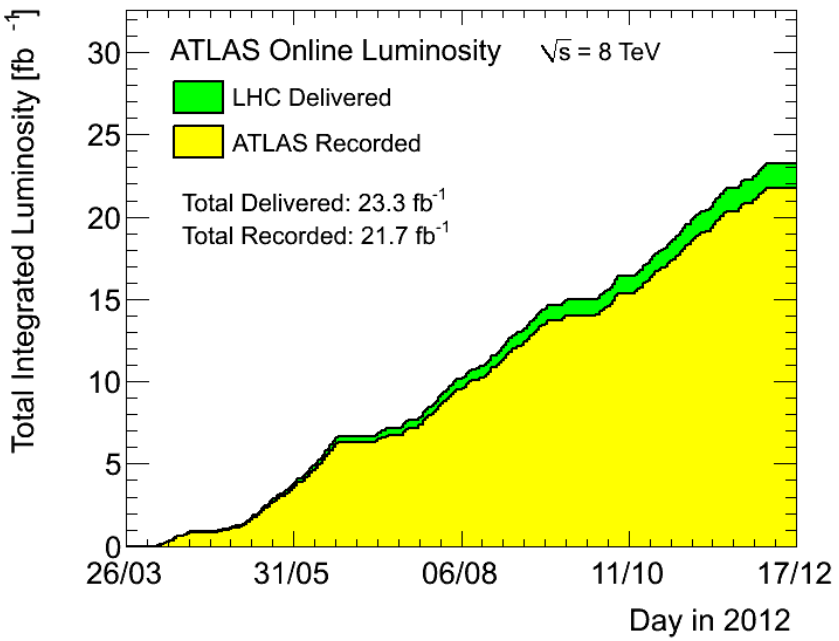
- superconducting toroids
- high hermeticity (full ϕ and $|\eta| < 5$)



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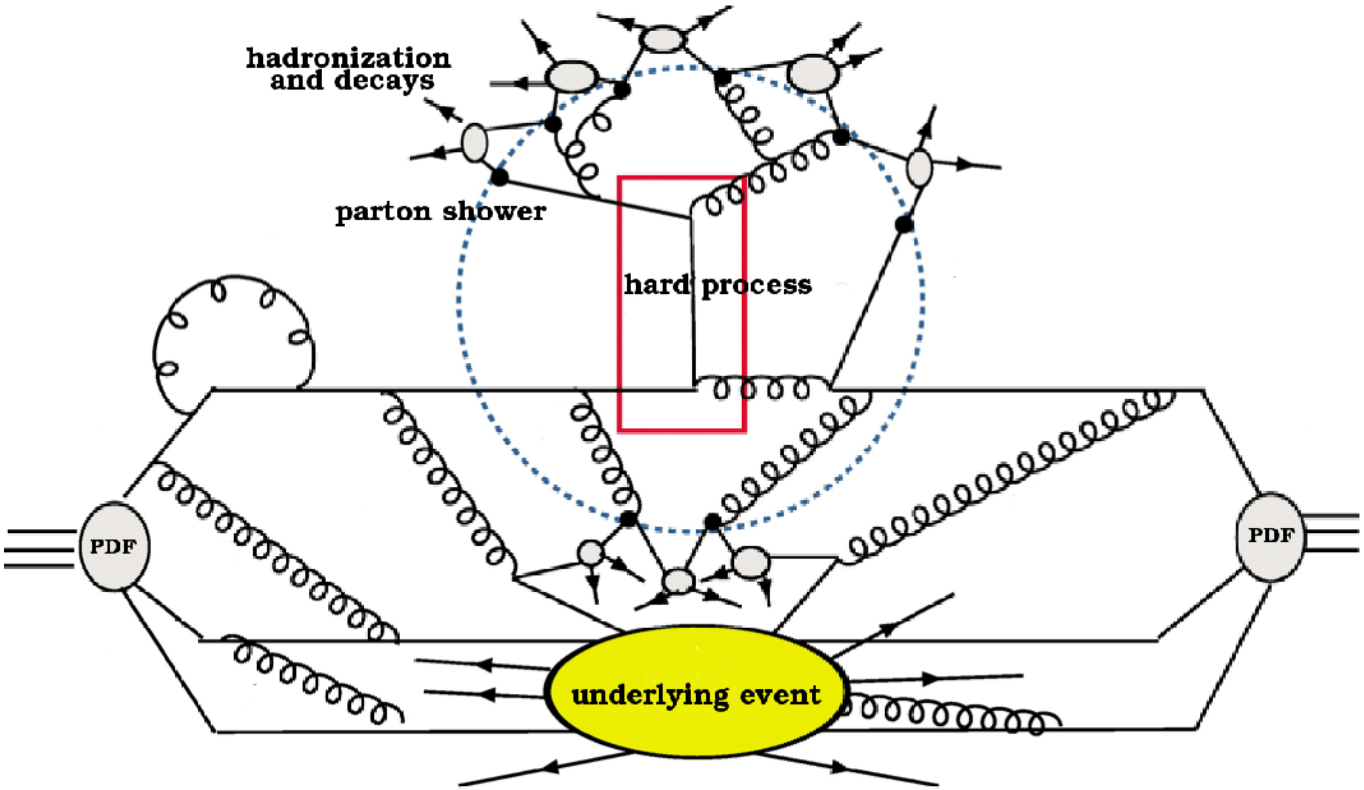
See ATLAS public page

Will present results obtained with 14.3fb^{-1} of 2012 data

Outline

Modelling of hadron collisions

want to do physics at hadron colliders?
need a good understanding of incoming hadrons



Modelling of hadron collisions

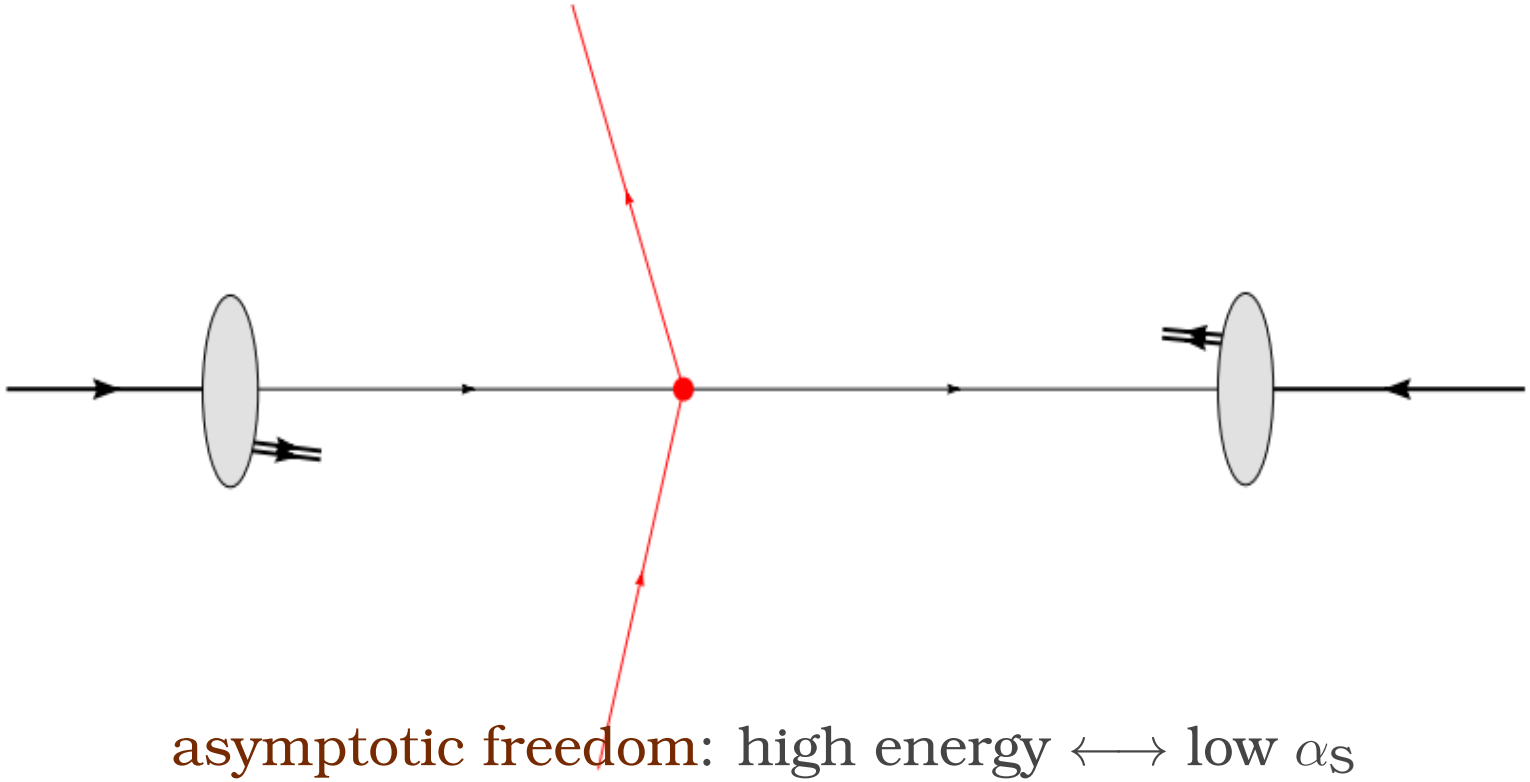
Drawings from [?]

Quarks are distributed according to PDFs inside the proton

$\Downarrow$

intial energy unknown

Hard scattering of two partons

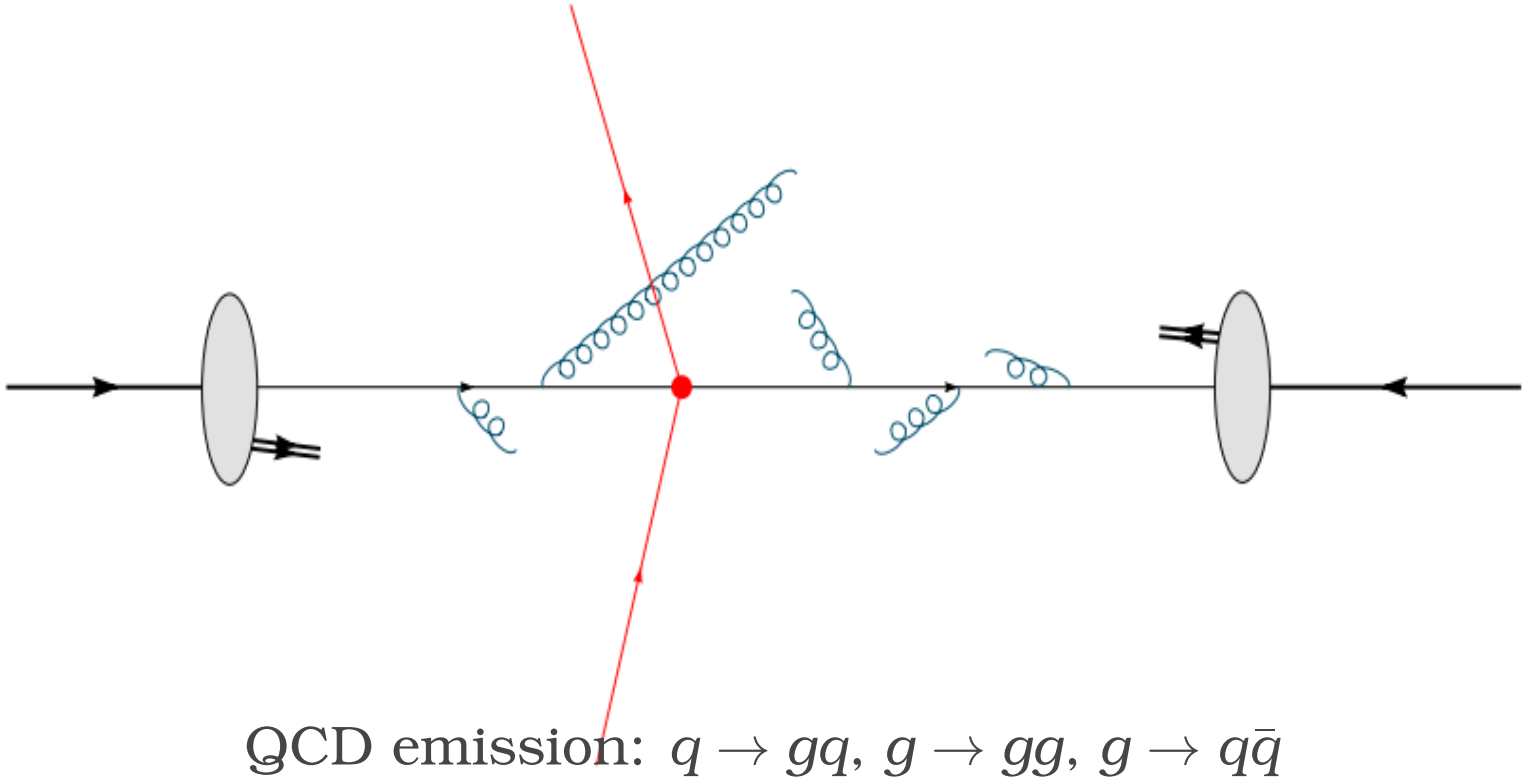


asymptotic freedom: high energy $\longleftrightarrow$ low α_S

$\Downarrow$

(fixed order) pQCD

Parton showering

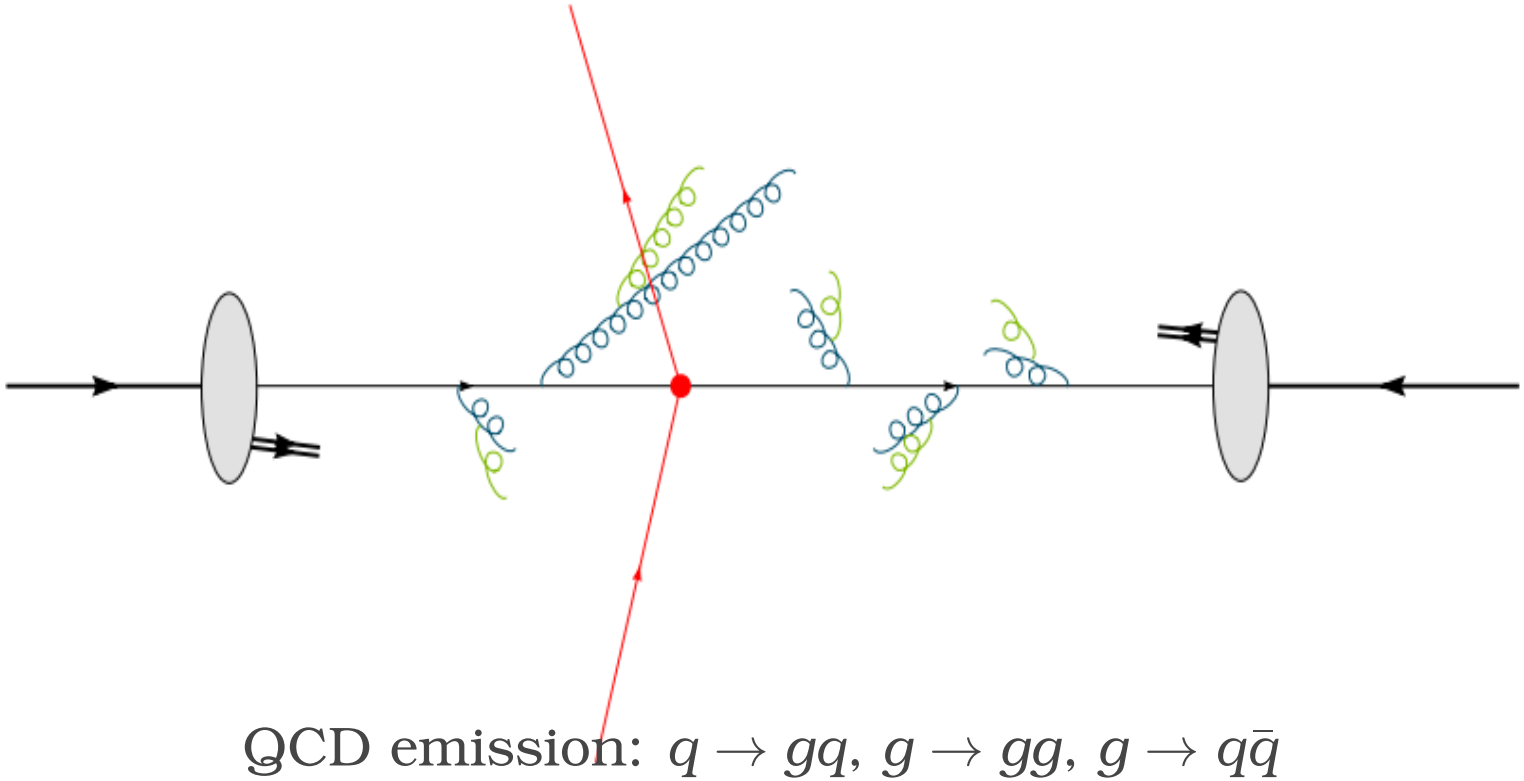


QCD emission: $q \to gq$, $g \to gg$, $g \to q\bar{q}$

$\Downarrow$

higher-order corrections

Parton showering



QCD emission: $q \to gq$, $g \to gg$, $g \to q\bar{q}$

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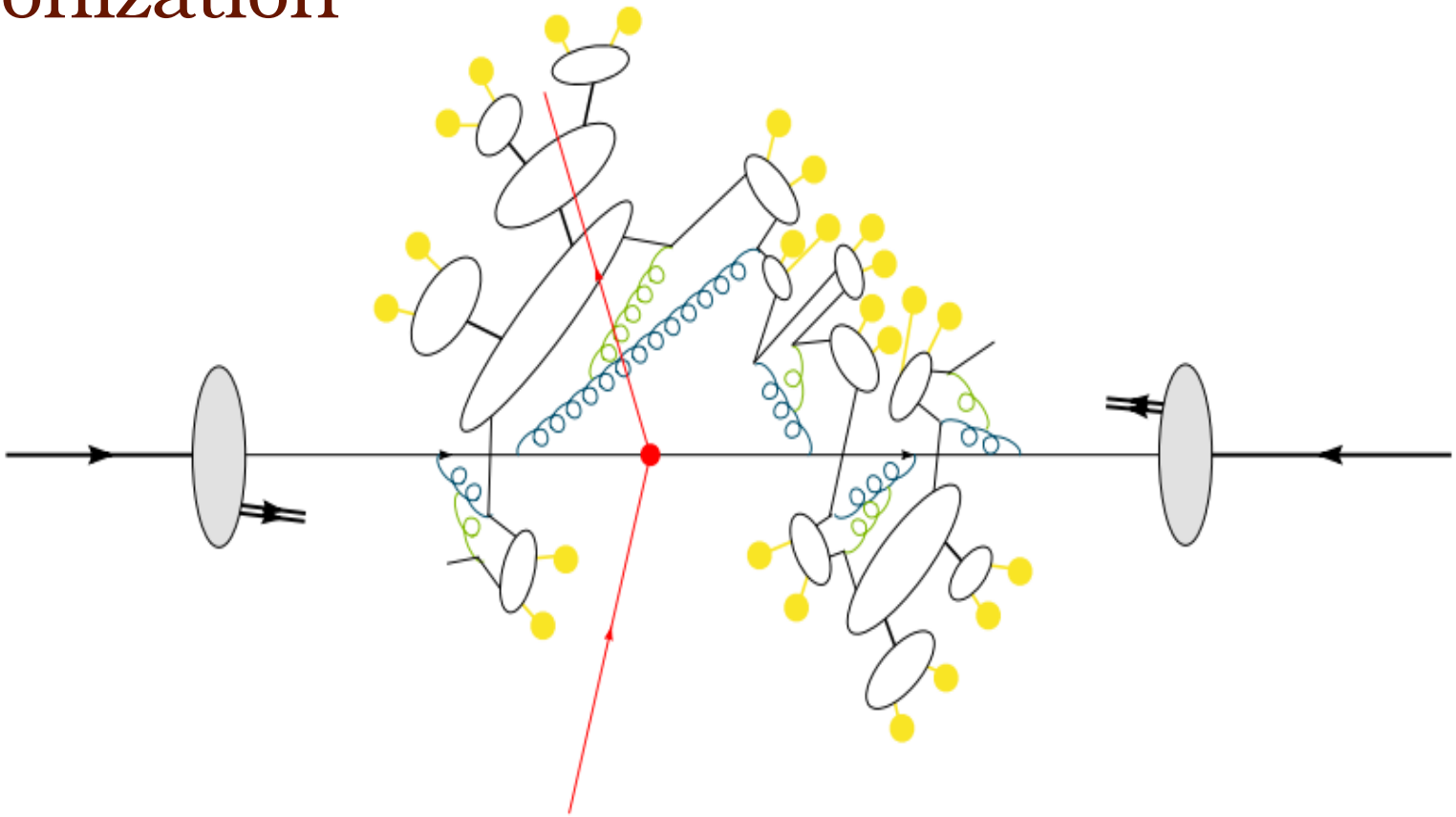
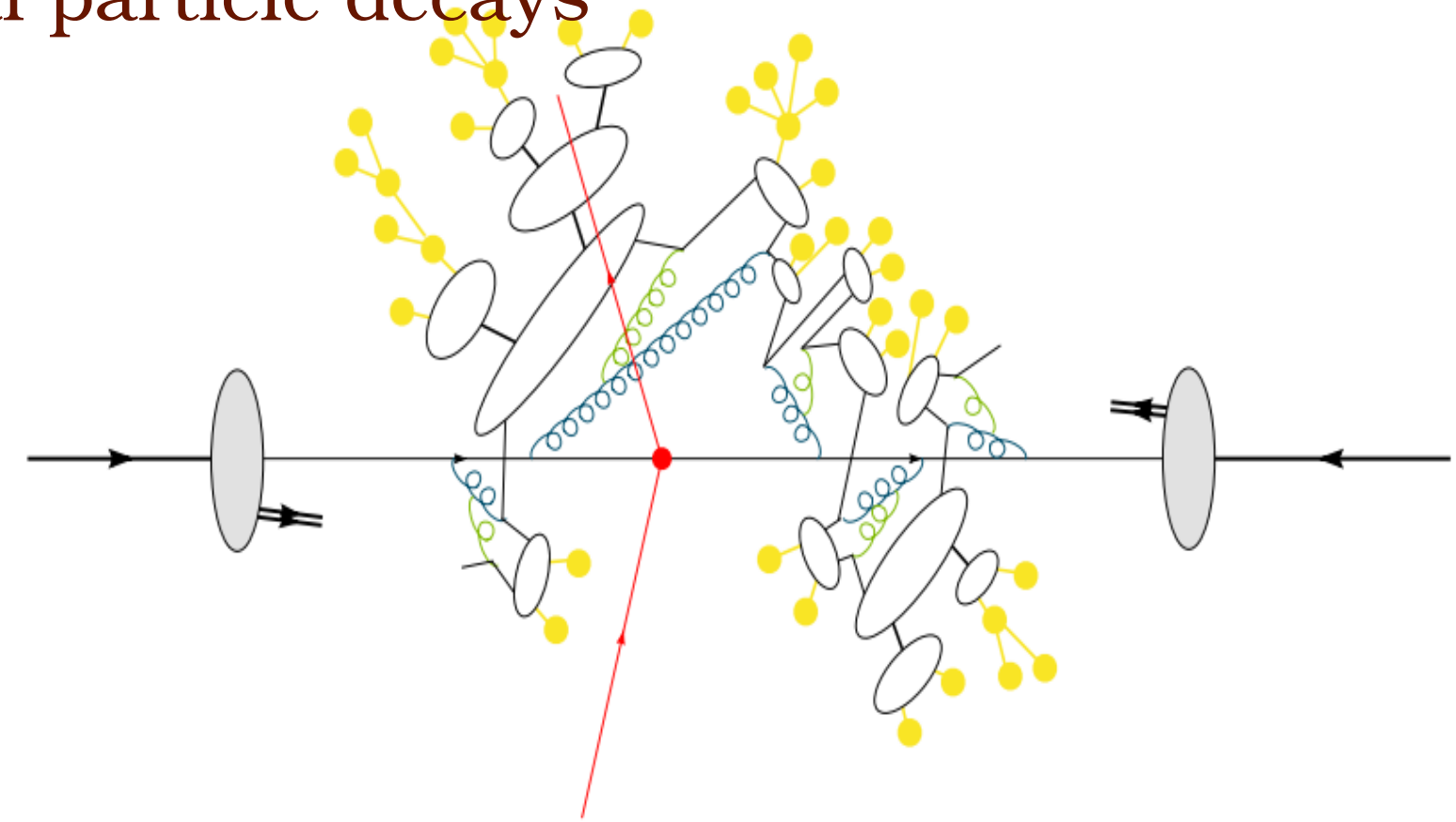
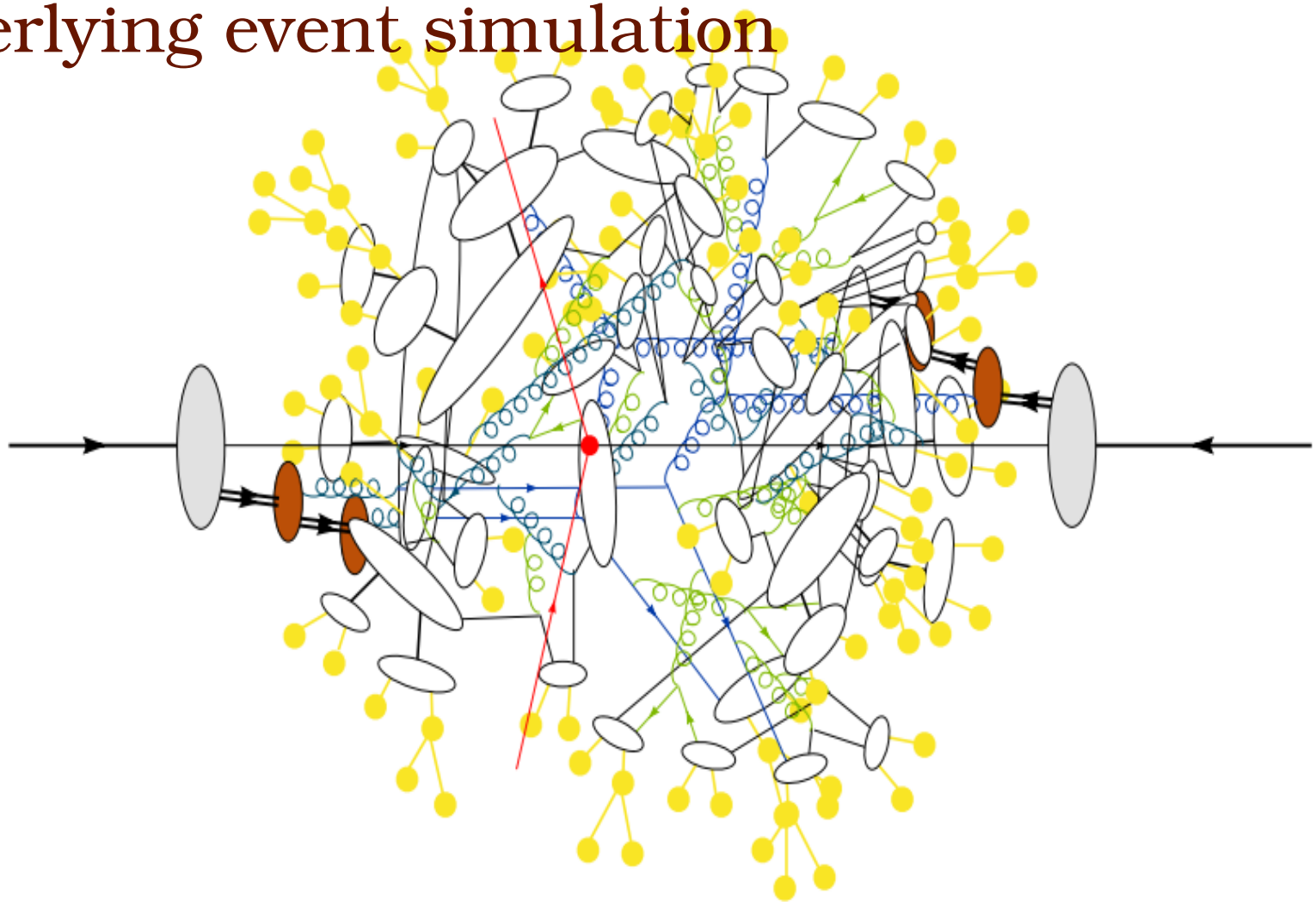
Hadronization



Final particle decays

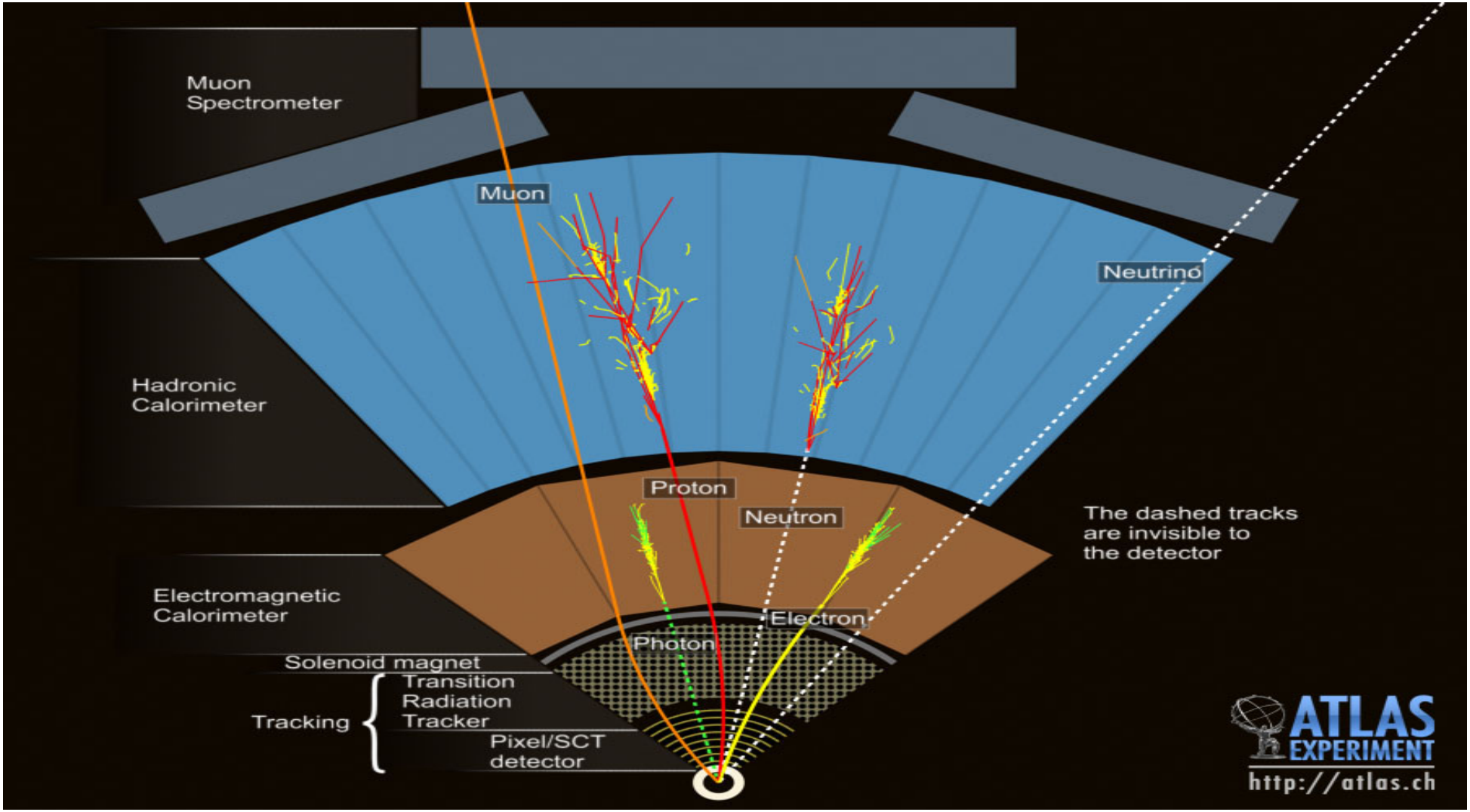


Underlying event simulation



Outline

Physics objects puzzle



One lepton

Many jets

Missing transverse energy

Outline

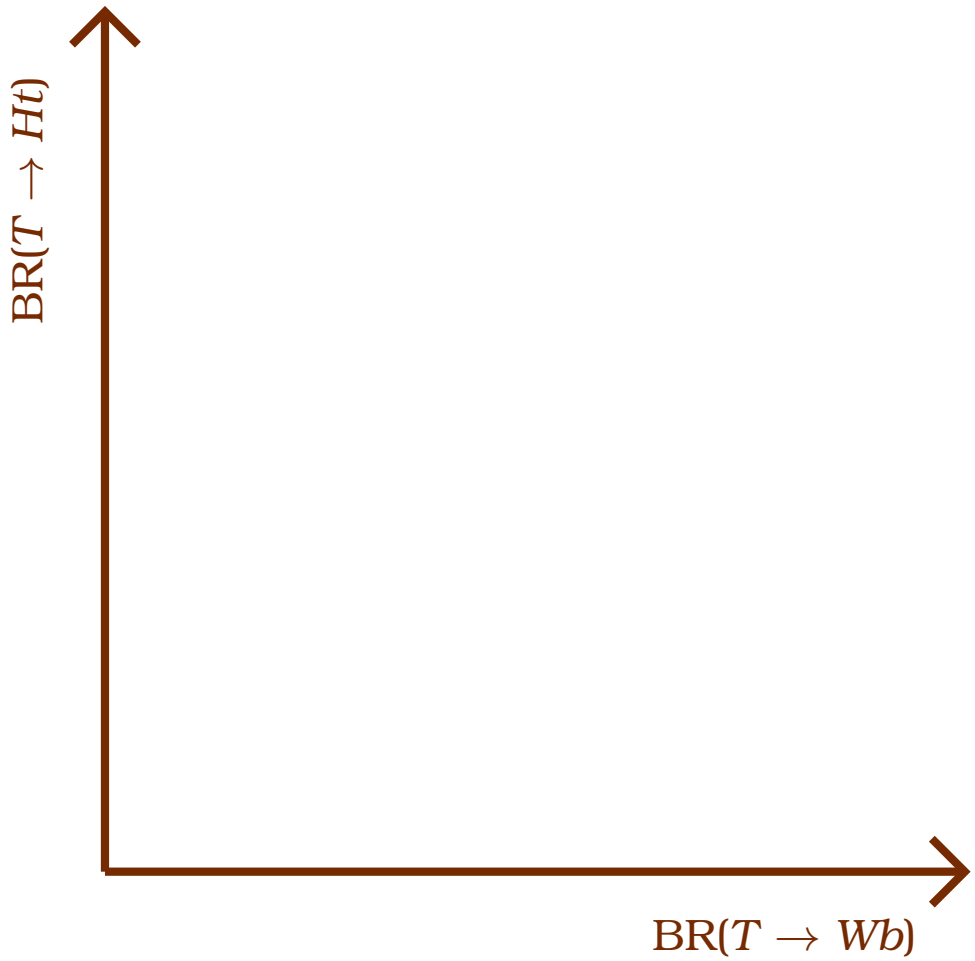
One lepton

Model Independent Strategy started Oct 2012 [**?**]

- Build a 2-dim plane to scan model mixing

BR($T \to Wb$)

Model Independent Strategy started Oct 2012 [**?**]



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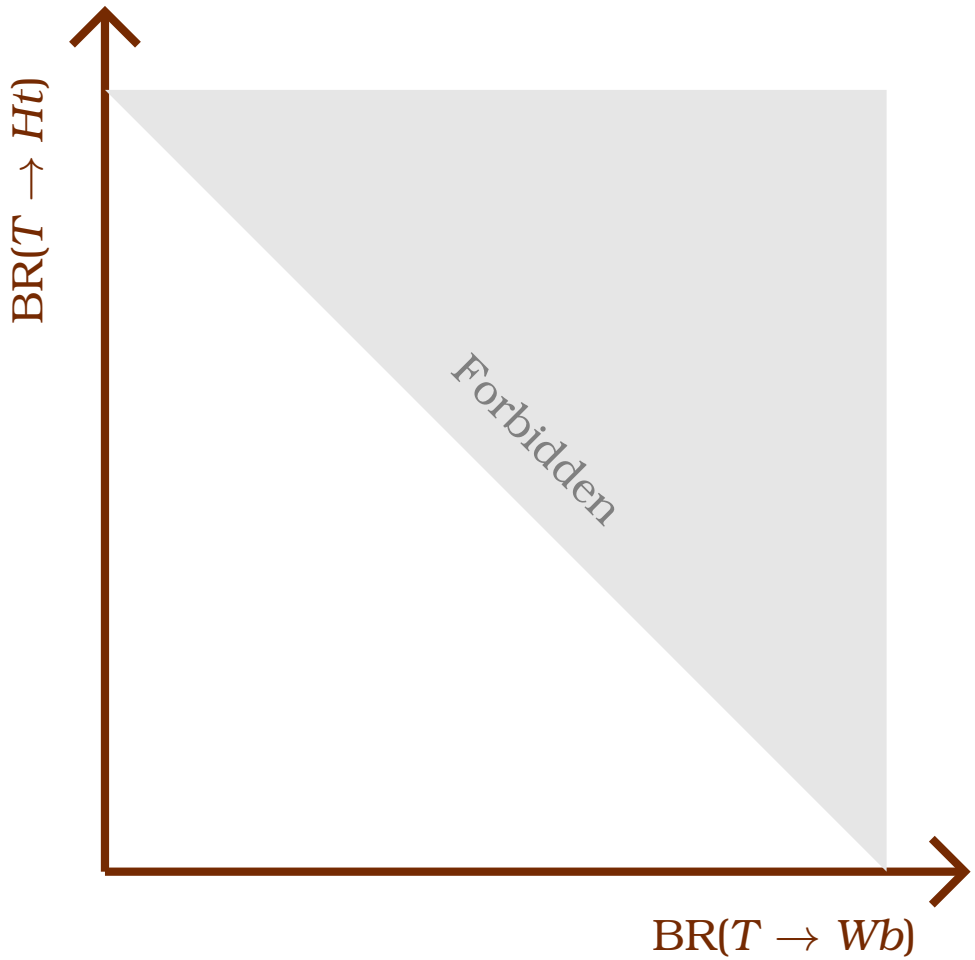
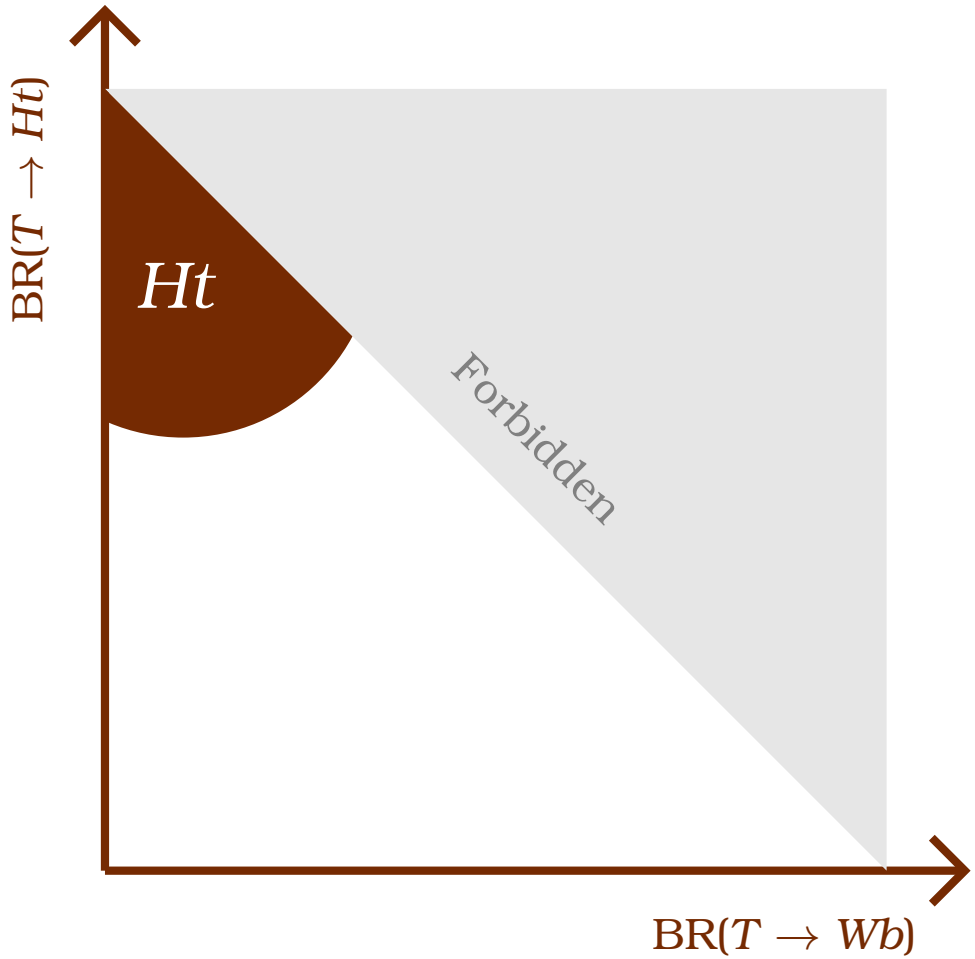
Model Independent Strategy started Oct 2012 [?]



- Build a 2-dim plane to scan model mixing
- Sum of BRs is $1^{(a)}$

$^{(a)}$BR($T \to Zt$) = 1 - BR($T \to Ht$) - BR($T \to Wb$)

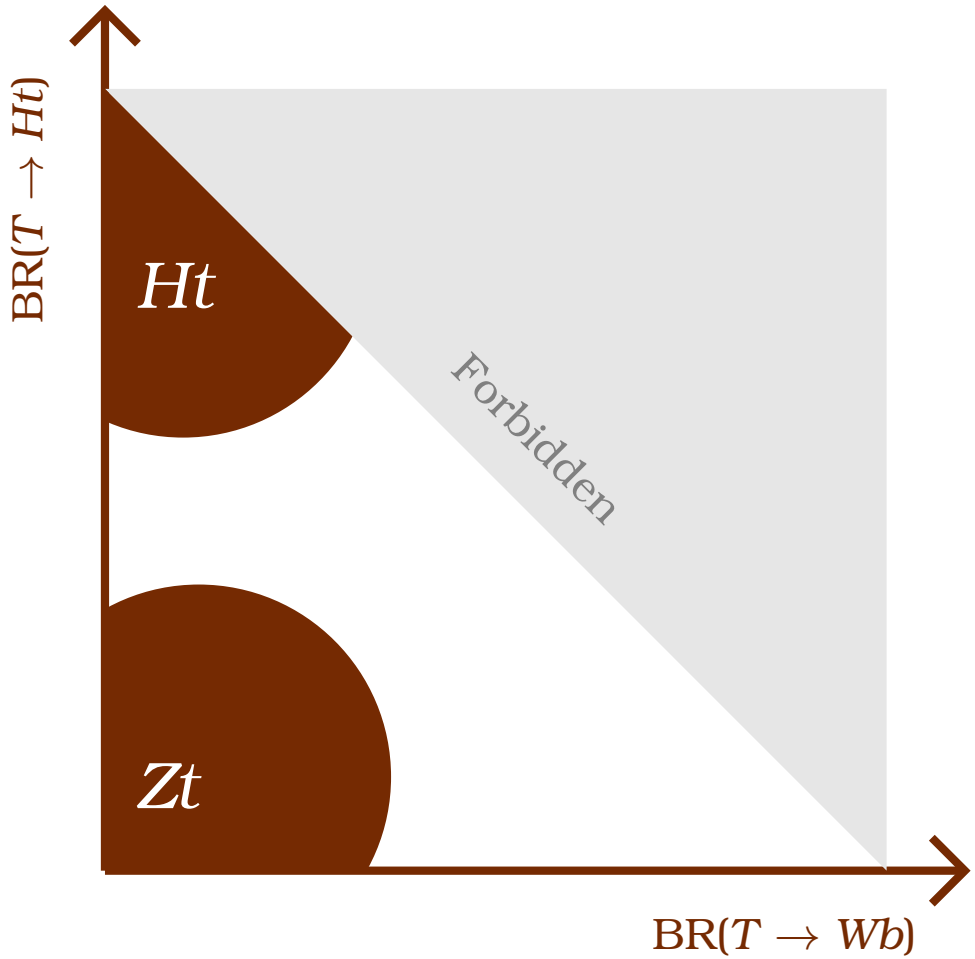
Model Independent Strategy started Oct 2012 [?]



- Build a 2-dim plane to scan model mixing
- Sum of BRs is 1 [a]
- Different analyses are sensitive to different areas

[a] BR($T \to Zt$) = 1 - BR($T \to Ht$) - BR($T \to Wb$)

Model Independent Strategy started Oct 2012 [?]



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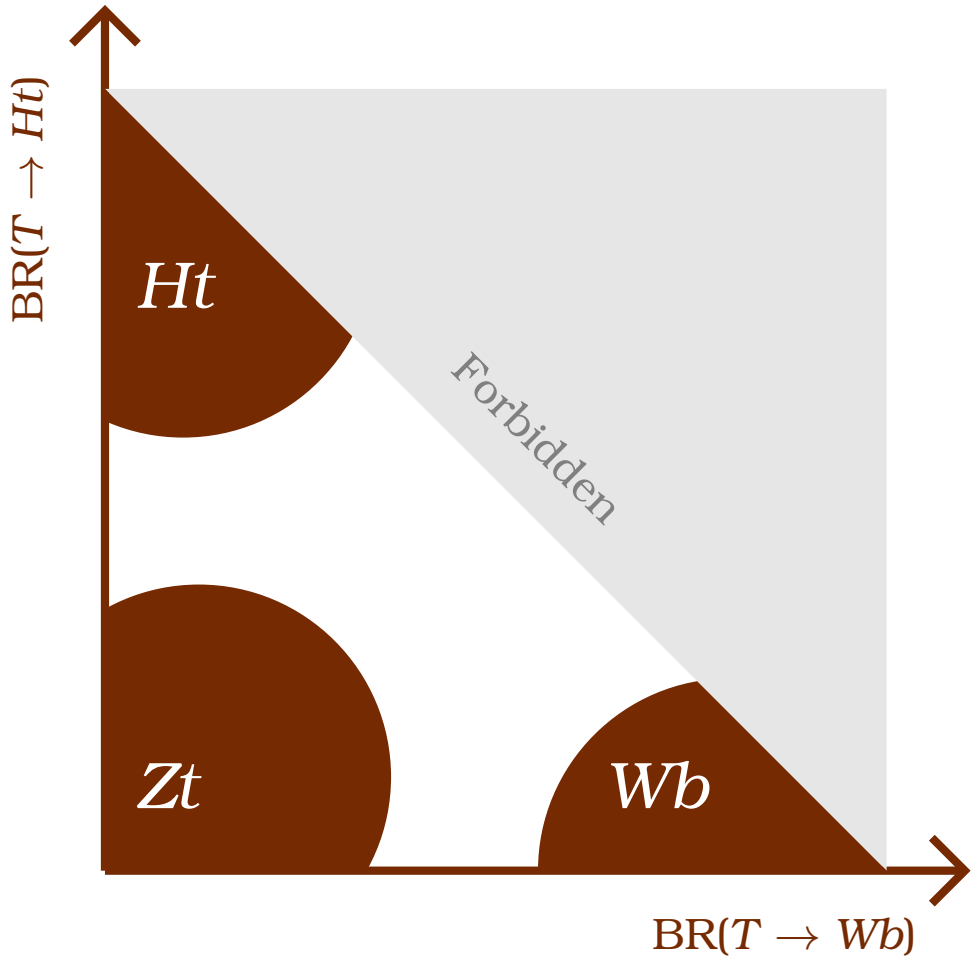

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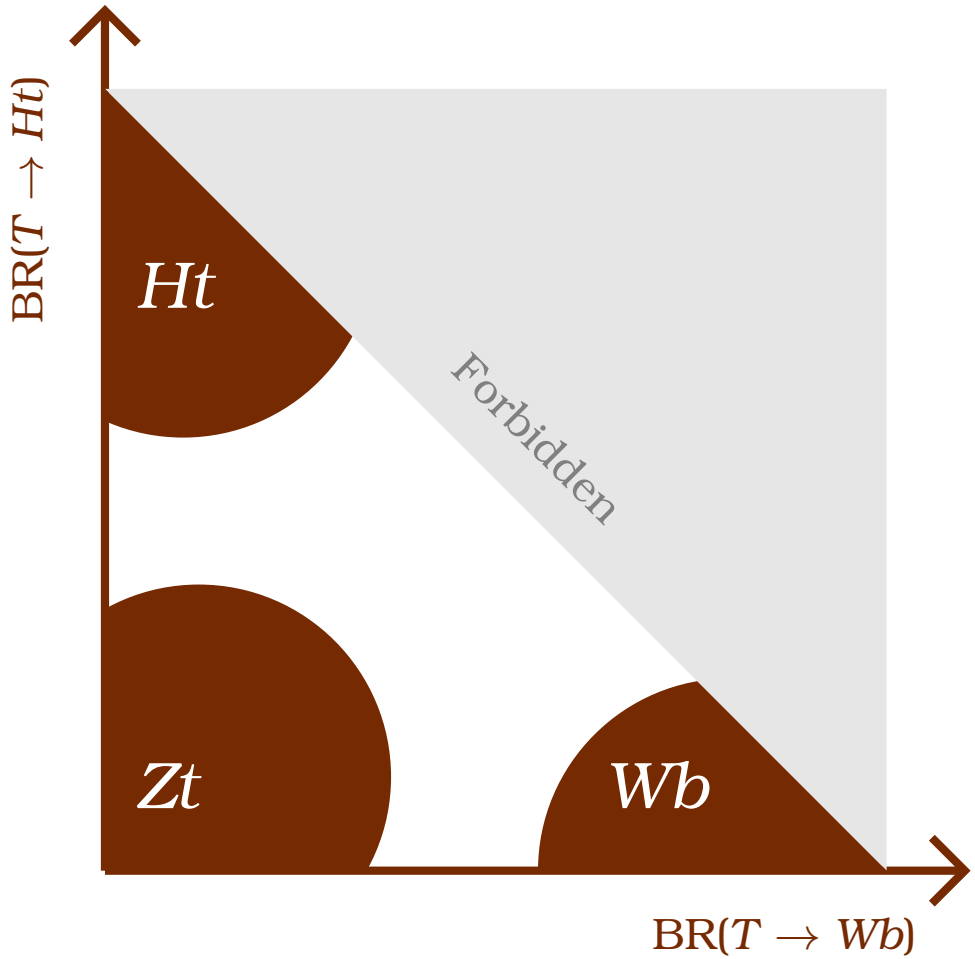

- Build a 2-dim plane to scan model mixing
- Sum of BRs is $1^{(a)}$
- Different analyses are sensitive to different areas
- Set exclusion using CL_s technique [?, ?]

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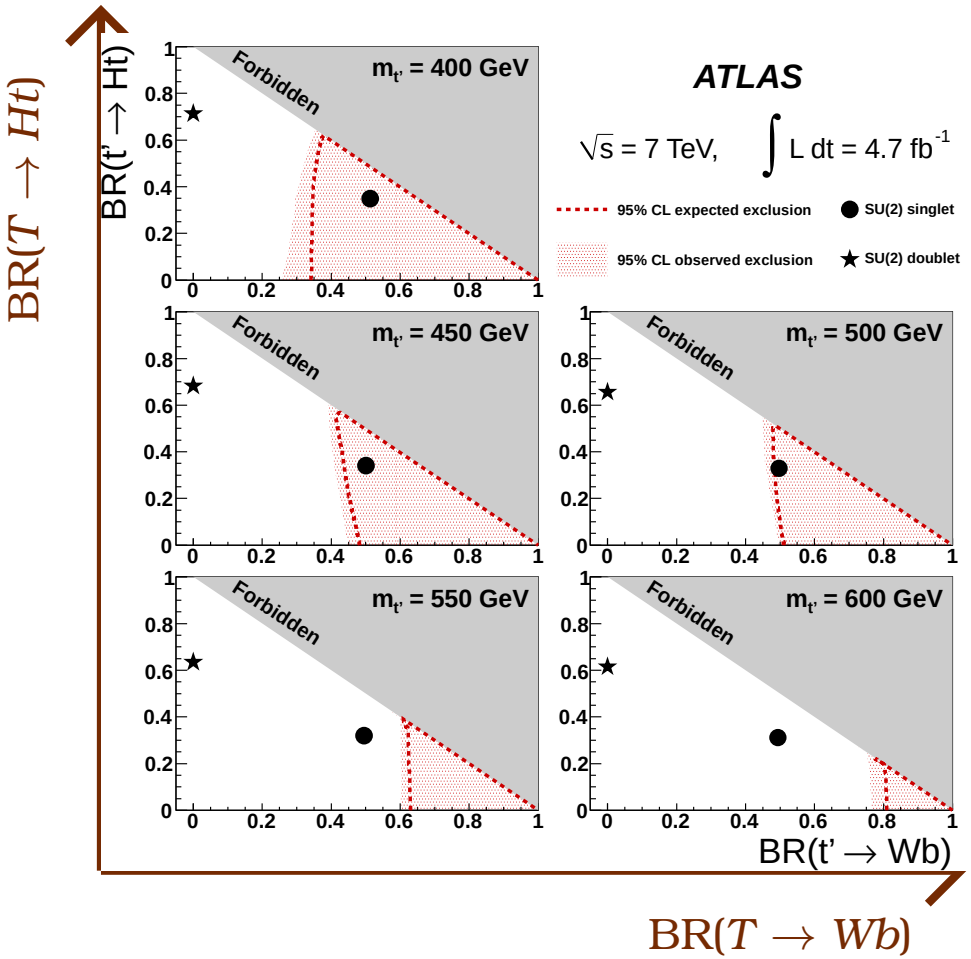
Model Independent Strategy started Oct 2012 [?]



- Build a 2-dim plane to scan model mixing
- Sum of BRs is 1 [a]
- Different analyses are sensitive to different areas
- Set exclusion using CL_s technique [?, ?]
- Updating 7 TeV results

[a] BR($T \to Zt$) = 1 - BR($T \to Ht$) - BR($T \to Wb$)

Outline

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References I

BACKUP SLIDES

LHC parameters

Parameter	designed	2010	2011	2012
Beam energy (TeV/c)	7	3.5	3.5	4
Beta function $\beta*$ (m)	0.55	2.0/3.5	1.5/1.0	0.6
Max. No. bunches/beam	2808	368	1380	1380
Max. No. protons/bunch	1.15×10^{11}	1.2×10^{11}	1.45×10^{11}	1.7×1
Bunch spacing (ns)	25	150	75/50	50
Peak luminosity ($cm^{-2}s^{-1}$)	1×10^{34}	2.1×10^{32}	3.7×10^{33}	7.7×1
Emittance ε_n (μrad)	3.75	2.0	2.4	2.5
Max. $<\mu>$	19	4	17	37

Table: Overview of some parameters for the LHC performance comparing the design values with their time evolution during the first long run operation in 2010-2013 [**?**].