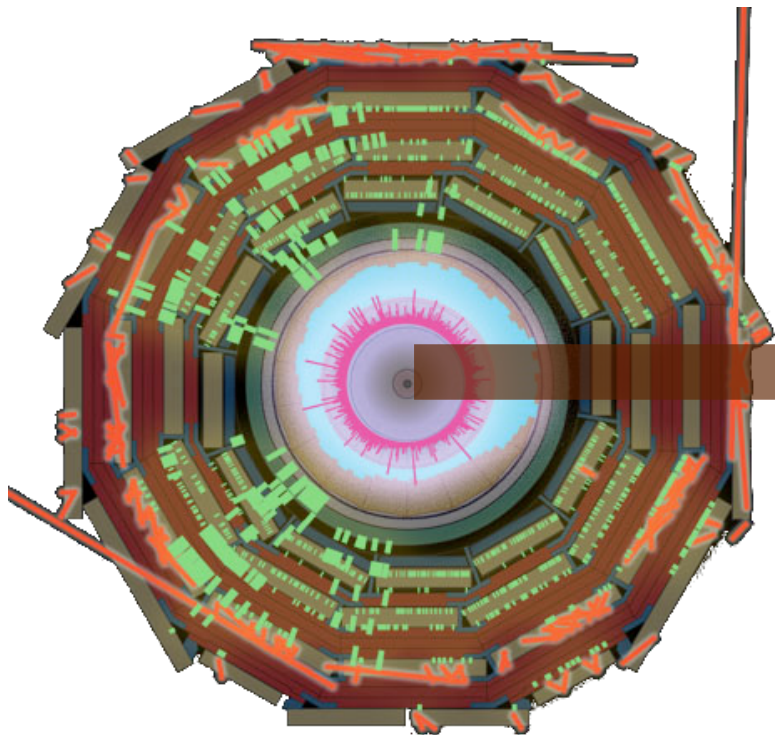


The Physics Analysis Toolkit *also known as "the PAT"*

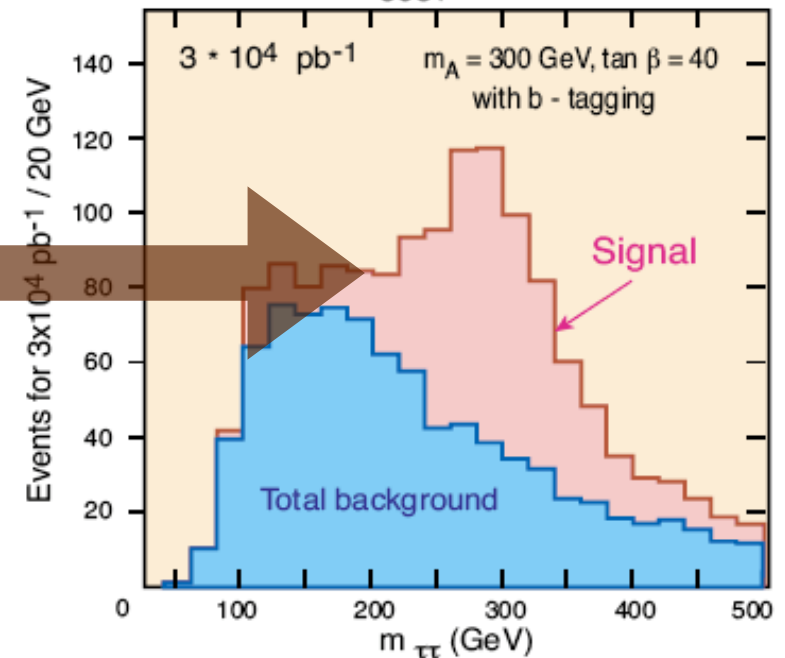
Frédéric Ronga
ETH Zurich

PAT e-learning course – module 3
January 20, 2009



Physics
Analysis
Toolkit

$A^0, H^0, h^0 \rightarrow \tau^+\tau^- \rightarrow e/\mu + \tau_{\text{jet}} + E_t^{\text{miss}}$
in $b\bar{b}H_{\text{SUSY}}$ final states





This morning's schedule

- Introduction to PAT: ~ 30'
 - why the PAT?
 - what can the PAT do for you?
 - ★ *quick overview of steps detailed in next modules of this course*
 - questions and discussion

- PAT hands-on tutorial: ~1h45' (*i.e.*, till lunch...)
 - running the PAT
 - checking the output
 - configuring the PAT



What is the PAT?

- ➔ A bridge between the “rough” AOD and physics plots
- ➔ A common set of basic tools for almost any physics analysis in CMS
 - ★ *no code duplication and faster development with a common tool*
 - ★ *common definition of Physics objects*
 - ★ *enhanced code reliability*
- ➔ Providing sensible defaults and configurations
 - ★ *but they **cannot** cover all use-cases: you **have** to configure it on your own*
 - Physics groups should come up with a common configuration
- ➔ Trying to support two (almost contradictory) requirements
 - ★ *high flexibility*
 - ★ *user friendliness*
- ➔ Also: crossing point between
 - ★ *Physics Object Groups (POGs): the content providers,*
 - ★ *Physics Analysis Groups: the users,*
 - ★ *and Offline: the software supervisor*



What is it *not*?

- ➔ The PAT does not re-invent the wheel
 - ★ *Not rewriting the AOD objects: stay in the **Candidate model** (CMSSW standard)*
 - ★ *Interface to **POG algorithms** (providing feedback!)*
 - ★ *Infrastructure for **PAG analyses***

- ➔ The PAT is not a framework on its own
 - ★ *Fully embedded in the CMSSW Event Data Model (EDM)*
 - ★ *Profits from framework's persistency and provenance tracking*

- ➔ Not claiming to cover all possible analysis use-cases
 - ★ *aiming at 90%...*
 - ★ *feedback and contributions welcome!*



So: why the PAT?

Earlier frameworks showed the need for such a tool:

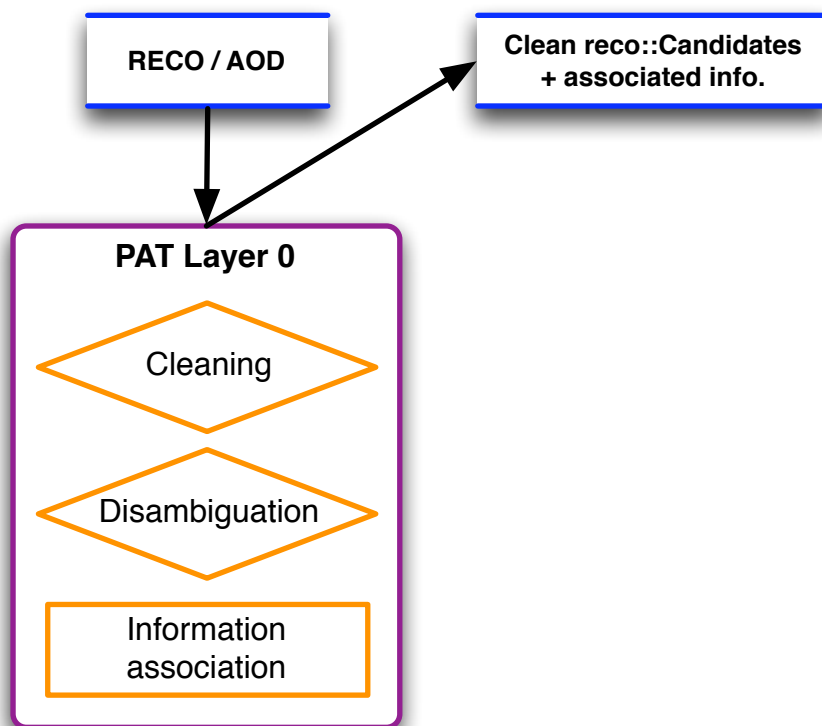
- It provides a good starting point for a new analysis
- It is highly configurable
- PAT objects are easy to handle
- Standard POG algorithms are made easily accessible
- The output is highly customisable
- ... and other reasons you will find out yourself!

Layer 0

Cleaning and disambiguation

Additional analysis tasks

(e.g., MC matching)

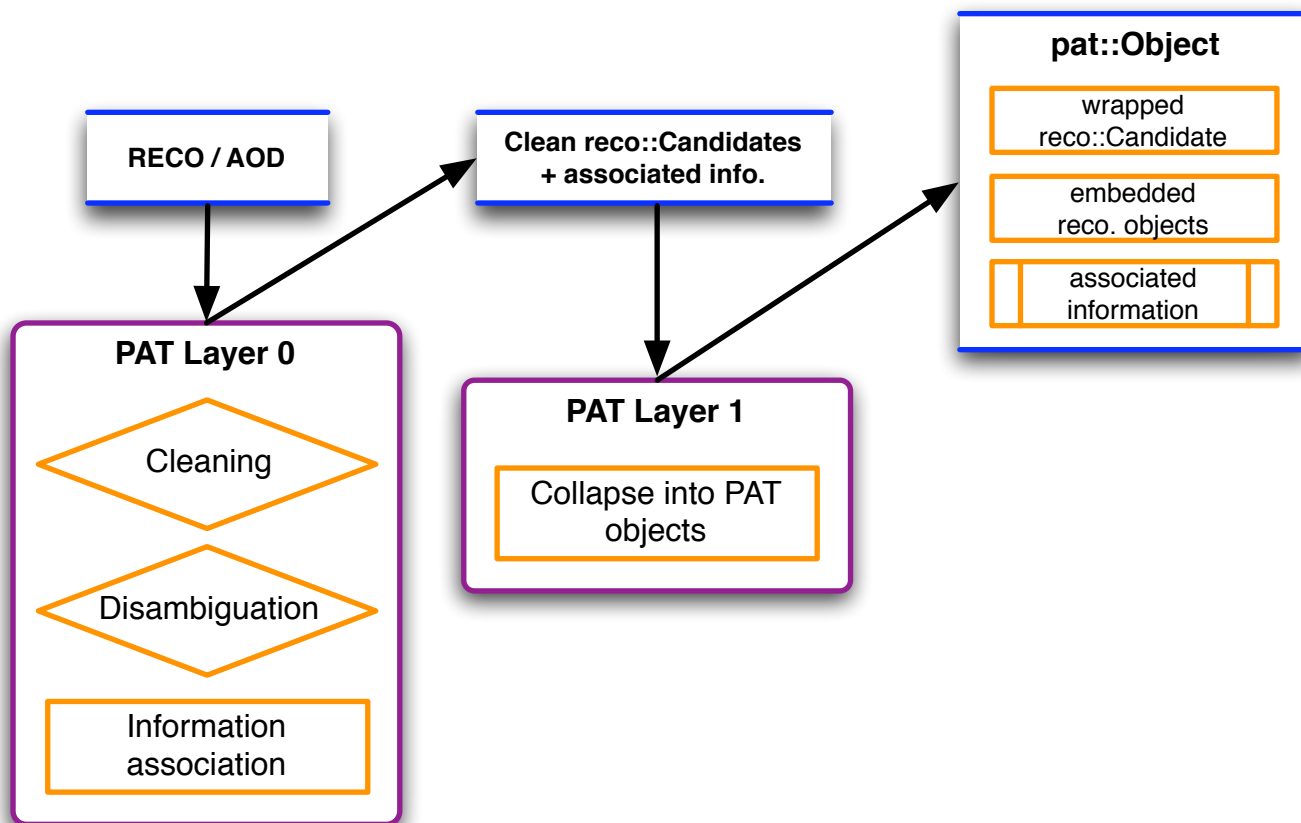


Layer 0

Cleaning and disambiguation
 Additional analysis tasks
 (e.g., MC matching)

Layer 1

Creation of PAT objects
 Collapse external information
 into “fat” objects
More in module #4





The PAT in layers

Layer 0

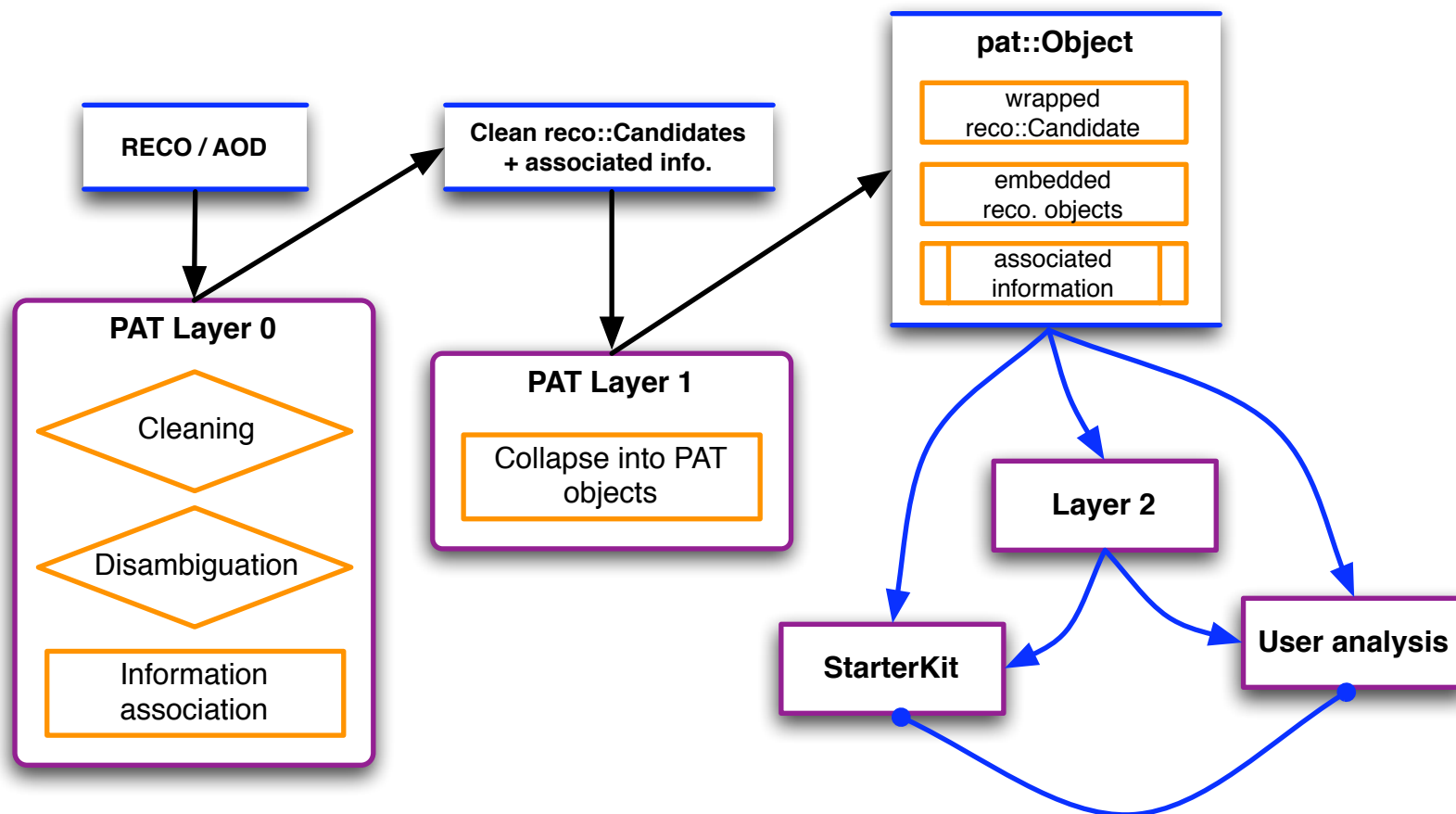
Cleaning and disambiguation
Additional analysis tasks
(e.g., MC matching)

Layer 1

Creation of PAT objects
Collapse external information
into “fat” objects
More in module #4

Layer 2

Physics Analysis...
More in module #9





Layer 0 tasks (overview)

- ➔ Works on AOD objects
 - ★ *AOD (analysis object data) is a sub-set of all reconstructed information*
 - ★ *includes association between basic objects and reco. information*
 - e.g., a reco::Electron and its electron ID
- ➔ Produces additional information (using POG algorithms)
 - ★ *e.g., particle ID and isolation variables, if missing*
- ➔ Cleans and flags AOD objects
 - ★ *Selection based on particle ID (can be done later)*
 - Cf. module #8
 - ★ *Duplicate removal and cross-objects ambiguity resolution*
 - e.g., electron-photon, jet-electron,...
 - Cf. module #6
- ➔ Performs trigger and MC matching
 - Cf. module #7
- ➔ *Output: “cleaned” AOD collections*
- ➔ *All of this is configurable*



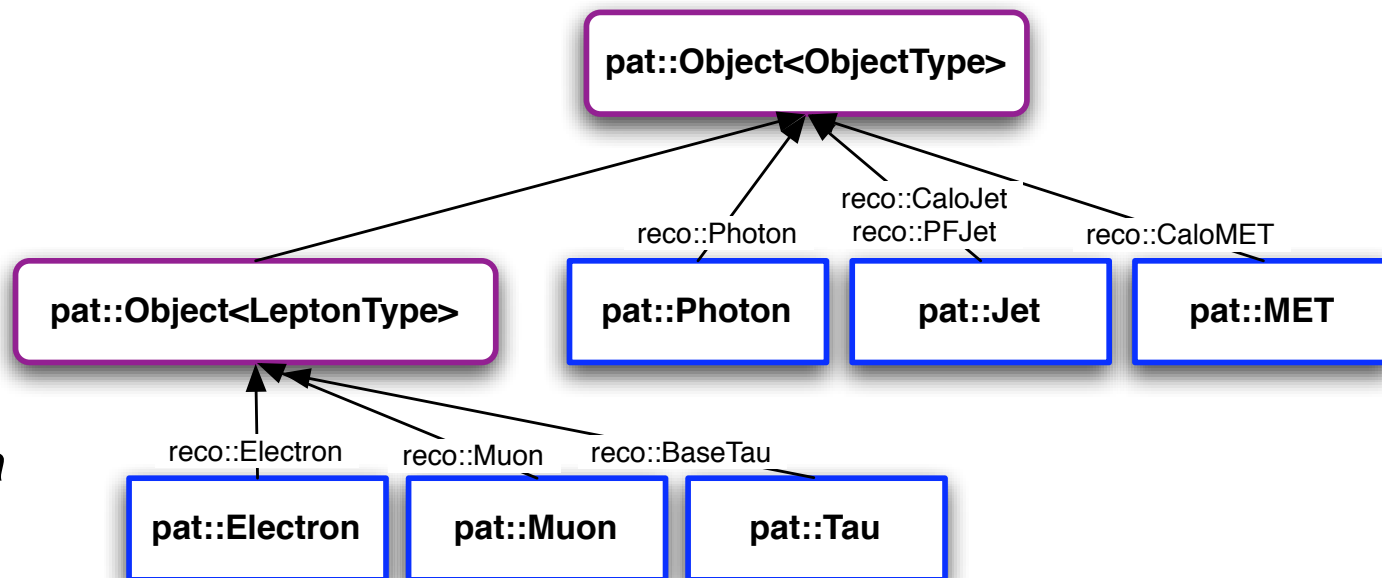
Layer 1: production of PAT objects

PAT objects are an **enriched** “reco.” data format

- All related information brought together in one “fat” object
 - ★ *easy one-entry user interface to previously associated information*

→ PAT Layer 1 objects:

- ★ *Muon, Electron, Photon, Tau, Jet, MET*
- ★ *inherit from reco. counter-part*
- ★ *additional members and methods to access extra information*
- ★ *only stores what is asked for by user (“embedding”)*
- ★ *also: uniform interface to Particle Flow objects (PF2PAT)*



More details in module #4



PAT Layer-1: objects' interface

In addition to the reco's interface:

→ All PAT objects

★ *have methods to access their MC and trigger matches*

→ pat::Photon, pat::Electron, pat::Muon and pat::Tau

★ *contain methods to access isolation and ID variables*

→ pat::Jet

★ *provides access to b-tagging information*

★ *methods for handling jet corrections*

★ *access to jet flavour from MC*

★ *interface to associated tracks and jet charge*

More details in module #4



Using the PAT (more on that soon!)

Default analysis flow

- ➔ Layer-0 and Layer-1 can be steered by the user solely using config files
 - ★ 2 includes in a cfg provide the PAT objects with default settings
 - ★ a layer-1 pre-selection chain is available

- ➔ for all steps in the flow, sensible defaults are provided, but clearly this is not applicable in all cases; **the user needs to know what he is doing!**
 - ★ *this is the aim of this course...*

- ➔ there are out-of-the-box examples in place
 - ★ *to run Layer-0, Layer-1 or both*
 - ★ *to run on full simulation AOD's*
 - ★ *to run on fast simulation AOD's or from scratch*

- ➔ more details...
 - ★ *in the tutorial session!*



Documentation and support

For future reference: a few links

→ central wiki page in the **CMS Software Guide**:

★ <https://twiki.cern.ch/twiki/bin/view/CMS/SWGuidePAT>

→ PAT examples' twiki, also with **PAG examples**:

★ <https://twiki.cern.ch/twiki/bin/view/CMS/SWGuidePATExamples>

→ The PAT section of the **Reference Guide** (doxygen)

★ http://cms-service-sdtweb.web.cern.ch/cms-service-sdtweb/doxygen/CMSSW_2_2_3/doc/html/d8/d06/namespacepat.html

→ The PAT in the **CMS Workbook**:

★ <https://twiki.cern.ch/twiki/bin/view/CMS/WorkBookPAT>

→ **All questions should go to the PhysicsTools hypernews:**

★ hn-cms-physTools@cern.ch

★ <https://hypernews.cern.ch/HyperNews/CMS/get/physTools.html>

→ *And also, for this course:* <https://espace.cern.ch/learncms/pat/default.asp>



A few names

PAG Examples and contact persons NEW

Group	Contacts	Link to PAT analysis
B & heavy flavour	Keith Ulmer	
Electroweak	Bryan Dahmes	CSA08 Z→μμ analysis
Exotica	Kai-Feng Chen	
Heavy Ions	Yetkin Yilmaz	
Higgs	Nicola de Filippis	HiggsPAT in Higgs WGSoftware
Forward Physics	Dilson de Jesus Damiao	
QCD	Vivian O'Dell	
SUSY	John Jones, Jean-Roch Vlimant	SusyPat
Top quark	Roger Wolf, Steven Lowette	Top Analysis examples

POG contacts NEW

Group	Contacts
EgammaPOG	TBD
JetMET	Christian Autermann, Attilio Santocchia, Roger Wolf
Particle Flow / tau	Colin Bernet
MuonPOG	Dmytro Kovalskyi
b-tag / vertex	Francisco Yumiceva

PAT main developers

Task	Names
Layer 0 & 1	GiovanniPetrucciani , StevenLowette
MC matching	WolfgangAdam
Trigger matching	VolkerAdler
StarterKit	SalvatoreRappoccio
Coordination	FredericRonga



Conclusion and outlook

- ➔ the PAT is a lively project
 - ★ *started from and unifies the several CMS “analysis frameworks”*
 - ★ *emphasis on both flexibility and user-friendliness*
 - ★ *ever-growing user base*

- ➔ the PAT is waiting for you!
 - ★ *out-of-the-box examples available*
 - ★ *documentation in place*
 - ★ *POG contacts reviewing/maintaining interface*
 - ★ *users/testers from all PAGs*

- ➔ there is still a to-do list of course
 - ★ *the PAT is a Physics software project: two good reasons for constant evolution*
 - but no big revolution: what you learn here will remain valid
 - ★ *we’re welcoming your feedback*
 - indeed: we have high expectation for this course!
 - ★ *we’re looking forward to your contribution!*