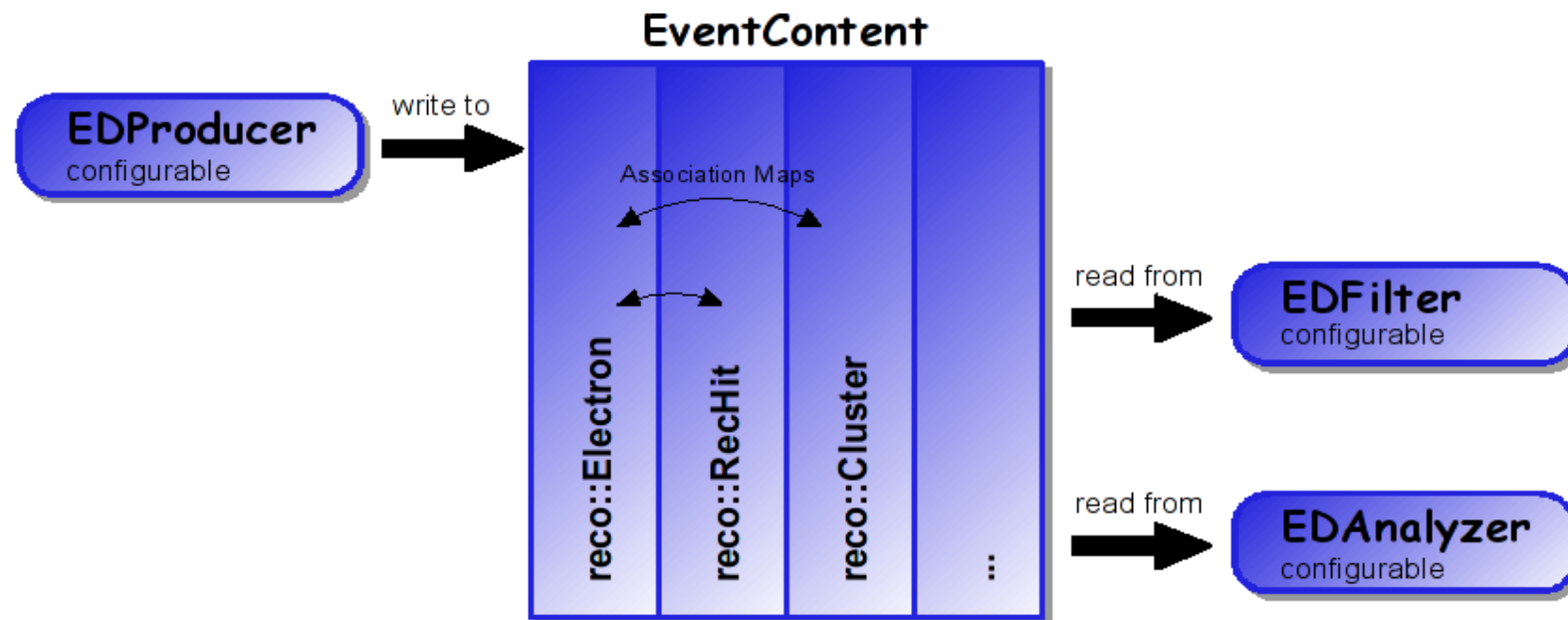# What is PAT and How to use it

Roger Wolf

PAT Tutorial 15.06.2009

The Event Data Model

- Major concept of CMSSW

- Fully configurable edm::Modules communicate via EventContent

- Same file structure for: Gen – Sim – Digi – Reco - Analysis

- Single framework for Reconstruction (POGs) and Analysis (PAGs)

The Physics Analysis Toolkit

- Interface between Reconstruction Level and Analysis Level

  - Simplifies Access within DataFormats (prevents errors with Association Maps)

  - Focuses Expertise (POG and PAG contact persons recent example: JetMET)

  - Crossing Point between POGs and PAGs ('vertical integration')

- Common Tool between Analysts

  - Approved Algorithms and Sensitive Default Configurations from POGs

  - Synergy (everybody can profit from recent developments)

  - Quick Start into Analysis for Beginners

- Standardized Data Transfer

  - Facilitates data transfer between Analysits (no private n-tuples)

  - PAG common configurations

  - Sustained Provenance

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A PAT 'Disclaimer'

- PAT does NOT re-invent the wheel
  - PAT prevents re-inventions
  - PAT helps to standardize and spread finest knowledge in a collaboration of 3000 physicists

- PAT is NOT an antipode to CMSSW
  - PAT is fully CMSSW contained
  - PAT prevents frameworks within the framework

- Consequence and Completion of the Event Data Model

Concepts

- Make use of the modular structure of CMSSW (in full FW/FWLite)

- Provide easy access via member functions in DataFormats

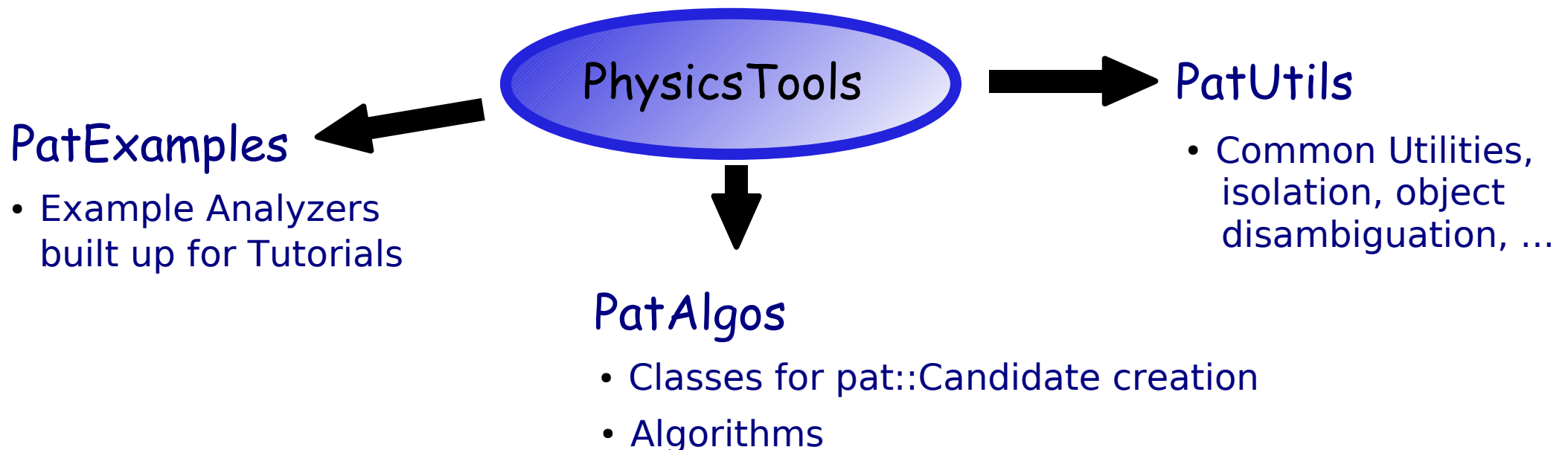- Serve 80% of all analyses use cases in CMS

Flexibility

User Friendliness

Maximal Configurability
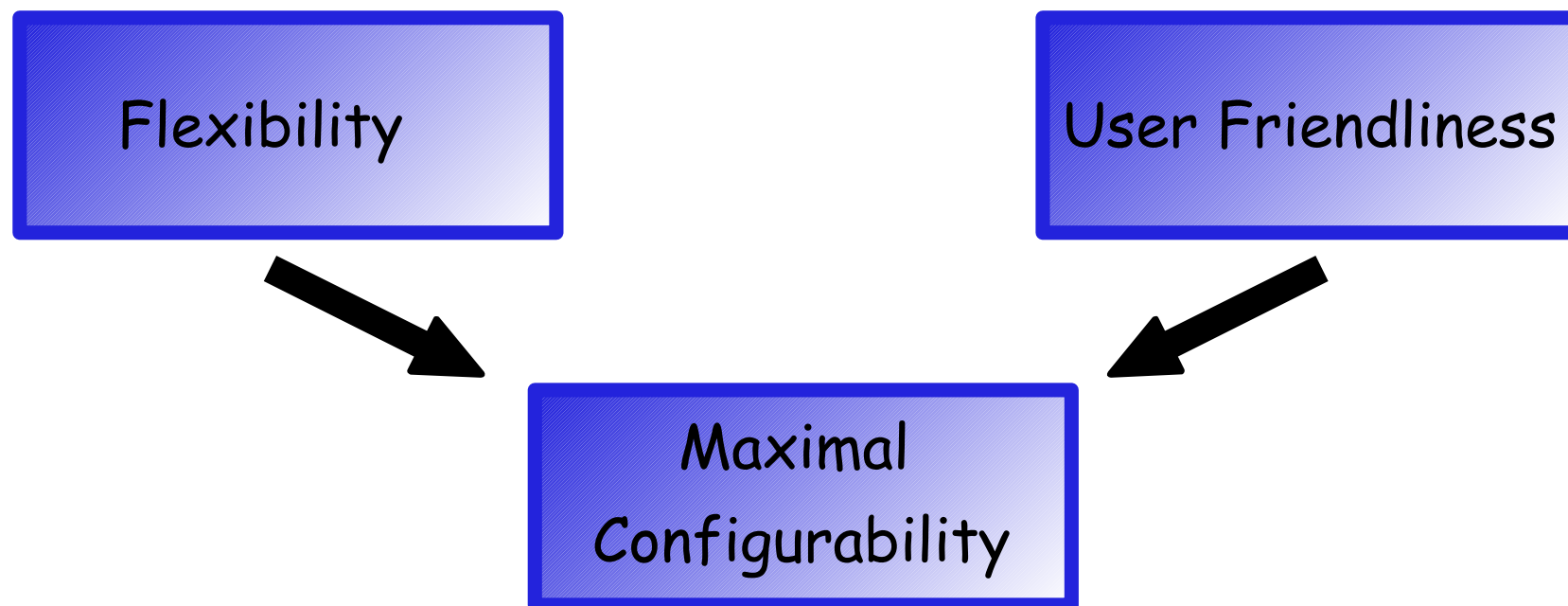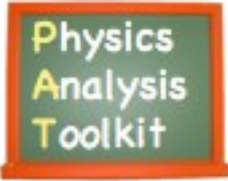
Code Location

- All code located in the CMSSW domain distributed over two systems

  - DataFormats/PatCandidates
    - Structures and Candidate Classes
    - pat::Photon, pat::Electron, pat::Muon, pat::Jet, pat::MET, …

PhysicsTools

PatUtils
- Common Utilities, isolation, object disambiguation, …

PatExamples
- Example Analyzers built up for Tutorials

PatAlgos
- Classes for pat::Candidate creation
- Algorithms

Development

- Antagonism between code development & users needs

- Provide stability and development (beyond releases)

  - Installation Recipes with new developments/fixes for the user

  CMSSW_2_2_X (with PAT version 2)

  Latest tag: To check out the latest tags do the following

  Show ▶

  Head version: To check out the head version of the B22X development branch do the following

  Show ▶

 **Important Notes:** For further information about the use of PAT (version 2) have a look below:

  Show ▶

  See the corresponding Release Notes for details.

  - Several layers of development for the developer

Branch	Release	PATCandidtes	PATAlgos	PATUtils	Comments
B22X_Production_v1	CMSSW_2_2_9	V03-18-ZZ	V04-14-ZZ	V03-05-02-ZZ	no development
B2_2_X	CMSSW_2_2_10	V03-YY-ZZ	V05-YY-ZZ	V03-06-ZZ	development branch
HEAD	CMSSW_3_1_X	V05-YY-ZZ	V07-YY-ZZ	V03-YY-ZZ	development branch

Have a look at SWGuidePATRecipes for more details

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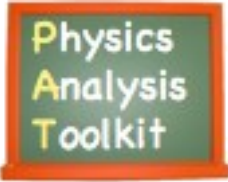
Installation Recipes

- **Recommended Installation Recipes**

  - Stable and tested as far as possible (PAT validation in progress)

  - Regularly updated

  - Can be applied by copy & paste

  - First aim: push these tags into new releases

  - We also provide 'Release Notes' with it

CMSSW_2_2_X (with PAT version 2)

Latest tag: To check out the latest tags do the following

Hide ▾

```
cmsrel CMSSW_2_2_13
cd CMSSW_2_2_13/src
cmsenv
addpkg DataFormats/PatCandidates V03-26-05
addpkg PhysicsTools/PatAlgos V05-05-10
addpkg PhysicsTools/PatUtils V03-06-03
```

These packages have the following dependencies:

```
addpkg CondFormats/JetMETObjects   V01-08-04
addpkg PhysicsTools/RecoAlgos V08-06-16-06-02
addpkg PhysicsTools/PFCandProducer V03-01-16
addpkg RecoMET/Configuration V00-04-02-17
addpkg RecoMET/METAlgorithms V02-05-00-21
addpkg RecoMET/METProducers V02-08-02-17
addpkg DataFormats/METReco V00-06-02-09
addpkg DataFormats/MuonReco V07-02-12-03
addpkg JetMETCorrections/Type1MET VB04-00-02-04
addpkg RecoJets/JetAssociationAlgorithms V01-04-03
addpkg JetMETCorrections/Algorithms V01-08-02-01
addpkg JetMETCorrections/Configuration V01-08-15
addpkg JetMETCorrections/JetPlusTrack V03-02-06
addpkg JetMETCorrections/Modules V02-09-02
```

Maximal Configurablity

• EventContent

• Configurable

4-fold

• Data Formats (8)

• Collections

• Workflow (11)

Data Formats

- Data Formats in pat::Candidates

  - pat::Muon

  - pat::Electron

  - pat::Tau

  - ...

- All objects inherit from their corresponding reco::Candidates

- Find further documentation on the TWiki

Data Formats

- Find further documentation on available member functions on the TWiki

How to access pat::Objects

- Data access via an EDAnalyzer (configuration file)

How to access pat::Objects

- Data access via an EDAnalyzer (plugin)

How to access pat::Objects

- Data access via an FWLite (hard coded)

Workflow

- WorkflowPicture from TWiki

AOD/Reco Steps

- AOD/Reco steps before the creation of pat::Candidates

Trigger Event

- Accessing Trigger Information via PAT

Matching to Trigger Candidates

- Matching to Trigger Objects

Matching to Generator Candidates

- Matching to generator information

pat::Candidate Creation

- Contract all event information of the previous slides into 1 object

- Emphasize that pat includes reco!

- From here on we discuss object configuration via configuration file

allLayer1Photons

- What extra information will be part of the pat::Photon

allLayer1Electrons

- What extra information will be part of the pat::Electron

allLayer1Muons

- What extra information will be part of the pat::Muon

allLayer1Taus

- What extra information will be part of the pat::Tau

allLayer1Jets

- What extra information will be part of the pat::Jet

allLayer1METs

- What extra information will be part of the pat::MET

selectedLayer1Candidates

- How does the selection string work

- This is the standard layer w/o any cleaning

selectedLayer1Candidates

- What is the default configuration? – see TWiki

cleanedLayer1Candidates

- What is object cleaning

- The simple example of electrons and jets

cleanedLayer1Candidates

- How to configure object cleaning in PAT

- PAG specific cross cleaning

EventContent

- Composition of EventContent

- Typical EventSize estimates

- Tools for event size estimates

Workflow Tools

- WorkflowPicture from TWiki

- Additional jets, switch jet collection, caloTaus, add Trigger, ...

Switch Jet Collection

- WorkflowPicture from TWiki

- Additional jets, switch jet collection, caloTaus, add Trigger, ...

Add Jet Collections

- WorkflowPicture from TWiki

- Additional jets, switch jet collection, caloTaus, add Trigger, ...

Support

- Hypernews

- Community

- POG PAG contacts

- Developers

Documentation

- Main TWiki

- Data Formats

- Configuration

- Workflow

- Tools

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Summary

- The PAT tuple is a success
  - PAT tuples are well received
  - In use of many PAGs (despite of with known deficits)

- Boost for PAT itself (more users)

- Official production was of help for increasing the acceptance & PR

- PAG show strong interest to continue the production on their own responsibility (cycle of ~1 month)

- To guarantee the success the PAT (tuple) needs:
  - Continuity in content and workflow
  - It must be significantly smaller than AOD
  - It must be easy and transparent to produce (source of more PAT experts?)

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