O Trigger de jatos de ATLAS no início do run II

R.Gonçalo, ATLAS@LIP – Séniores, 3 de Julho de 2015

Sumário

- 1 de ~~Abril~~ Março de 2014:
  - Ricardo ainda acredita que só vai passar 30% do seu tempo no trigger
  - Não existe nenhum trigger de jatos a funcionar no High Level Trigger

- 1 de Julho de 2015:
  - Ricardo passa as rédeas do trigger de jatos e é um bocadinho menos ingénuo
  - Software:
    - Trigger de jatos reproduz de perto processamento offline
    - Mas com plano de segurança (partial scan) made at LIP!
    - Infraestrutura de validação do software bem desenvolvida
  - Menu:
    - Vários tipos de jatos para diferentes fins de física e calibração, e HT
    - Menu do express stream recolhe dados para monitorização online e offline (trigger & reco)
    - Mais stream para Data scouting de eventos com di-jatos
  - Operações:
    - Software de monitoring a funcionar e bem testado
    - Equipa de experts bem rodada nas operações do trigger
    - O(100M) eventos: calibração da reconstrução de jatos (eta intercalibration; phi modulation) e física
  - Primeira nota de física com jatos a ser escrita:
    - ATL-COM-PHYS-2015-290: exclui interações de contacto até $m_{jj} \approx 3.4$TeV com $6.6 pb^{-1}$

Jet Menu for p-p Data

Key

- Jet Algorithm:
  - **a4** = anti-kt jet finding algorithm with R parameter of 0.4
  - **a10** = anti-kt jet finding algorithm with R parameter of 1.0
- Input objects used for jet finding:
  - **tc** = TopoClusters reconstructed from calorimeter cells
  - **TT** = Level 1 TriggerTowers read out in HLT to allow fast but coarse full calo scan (a.k.a. Level 1.5)
- Calorimeter scan:
  - **PS** = partial calorimeter scan seeded by L1 RoI or L1.5
  - **FS** = full calorimeter scan (default)
- Pseudorapidity range:
  - **xxetayy =** jets in interval xx < |η| < yy – default is **0eta32** (old central jets)
- Cluster Energy Scale correction:
  - **em** = no weights applied
  - **lcw** = local cluster weighting
- Jet Energy Scale correction:
  - **jes** = JES calibration factors without pileup subtraction
  - **sub** = pileup subtraction applied but no JES factors
  - **subjes** = both pileup subtraction and JES factors
  - **nojcalib** = no jet calibration

```
# ---- Jet Dictinary of default
JetChainParts_Default = {
    'signature'    : ['Jet'],
    'L1item'       : '',
    'threshold'    : '',
    'multiplicity' : '',
    'etaRange'     : '0eta320',
    'trigType'     :'j',
    'extra'        : '',
    'recoAlg'      :'a4',
    'dataType'     :'tc',
    'calib'        :'em',
    'jetCalib'     :'subjes',
    'scan'         :'FS',
    'addInfo'      : [],
    'topo'         : [],
    'bTag'         : '',
    'bTracking'    : '',
    'bConfig'      : [],
    'dataScouting' : '',
```

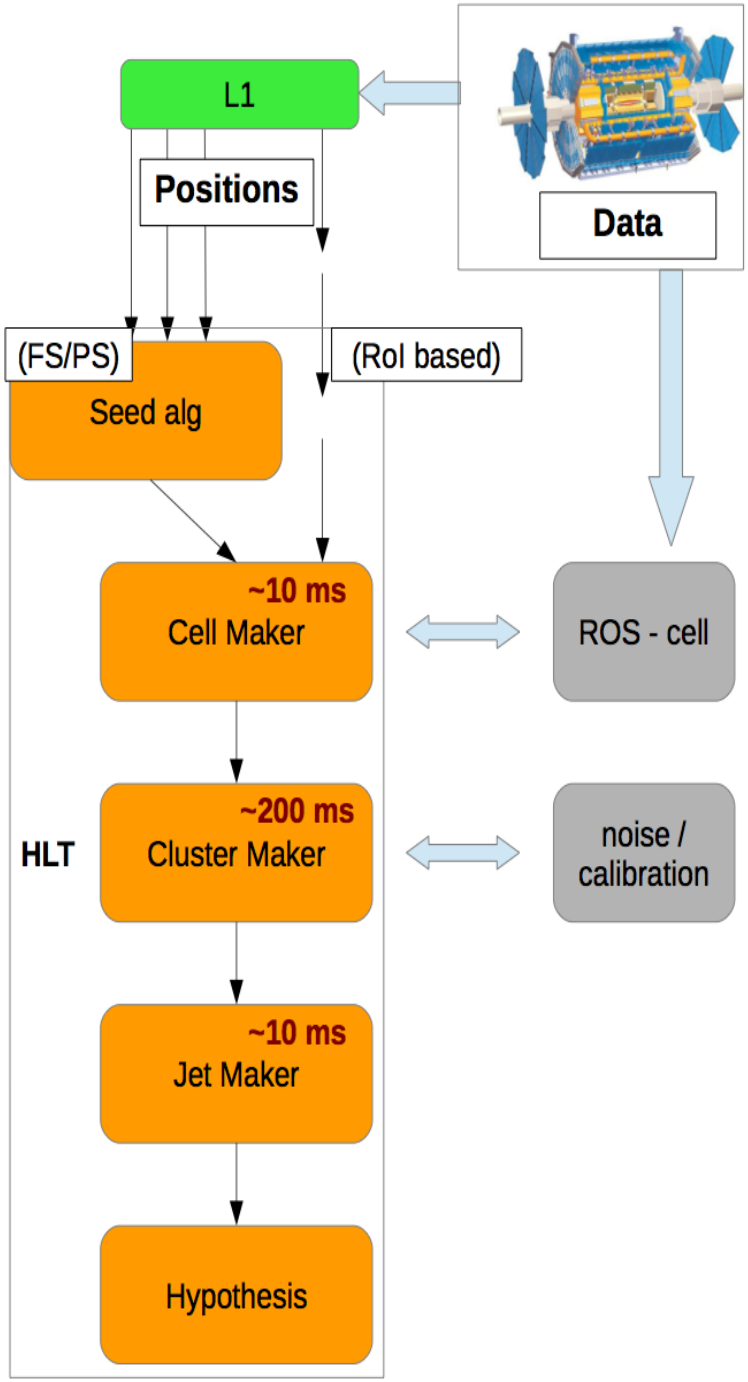
- Defaults:
  - **Default options don't appear in chain names**
  - **0eta320**
  - **a10_tc_em_subjes_FS** = jets built from EM-scale clusters from calorimeter full scan, with pile-up subtraction and jet-level calibration
  - **a10_tc_em_nojcalib_FS** = jets built from EM-scale clusters from calorimeter Full Scan and no jet-level calibration or area subtraction

Primary p-p jet menu

- Primary unprescaled triggers:
  - $5x10^{33}$ menu:
    - j360, a10_360, 4j85, 5j60, 6j50.0eta24, ht800
  - $2x10^{34}$ menu:
    - j400, a10_j450, 4j100, 5j85, 6j50.0eta24, ht1000
- Current default calibration: **em_subjes**
  - Plus cross check chains with different calibration for a few specific thresholds
- Additional chains to add segmented eta ranges
  - [0, 2.5] for e.g. b-tag (ID coverage)
  - [2.8, 3.2] + [3.2, 4.9] for granularity in forward region
- In each scenario, total jet menu rate adds up to around 100Hz

Chain Type	L1 Seed at $0.5x10^{34}$	HLT Item at $0.5x10^{34}$	L1 Seed at $2x10^{34}$	HLT Item at $2x10^{34}$
Single jet	J75	j360	j100	j400
Single fat jet	HT150	j360_a10	HT190	j450_a10
4 jets	3J40	4j85	3J50	4j100
5 jets	4J15	5j60	4J20	5j85
6 jets	5J15.0ETA24	6j50.0ETA24	5J15.0ETA24	6j50.0ETA24
HT trigger	HT190	ht800	HT190	ht1000

Software de trigger de jatos



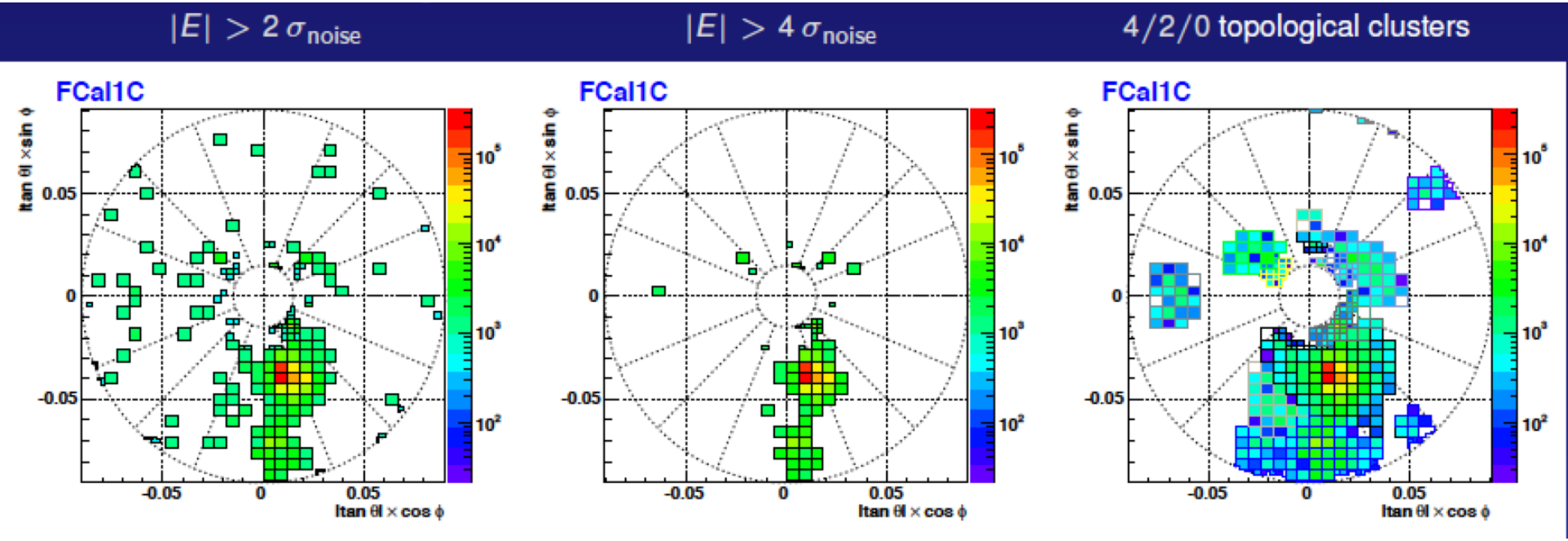
Changes Since Run 1

- No L2 anymore
  - And no EF, just High Level Trigger
- Move as close as possible to offline jet reconstruction
  - Add pileup subtraction (jet area)
  - Recover from L1 bias in close-by jets
  - Get best possible ET resolution to optimize use of bandwidth
    - Use offline calibration schemes
- Two possible readout schemes:
  - Full-scan of calorimeter: more accurate but takes time/CPU
  - Partial-scan as plan B if needed: no pileup subtraction
- Ongoing: Use L1.5 Trigger Tower full scan to reduce input HLT rate

TopoClustering, Full and Partial Scan, and all that…

- Several techniques developed and maintained in the offline world that are needed in trigger
  - Pileup suppression will become more important
  - Calibration should be taken from offline
  - We don't have the capability to keep maintain our own versions (and would complicate things)

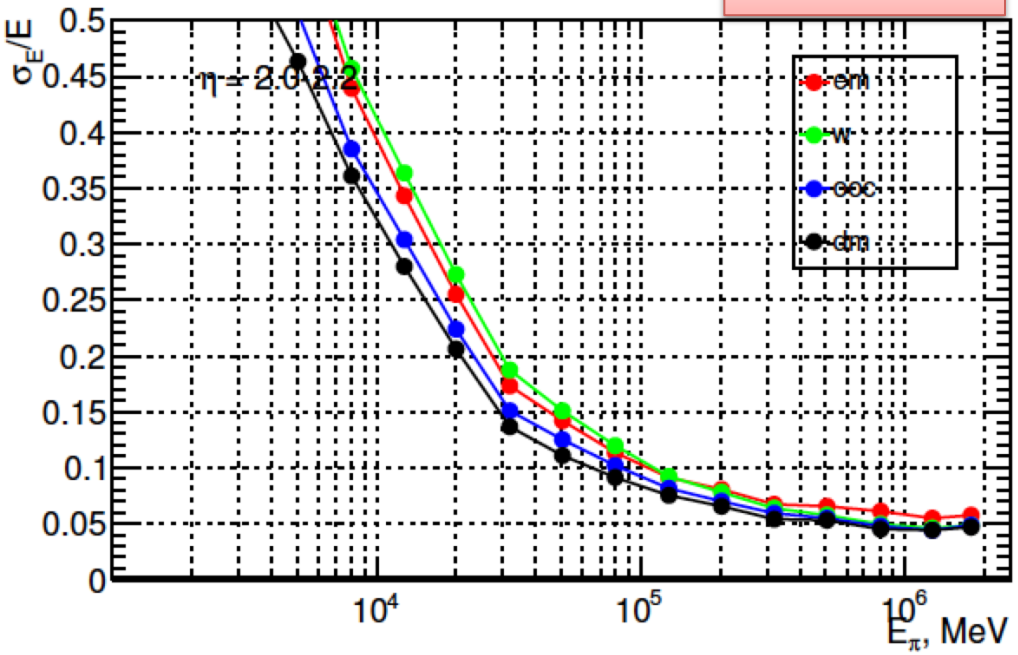
- TopoCluster making:
  - 3D groups of adjoining cells started from seed cells (4σ above noise)
  - Add adjoining cells if above 2σ above noise, plus an extra layer 0σ above noise (4/2/0 scheme)
  - Split initial clusters into smaller ones surrounding hot spots – splitting
  - Following that: calculate cluster moments, classify clusters (EM/HAD), apply calibration, find jets, calibrate

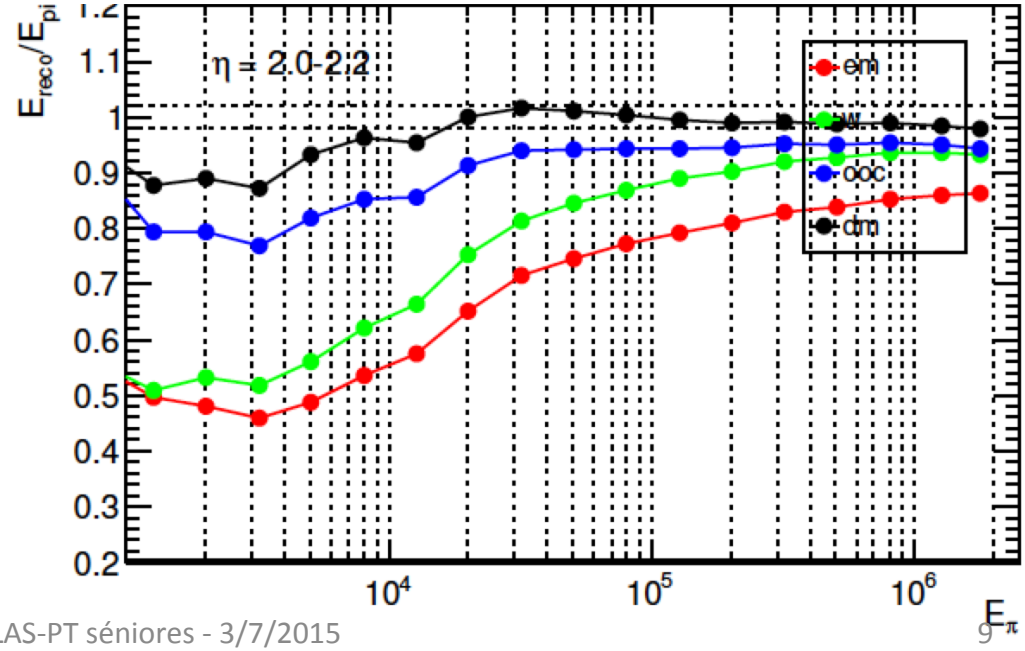


Calibration

- Resolution and linearity improvement for charged pions after each correction:
  - EM
  - LCW
  - Out of cluster
  - Dead material
- Conditions:
  - <μ>=0
  - IBL geometry
  - 2<|η|<2.2
  - 4 samplings

Sven Menke





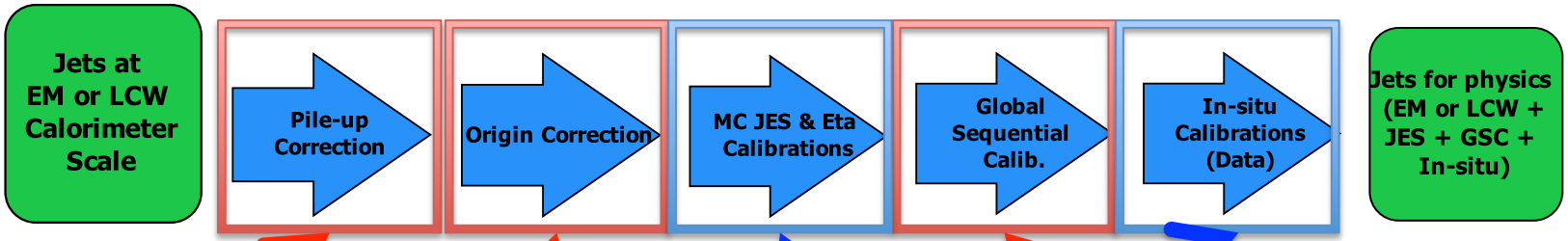
Overview of the offline jet calibration

Begin with input jets...

1. Jet area and residual pile-up corrections decrease effects from pile-up conditions
2. Origin correction points reconstructed jet to primary hard scatter vertex
3. MC energy & η calibrations correct for effects such as leakage, dead material and noncompensation
4. Global Sequential Calibration (GSC) uses global variables to improve energy resolution and decreases systematics such as dependence on jet flavour
5. In-situ calibration applied to data uses reference objects to validate MC calibrations against data

... Jets ready for physics!

Overview of the offline jet calibration



Begin with input jets...

1. ...area and residual pile-up ...decrease effects ...conditions ...reconstructed hard scatter vertex
3. MC energy & η calibrations correct for effects such as leakage, dead material and noncompensation
4. ...Global Sequential Calibration ...es global variables to ...ne... ...sy... ...ce...
5. In-situ calib... data uses reference objects to validate MC calibrations against data

... Jets ready for physics!

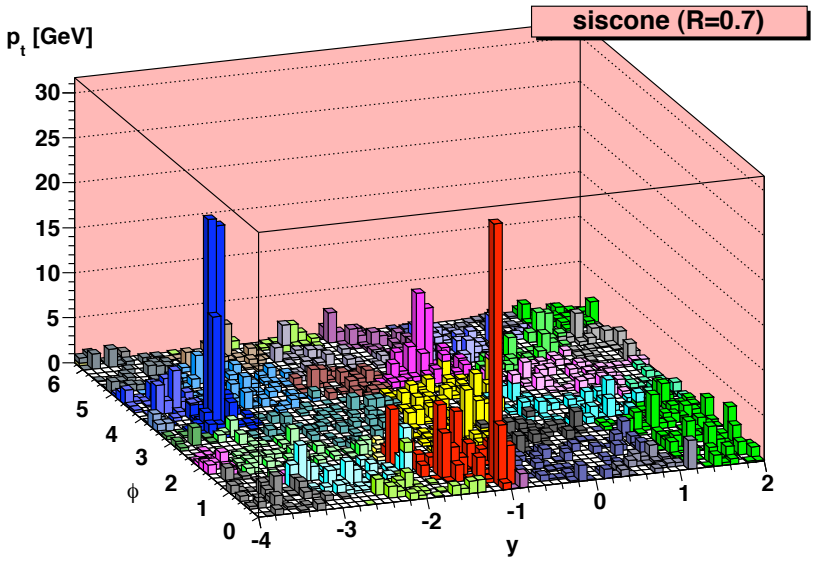
Requires full event topoclusters for rho calculation

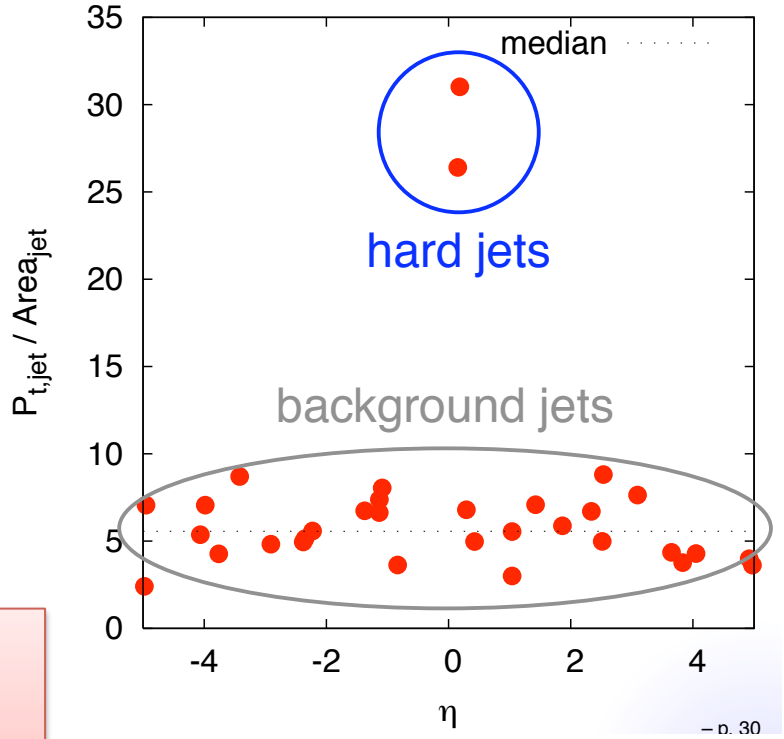
Requires full event tracks and PV identification

Only requires derived constants: f(pT, eta)

Requires extra jet info like layer energies and full tracking info

Pile-up subtraction: rho



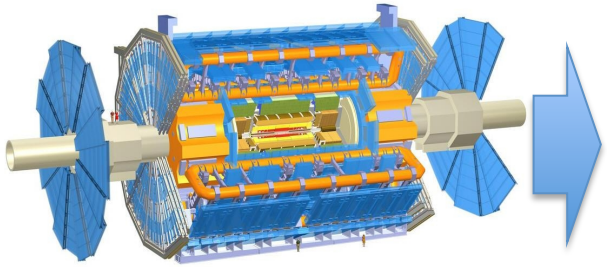


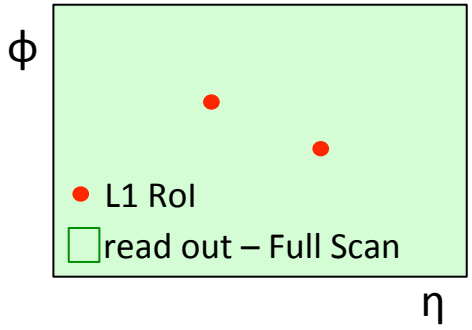
$$\rho = \text{median}\left\{\frac{p_{j,t}}{A_{j,t}}\right\}$$

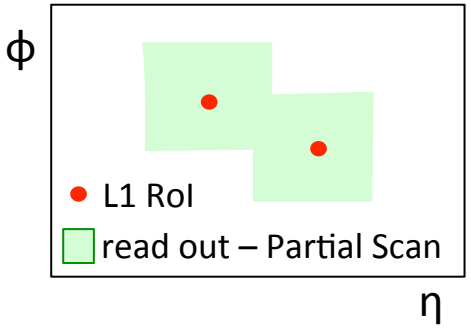
Requires full event topoclusters for rho calculation

$$p_{t,\text{subtracted}} = p_{t,\text{jet}} - \rho_{\text{pileup}} \times \text{Area}_{\text{jet}}$$

Full Scan e alternativas







- Partial Scan Made in LIP! (Ademar)
  - CPU time muito mais pequeno do que Full Scan
  - Performance muito razoável
  - Diferenças maiores em topologias de multijatos
- Bottom line:
  - Default: Full Scan – o maior ajuste possível ao offline
  - Alternativa: Partial Scan – a nossa apólice de seguro para alta taxa de contagem
- Outra alternativa: L1.5
  - Full scan usando Trigger Towers
  - Menor granularidade (7k TTs em vez de 200k cells) – muito mais rápido
  - Performance: resolução parecida ao L1

Ademar Delgado

Partial vs Full Scan – Timing Summary

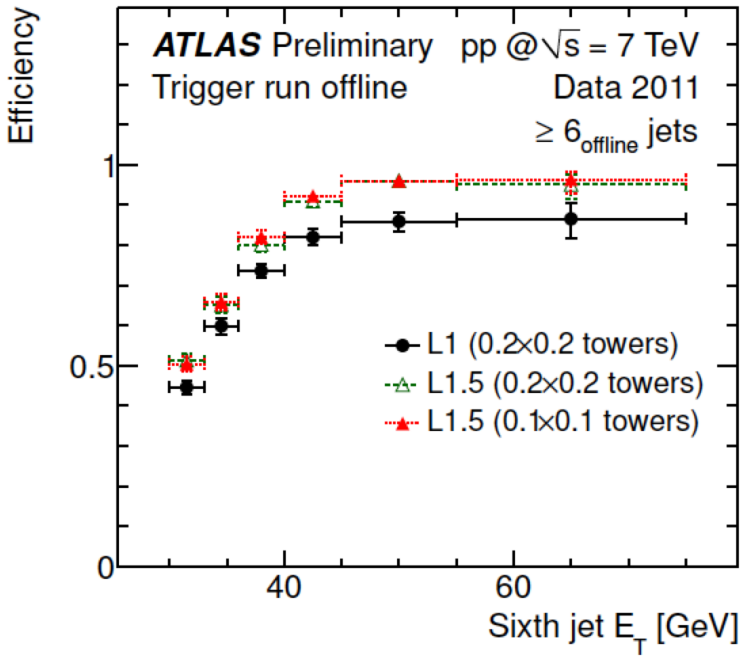
- **NOTE: indicative numbers only!**
- Cluster making time roughly same as calibration
- PS much less than FS but longer tails
- Small effect from pileup
- Comparing to r.17:
  - 6% increase in clustering in r.19
  - 6x reduction in cell container making (60 to 10ms/evt)

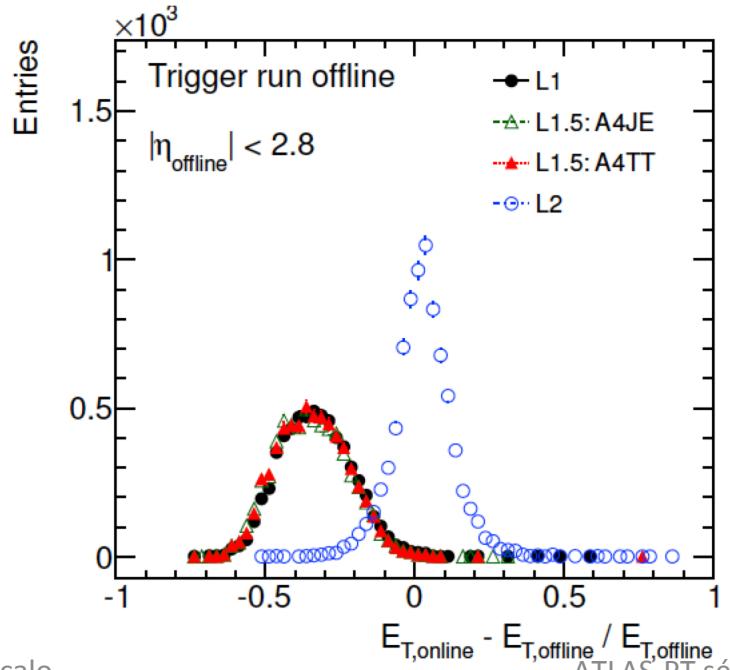
Clustering [ms]	<μ>=40	<μ>=80	Calibration [ms]	<μ>=40	<μ>=80
Cells	9.9	9.7	Moments	27.0	29.7
Clusters	53.7	52.7	Dead Material	18.5	17.2
Cluster splitting	57.7	61.9	Out of cluster	17.8	16.3
Full calorimeter scan			Local calibration	23.9	26.4
			Out of cluster Pi0	17.8	16
Totals:	121.3	124.3	Totals:	105	105.6

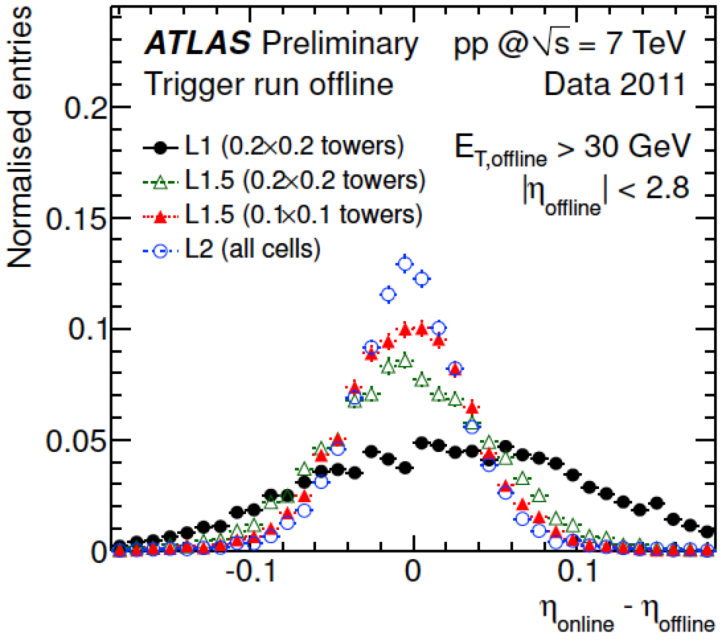
Clustering [ms]	<μ>=40	<μ>=80	Calibration [ms]	<μ>=40	<μ>=80
Cells	4.9	5.1	Moments	2.3	2.5
Clusters	4.8	5.4	Dead Material	2.1	2.4
Cluster splitting	6.0	6.6	Out of cluster	2.0	2.2
Partial calorimeter scan			Local calibration	2.9	3.2
			Out of cluster Pi0	2.0	2.2
Totals:	15.7	17.1	Totals:	11.3	12.5

L1.5 performance

- The TriggerTower full scan recovers L1 inefficiency for close-by jets
  - See ATL-COM-DAQ-2012-009
- Reasonable spacial resolution
- Energy resolution same as L1
  - See ATL-COM-DAQ-2012-009



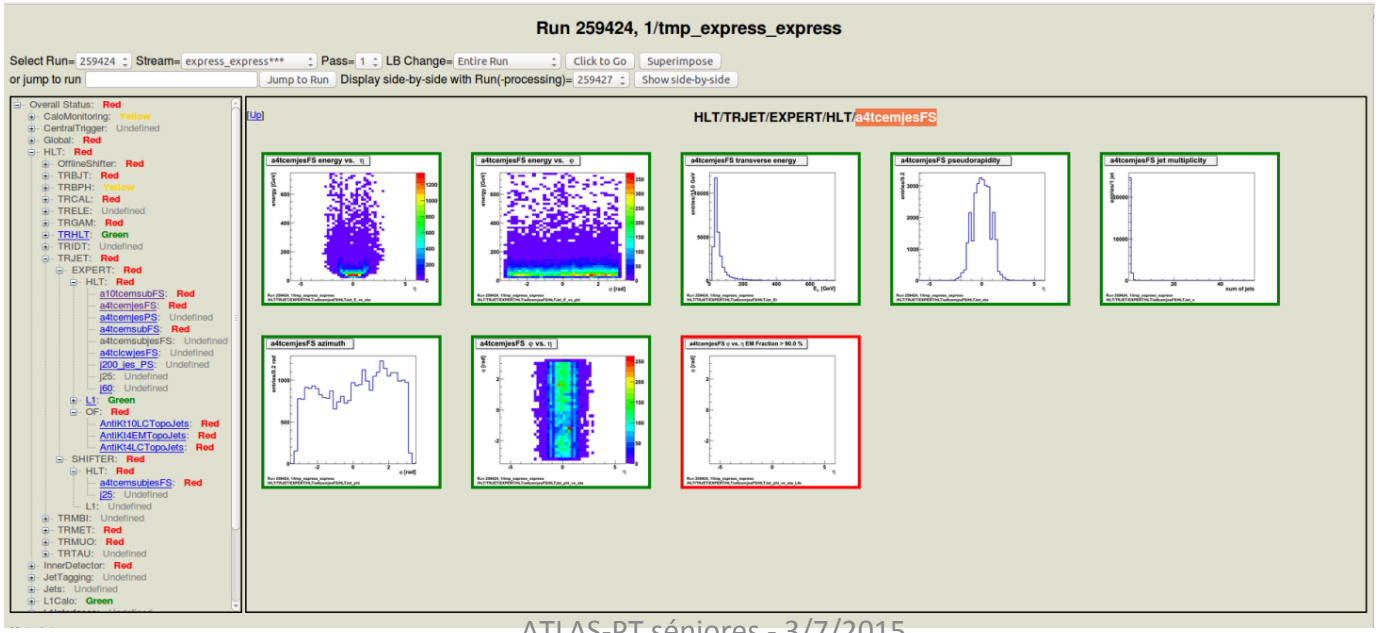




Operações

Monitoring e commissioning

- Offline monitoring em dia e bem mantida
  - Equipa de 3-4 slice experts a trabalhar desde fim de 2014 em Milestone Weeks (M weeks)
  - Código da responsabilidade de Louisiana em constante evolução e melhoramento
  - Plano de adicionar plots de eficiência e de rate/Lumi vs #lumi block para ter indicadores independentes da luminosidade instantânea
- Commissioning:
  - Estratégia foi ter software novo online o mais cedo possível – desde M5
  - Partial scan, full scan, jet area subtraction (pileup), várias calibrações etc
  - Tudo testado com raios cósmicos permitindo testar também software de monitoring
  - Testado de novo em beam commissioning periods e primeiras colisões



Express stream

- See wiki: https://twiki.cern.ch/twiki/bin/view/Atlas/ExpressStream#E34_menu_Physics_pp_v4_menu_coll
- The express stream has the following features:
  - Contain a subset of the physics data corresponding to ~10Hz total.
  - Full events (unlike the calibration stream) but not for physics analysis.
  - Every event in the express stream will also be in the physics streams.
  - Will be reconstructed quasi-real time and looked at promptly (before the main reconstruction starts) for calibration and monitoring.
  - Used to check data quality, monitor the status of the detector, alignment and calibration, etc.
- Jet menu in express stream (looking for voluntary for contact person):

Trigger name	Desired rate in Hz	Short Motivation	DQ contact person
j25	0.8	from L1_RD0; calo & jet monitoring & calibration	Ricardo Goncalo
j60_L1RD0	0.2	jet/MET monitoring & calibration; bootstrapping	Ricardo Goncalo
j60	0.2	jet/MET monitoring, eta inter-calibration	Ricardo Goncalo
j60_280eta320	0.2	jet/MET monitoring, eta inter-calibration	Ricardo Goncalo
j60_320eta490	0.2	jet/MET monitoring, eta inter-calibration	Ricardo Goncalo
j360	0.2	from L1_J100; jet monitoring for high-pT chains	Ricardo Goncalo
j80_xe80	0.2	jet/MET monitoring for combined chain	Ricardo Goncalo

Futuro…

O que falta…

- Documentação:
  - Nota interna a documentar trigger de 2015 (menu, software, monitoring,…)
  - CONF note com resultados de performance inicial no Run II
  - Paper de 2011 ainda não acabado…
- Jet trigger software maintenance & development
  - Bus problem…
- Trigger Jet Energy Scale:
  - a caminho… Louisiana (M.Wobisch) e Weizmann (Merlin Davies)
- Estudos de performance:
  - Janela de oportunidade agora – CONF note on jet trigger performance with early data
  - Contribuição mais tarde para paper de performance de run 2?

Trigger de jatos no LIP

- O nosso grupo manteve uma posição importante no trigger de jatos nos últimos anos
  - Essêncial manter esta posição: fonte de projetos de qualificação para estudantes, fonte de OTP, valorizada a continuidade a nível institucional em ATLAS, etc
- OTP:
  - Classe 1:trigger expert
  - Classe 2: jet/E_T^{miss}/HLTCalo trigger on-call expert – possibilidade de shifts remotos (menos despesas)
  - Classe 3: contribuições com software development&maintenance, estudos de performance para tuning e publicações, para ATLAS authorship, etc
- Person power:
  - Até 1 de Janeiro 2015:
    - Patricia, Ademar, Lourenço, Mário, Ricardo, Rob – SW maintenance, performance, etc
  - Desde 1 de Janeiro:
    - Ricardo – shifts classe 1 e 2, coordenação (classe 3)
  - Desde 1 de Julho: ninguém!
- Muito importante termos envolvimento sério a partir de Setembro/Outubro
  - Nenhum candidato óbvio!
  - Possibilidade: Lia – estudos de performance no âmbito de mestrado?
    - Sim, mas não resolve o problema: vai precisar de tempo de aprendizagem; início do mestrado incerto, etc.

Conclusões

- Temos mantido uma presença importante no trigger de jatos
  - Esforço importante durante o último ano de shutdown resultou!
  - Trigger de jatos agora sólido e funcional, com ainda maior potencial que no fim do run 1

- Mas o futuro é incerto!
  - Estudos para o upgrade a evoluír a bom ritmo (não é contribuição para as operações do ATLAS atual)
  - Mas precisamos urgentemente de identificar pessoas para contribuir para o trigger de jatos atual!