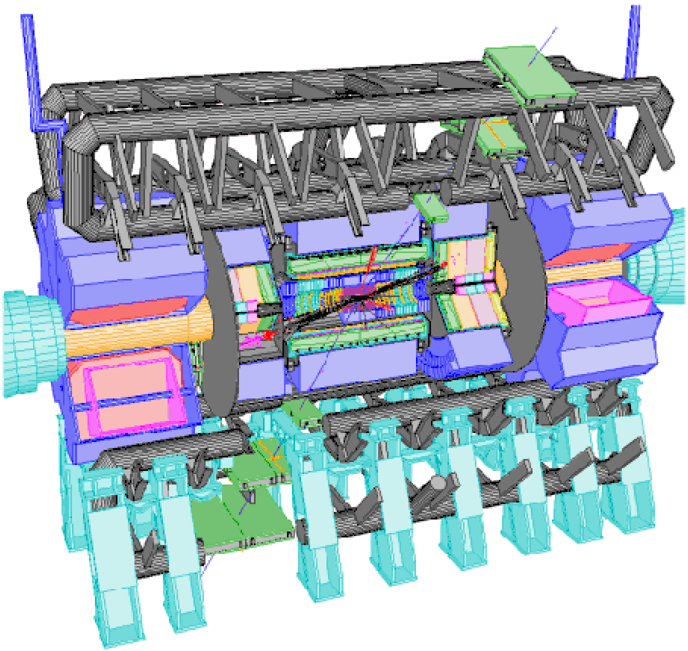
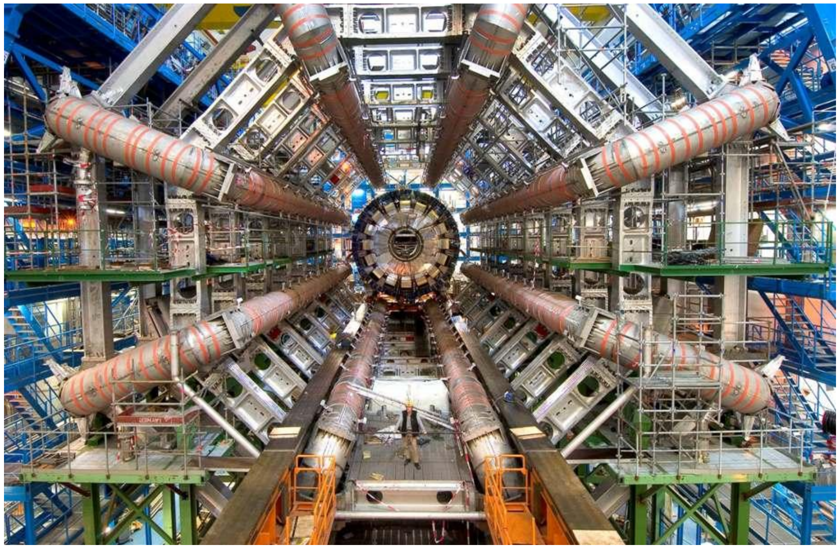
ATLAS – China/SACLAY (CEA-IRFU-SPP)





Atlas-China-Saclay : LHC-ACC-CEA project

- **CEA-Saclay group:**
  ~ 30 physicists
- ***LAr Calorimeter***
- ***Muon Spectro***
- **Physics topics**
  - **SM (W,Z)**
  - **Top**
  - **Z'**
  - **Higgs -> 4l**

LHC-ACC-CEA-Atlas: **Title of the project**

French Group			Chinese Group		
Name	**Title**	**Affiliation**	**Name**	**Title**	**Affiliation**
Leader: Bruno Mansoulie	Dr.	IRFU/SPP	Leader: JIN Shan	Prof.	IHEP
Anne-Isabelle Etienvre	Dr		YU Jie	phD	NJU
LIAO Hongbo	Dr		XU Chao	phD	USTC
Jean-Pierre Meyer	Dr		CHEN Shenjian	Prof.	NJU
Jérôme Schwindling	Dr		JIANG Yi	Prof.	USTC
Eric Lançon	Dr		ZHANG Xueyao	Prof.	SDU
Paul Colas	Dr		ZHAO Zhengguo	Prof.	USTC
			Liang HAN	Prof.	USTC

In Chinese cluster:
IHEP
NJU
SDU
USTC

LIAO Hongbo(IHEP): 2 years at Saclay

YU Jie (Nanjing) and XU Chao (USTC) : students , codirected theses (CEA, Univ Paris-Sud)

Collaboration topics

Physics analysis *(simulations, preparing for real data)*:

- **Top quark**
  - Top mass (A-I Etienvre, A Marzin, J-P Meyer, J Schwindling) — > 5 years
    in particular b-jet calibration (LIAO Hongbo) — > 1 year
  - Top cross-section (J S, YU Jie) — > 5 months

- **Standard Model**
  - Z, Z+jets cross-section (E Lançon, XU Chao) — Starting

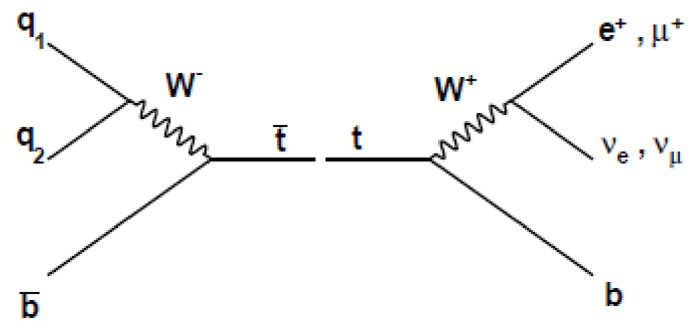
Atlas upgrade: — Future

- Micromegas for forward muon chambers at high luminosity
  (USTC, Paul Colas, with IRFU detector division)

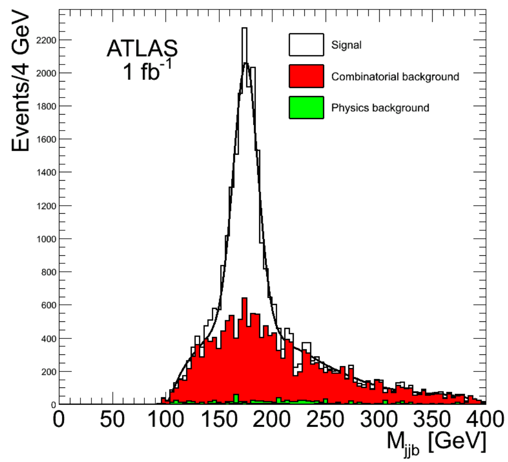
Top mass studies

- **Several methods have been developed with time**

- **1) invariant j-j-b mass**
  - Choice of jets algorithm
  - JES: rescale light jets to W mass
  - ISR/FSR
  - B-tag: optimal?



CSC note
« Top quark mass measurement »



Systematic uncertainty	[illegible]
Light jet energy scale	0.2 GeV /%
b jet energy scale	0.7 GeV /%
ISR/FSR	$\simeq$ 0.3 GeV
b quark fragmentation	$\leq$ 0.1 GeV
Background	negligible
Method	0.1 to 0.2 GeV

δm(top) : 1 GeV for 1% Jet Energy Scale uncertainty for 1 fb^{-1} . No bias .

Top mass cont'd

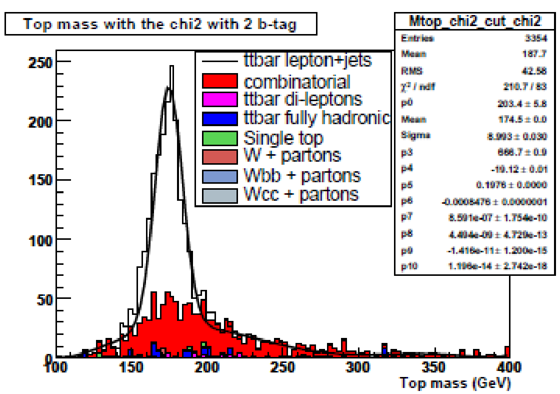
- **2) Kinematic fit of the final state (calibrates jets energy scale to W mass)**

$$\chi^2 = \sum_{4jets+lepton} \left(\frac{E_{jet}^{mes} - E_{jet}^{fit}}{\sigma_E} \right)^2 + \left(\frac{M_{jj} - M_W^{PDG}}{\Gamma_W^{PDG}} \right)^2 + \left(\frac{M_{l\nu} - M_W^{PDG}}{\Gamma_W^{PDG}} \right)^2$$
$$+ \left(\frac{M_{jjb_{had}} - 0.7 - M_{top}^{fit}}{\sigma_{top_{had}}} \right)^2 + \left(\frac{M_{l\nu b_{lept}} - 0.4 - M_{top}^{fit}}{\sigma_{top_{lept}}} \right)^2$$

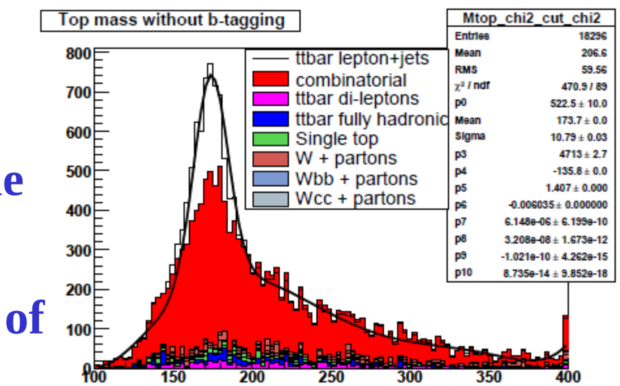
- **Minimizes χ^2 for each combination of jets and $p_z(\nu)$**

- **With b-tag:**

Precision on mtop similar to (1), with 2.5 less background



Without b-tag, already possible with 100 pb^{-1} with stat error of 0.4 GeV



Top mass cont'd

- **3) Template method : simultaneous measurement of mass and JES**
  - Reconstruct final state with fit
  - Templates from M-C for different Mtop and different JES both for signal and main backgrounds
  - Comparison of (pseudo)data to templates=> Mtop and JES.

Reduces syst error from light jets energy scale. Good results at low statistics

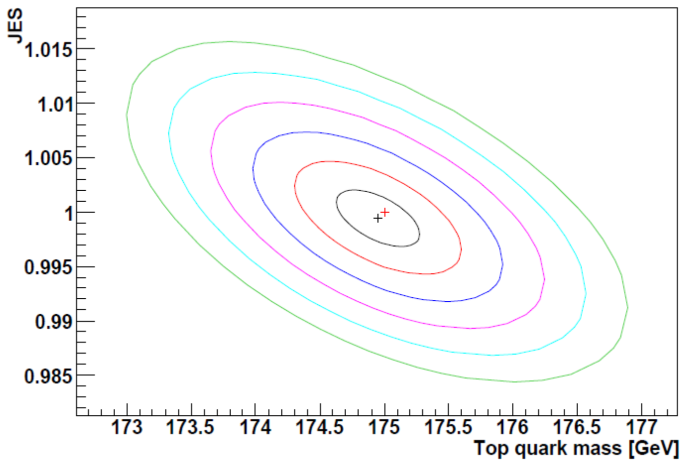


Figure 11: Contours at s-standard-deviations (s = 1,2,...,6) for a top quark mass generated at 175 GeV and a JES generated at 1 (red cross). with $N_s = 3357$ and $N_b = 520$ ($\mathcal{L} = 850$ pb^{-1}). The likelihood fit leads to $m_{top} = 174.95 \pm 0.33$ GeV and JES = 0.9994 ± 0.0027 (black cross).

Source of uncertainty	Estimation
Global jet energy scale	0.2 GeV
Difference between light JES and b JES	0.6 GeV/%
ISR/FSR	0.4 GeV
b-tagging performance	negligible
$\not{E}_T$ uncertainty of 5 %	0.1 GeV
jet energy resolution uncertainty of 20 %	0.1 GeV
Statistic	0.3 GeV
Method	negligible

For 850 pb^{-1}

b-jet energy scale

- **Essential for ultimate top mass measurement**

1% error on light jet energy → 0.2 GeV on top mass ; light jets calibrated « in-situ »

1% error on b jet energy → 0.7 GeV on top mass

- **Need to calibrate b jets (or the b/light ratio) using other processes**

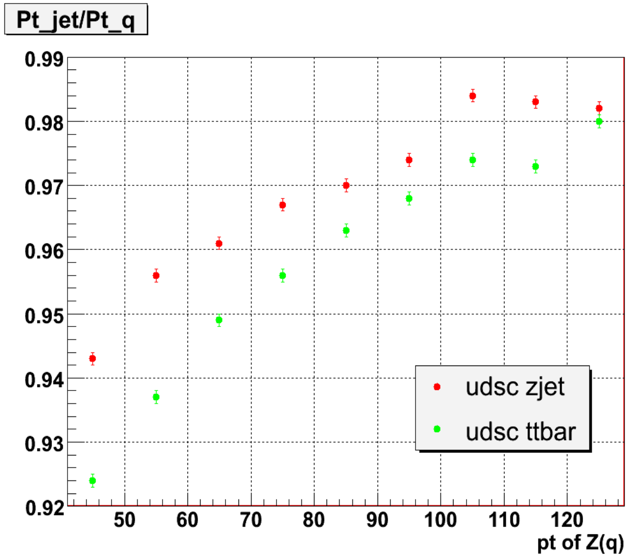
  ⇒ **Comparison of JES in Z+jet and ttbar events**

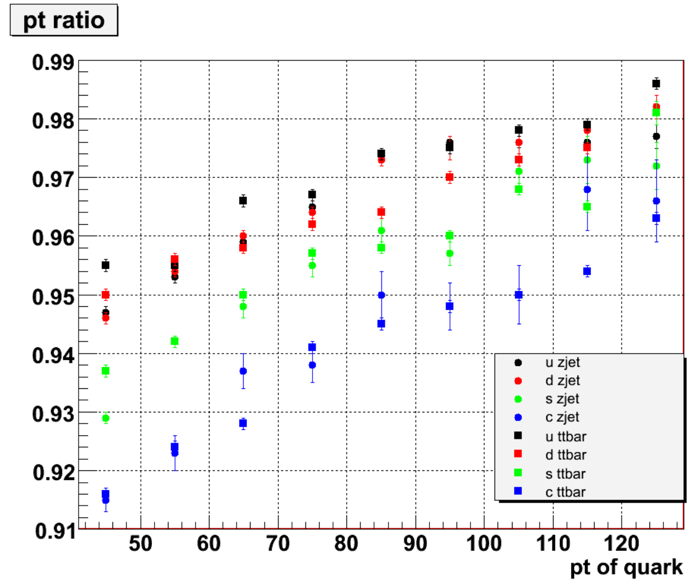
- Full simulation; Pythia qg → Zq, qq → Zg, with Z → μμ

- 1.5M events → 5.7 fb^{-1}.

- Cuts after reconstruction: $p_T(Z) > 40$ GeV; only 1 jet; $\Delta\phi$ (jet – Z) > 3

b-jet energy scale: do we understand light jets?





$R_q = p_T(jet)/p_T(q)$; higher for Z + j than for ttbar.

But same for the same flavor

due to Ru = Rd > Rs > Rc

and different flavor mix

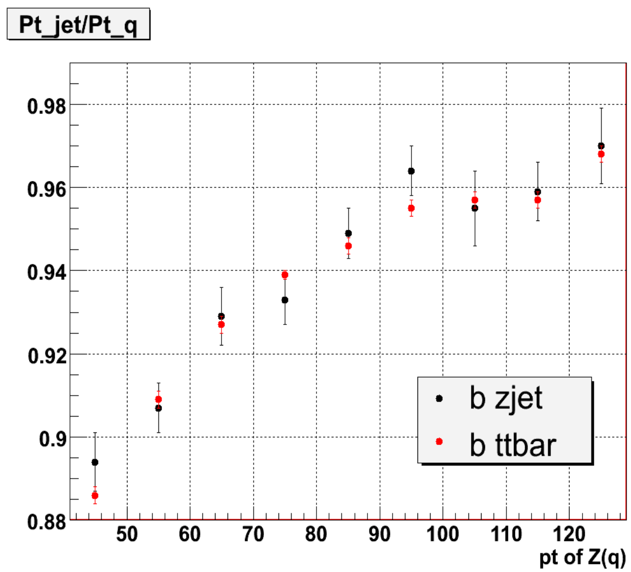
	Z+jet	ttbar
u	43%	28%
d	33%	23%
s	15%	23%
c	10%	27%

jet energy scale in Z + jet

- **Effect of Initial State Radiation: with ISR, $p_T q/p_T Z$ decreases by 2%**

- **20% gluon jets in Z+ jet, Rg = 0.92 x Rq => global JES in Z+jet lower than udsc JES by 1.5%**

- **b JES in Z+ jet similar to b JES in ttbar**



- **b jet contaminated by udscg. 1.5 M Z + jet => after b-tagging : 6062 b, 2377 c, 2319 udsg.**

Summary of study on b-jet energy scale

- **Several differences between jets in Z+j and jets in ttbar events**

To calibrate b jets, we must take them into account:

- **Different P_T distributions**
- **Contribution from gluon jets**
- **Effect of gluon ISR**
- **Non perfect b-tagging**

- **Impact of systematics for top mass: in progress.**
- Check vs TeVatron errors? (no such study known…)

- **To be presented at CERN on March 25th**

Top cross-section

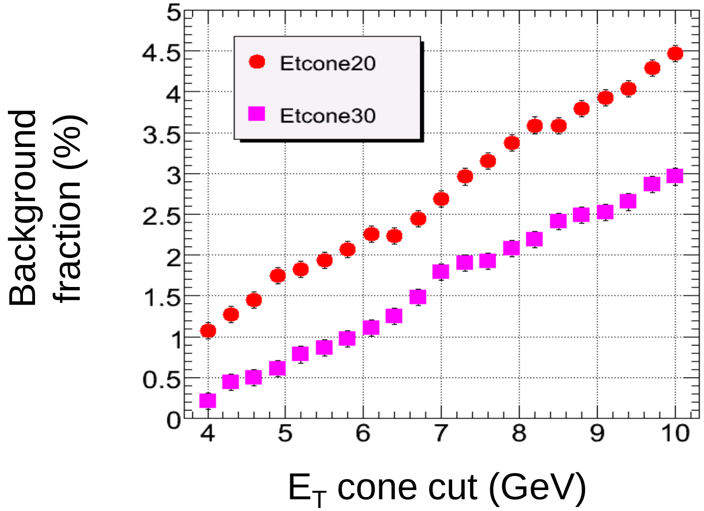
- **Work very complementary to top mass measurement:**
  - **Same tools, data samples, …**
  - **Maybe same event selection (but may want simpler selection for smaller systematics)**
  - **Different systematics (Jet Energy Scale less important, selection efficiency more important)**

- **Measure cross section for tt → lνb + qqb (l = e or μ), but maybe also lνb + lνb**

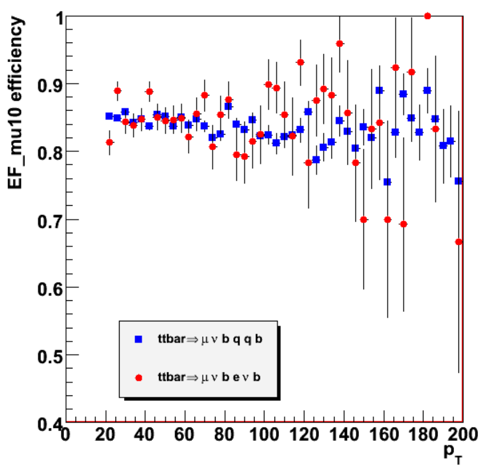
- **Work before data taking**
  - **estimate the systematics from selection, trigger efficiency, backgrounds**
  - **try to design ways to measure them using real data**

Top cross-section: ongoing studies

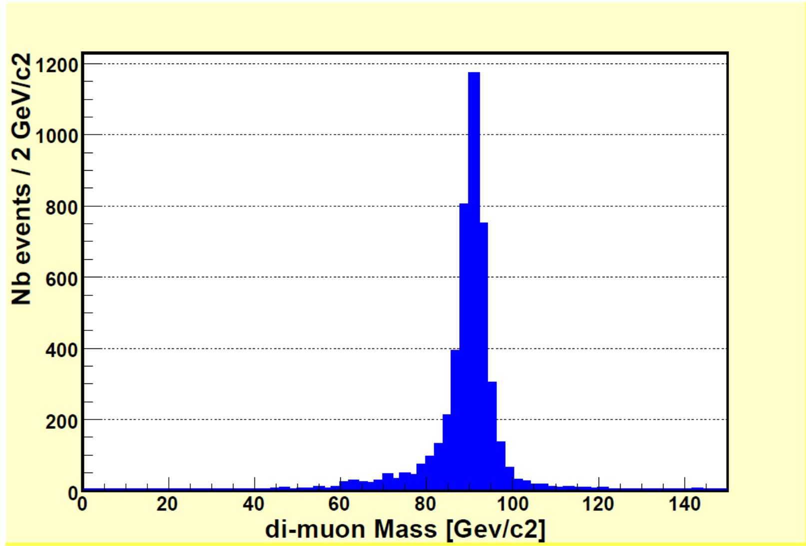
- **Lepton isolation**
  - **Contribution of backgrounds**



- **Trigger efficiency**
  - **Measure with ll events**
    - **Backgrounds ?**



Z and Z+jets



- **Z and Z+jets cross-section**
  - **Fast measurements with early data**
  - **Use tools developed in the group**
  - **Useful for a number of backgrounds**

- **Thesis roadmap**
  - Z -> ll (l = e,μ) event selection
  - Determination of lepton momentum scale and resolution from Z-mass constrained fit
  - Study of lepton isolation and reconstruction efficiency
  - Differential distribution of Z-boson P_T
  - Distribution of number of jets produced in association with a Z-boson

Hardware: Atlas upgrade

- **At SLHC, rate too high in forward muon chambers**

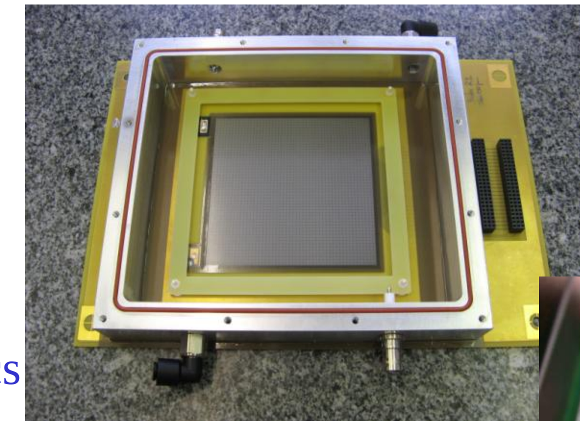
  => Replace with high rate tolerant device.

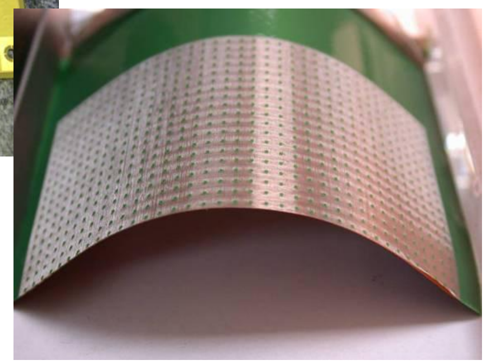
  Try to combine trigger and precision in one device : micro-pattern chamber

  RD 51 project at Cern

- **Saclay development: Micromegas *Strong team in SEDI, IRFU's detector division***
  - Used in: Cast, Compass, T2K… in ~medium area devices (30x30 cm)

- **Adapt to Atlas upgrade**
  - R&D on device
    - « Bulk » technology
    - Size => 1m x 1m
    - Resistive film
  - System design: adapt geometry, electronics





- **Collaborate with USTC on all aspects.**
  - Test beams

Conclusion

- **LHC-AAC-CEA project well started on analysis**

- **Nice prospective for Hardware on the Atlas upgrade**

- **Many thanks to several people**
  - **FCPPL chair: *Lydia, Olivier***
  - **Agencies, institutes and participants**
  - **Universities (*and their administrative staff*)**
  - **French Embassy in Beijing (*in particular Nuclear Advisor Service/ Damien Murat*)**

… and to our hosts in Wuhan of course.

Thanks!

谢谢