

# Higgs@ENIGMASS

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*Projets Post-Docs ENIGMASS 2012, Annecy-le-Vieux*

# Higgs: Au centre et au coeur du Projet ENIGMASS

la preuve?

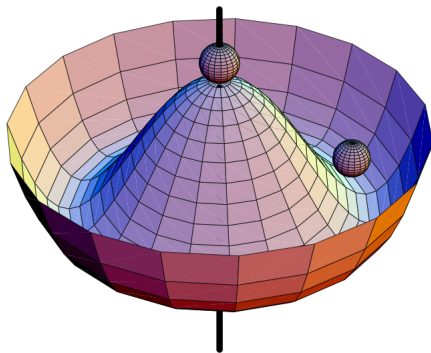
## Higgs: Au centre et au coeur du Projet ENIGMASS

# Enigmass

A stylized orange graphic representing a particle path. It features a solid orange line that forms a curve with a minimum at the bottom, where a small black sphere is positioned. From this minimum, the path splits into two branches: one is a dashed orange line that spirals upwards and to the right, and the other is a solid orange line that curves upwards and to the right.

The enigma of the mass

# Higgs: Au centre et au coeur du Projet ENIGMASS



# Higgs au coeur du Projet

Figure 1 shows our tentative schedule and milestones.

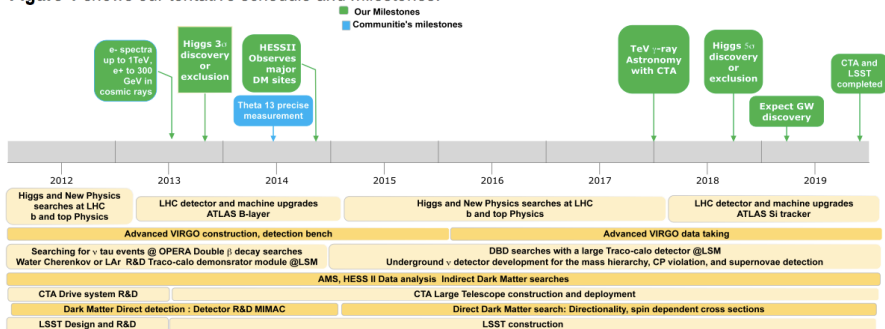


Figure 1 : The ENIGMASS Time line

Depuis juillet 2012, l'urgence est encore plus grande, le recentrage essentiel!

Figure 1 shows our tentative schedule and milestones.

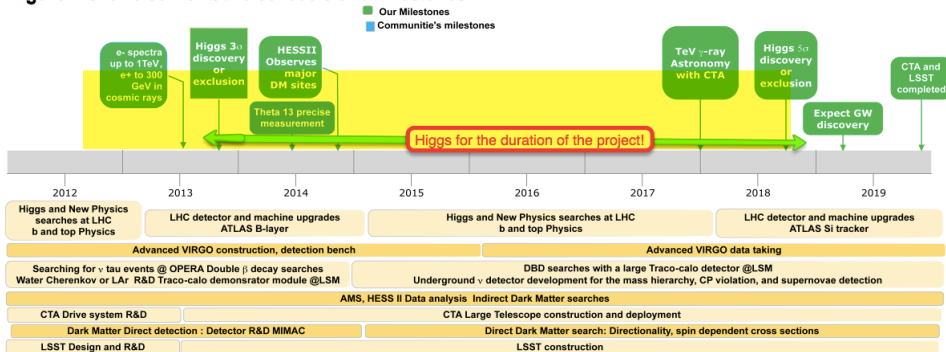


Figure 1 : The ENIGMASS Time line

The image shows a tilted screenshot of a BBC News website article. At the top, the BBC logo is visible. The main navigation bar includes 'NEWS SCIENCE & ENVIRONMENT' and various news categories: News, Sport, Weather, Travel, Future. A secondary navigation bar lists regional sections: Home, UK, Africa, Asia, Europe, Latin America, Mid-East, US & Canada, Business, Health, and Sci/Environ. The article is dated '4 July 2012' and was last updated at '07:35 GMT'. The headline reads 'Higgs boson-like particle discovery claimed at LHC'. Below the headline, it says 'COMMENTS (1665)' and 'By Paul Rincon, Science editor, BBC News website, Geneva'. There are social media sharing icons for Facebook, Twitter, and Email, along with a '27K Share' button. The main image shows a large group of people in a conference hall, many with their arms raised in celebration. A play button icon is overlaid on the image. Below the image, the text reads: 'The moment when Cern director Rolf Heuer confirmed the Higgs results' and 'Cern scientists reporting from the Large Hadron Collider (LHC) have claimed the discovery of a new particle consistent with the Higgs'. At the bottom right of the article preview, it says 'Related Stories'.

News | Sport | Higgs boson

# SHORTCUTS BLOG

A SIDEWAYS LOOK AT THE NEWS

Home UK

4 July 2012 Last

## Higgs boson claimed at CERN

COMMENTS (1665)


By Paul Rincon  
Science editor, BBC News website, UK

Blog home

### How to explain Higgs boson discovery

Everyone's talking about the 'God particle' – but what if someone asks you to explain it. Well, it depends if it's an A-level physics student or a religious fundamentalist. Just use our guide

Don't try this one: Professor Peter Higgs with a description of the Higgs model.  
Photograph: Murdo Macleod



The moment when Cern director Rolf Heuer confirmed the Higgs results

Cern scientists reporting from the Large Hadron Collider (LHC) have claimed the discovery of a new particle consistent with the Higgs boson

Related Stories



# Sujet d'actualité

News Sport Higgs boson

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Home UK

CCUEIL > LA CHRONIQUE DE FRANÇOIS REYNAERT > CLASSE HIGGS

## Classé Higgs

Publié le 03-08-2012 à 19:50 - Mis à jour le 04-08-2012 à 08:10

le vrai peuple de l'été ne sort pas d'une soirée mousse à Ibiza, mais d'un accélérateur des particules à Genève. Alors, osons le boson.

Par François Reynaert

Abonnez-vous au Nouvel Observateur

REAGIR 5

Partager



lots-cats : chronique, François Reynaert, Justin Bieber, physique, Boson de Higgs

RECOMMANDER 37 R+1 3

Partager



f the Higgs model.

**SUR LE MÊME SUJET**

- VIDEO. Boson de Higgs : le Cern découvre une nouvelle particule

... des particules, on n'y comprend donc rien. (P@P@P@K)

... une célébrité qui tranche en

... on voit s'ébrouer en

... mis la main

... Vous voyez qui ?

... que vous autres, en

... séparation de

... Privar

CCJUEL -> LA CHRONIQUE  
Classé Hig  
tré le 03-09-2011  
e vral  
icclé



# M Idées

IDÉES

Les débats

Think tanks

Points de vue

Editoriaux

Opinions du Monde

Analyses

Ide

## La découverte du boson de Higgs, symbole de l'excellence européenne

LE MONDE | 28.07.2012 à 14h47 • Mis à jour le 31.07.2012 à 09h17

Par François de Rose

Abonnez-vous à partir de 1 €



Réagir



Classifier



Imprimer



Envoyer

Partager



Recommander



Envoyer



83 personnes le recommandent. Sign Up pour voir ce que vos amis recommandent.

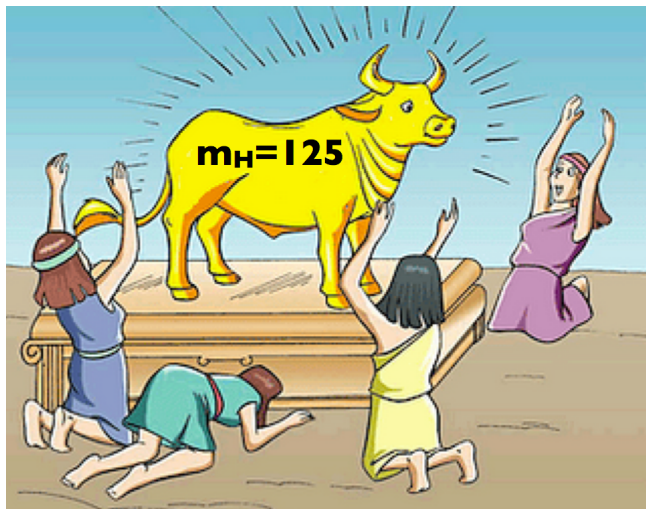


On a découvert le Higgs. Une grosse partie de l'énigme est résolue?

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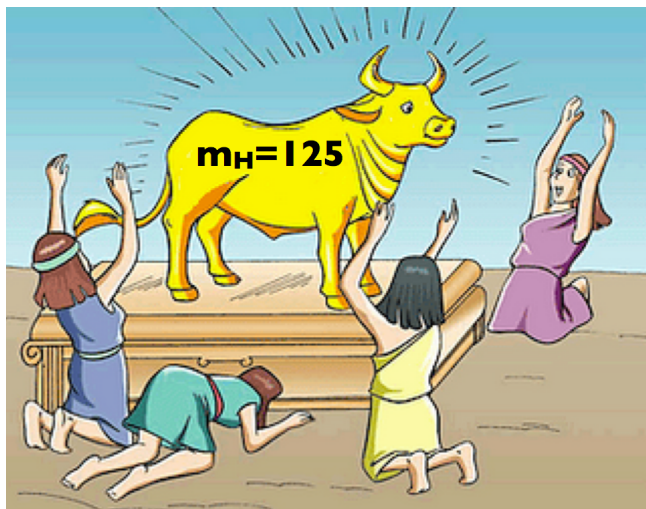
On nous coupe le financement?

Hare Higgsna, Hare Hare...



*from Adam Martin, from?*

Hare Higgsna, Hare Hare...



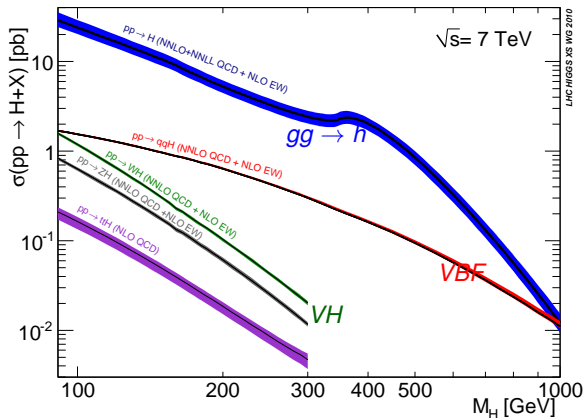
why not just praise the Lord and the SM

The holy cow has got 4 legs: 3 Goldstones and one scalar

## Hare DonkeyColour

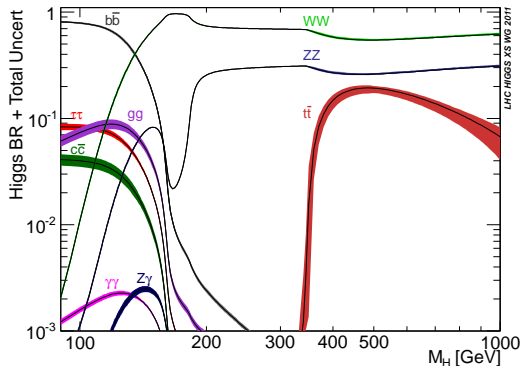


# The Standard Model Higgs search : production





# The Standard Model Higgs search : channels



for  $m_h = 125\text{GeV}$

$\Gamma_h = 4.2\text{MeV}$

$h \rightarrow b\bar{b}$  56%

$h \rightarrow WW^*$  23%

$h \rightarrow \tau\tau$  6%

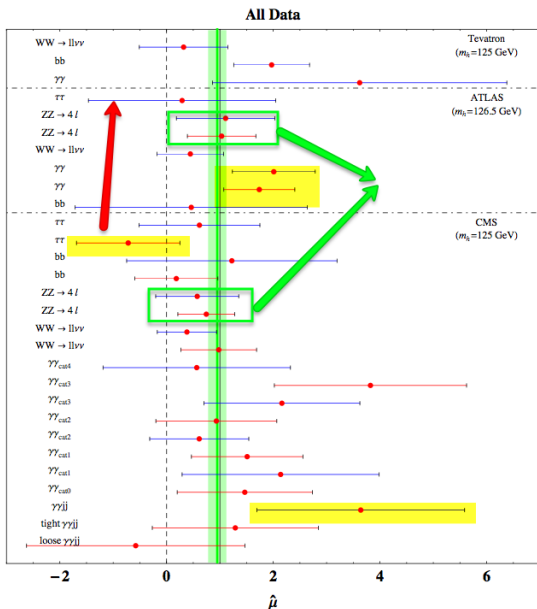
$h \rightarrow ZZ^*$  3%

$h \rightarrow \gamma\gamma$  0.2%

Thank you Nature=Hare Higgsna!

## The Standard Model Higgs search : channels

- ▶  $\gamma\gamma$  : low masses
  - ▶ can probe VBF with  $\gamma\gamma + 2j$
- ▶  $ZZ$  : different subchannels ( $4l, 2l2\nu \dots$ )  
Good sensitivity even below the threshold
- ▶  $WW$  : similar features
  - ▶ can probe VH, VBF with  $WW + 1/2j$
- ▶  $\bar{\tau}\tau$  : whole mass range
  - ▶ MSSM-like analysis since this channel is  $t_\beta$  enhanced
- ▶  $VH \rightarrow V\bar{b}b$  : low masses
  - ▶ Independent of  $gg \rightarrow H$ !



All is standard? what is still hidden in other mass ranges?

*Higgs and Symmetry Breaking*  
*A proposal*

for

**ENIGMASS**

Fawzi BOUDJEMA

LAPTh, CNRS, Annecy-le-Vieux, France

for

the Task Force **HIGGS@ENIGMASS**

# WG1: Higgs at 125GeV

Study and reconstruction of Couplings

SM/QCD Photon Physics

(Higgs Potential)

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Benchmarks for  $H^\pm, A^0$

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Higgs Portal and Dark Matter

New Physics Signals of top-siblings

LHC upgrade, LC

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$\gamma$ Physics, Diphox, VBF

$\tau b!$

WW scattering

Fitters: CKMFitters, Sfitter

simulators: Delphes?,...

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Indirect Constraints

Natural SUSY  
Reanalysis  $50 < M_{H,S} < 800\text{GeV}$

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Direct and indirect Detection

Relic Density

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*WG1: Higgs at 125GeV*  
*Nature of the Higgs and its Naturalness* \*\*\*

Study and reconstruction of Couplings

SM/QCD Photon Physics

spin determination

(Higgs Potential)

## Acteurs d'ENIGMASS concernés (% = FTE) :

LAPTh G. Bélanger, 40%, F. Boudjema, 70% D. Guadagoli, 30%, B. Herrmann, 15%

LPSC: J. Collot, S. Kraml, 50% , C. Smith, 30% (LPSC), A. Lucotte

LAPP: N. Bergé, M. Delmastro, C. Goy, R. Lafaye, V. Tisserand

Exp: sans % mais s'associent au WG et ....à la demande ANR, 13/12/2012

# Why Multi-Higgs? Other Higgses? Nature of the vacuum: Why Beyond SM, ..still?

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Sounds familiar?

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Sounds familiar? Yes, **Supersymmetry, UED, More unknown theories**

## We may have been too naive: SUSY as an example

- ▶ SUSY provides nice solutions (Naturalness, DM, ) but the MSSM may have been too simple and naive
- ▶ Supersymmetric Effective Approach: encapsulates effects from different implementations. **Higgs is a very good window.**
- ▶ Effective approach: what do we learn from discovering the first Higgs,  $h$ . Importance of accessing as many channels of  $h$  as possible
- ▶ Signatures depend not only on the different implementations but also on the role of the stops.
- ▶ The role of Higgsinos and naturalness
- ▶ What about the other Higgses, keep analyzing the data in a wide range of Higgs masses
- ▶ Flavour observables important:  $B \rightarrow X_s \gamma^*$
- ▶ Direct Detection important

## New analysis, stage 1: Recasting to non-SM models

FB, G. Drieu La Rochelle (PhysRevD 2011)

- ▶ Use the exclusion ratio in the no signal case

$$R_{XX}^{\text{excl 95\%}} = \frac{\sigma_{pp \rightarrow \phi \rightarrow XX}}{\sigma_{pp \rightarrow \phi \rightarrow XX}^{\text{excl 95\%}}}$$

- ▶ Use signal strength in the case of a signal

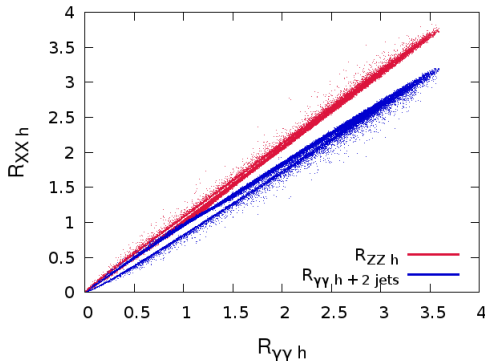
$$R_{XX} = \frac{\sigma_{pp \rightarrow \phi \rightarrow XX}}{\sigma_{pp \rightarrow H \rightarrow XX}^{\text{SM}}}$$

- ▶ Use the MSSM production modes

$$\sigma_{pp \rightarrow \phi \rightarrow XX} = (\sigma_{ggh} + \sigma_{VBF} + \sigma_{Vh} + \sigma_{\bar{b}bh}) \times BR(\phi \rightarrow XX)$$

## Higgs signal, $h$ as a signal in Model A

- ▶ The reduction of  $g_{h\bar{b}b}$  implies strong correlations between enhanced channels



$$R_{\gamma\gamma} \simeq R_{ZZ} \sim R_{\gamma\gamma+2 \text{ jets}}$$

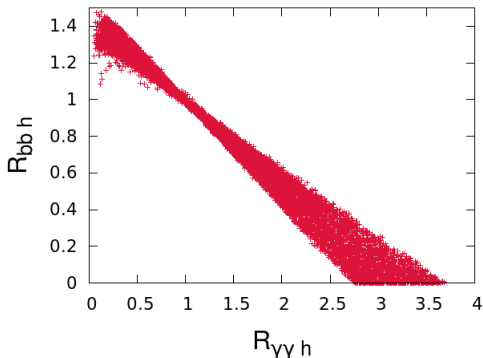
$R_{\gamma\gamma} = 2$  is possible. ex:

$$R_{\gamma\gamma} = 2, R_{ZZ} =$$

$$1.7, R_{\gamma\gamma+2 \text{ jets}} = 1.5$$

## Higgs signal, $h$ as a signal in Model A

- ▶ The reduction of  $g_{h\bar{b}b}$  implies strong correlations between enhanced channels
- ▶ Correlation with  $VH \rightarrow V\bar{b}b$  channel.



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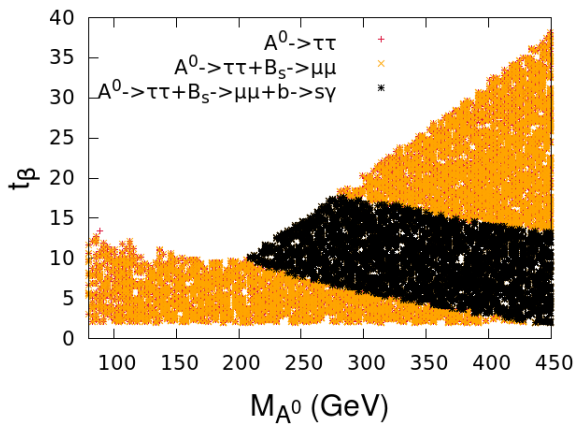
$$R_{\gamma\gamma} = 2, R_{ZZ} =$$

$$1.7, R_{\gamma\gamma+2 \text{ jets}} = 1.5$$

$$R_{VH, Vbb} = 0.6 \text{ with}$$

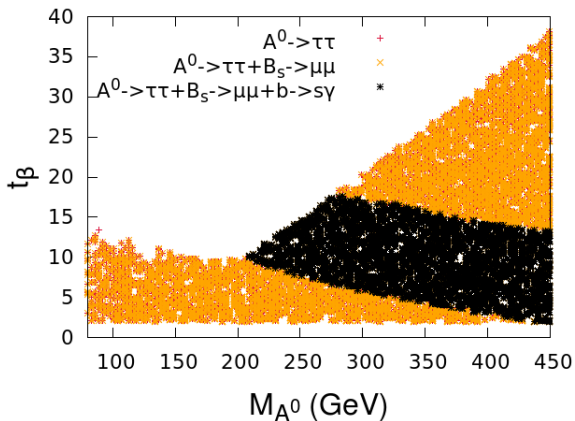
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## Model A facing flavour



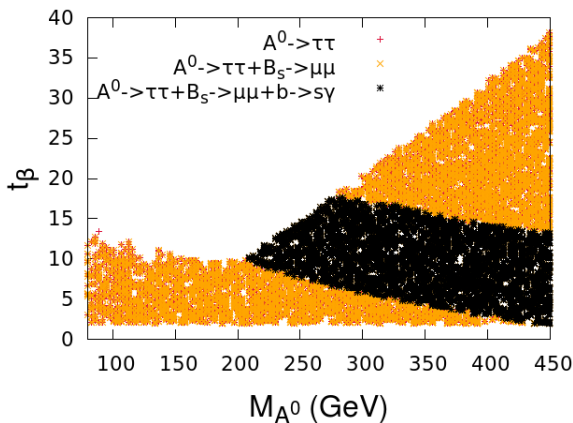


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First consequence :  $M_{A_0} < 200$  GeV excluded for all  $t_\beta \in [2, 40]$

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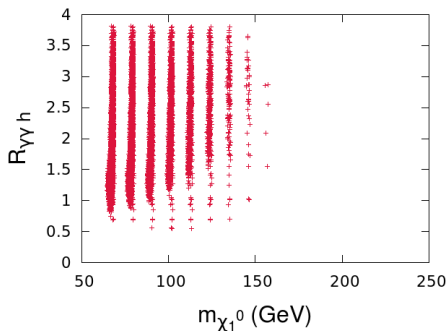
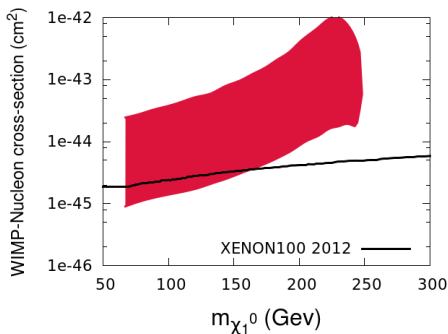
First consequence :  $M_{A_0} < 200$  GeV excluded for all  $t_\beta \in [2, 40]$

$B \rightarrow X_s \gamma^*$  more restrictive even if more luminosity is taken for  $A \rightarrow \tau\tau$  LHC analysis

## Adding Direct Detection, XENON100 (2012), Model A

Assume the correct abundance, no assumption on thermal history

$M_2 = \mu = 300\text{GeV}$  scan over  $M_1 : 7 - 300\text{GeV}$



Xenon100 (2012) very restrictive, only small values of  $M_1, m_{\tilde{\chi}_1^0}$

$R_{\gamma\gamma} \sim 2$  possible with  $m_{\tilde{\chi}_1^0} < 150\text{GeV}$

## Profil du Poste

- ▶ Un jeune théoricien travaillant avec des expérimentateurs
- ▶ Nous avons un manque de model builders et model independent approaches (Au delà du MSSM, UED..)
- ▶ Pouvant utiliser les approches statistiques et simulations, fits,...
- ▶ Connaissance DM
- ▶ Precision Physics
- ▶ Annonce serait faite le 15 octobre 2012. Recrutement pour 3 ans à partir du 1er octobre 2013.
- ▶ Préférence pour thèse+3 mais un très bon Thèse+0 sera le bienvenu