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Search for radion decay into Higgs boson pairs in CMS

Approved CMS study by

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CMS Note under preparation, published in Les Houches 2003 proceedings

$\phi \rightarrow hh \rightarrow \gamma\gamma bb$

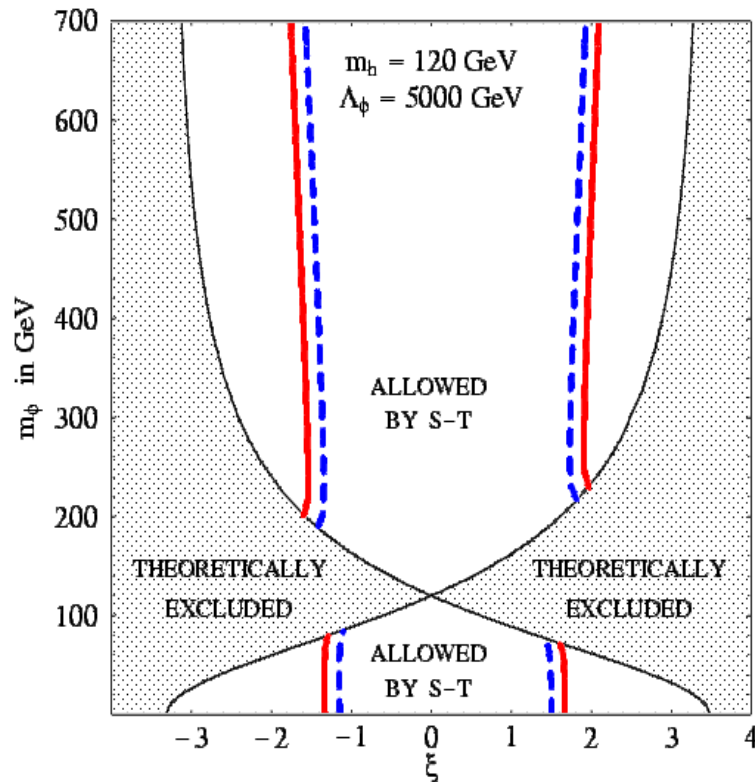
$\phi \rightarrow hh \rightarrow \tau\tau bb$ ($\tau_1 \rightarrow l$, $\tau_2 \rightarrow \text{hadr}$)

$\phi \rightarrow hh \rightarrow bbbb$

Introduction

5D Randall-Sundrum model; Free parameters of theory: m_ϕ , m_h , Λ_ϕ , ξ

Constraints from Precision EW Data
J. F. Gunion, M. Toharia, J.D. Wells
hep-ph/0311219

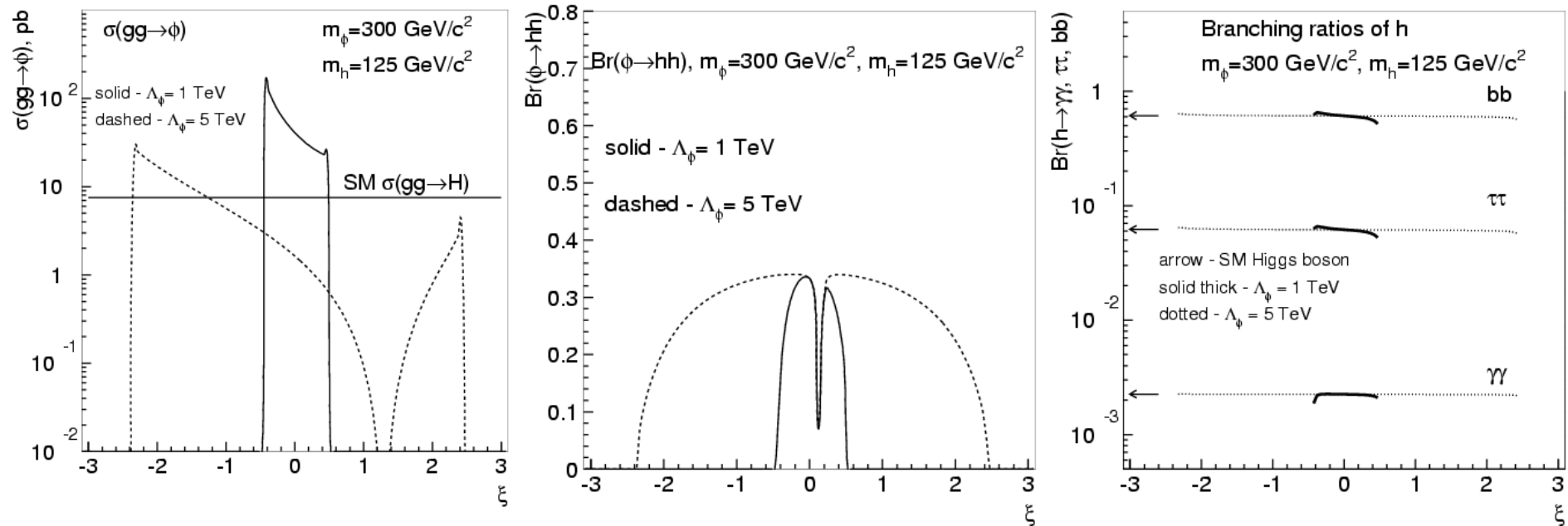


We fixed :

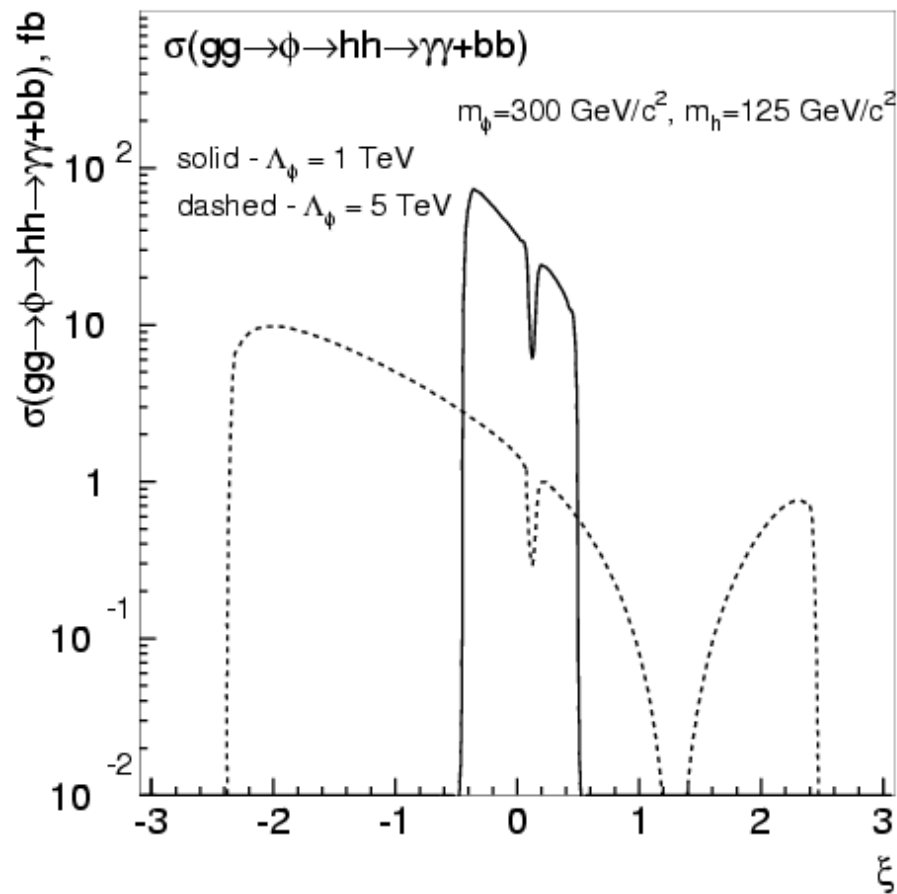
$m_\phi = 300$ GeV, $m_h = 125$ GeV
and scan in the
 (ξ, Λ_ϕ) plane

- full simulation for signal
- fast simulation for background
- MadGraph for
 - $\gamma\gamma jj$, $\gamma\gamma cc$, $\gamma\gamma bb$ background
- CompHEP for Zbb background
- Signal with corrected PYTHIA
- σ , Br with modified HDECAY + HIGLU

Radion $\phi \rightarrow hh$; phenomenology (I)



Radion $\phi \rightarrow hh$; phenomenology (II)



Max σ Br at $\Lambda_\phi = 1 \text{ TeV}, \xi = -0.35$

$\gamma\gamma bb$: 71 fb

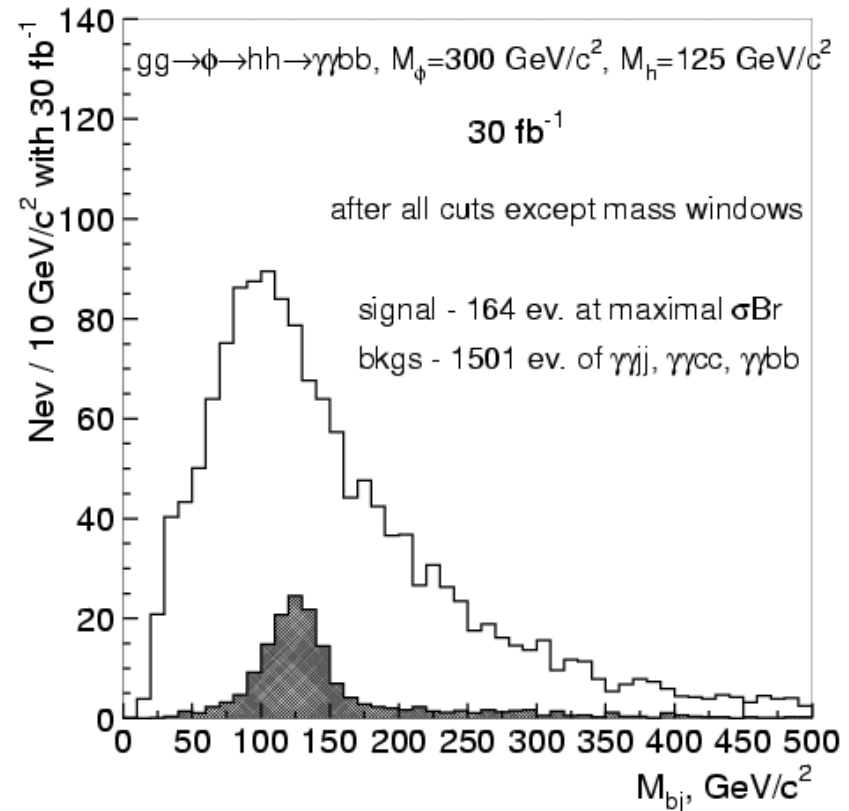
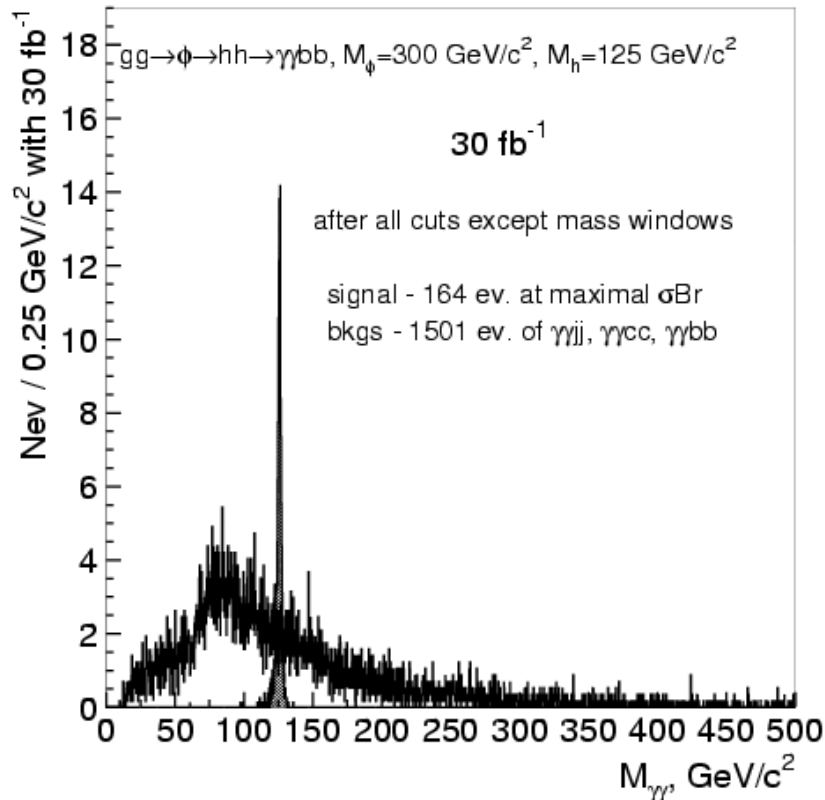
$\tau\tau bb$: 960 fb

Br($\tau \rightarrow l, \tau \rightarrow \text{hadr}$) included

$bbbb$: 10 300 fb

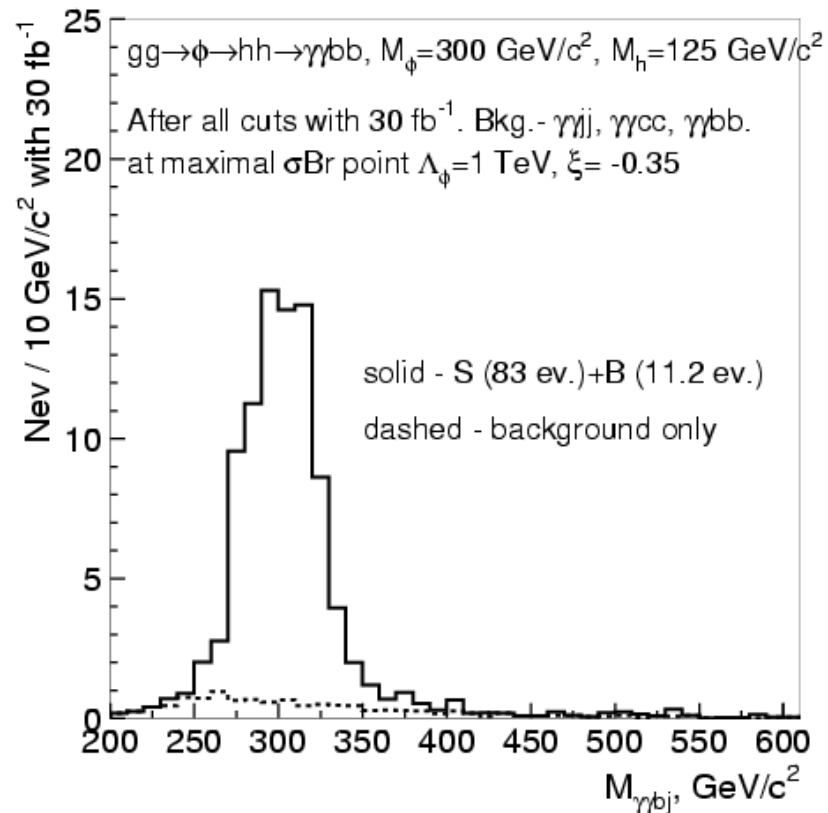
Radion $\phi \rightarrow hh \rightarrow \gamma b b$ search. selections

- Two isolated photons,
- Two jets of $E_T > 30$ GeV, $|\eta| < 2.4$, at least one b-tagged jet
- $M_{\gamma\gamma}$, M_{bj} , $M_{\gamma bj}$ mass cuts

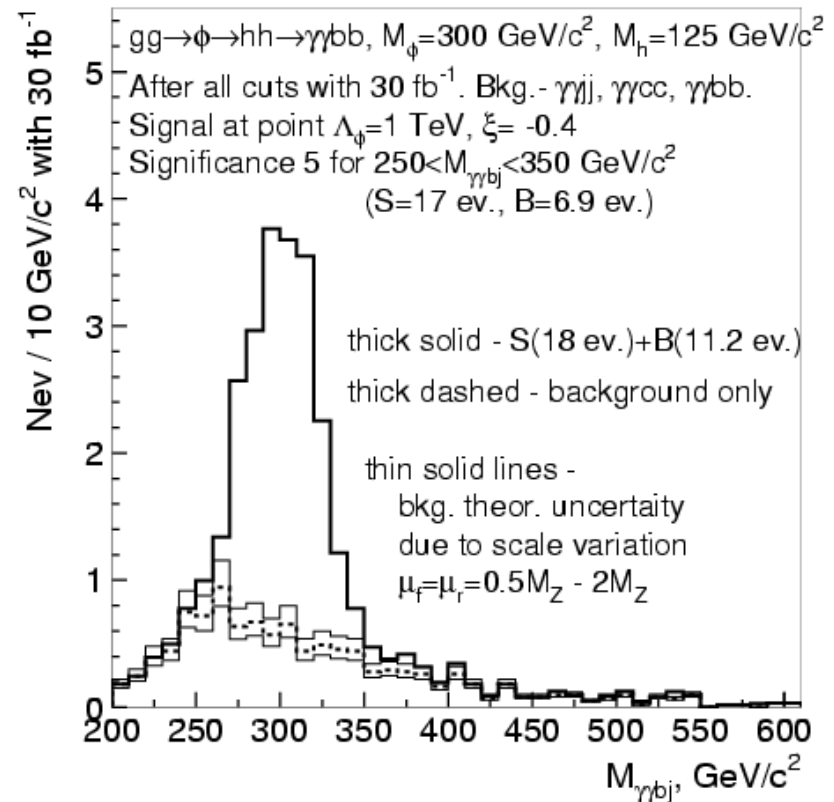


Radion $\phi \rightarrow hh \rightarrow \gamma\gamma bb$ search. radion mass after selections

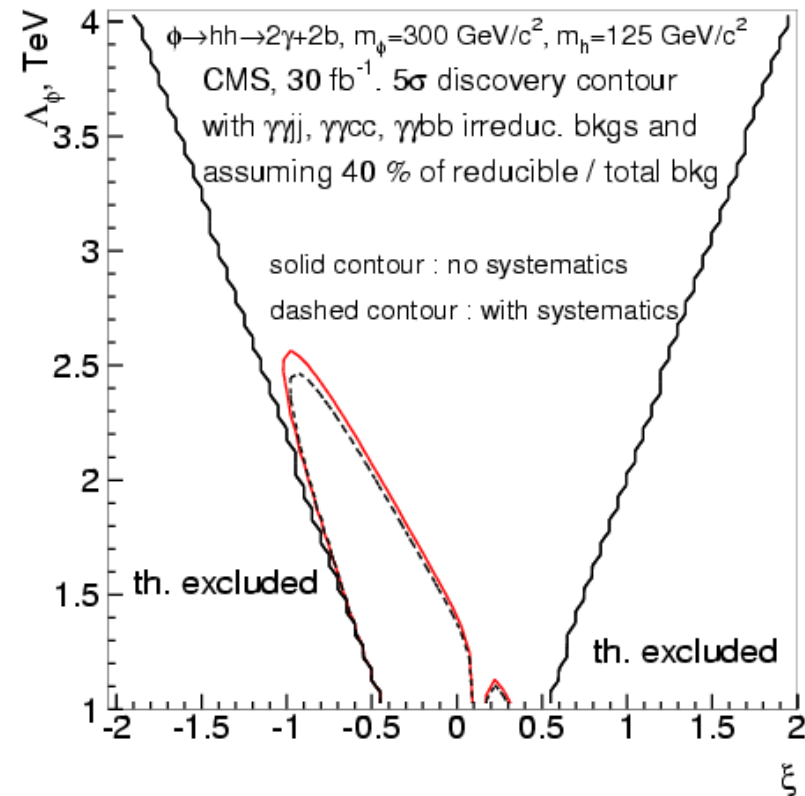
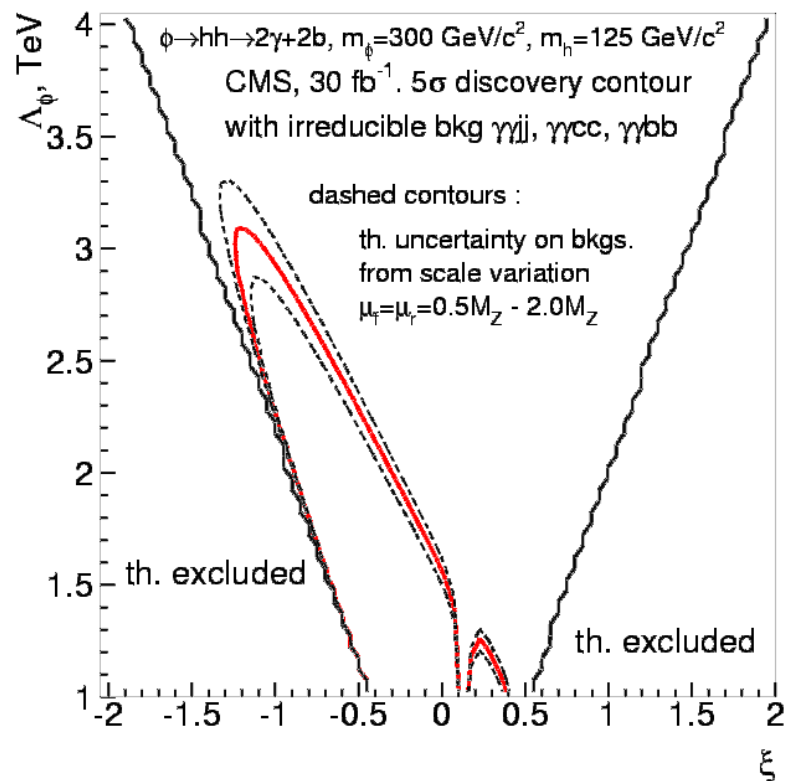
at maximal signal σBr point in
 Λ_ϕ - ξ plane



at 5 σ discovery point



Radion $\phi \rightarrow hh \rightarrow \gamma\gamma bb$ search. the 5σ discovery in Λ_ϕ - ξ plane



$\gamma\gamma bb$ signature is also very important for MSSM $H \rightarrow hh$ search at low $\tan(\beta)$
 with high luminosity U.Baur, T.Plehn, D. Rainwater CERN-TH/2003-186

Radion $\phi \rightarrow hh \rightarrow \tau\tau bb$ search.

assumed that Higgs mass will be known

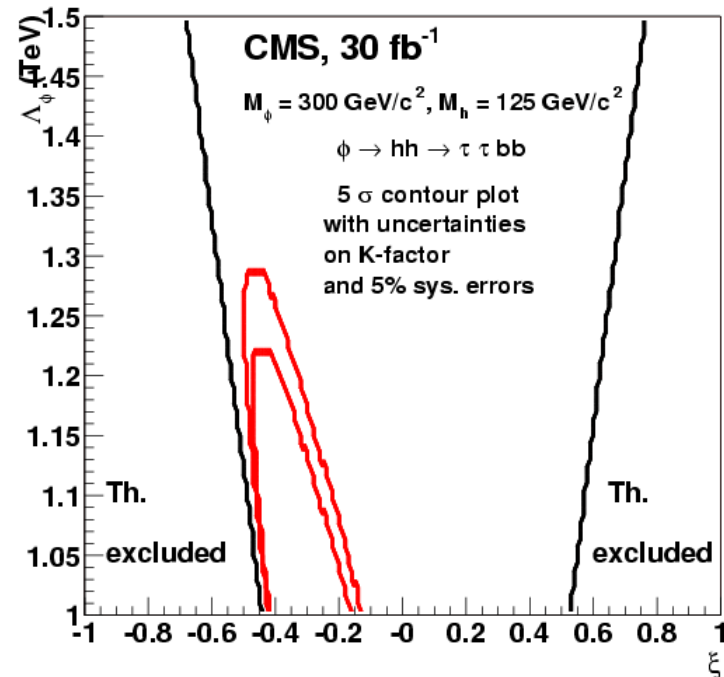
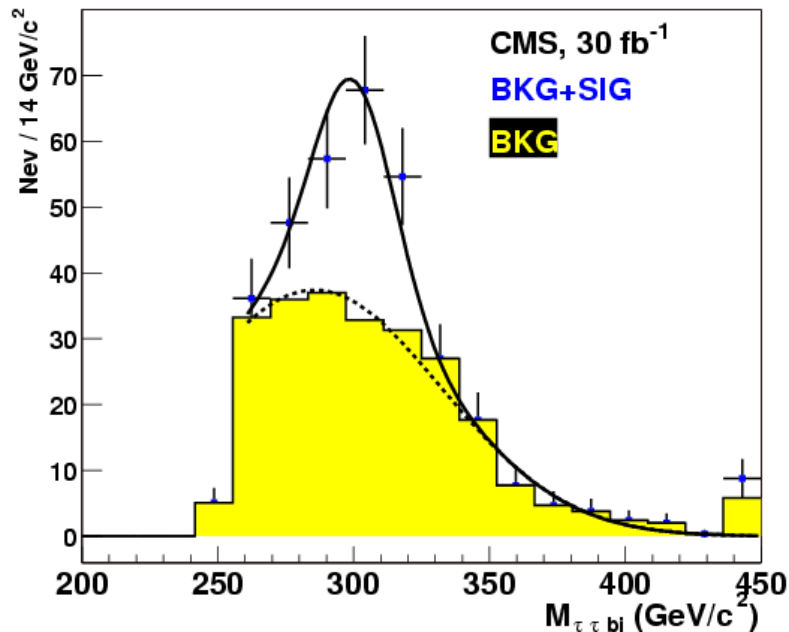
Background :

$t\bar{t} \rightarrow Wb + W\bar{b} \rightarrow l + \nu + jets + b\bar{b}$
 $t\bar{t} \rightarrow Wb + W\bar{b} \rightarrow l + \nu + \tau - jet + b\bar{b}$
 $Zb\bar{b} \rightarrow \tau\tau + b\bar{b}$
 $Z + jets \rightarrow \tau\tau + jets$
 $W + jets \rightarrow l + \nu + jets$

Selections:

- hadronic and leptonic tau,
- 2 jets with $E_T > 30$ GeV and at least one b-tag
- $E_T^{lv} < 35$ GeV

At maximal σ Br point



Radion $\phi \rightarrow hh \rightarrow bbbb$ search.

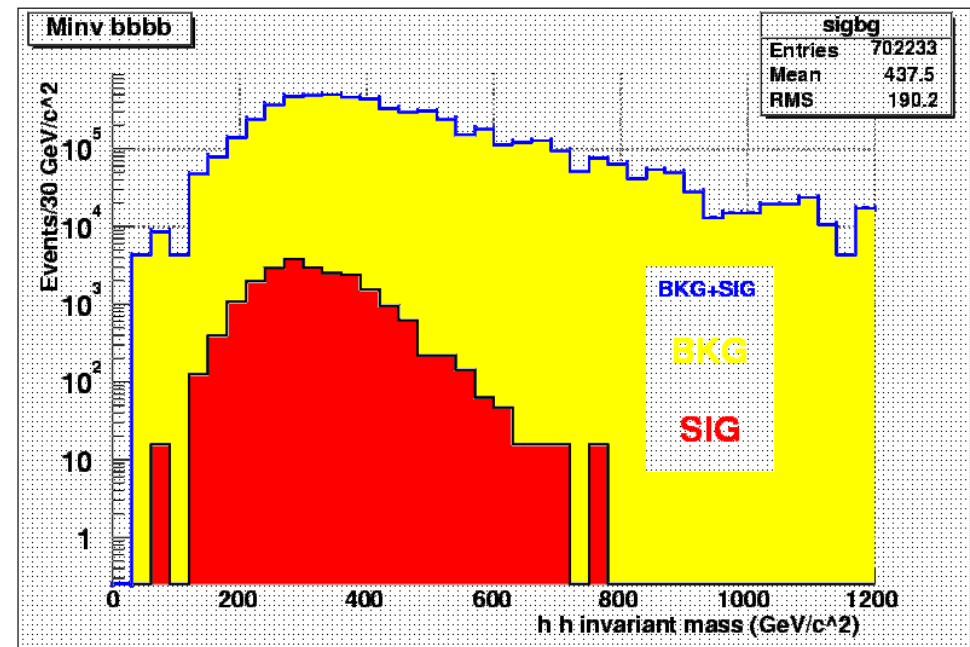
assumed that Higgs mass will be known

Selections:

- Level-1 multi jet trigger
- double b tagging at HLT
- mass constraint in off-line

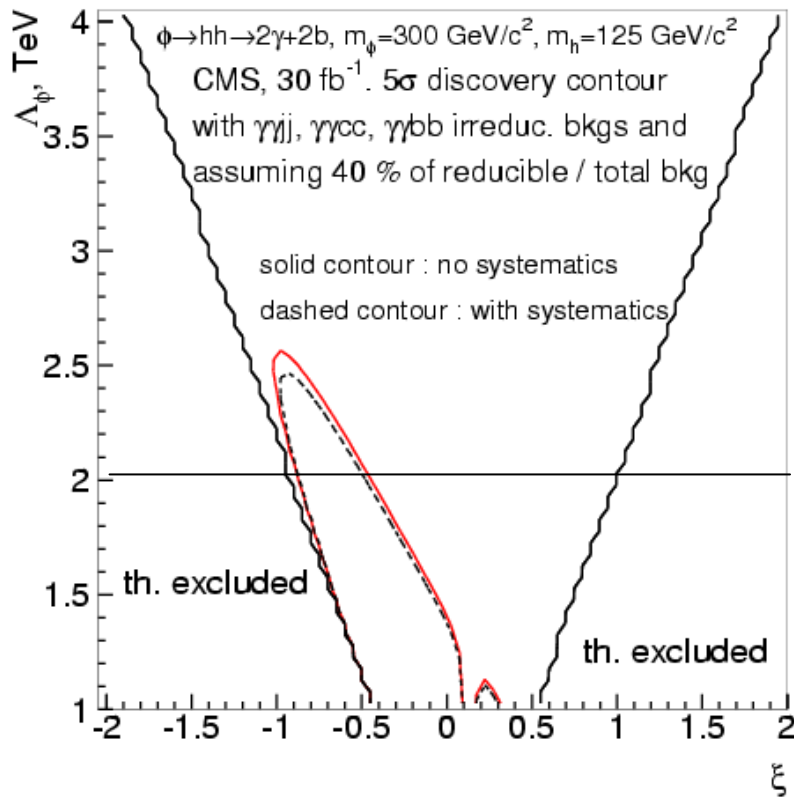
In order to have the 5 s discovery at the maximal σ Br the uncertainty of the background extrapolation to the signal region should be less than 0.1 %

Signal at maximal σ Br point
with 30 fb⁻¹

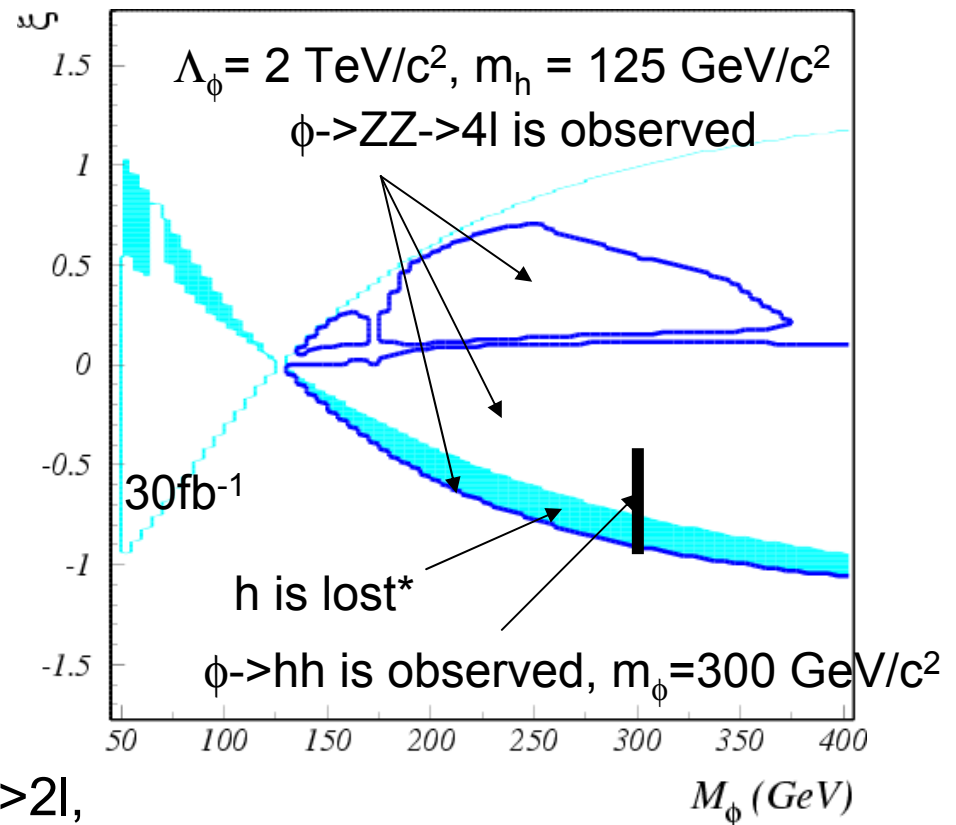


Radion and Higgs boson search complementarity

Scan in (Λ_ϕ, ξ) plane for
 $m_\phi=300 \text{ GeV}/c^2, m_h=125 \text{ GeV}/c^2$



Scan in (m_ϕ, ξ) plane for
 $\Lambda_\phi=300 \text{ GeV}/c^2, m_h=125 \text{ GeV}/c^2$



* with combined channels: $h \rightarrow \gamma\gamma$,
 $t\bar{t}h(h \rightarrow b\bar{b})$, $h \rightarrow ZZ^* \rightarrow 4l$, $h \rightarrow WW^* \rightarrow 2l$,
 $qqh(h \rightarrow 2\tau)$ and $Wh(h \rightarrow \gamma\gamma)$; data from CMS Note 2003/033 were used