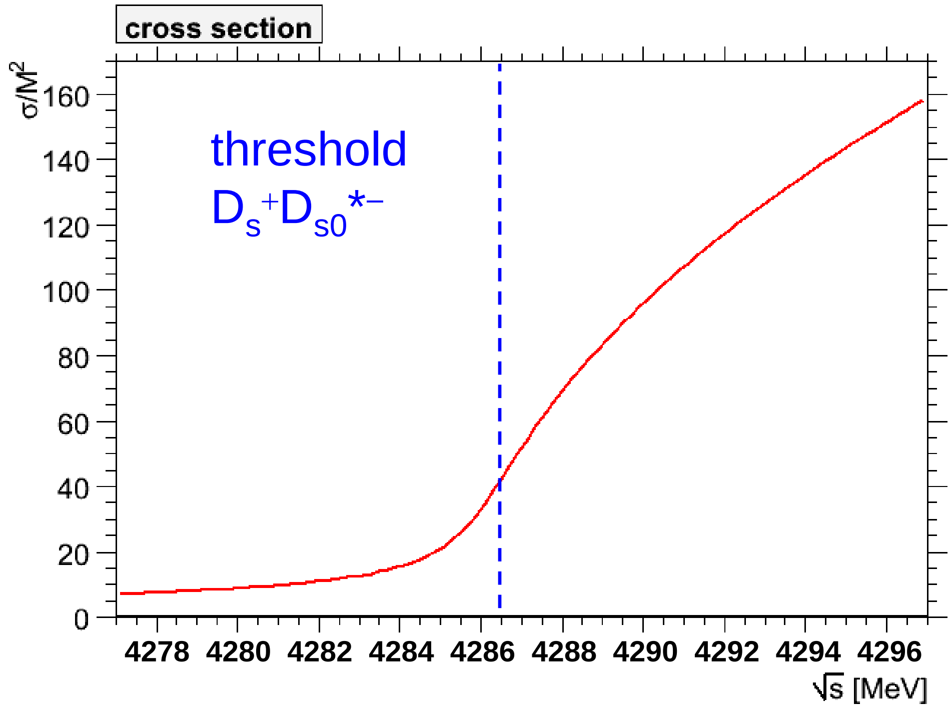
Status of Analysis
$\bar{p}p \rightarrow D_s D_{s0}^*(2317)$

Klaus Götzen
GSI Darmstadt

PANDA Collaboration Meeting
Sep. 2007

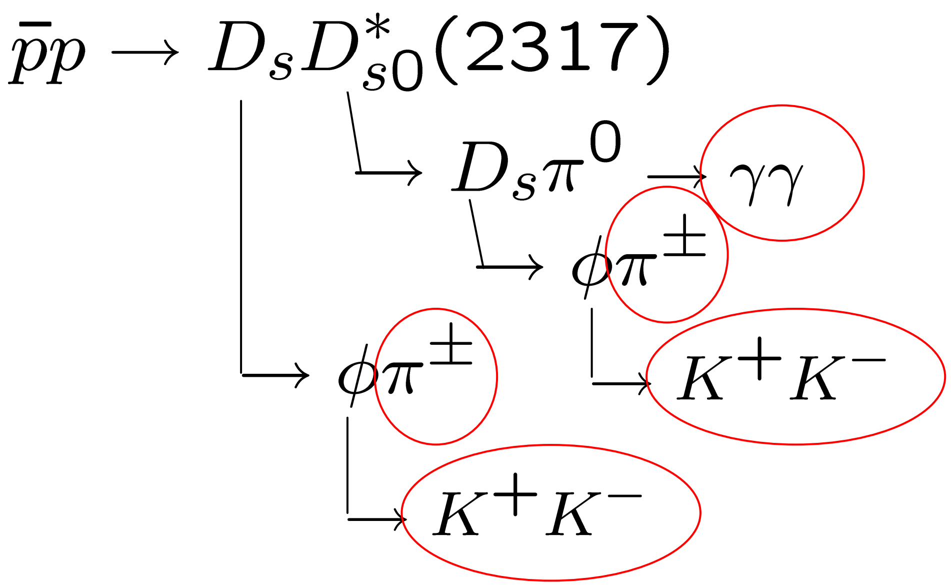
Measurement

- Determine width Γ of $D_{s0}^*(2317)$
- Method
  - Energy scan around $D_s^+ D_{s0}^{*-}$ threshold,
    e.g. 20 steps from -10 MeV to +10 MeV below/above threshold
  - Determine number of reactions of signal type for each step
    → signal cross section energy dependend (excitation function)
  - Shape of excitation function tells you about width



Reconstruction $D_s D_{s0}^*(2317)$

- Decay Tree @ $\sqrt{s}$ = 4.306 GeV (p_{pbar} = 8.8931 GeV/c)

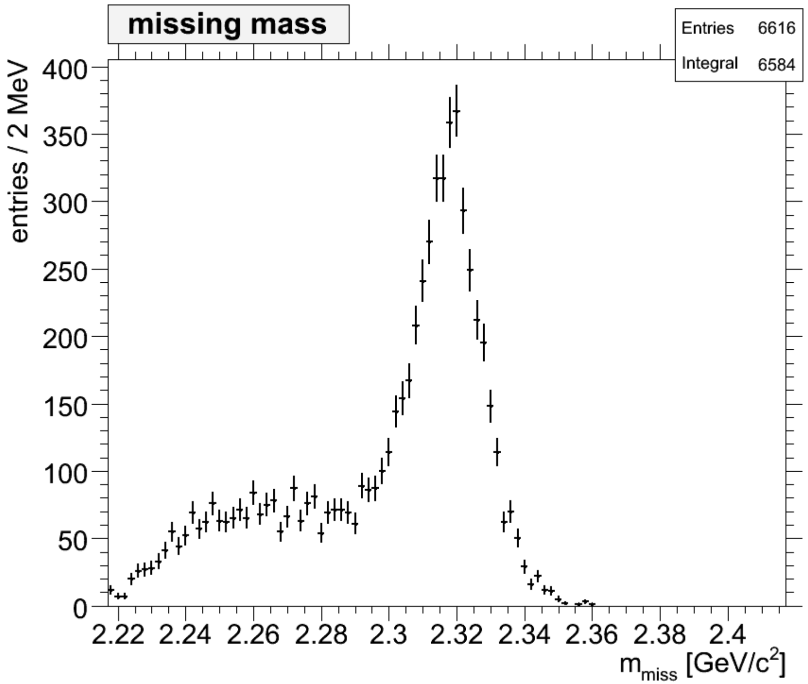


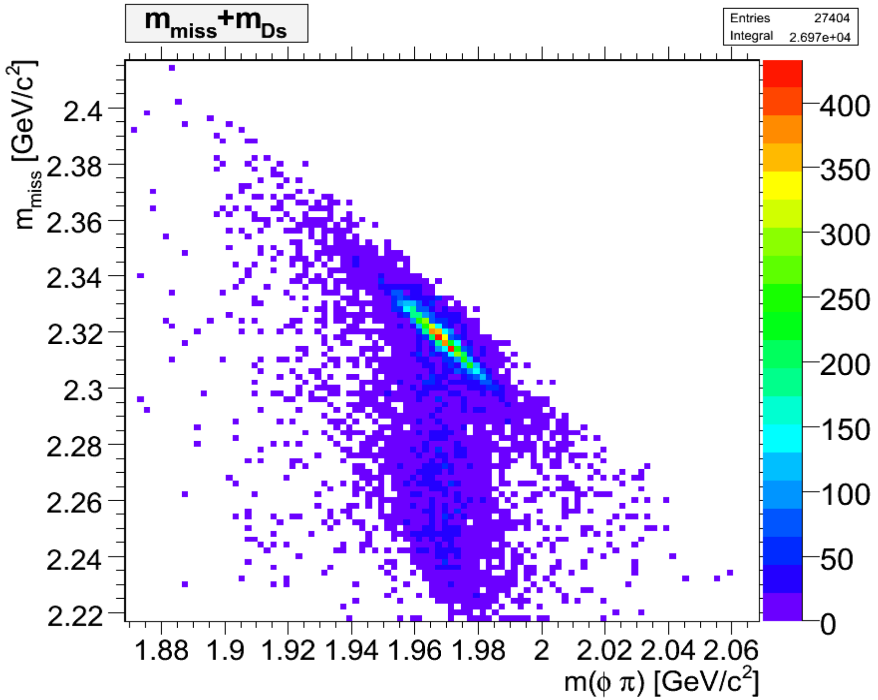
- Data
  - 20k signal events
  - 780k DPM events

- Reconstruction (2 approaches)
  - full exclusive
  - inclusive (reco only recoiling D_s)

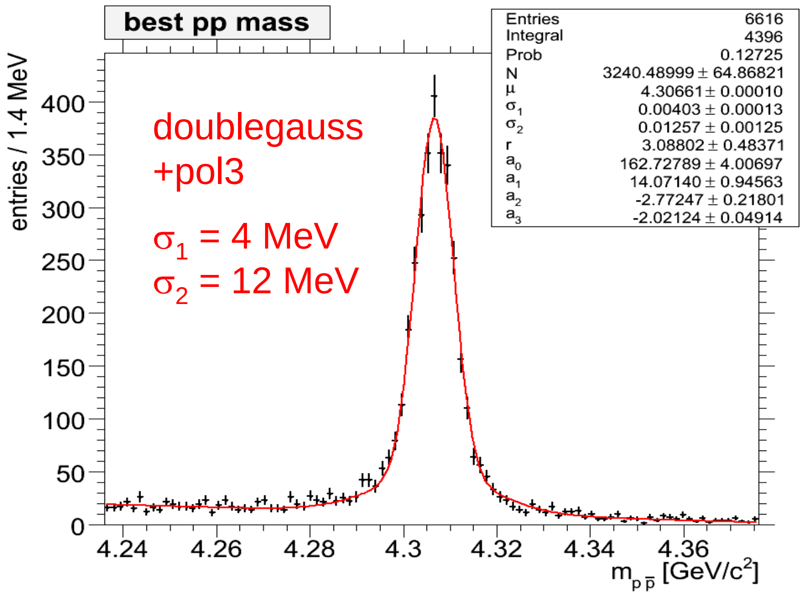
Exclusive Reco

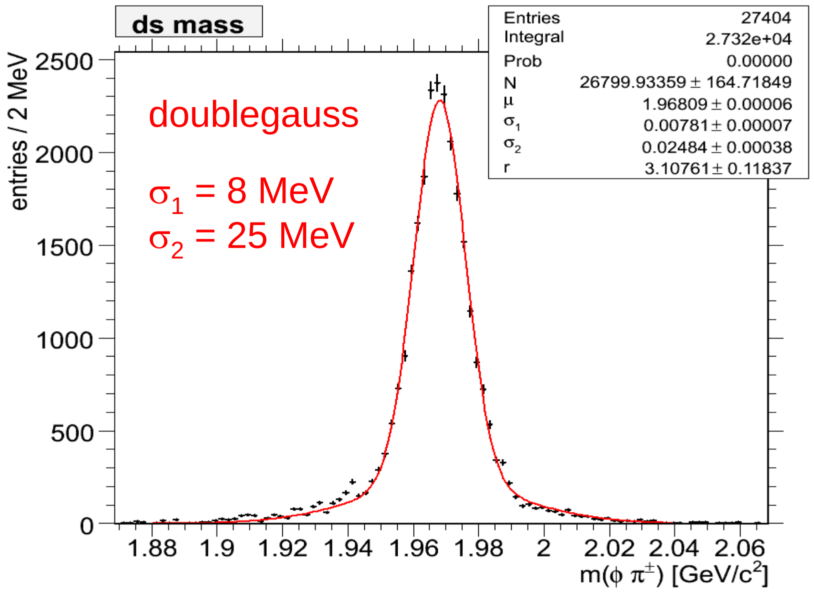
- Exclusive Selection
  - apply mass constraint to π^0 and D_s (fit ppbar system)
  - vertex fit of the ϕ
  - mass cut $|m(\phi\pi) - m_{Ds,\,PDG}| < 30$ MeV/c^2 (both D_s)
  - Fit Probability for ppbar system P > 0
  - Select candidate with best P per event
  - signal = sum $m_{miss} + m_{Ds,reco}$ with $m_{miss} = \left|\vec{p}_{beam} - \vec{p}_{D_s}\right|$

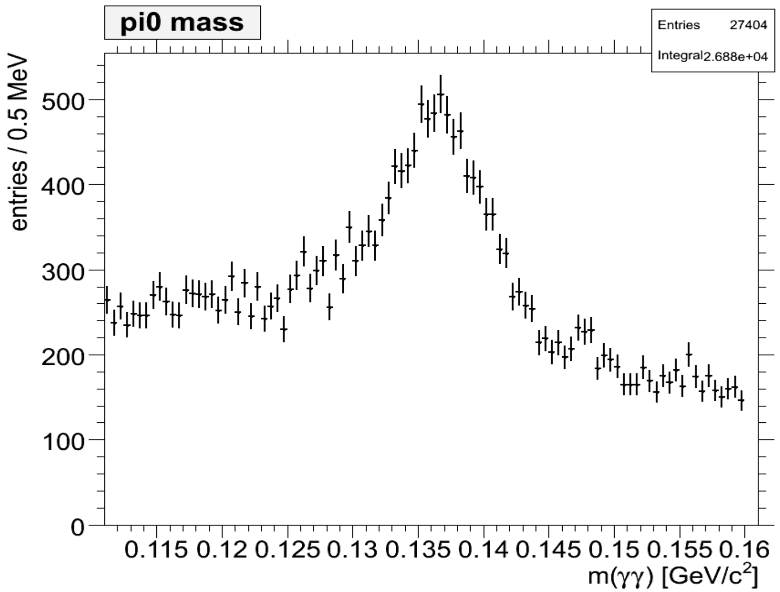


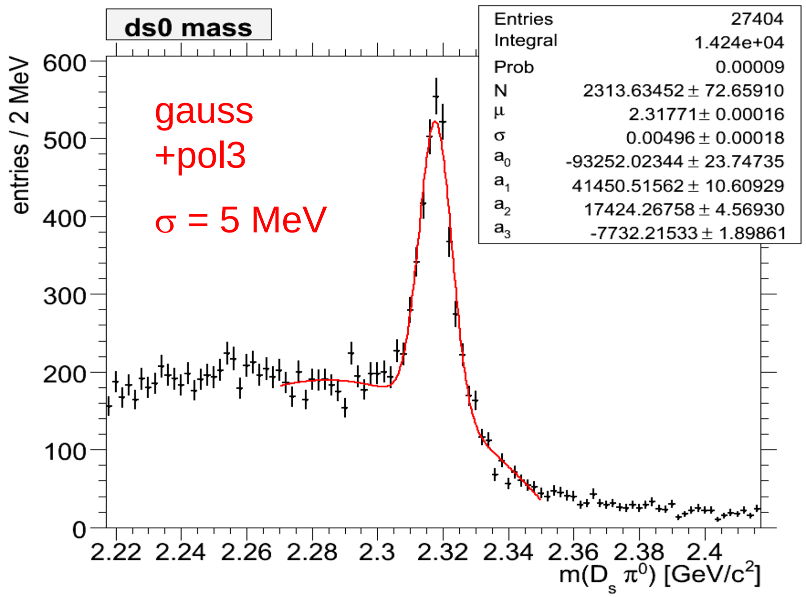


Exclusive Reco



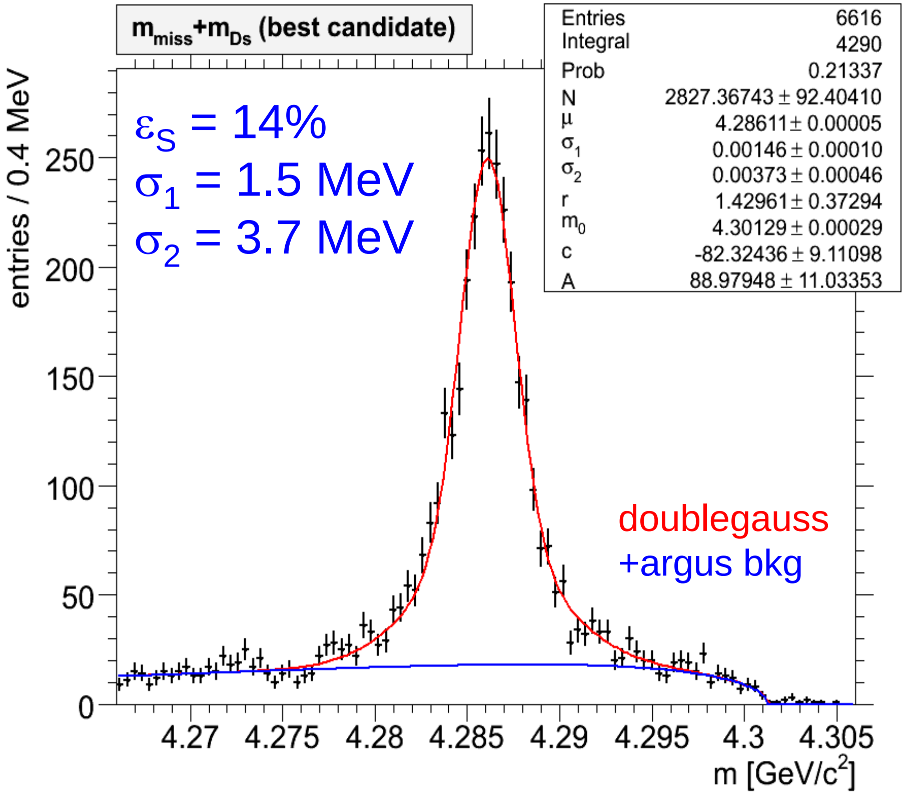




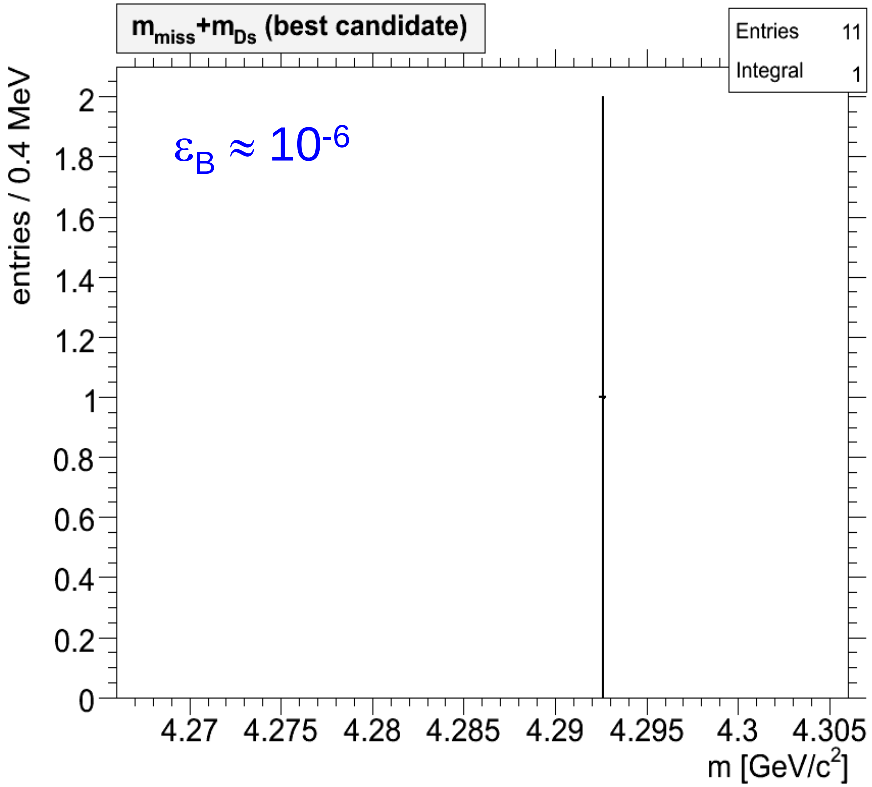


Exclusive Signal

20k Signal events



780k DPM events



Assumption for cross section: $\sigma_B \approx 10^5 \cdot \sigma_S$

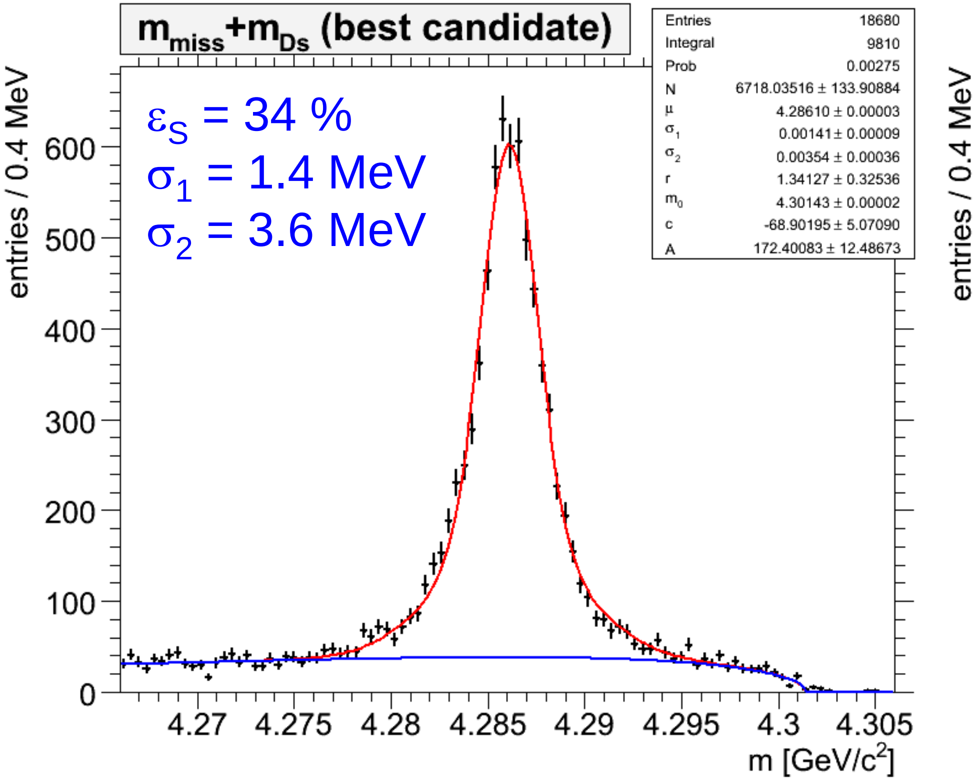
Fraction reco'd evts : $f = BR(D_s \to \phi\pi)^2 \cdot BR(\phi \to K^+ K^-)^2 \cdot BR(D_{s0}^* \to D_s\pi^0) < 4.7 \cdot 10^{-4}$

$$S/B = (\sigma_S \cdot \varepsilon_S \cdot f)/(\sigma_B \cdot \varepsilon_B) < 1 \cdot 0.14 \cdot 4.7 \cdot 10^{-4} / 10^5 \cdot 10^{-6} = 1/1520$$

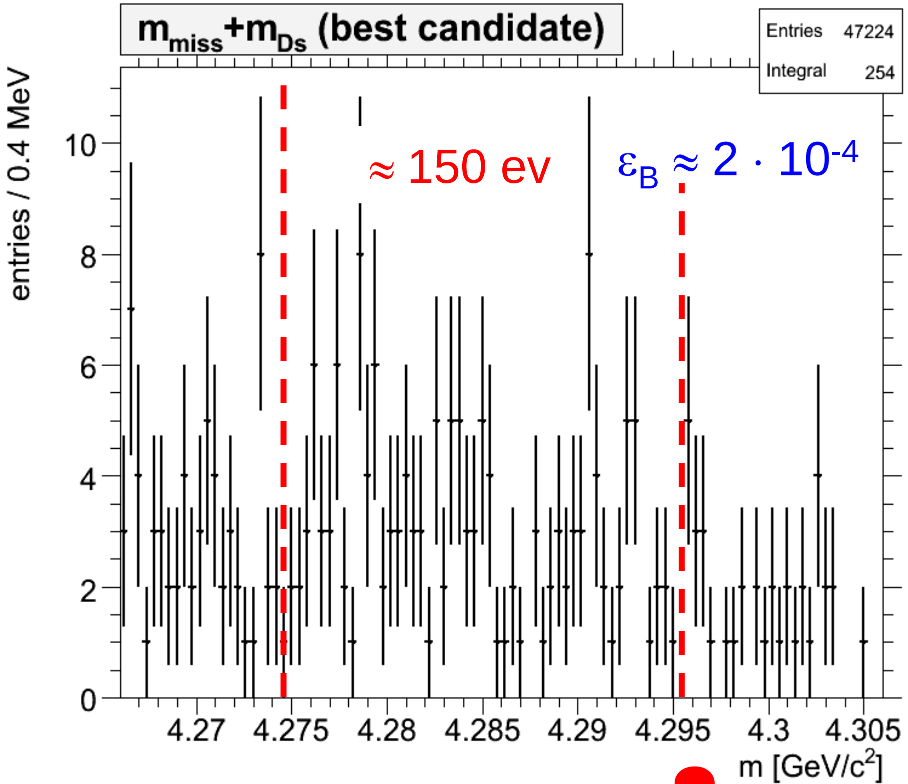
Inclusive Signal

- Inclusive Selection
  - mass cut $|m(\phi\pi) - m_{Ds,\ PDG}| < 30\ MeV/c^2$
  - vertex fit of the ϕ (probability P>0.0001)
  - $n_K + n_\pi > 3$

20k Signal events



780k DPM events



$f = BR(D_s \to \phi\pi) \cdot BR(\phi \to K^+ K^-) = 2.2 \cdot 10^{-2}$

$\Rightarrow S/B = 1/2700$?

Comparison - Timescale

- How long do we have to measure?
- Assumption:
  - $\sigma_S \approx 1$ nb
  - int. luminosity/day $L_{int} \approx 10\ pb^{-1} = 10000\ nb^{-1}$
  - N_S/day = $\sigma_S \cdot L_{int}$ = 10000
- Exclusive reconstruction:
  - $N_{S,reco}/day = N_S \cdot \varepsilon_{S,ex} \cdot f_{ex} = 10000 \cdot 6.58 \cdot 10^{-5} = 0.658$

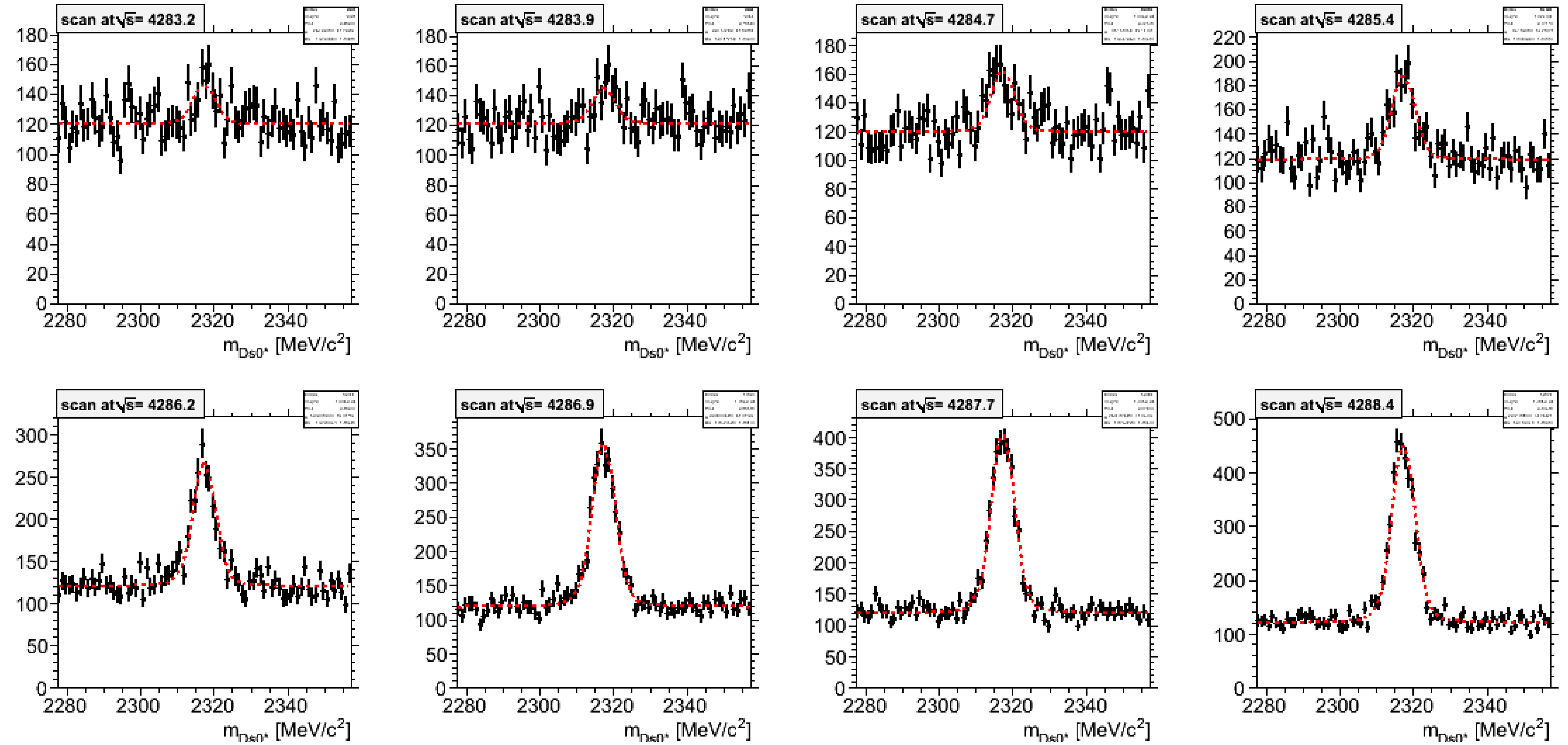
    $N_{S,reco} \stackrel{!}{=} 1000 \Rightarrow t_{ex} = 1510d = 50$ months
- Inclusive reconstruction:
  - $N_{S,reco}/day = N_S \cdot \varepsilon_{S,inc} \cdot f_{inc} = 10000 \cdot 7.7 \cdot 10^{-3} = 77$

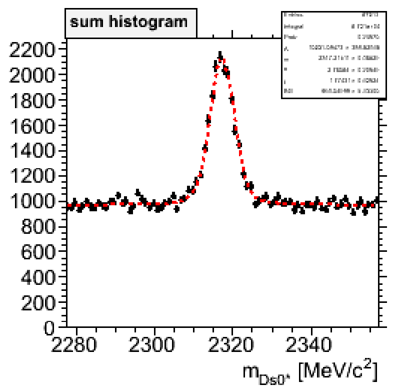
    $N_{S,reco} \stackrel{!}{=} 1000 \Rightarrow t_{inc} = 13d$

Determination of Width

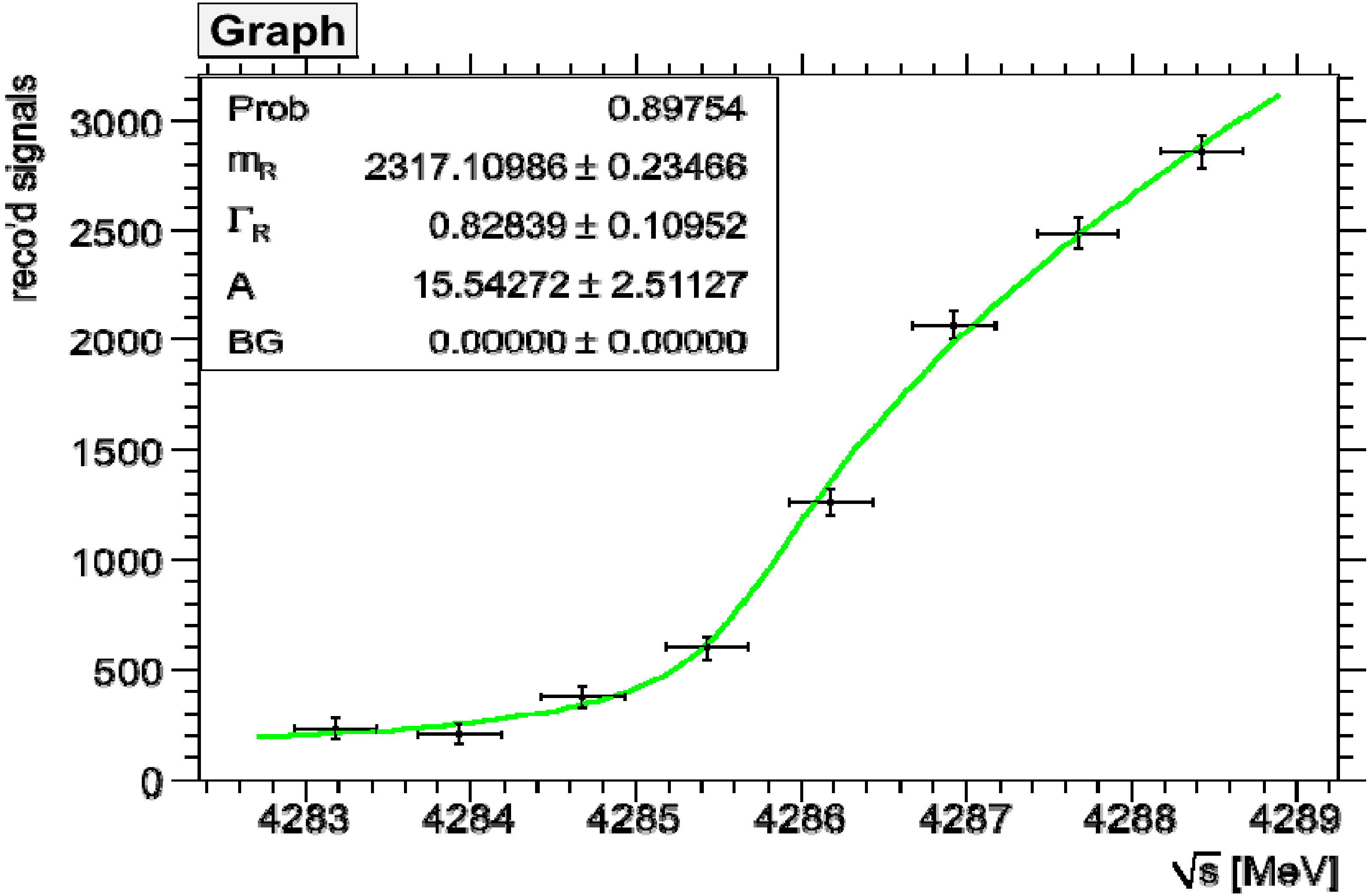
- Try to exactly simulate procedure we'll do on data
- For n scanpoint create n histograms with signal+bkg
  - Voigtian = convolution Gauss $*$ Breit-Wigner for signal
  - flat background distribution
- Fit same function to the resulting histograms
  $\rightarrow$ extract integral of voigtian $\rightarrow$ # signals
- Fill into a graph for all scanpoints
- Fit excitation function to this distribution
  $\rightarrow$ extract Γ, mass
- Parameters to vary
  - total number of signals
  - Width Γ
  - Signal to noise ratio S/B
  - (scanpoints – number & positions)

Scan – example



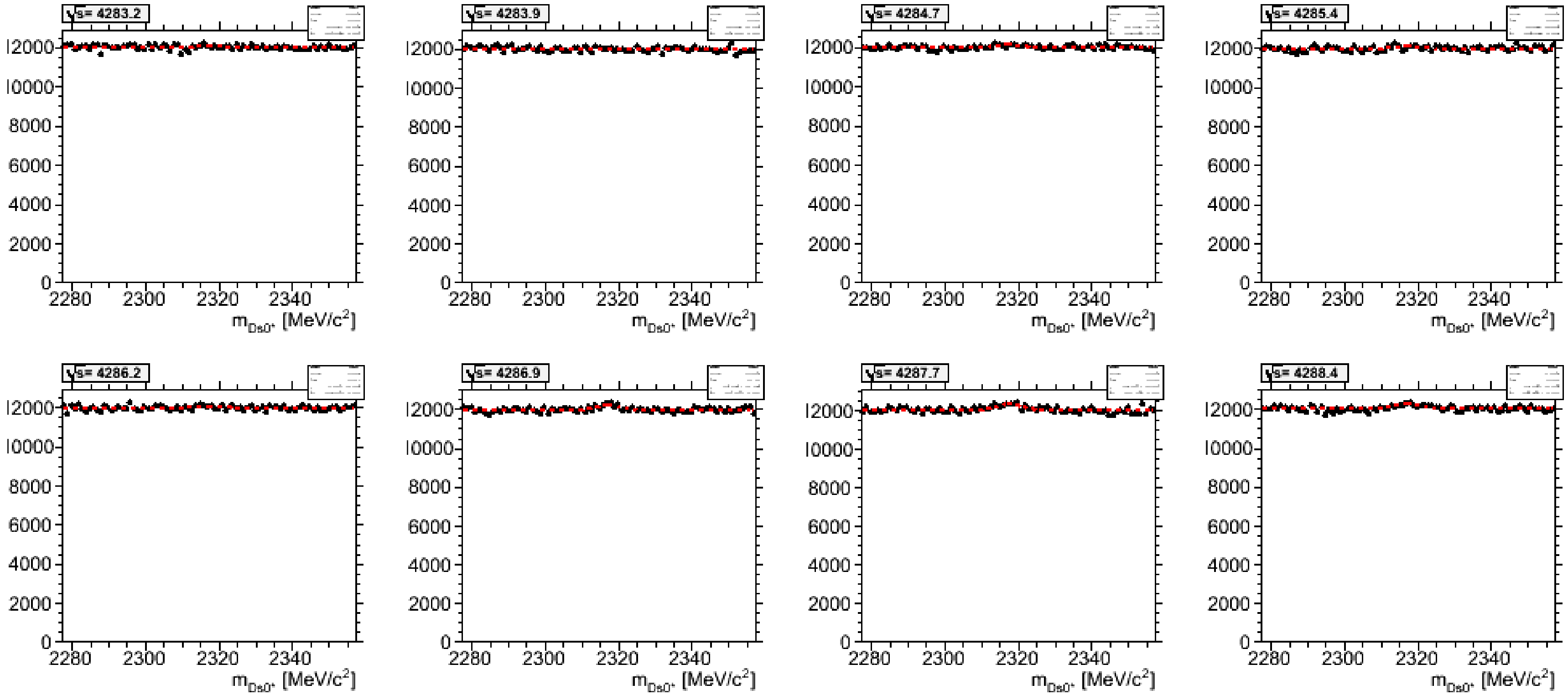


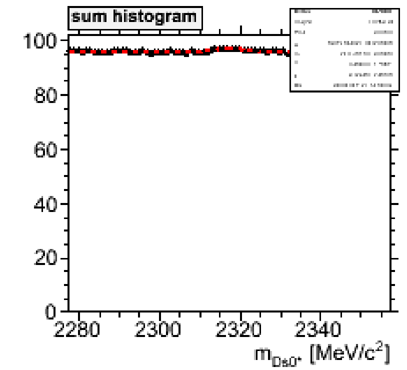
- ‚simple' scenario:
  - 8 scanpoints
  - N=10000
  - Γ=1 MeV
  - S/B = 1 (for highest energy, signal region)
- Fit sum histo (get Γ, σ, m); fix for all fits; extract signals



- Significance = $\Gamma/\Delta\Gamma = 7.5\ \sigma$

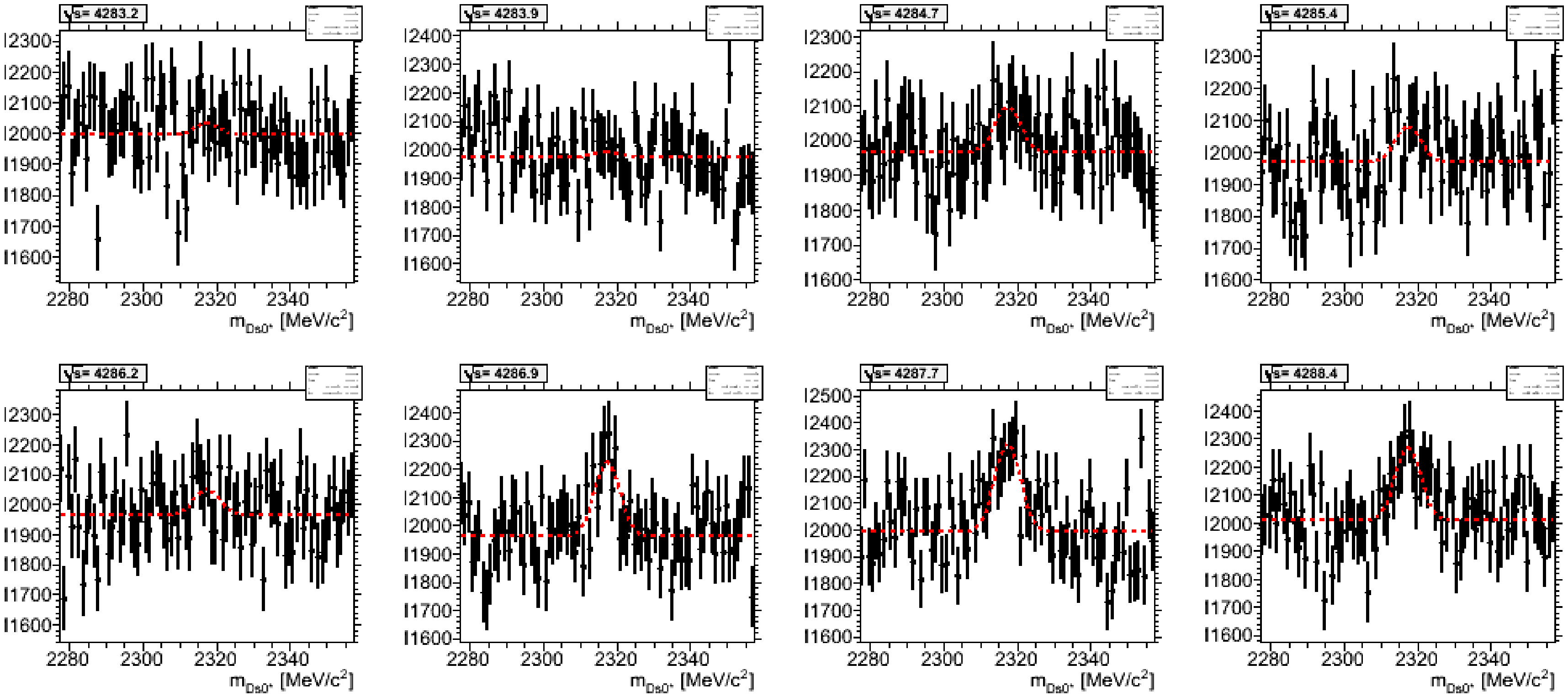
Scan – more realistic

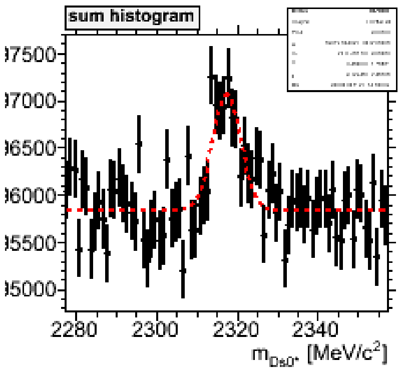




- ‚realistic' scenario:
  - 8 scanpoints
  - N=10000
  - Γ=1 MeV
  - S/B = 100 (for highest energy, signal region)
- Fit sum histo (get Γ, σ, m); fix for all fits; extract signals

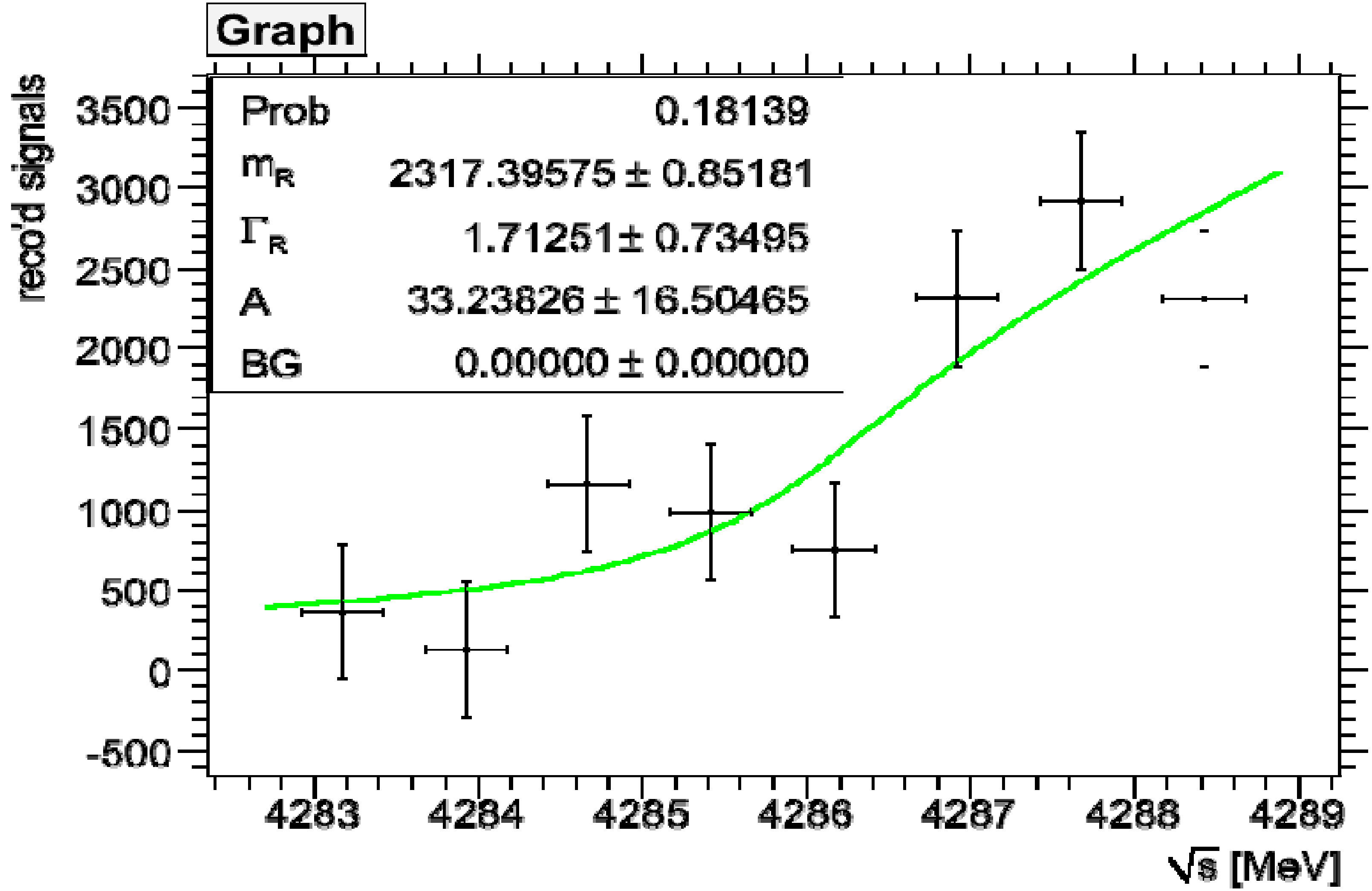
Scan – more realistic





- ‚realistic‘ scenario:
  - 8 scanpoints
  - N=10000
  - Γ=1 MeV
  - S/B = 100 (for highest energy, signal region)
- Fit sum histo (get Γ, σ, m); fix for all fits; extract signals

Excitation funciton



- Significance = $\Gamma/\Delta\Gamma$ = 2.3 σ

Summary/Conclusion

- Reconstruction of the channel with
  - Exclusive reco (slighly better in S/B ratio)
  - Inclusive reco (100 times shorter measuring time)

- Need to improve/optmimize both selections for better S/B!

- Systematic parameter studies for the scan underways to determine sensitivity for different
  - Γ's, N_{signal}, S/B ratios, scan regions ...

- Still need to build in the beam smearing (only impact for really small Γ...)