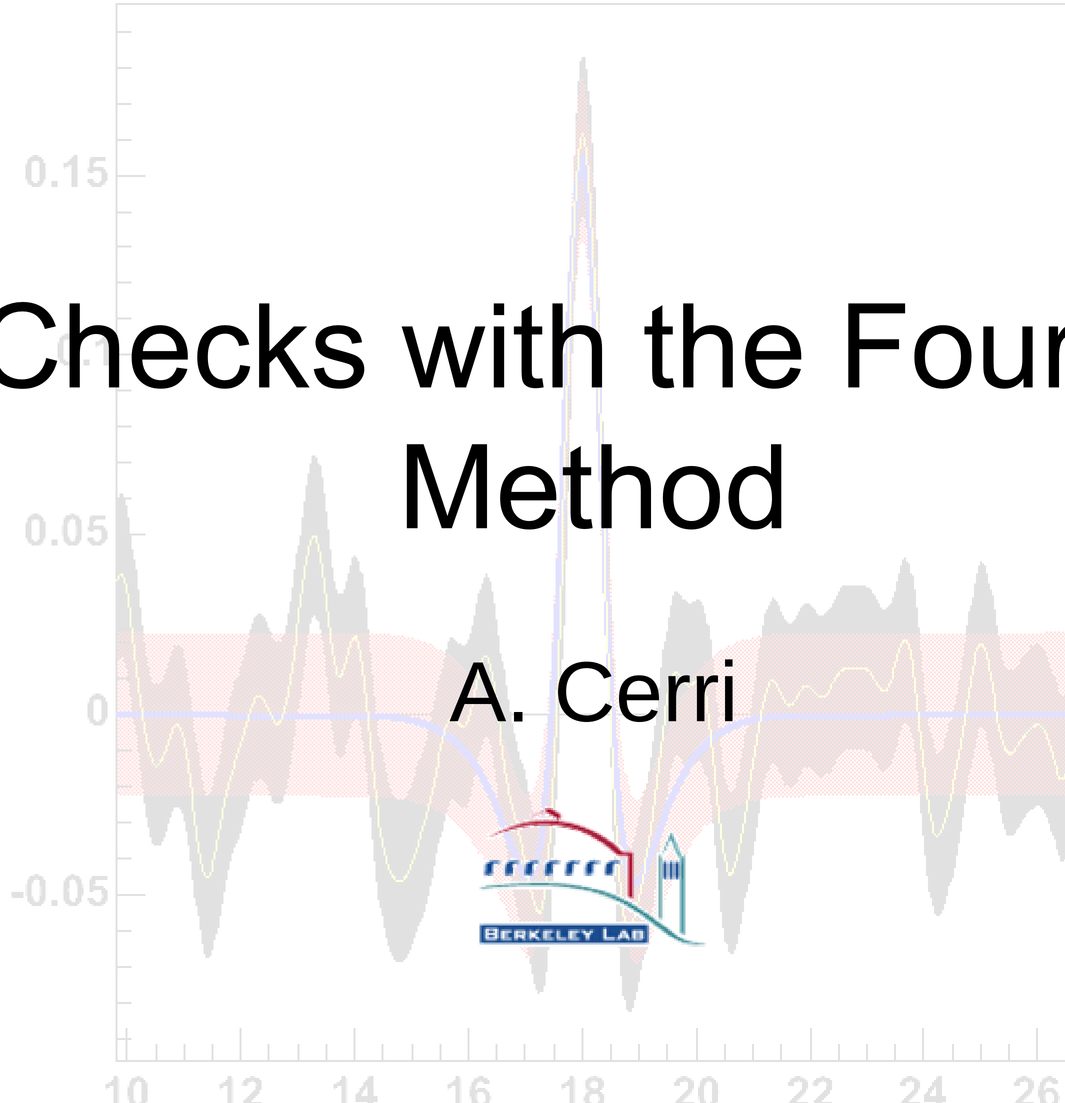
Checks with the Fourier Method

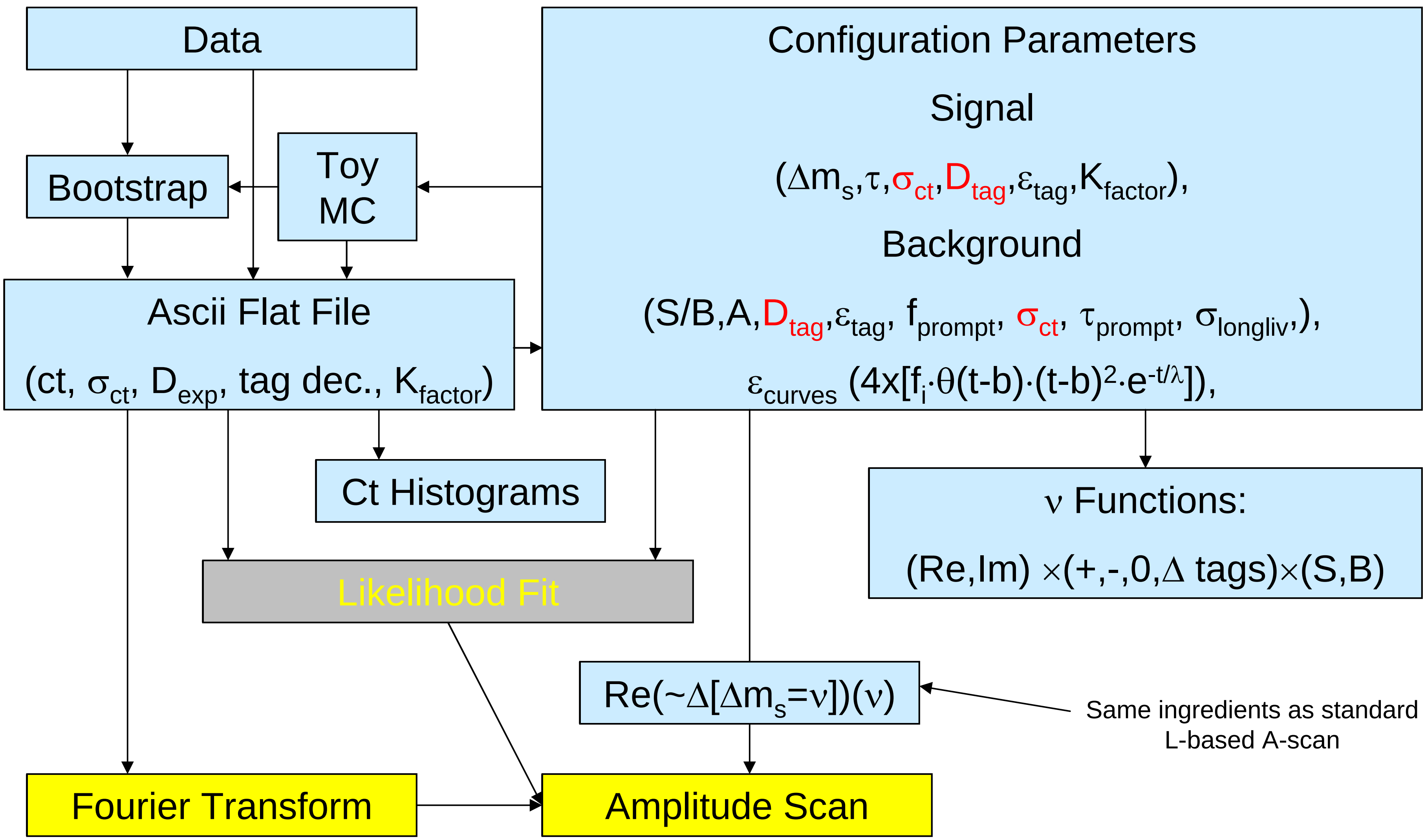
A. Cerri



Outline

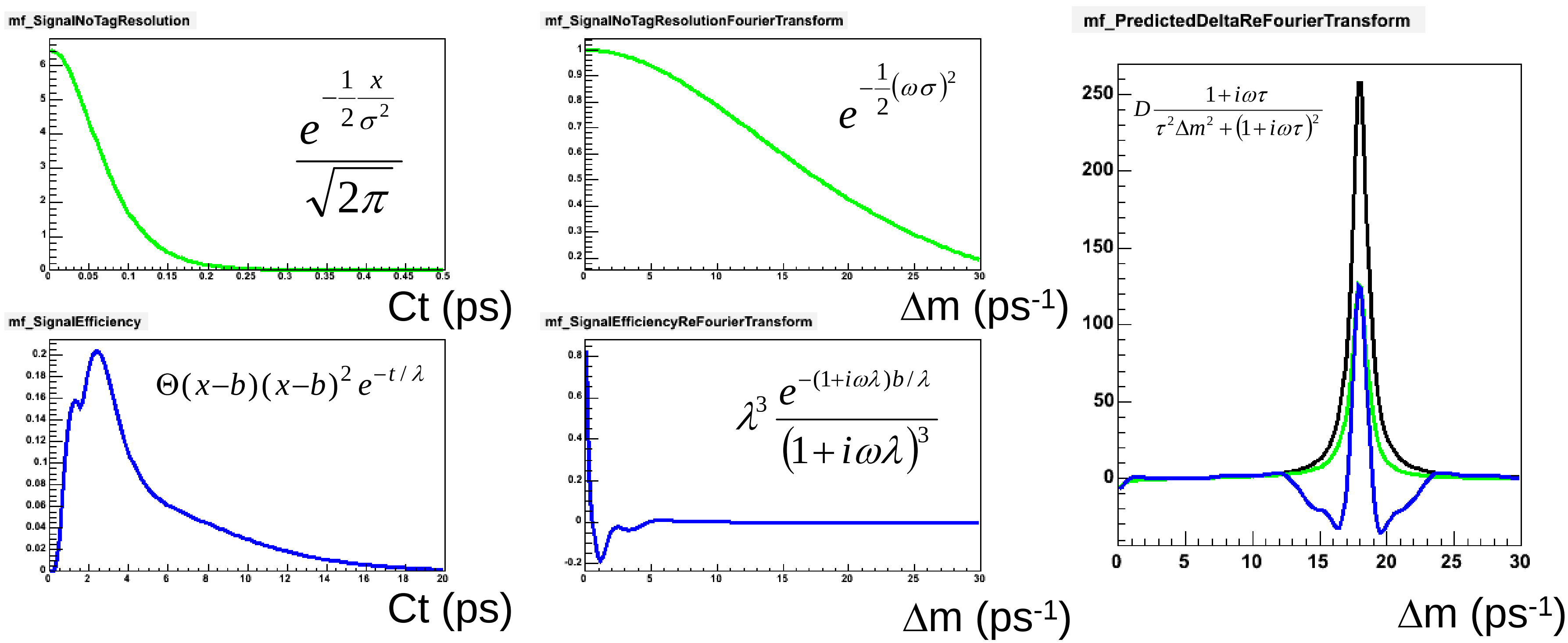
- Description of the tool
- Validation devices
  - “lifetime fit”
  - Pulls
- Toy Montecarlo
  - Ingredients
  - Comparison with data
- Proposed cross-checks

Tool Structure



Ingredients in Fourier space

Resolution Curve (e.g. single gaussian)

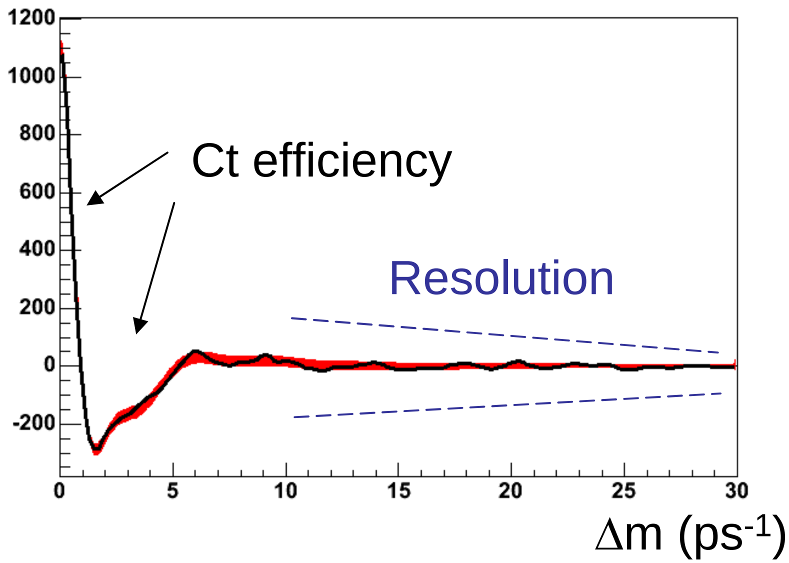


Ct efficiency curve, random example

Validation Tools

“lifetime fit”

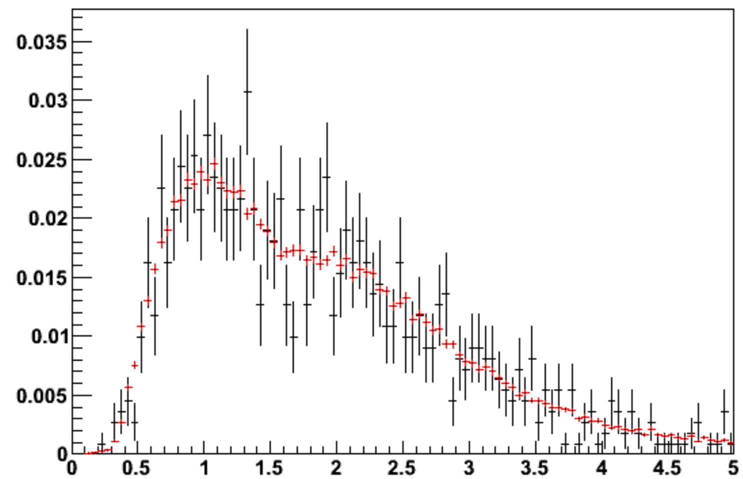
Realistic MC+Model



Re(+)+Re(-)+Re(0) Analogous to a lifetime fit:

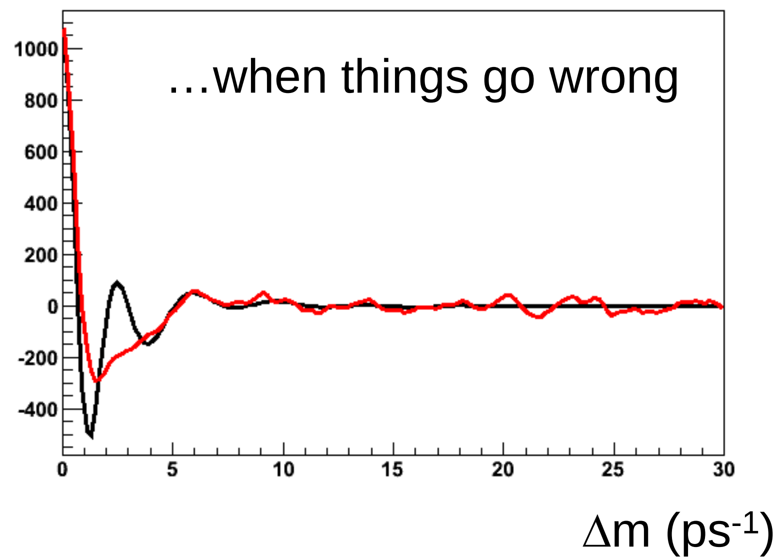
- Unbiased WRT mixing
- Sensitive to:
  - Eff. Curve
  - Resolution

Realistic MC+Toy



Ct (ps)

Realistic MC+Wrong Model



Validation Tools

"pulls"

Re(x) or Δ=Re(+)-Re(-) predicted (value,σ) vs simulated.

Analogous to Likelihood based fit pulls

•Checks:

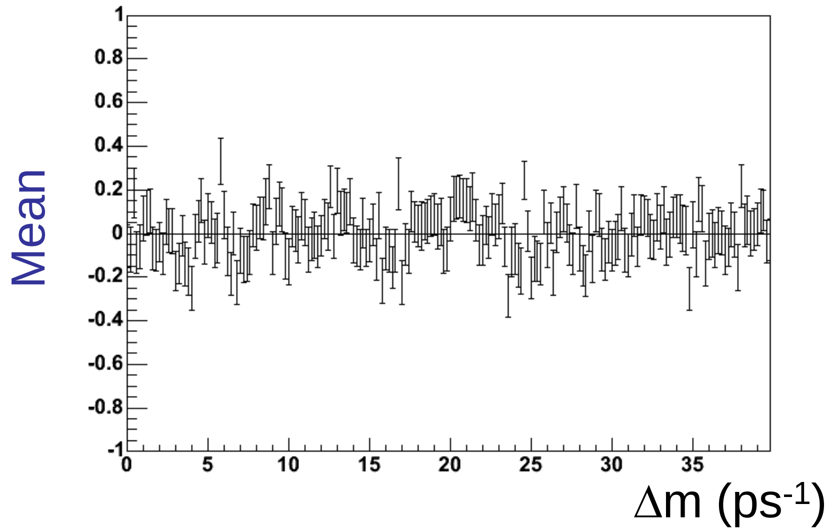
•Fitter response

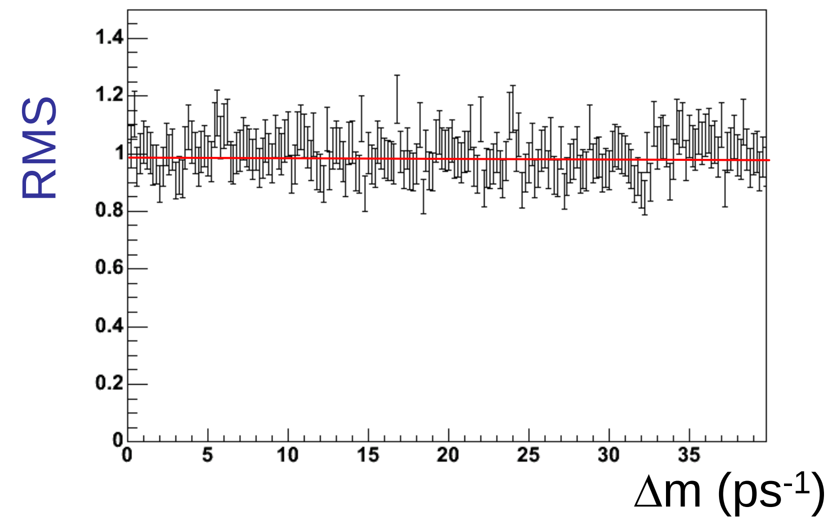
•Toy MC

•Pull width/RMS vs Δm_s shows perfect agreement

•Toy MC and Analytical models perfectly consistent

•Same reliability and consistency you get for L-based fits

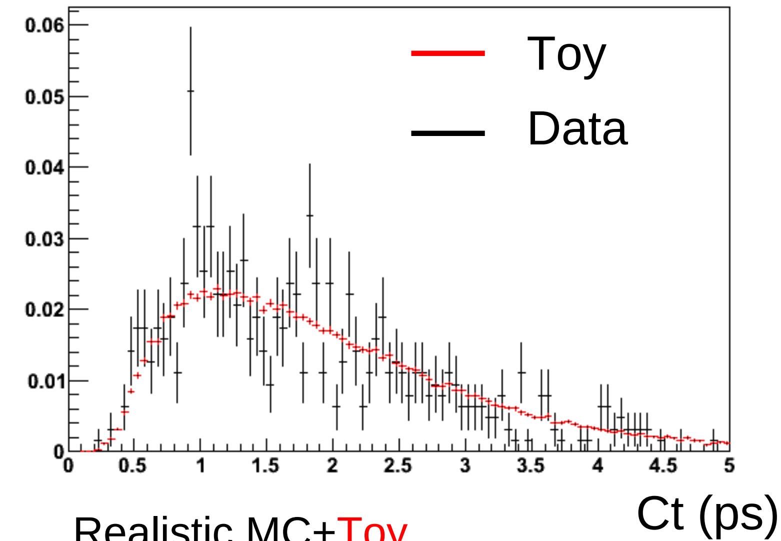




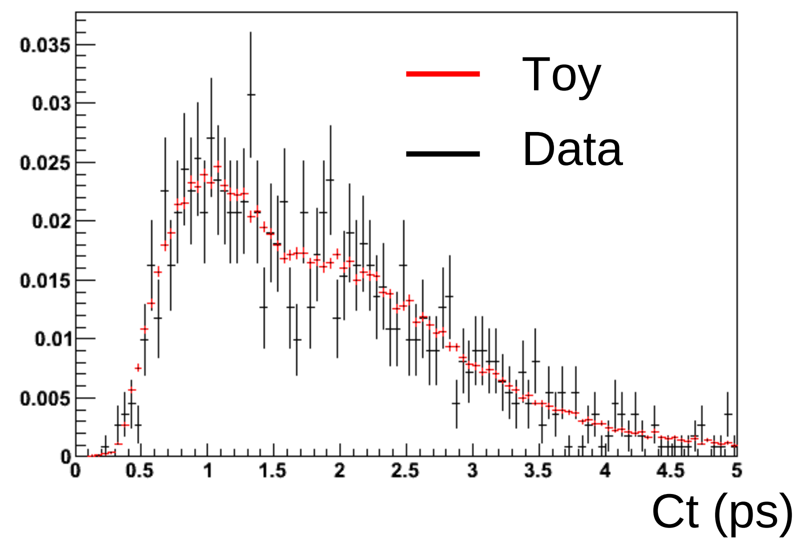
Toy Montecarlo

- As realistic as it can get:
  - Use histogrammed σ_{ct}, D_{tag}, K_{factor}
  - Fully parameterized ε_{curves}
  - Signal:
    - Δm, Γ, $\Delta\Gamma$
  - Background:
    - Prompt+long-lived
    - Separate resolutions
    - Independent ε_{curves}

Data+Toy

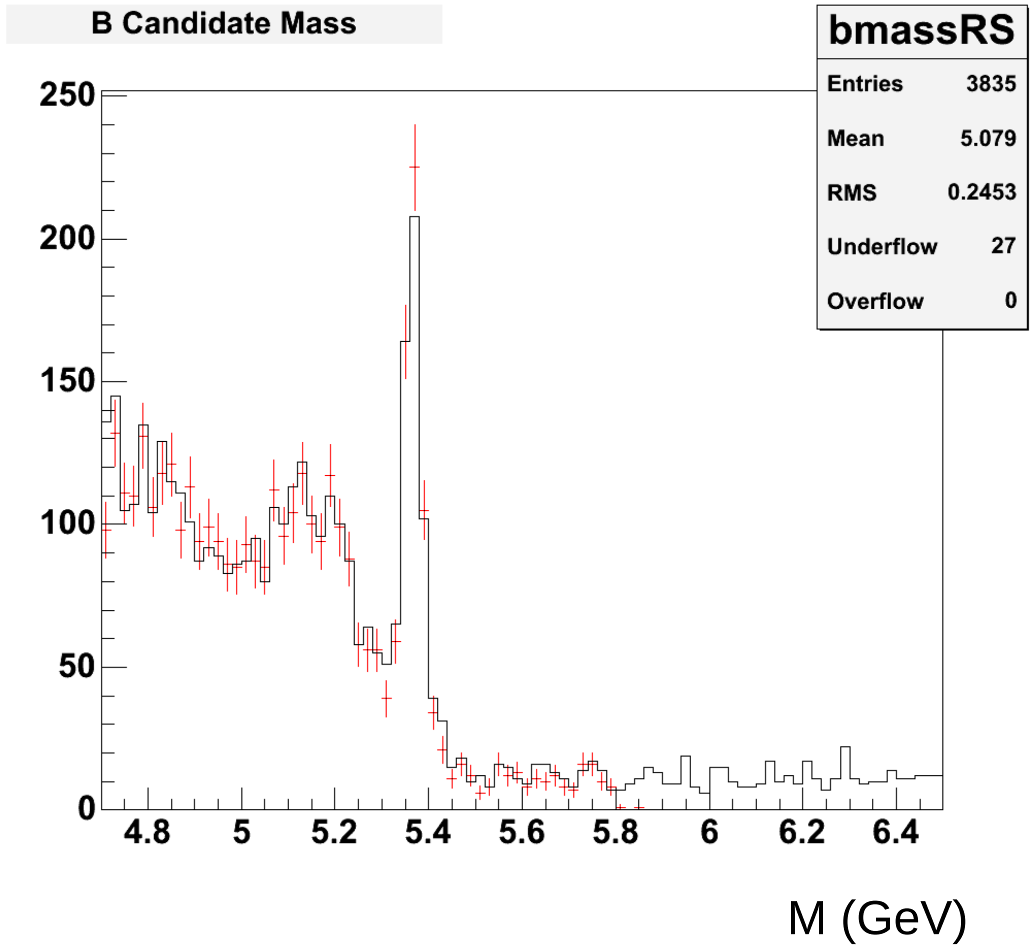


Realistic MC+Toy



Unblinded Data

- Cross-check against available blessed results
- No bias since it's all unblinded already
- Using OSTags only
- Red: our sample, blessed selection
- Black: blessed event list
- This serves mostly as a proof of principle to show the status of this tool!

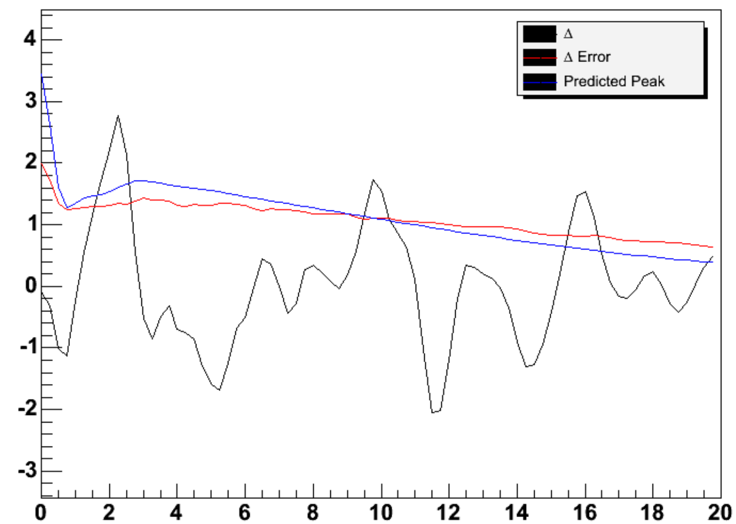


Next plots are based on data skimmed and selected from scratch. For cross checks of the ongoing analysis it would be better to start from the same ascii files, to factor out coding/selections/tagger usage issues!

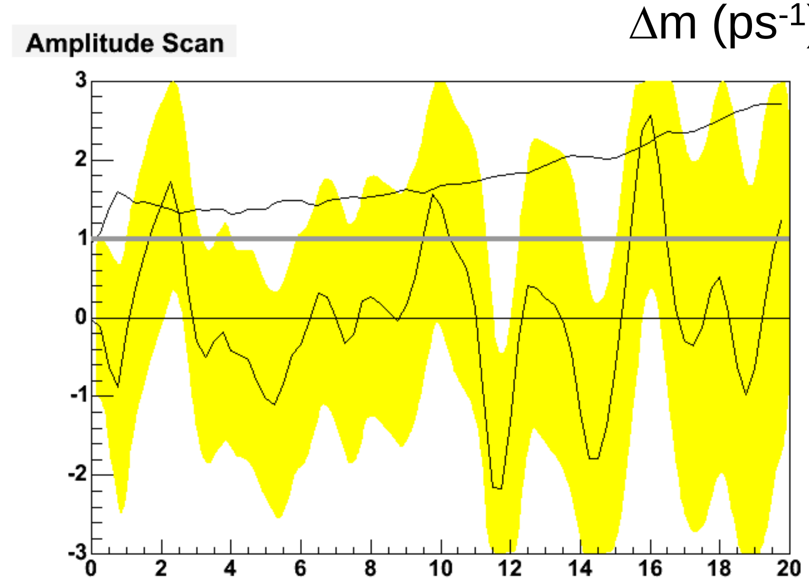
From Fourier to Amplitude

- Recipe is straightforward:
  1) Compute Δ(freq)
  2) Compute expected N(freq)=Δ(freq | Δm=freq)
  3) Obtain A= Δ(freq)/N(freq)
- No more data driven [N(freq)]
- Uses all ingredients of A-scan
- Still no minimization involved though!
- Here looking at Ds($\phi\pi$)π only (350 pb^{-1}, ~500 evts)
- Compatible with blessed results

Fourier Transform+Error+Normalization



Δm (ps^{-1})

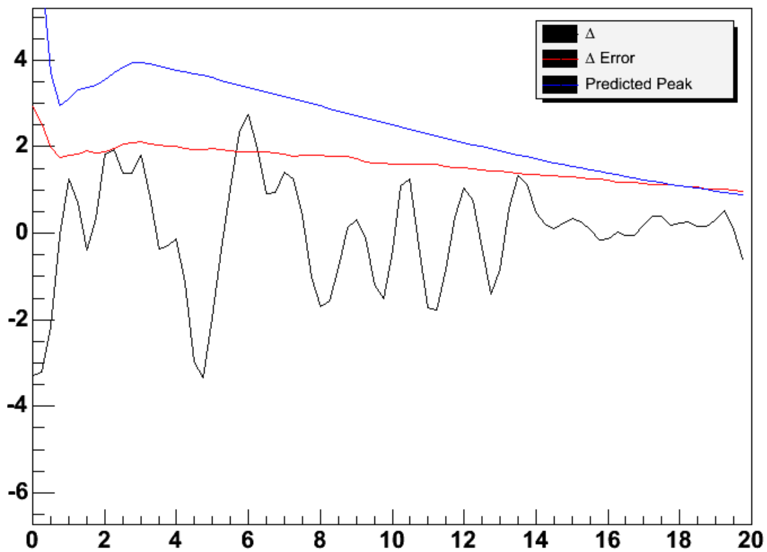


Δm (ps^{-1})

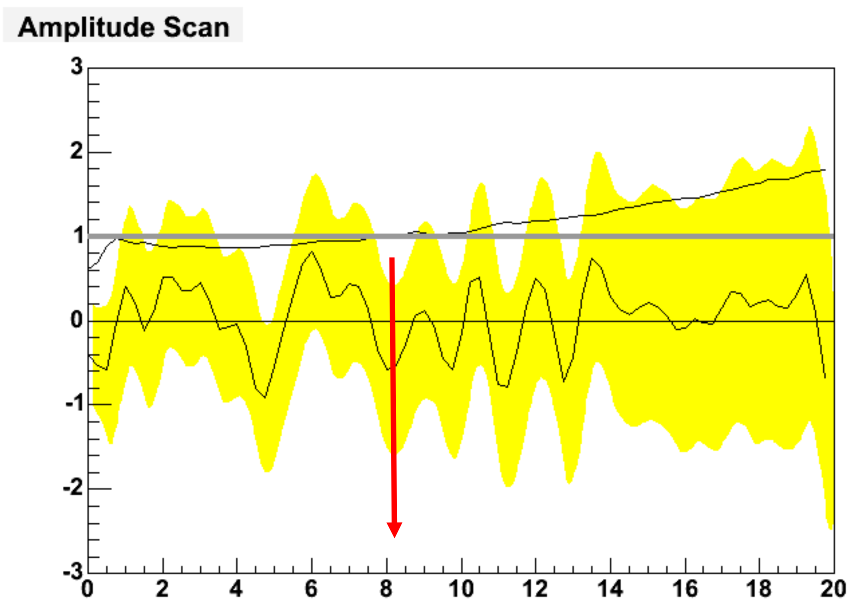
Toy MC

- Same configuration as $D_s(\phi\pi)\pi$ but ~1000 events
- Realistic toy of sensitivity at higher effective statistics (more modes/taggers)

Fourier Transform+Error+Normalization



Δm (ps^{-1})

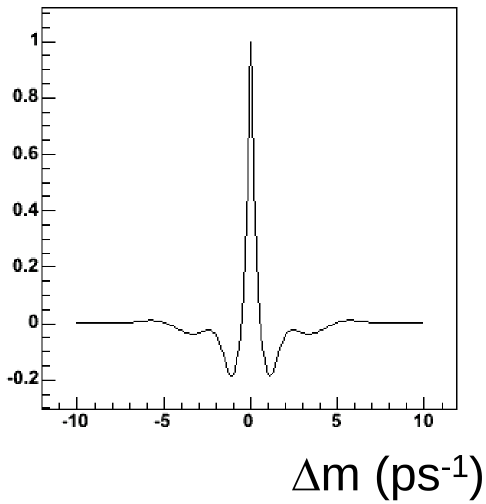


Δm (ps^{-1})

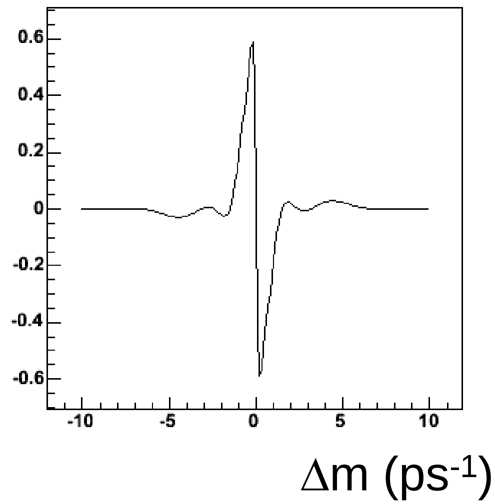
Able to run on data (ascii file) and even generate toy MC off of it

Efficiency Curve

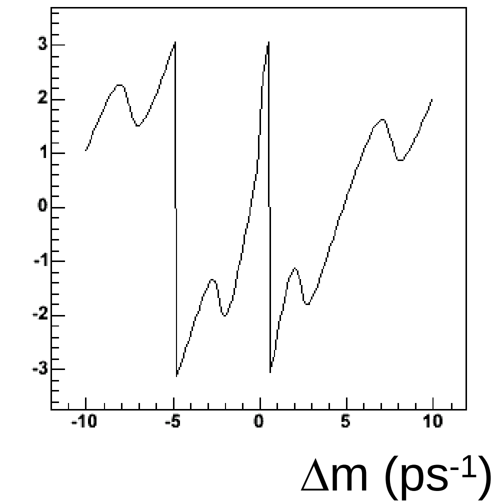
Re($\sim\varepsilon_{curve}$)



Im($\sim\varepsilon_{curve}$)



Arg($\sim\varepsilon_{curve}$)



- Efficiency curve is not real
- Phase is non trivial!

} Signals Real part feeds into Imaginary part

- This curve convolutes with signal → effective attenuation of peak due to x-talk with Im part!

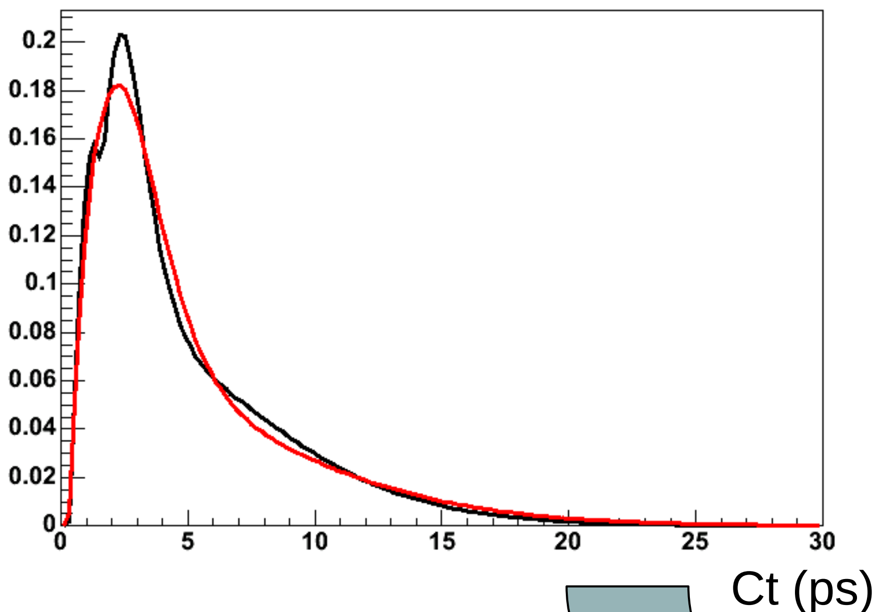
Variations to the ε_{curve} DO cancel, but only at first order!

Efficiency Curve Bias

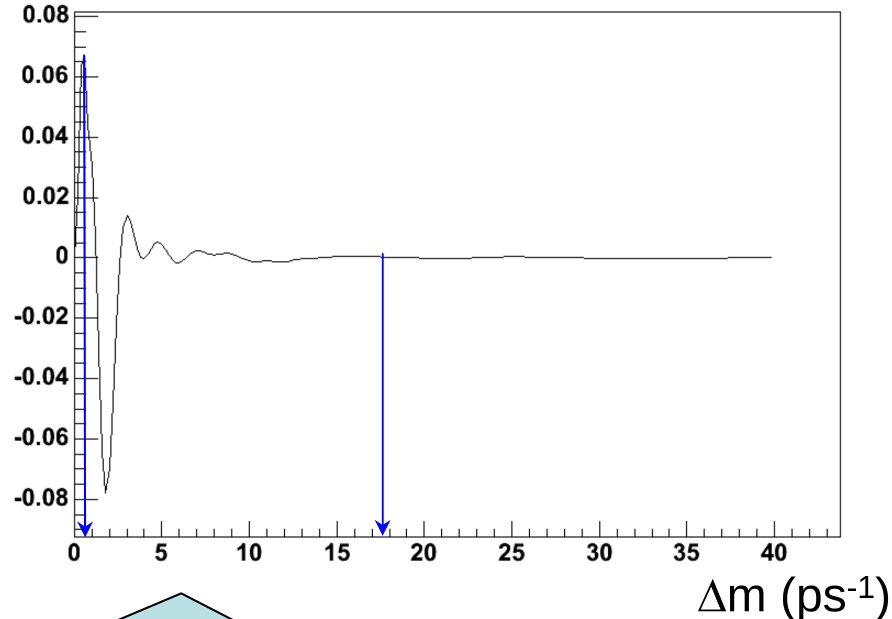
- MC run range != data run range
- Significant effect?
- Gross over-estimate of the effect:
  - Divide in scenarios (A, C, Low…)
  - Derive ε_A ε_C ε_{Low}…
  - Compute A-scan with each of them
  - Use difference as systematics
- Alternative less conservative procedure:
  - Take $\varepsilon(0h)/\varepsilon(0d)$ as correction
  - Evaluate discrepancy using $\varepsilon(0d)$ vs $(\varepsilon(0h),\varepsilon(0d))$

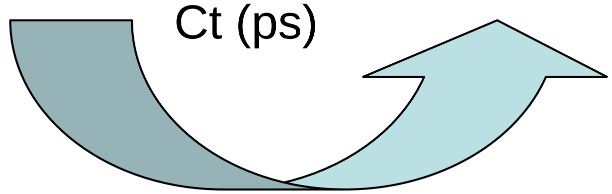
Example of Bias Study

Pick two different ε curves



Compute the effect on the Amplitude





We can assess these effects in O(10 minutes!)

Effect not trivially negligible in tagger calibration!

Proposed Cross Checks

- Data driven "signal" significance
- Study of sensitivity using elaborate toy-MC
- Sanity check with completely orthogonal approach/code
- Requirements (mostly req'd anyway at blessing):
  - L0: flat files of data points
  - L1: parameterization of ε and bck.
  - L2: ascii file of A-scan for point-by-point quantitative check
- Quick turnaround (~ 1/2 day per step above)

With modest impact on analysis speed we can relieve the main proponents from the burden of additional cross-checks

Conclusions

- Full-fledged implementation of the Fourier “fitter”
- Accurate toy simulation
- Code scrutinized and mature
- This allows:
  - Fully data-driven cross-check
  - Complementary fit
  - Fast study of additional systematics
  - Detailed understanding of finer effects
- With little effort from the core group, we could effectively contribute to speed up the analysis finalization
- Breakdown of possible effects easier & faster if we start off the same ascii files, ε, background parameters