Discussion: Dispersive Methods, Theory vs. Experiment

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with input from J. Bijnens, M. Hoferichter, A. Kupść

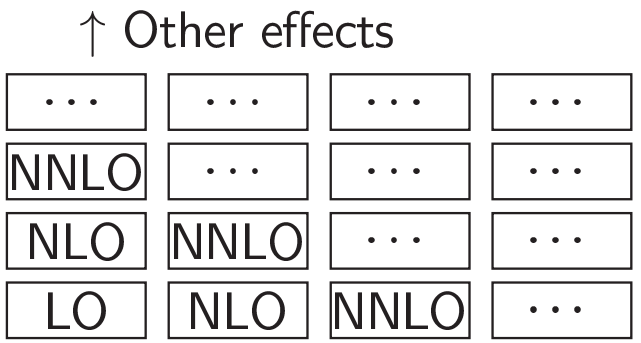
Potential topics

- $\eta \to 3\pi$: ChPT + dispersion relations
- other 3π decays (ω, ϕ, η') : effective parameterisations?
- $e^+e^- \to 3\pi$ cross sections
- theory for $\gamma^{(*)}\gamma^{(*)} \to \pi\pi$ Monte Carlo generators

ChPT + dispersion relations for $\eta \to 3\pi$

$\eta \to 3\pi$: LO, NLO, NNLO, NNNLO,...

- IN Gasser,Leutwyler, 1985 ($\sqrt{2.4} = 1.55$):
  about half: $\pi\pi$-rescattering
  other half: everything else
- $\pi\pi$-rescattering important Roiesnel, Truong, 1981
- Dispersive approach (next talk): resum all $\pi\pi$
- assume rescattering + rest separable:



$\to \pi\pi$-rescattering

dispersive does this all the way

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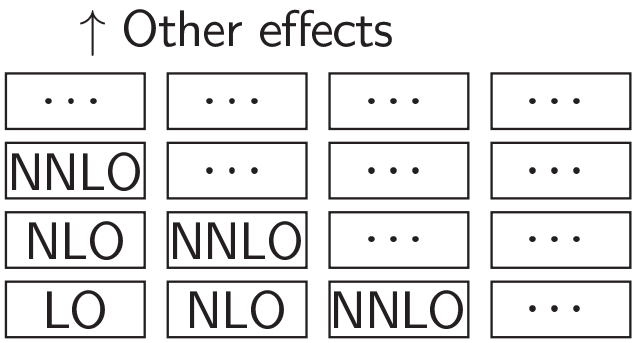
ChPT + dispersion relations for $\eta \to 3\pi$

Why look at it this way?



$\to \pi\pi$-rescattering

dispersive does this all the way

- $\delta_\pi = 0.3$, $\delta_O = 0.3$
- LO $= 1$
- NLO $= \delta_\pi + \delta_O = 0.6$
- NNLO $= \delta_\pi^2 + \delta_\pi\delta_O + \delta_O^2 = 0.27$
- Squared: $1 \to 2.6 \to 3.5$
- Underlying other is: $1 + 0.3 + 0.09$
- Goal: remove dispersive from ChPT, then add again via dispersion relations (but now all boxes)
- Problem: Separation is not trivial

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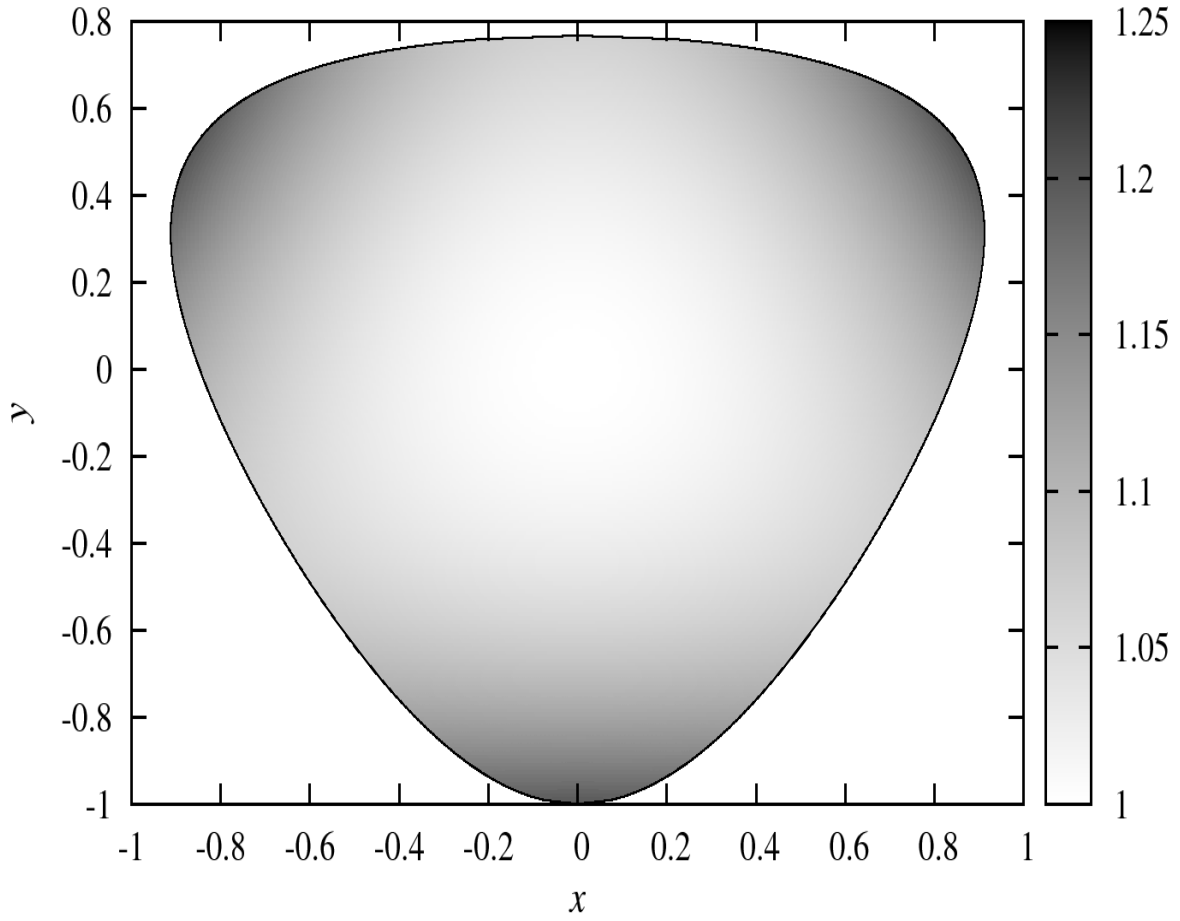
Parameterisations for other 3π Dalitz plots

- $\omega \to 3\pi$ Dalitz plot smooth $\longrightarrow$ polynomial parameterisation

$$|\mathcal{F}_{\rm pol}(z,\phi)|^2 = |\mathcal{N}|^2 \Big\{ 1 + 2\alpha z + 2\beta z^{3/2} \sin 3\phi + 2\gamma z^2 + 2\delta z^{5/2} \sin 3\phi + \mathcal{O}\big(z^3\big) \Big\}$$



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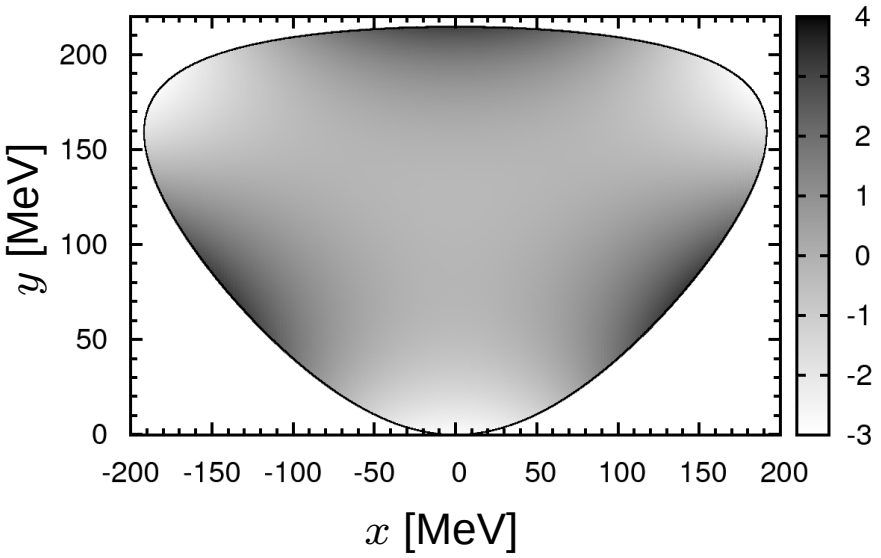
$\big(|\mathcal{F}_{\rm pol}(z,\phi)|^2/|\mathcal{F}(z,\phi)|^2 - 1\big)$[%]



$\alpha \times 10^3$	$\beta \times 10^3$	$\gamma \times 10^3$	$\delta \times 10^3$
$84 \ldots 96$	—	—	—
$74 \ldots 84$	$24 \ldots 28$	—	—
$73 \ldots 81$	$24 \ldots 28$	$3 \ldots 6$	—
$74 \ldots 83$	$21 \ldots 24$	$0 \ldots 2$	$7 \ldots 8$

Niecknig, BK, Schneider 2012

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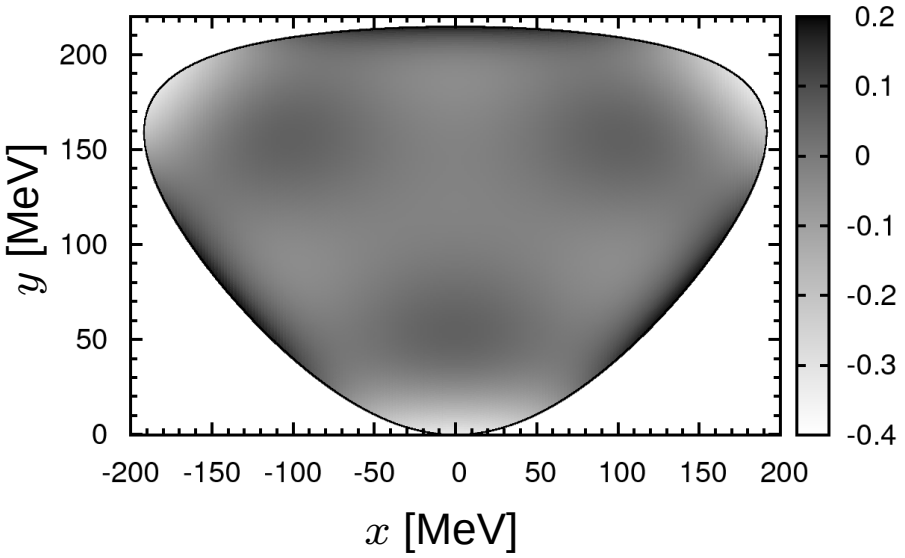

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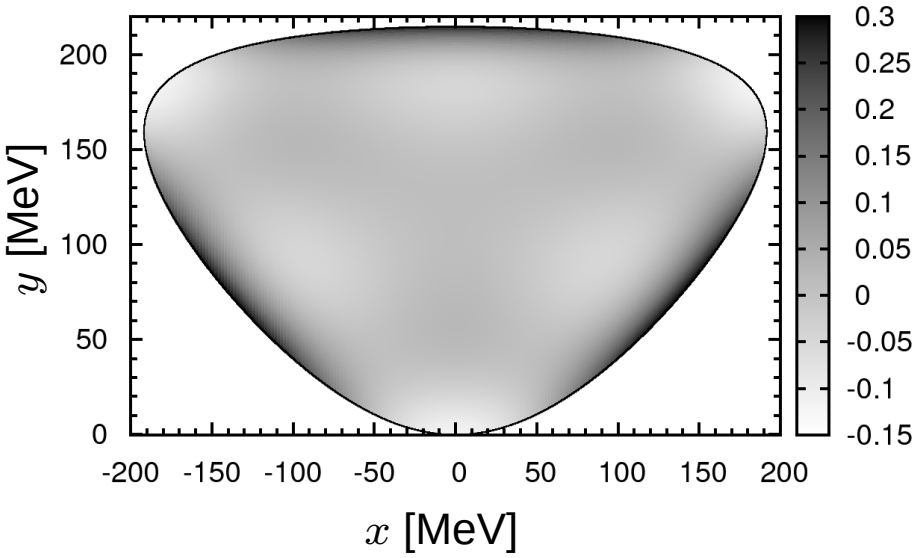

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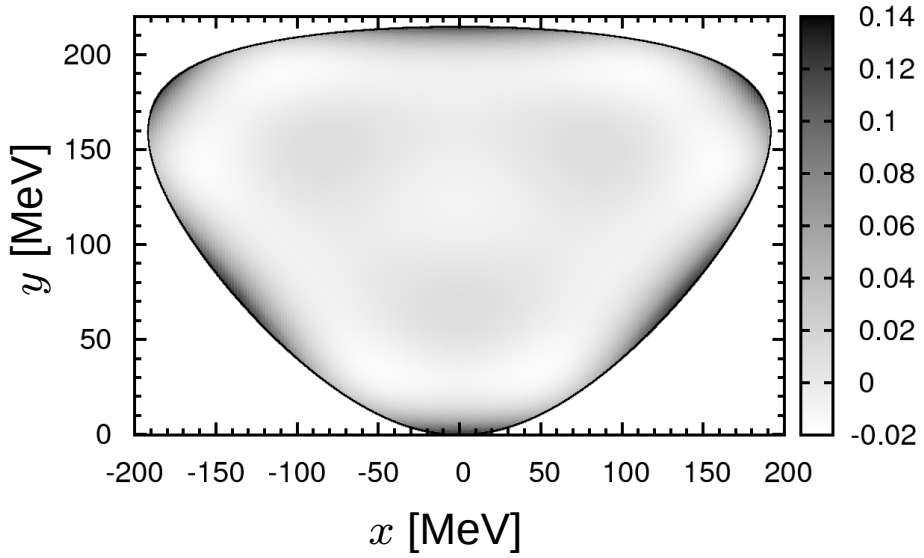

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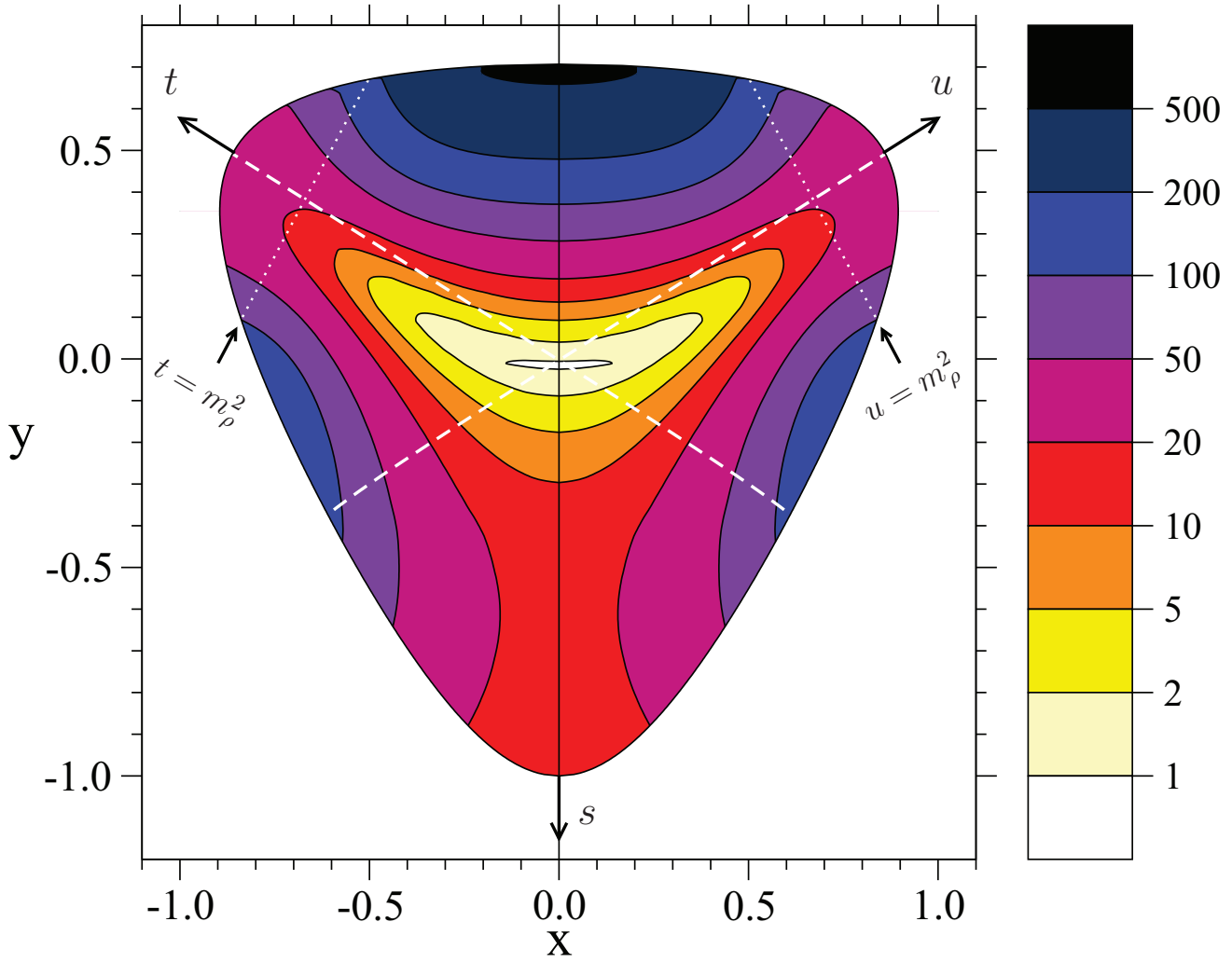
Niecknig, BK, Schneider 2012

$\longrightarrow$ Dalitz plot parameters not efficient/not precise enough

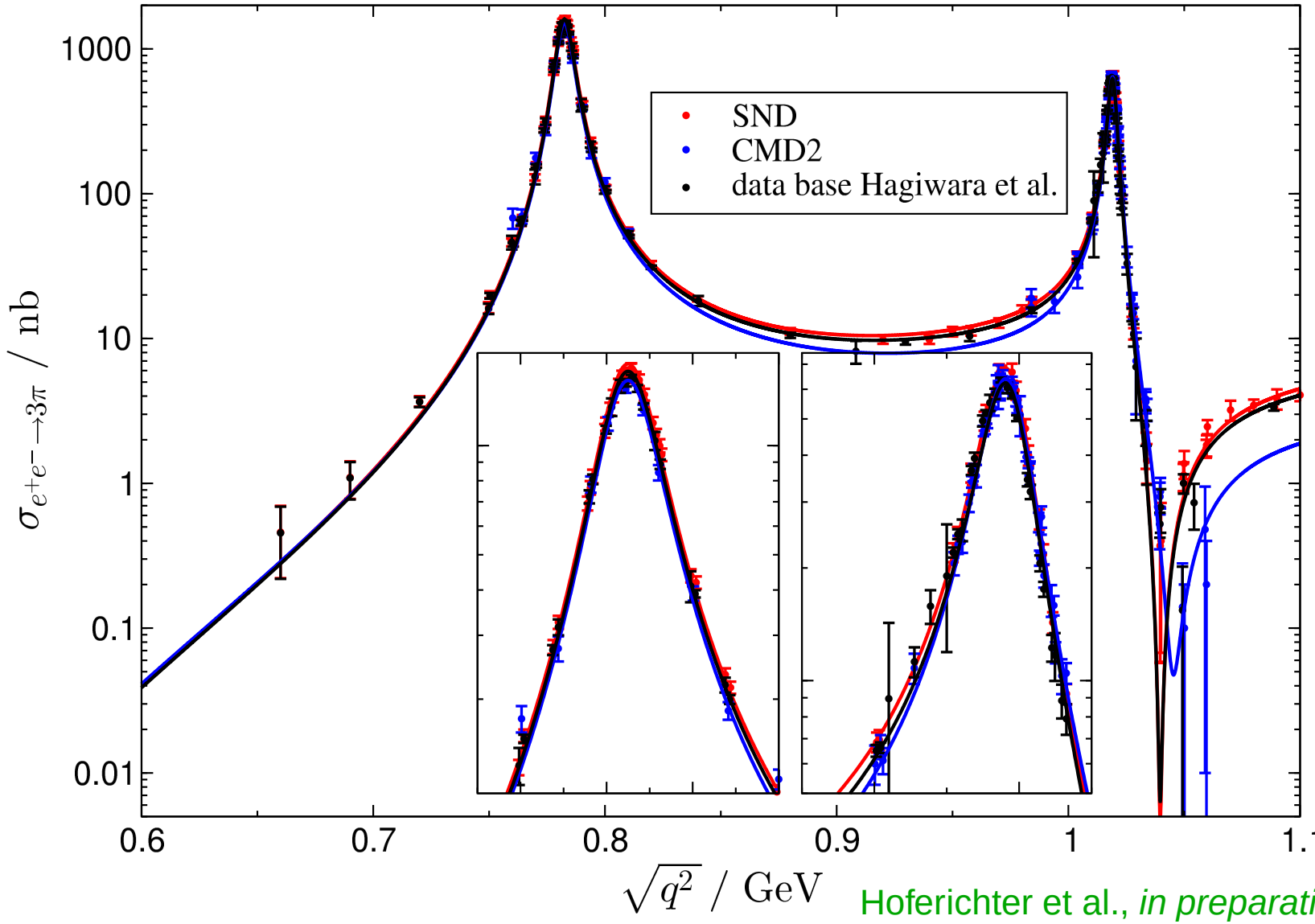
Parameterisations for other 3π Dalitz plots

- $\eta' \to \pi^+\pi^-\pi^0$ Dalitz plot



Nißler, PhD thesis 2007

Inconsistent $e^+e^- \to 3\pi$ data sets

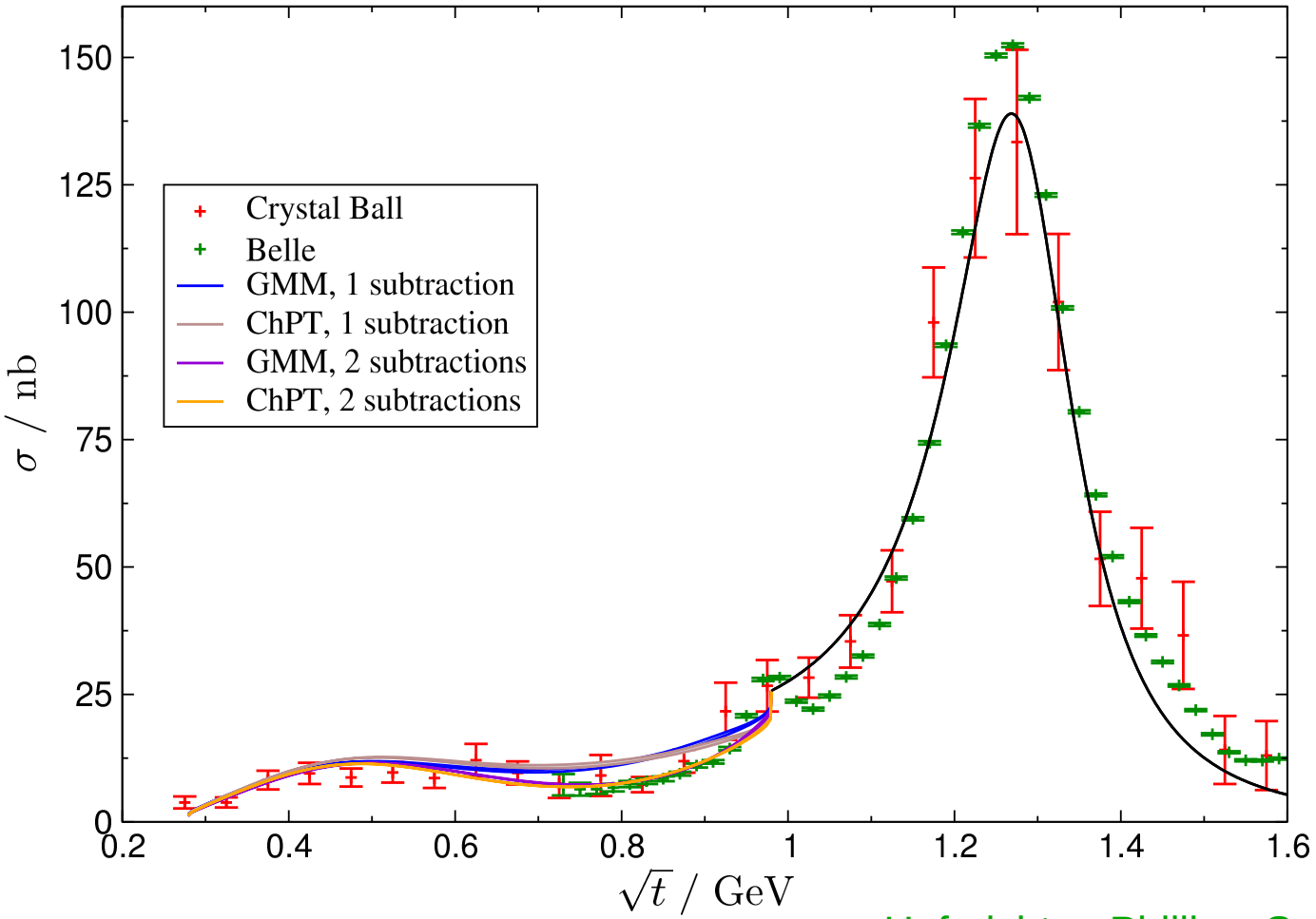


Hoferichter et al., *in preparation*

$\longrightarrow \chi^2/\#\text{dof}$ [SND / CMD-2 / Hagiwara et al.] = 1.0 / 2.4 / 6.3

Monte Carlo for $\gamma^{(*)}\gamma^{(*)} \to \pi\pi$

- pion–pion S-waves: $f_0(500)$; D-waves: $f_2(1270)$



Hoferichter, Phillips, Schat 2011

$\longrightarrow$ good parameterisations made available for MC generators?