Further studies on IPCHI2 fit

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Ω_c^0 *lifetime measurement meeting*

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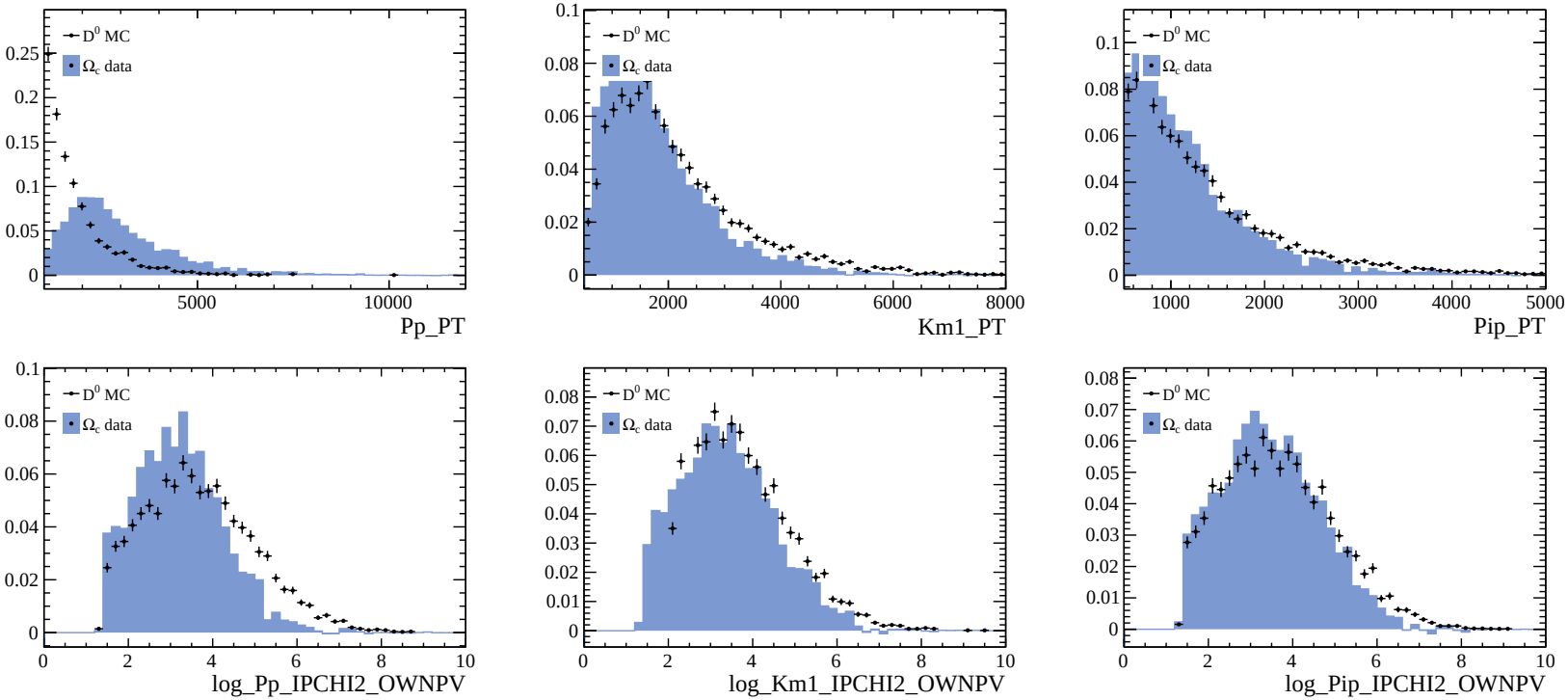
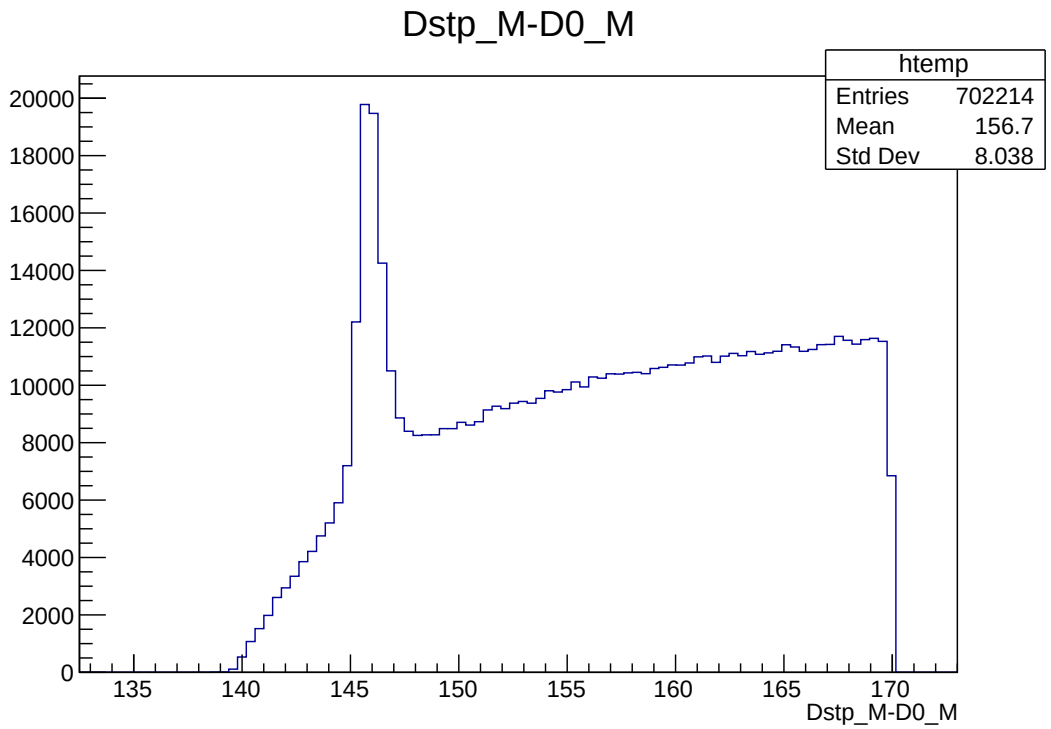
BDT selection

- Low efficiency when apply the BDT trained on the Ω_c^0 data to the D^0 MC sample
  - Possibly due to the different distributions of the signal



The window of Δm

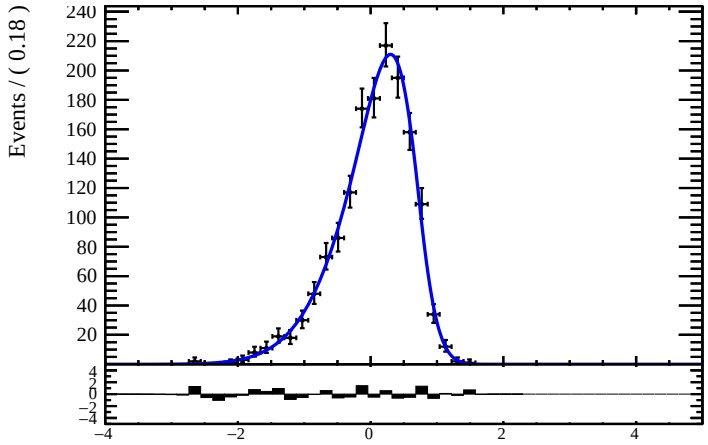
- Require $|\Delta m - 146| < 6$ to further suppress backgrounds

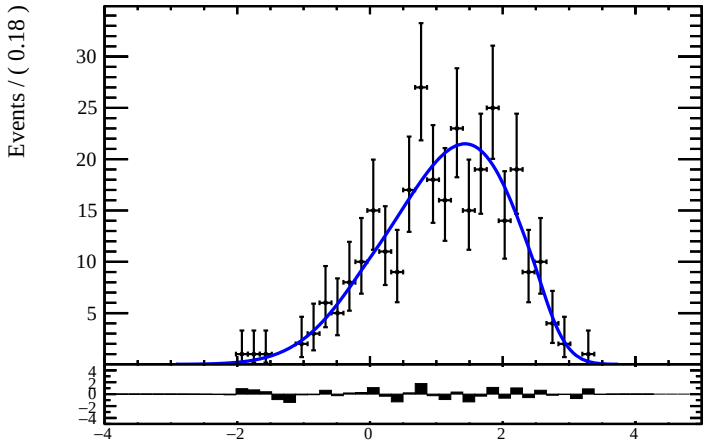


Fit strategy

- Selection
  - Apply to the D^0 sample the same lifetime-related cuts as those of Ω_c signal mode
  - Apply the loose cut $BDT > 0.0$ (compared with $BDT > 0.11$ in the signal mode)
  - Require the mass window of Δm
- IPCHI fit
  1. Fit to the MC sample
  2. Fit to the data sample with all parameters free and the initial values to be those of the MC fit results
  3. Fit to the data sample with prompt parameters fixed to values of the MC fit except the prompt μ to the value of the free fit
  4. Further fix the secondary ξ and σ due to the agreement with values of the MC fit and to get correct error matrix
  5. The total number of signals constrained to values from the mass fit

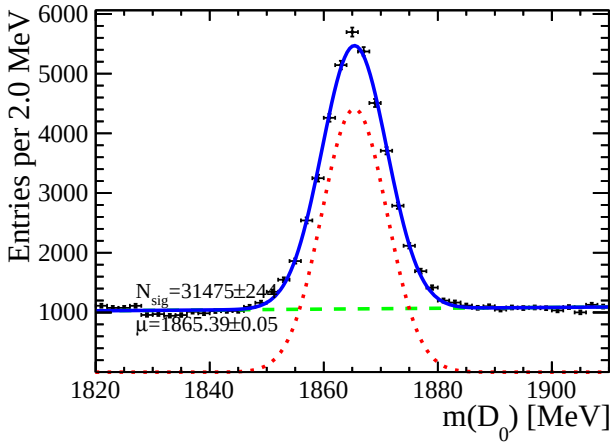
Fit results: MC samples

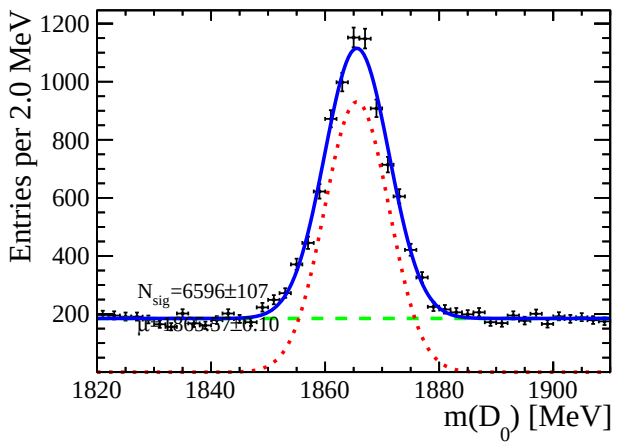


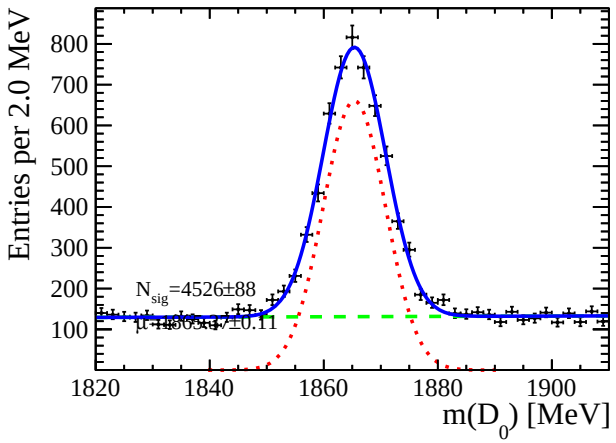


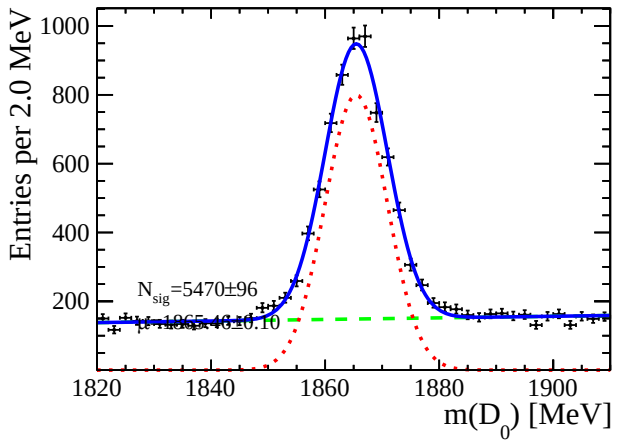
Fit results: data mass fits

- Binning scheme (the same as the signal mode): [0.1, 0.45, 0.52, 0.57, 0.63, 0.69, 0.75, 0.81, 0.9, 1.05, 2.0] ps
- Bin 0-3



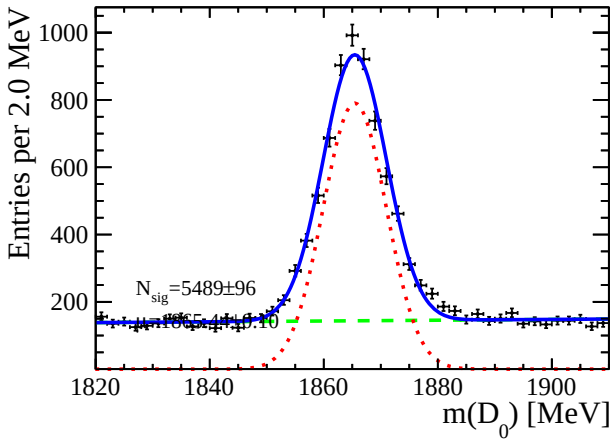


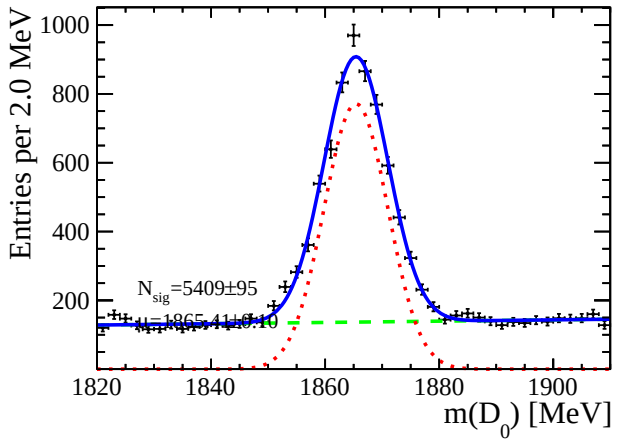


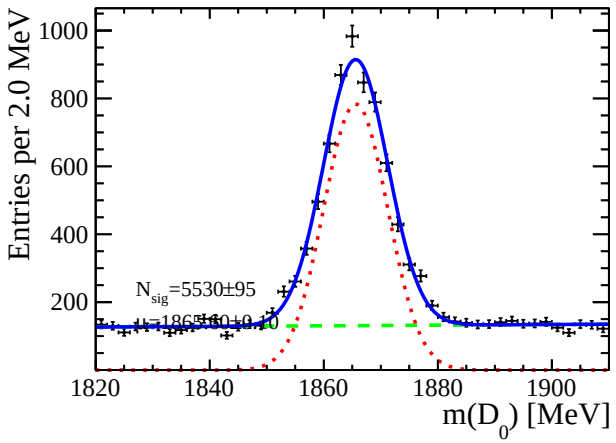


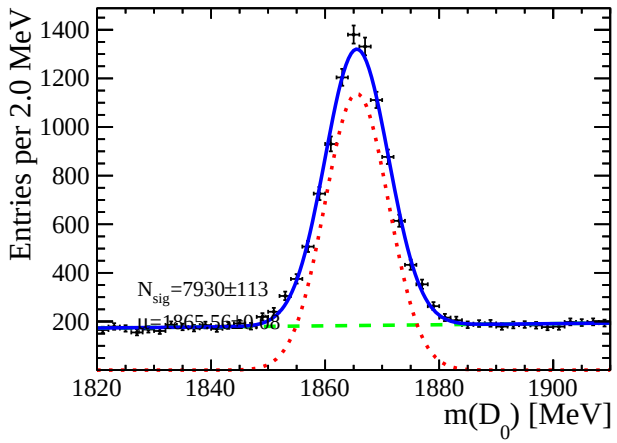
Fit results: data mass fits

- Binning scheme (the same as the signal mode): [0.1, 0.45, 0.52, 0.57, 0.63, 0.69, 0.75, 0.81, 0.9, 1.05, 2.0] ps
- Bin 4-7



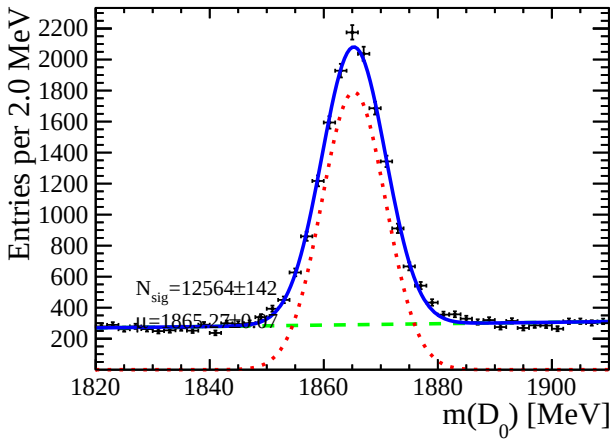


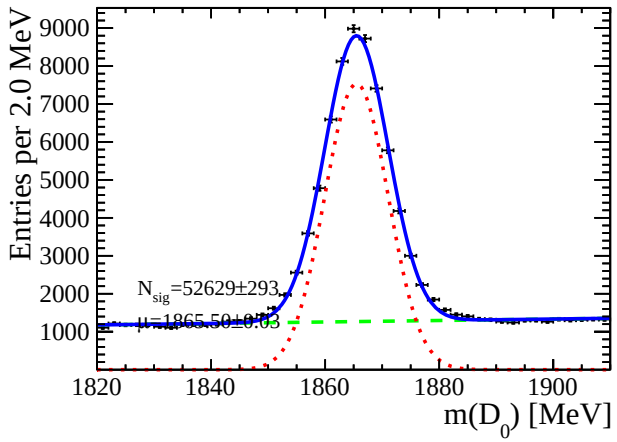




Fit results: data mass fits

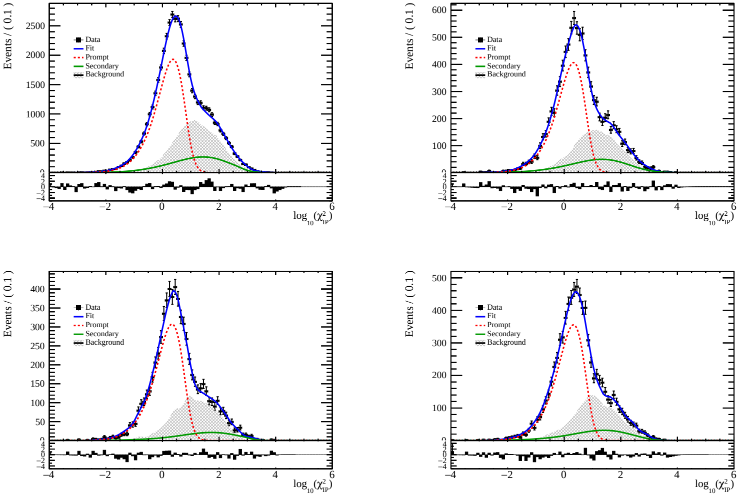
- Binning scheme (the same as the signal mode): [0.1, 0.45, 0.52, 0.57, 0.63, 0.69, 0.75, 0.81, 0.9, 1.05, 2.0] ps
- Bin 8-9





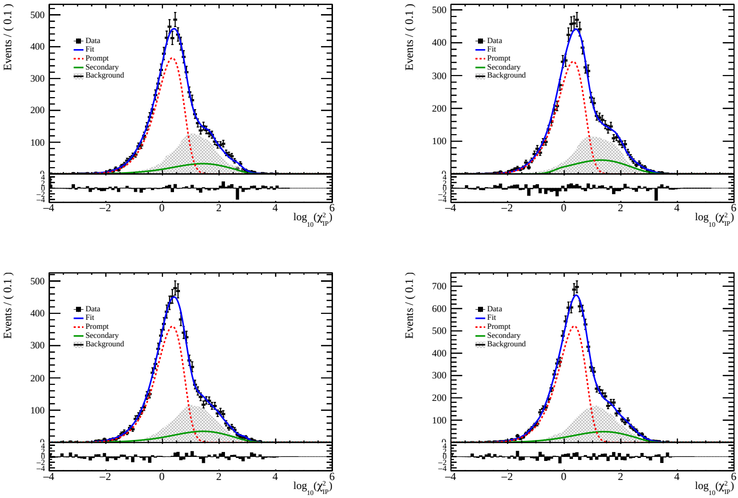
Fit results: data χ^2_{IP} fits

- Bin 0-3



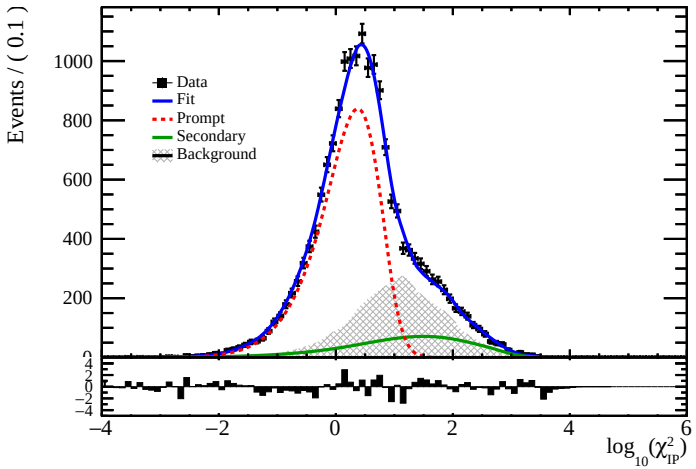
Fit results: data χ^2_{IP} fits

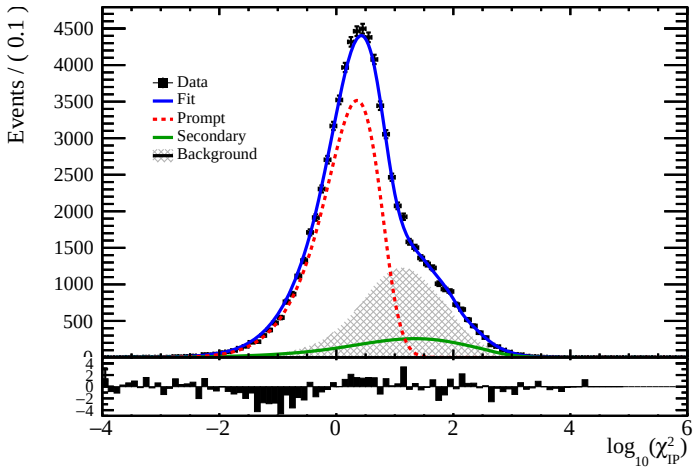
- Bin 4-7



Fit results: data χ^2_{IP} fits

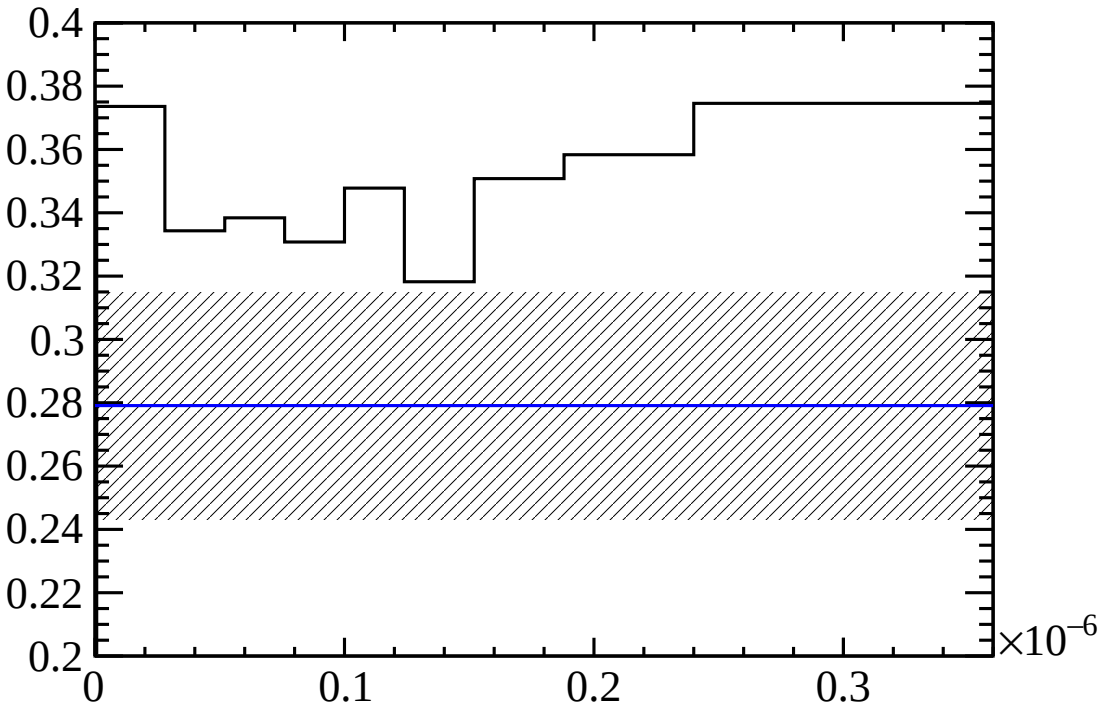
- Bin 8-9





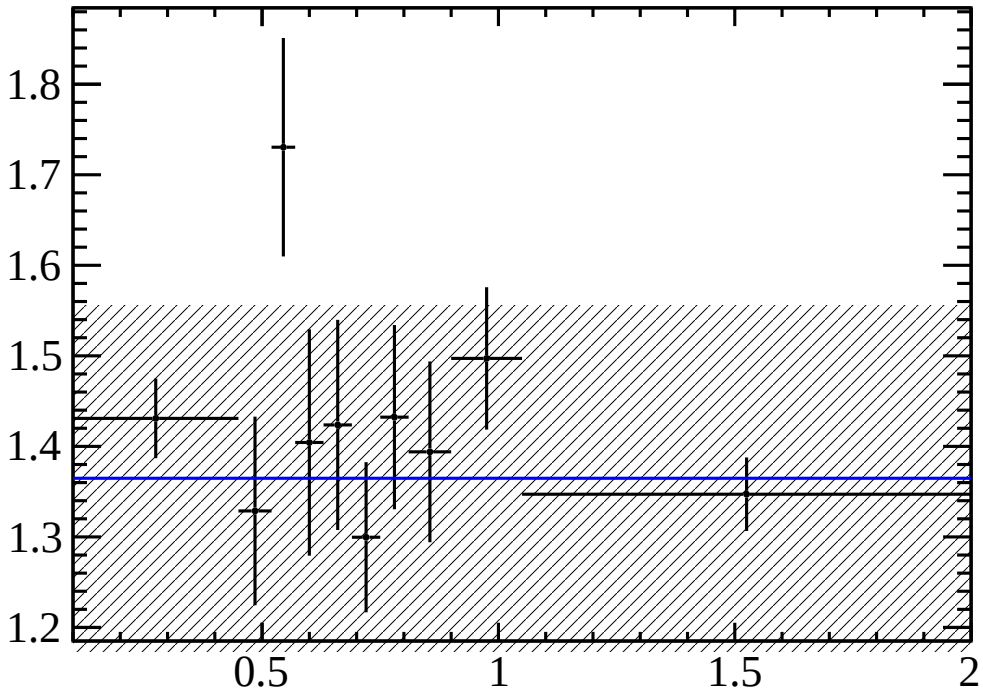
Fit results as a function of decay time

- Prompt μ



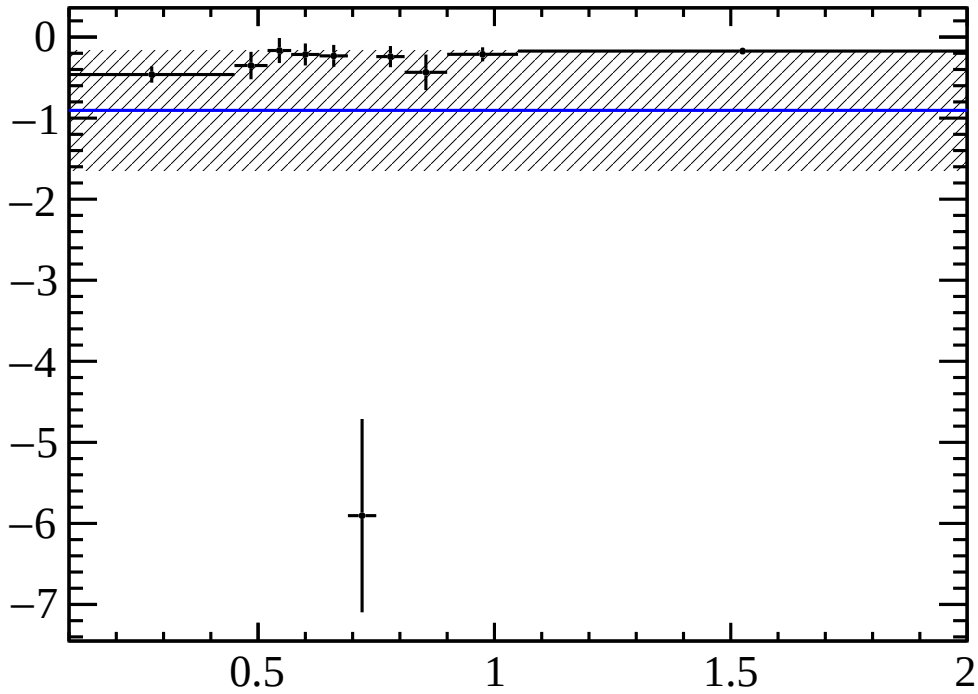
Fit results as a function of decay time

- Secondary μ



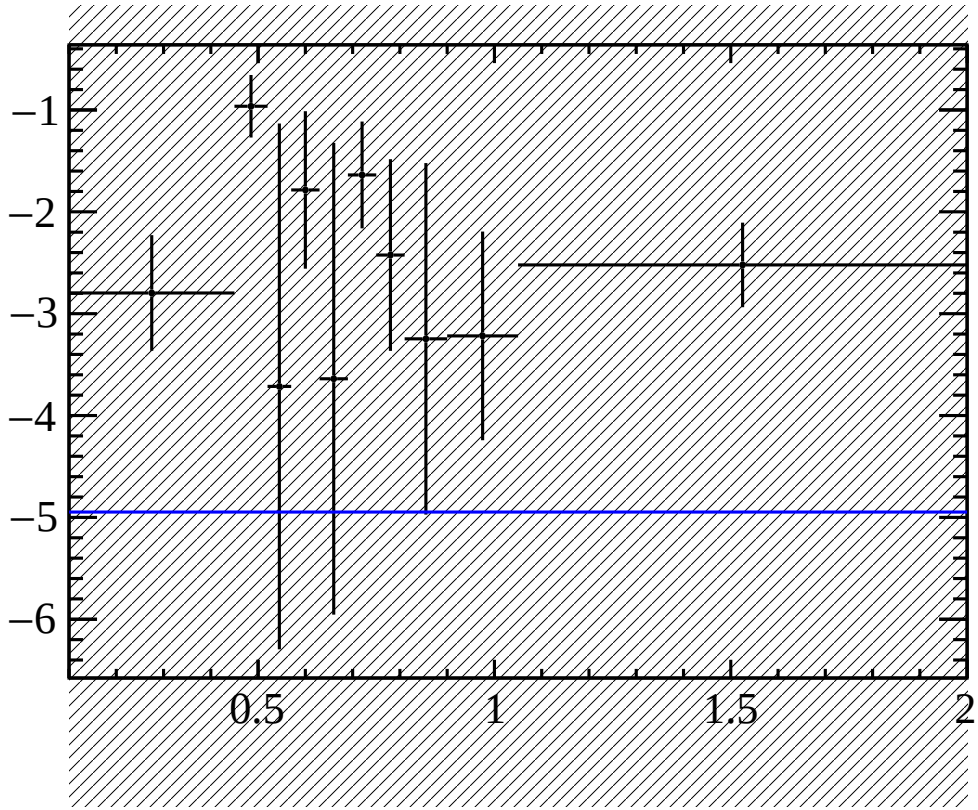
Fit results as a function of decay time

- Secondary ρ_1



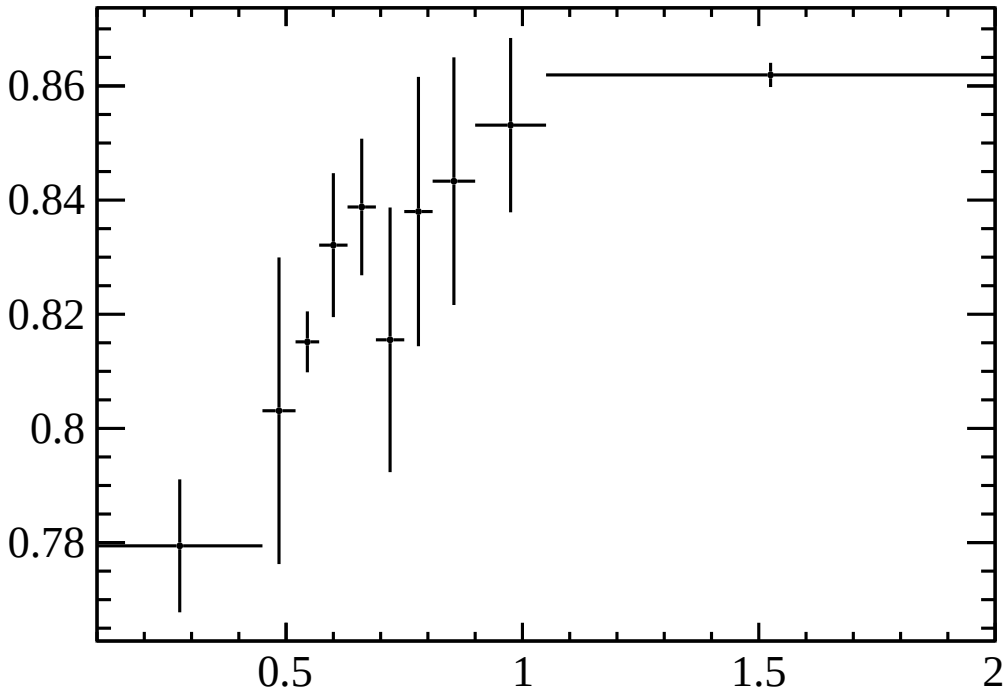
Fit results as a function of decay time

- Secondary ρ_2



Fit results as a function of decay time

- Prompt yield fraction



Fit results in bin 0

		MC	config 1	config 2	config 3
Prompt	μ	0.28 ± 0.04	0.37 ± 0.01	0.36	0.37
	σ	0.49 ± 0.02	0.45 ± 0.01	0.49	0.49
	ξ	-0.19 ± 0.05	-0.20 ± 0.01	-0.19	-0.19
	ρ_1	-0.17 ± 0.08	-0.37 ± 0.06	-0.17	-0.17
	ρ_2	-1.29 ± 0.59	-1.49 ± 0.29	-1.29	-1.29
Secondary	μ	1.36 ± 0.19	0.93 ± 0.18	1.36 ± 0.00	1.43 ± 0.04
	σ	1.03 ± 0.07	1.28 ± 0.04	0.84 ± 0.00	1.03
	ξ	-0.10 ± 0.15	-0.07 ± 0.08	0.02 ± 0.00	-0.10
	ρ_1	-0.90 ± 0.74	-1.23 ± 0.26	-0.09 ± 0.00	-0.46 ± 0.10
	ρ_2	-4.95 ± 7.27	-3.58 ± 0.99	-1.72 ± 0.00	-2.80 ± 0.57

Fit results in bin 1

		MC	config 1	config 2	config 3
Prompt	μ	0.28 ± 0.04	0.33 ± 0.04	0.34	0.33
	σ	0.49 ± 0.02	0.48 ± 0.03	0.49	0.49
	ξ	-0.19 ± 0.05	-0.17 ± 0.09	-0.19	-0.19
	ρ_1	-0.17 ± 0.08	-0.28 ± 0.30	-0.17	-0.17
	ρ_2	-1.29 ± 0.59	-1.47 ± 0.37	-1.29	-1.29
Secondary	μ	1.36 ± 0.19	1.19 ± 0.14	1.34 ± 0.02	1.33 ± 0.10
	σ	1.03 ± 0.07	1.10 ± 0.13	0.79 ± 0.07	1.03
	ξ	-0.10 ± 0.15	-0.13 ± 0.09	-0.00 ± 0.00	-0.10
	ρ_1	-0.90 ± 0.74	-0.37 ± 0.28	-0.74 ± 0.31	-0.35 ± 0.17
	ρ_2	-4.95 ± 7.27	-0.88 ± 0.42	-0.65 ± 0.09	-0.96 ± 0.31

Fit results in bin 2

		MC	config 1	config 2	config 3
Prompt	μ	0.28 ± 0.04	0.34 ± 0.01	0.35	0.34
	σ	0.49 ± 0.02	0.46 ± 0.01	0.49	0.49
	ξ	-0.19 ± 0.05	-0.17 ± 0.01	-0.19	-0.19
	ρ_1	-0.17 ± 0.08	-0.31 ± 0.29	-0.17	-0.17
	ρ_2	-1.29 ± 0.59	-1.09 ± 0.40	-1.29	-1.29
Secondary	μ	1.36 ± 0.19	0.91 ± 1.71	1.23 ± 0.18	1.73 ± 0.12
	σ	1.03 ± 0.07	1.53 ± 0.09	0.96 ± 0.08	1.03
	ξ	-0.10 ± 0.15	-0.00 ± 0.07	0.07 ± 0.11	-0.10
	ρ_1	-0.90 ± 0.74	-1.31 ± 1.90	-5.90 ± 8.55	-0.17 ± 0.15
	ρ_2	-4.95 ± 7.27	-9.91 ± 5.02	-2.28 ± 1.32	-3.71 ± 2.58

Fit results in bin 3

		MC	config 1	config 2	config 3
Prompt	μ	0.28 ± 0.04	0.33 ± 0.01	0.35	0.33
	σ	0.49 ± 0.02	0.46 ± 0.01	0.49	0.49
	ξ	-0.19 ± 0.05	-0.19 ± 0.01	-0.19	-0.19
	ρ_1	-0.17 ± 0.08	-0.17 ± 0.02	-0.17	-0.17
	ρ_2	-1.29 ± 0.59	-1.49 ± 0.31	-1.29	-1.29
Secondary	μ	1.36 ± 0.19	0.86 ± 1.26	1.33 ± 0.15	1.40 ± 0.13
	σ	1.03 ± 0.07	0.96 ± 0.05	0.66 ± 0.07	1.03
	ξ	-0.10 ± 0.15	0.11 ± 0.05	0.18 ± 0.45	-0.10
	ρ_1	-0.90 ± 0.74	0.06 ± 0.24	-0.23 ± 2.89	-0.21 ± 0.14
	ρ_2	-4.95 ± 7.27	-1.58 ± 1.42	-1.01 ± 0.17	-1.79 ± 0.77

Fit results in bin 4

		MC	config 1	config 2	config 3
Prompt	μ	0.28 ± 0.04	0.35 ± 0.02	0.35	0.35
	σ	0.49 ± 0.02	0.50 ± 0.01	0.49	0.49
	ξ	-0.19 ± 0.05	-0.16 ± 0.03	-0.19	-0.19
	ρ_1	-0.17 ± 0.08	-0.14 ± 0.05	-0.17	-0.17
	ρ_2	-1.29 ± 0.59	-1.09 ± 0.40	-1.29	-1.29
Secondary	μ	1.36 ± 0.19	2.07 ± 0.08	1.40 ± 0.00	1.42 ± 0.12
	σ	1.03 ± 0.07	0.53 ± 0.13	0.76 ± 0.00	1.03
	ξ	-0.10 ± 0.15	-0.30 ± 0.11	0.03 ± 0.05	-0.10
	ρ_1	-0.90 ± 0.74	0.05 ± 0.04	0.07 ± 0.00	-0.23 ± 0.14
	ρ_2	-4.95 ± 7.27	0.05 ± 0.24	-1.46 ± 0.00	-3.64 ± 2.32

Fit results in bin 5

		MC	config 1	config 2	config 3
Prompt	μ	0.28 $\pm$ 0.04	0.32 $\pm$ 0.01	0.32	0.32
	σ	0.49 $\pm$ 0.02	0.43 $\pm$ 0.01	0.49	0.49
	ξ	-0.19 $\pm$ 0.05	-0.10 $\pm$ 0.01	-0.19	-0.19
	ρ_1	-0.17 $\pm$ 0.08	-0.07 $\pm$ 0.02	-0.17	-0.17
	ρ_2	-1.29 $\pm$ 0.59	-1.09 $\pm$ 0.35	-1.29	-1.29
Secondary	μ	1.36 $\pm$ 0.19	0.92 $\pm$ 0.03	1.02 $\pm$ 0.18	1.30 $\pm$ 0.08
	σ	1.03 $\pm$ 0.07	1.32 $\pm$ 0.01	0.85 $\pm$ 0.04	1.03
	ξ	-0.10 $\pm$ 0.15	-0.14 $\pm$ 0.02	0.13 $\pm$ 0.12	-0.10
	ρ_1	-0.90 $\pm$ 0.74	-2.52 $\pm$ 0.25	-5.90 $\pm$ 6.87	-5.90 $\pm$ 1.19
	ρ_2	-4.95 $\pm$ 7.27	-2.13 $\pm$ 0.67	-1.59 $\pm$ 0.75	-1.64 $\pm$ 0.52

Fit results in bin 6

		MC	config 1	config 2	config 3
Prompt	μ	0.28 $\pm$ 0.04	0.35 $\pm$ 0.01	0.36	0.35
	σ	0.49 $\pm$ 0.02	0.49 $\pm$ 0.02	0.49	0.49
	ξ	-0.19 $\pm$ 0.05	-0.15 $\pm$ 0.02	-0.19	-0.19
	ρ_1	-0.17 $\pm$ 0.08	-0.13 $\pm$ 0.06	-0.17	-0.17
	ρ_2	-1.29 $\pm$ 0.59	-1.34 $\pm$ 0.28	-1.29	-1.29
Secondary	μ	1.36 $\pm$ 0.19	1.68 $\pm$ 0.04	1.29 $\pm$ 0.32	1.43 $\pm$ 0.10
	σ	1.03 $\pm$ 0.07	0.89 $\pm$ 0.03	0.81 $\pm$ 0.24	1.03
	ξ	-0.10 $\pm$ 0.15	-0.19 $\pm$ 0.02	0.08 $\pm$ 0.09	-0.10
	ρ_1	-0.90 $\pm$ 0.74	-0.10 $\pm$ 0.06	0.08 $\pm$ 0.15	-0.24 $\pm$ 0.13
	ρ_2	-4.95 $\pm$ 7.27	-1.10 $\pm$ 0.27	-1.73 $\pm$ 1.16	-2.42 $\pm$ 0.94

Fit results in bin 7

		MC	config 1	config 2	config 3
Prompt	μ	0.28 ± 0.04	0.36 ± 0.01	0.35	0.36
	σ	0.49 ± 0.02	0.46 ± 0.02	0.49	0.49
	ξ	-0.19 ± 0.05	-0.18 ± 0.01	-0.19	-0.19
	ρ_1	-0.17 ± 0.08	-0.13 ± 0.05	-0.17	-0.17
	ρ_2	-1.29 ± 0.59	-1.09 ± 0.39	-1.29	-1.29
Secondary	μ	1.36 ± 0.19	1.05 ± 0.38	1.32 ± 0.09	1.39 ± 0.10
	σ	1.03 ± 0.07	1.19 ± 0.04	0.71 ± 0.11	1.03
	ξ	-0.10 ± 0.15	-0.05 ± 0.05	0.14 ± 0.11	-0.10
	ρ_1	-0.90 ± 0.74	-0.76 ± 0.38	-0.81 ± 1.93	-0.43 ± 0.22
	ρ_2	-4.95 ± 7.27	-4.25 ± 4.15	-1.55 ± 0.82	-3.25 ± 1.73

Fit results in bin 8

		MC	config 1	config 2	config 3
Prompt	μ	0.28 ± 0.04	0.37 ± 0.01	0.37	0.37
	σ	0.49 ± 0.02	0.46 ± 0.01	0.49	0.49
	ξ	-0.19 ± 0.05	-0.19 ± 0.01	-0.19	-0.19
	ρ_1	-0.17 ± 0.08	-0.08 ± 0.02	-0.17	-0.17
	ρ_2	-1.29 ± 0.59	-1.49 ± 0.28	-1.29	-1.29
Secondary	μ	1.36 ± 0.19	1.19 ± 0.35	1.34 ± 0.09	1.50 ± 0.08
	σ	1.03 ± 0.07	1.07 ± 0.04	0.82 ± 0.06	1.03
	ξ	-0.10 ± 0.15	0.00 ± 0.03	0.04 ± 0.06	-0.10
	ρ_1	-0.90 ± 0.74	-0.34 ± 0.20	0.04 ± 0.07	-0.21 ± 0.09
	ρ_2	-4.95 ± 7.27	-3.61 ± 2.60	-1.66 ± 0.61	-3.22 ± 1.02

Fit results in bin 9

		MC	config 1	config 2	config 3
Prompt	μ	0.28 ± 0.04	0.36 ± 0.01	0.36	0.36
	σ	0.49 ± 0.02	0.47 ± 0.01	0.49	0.49
	ξ	-0.19 ± 0.05	-0.16 ± 0.01	-0.19	-0.19
	ρ_1	-0.17 ± 0.08	-0.18 ± 0.04	-0.17	-0.17
	ρ_2	-1.29 ± 0.59	-1.43 ± 0.22	-1.29	-1.29
Secondary	μ	1.36 ± 0.19	1.18 ± 0.20	0.86 ± 0.01	1.35 ± 0.04
	σ	1.03 ± 0.07	1.12 ± 0.09	0.87 ± 0.02	1.03
	ξ	-0.10 ± 0.15	-0.14 ± 0.09	0.20 ± 0.01	-0.10
	ρ_1	-0.90 ± 0.74	-0.37 ± 0.26	0.12 ± 0.01	-0.17 ± 0.04
	ρ_2	-4.95 ± 7.27	-2.10 ± 0.68	-2.40 ± 0.29	-2.52 ± 0.42

Backup

$\log \chi^2_{IP}$ modelling

- Bukin function, a modified Novosibirsk function with extended tail parameters

$$\mathcal{P}(x;\mu,\sigma,\xi,\rho_1,\rho_2) = \begin{cases} \exp\left\{ \dfrac{(x-x_1)\xi\sqrt{\xi^2+1}\sqrt{2\ln 2}}{\sigma\left(\sqrt{\xi^2+1}-\xi\right)^2 \ln\left(\sqrt{\xi^2+1}+\xi\right)} + \rho_1\left(\dfrac{x-x_1}{\mu-x_1}\right)^2 - \ln 2 \right\} & x \le x_1, \\ \exp\left\{ -\left[\dfrac{\ln\left(1+2\xi\sqrt{\xi^2+1}\dfrac{x-\mu}{\sigma\sqrt{2\ln 2}}\right)}{\ln\left(1+2\xi^2-2\xi\sqrt{\xi^2+1}\right)}\right]^2 \times \ln 2 \right\} & x_1 < x < x_2, \\ \exp\left\{ \dfrac{(x-x_2)\xi\sqrt{\xi^2+1}\sqrt{2\ln 2}}{\sigma\left(\sqrt{\xi^2+1}-\xi\right)^2 \ln\left(\sqrt{\xi^2+1}+\xi\right)} + \rho_2\left(\dfrac{x-x_2}{\mu-x_2}\right)^2 - \ln 2 \right\} & x \ge x_2. \end{cases}$$

where

$$x_1 = \mu + \sigma\sqrt{2\ln 2}\left(\frac{\xi}{\sqrt{\xi^2+1}} - 1\right)$$

$$x_2 = \mu + \sigma\sqrt{2\ln 2}\left(\frac{\xi}{\sqrt{\xi^2+1}} + 1\right)$$

Illustration of Bukin functions

- Influence of asymetry and tail parameters with $\mu = 0, \sigma = 1, \rho_1 = 0$