Analysis Test Beam

Giovanni Gaudino – FCC Napoli – 2025, 29th January
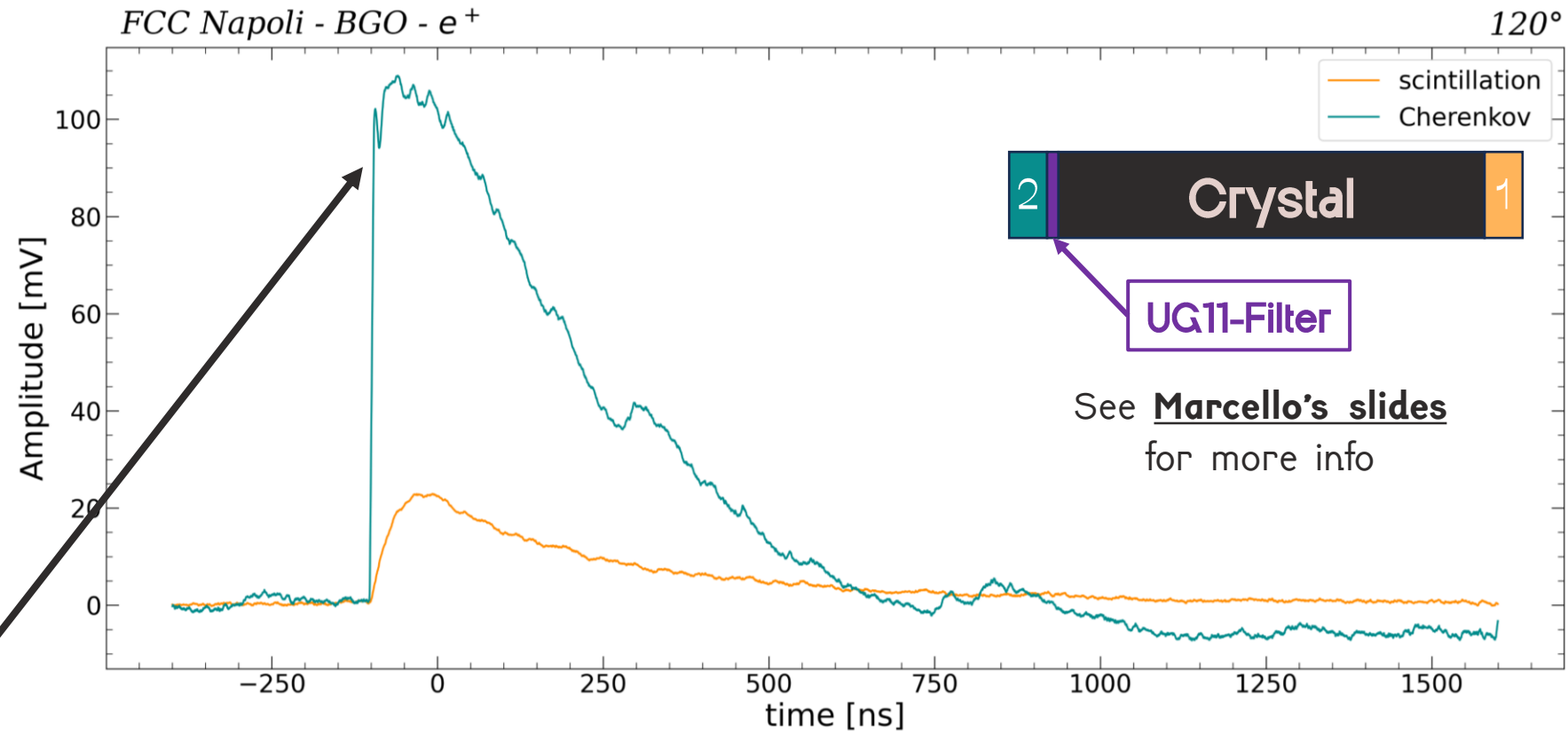
Starting Point

- Each waveform passes a moving average algorithm, to remove most of the noise
- The pedestal is removed a posteriori (average of the first 15 points)

The idea is to extract the Čerenkov peak from the waveform in all the crystal configurations


The **'best'** (maybe) way to extract the signal from the wavefrom is via a fit:
- We should find the templates

See **Marcello's slides** for more info

UG11-Filter

Crystal

Step 1: Model single photon response (**SPR**) from data

SPR modelled using LED pulse data.
- Shape modelled as double exponential + **high-pass filter** (preAmp AC is coupled to SiPM cathode) on LED driver data
- Amplitude calibrated from LED driver data (finger plots → see Lucrezia's slide)
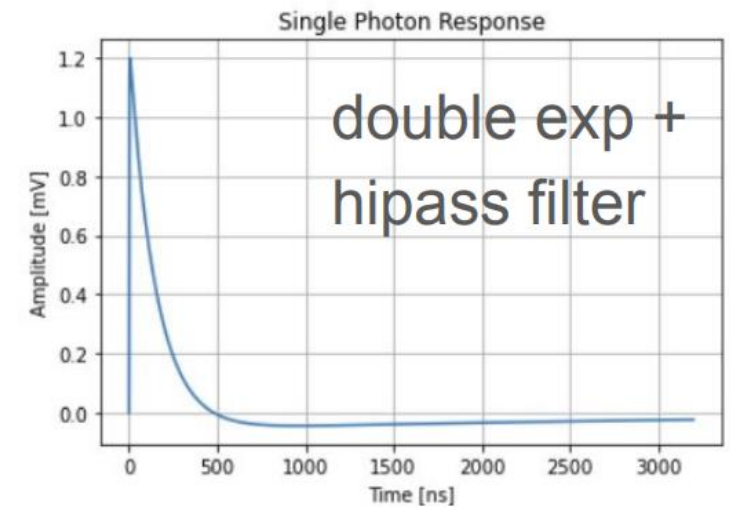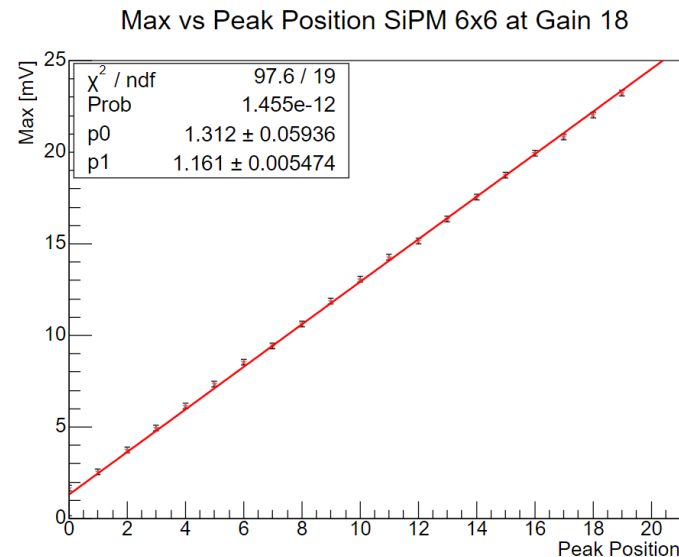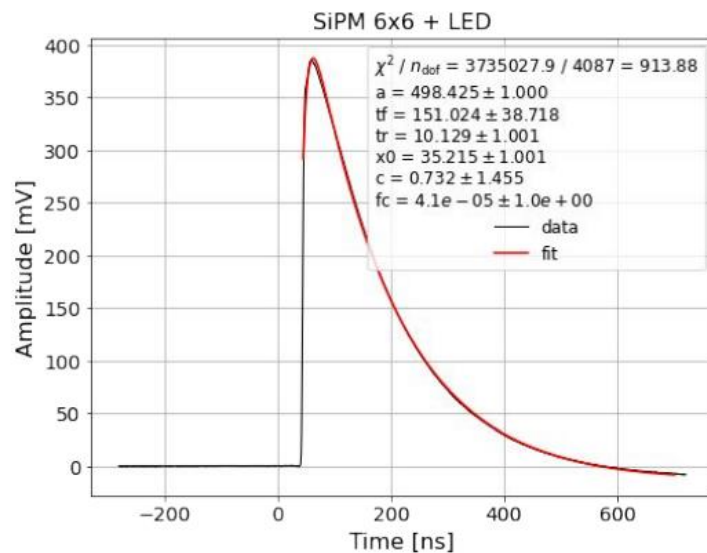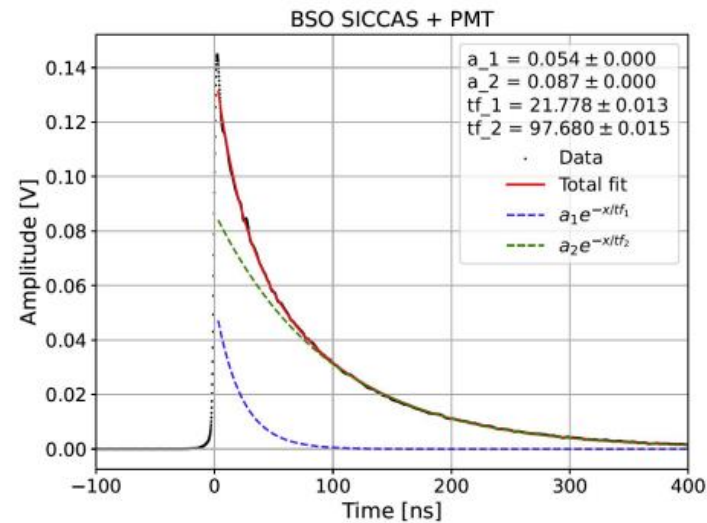
Fitting Strategy - Templates
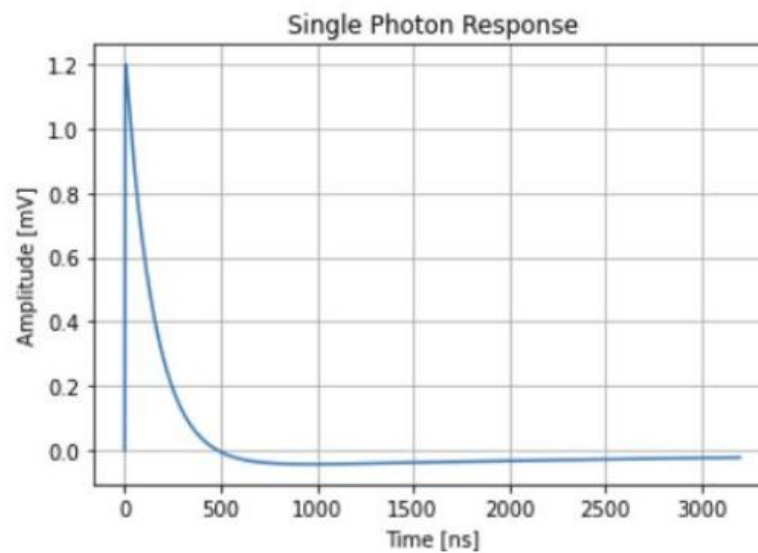
Scintillation Template

Signal modelled from the convolution of **SPR** with the characteristic crystal time distribution (measured in cosmic data using PMT)
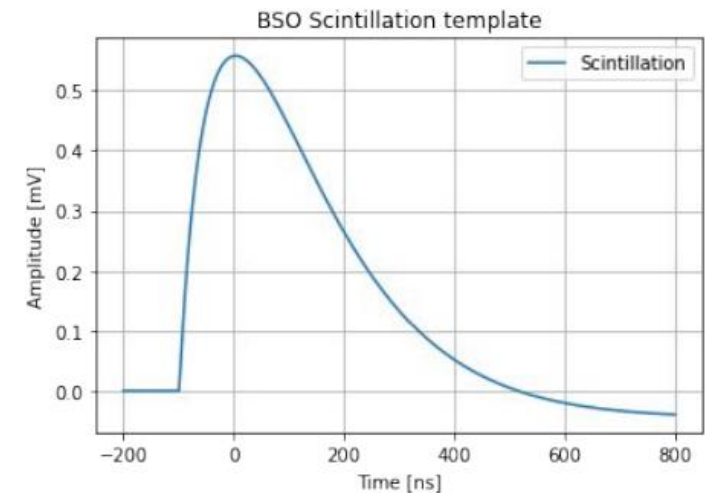
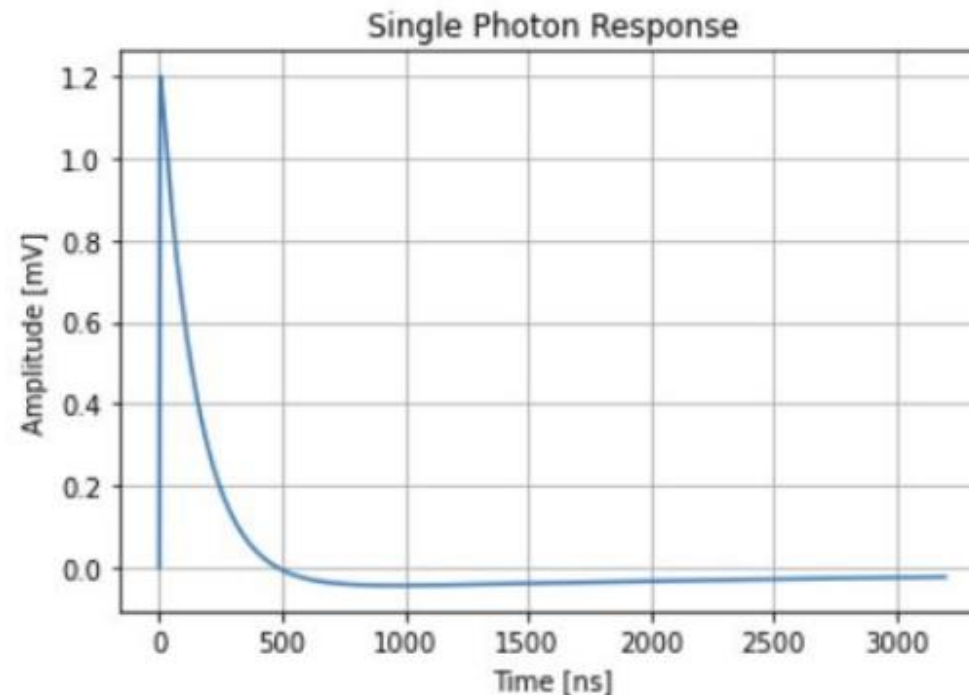**Scintillation Time Distribution**   **SPR**   **Final Template**

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Fitting Strategy - Templates

Čerenkov Template
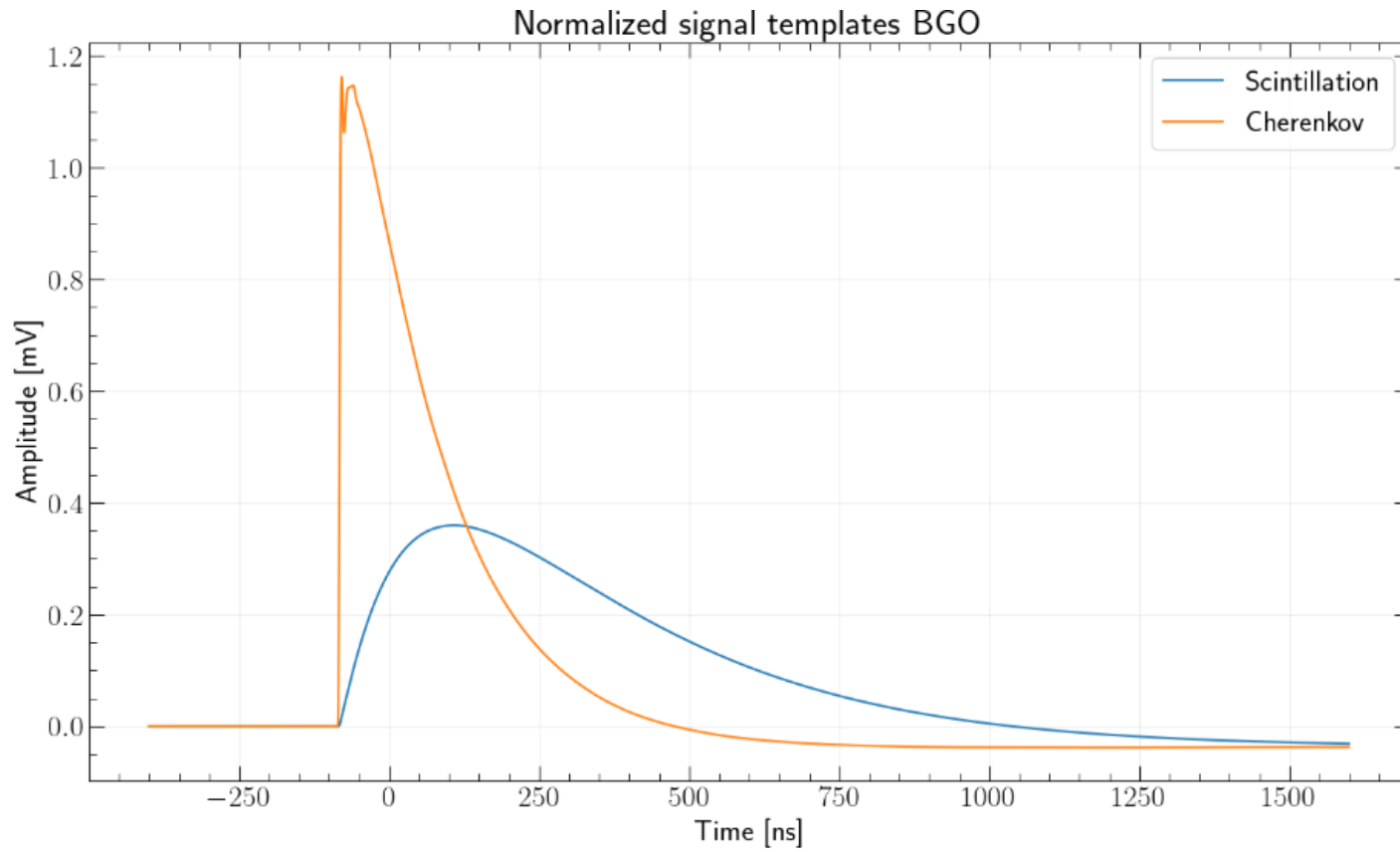
Čerenkov photons are prompt, so same signal shape as **SPR**

SPR

SPR from Calibration with Laser, see Lucrezia slide for experimental details

Normalized signal templates BGO

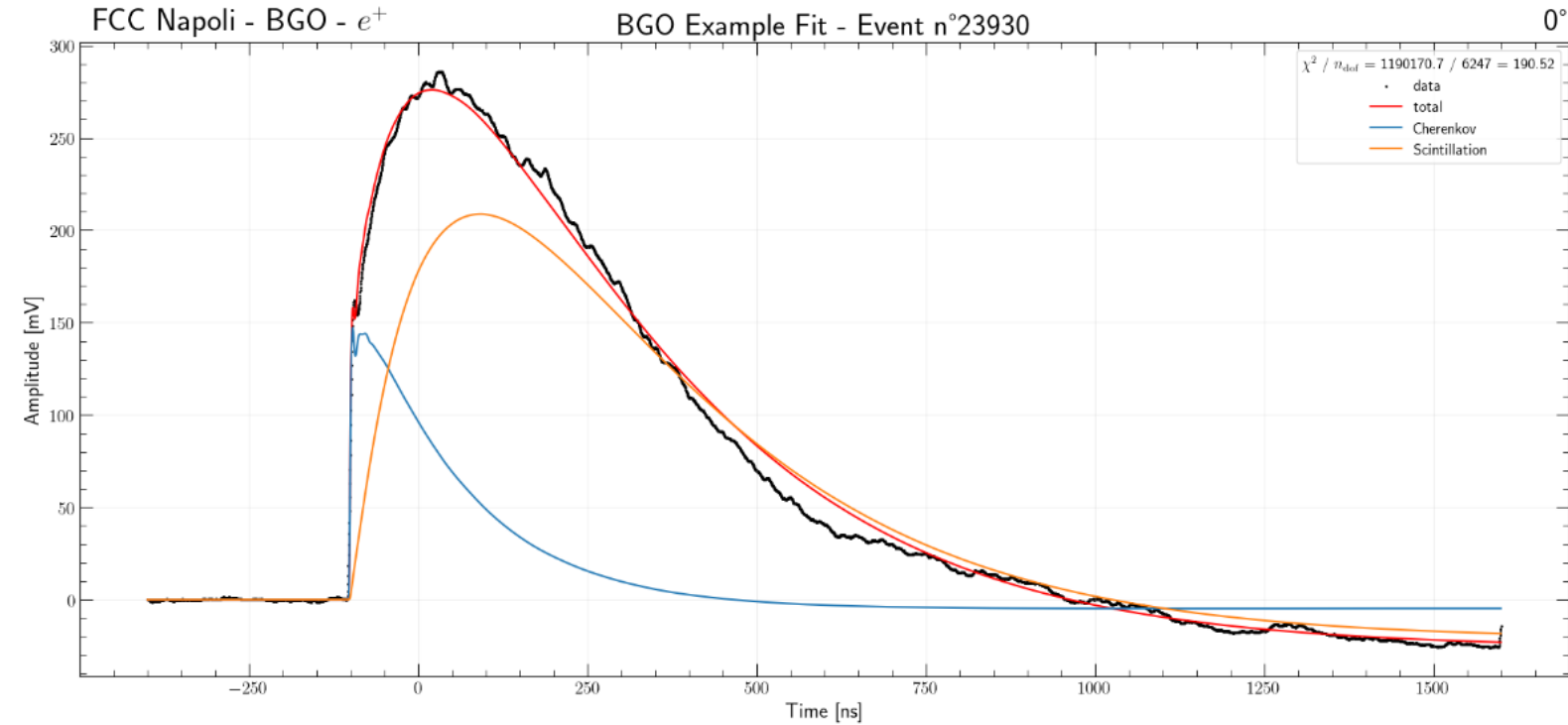

Templates of Čerenkov and Scintillation waveforms, with new SPR
- Čerenkov time is assumed to be prompt (τ=0.1ns)

23/01/2025	sipm 6x6 serie 1		preamp 2			
finestra temporale più grande						
misure led PLP	run		gain	configurazione lenti	power	trigger led PLP
~175 fotoni		475	28	3x3		15
~275 fotoni		477	28	2x3		15
~400 fotoni		478	18	2x3		15
~200 fotoni		479	18	3x3		15
	sipm 3x3		preamp 1			
misure led PLP	run		gain	configurazione lenti	power	trigger led PLP
		480	28	2x3		15
		481	18	2x3		15
	sipm 3x3		preamp passivo			
misure led PLP	run		gain	configurazione lenti	power	trigger led PLP
		483	-	1x2		15

An example of fit

FCC Napoli - BGO - e^+ BGO Example Fit - Event n°23930   0°

$\chi^2 / n_{dof} = 1190170.7 / 6247 = 190.52$

- data
- total
- Cherenkov
- Scintillation

- Čerenkov signal: it is prompt, so same shape as SPR;
- Scintillation signal: from the convolution of SPR with the characteristic crystal time distribution;

Floating parameters:
- normalizations → C and S yields
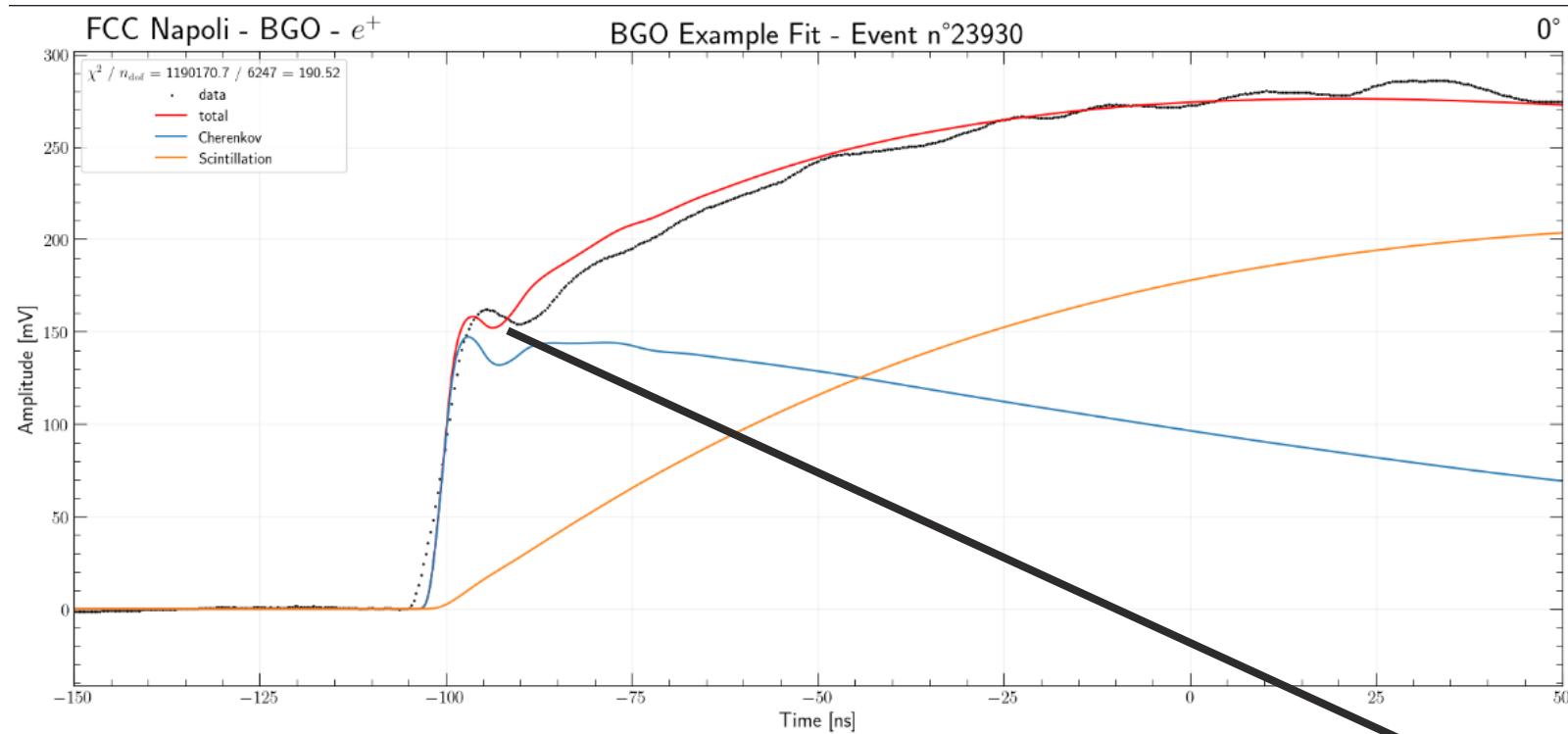- Trigger time
- Offset fixed at 0

- The templates follow the decay time of the waveform very well, also for negative values
- We can estimate the Čherenkov yield wrt the scintillation yield

- Čerenkov signal: it is prompt, so same shape as SPR;
- Scintillation signal: from the convolution of SPR with the characteristic crystal time distribution;

Floating parameters:
- normalizations → C and S yields
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Possible improvement
Let float the Čerenkov rising time

- The templates follow the decay time of the waveform very well, also for negative values
- We can estimate the Čherenkov yield wrt the scintillation yield

Angle Scan

Repeating the fit for all the runs with BGO we obtain the expected shape

We improved the framework and put all the scripts in a github repo:
_FCCNA/fcc-testbeam_analysis_

Lucrezia is working on BSO

FCC Napoli - BGO - e^+ Čerenkov channel (template from Laser)