Tuning of DC digitization in GEMC

Mariana Tenorio Pita

CLAS Collaboration Meeting 2024

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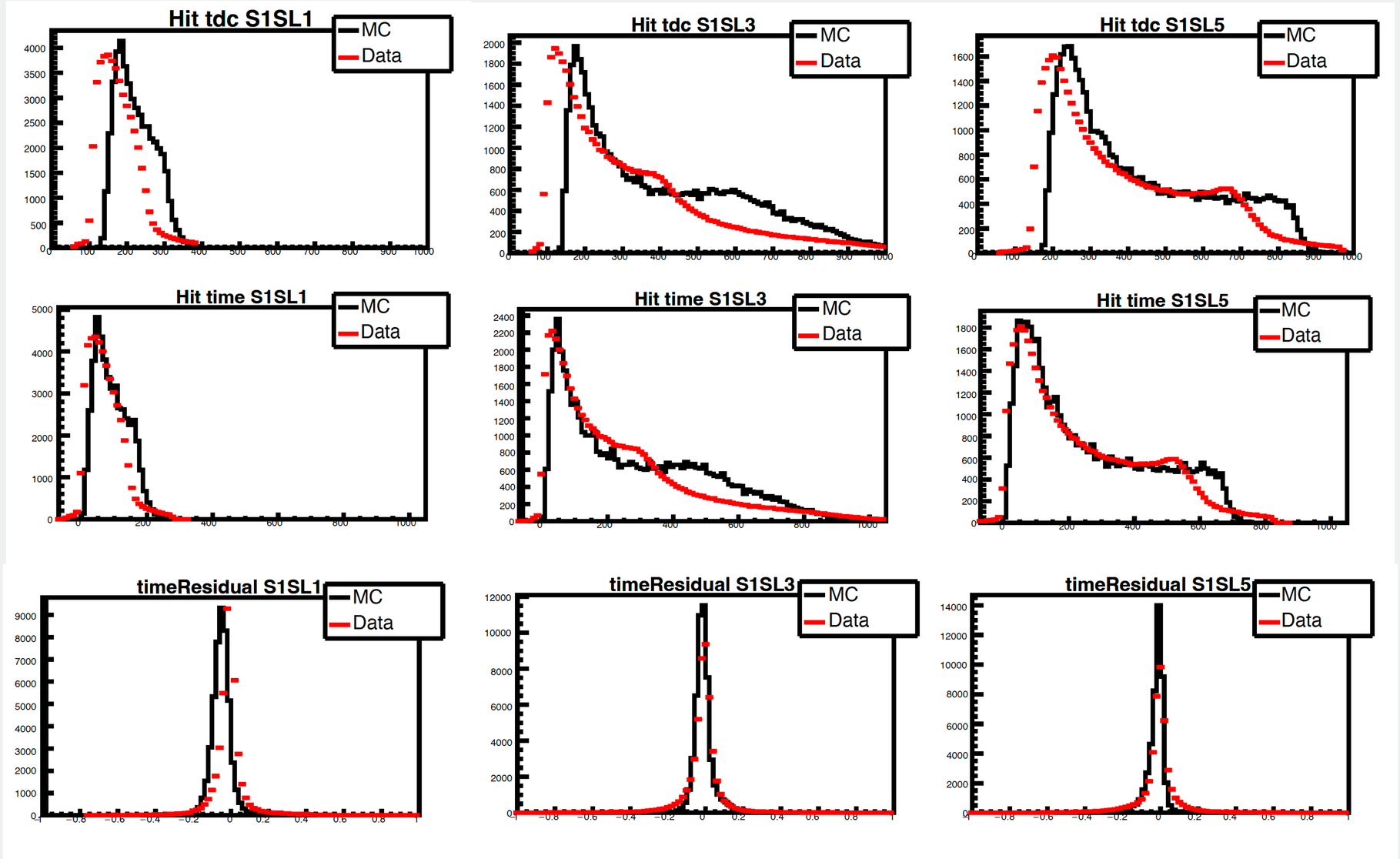
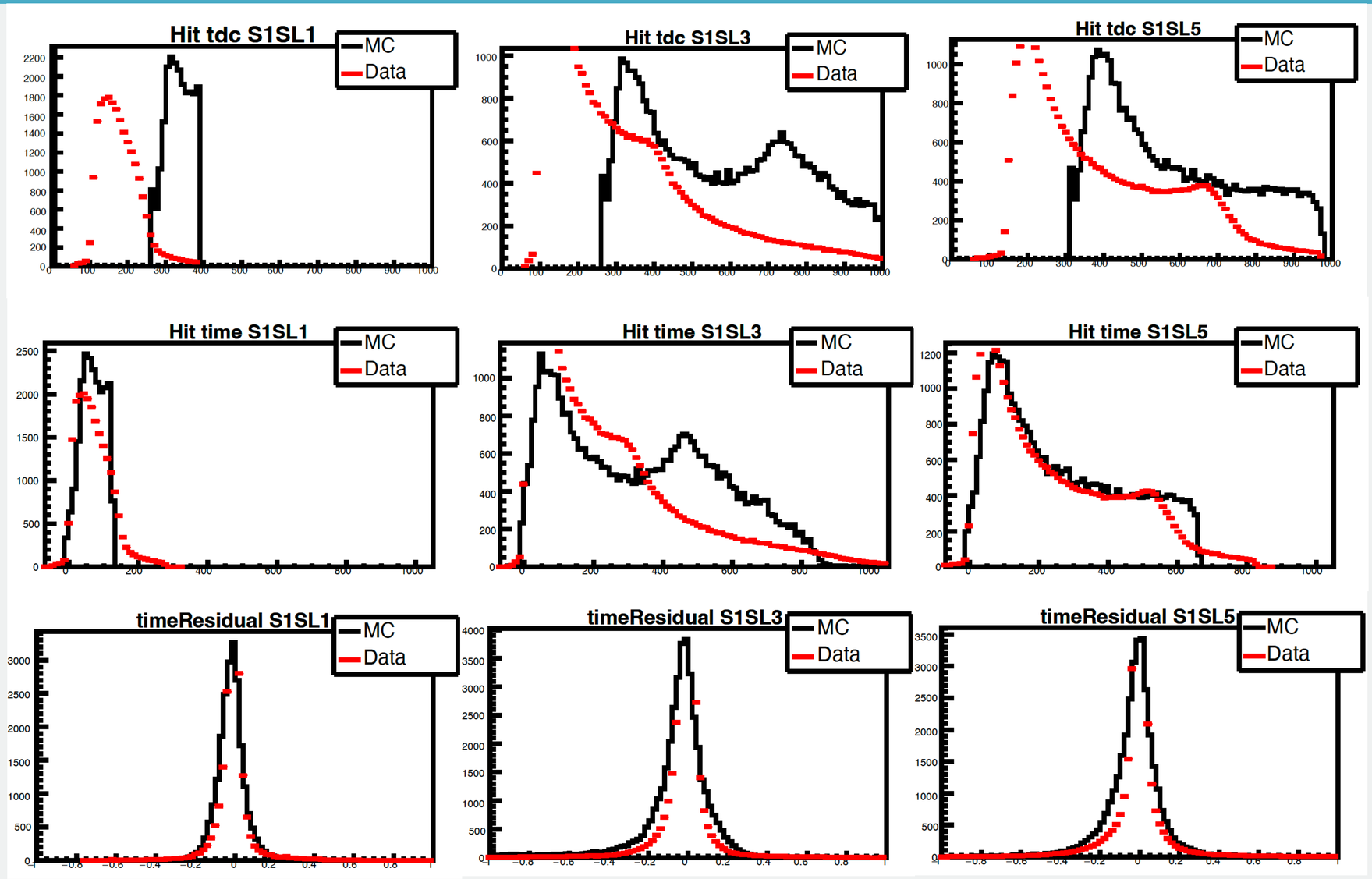
DC smearing motivation



Run 5700: Sector 1, Super layers 1, 3 and 5. MC produced with gemc 5.3.

First attempt



Run 5700: Sector 1, Super layers 1, 3 and 5.

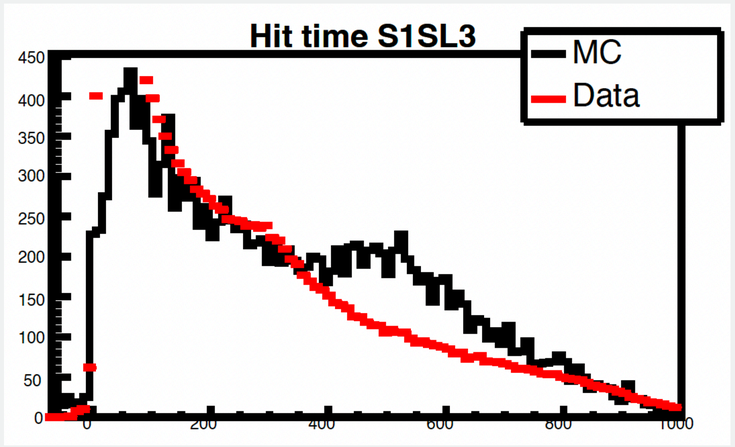
Models Attempted

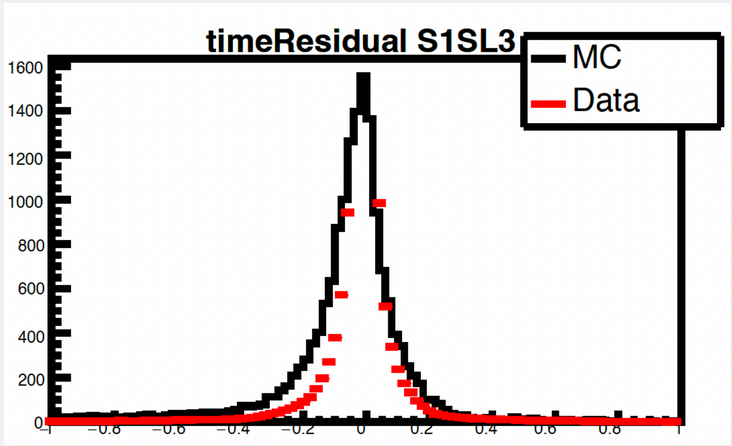
Smearing model	GEMC	Reconstruction
time-Landau	$t_{tdc} = t_{unsmearedDoca} + t_{smearingByLandau} + T_0$	$t = t_{tdc} - T_0$
time-Gaussian	$t_{tdc} = t_{unsmearedDoca} + t_{smearingByGaussian} + T_0$	$t = t_{tdc} - T_0$
doca-Gaussian	$t_{tdc} = t_{smearedDoca} + T_0$	$t = t_{tdc} - T_0$
doca-Landau	$t_{tdc} = t_{smearedDoca} + T_0$	$t = t_{tdc} - T_0$

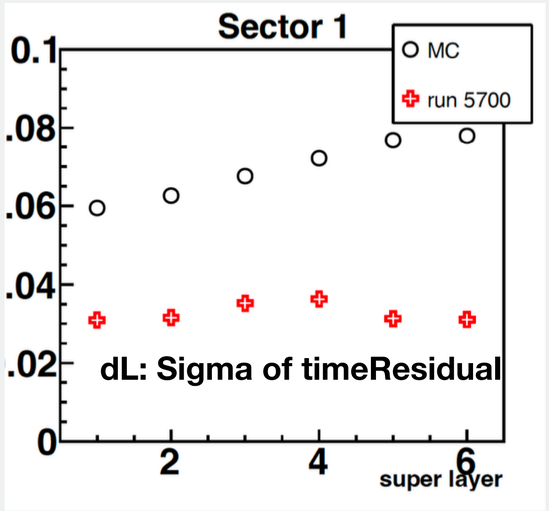
- We produce the MC samples and did comparisons with data for hit time, hit tdc, time residuals and more.
- We use run 5700. No background merging.
- All sectors present similar results.

Models Attempted

- Out of these 4 models, the first one to be discarded was doca smeared by Landau.

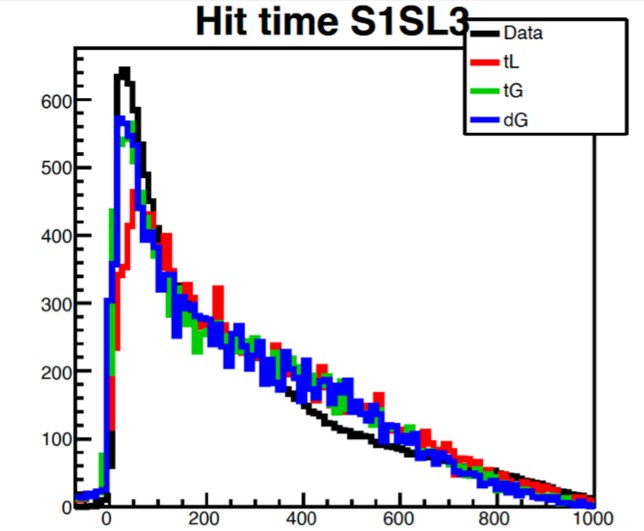


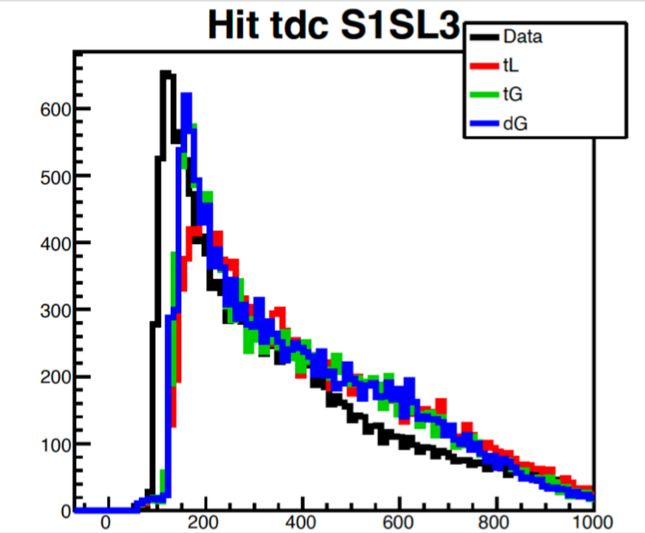


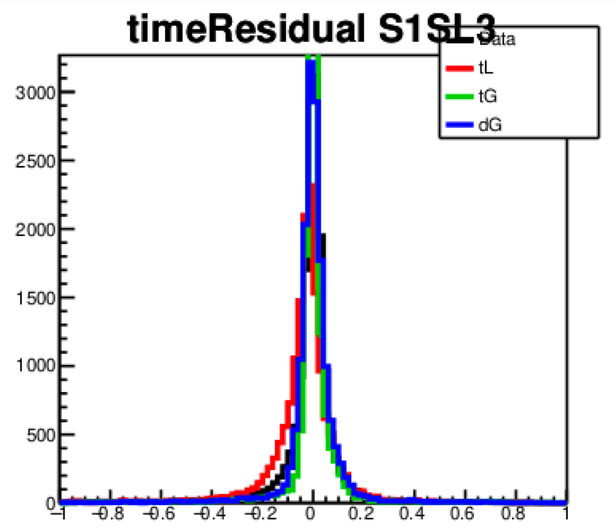


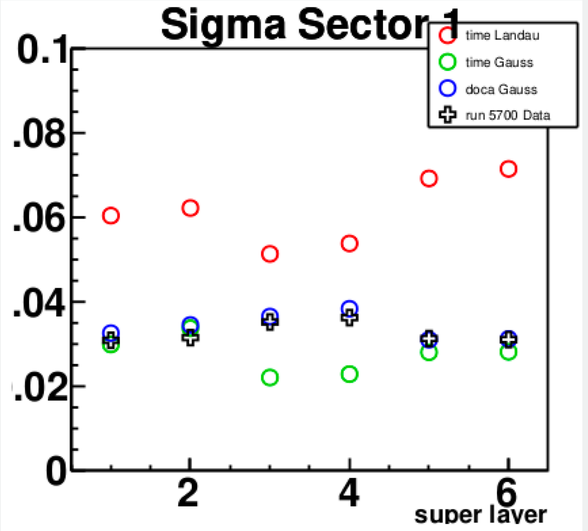
Run 5700: Sector 1, Superlayer 3. Comparison of data and MC using doca-landau smearing model.

Models Attempted









Run 5700: sector 1, super layer 3. Comparison between data and MC using 3 remaining models.

- We compare time smeared by Gauss(green), time smeared by Landau(red) and doca smear by Gauss (blue).

Updates of smearing model

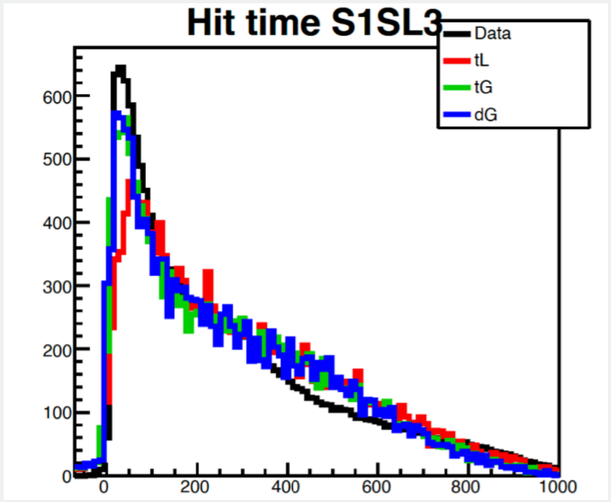
	Smearing model	**GEMC**	**Reconstruction**
With T_{start} in GEMC	time-Landau	$t_{tdc} = t_{unsmearedDoca} + t_{smearingByLandau} + T_0 + T_{start}$	$t = t_{tdc} - T_0 - T_{start} - T_{flight}$
	time-Gaussian	$t_{tdc} = t_{unsmearedDoca} + t_{smearingByGaussian} + T_0 + T_{start}$	$t = t_{tdc} - T_0 - T_{start} - T_{flight}$
	doca-Gaussian	$t_{tdc} = t_{smearedDoca} + T_0 + T_{start}$	$t = t_{tdc} - T_0 - T_{start} - T_{flight}$

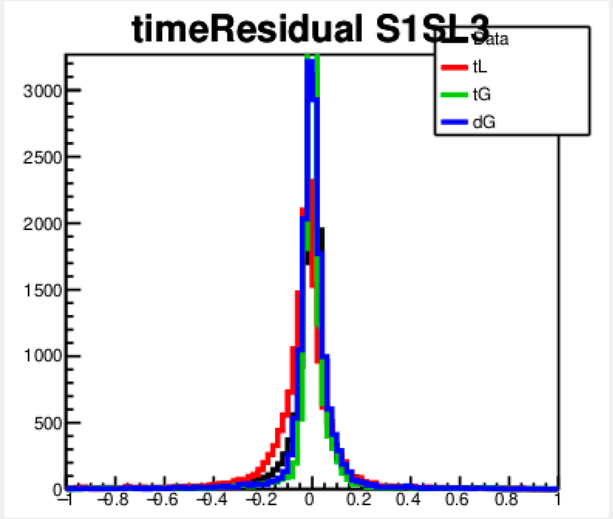
*** T_{start} in GEMC includes start time and flight time**

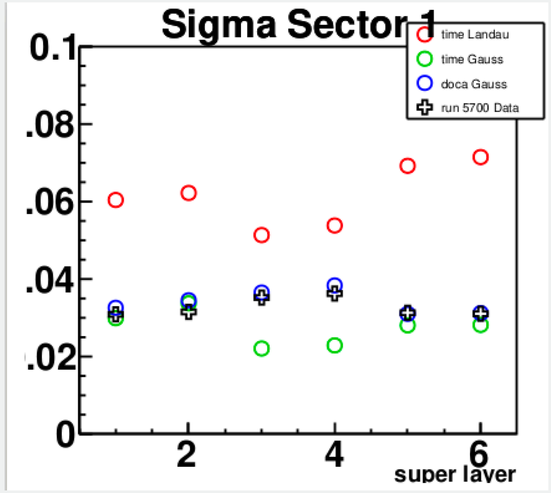
For gemc, a random start time is added.
For coatjava, TStart and TFlight are added, while TProp is still 0

Updates of smearing model

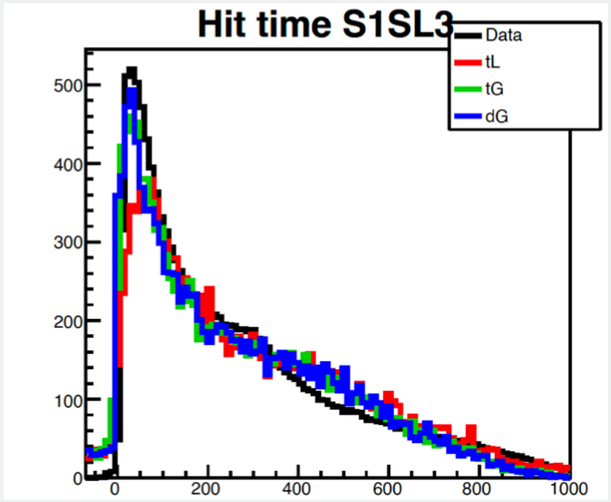
No t_{Start} and t_{Flight}

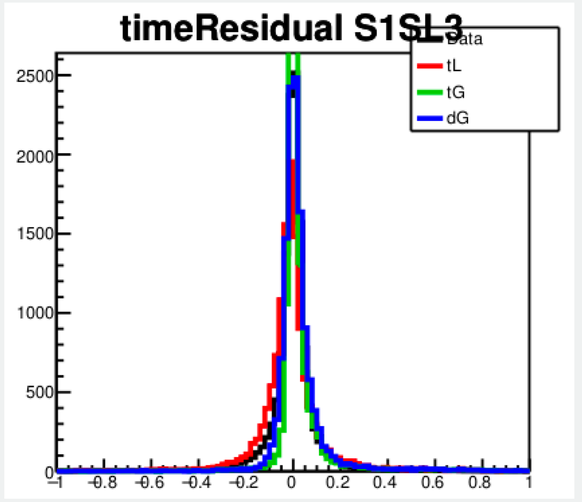


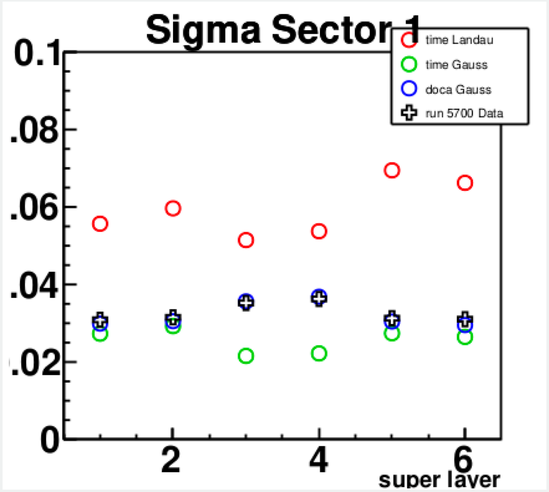




With t_{Start} and t_{Flight}

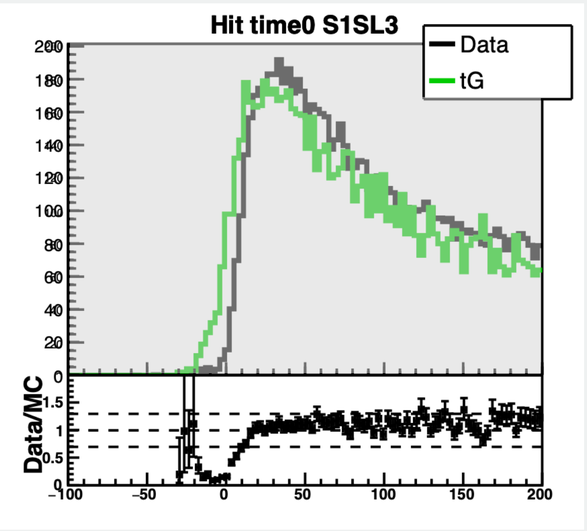


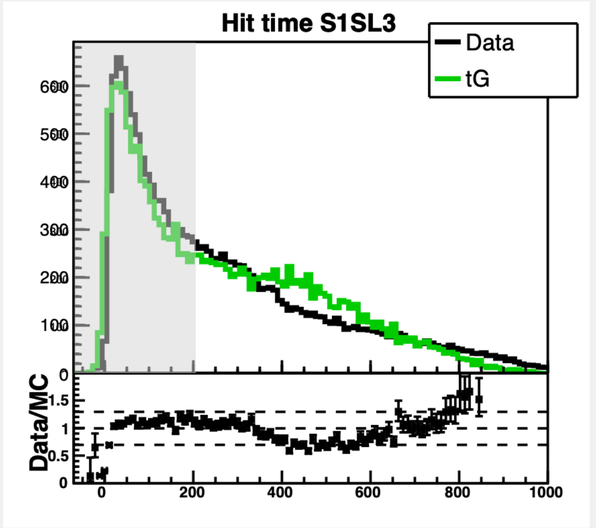




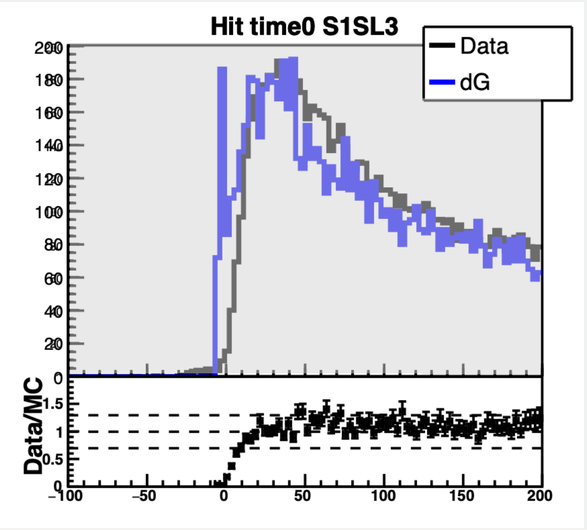
Time and Doca Gaussian

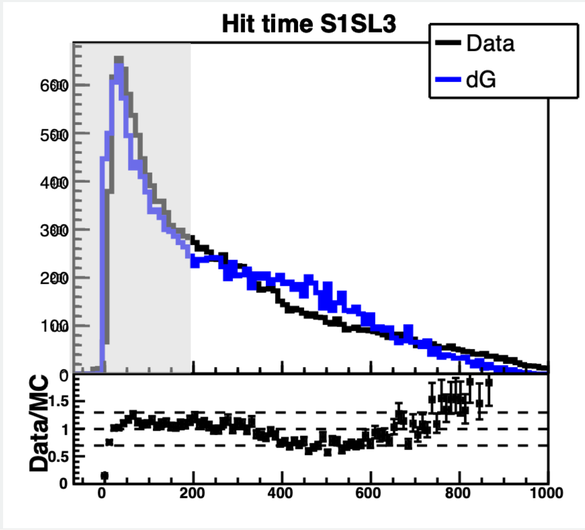
Time-Gaussian





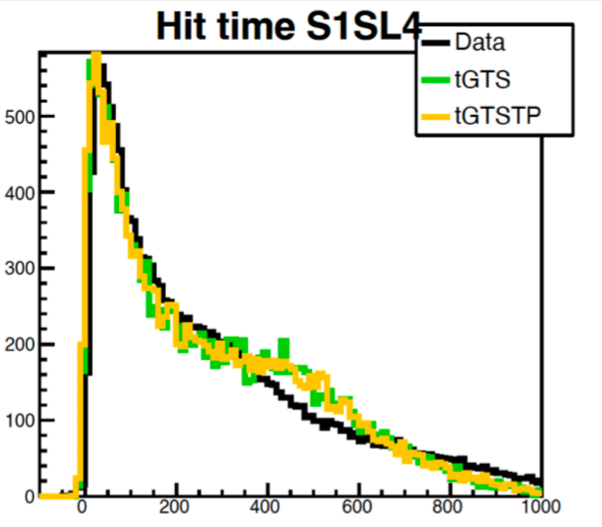
Doca-Gaussian

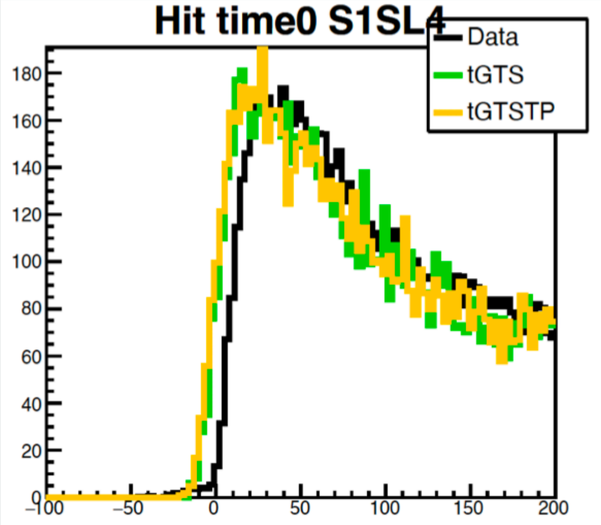


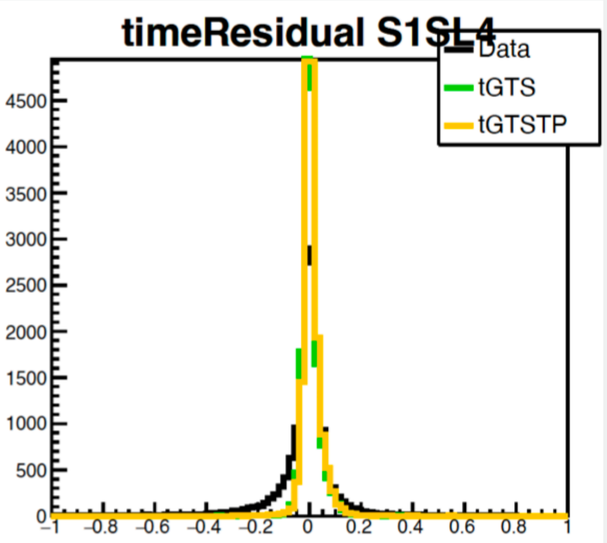


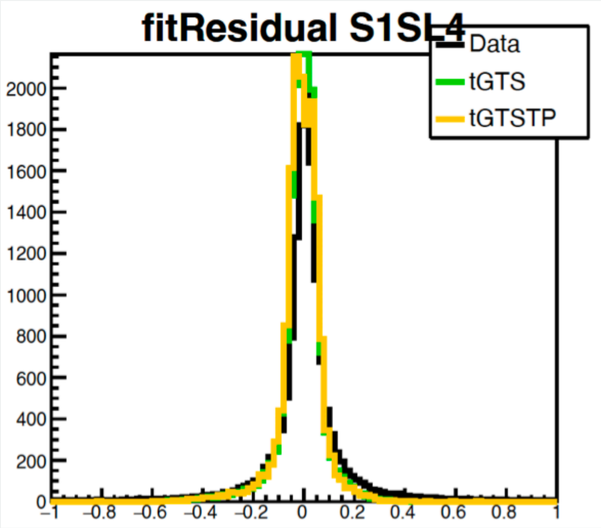
- By comparison between the other models and the data, time-Gaussian was the best choice.

Adding TProp







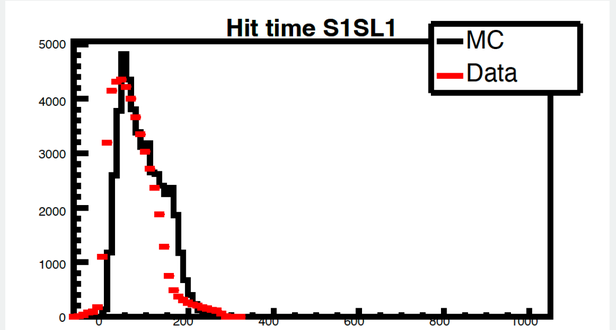


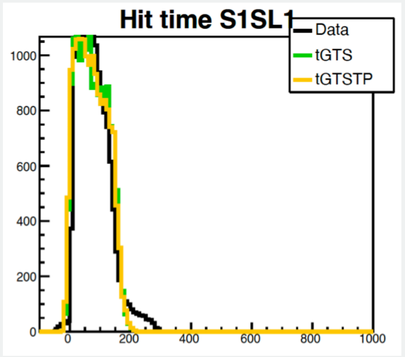
Run 5700
No Background
Time Smeared by Gauss

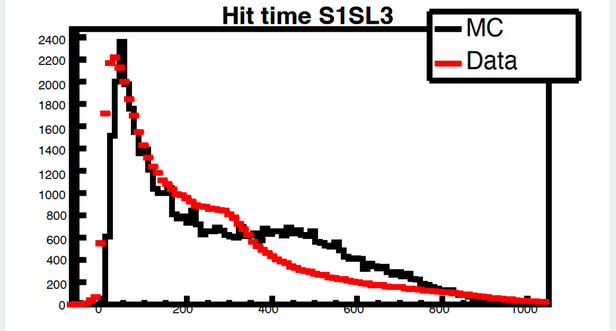
Green: With TStart
Yellow: With TStart and TProp

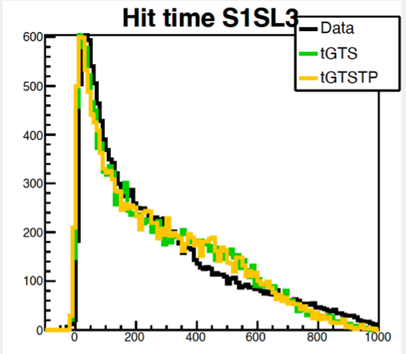
Next steps

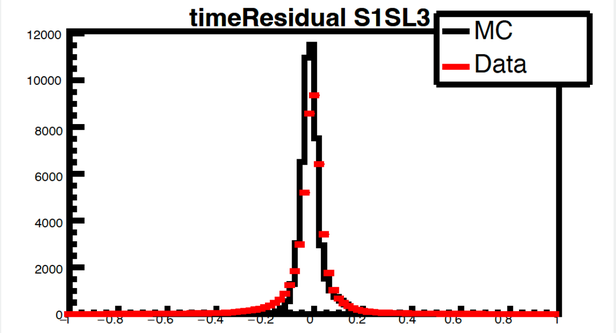
- There has been a lot of progress in this project.
- Right now, we are investigating the effects of TWalk.
- Comparison is taken between MC without background and run5700. A comparison with background and other runs is necessary.
- Currently, there are some physics test being done.

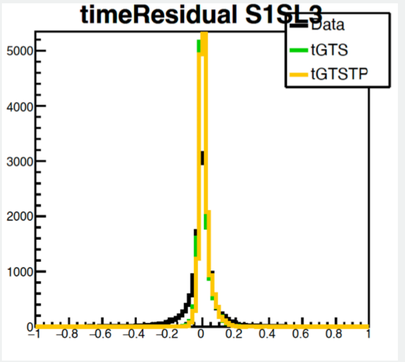










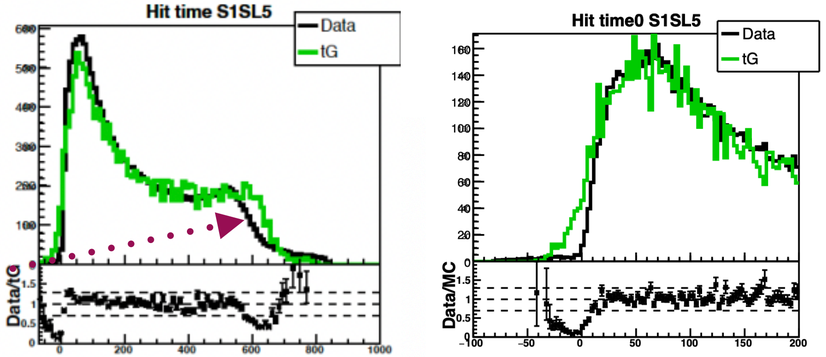


Thank you!

Functions for doca-to-time in GEMC

UnsmearedDoca

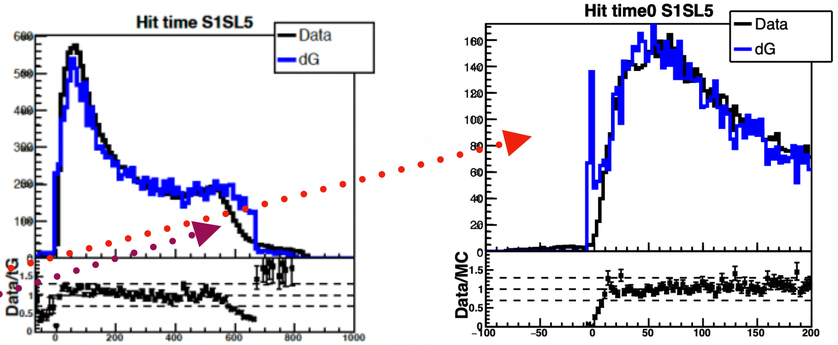
time-Gaussian




```
// NEW Polynomial function: returns a time in ns give:
// x      = distance from the wire, in cm
// dmax   = cell size in superlayer
// tmax   = t max in superlayer
// alpha  = local angle of the track
// bfield = magnitude of field in tesla
// sector      = sector
// superlayer      = superlayer
double dc_HitProcess :: calc_Time(double x, double dmax, double tmax, double alpha, double bfield, int sector, int superlayer)
{
    if(x>dmax)
        x=dmax;
```

SmearedDoca

doca-Gaussian

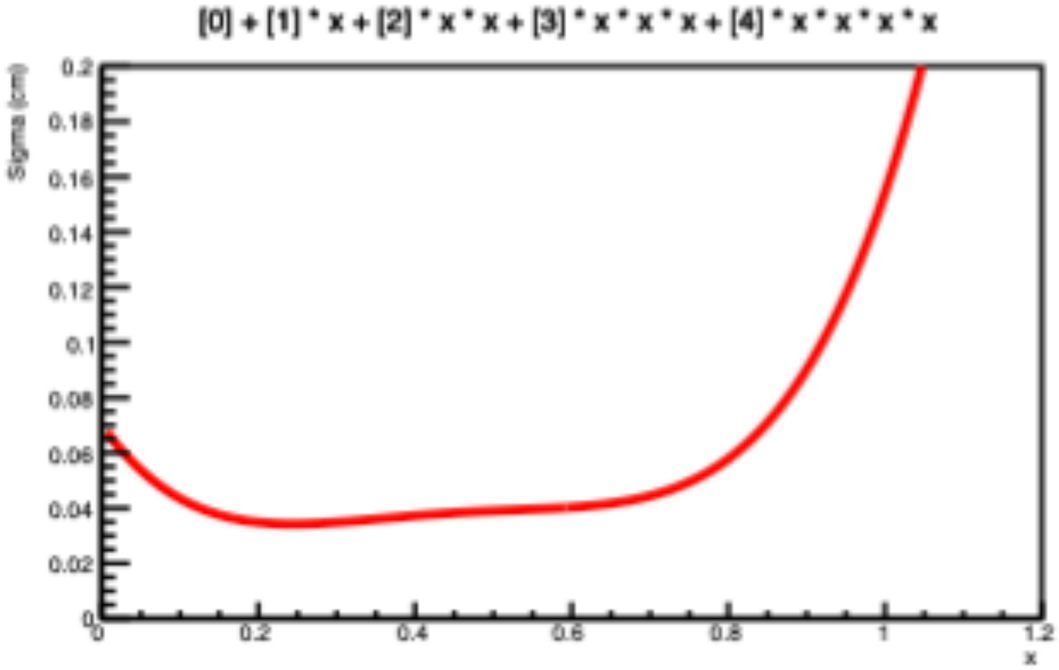


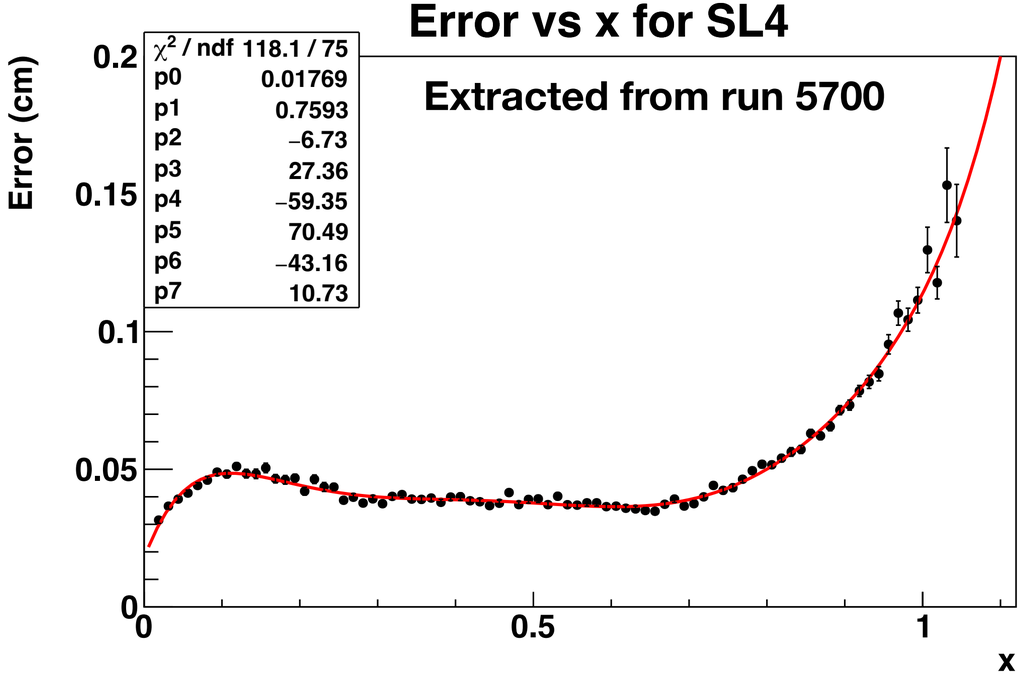

```
// NEW Polynomial function: returns a time in ns give:
// x      = distance from the wire, in cm
// dmax   = cell size in superlayer
// tmax   = t max in superlayer
// alpha  = local angle of the track
// bfield = magnitude of field in tesla
// sector      = sector
// superlayer      = superlayer
double dc_HitProcess :: calc_Time(double x, double dmax, double tmax, double alpha, double bfield, int sector, int superlayer)
{

    if(x<=0) return 0;

    if(x>dmax)
        x=dmax;
```

Slide from T. Cao

Sigma of Gaussian for tG mode

- Sigma of Gaussian for time smearing model is calculated by superlayer-dependent functions, which are extracted by hit resolution calibration.
- Recently, hit resolution was reinvestigated. The study shows that the original functions for hit resolution are not correct.
- Currently, functions for hit resolution are extracted from run 5700. Run-dependent functions should be extracted.





Cell size for doca normalization is different.

Slide from T. Cao