Wired Behavior of Mahi at +4BX

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Goal:
- debug Default version of MahiFit.cc and remove wired behavior at +4BX

Samples:
- Release: CMSSW release: 10_4_0_patch1
- Datasets:
  - /check
  - Run: 316944
Jae Reported
Evt=1554451 ls=21 ieta=21 iphi=55 depth=2

**Wiered peak at +4BX**

**Need to compare Jae’s MahiFit.CC with default MahiFit.cc.**

**Find two important difference b/w two**

1. \[\text{pulseCov}(iTS+\text{nnlsWork}'.maxoffset,jTS+\text{nnlsWork}'.maxoffset) += \text{tmp};\]
   \[\text{pulseCov}(jTS+\text{nnlsWork}'.maxoffset,iTS+\text{nnlsWork}'.maxoffset) += \text{tmp}; \quad \text{- - - Jae}\]
   \[\text{pulseCov}(jTS+\text{nnlsWork}'.maxoffset,iTS+\text{nnlsWork}'.maxoffset) += \text{tmp}; \quad \text{- - - defalult}\]
   \[\text{if}(iTS!=jTS)\text{pulseCov}(iTS+\text{nnlsWork}'.maxoffset,jTS+\text{nnlsWork}'.maxoffset) += \text{tmp}; \quad \text{- - - defalult}\]

2. \[\text{pulseDeriv.coeffRef}(iTS+\text{nnlsWork}'.maxoffset) = 0.5*(\text{nnlsWork}'.pulseM[iTS+\text{delta}]+\text{nnlsWork}'.pulseP[iTS+\text{delta}])/(2*\text{nnlsWork}'.dt); \quad \text{- - - Jae}\]
   \[\text{pulseDeriv.coeffRef}(iTS+\text{nnlsWork}'.maxoffset) = 0.5*(\text{nnlsWork}'.pulseM[iTS+\text{delta}]-\text{nnlsWork}'.pulseP[iTS+\text{delta}])/(2*\text{nnlsWork}'.dt); \quad \text{- - - defalult}\]
Result reproduced using the default version of MahiFit.cc by modifying the lines only in the phase1Debug function in the default MahiFit.cc
Remove first difference only in default version

8 pulses + no baseline: run=316944 ls=21 evt=1554451 (21, 55, 2), E= 334.2 GeV, $\chi^2= 2.5$

- digi
  - -3BX (1.2 GeV)
  - -1BX (1.5 GeV)
  - 0BX (334.2 GeV)
  - +1BX (5.1 GeV)

Event pulse fit removing first diff

- wired behavior disappeared (so this difference responsible for wired behavior)
- this change basically avoid double counting the diagonal terms of the covariance matrices but default code seems correct
Remove second difference only in default version

8 pulses + no baseline: run=316944 ls=21 evt=1554451 (21, 55, 2), E= 334.2 GeV, $\chi^2=516.5$

- $digi$
  - -3BX (1.1 GeV)
  - -1BX (62.0 GeV)
  - 0BX (334.2 GeV)
  - +1BX (5.1 GeV)
  - +4BX (225.3 GeV)

Event pulse fit removing second diff

- wired behavior still there (so this difference not responsible for wired behavior)
- this change define a derivative and this is correct in Jae’s file
Remove both difference simultaneously in default version

8 pulses + no baseline: run=316944 ls=21 evt=1554451 (21, 55, 2), E= 334.2 GeV, \( \chi^2 = 2.5 \)

- 3BX (1.2 GeV)
- 1BX (1.5 GeV)
0BX (334.2 GeV)
+1BX (5.1 GeV)

Event pulse fit removing both diff

- wired behavior disappear that basically confirm that wired behavior is because of the first change only
Correction in TS loop

8 pulses + no baseline:  run=316944 ls=21 evt=1554451 (21, 55, 2), E= 340.8 GeV, $\chi^2 = 18.9$

- digi
  - -3BX (1.2 GeV)
  - -1BX (1.5 GeV)
  - 0BX (340.8 GeV)
  - +1BX (5.1 GeV)

Event pulse fit after loop correction diff

- wired behavior disappear that basically confirm that wired behavior is because of the this bug
- The index goes from 0 to 7 (i.e. iTS is used.) while later in the loop from line 287, it goes from 1 to 8 (i.e. iTS+delta is used)
• Correction in TS loop is responsible for the wired behavior of +4BX.
• only one difference in MahiFit.CC may be responsible for the wired behavior of the +4BX also but default code looks logical i.e

```
pulseCov(iTS+nnlsWork'.maxoffset,jTS+nnlsWork'.maxoffset) += tmp;
pulseCov(jTS+nnlsWork'.maxoffset,iTS+nnlsWork'.maxoffset) += tmp; - - - Jae
- - - - - - - - - - - - - - - - - - - - -
pulseCov(jTS+nnlsWork'.maxoffset,iTS+nnlsWork'.maxoffset) += tmp;
if(iTS!=jTS)pulseCov(iTS+nnlsWork'.maxoffset,jTS+nnlsWork'.maxoffset) += tmp; - - - defalult
```