2018 VdM Analysis

Lumi-PAG Meeting, Apr. 14, Chong Kim (PNU)

- **Outline**
  - Reviewed analysis processes
    a. Went through all of Guillermo's guide
    b. Now I can estimate cross-sections in certain conditions
       (ex. BPTX for intensity + V0 for rate + GP2 for fit)
  - Items in this report
    a. Overview of analysis
    b. Implemented a "retry fit" routine in hxhy calculation
       * it wasn't necessary at this time, but "shake the parameters for each retry" also implemented
    c. Results for Fill 6864
       c-1. Cross-sections by various conditions
       c-2. Systematic errors: effect of BG correction and pileup correction

Overview Goal and Adjustable conditions

- **Goal and Conditions**
  - Goal of the analysis: visible cross section $\sigma_{vis} = R(0,0)/L$
    a. $R(0, 0)$: head-on rate
    b. $L = N_1 N_2 f_{rev} / h_x h_y$
       N_1, N_2 : particle intensity of each bunch
       f_{rev} : accelerator revolution frequency
       $h_x h_y$: scanned area under the $R(\Delta x, 0)$ and $R(0, \Delta y)$
  - Conditions in actual analysis
    a. Scan direction: x or y (variables highlighted in green are tested in this time)
    b. Separation points determination by method:
       b-1. Nominal
       b-2. BBD (beam-beam dynamics)
       b-3. ORD (orbit-drift correction)
    c. Intensity by external source:
       c-1. BPTX (ATLAS Beam-Picking Timing System)
       c-2. FBCT (Fast Beam Current Transformers)
    d. Rate by ALICE detector:
       d-1. VBAandVBC (V0)
       d-2. TVX (T0)
    e. Fit by model: GP2 (Gaussian + pol2), GP6, G, Numeric Integration, and Double G

* What are the "standard" conditions?

(ex. Std = x + Nominal + BPTX + V0 + GP2)

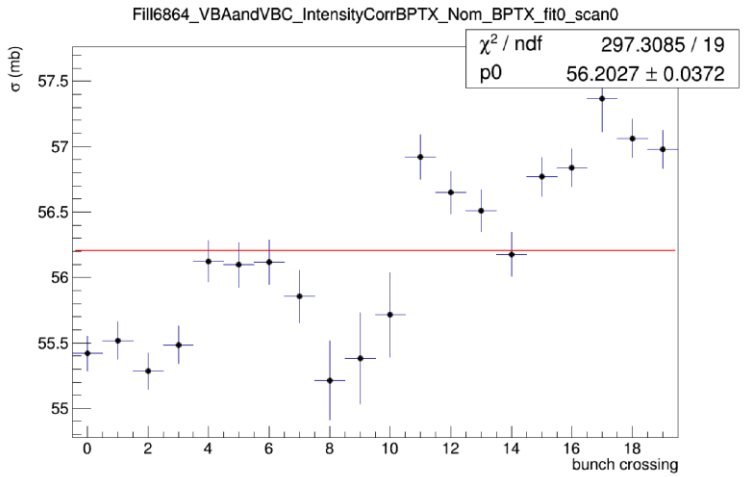
Overview Analysis process

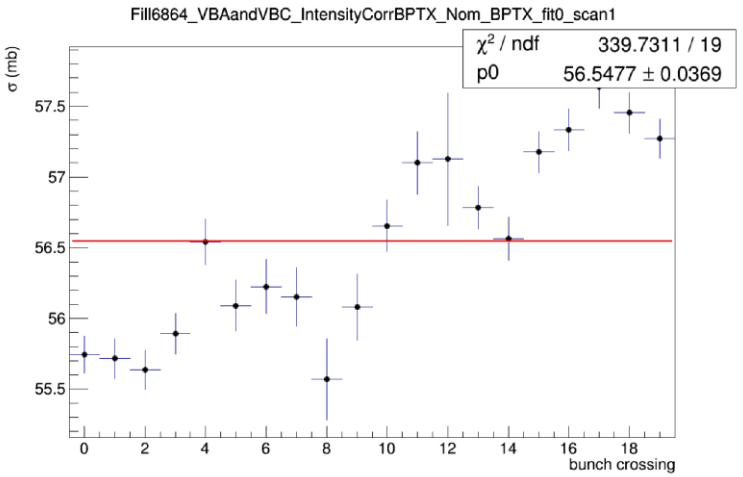
- **Analysis process (technical)**

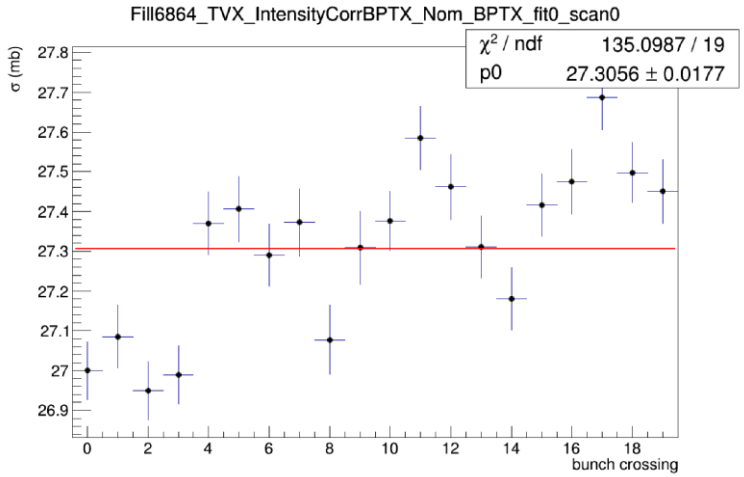
1. Set input: Fill 6864
2. Get the separation points: only “Nominal” method used
3. Get the intensity, bunch-crossing by bunch-crossing
   a. Options: BPTX or FBCT
   b. Correction: normalization by using DCCT (DC Current Transformer)
4. Get the rate
   a. Options: VBAandVBC (V0) or TVX (T0)
   b. Corrections: Raw → BG correction → Pileup correction → Intensity correction
   c. Systematic studies in next page:
      c-1 Pileup: modified only the pileup correction factors and re-ran later analysis chain
      RatioA (V0) = 0.07684 ± 0.0004, RatioC (V0) = 0.06193 ± 0.0004
      RatioA (T0) = 0.49 ± 0.0007, RatioC (T0) = 0.49 ± 0.0007
      c-2. BG: input branch changes - separately produced an output continually, for later analysis chain
      use Branch w/ tag “sys” instead of “acc” (ex. bv0acc_setv0 → bv0sys_setv0) , in “ *Create_bkgd_correction_file.C* ”
5. Get the hxhy and Cross-sections
   a. Options: fit models (GP2, GP6, G, NI, and DG)
   b. Extracted final, single cross section value by using QA_xs.C (pol0 fit on all ~20 bunches)

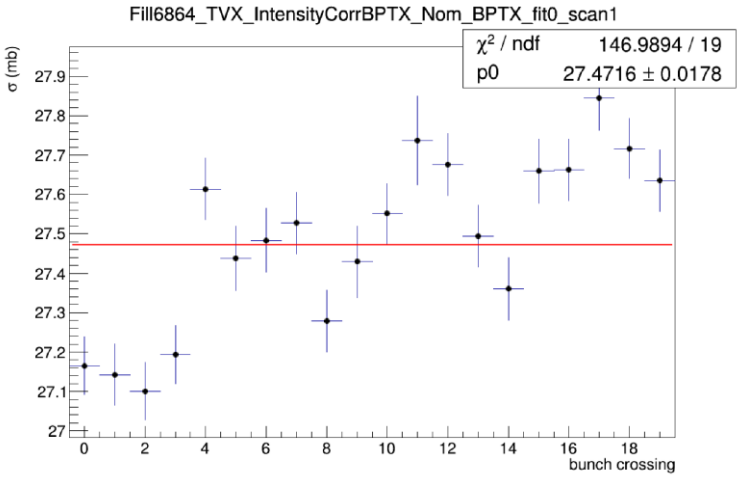
Cross section results

Sample output, by Nominal + BPTX + GP2









- Top: VBAandVBC (V0), Bottom: TVX (T0), Left: scan X, Right: scan Y
- Make sure all fit succeeded for each bunch (used fit retry routine, * backup)

Cross section results

Summary table with BG/Pileup systematic study

Intensity	Rate	Error sign	Scan X	Scan Y
Default				
FBCT	VBAandVBC	N/A	56.1710 ± 0.0370	56.5432 ± 0.0362
BPTX	VBAandVBC		56.2027 ± 0.0372	56.5477 ± 0.0369
FBCT	TVX		27.2836 ± 0.0181	27.4603 ± 0.0179
BPTX	VTX		27.3056 ± 0.0177	27.4716 ± 0.0178
Systematic: pileup				
BPTX	VBAandVBC	+ A/ + C	56.2020 ± 0.0373	56.5473 ± 0.0369
	VBAandVBC	+ A/ - C	56.1950 ± 0.0370	56.5476 ± 0.0369
	VBAandVBC	- A/ + C	56.1952 ± 0.0370	56.5374 ± 0.0368
	VBAandVBC	- A/ - C	56.1960 ± 0.0370	56.5807 ± 0.0359
	TVX	+ A/ + C	27.2970 ± 0.0181	27.4702 ± 0.0178
Systematic: BG				
FBCT	VBAandVBC	N/A	56.3851 ± 0.0333	56.7433 ± 0.0331
BPTX	VBAandVBC		56.4085 ± 0.0333	56.7849 ± 0.0329
FBCT	TVX		27.3009 ± 0.0177	27.4769 ± 0.0173
BPTX	TVX		27.3079 ± 0.0181	27.4929 ± 0.0174

- Fixed conditions:
  a. Separation: nominal
  b. Fit model: GP2
- If I pick an arbitrary “std” setup as “x + BPTX + VBAandVBC”, systematic errors are:
  a. Scan direction:
  |56.2027 - 56.5477| = 0.3450
  b. Intensity source:
  |56.2027 – 56.1710| = 0.0317
  c. Pileup effect in rate:
  |56.2027 – 56.1950| = 0.0077
  d. BG effect in rate:
  |56.2027 – 56.4085| = 0.2058
  ---
  e. Total: 0.5902
  e-1. 0.5902/56.2027 = 0.0105
  e-2. separation/fit syst. are missing

Backup

Fit retry routine under *FitUtils.h/Fit_rate_separation()*

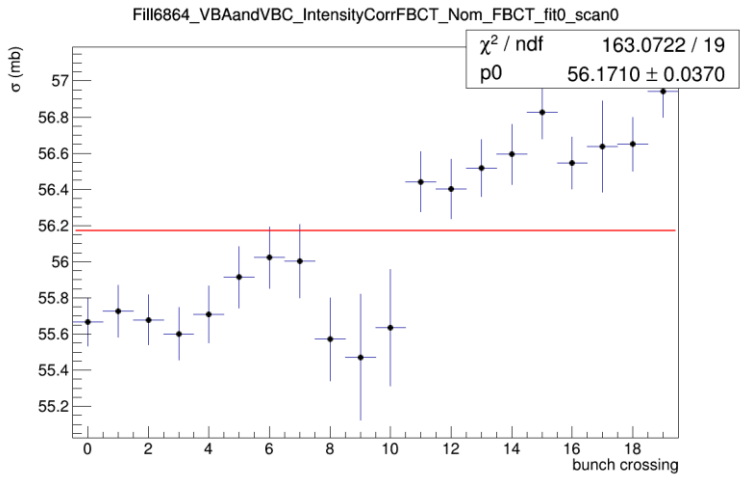
NPL

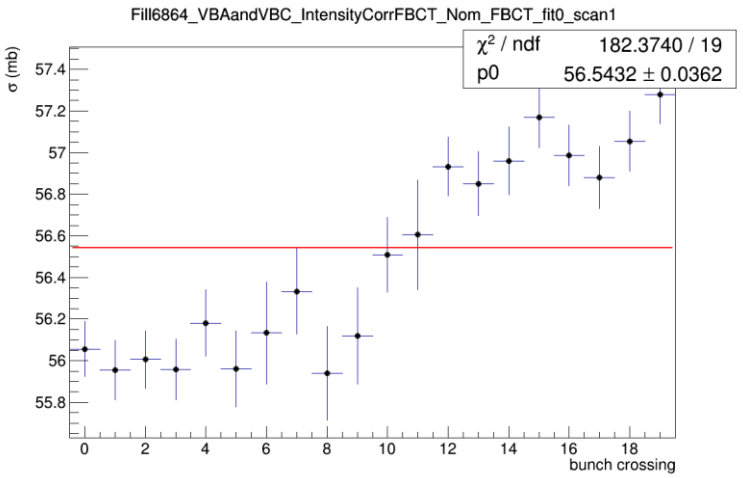
```
//-----------------------------------------

gStyle->SetOptFit(1);

char name[120];
if (scan_type == 1) sprintf(name,"Scan_%d_x_bc_%d",scan,bc);
if (scan_type == 2) sprintf(name,"Scan_%d_y_bc_%d",scan,bc);
const char* cName = Form("%s_%s_%s_%s", rate_name, rate_type, g_fit_model_name[fit_type], name);

//Retry fit if it failed
if (!gMinuit->fCstatu.Contains("CONVERGED"))
{
    //Temporary TH1 for pit parameters
    TH1* H1Temp = new TH1F(Form("H1Temp_%s", cName), "", n*2, sep[0], sep[n-1]); H1Temp->Sumw2();
    for (int a=0; a<n; a++)
    {
        const int   xBin = H1Temp->GetXaxis()->FindBin(sep[a]);
        const float yVal = rate[a];
        const float yErr = rate_err[a];
        H1Temp->SetBinContent(xBin, yVal);
        H1Temp->SetBinError  (xBin, yErr);
    }
    const double tMax  = H1Temp->GetMaximum();
    const double tMean = H1Temp->GetMean();
    const double tRMS  = H1Temp->GetRMS();
    H1Temp->Delete();

    //Retry fit
    int reFit = 0;
    while (reFit < 10)
    {
        cout <<Form("Retry fit for %s: %i...", cName, reFit) <<endl;

        if (reFit > 0) //from 2nd iteration, for the case of simple retry doesn't work
        {
            TDatime DT;
            TRandom2 RD2(DT.GetTime() + reFit);
            double tPar[3] = {0};
            tPar[0] = RD2.Uniform(tMax*0.9, tMax*1.1);
            tPar[1] = RD2.Uniform(-2*fabs(tMean), 2*fabs(tMean));
            tPar[2] = RD2.Uniform(tRMS*0.5, tRMS*2);
            cout <<Form(" trying: max %4.3f, mean %4.f, and sigma %4.3f", tPar[0], tPar[1], tPar[2]) <<endl;

            //Release Gaussian parameters and set again
            for (int a=0; a<Get_number_par(fit_type); a++)
            {
                fit_model->ReleaseParameter(a);
                fit_model->SetParameter(a, tPar[a]);
            }
        }

        r = gr->Fit("fit_model","Q0RS");
        if (gMinuit->fCstatu.Contains("CONVERGED")) break; //Converged: stop
        else reFit++;
    }//Refit
    cName = Form("%s_reFit%i", cName, reFit);
}//Retry fit
```

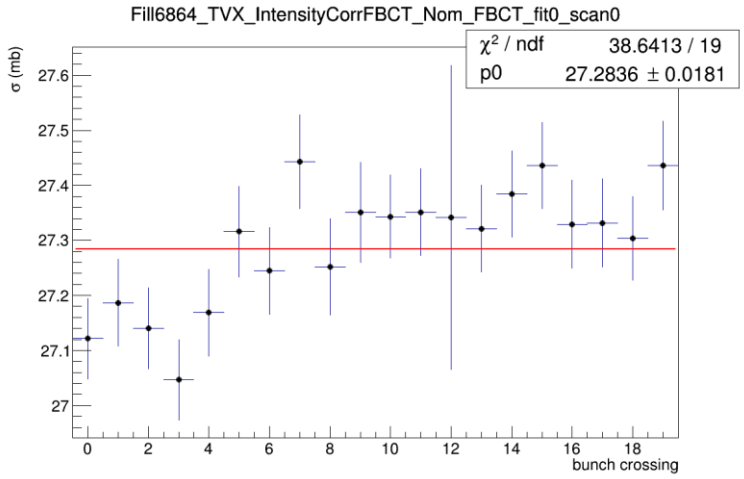
516,0-1 85%

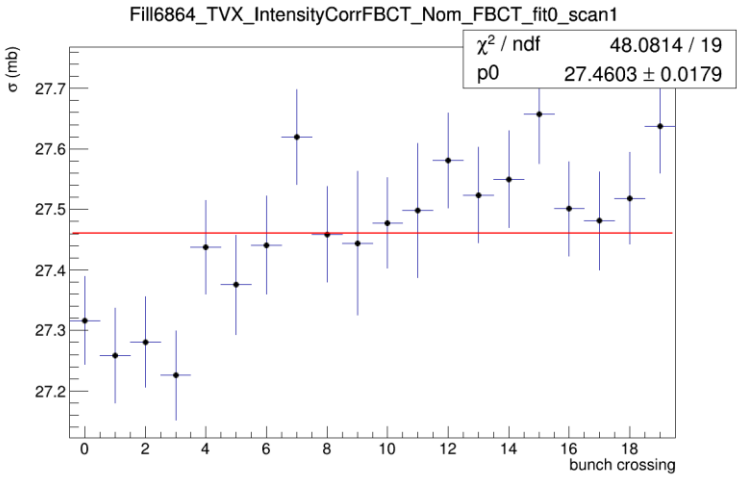
```
Processing Create_intensity_corrected_rate_file.C+(6864, "VBAandVBC", "BPTX", 0)...
KEBI Library Loaded

Processing Create_hxhy_file.C+(6864, "VBAandVBC", "IntensityCorrBPTX", "Nom", 0, 0)...
Retry fit for VBAandVBC_IntensityCorrBPTX_GP2_Scan_0_x_bc_12: 0...
Retry fit for VBAandVBC_IntensityCorrBPTX_GP2_Scan_0_y_bc_19: 0...
Retry fit for VBAandVBC_IntensityCorrBPTX_GP2_Scan_1_x_bc_12: 0...
Retry fit for VBAandVBC_IntensityCorrBPTX_GP2_Scan_1_x_bc_14: 0...
Retry fit for VBAandVBC_IntensityCorrBPTX_GP2_Scan_1_y_bc_5: 0...
Retry fit for VBAandVBC_IntensityCorrBPTX_GP2_Scan_1_y_bc_13: 0...
Retry fit for VBAandVBC_IntensityCorrBPTX_GP2_Scan_1_y_bc_14: 0...
KEBI Library Loaded

Processing Create_xs_file.C+(6864, "VBAandVBC", "IntensityCorrBPTX", "Nom", "BPTX", 0, 1,1,1,1, 0)...
KEBI Library Loaded

Processing  QA_xs.C+(6864, "VBAandVBC","IntensityCorrBPTX","Nom","BPTX", 0,0,0)...

****************************************
Minimizer is Linear
Chi2                      =     297.309
NDf                       =          19
p0                        =     56.2027   +/-   0.0372317
KEBI Library Loaded
```

Backup XS results: default, Nominal + FBCT + GP2



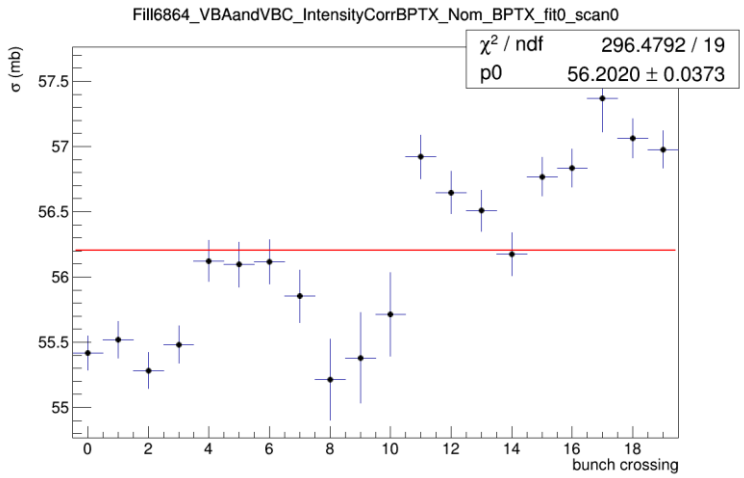


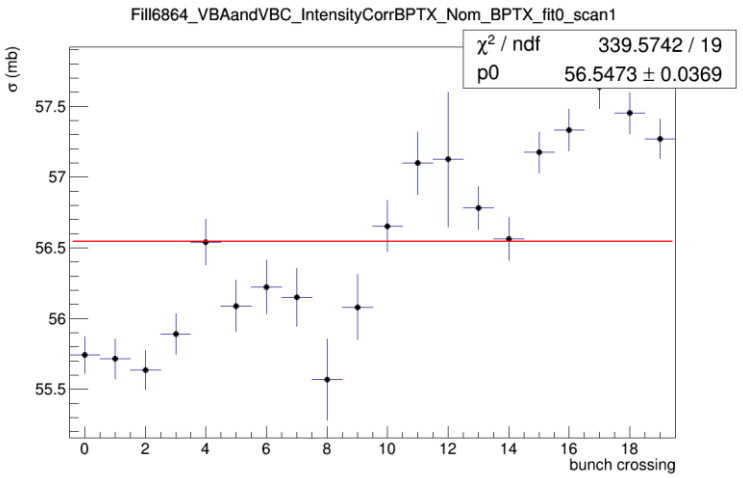


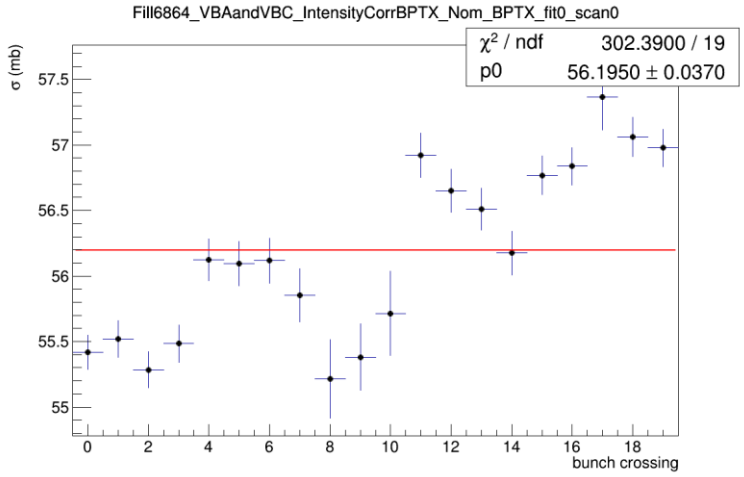


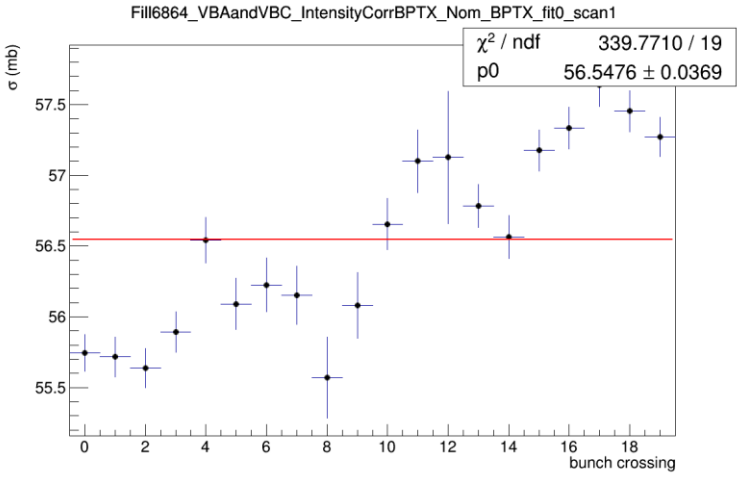
Backup

XS results: pileup syst. study, BPTX + V0 + “+A/+C” and “+A/-C”

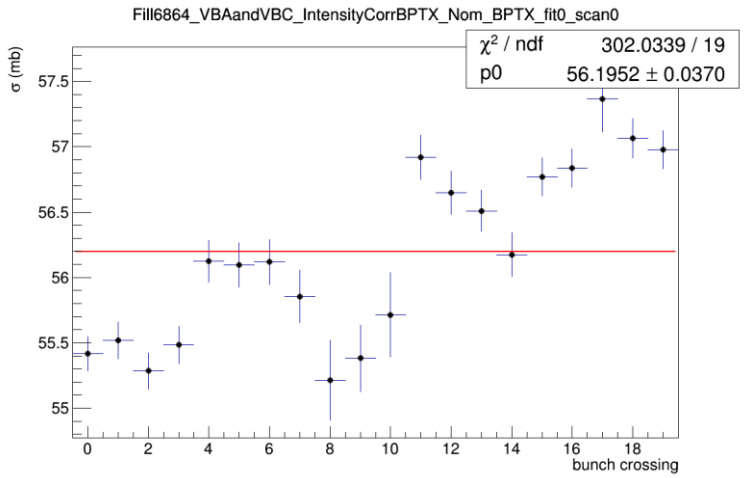


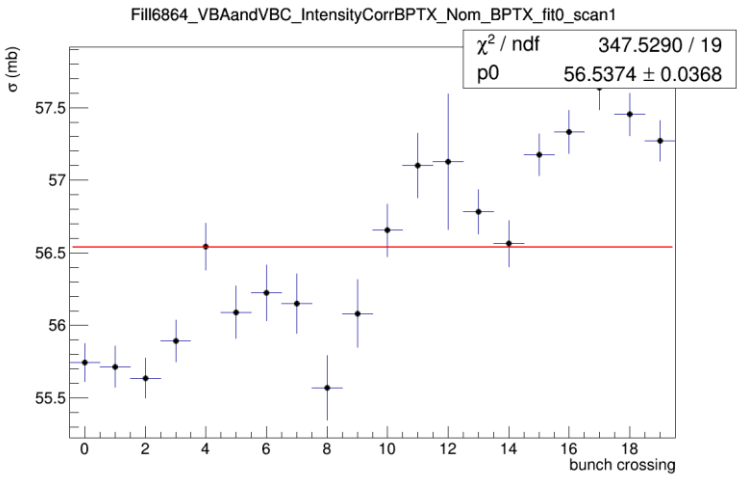


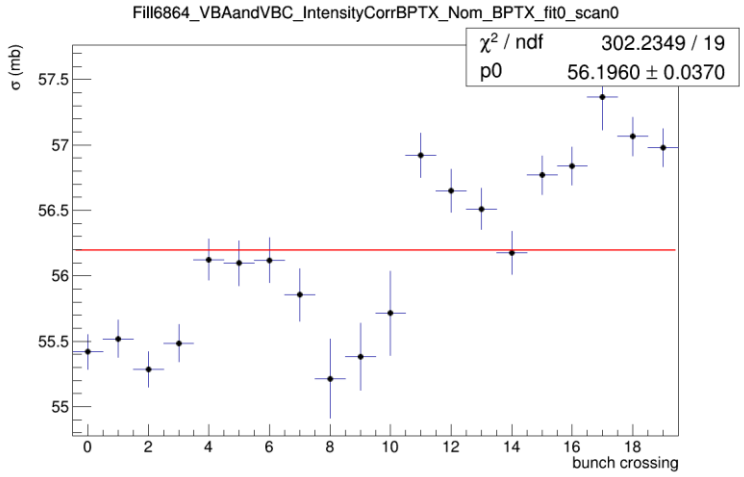


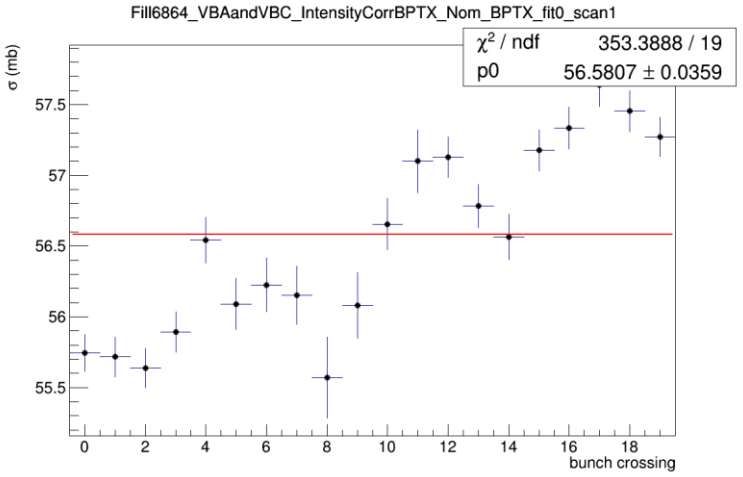


Backup XS results: pileup syst. study, BPTX + V0 + "-A/+C" and "-A/-C"

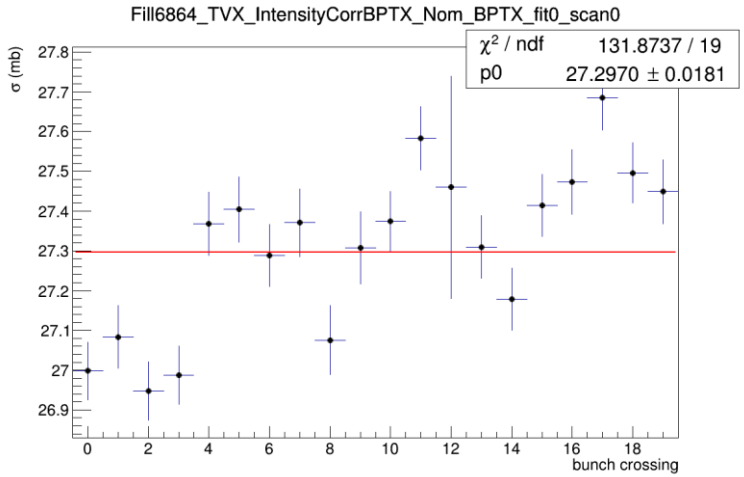


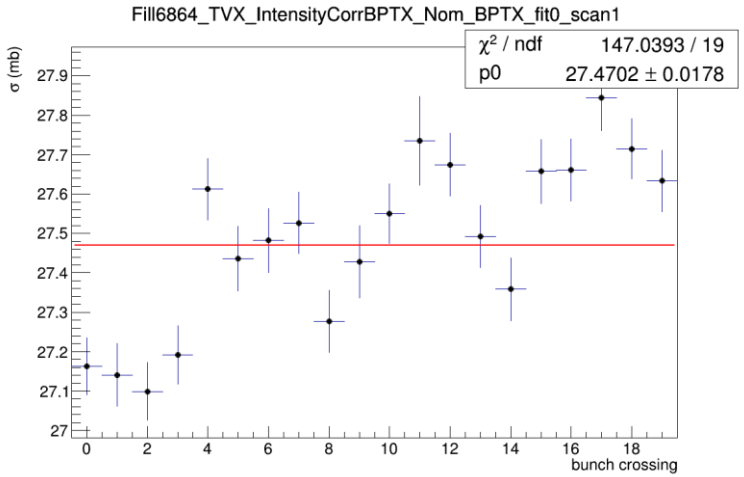






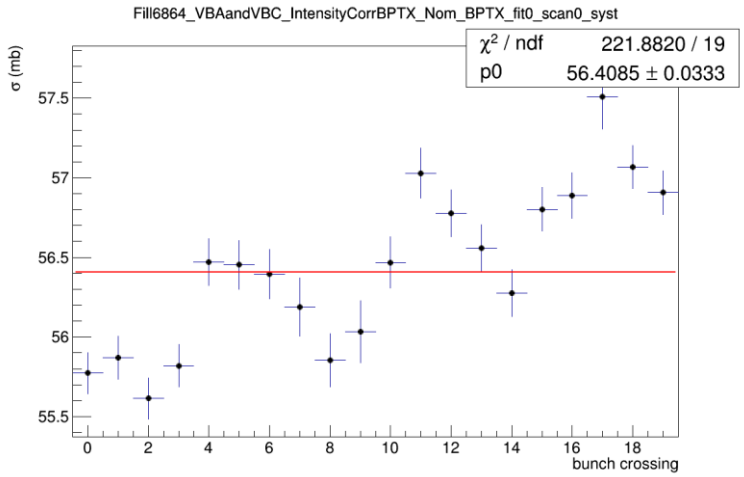
Backup XS results: pileup syst. study, BPTX + T0 + "+A/+C"

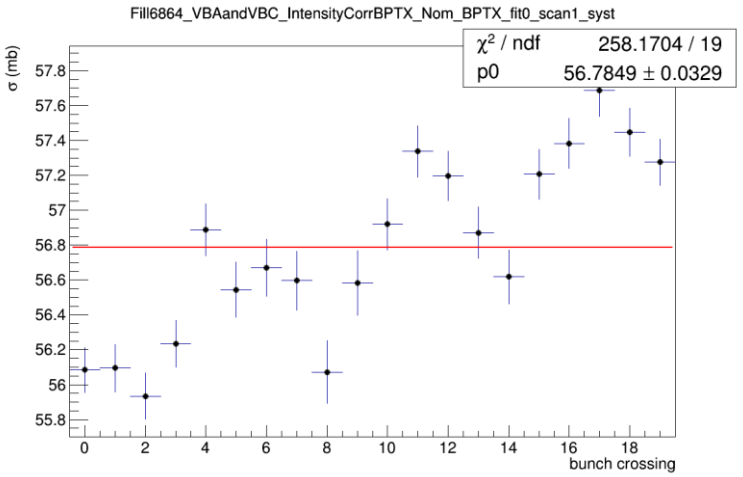


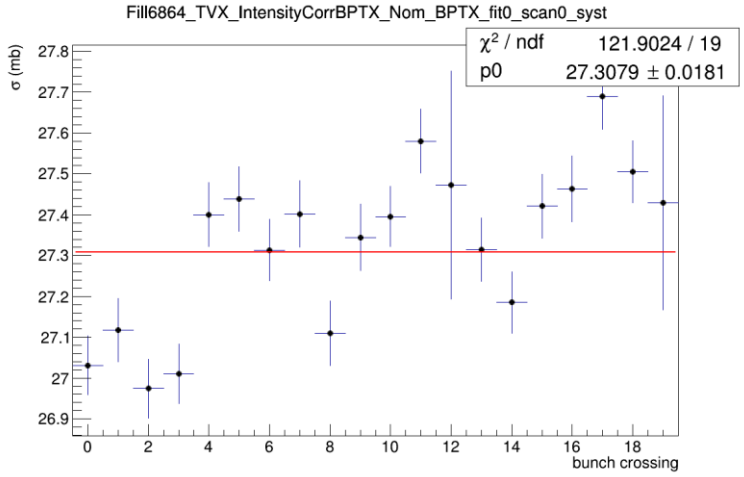


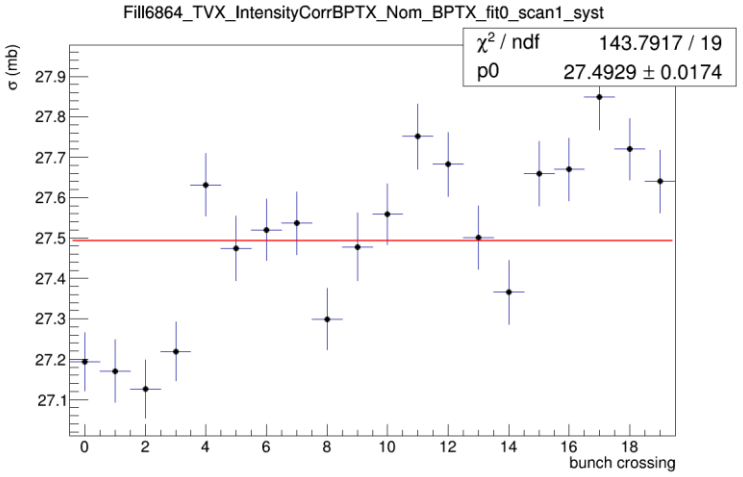
Backup

XS results: BG syst. study, BPTX









Backup XS results: BG syst. study, FBCT