

# Tracking updates: alignment pass2 from FEEs

PF

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U.S. DEPARTMENT OF  
**ENERGY**

Stanford  
University

**SLAC** NATIONAL  
ACCELERATOR  
LABORATORY

# Starting point

- I checked how in 2016 the survey constants were added to the HPS tracker detector
- The survey constants are applied to the compact via dedicated fields in the compact file
- I report here some of the Survey Constants used in 2016. They provide:
  - Location of the UChannels in the SvtBox
  - Location of the Modules in the UChannels
  - Location of the Sensors in the Modules
- We only have **partial survey data** available for the new 2019, i.e. the locations of L0-L1 sensors (X-Y-Z)\*, global Y location of the \*axial\* side of L3 and L4.
- **As a starting point I decided to use the full 2016 survey for 2019 back of the detector, plus the 2016 alignment constants for the tu and rw of the sensors.**

```
<SurveyVolume name="support_bottom_L46" desc="B46 ball basis in box fiducial frame:">
  <origin x="-5.9779+1.0" y="-8.4112" z="789.6352" />
  <unitvec name="X" x="9.9955e-01" y="-7.7349e-05" z="-3.0082e-02" />
  <unitvec name="Y" x="7.6453e-05" y="1.0000e+00" z="-3.0945e-05" />
  <unitvec name="Z" x="3.0082e-02" y="2.8631e-05" z="9.9955e-01" />
</SurveyVolume>
<SurveyVolume name="support_top_L46" desc="T46 ball basis in box fiducial frame:">
  <origin x="-6.3106" y="8.462" z="773.7906" />
  <unitvec name="X" x="9.9954e-01" y="7.3687e-05" z="-3.0209e-02" />
  <unitvec name="Y" x="-7.2695e-05" y="1.0000e+00" z="3.3946e-05" />
  <unitvec name="Z" x="3.0209e-02" y="-3.1734e-05" z="9.9954e-01" />
</SurveyVolume>
<SurveyVolume name="support_bottom_L13" desc="B13 ball basis in pivot frame:">
  <origin x="0.+1.0" y="59.9476" z="-304.9173" />
  <unitvec name="X" x="1." y="0." z="0." />
  <unitvec name="Y" x="0." y="1." z="0." />
  <unitvec name="Z" x="0." y="0." z="1." />
</SurveyVolume>
```

- Notice a +1 mm shift in X location of the support
- **I did not add the 1 mm shift (but alignment procedure found it)**
- **I haven't validated these survey constants for 2019 detector:**
  - We should:
    - Check the location of the supports/modules/sensors and check that this is still fully valid
- **I \*assumed\* in the next steps that they are valid.**

\* x measurement is still not validated, the Z measurement we are waiting for clarification where that is taken, i.e. surface or centre of the sensor.

# Bot Volume status for 9921

- As a crosscheck I did a more complex iteration fluctuating the tu's of the Axial-Stereo sensors
  - Iter6/7/8:** UC Tx/Ty, Modules Tu, Sensors Tu

$$\text{Constraints: } \sum_{mod=1}^4 T_u^{mod} = 0, \quad \sum_{s=ax,st} T_u^s = 0$$

$$\sum_{stereo=1}^4 T_u^s = 0$$

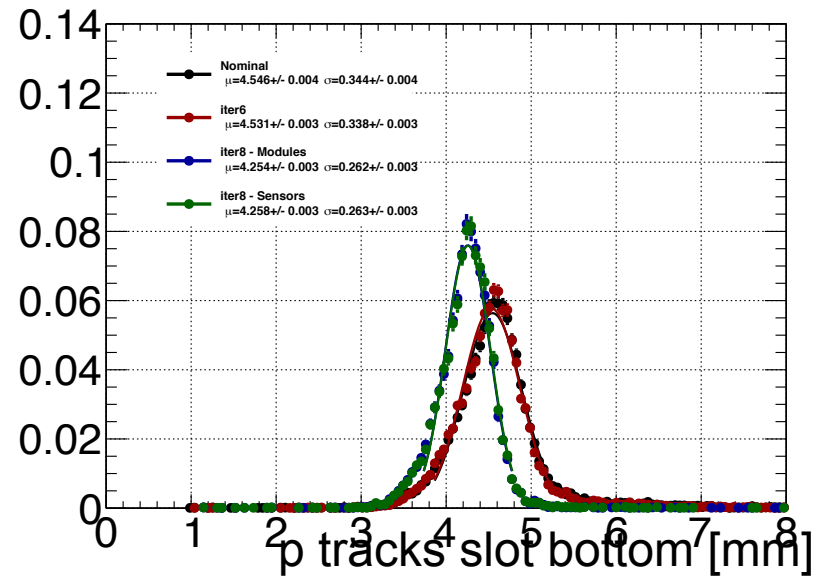
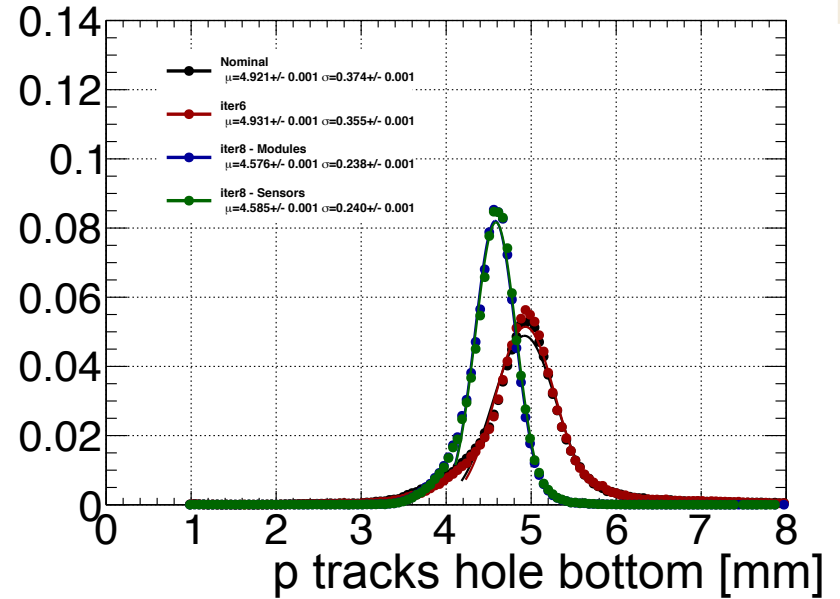
Momentum Constraint at 4.55 GeV

- The solution brings different corrections, but is identical to before in terms of performance (effectively the same DoFs are left floating)

11101	0.21098E-02	module_L1t_halfmodule_axial
11102	-0.21204E-02	module_L1t_halfmodule_stereo
11103	-0.27628E-01	module_L2t_halfmodule_axial
11104	0.27767E-01	module_L2t_halfmodule_stereo
11105	0.13802E-01	module_L3t_halfmodule_axial
11106	0.13871E-01	module_L3t_halfmodule_stereo
11107	0.11717E-01	module_L4t_halfmodule_stereo
11108	0.11776E-01	module_L4t_halfmodule_axial

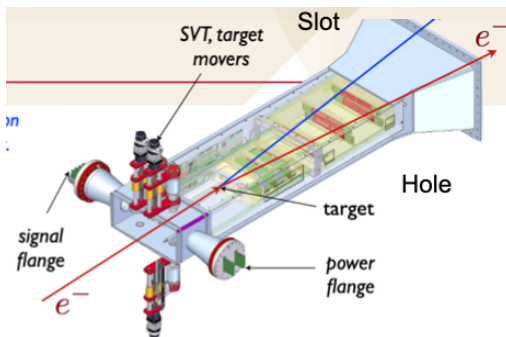
11161	0.96333E-02	module_L1b_fullmodule
11162	0.18456E-01	module_L2b_fullmodule
11163	-0.87154E-02	module_L3b_fullmodule
11164	-0.19374E-01	module_L4b_fullmodule

11180 1.1334 front\_support\_bot



# 2019 Data and MC samples

- The following samples are used in the various studies shown today:
  - Run 10103 - FEE Trigger, 100 file
  - Detector Conditions:
    - Bottom Ly5 Slot Side is dead
    - Top Ly7 dead
  - Run 9921 - FEE Trigger, 50 files
  - Full Detector Working
- MC simulation (thanks Cameron)
  - FEE Run 1194500
  - Location: [Samples For Tracking Studies](#)
  - Full Detector Working 120nA / 8um target thickness
  - Word of caution: processing time 5-6Hz with current tracking
  - **TODO: We need to check the code timing \*again\***



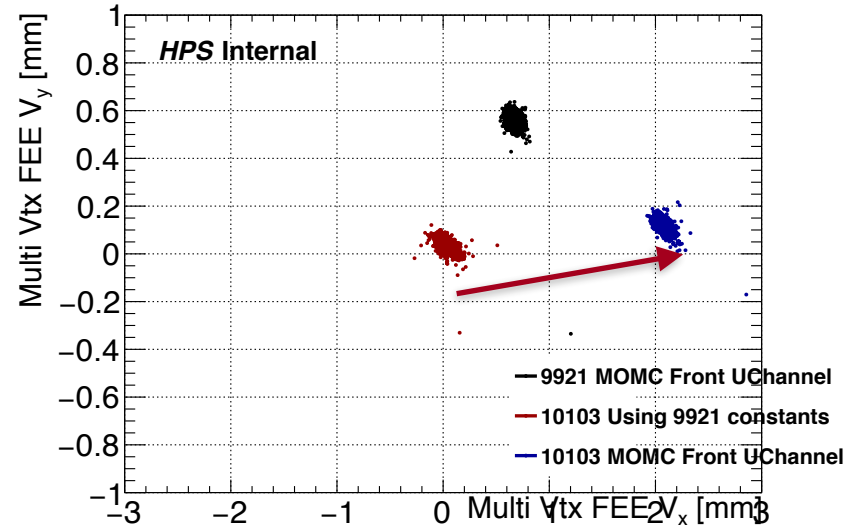
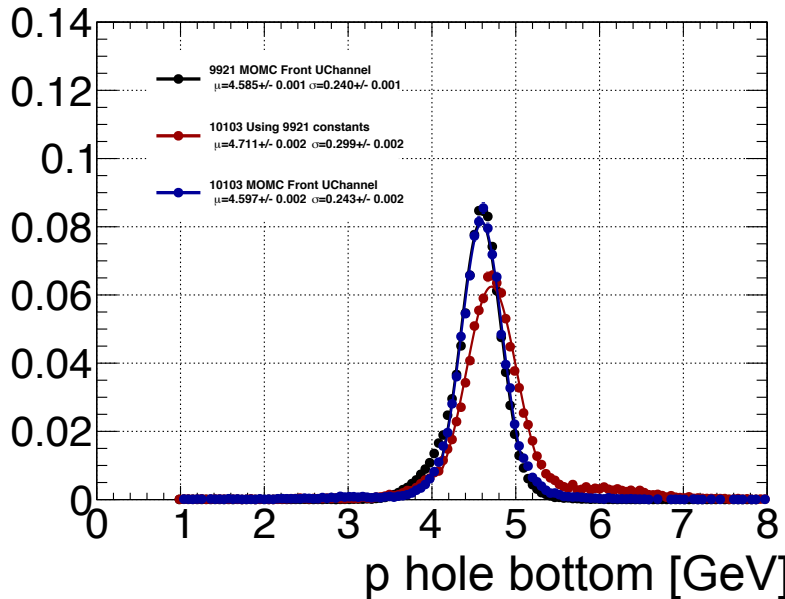
- I split tracks in slot and hole side.
- Hole side is the bending direction of electrons.

# Alignment procedure

- For Top Volume:
  - Used run 10103 directly.
  - Aligned front UChannel Ty and Rx. Back UChannel I used 2016 survey + alignment constants
  - Aligned at sensor level using momentum constraint the front UChannel.
  - Imposed beamspot and momentum constraint and aligned front UChannel and back UChannel Tx, Ty, Tz, Rx.
- For Bottom Volume:
  - Used run 9921 to align front wrt back UChannel
  - Aligned front UChannel at sensor level using momentum constraint.
  - Used 10103 imposing beamspot and momentum constraint and aligned from UChannel and back UChannel Tx,Ty,Tz and Rx

# Back UChannel alignment tests

- While beamspot location depends (mostly) from the location of the front UChannel, momentum is mostly driven from the relative front-back UChannel locations.
- So far we always tried to align the front UChannel keeping the back fixed. However this leads in the bottom to:
  - Precise determination of the momentum
  - up to ~2 mm shift in the beamspot location when aligning the front wrt back



```
millepede_constant name="21180" value="0.0 + 0.991020
```

This is the Tx correction extracted from 9921. Notice:

```
<SurveyVolume (name="support_bottom_L13" desc="B13 ball basis in pivot frame:")>  
<origin x="0.+1.0" y="59.9476" z="-304.9173" />
```

# Back UChannel alignment tests

- The idea would be to then align at the same time back and front UChannels, one respect to the other
- Used ideal (fully working) MC sample to check the alignment procedure. I displaced the front uChannel of **Tx=-1mm** and tried to recover it.
- Freeing Tx for both front and back of the detector is a weak mode. Momentum constraint is not sufficient to pin it. Beamspot constraint is necessary (as it will fix the front UChannel, basically)

## Momentum Constraint Only

Tx Front	front_support_bot	19.632000	+-	0.478470	21180
Tx Back	back_support_bot	-20.634000	+-	0.478660	21190
Ty Front	front_support_bot	-0.017964	+-	0.000476	21380
Rx Front	front_support_bot	-0.000034	+-	0.000002	22180

## Momentum Constraint + Beamspot Constraint

	front_support_bot	-1.049700	+-	0.001202	21180
	back_support_bot	0.054681	+-	0.002409	21190
	front_support_bot	0.001697	+-	0.000175	21380
	front_support_bot	-0.000004	+-	0.000001	22180

- We don't have a full volume structure to align both the front and back at the same time
- This should be made a priority to develop.

# 10103 correction of back Channel

- So I imposed the (0,0,-7.5) beamspot constraint to the alignment procedure and aligned at the same time front and back uChannels.
- Just freeing Tx one can notice that the solution recovers the 1mm inserted in the survey constants (the alignment corrections change sign)

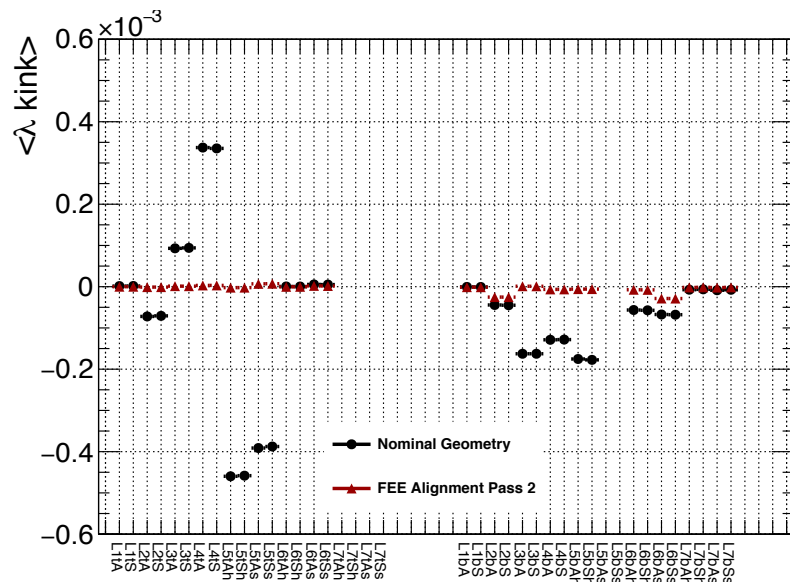
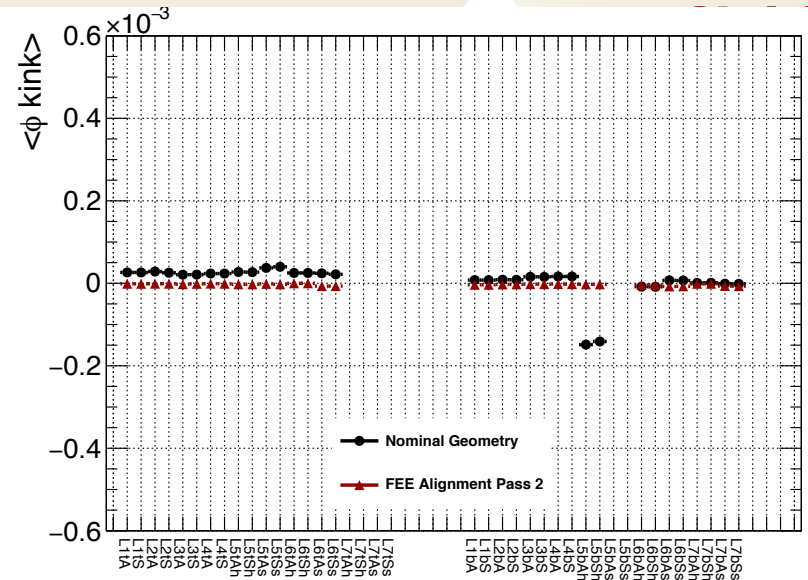
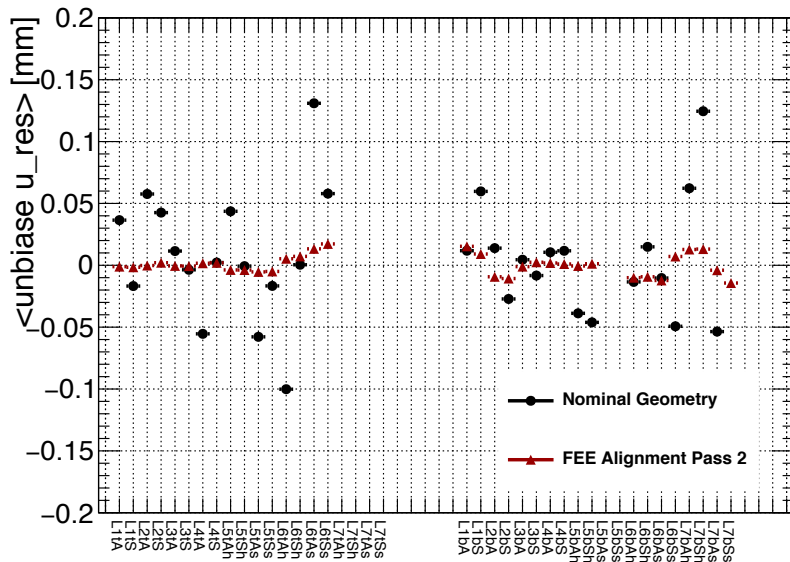
```
21180    0.75507E-01    0.0000    0.75507E-01
21190   -1.0079        0.0000   -1.0079
```

```
<SurveyVolume name="support_bottom_L46" desc="B46 ball basis in box fiducial frame:">
  <origin x="-5.9779+1.0" y="-8.4112" z="789.6352" />
  <unitvec name="X" x="9.9955e-01" y="-7.7349e-05" z="-3.0082e-02" />
  <unitvec name="Y" x="7.6453e-05" y="1.0000e+00" z="-3.0945e-05" />
  <unitvec name="Z" x="3.0082e-02" y="2.8631e-05" z="9.9955e-01" />
</SurveyVolume>
```

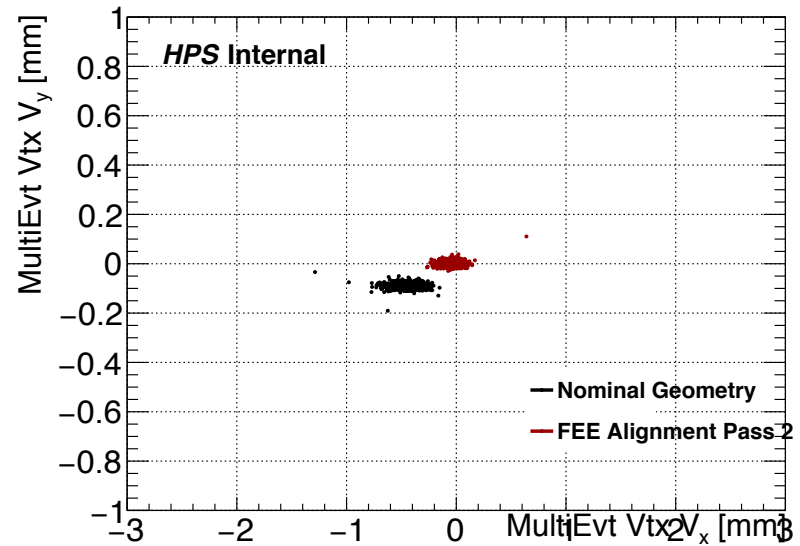
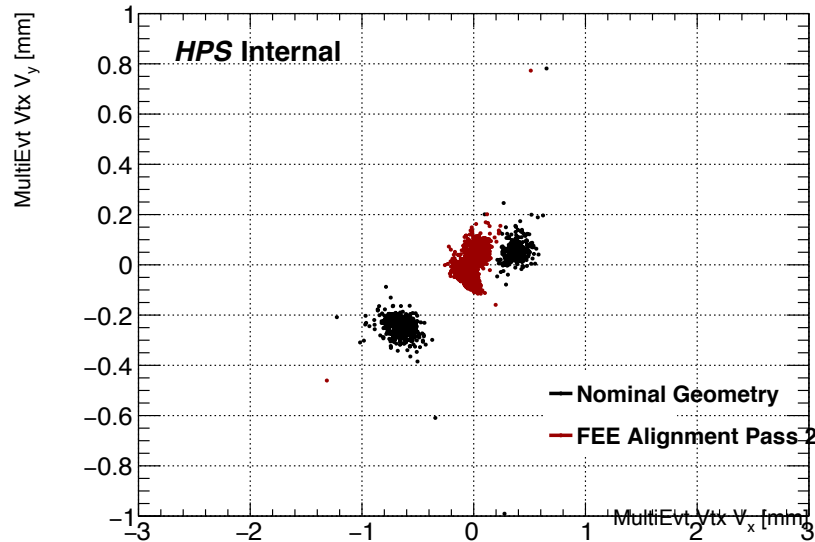
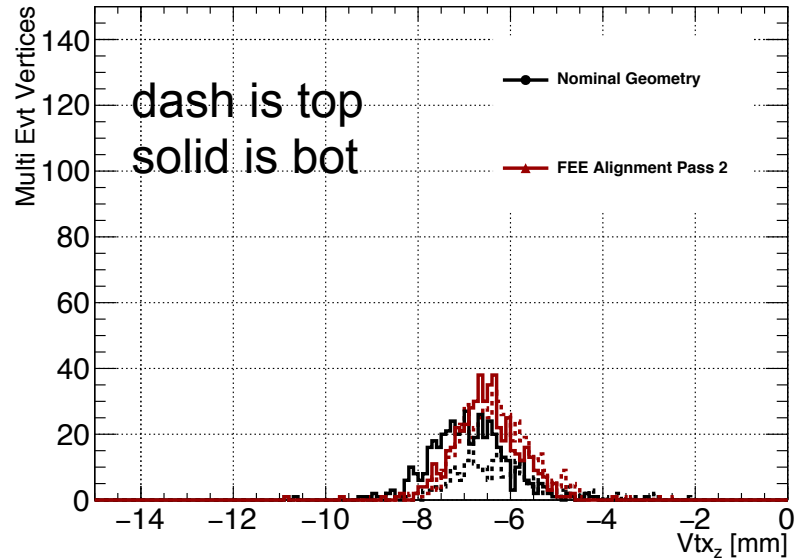
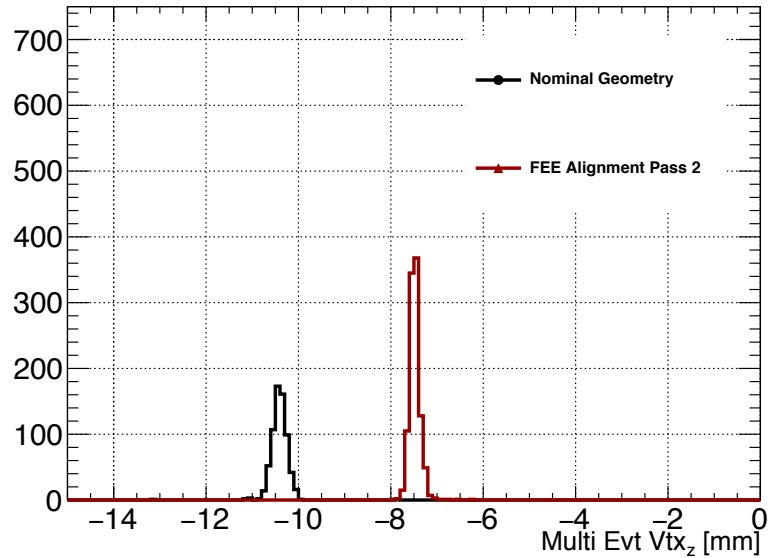
- I believe this is what was ~ done in the past (by hand) and this would keep the momentum in place and beamspot in place.
- Using the beamspot constraint is necessary to remove the weakmode. Not sure if a full bottom volume can supersede that constraint. Should be developed and tested



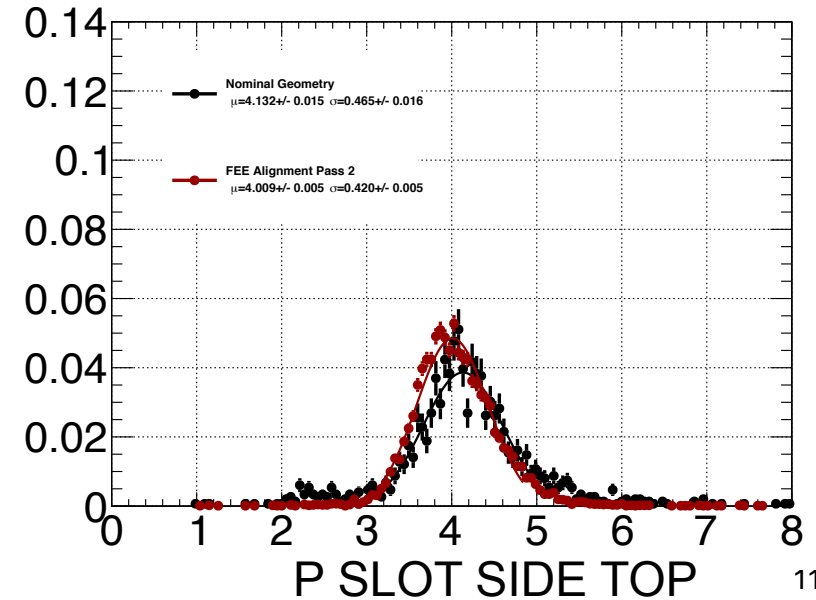
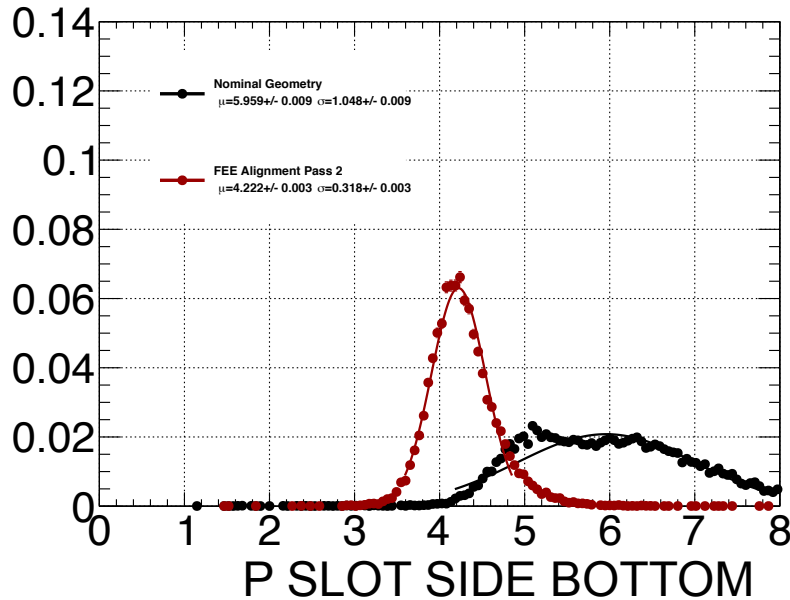
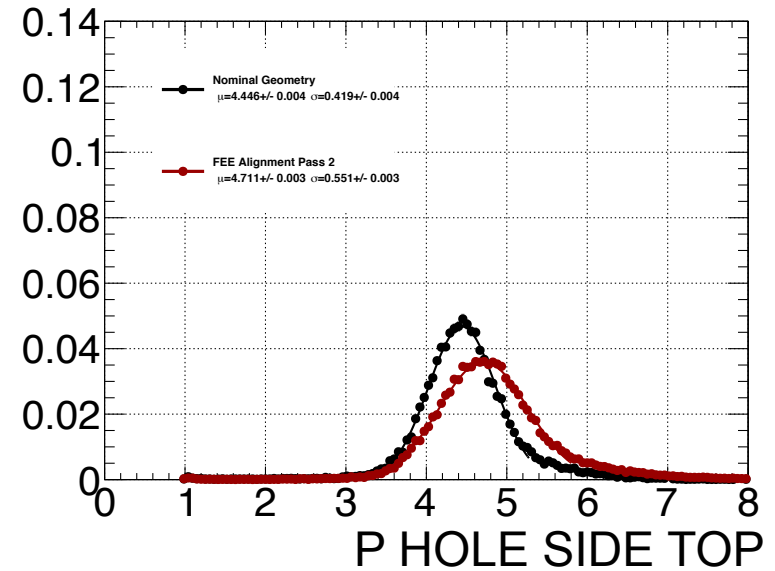
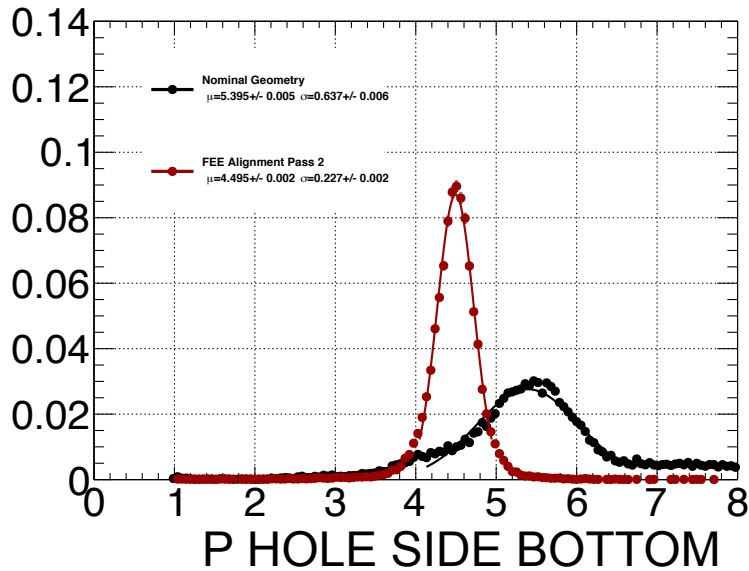
# Alignment status of SVT using 10103



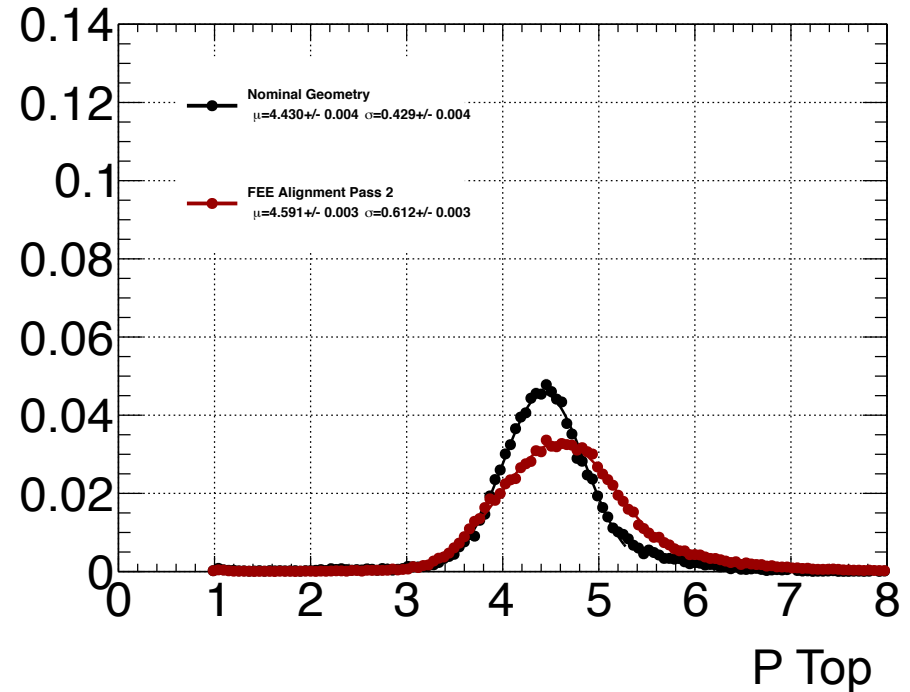
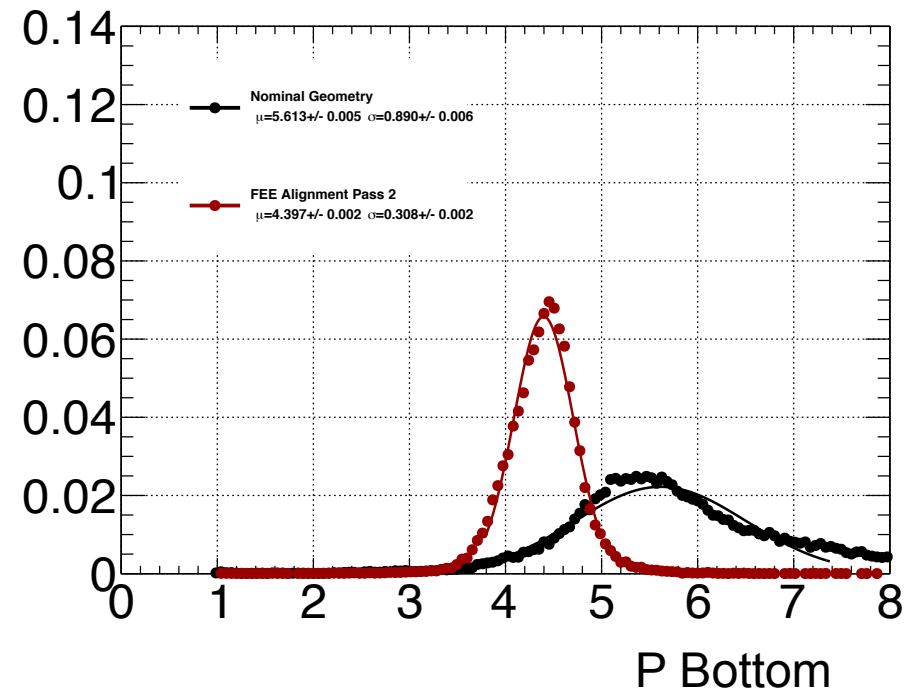
# Alignment status of SVT using 10103



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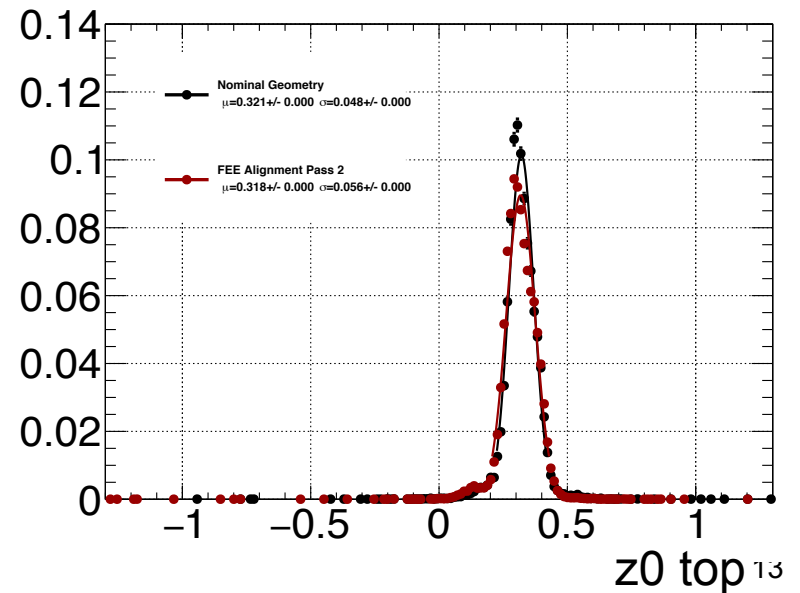
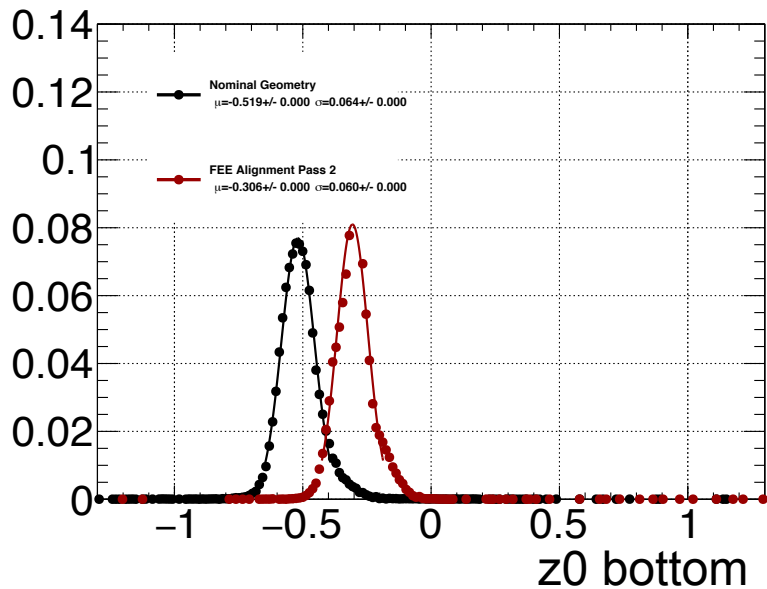
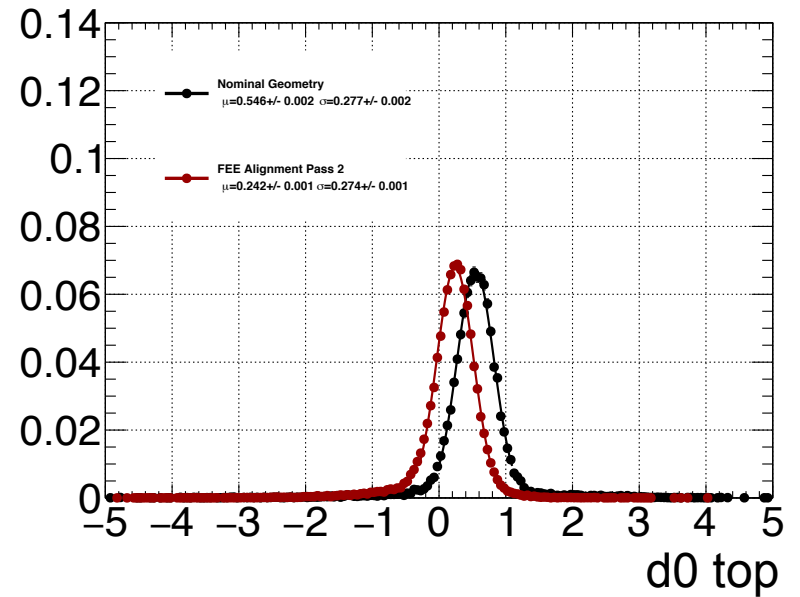
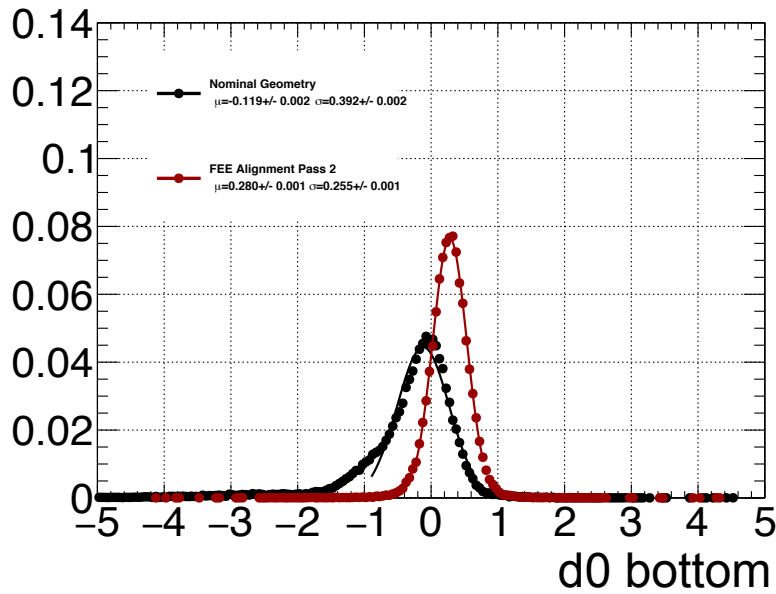


# Alignment status of SVT using 10103



- Not very happy about top momentum.
- At the moment not fully sure what is causing that.

# Alignment status of SVT using 10103



# Alignment status of SVT using 10103

