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Analysis report: B->J/psi pi0

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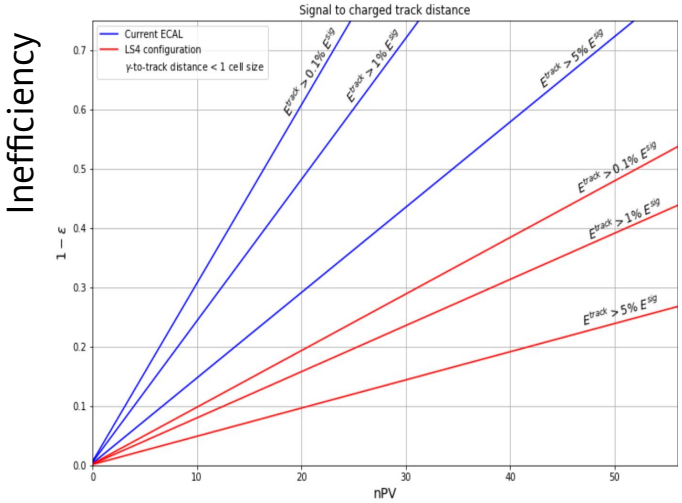
Inputs used

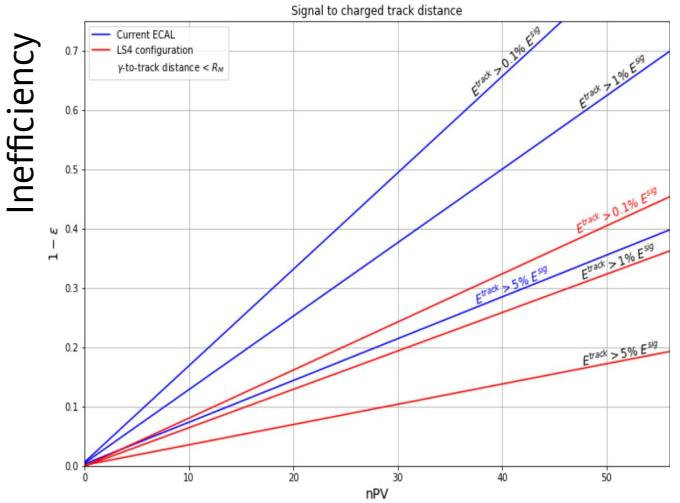
- Reference physics sample: $B_s^0 \to J/\psi(\to \mu^+\mu^-)\pi^0(\to \gamma\gamma)$
  - $\mathscr{L}$ = 1.5 x 10^{34} $cm^{-2}s^{-1}$
  - Single/Double readout configurations for Run 5
- Basic cuts:
  - $p_T(\gamma) > 500$ MeV
  - $p_T(\pi^0) > 1000$ MeV
  - $p_T(B_S^0) > 2000$ MeV
  - $M(\pi^0) = 100...170$ MeV/c^2
  - $M(B_s) = 4700...6000$ MeV/c^2
  - Charged tracks veto (see next slide)
- ML-based reco based on 3 sets of regressors to estimate:
  - Position
  - Energy
  - Time

Charged tracks veto

Photon candidate requires no charged track nearby



distance < 1 cell size



distance < 1 Molière radius

1: Outer region, cell size = 12.12 x 12.12 cm^2
2: Middle region, cell size = 6.06 x 6.06 cm^2
3: Inner region, cell size = 4.04 x 4.04 cm^2

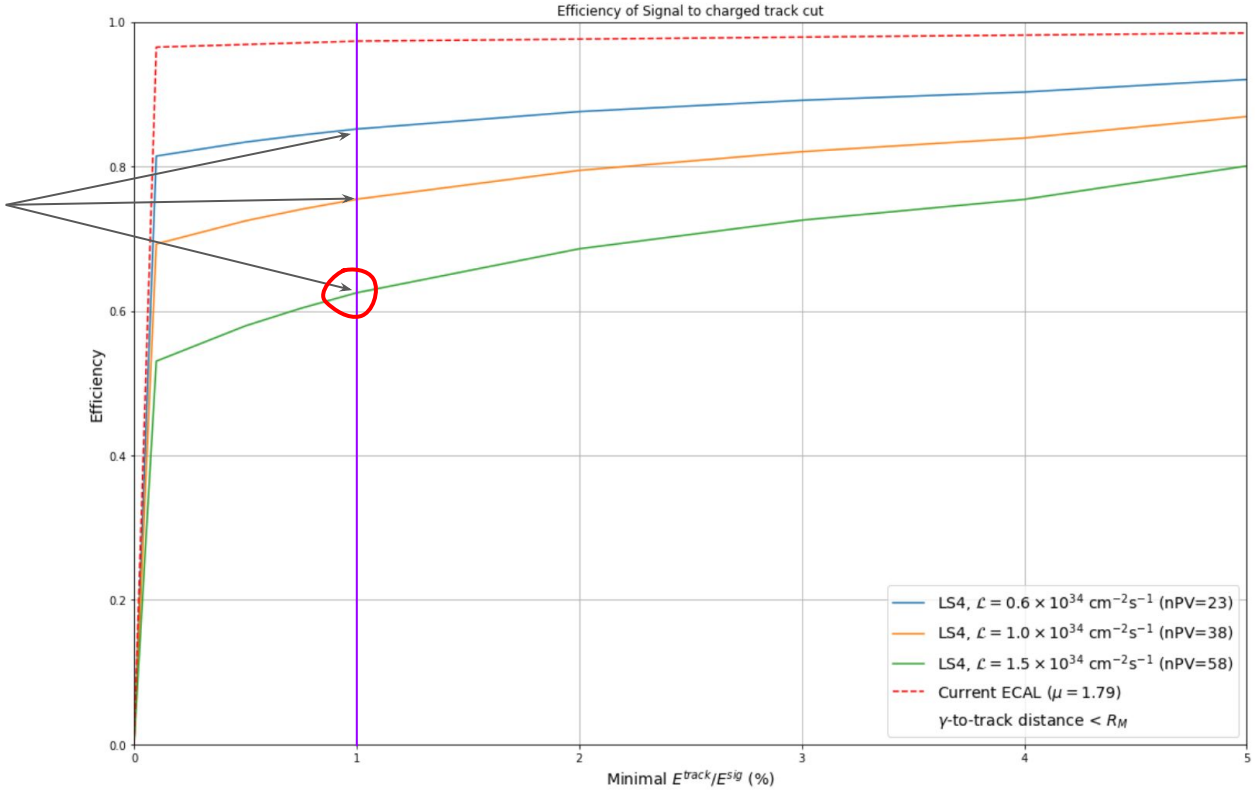
} R_M = 35.0 mm

4: cell size = 3.03 x 3.03 cm^2 R_M = 14.5 mm

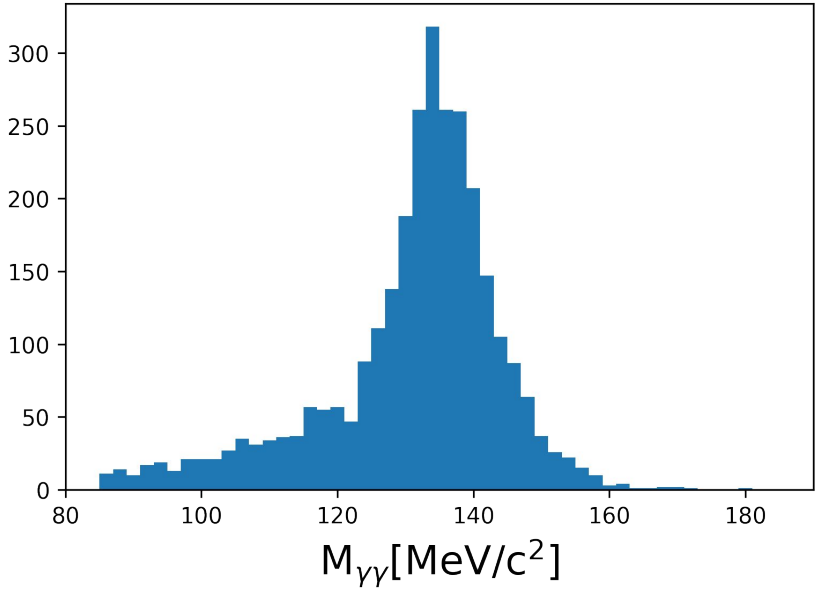
5: cell size = 1.515 x 1.515 cm^2 R_M = 29.5 mm

Charged tracks to photon distance

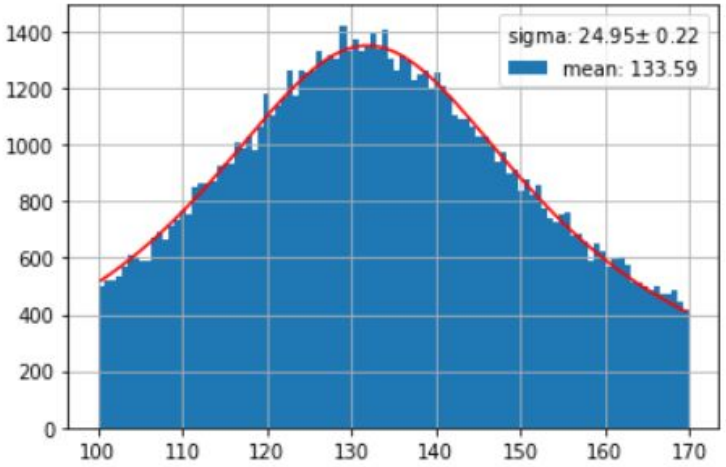
Used for the performance results below



Reconstructed π^0 width



Signal only



Signal merged with minimum bias for $\mathscr{L} = 1.5 \times 10^{34}\ cm^{-2}s^{-1}$

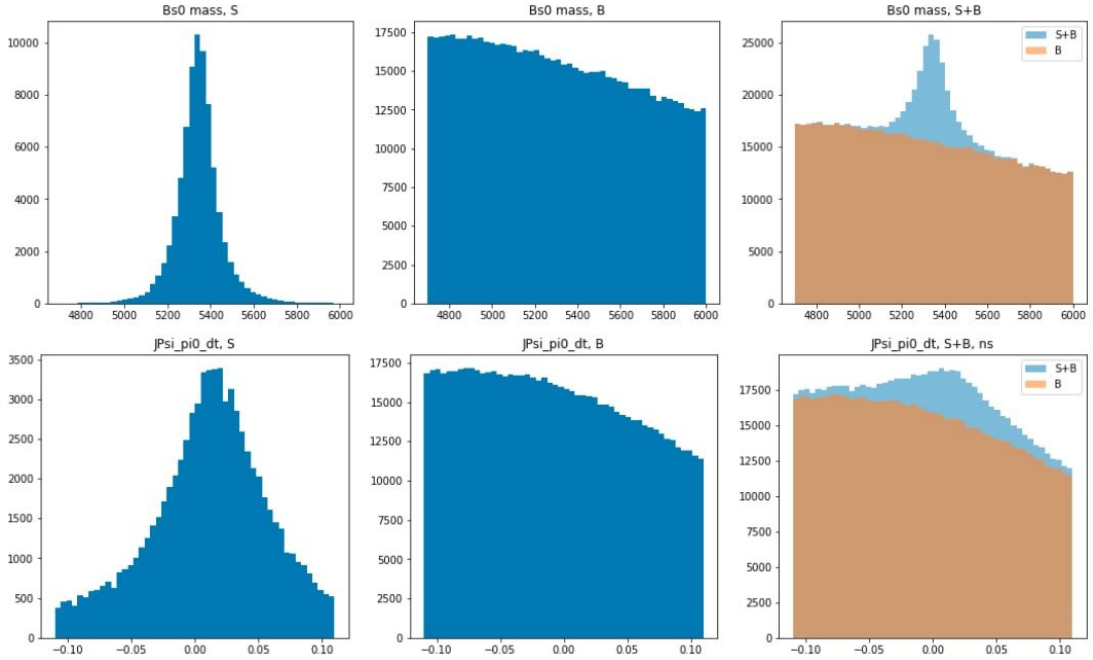
- Energy from regressor
- Position from regressor
- No timing

Time information

- Time for signal and background is determined by the time properties of the primary vertex (due to the (z, t)-profile of the beam)
- Time is corrected by angle
- Reconstructed pi0 time is considered by averaging the reconstructed time of photons
- 5x5(x2) cells as base features for time regressors for Shashlik (Spacal) modules
  - Same time for cells contained signal-only deposits
  - t_{cell} for cells with both signal + background deposits $t_{cell} = \frac{\sum t_i E_i}{\sum E_i}$
  - Regressor minimises t - t_{MC}
- Module / electronics time resolution is **not considered**

Using time information

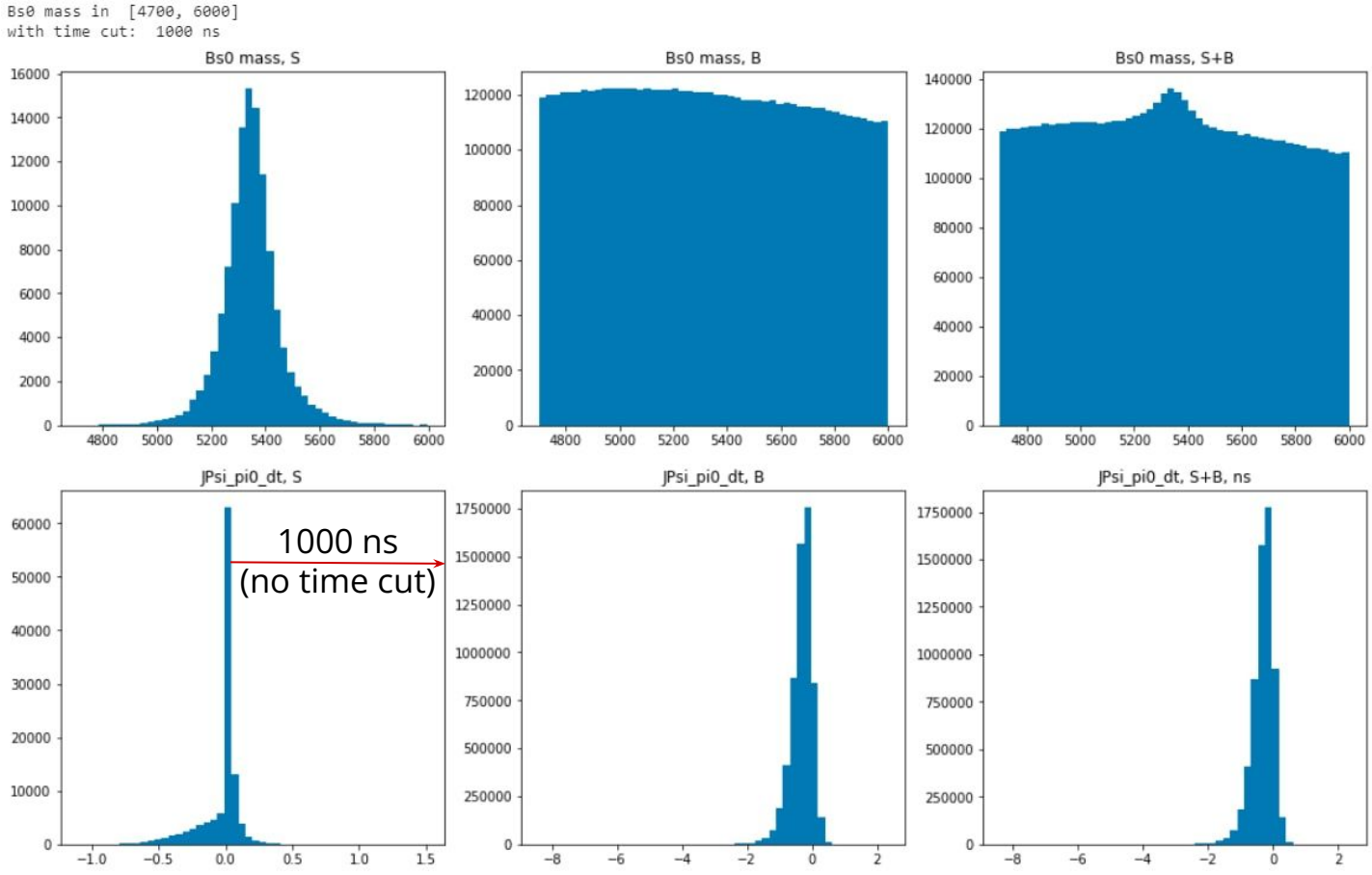
For the selected time window, mass window is optimised by finding the maximum of significance.



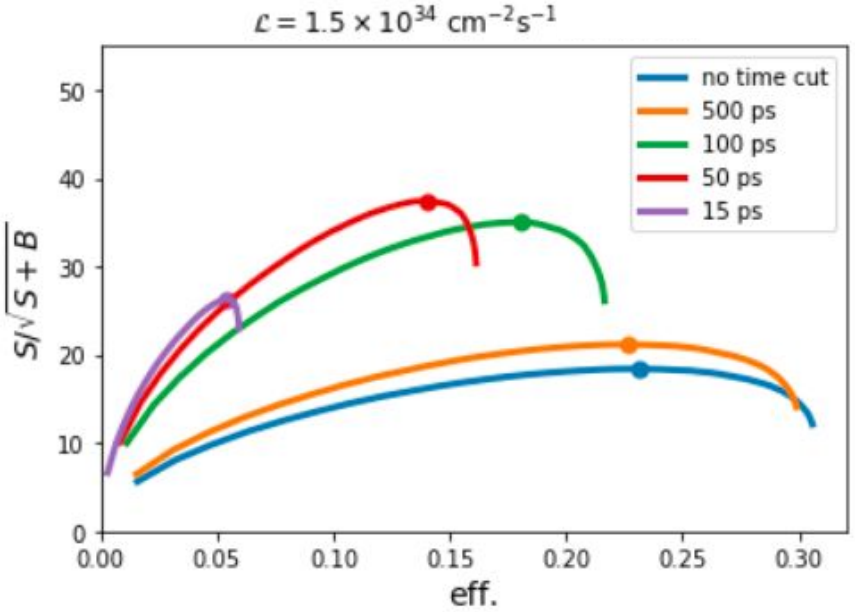
Mass window

Time window

Time information



Performance using time information



Cut	Value, MeV(/c^2)	Rel., %
Geom. acc.		100
$p_T(\gamma)$	> 500	79
$p_T(\pi^0)$	> 1000	45
$p_T(B_S^0)$	> 500	22
$M(\pi^0)$	[100,170]	21

Conclusions

- ML-based Reco is used for **Run 5 ECAL & FTDR** configurations
- Spatial resolution and charged track veto are presented
- Physics metrics are evaluated for $B_s^0 \to J/\psi(\to \mu^+\mu^-)\pi^0(\to \gamma\gamma)$ ($\mathscr{L}$ = 1.5 x 10^{34} $cm^{-2}s^{-1}$):
  - sigma of π^0 width
  - sigma of B_s width
- Significance vs. Efficiency dependencies are obtained using the time information predicted by the regressors

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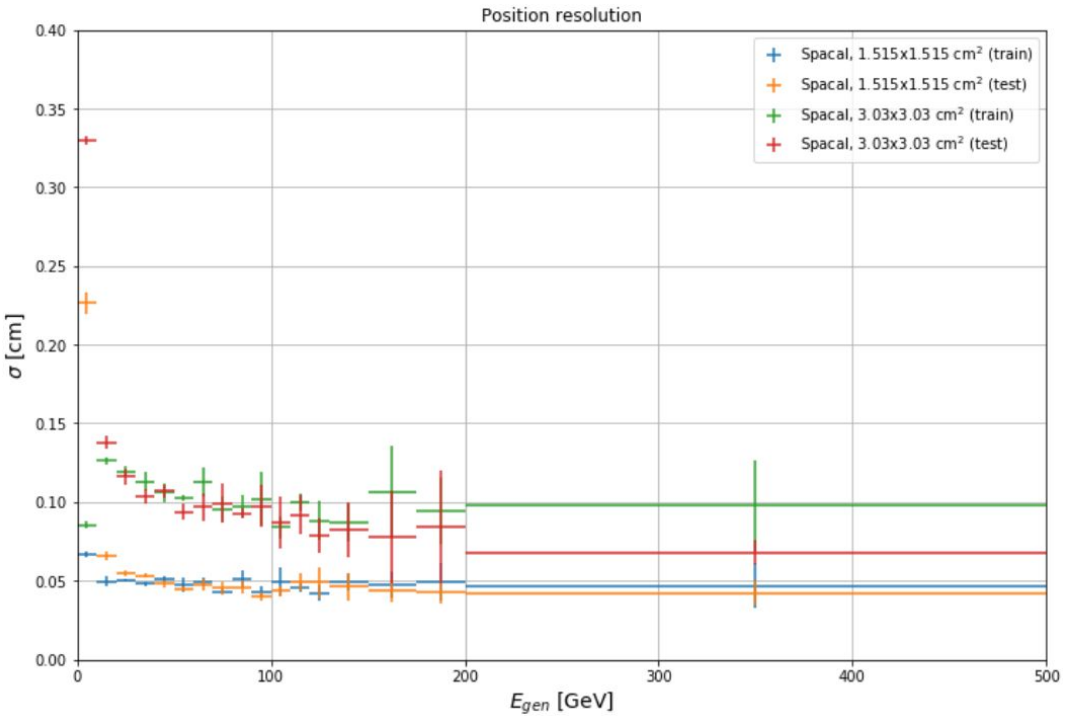
Backup slides

Spatial resolution for Spacal modules

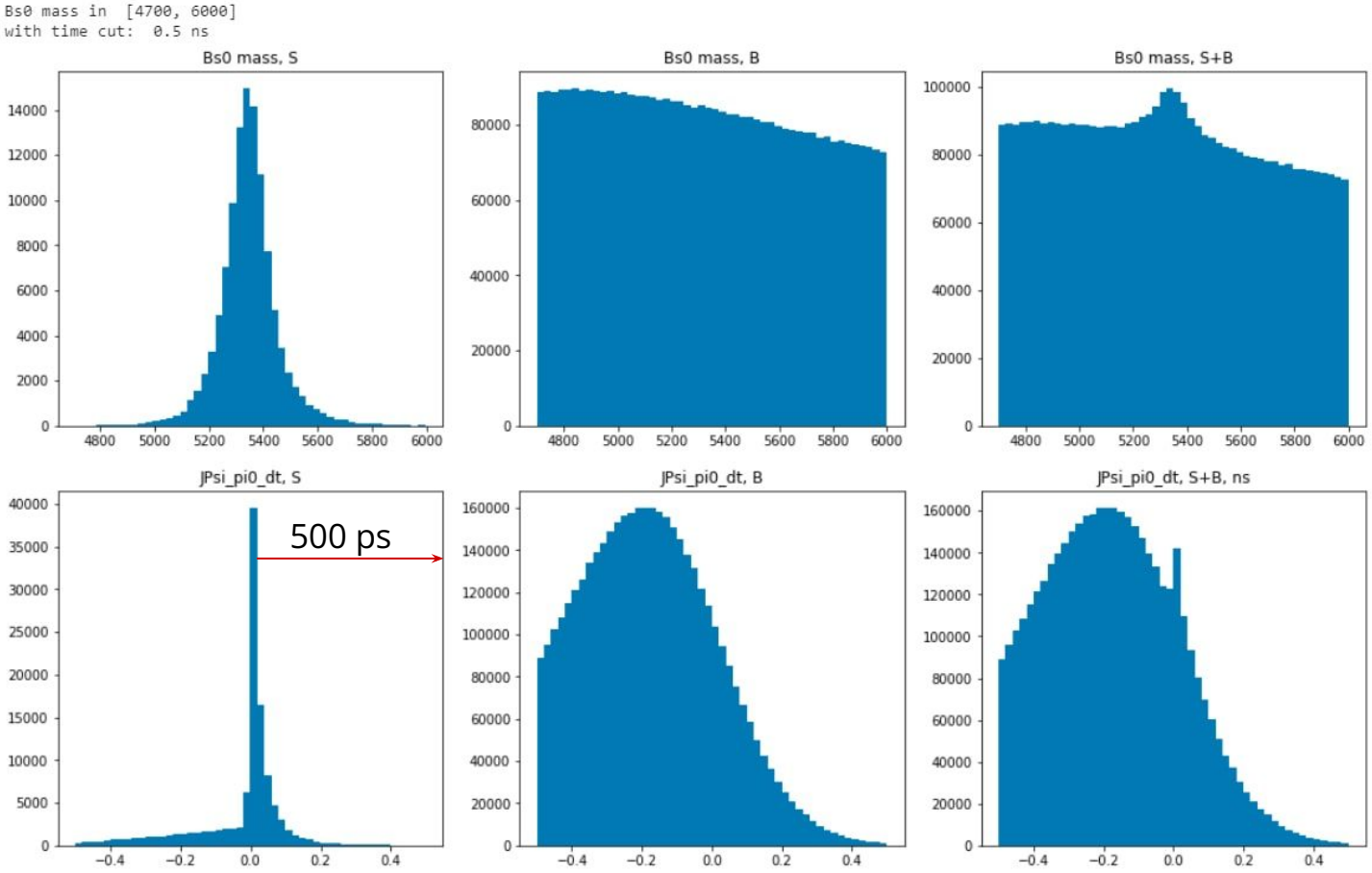


- Without pile-up
- Separate regressors on (Rec - Gen) RMSE for x & y positions of the hit
- Considered 5x5x2 cells as features for the regressors

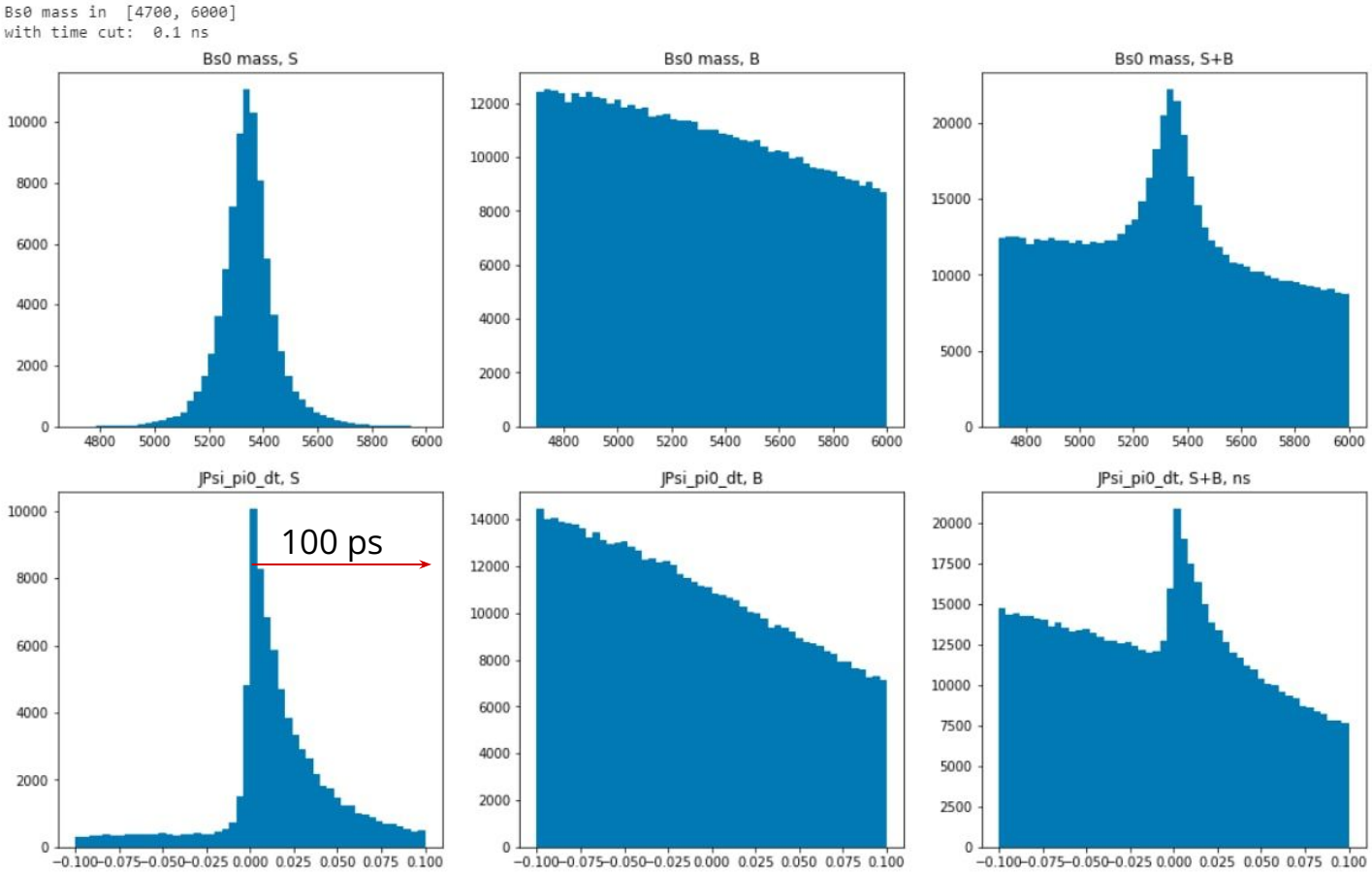
Spatial resolutions for the Spacal W/GAGG and Pb/Polystyrene modules are flat above 50 GeV
Stat. uncertainties are low.

In this figure, Spacal 1.5x1.5 cm^2 modules aren't tilted (see backup slides for the details)

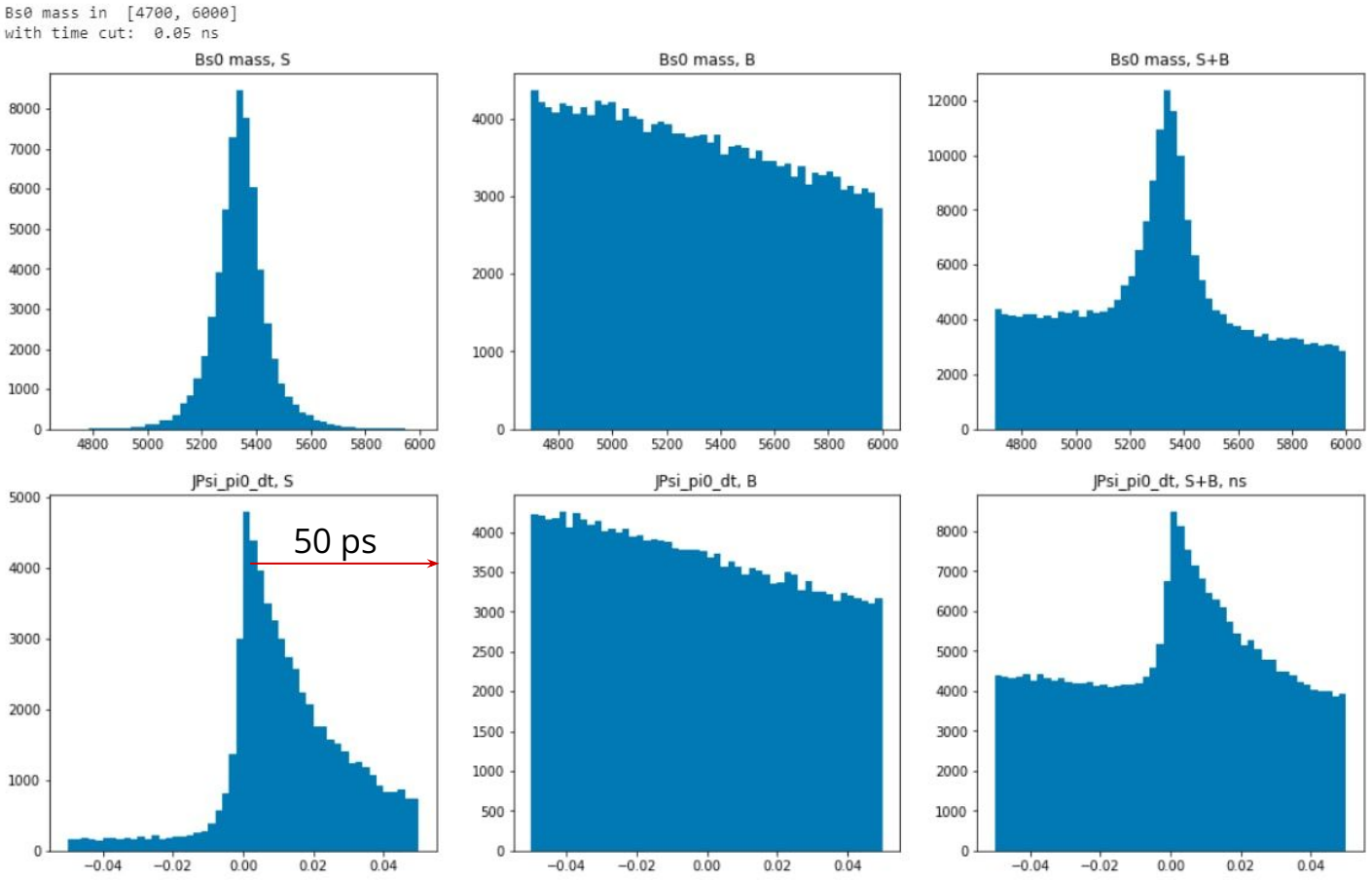
Time information



Time information



Time information



Time information