

Particle Weighting

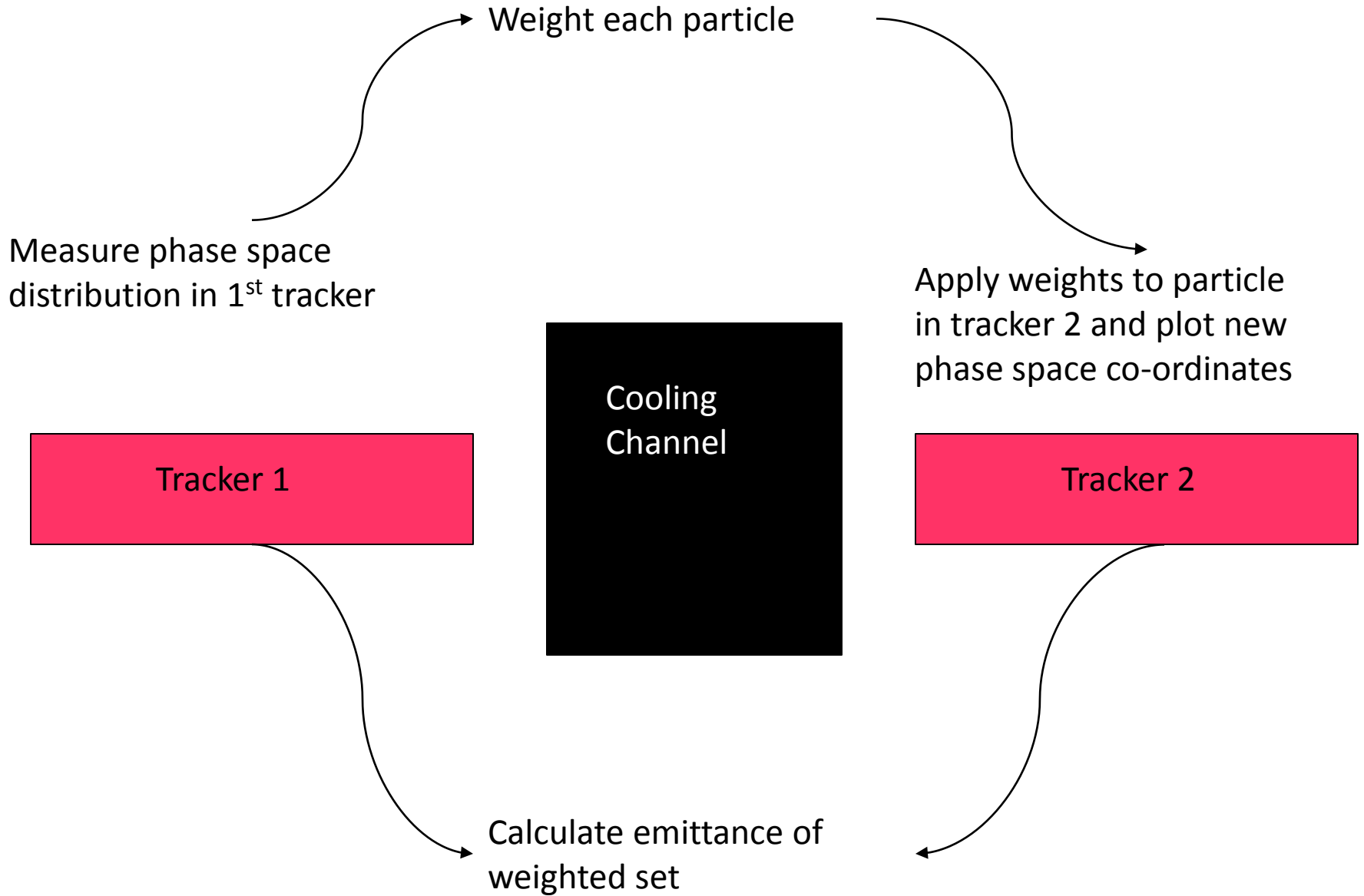
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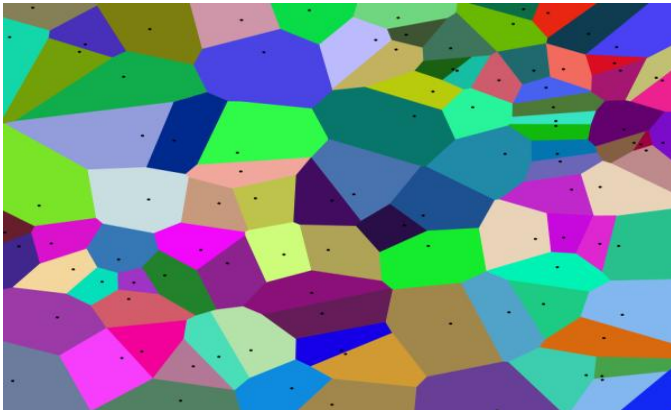
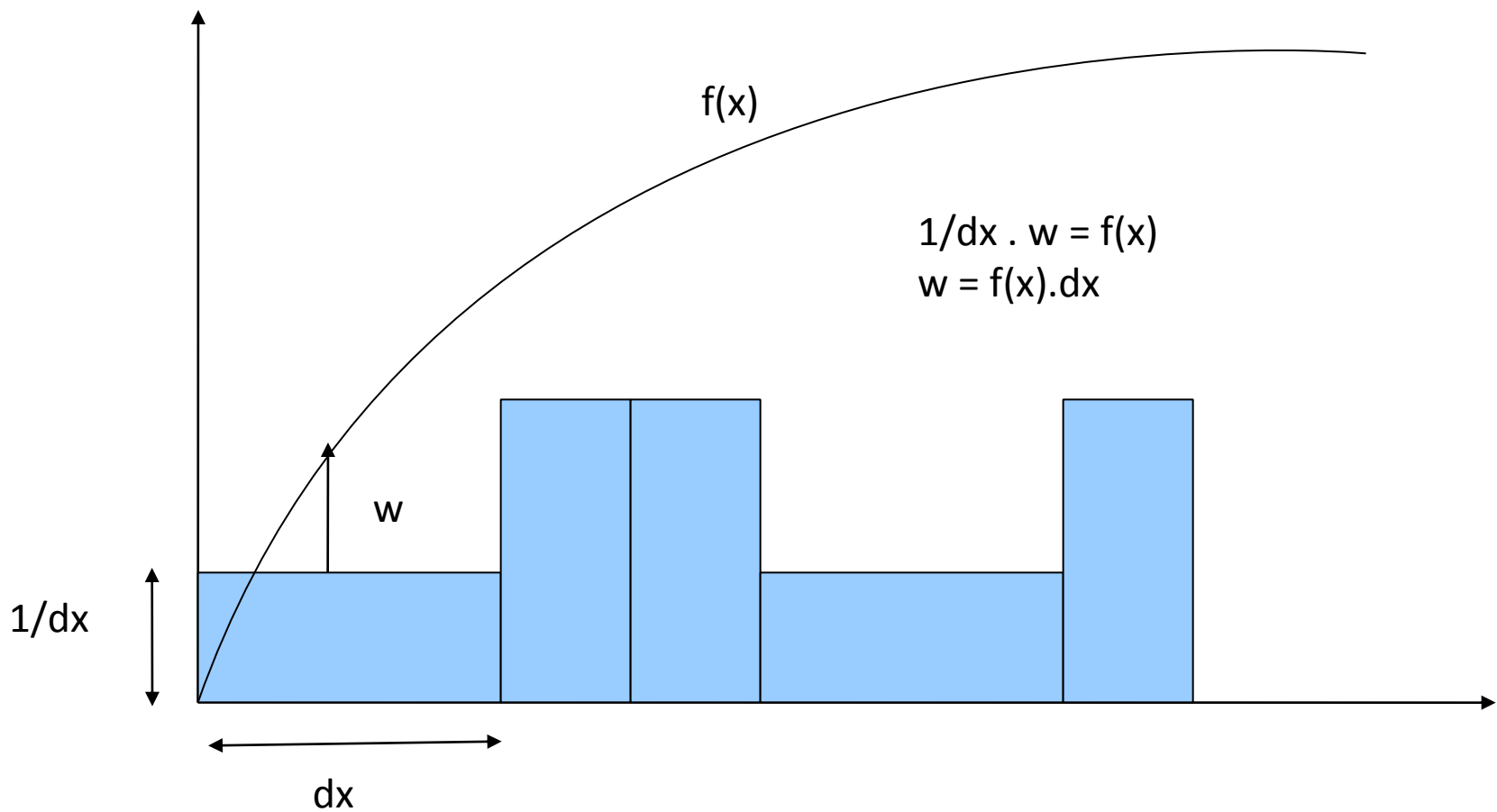
CM27 Analysis Session

9/7/10

Weighting

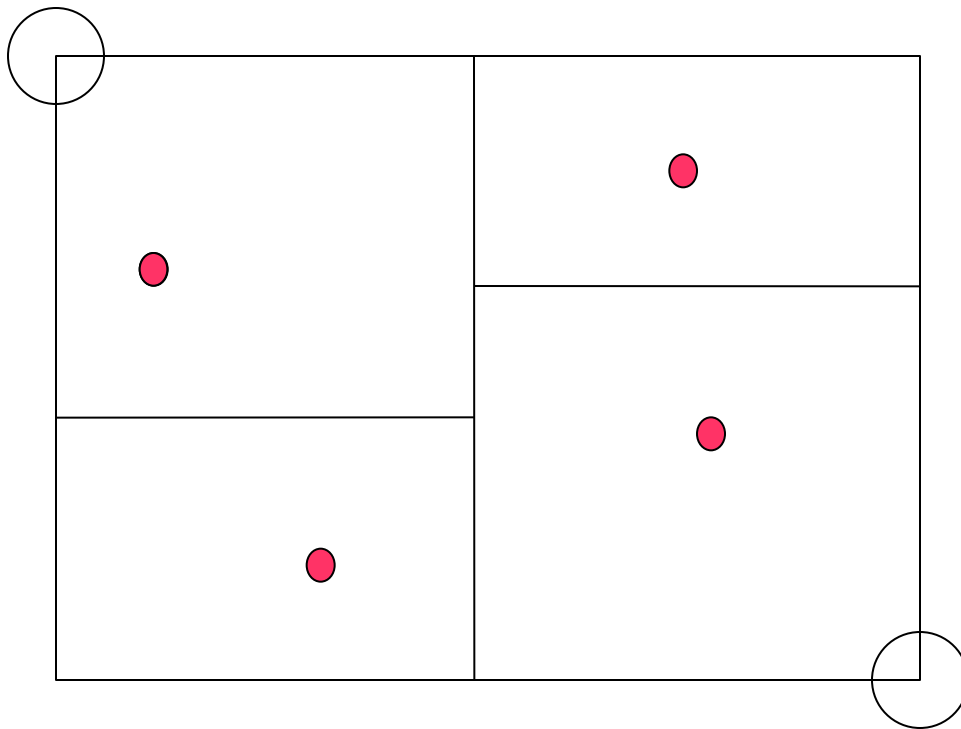
- Option to weight a particle distribution according to its similarity to a desired case
- Using an approximate Voronoi diagram + covariance matrix defined from desired parameters (ϵ, β, p)





- Integrate function over single valued bin
- 1D Voronoi diagram
- Expand to N-D
- Approximate for processing and integration

Creating Approximate Diagram

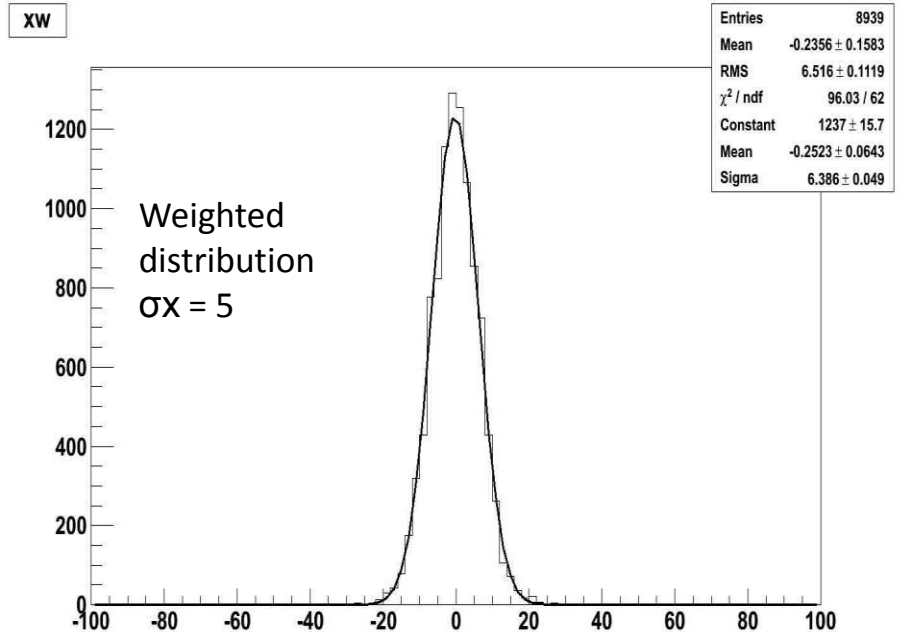
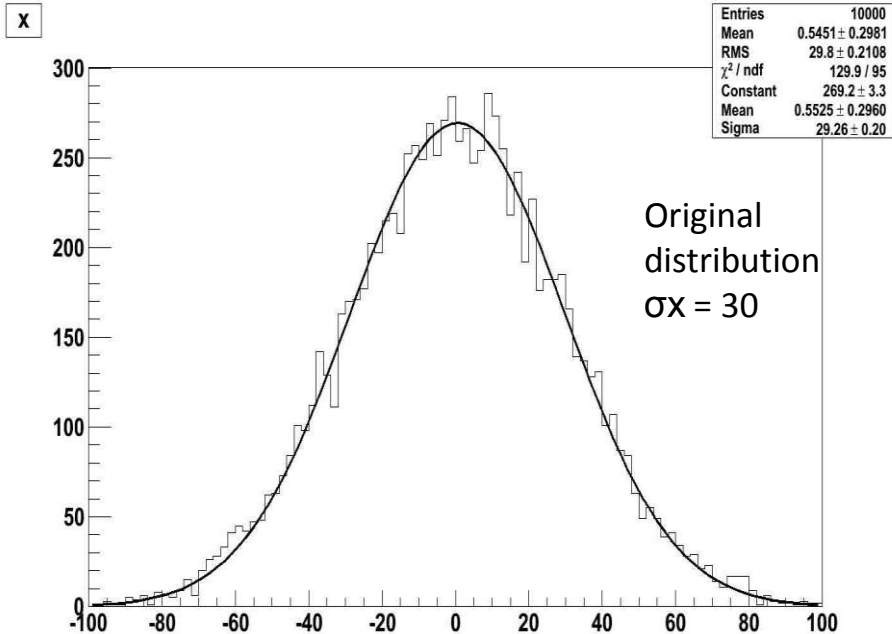


Only store 2 points regardless of n-D

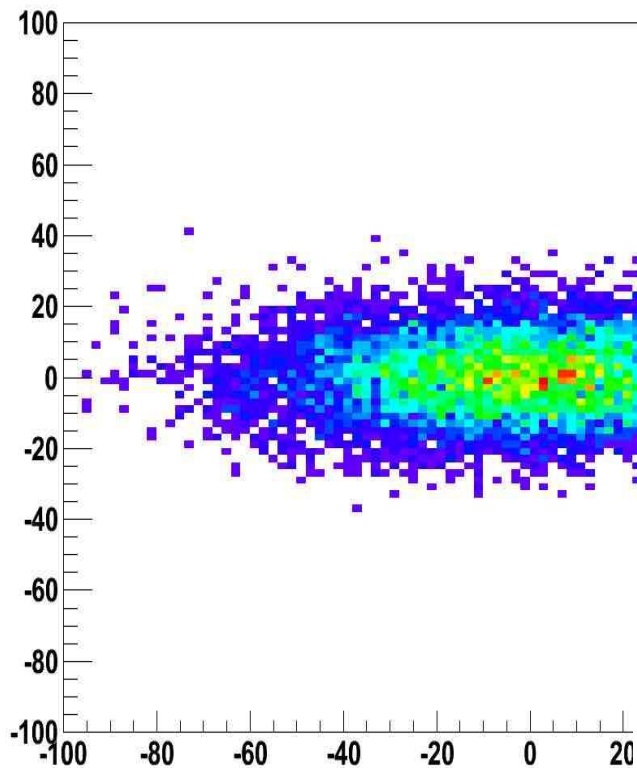
- Bisect region at midpoint.
- Add another point
- Find which regions contains point
- Bisect with existing point in region in dimension with largest difference
- Integrate probability density over each region

Simple Test Results

- Take 4D distribution of points, sampled from uni-variate Gaussians
- Draw diagram and weight to different set of uni-variate Gaussians.



xy



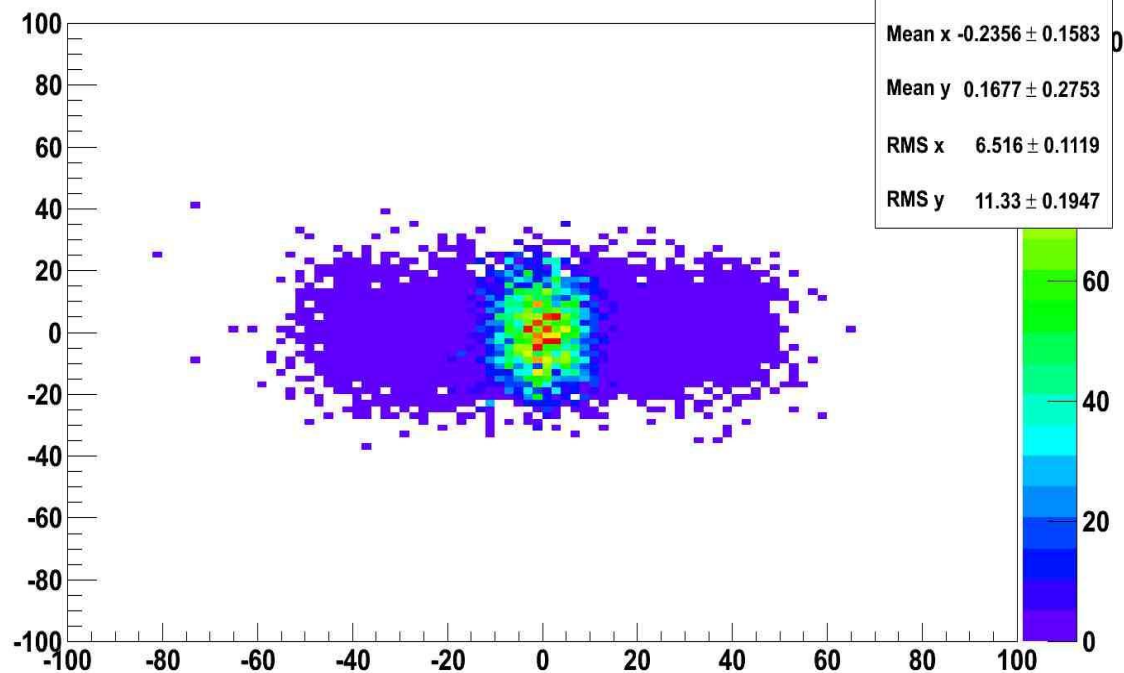
| | |
|---------|------------------------|
| Entries | 10000 |
| Mean x | 0.5451 ± 0.2981 |
| Mean y | -0.008389 ± 0.1003 |
| RMS x | 29.8 ± 0.2108 |
| RMS y | 10.03 ± 0.07092 |

Original distribution

$$\sigma_x = 30$$

$$\sigma_y = 10$$

xyw



| | |
|---------|----------------------|
| Entries | 8939 |
| Mean x | -0.2356 ± 0.1583 |
| Mean y | 0.1677 ± 0.2753 |
| RMS x | 6.516 ± 0.1119 |
| RMS y | 11.33 ± 0.1947 |

Weighted distribution

$$\sigma_x = 5$$

$$\sigma_y = 15$$

Multivariate Integration

- Brute force
- Numerically integrate 4D Gaussian over all regions

- Diagonalise covariance matrix
- Rotate points into diagonalised basis
- Draw diagram
- Integrate

- Improve search timing with KD tree
- More refined initial region definition

| Points/n-D | 2 | 4 | 6 |
|------------|-----|-----|-----|
| 100 | <1 | <1 | <1 |
| 1000 | 5 | 5 | 6 |
| 10000 | 453 | 446 | 467 |

Matrix is symmetric
Original Matrix:

```
20 10 15 15
10 5 5 0
15 5 20 35
15 0 35 10
```

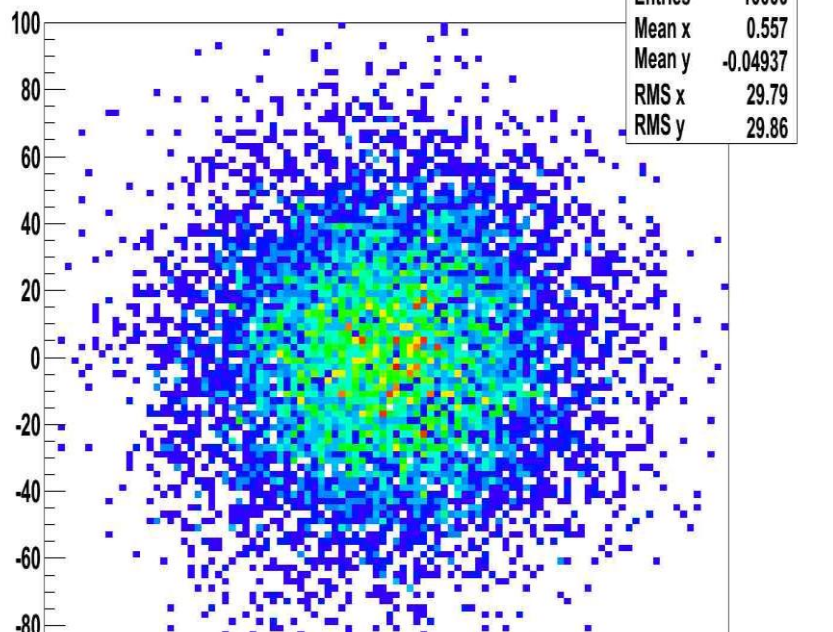
Eigenvectors:

```
-0.5544 0.7958 0.243 -0.01797
0.6827 0.5691 -0.3298 -0.3182
-0.08186 0.1533 -0.6329 0.7545
0.4689 0.1391 0.6569 0.5738
```

Diagonalised:

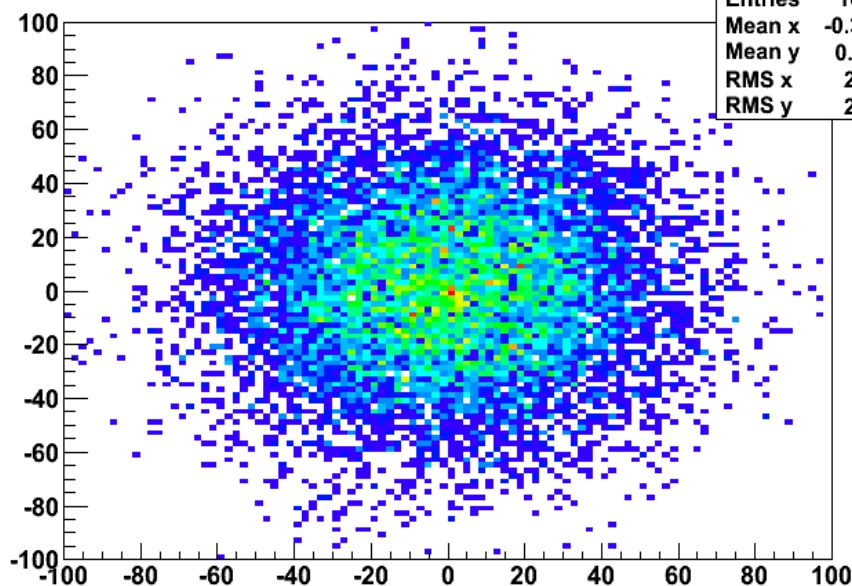
```
-0.4405 2.393e-07 4.054e-07 -7.477e-07
6.093e-07 14.1 -5.254e-07 -7.782e-07
-3.803e-07 8.492e-07 -20.99 -1.324e-06
-1.94e-08 -5.527e-07 -2.064e-06 62.33
```

xy



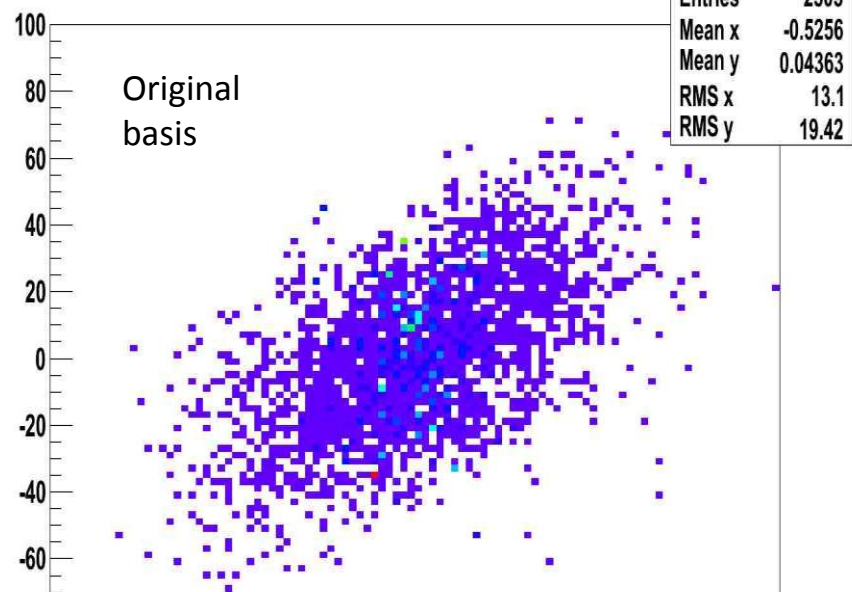
| xy | |
|---------|----------|
| Entries | 10000 |
| Mean x | 0.557 |
| Mean y | -0.04937 |
| RMS x | 29.79 |
| RMS y | 29.86 |

xy



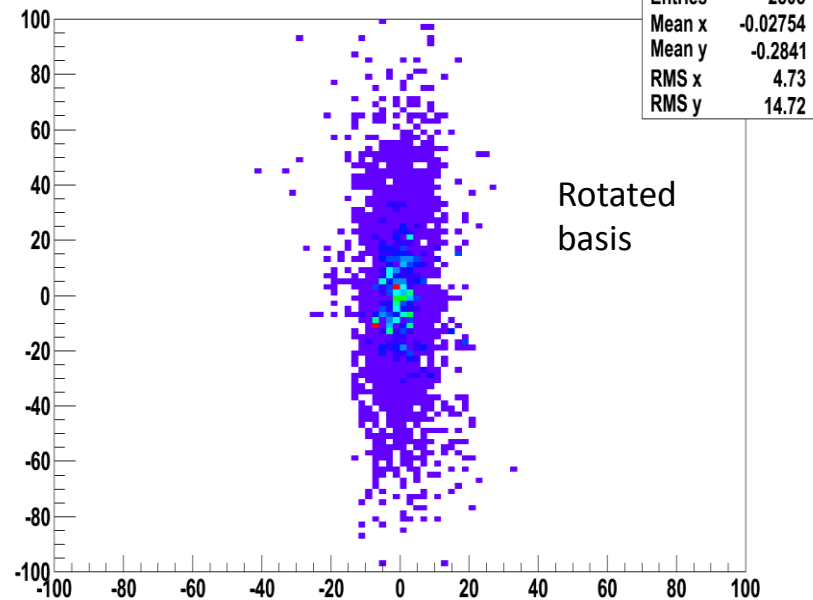
| xy | |
|---------|---------|
| Entries | 10000 |
| Mean x | -0.3278 |
| Mean y | 0.3581 |
| RMS x | 29.76 |
| RMS y | 29.99 |

xyw



| xyw | |
|---------|---------|
| Entries | 2505 |
| Mean x | -0.5256 |
| Mean y | 0.04363 |
| RMS x | 13.1 |
| RMS y | 19.42 |

xyw



| xyw | |
|---------|----------|
| Entries | 2505 |
| Mean x | -0.02754 |
| Mean y | -0.2841 |
| RMS x | 4.73 |
| RMS y | 14.72 |

Summary/Plans

- Even if not (4D)viable-needed-palatable, there is a case for selecting for RF
- Integration to multivariate still not satisfactory –
poor variance and covariance, large number of zero weights
- Need to check rotations, verify with numerical integration, scaling of weights
- Make it work.. (+tidy, +comment, +commit)
- Full Voronoi + Numerical integration
- Mismatched beam tests
- Phase space co-ordinates from recent data taking