Measurement

- Two independent units: SN09 and SN36
- Four measurement in total, exchanging direction East/West.
- Now come the nitty gritty details...

Error Calculation

Error on rate

- Measure number of events N in time t
  $\Rightarrow$ rate $r \equiv N/t$
- Error on time measurement is negligible
- Error on number of events is likely Poisson $1/\sqrt{N}$
- Total error on rate is $\sigma(r) = r/\sqrt{N}$

Error Calculation

Error on rate difference

- We have two rates, one facing East, one facing West
- Total error on rate difference is just sum-of-squares of individual errors

$$\Delta r \equiv r_E - r_W$$

$$\sigma(\Delta r) = \sqrt{\sigma(r_E)^2 + \sigma(r_W)^2}$$

Error Calculation

Define East-West asymmetry A as

$$2\frac{r_E - r_W}{r_E + r_W} \equiv \frac{\Delta r}{< r >}$$

- Since Δr is small, this dominates the error
- Neglect error on average rate (of order 1%)

Then

$$\begin{aligned}\sigma(A) &\approx \sigma(\Delta r)/ < r > \\ &= \sqrt{\sigma(r_E)^2 + \sigma(r_W)^2}\end{aligned}$$

Results

Run	Duration [s]	SN09 facing	counts SN09	counts SN36
1	2hr00m	E	1672	1448
2	0h55m	W	759	675
3	2h40m	W	2412	2312
4	1h29m	E	1284	1257

Total measurement time: about 7 hrs
Total facing E: $1672 + 675 + 2312 + 1284 = 5943$
Total facing W: $1448 + 759 + 2412 + 1257 = 5876$
$r_E = 0.2336 \pm 0.003$ Hz
$r_W = 0.2309 \pm 0.003$ Hz

Results

$r_E = 0.2336 \pm 0.003$ Hz
$r_W = 0.2309 \pm 0.003$ Hz
$\Delta r = 2.6$ mHz ± 4.2 mHz

So, for the final result:

$$A = 0.011 \pm 0.018$$

Too bad :(

Bonus: correcting for background rate

- We assumed that we were measuring only signal
- Background coincidence rate r_0
  e.g. random coincidences, coincidences from extended showers

$$
\begin{aligned}
A_{\text{true}} &= \frac{(r_E - r_0) - (r_W - r_0)}{(r_E - r_0) + (r_W - r_0)} \\
&= \frac{r_E - r_W}{r_E + r_W - 2r_0)} \\
&= \frac{r_E + r_W}{r_E + r_W - 2r_0} \times A_{\text{measured}}
\end{aligned}
$$

Our r_0 is about 0.067 Hz (from calibration measurement) and
$r_E \approx r_W = 0.21$ Hz.
$\Rightarrow$ Correction factor of about 1.5 (still not significant)