

About the error calculation of the parameters in PC fits for SNS 2020 data

YK and CR

In the fit of the 6 calibration points of PC attenuated rates the MINUIT (in HBOOK), PHYTON, and C++ Libraries

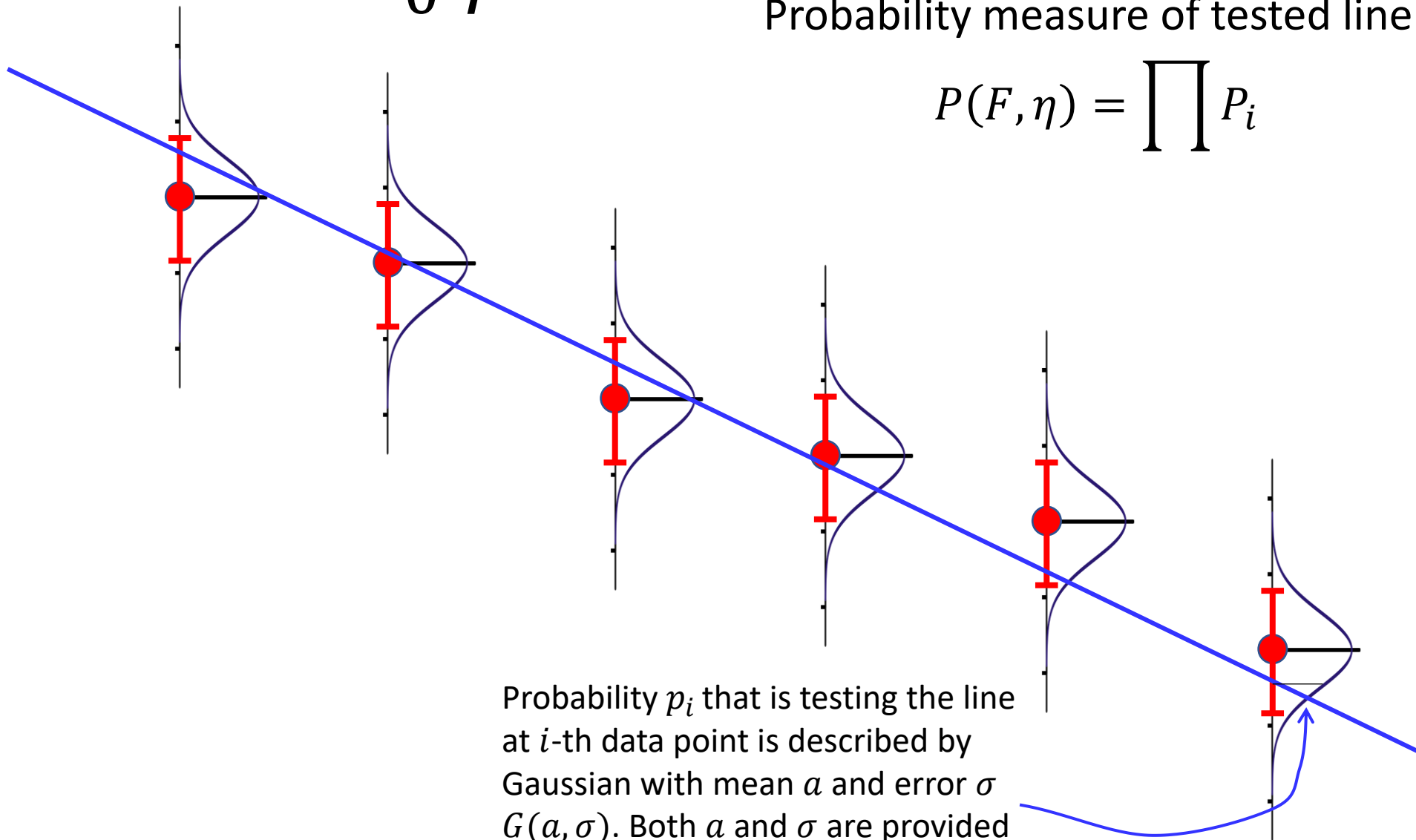
- For the fit function $f = F_0 \cdot \eta^n$, $n = 18, \dots, 24$
- Find the same χ^2 minimum in terms of parameters F_0 and η
- Have similar value of χ^2 at the minimum (C++ ?)
- **But** providing different estimates of the parameter errors

Let's use for the fit and for the error estimate a different procedure (similar to maximum likelihood) based on the measure of probability of the parameter of interest (in our case F_0) independent on the mentioned library procedures.

Line of function $F_0\eta^n$

Probability measure of tested line

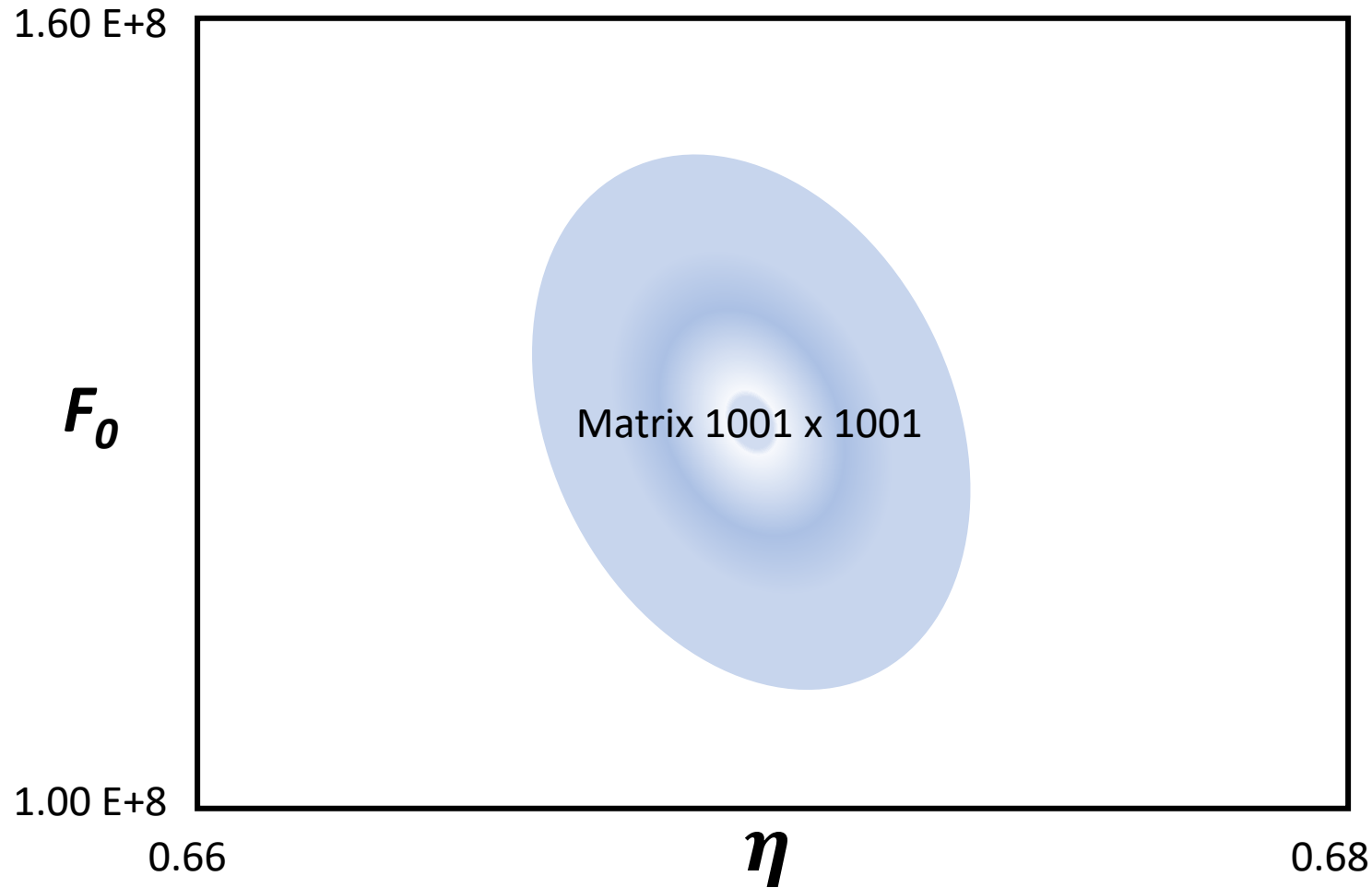
$$P(F, \eta) = \prod P_i$$



Probability p_i that is testing the line at i -th data point is described by Gaussian with mean a and error σ $G(a, \sigma)$. Both a and σ are provided by the measurement.

Field of tested parameters

(for simulation set)

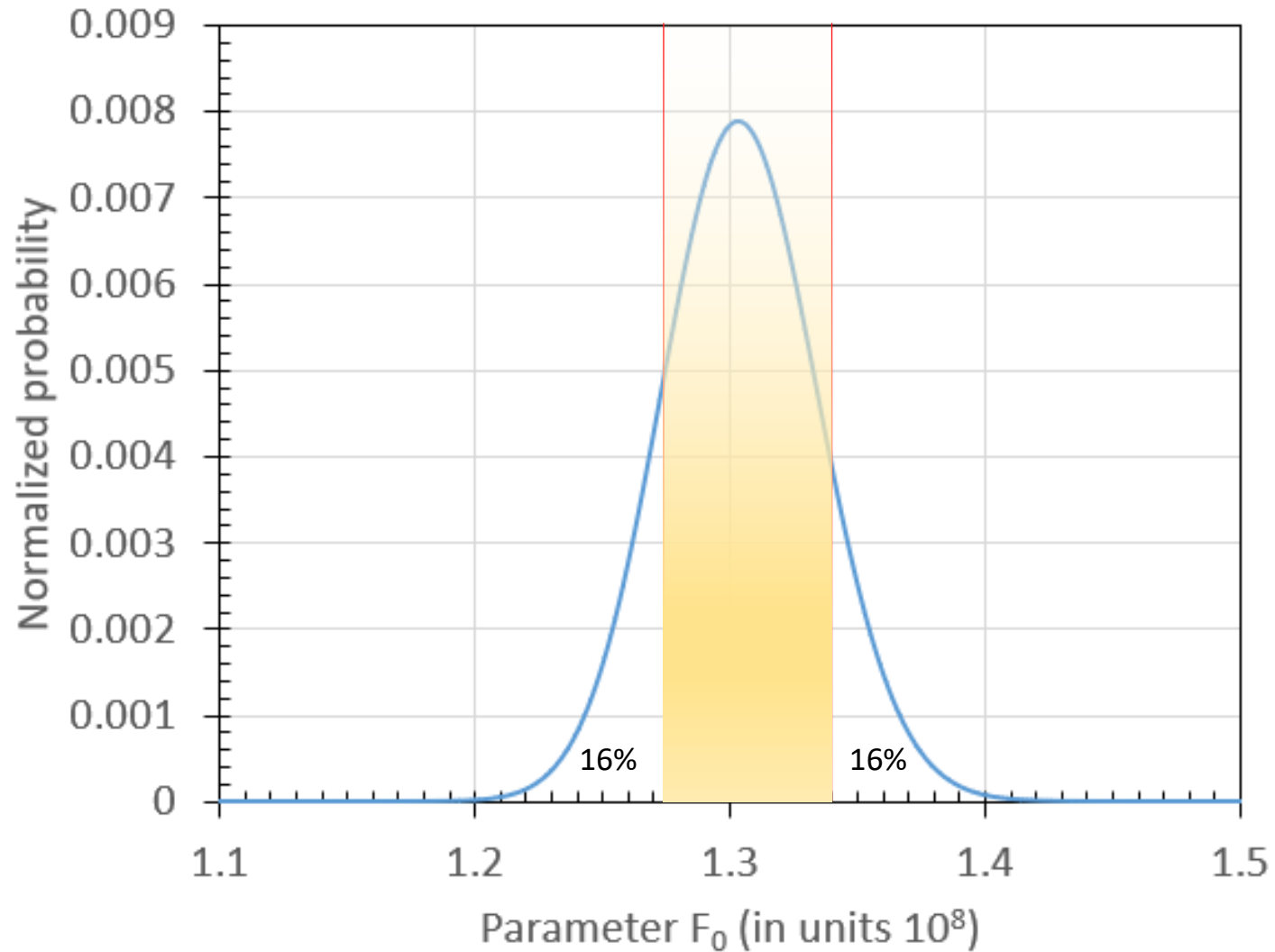


Projection on F_0 axis
(sum of probabilities)
gives the probability
(after renormalization)
of parameter F_0 realization
in the measurements
of 6-PC-points with given
errors (independent of η)

Min χ^2 has the same values of parameters as the max of probability

Simulation with 2020 pinhole

68% confidence interval for F_0 : $(1.2742-1.3408) \times 10^8$ or $F_0 = 1.308 \pm 0.033$



Simulated input data used

Simulation with pinhole 2020,
room temp., Cary's PHITS,
h-luci, with TOF cuts, 1E9 stat

$$\sigma = \sqrt{a}$$

<i>i</i>	<i>n</i>	<i>a</i>	σ
1	18	109232	330.503
2	19	73706	271.488
3	20	49692	222.917
4	21	33452	182.899
5	22	22637	150.456
6	24	10327	101.622

Comparison of the results

	Method	F_0	Error F_0	η	Error η	χ^2
Fit	MINUIT(HBOOK)	1.303246E+08	3.037438E+06	0.674635	0.000807	0.078924
Curve Fit	Python	1.303300E+08	8.500000E+05	0.6746	0.0002	0.078924
Fit TF1	ROOT	1.308700E+08	6.900000E+05	0.6745	0.0002	7837.67 ?
Likelihood	New treatment	1.303248E+08	3.76E+06 -2.90E+06	0.674635		0.0789205
or symmetrically $(1.308 \pm 0.033) \times 1.E+8$						
or 68% confidence interval $(1.2742-1.3408) \times 10^8$						

- Two possible reasons why errors are ~10% higher in the likelihood than in MINUIT

Cary will talk next about the revision if experimental calibration data fits in connection with these results