Quenching, G2 and Charge Yield Analysis

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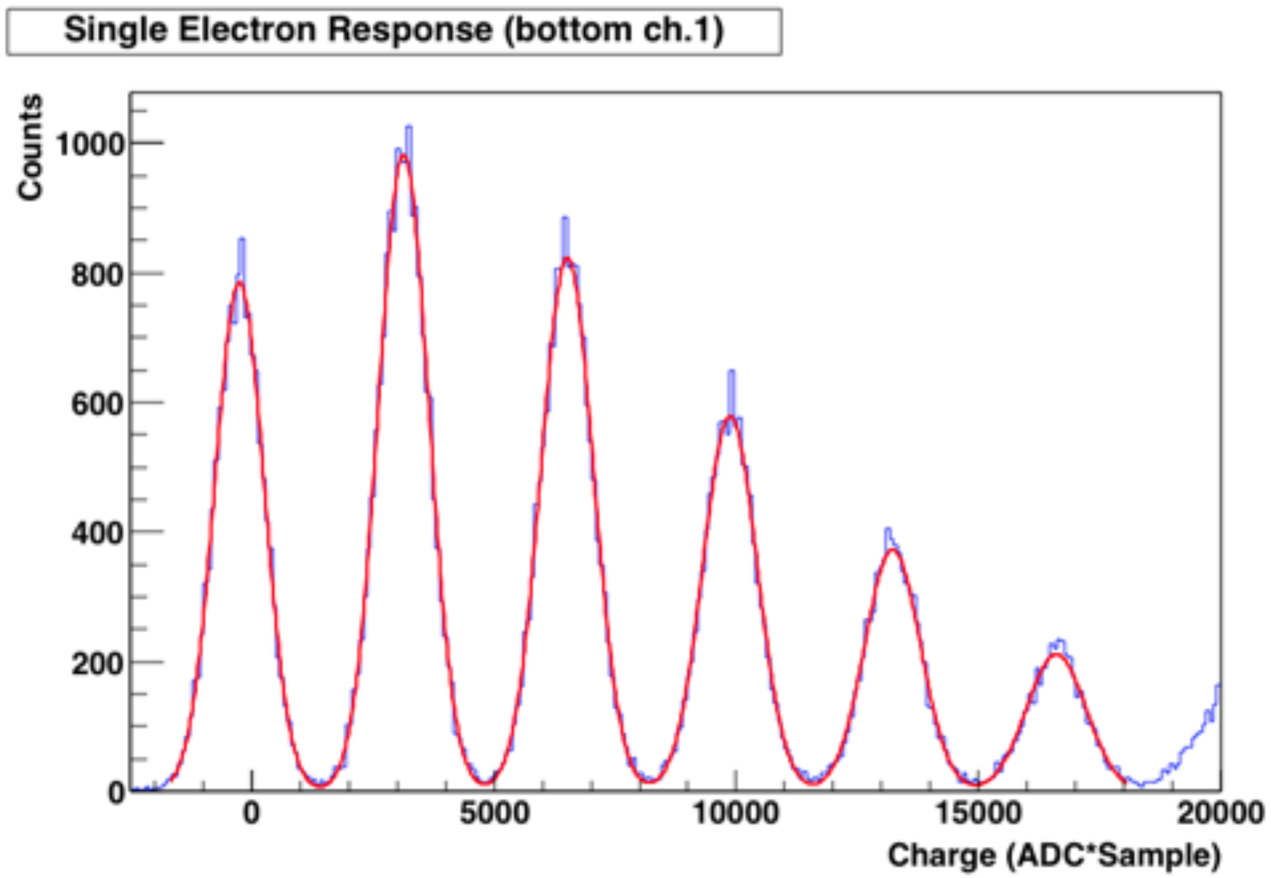
Analysis steps

- Single Electron Response curves:
    - Vinogradov analaysis;
- Single phase runs:
    - S1 vs TBA distribution:
        - S1 corrections;
    - Electric field quenching;
- Double phase runs:
    - S1 vs drift time distribution:
        - S1 corrections;
    - S2/S1 corrected vs drift time distribution:
        - S2 corrections;
    - S1 and S2 yields, vinogradov corrected (net LY);
    - Doke-like plot.

SERs and Vinogradov analysis



$$f_k(p,L) = \frac{\exp(-L)\cdot\sum_{i=0}^{k} B_{i,k}\cdot[L(1-p)]^i\cdot p^{k-i}}{k!}$$

where

$$B_{i,k} = \begin{cases} 1 & \text{if } i=0 \text{ and } k=0 \\ 0 & \text{if } i=0 \text{ and } k>0 \\ \frac{k!\cdot(k-1)!}{i!\cdot(i-1)!\cdot(k-i)!} & \text{otherwise} \end{cases}$$

$$K_{dup} = \frac{p}{1-p},$$

$$EX = L\times(1+K_{dup}),$$

$$Var(X) = L\times(1+K_{dup})\times(1+2\times K_{dup})$$

Fano Factor

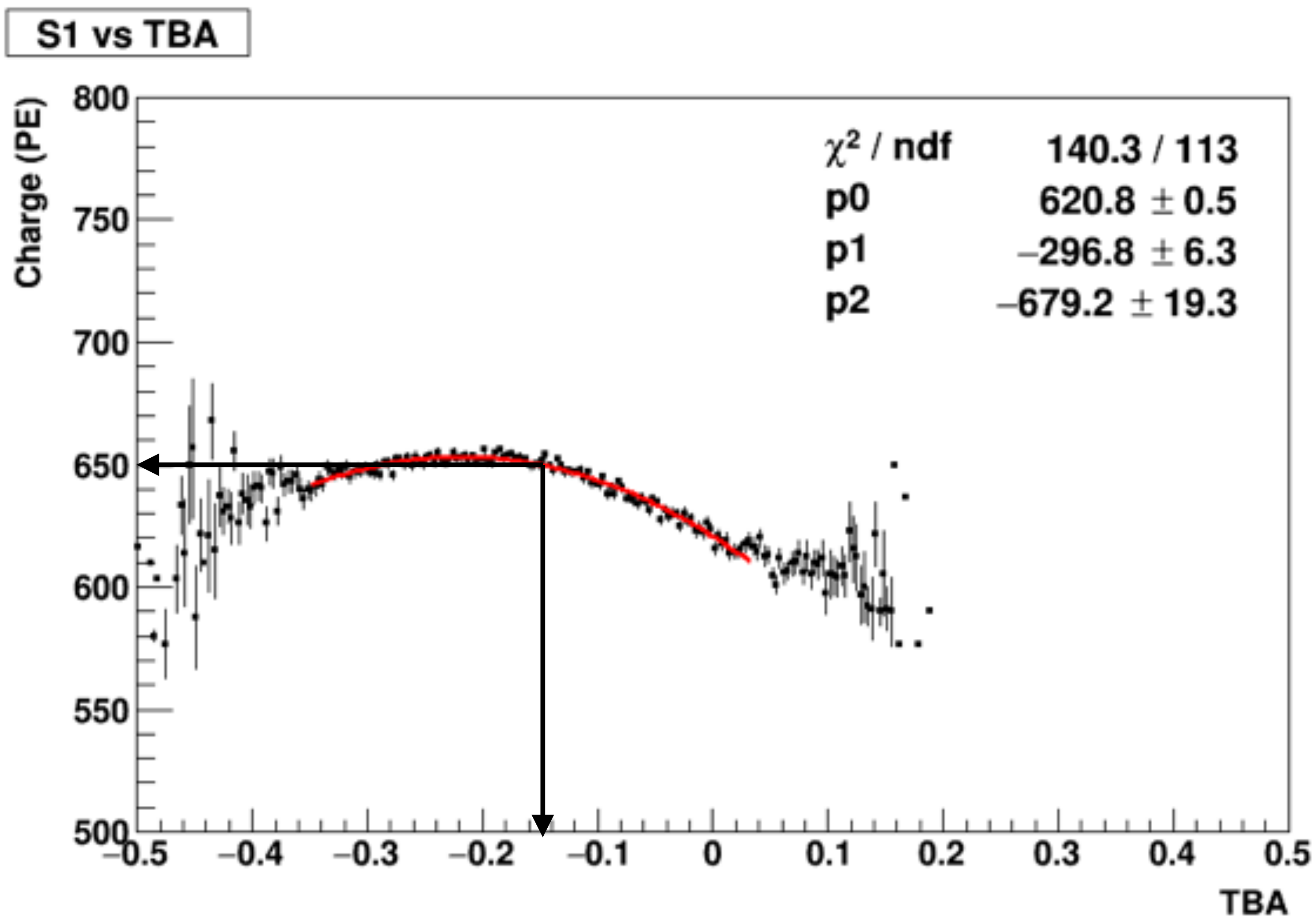
$$p = \frac{K_{dup}}{1+K_{dup}}$$

x-talks probability:
(1+Kdup) is the number of effective PE per one real PE

$$LY' = \frac{LY}{1+K_{dup}}$$

S1 studies

S1 vs TBA distribution



Cut flow:

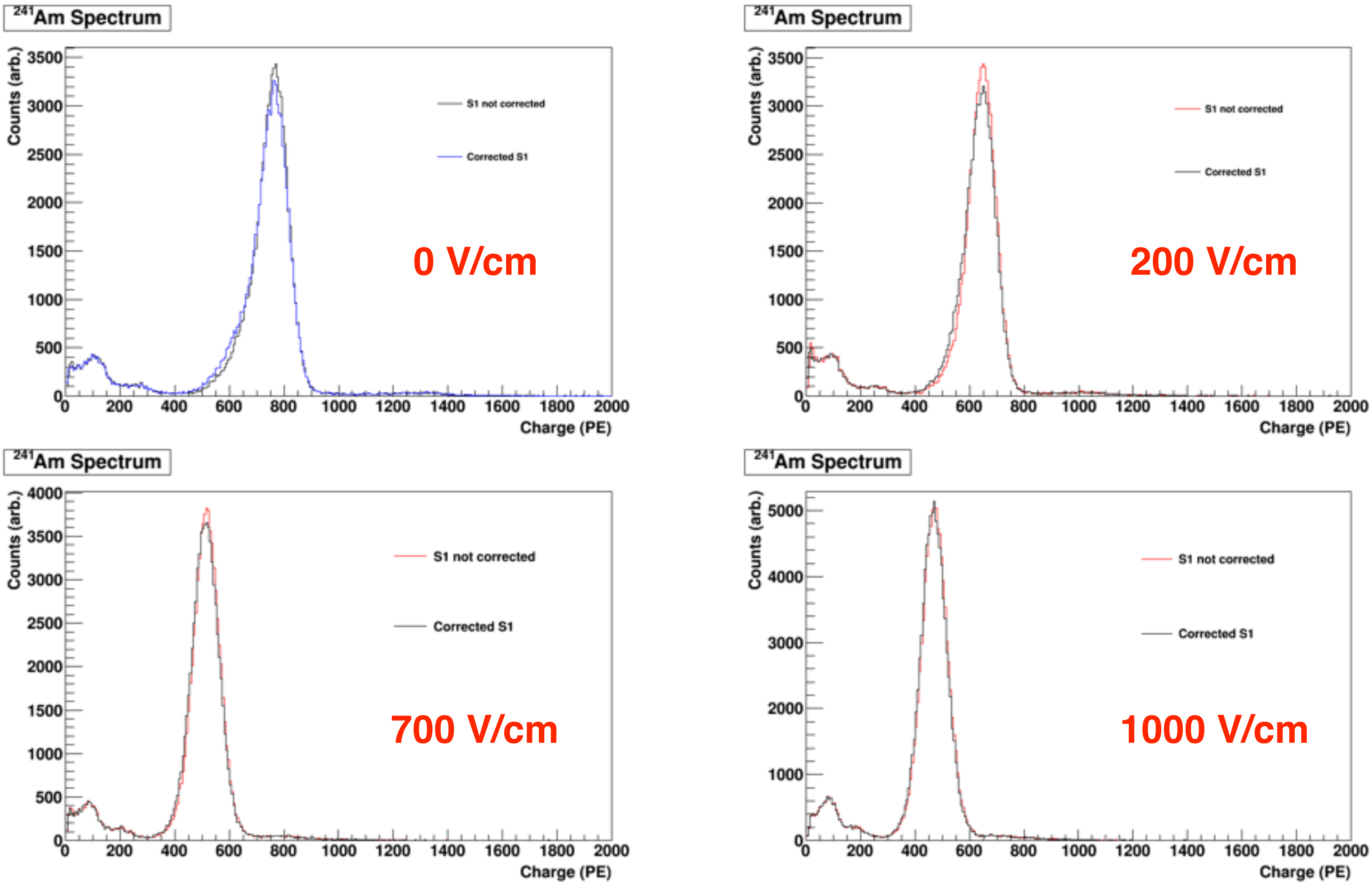
- S1>550 && S1<750;
- f90.at(0)>0.2 && f90.at(1)<0.2;
- rep.at(0)==1 && rep.at(1)==1;
- number_of_clusters==2

S1 correction:

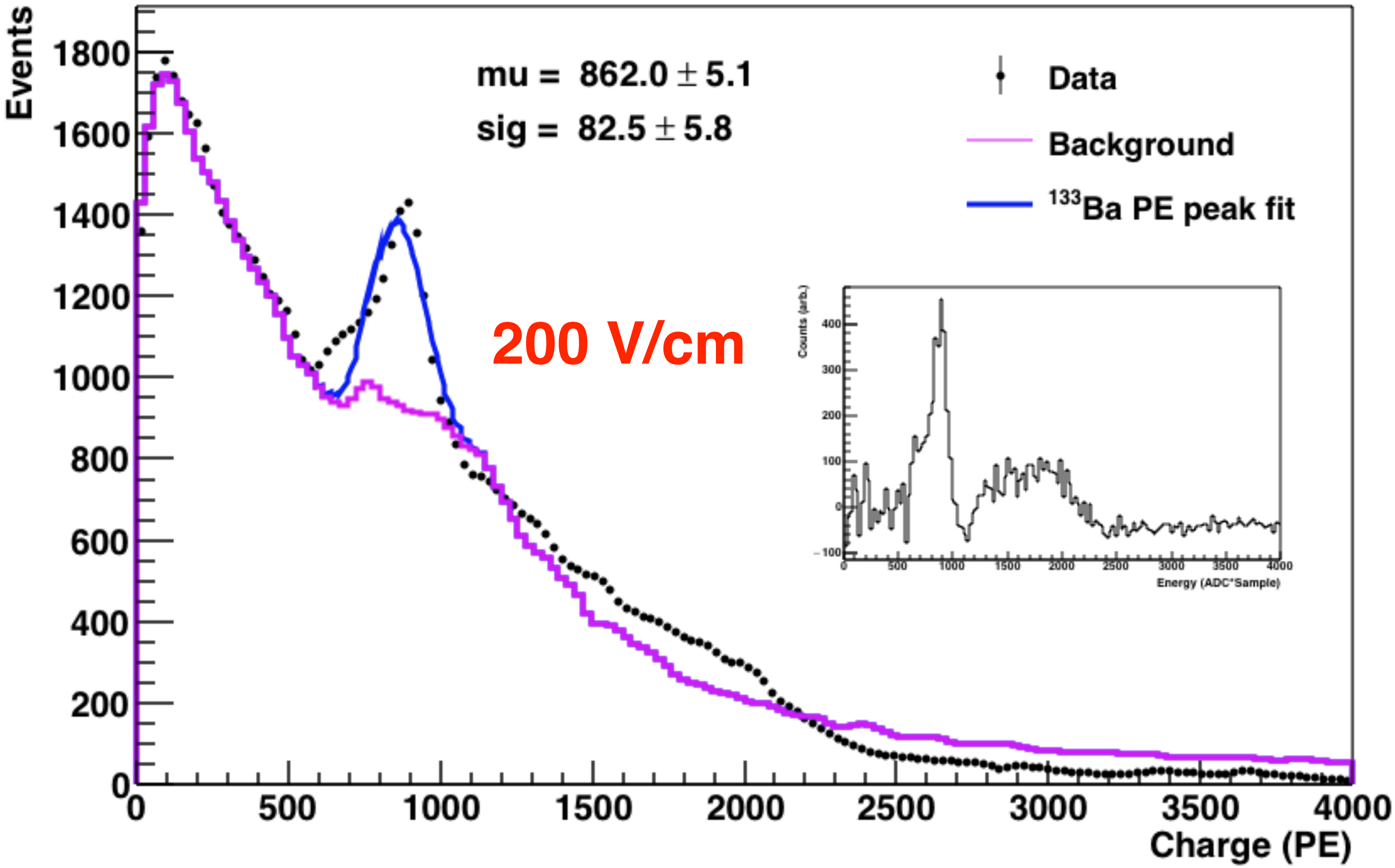
- fit with a polynomial function *f*;
- $corr_{S1} = \frac{f(tba_{1/2})}{f(tba)}$ with $tba_{1/2}$ TBA at half TPC (~ -0.15);

$$S1_{corr} = S1 \times corr_{S1}$$

S1 corrected vs not corrected



^{133}Ba runs



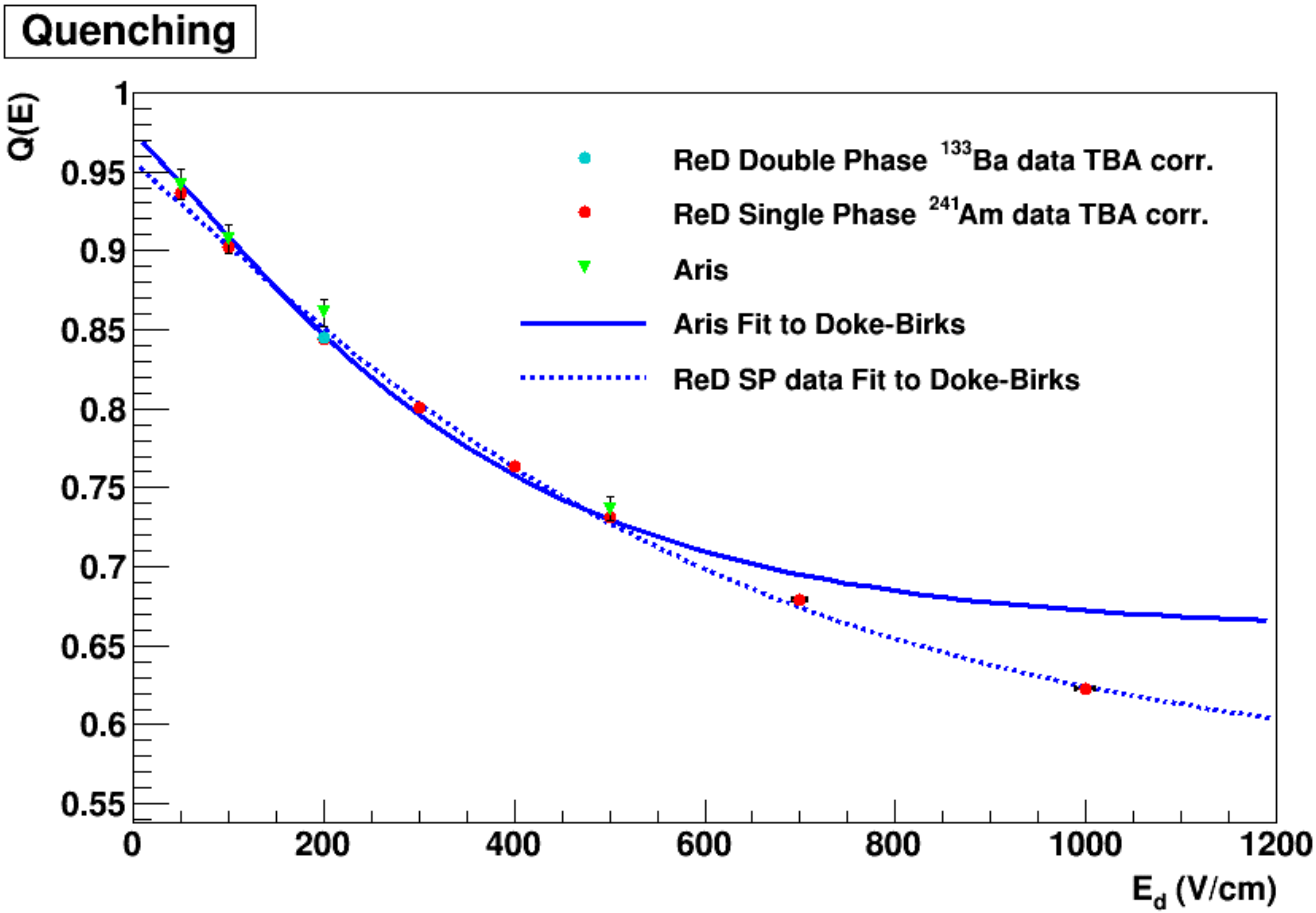
Events
1800
1600
1400
1200
1000
800
600
400
200
0
0
500
1000
1500
2000
2500
3000
3500
4000
Charge (PE)
mu = 862.0 ± 5.1
sig = 82.5 ± 5.8
Data
Background
133Ba PE peak fit
200 V/cm
Counts (arb.)
400
300
200
100
0
-100
Energy (ADC*Sample)

S1 Light Yield

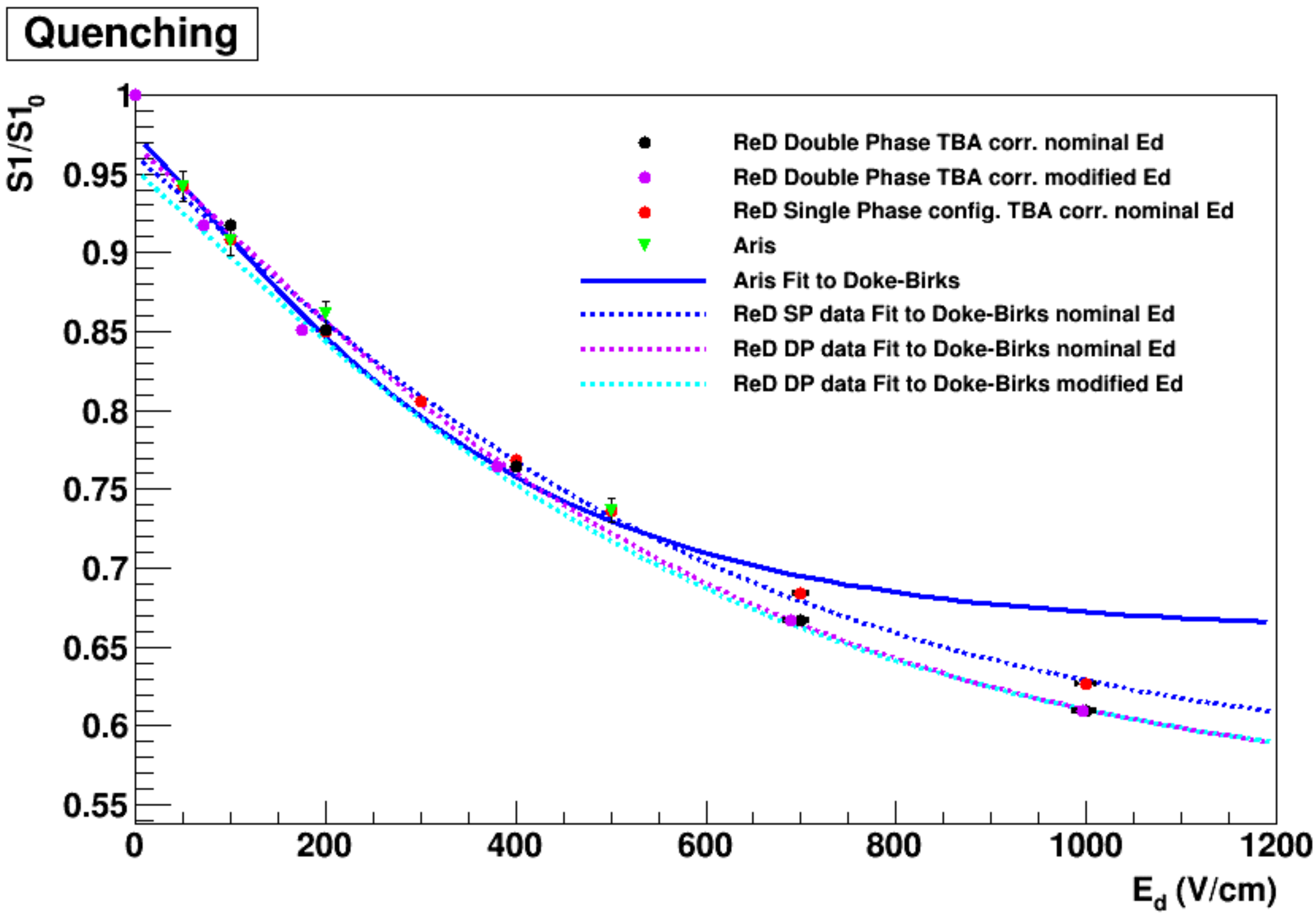
Run	Ed (V/cm)	LY Gross (PE/keV)	LY Net (PE/keV)	Quenching
1137	0	12.95(04)	9.74(04)	1
1141	50	12.13(04)	9.10(04)	0.94(05)
1144	100	11.69(03)	8.77(03)	0.90(04)
1145	200	10.93(04)	8.20(04)	0.84(04)
1148	300	10.37(04)	7.77(04)	0.80(04)
1151	400	9.89(03)	7.42(03)	0.76(04)
1152	500	9.47(03)	7.10(03)	0.73(04)
1155	700	8.79(03)	6.60(03)	0.68(04)
1156	1000	8.07(02)	6.05(02)	0.62(03)
1180*	**0**	**12.60(04)**	**9.43(04)**	**1**
1168*	**200**	**10.64(02)**	**7.91(0.2)**	**0.85(02)**

***^{133}Ba runs**

Electric field Quenching

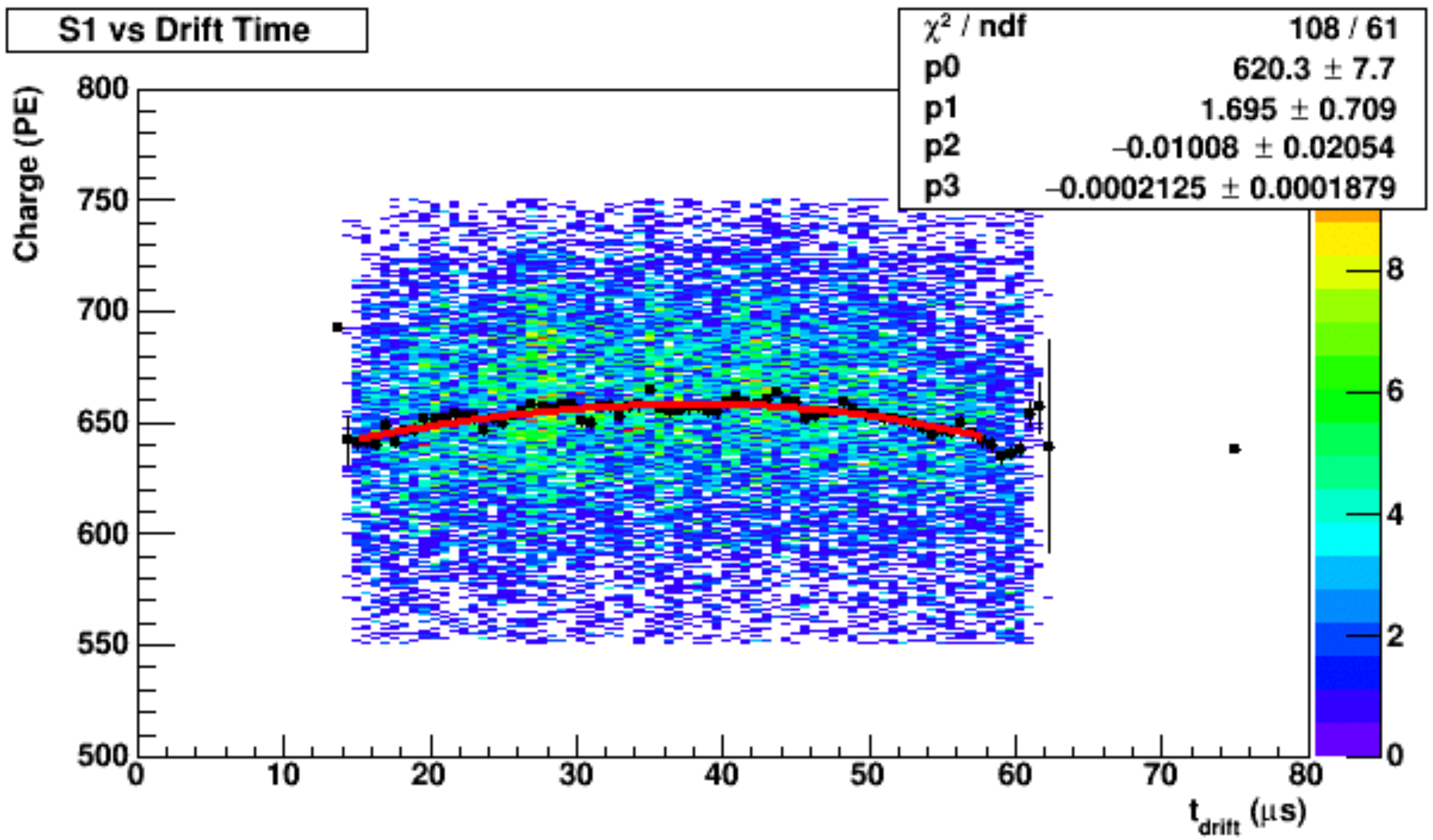


Electric field Quenching



S1+S2 studies

S1 vs drift time distribution



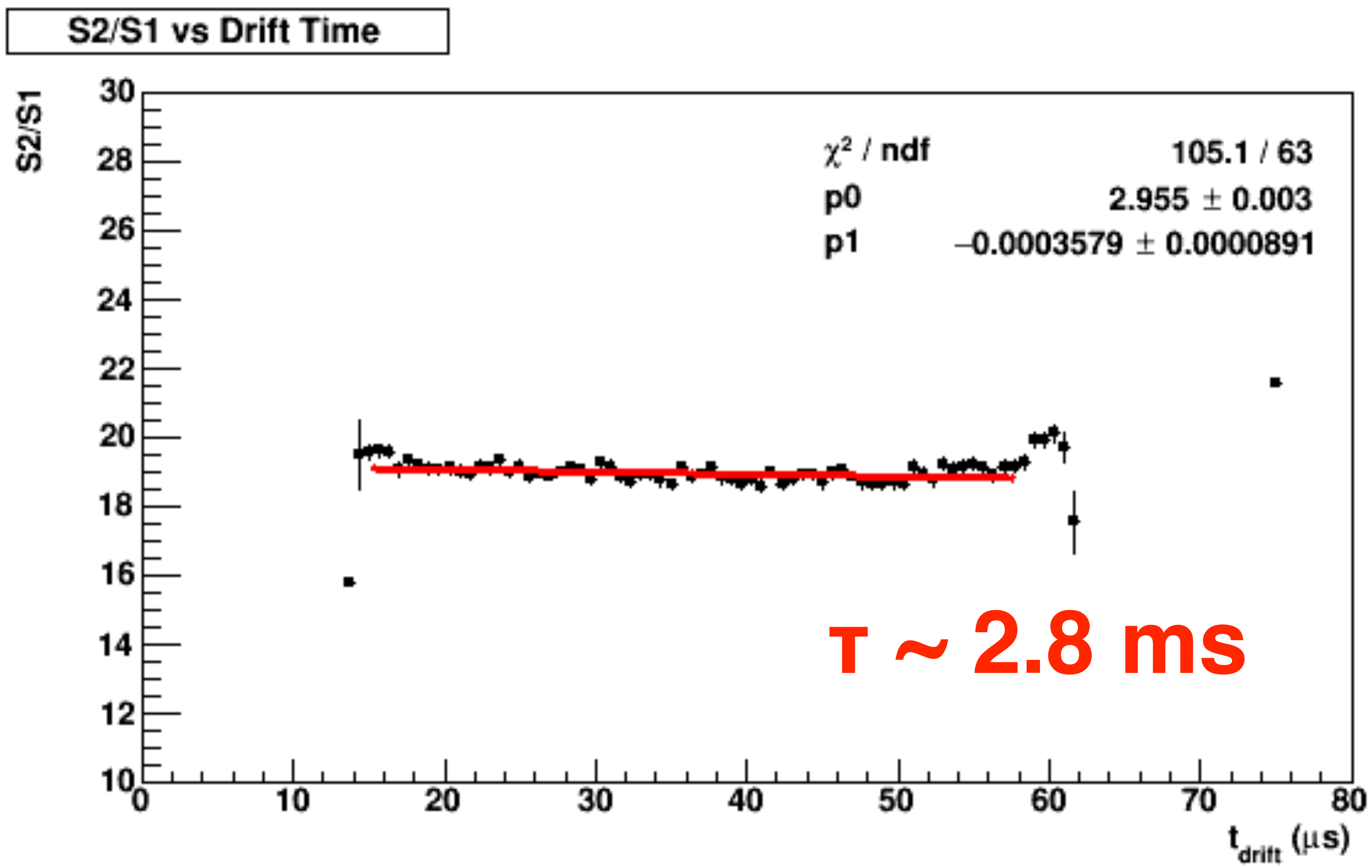
Cut flow:

- S1>530 && S1<720;
- <u>f90.at</u>(0)>0.2 && <u>f90.at</u>(1)<0.2;
- <u>rep.at</u>(0)==1 && <u>rep.at</u>(1)==1;
- number_of_clusters==2

S1 correction:

- fit with a polynomial function *f*;
- $corr_{S1} = \frac{f(t_{1/2})}{f(t_{drift})}$ with $t_{1/2}$ drift time at half tpc;
- $S1_{corr} = S1 \times corr_{S1}$

S2/S1$_{corr}$ vs drift time distribution



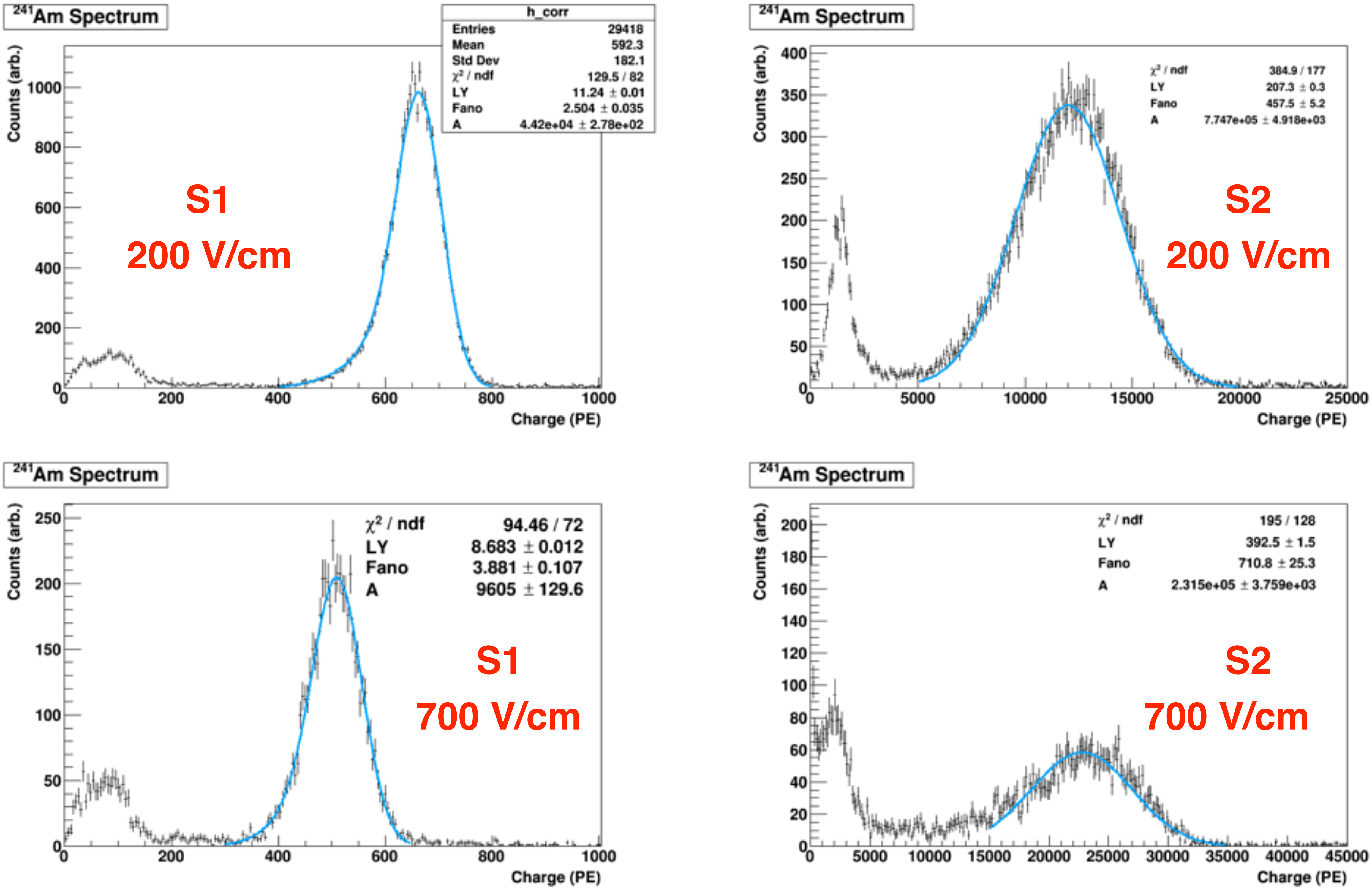
S2 correction:

- fit with an exponential function;
- $corr_{S2} = e^{-\frac{t_{drift}}{\tau}}$;
- $S2_{corr} = \dfrac{S2}{corr_{S2}}$.

Cut flow:

- S2<10000 && S2>15500;
- f90.at(0)>0.2 && f90.at(1)<0.2;
- rep.at(0)==1 && rep.at(1)==1;
- number_of_clusters==2

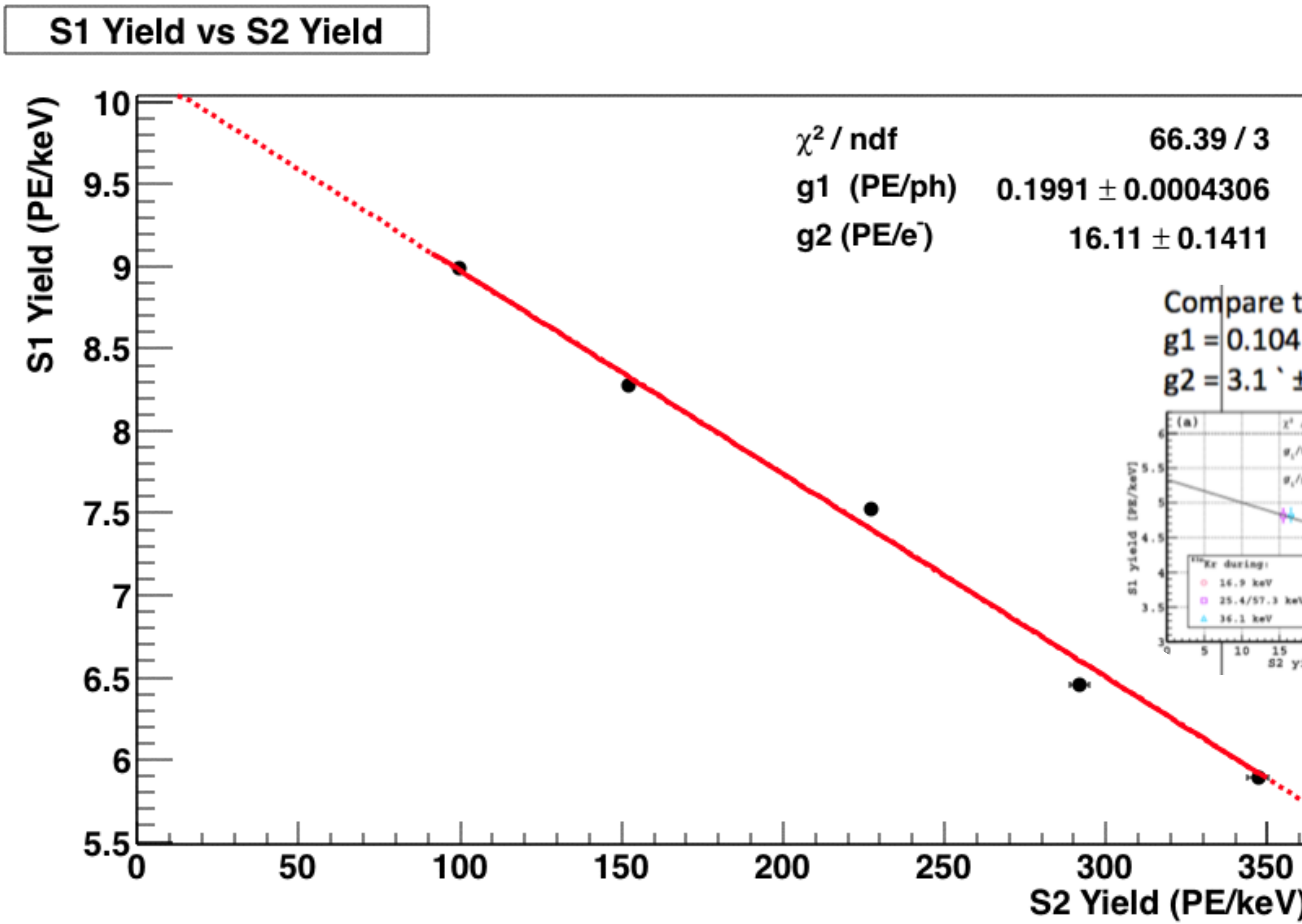
S1 and S2 corrected



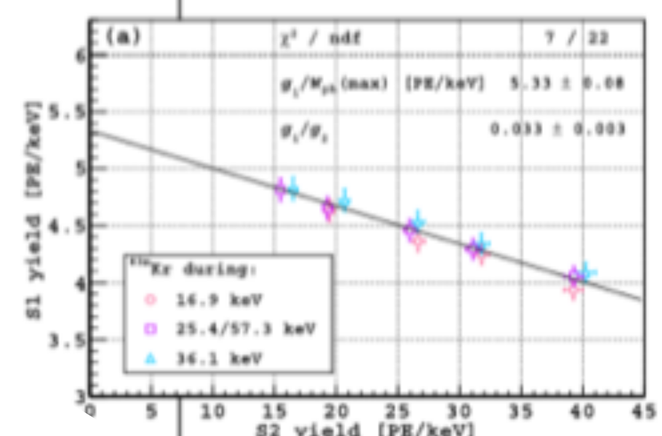
S1+S2 Light Yield

Run	Ed (V/cm)	S1 Yield Gross (PE/keV)	S1 Yield Net (PE/keV)	S2 Yield Gross (PE/keV)	S2 Yield Net (PE/keV)
1159	0	13.19(05)	9.65(05)	-	-
1164	100	12.02(06)	8.99(06)	133.42(24)	99.83(24)
1135	200	11.27(05)	8.28(05)	207.31(28)	152.35(28)
1165	400	10.06(07)	7.53(07)	303.78(62)	227.29(62)
1160	700	8.68(12)	6.45(12)	392.48(1.5)	291.72(1.5)
1161	1000	7.87(11)	5.89(11)	463.92(1.6)	347.12(1.6)

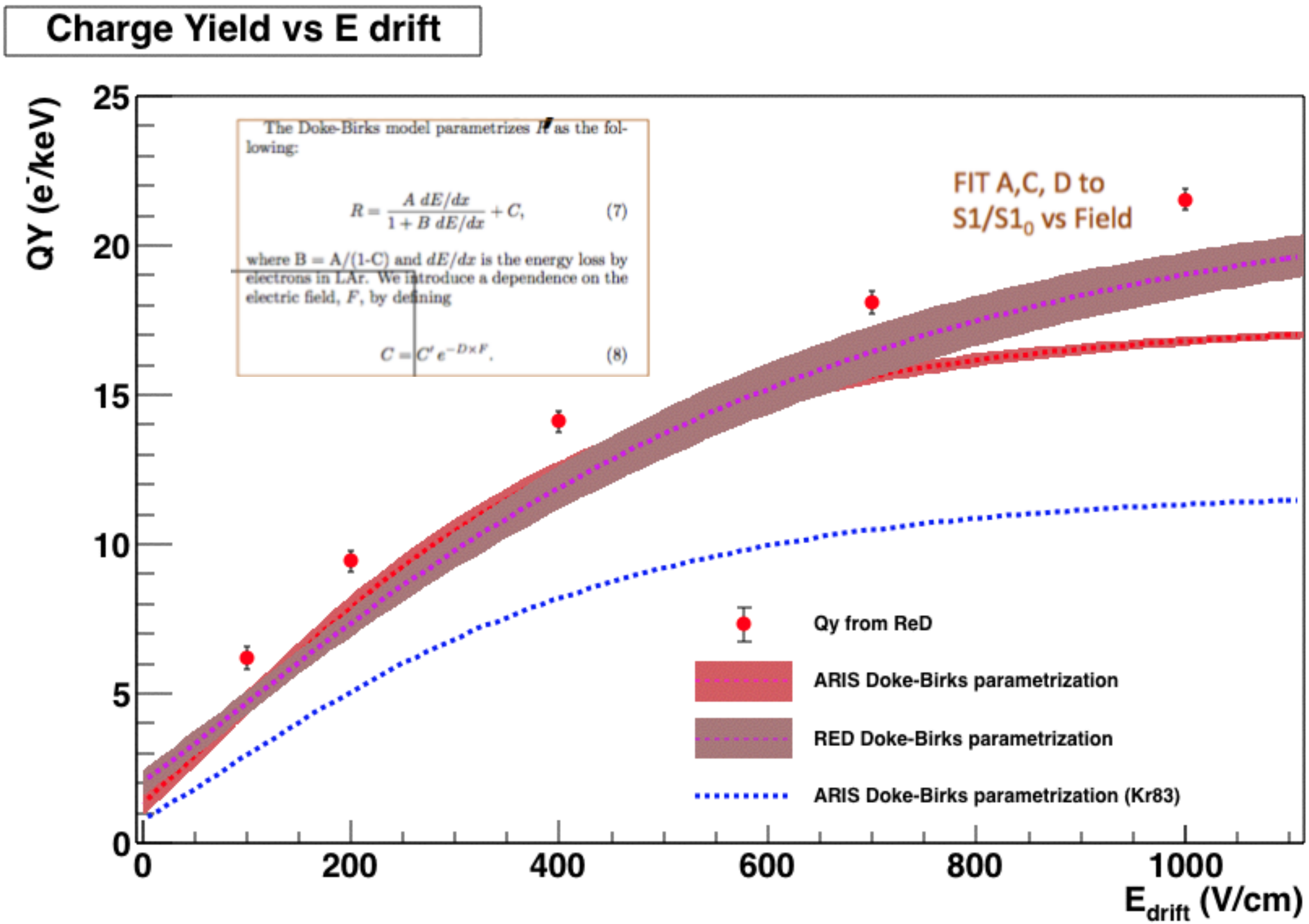
S1 vs S2



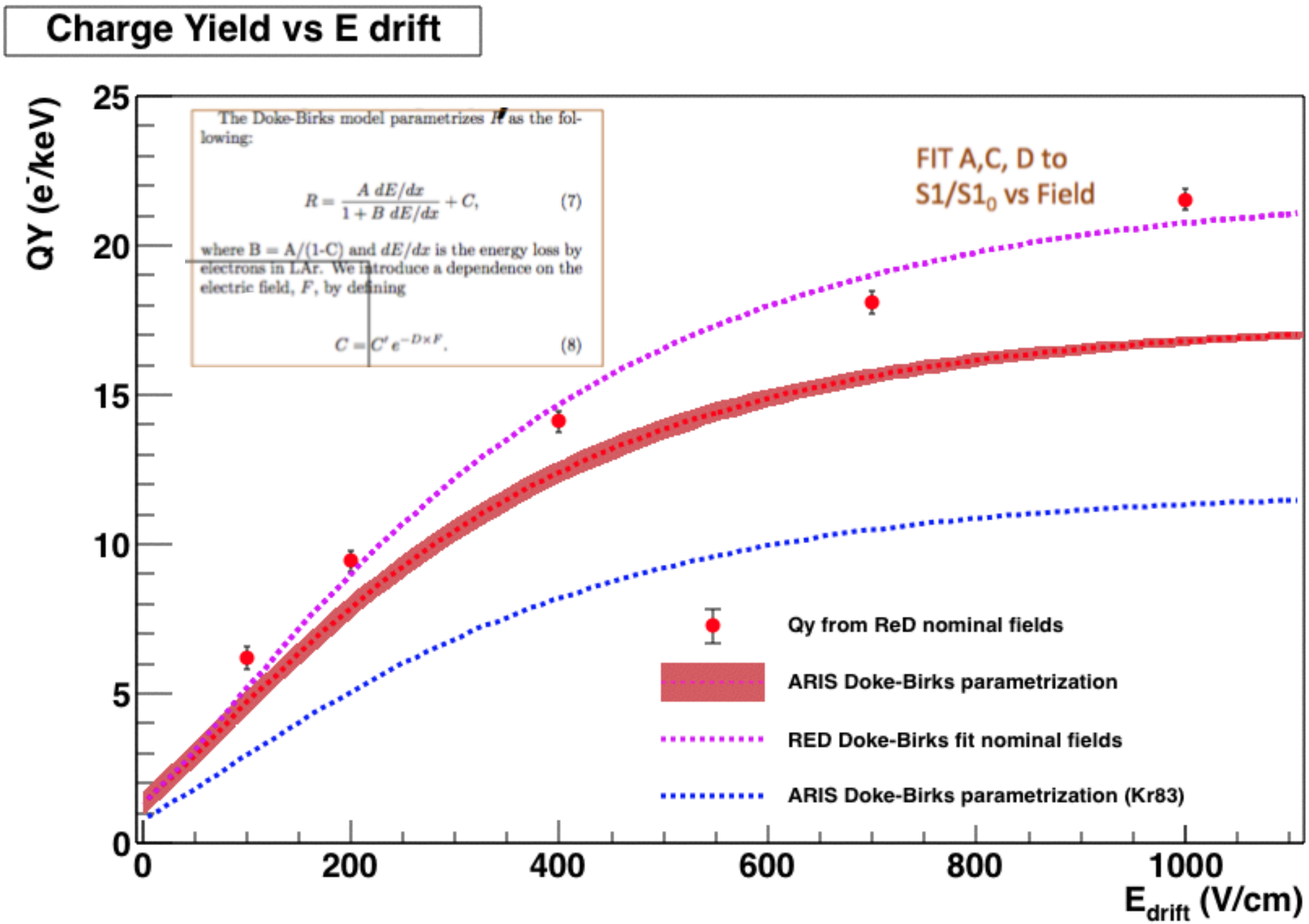
Compare to SCENE:
g1 = 0.104 ±0.006 PE/photon
g2 = 3.1 ` ±0.3 PE=e−



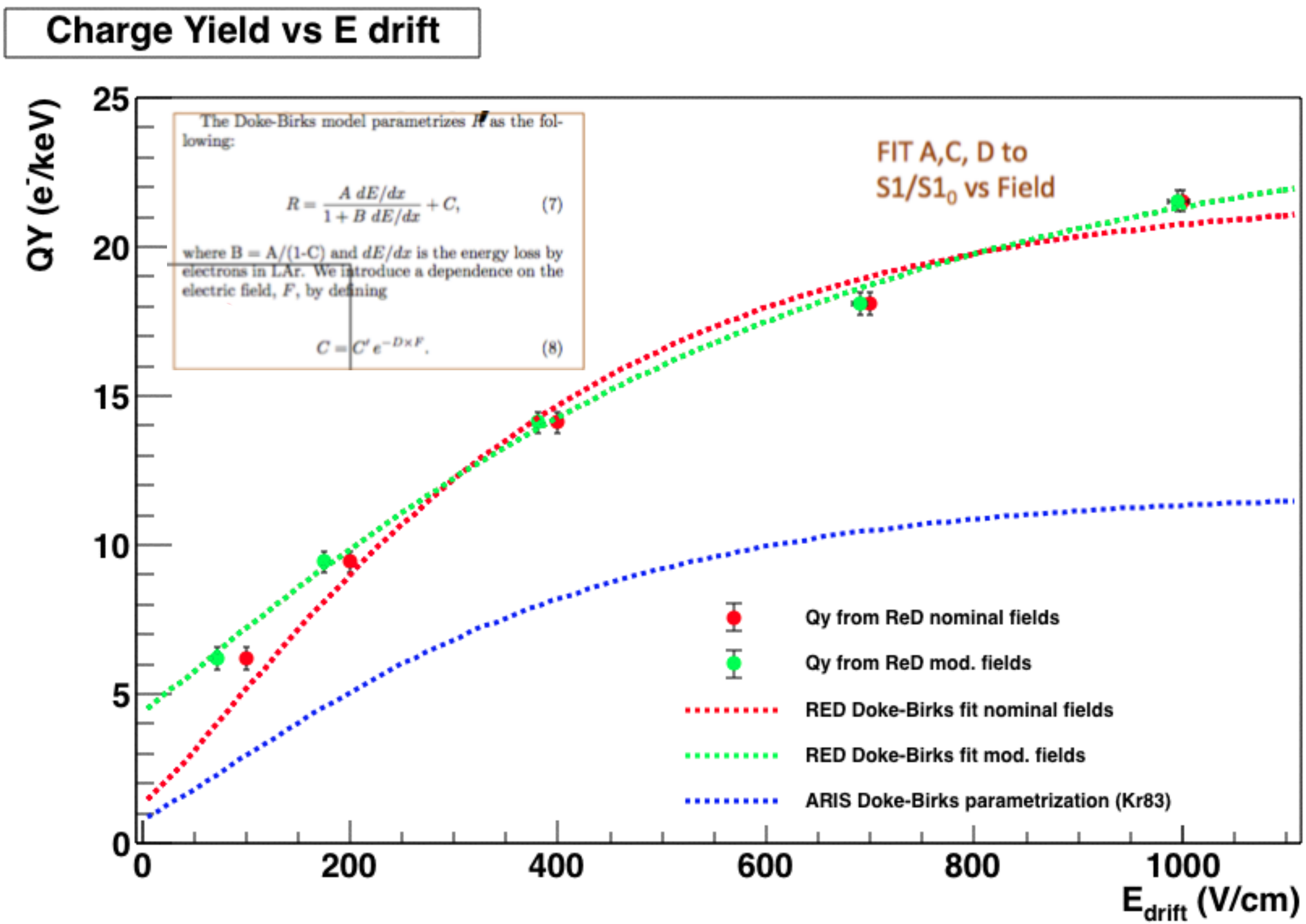
Qy with corrections



Qy with corrections



Qy with corrections

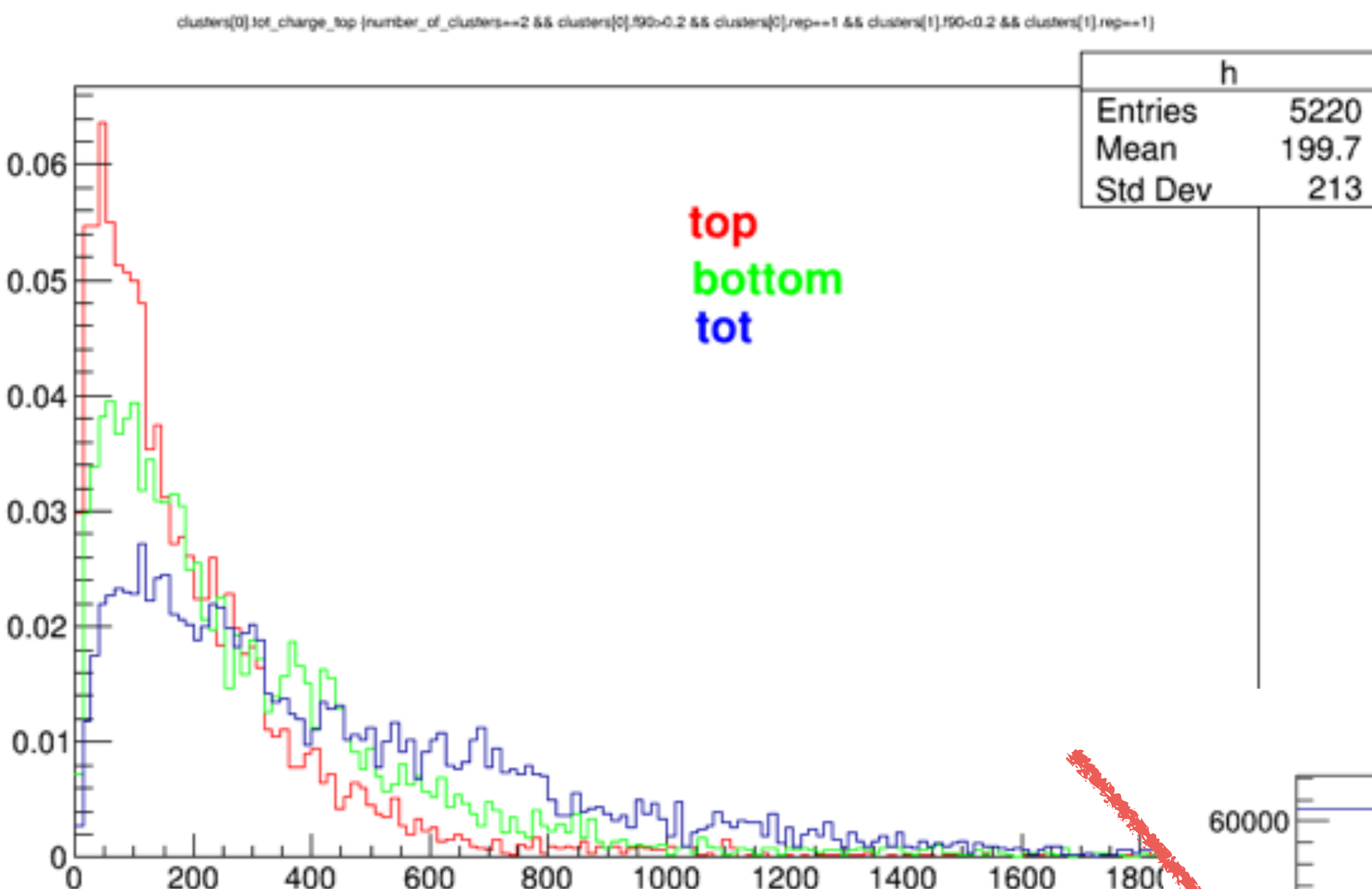


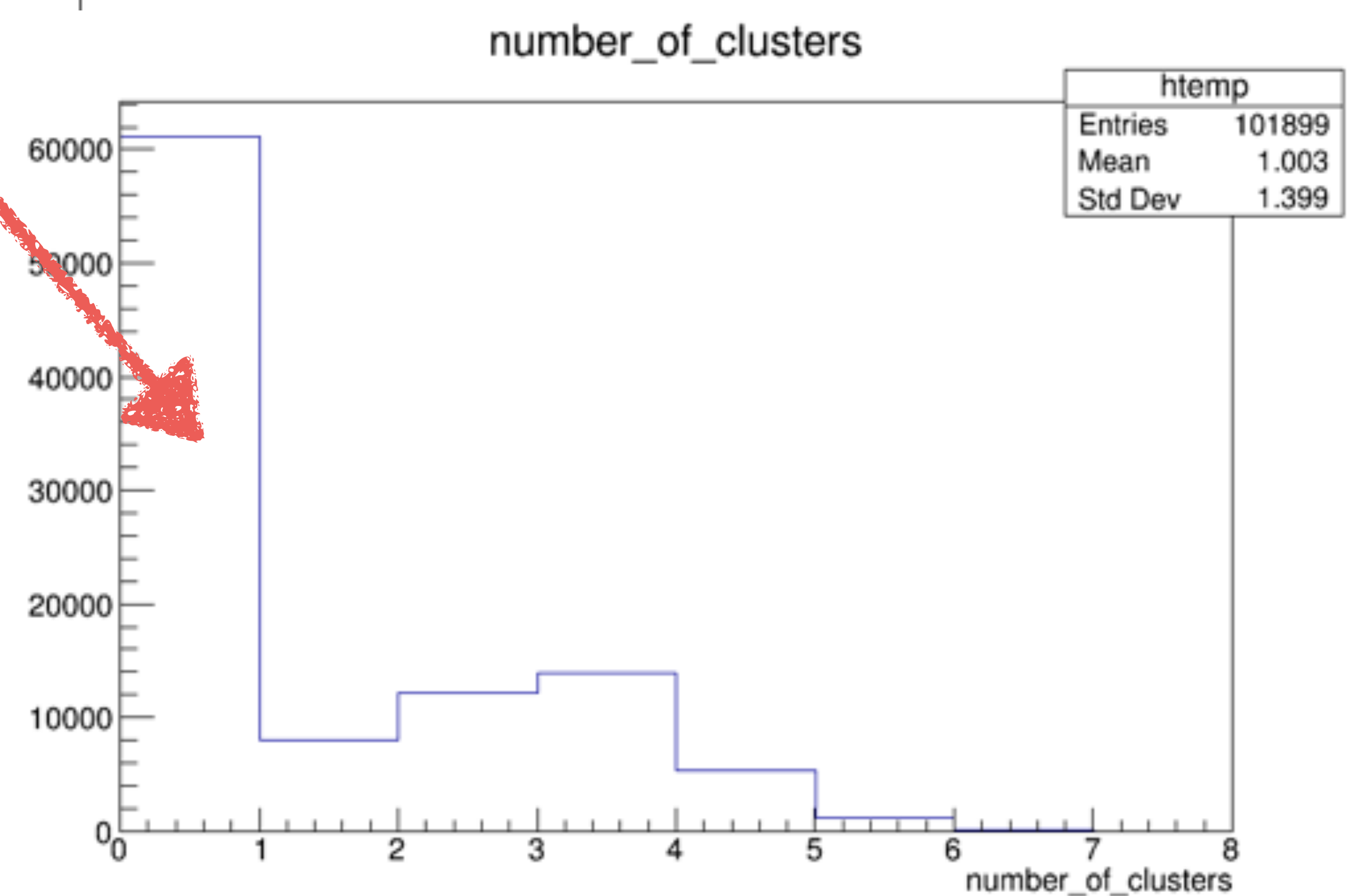
S1+S2 Light Yield + QY

Run	Ed (V/cm)	S1 Yield Gross (PE/keV)	S1 Yield Net (PE/keV)	S2 Yield Gross (PE/keV)	S2 Yield Net (PE/keV)	QY (e-/keV)
1159	0	13.19(05)	9.65(05)	-	-	-
1164	100	12.02(06)	8.99(06)	133.42(24)	99.83(24)	6.19(14)
1135	200	11.27(05)	8.28(05)	207.31(28)	152.35(28)	9.45(17)
1165	400	10.06(07)	7.53(07)	303.78(62)	227.29(62)	14.11(38)
1160	700	8.68(12)	6.45(12)	392.48(1.5)	291.72(1.5)	18.10(93)
1161	1000	7.87(11)	5.89(11)	463.92(1.6)	347.12(1.6)	21.54(0.1)

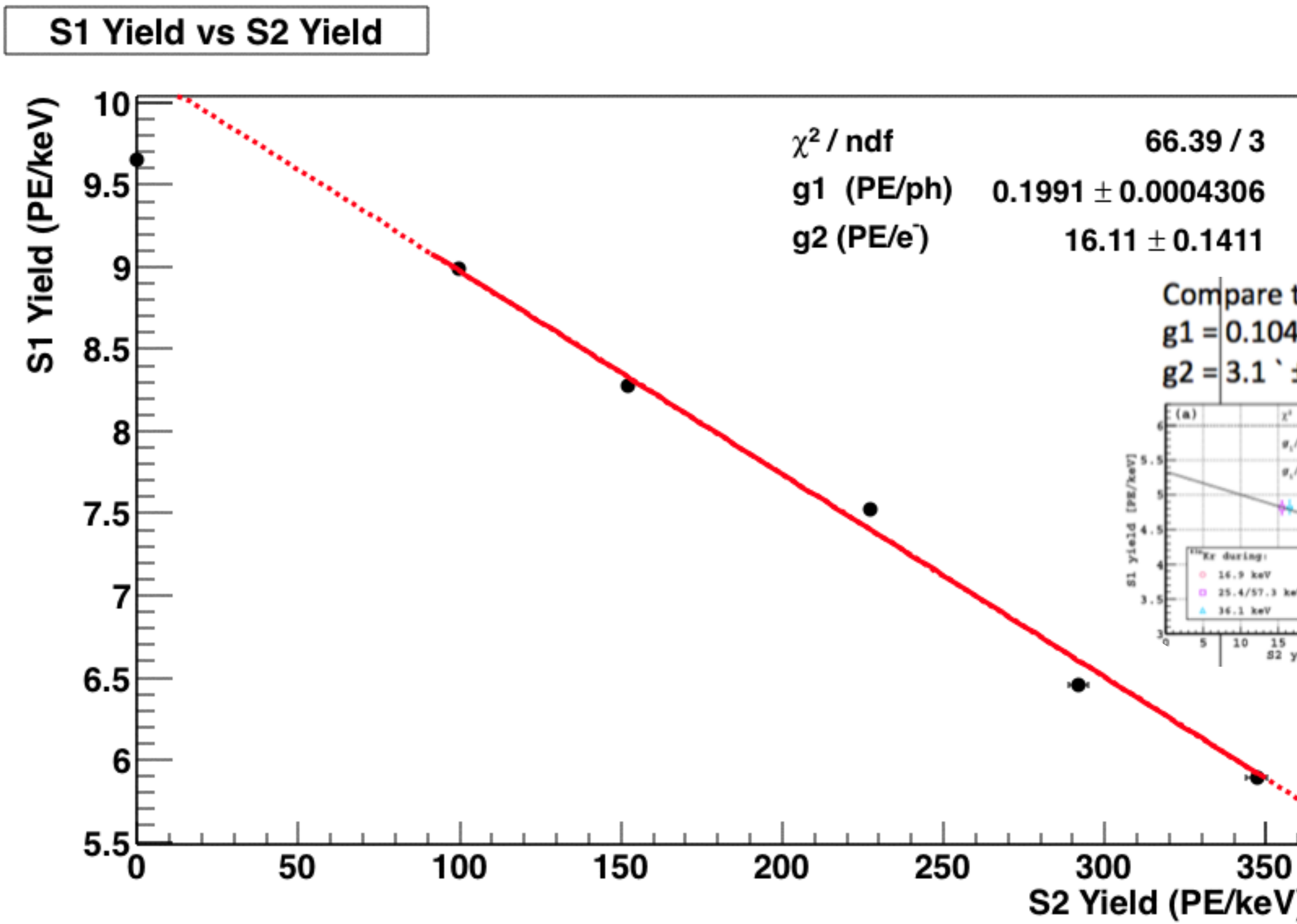
Spares

^{133}Ba runs @ 700 V/cm

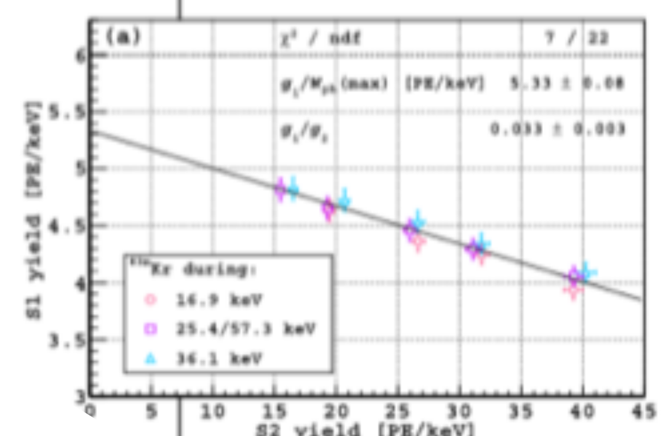




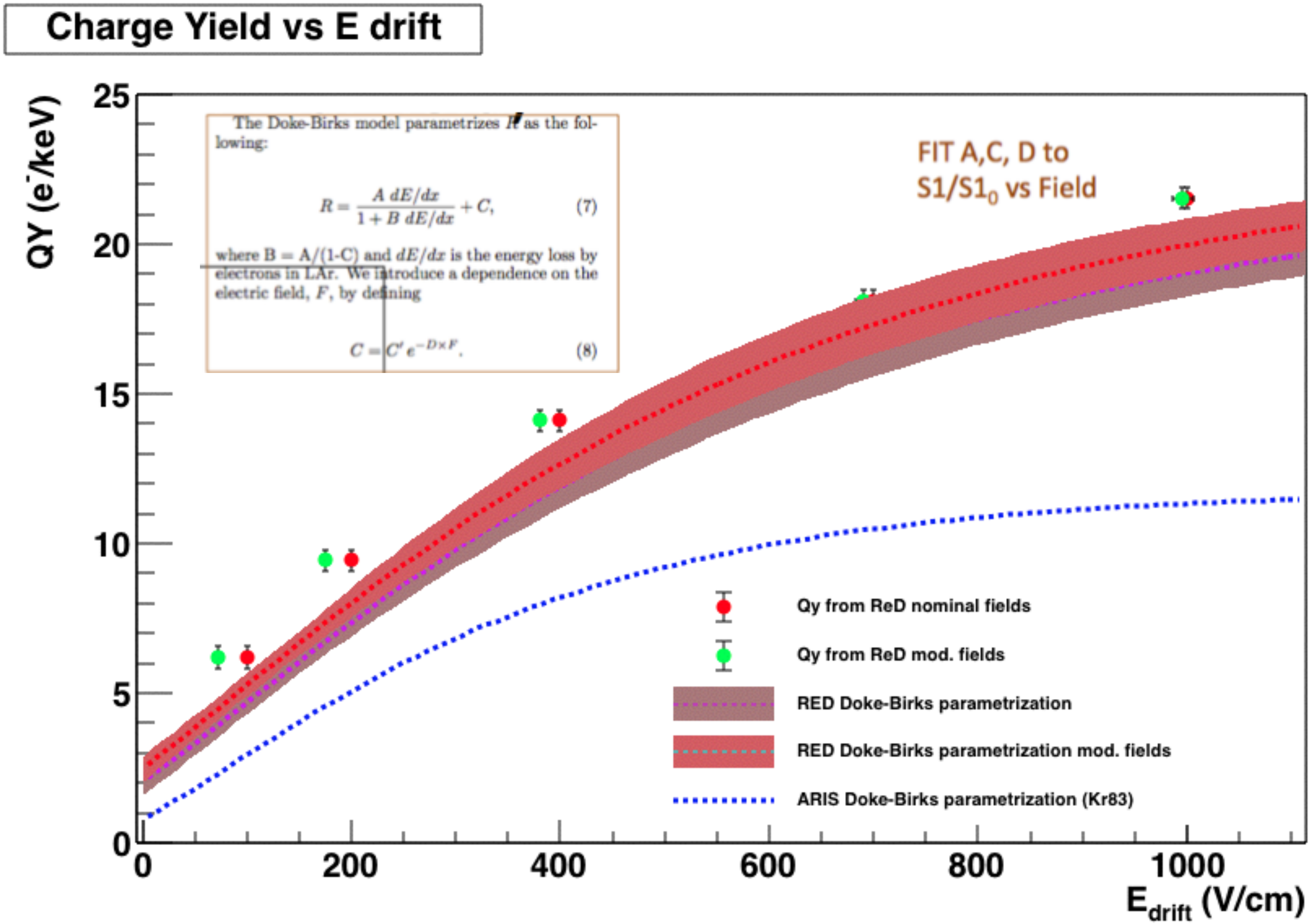
S1 vs S2



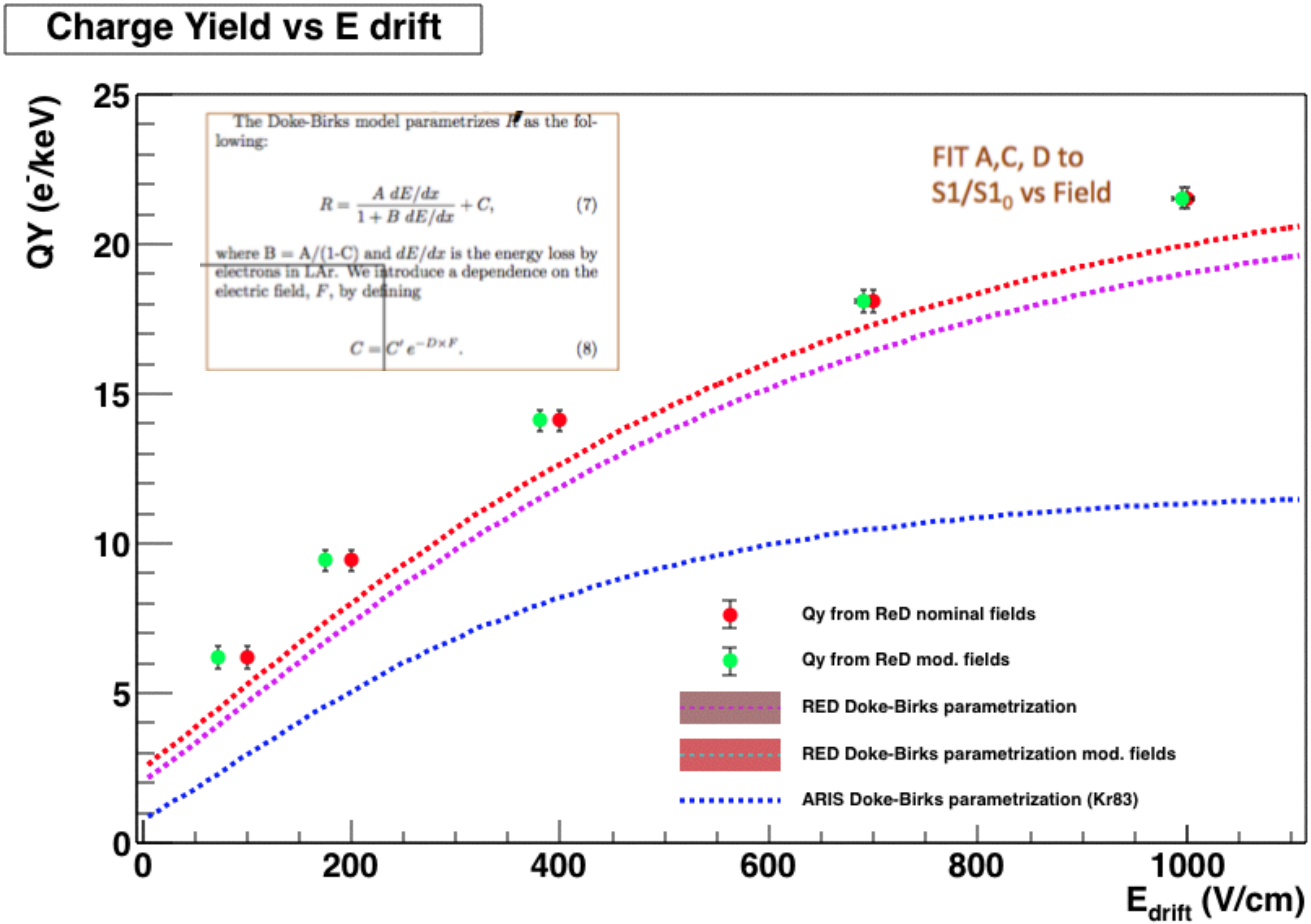
Compare to SCENE:
g1 = 0.104 ±0.006 PE/photon
g2 = 3.1 ` ±0.3 PE=e−



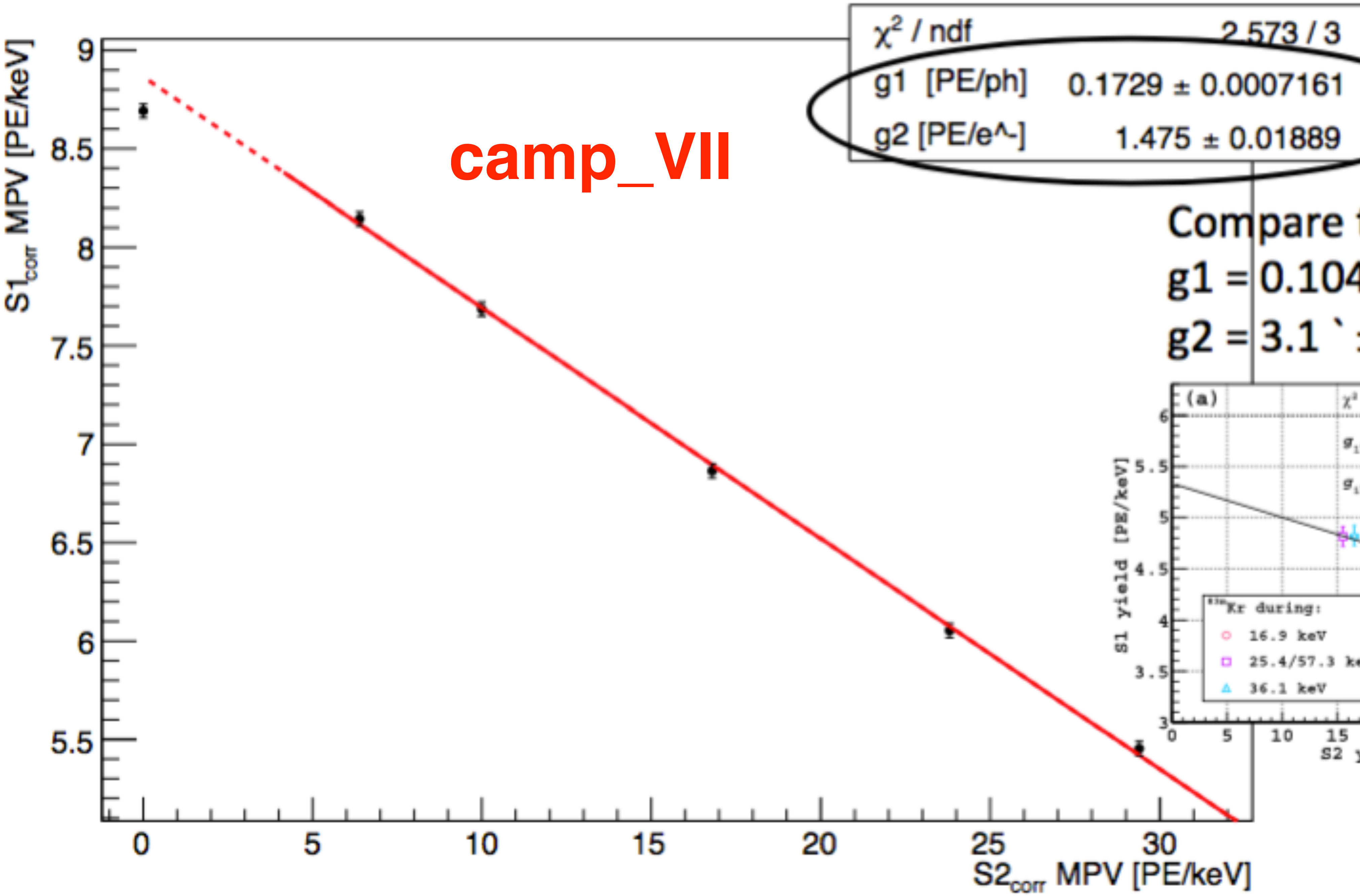
Qy with corrections



Qy with corrections



S1 vs S2



Compare to SCENE:
g1 = 0.104 ±0.006 PE/photon
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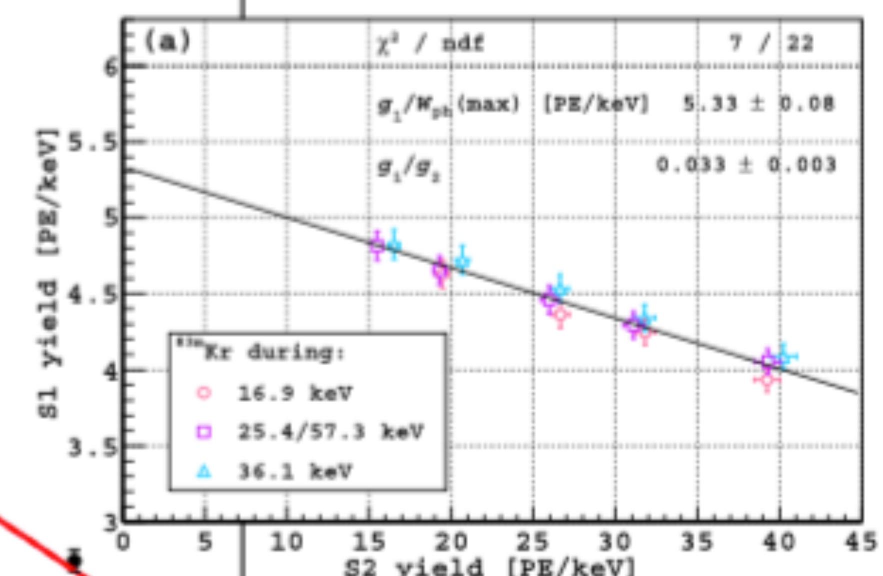
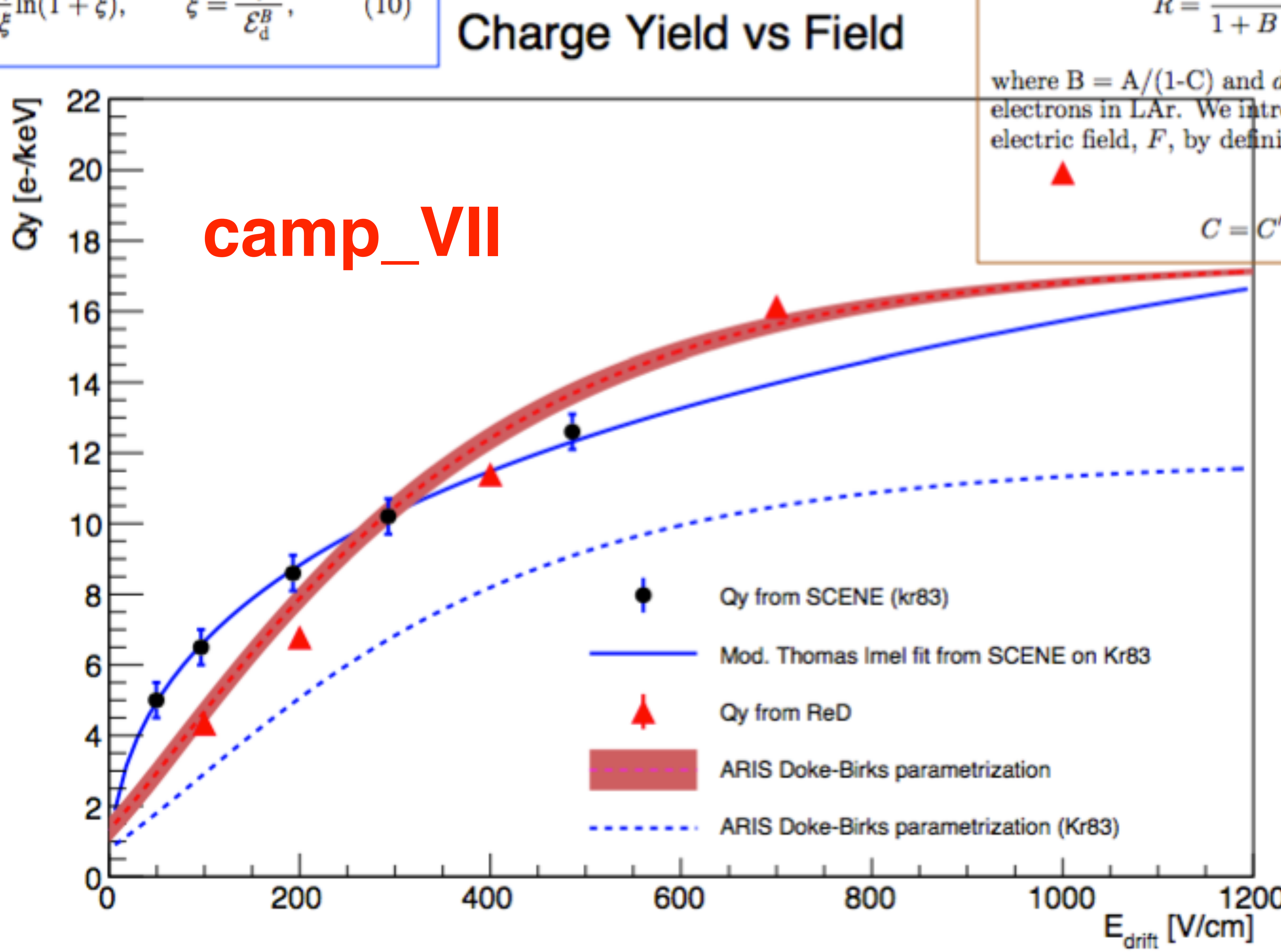


Qy with corrections

Thomas-Imel box model [46],

$$Q_y = g_2 \frac{N_i}{E\xi} \ln(1+\xi), \qquad \xi = \frac{N_i C}{\mathcal{E}_d^B}, \qquad (10)$$

FIT B and C



The Doke-Birks model parametrizes R as the following:

$$R = \frac{A\ dE/dx}{1 + B\ dE/dx} + C, \qquad (7)$$

where B = A/(1-C) and dE/dx is the energy loss by electrons in LAr. We introduce a dependence on the electric field, F, by defining

$$C = C' e^{-D \times F}. \qquad (8)$$

FIT A,C, D to $S1/S1_0$ vs Field