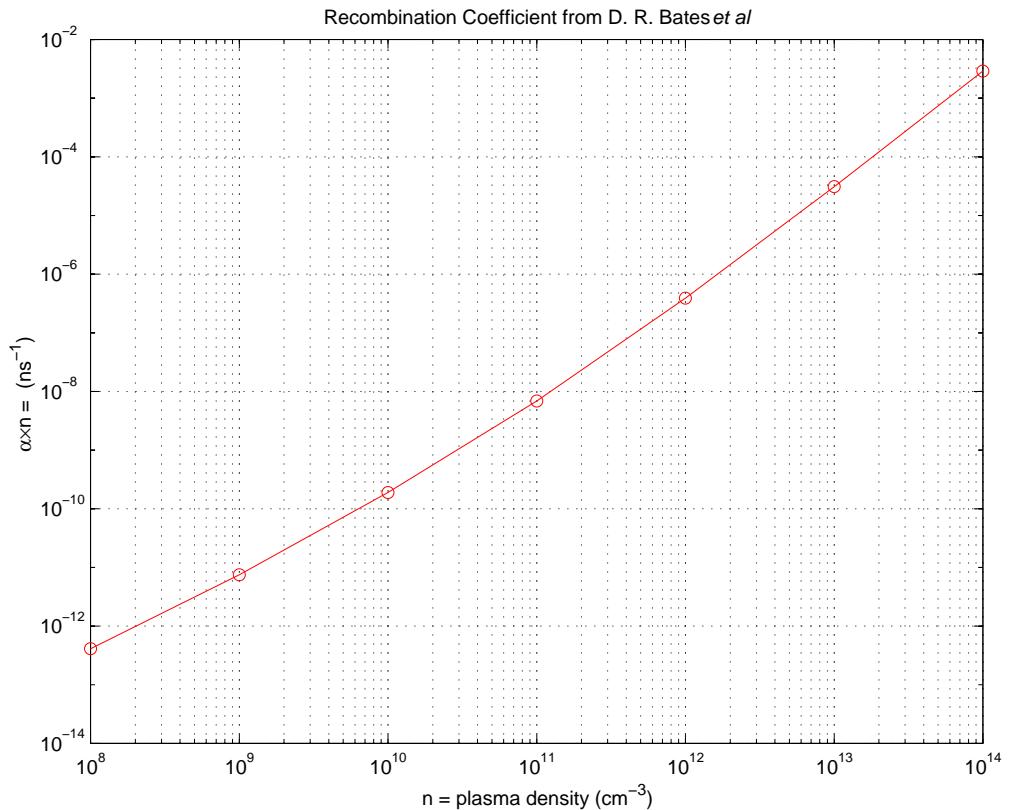


Collisional-radiative recombination coefficient from  
D. R. Bates et al, Proc of Royal Society **267**, 19 (1962)

Eqs (15) & (23)  
assuming a tenuous  
plasma

$$\frac{dn(Z^+)}{dt} = -\alpha n(Z^+)n(e^-)$$

Table 2A, T=1000K

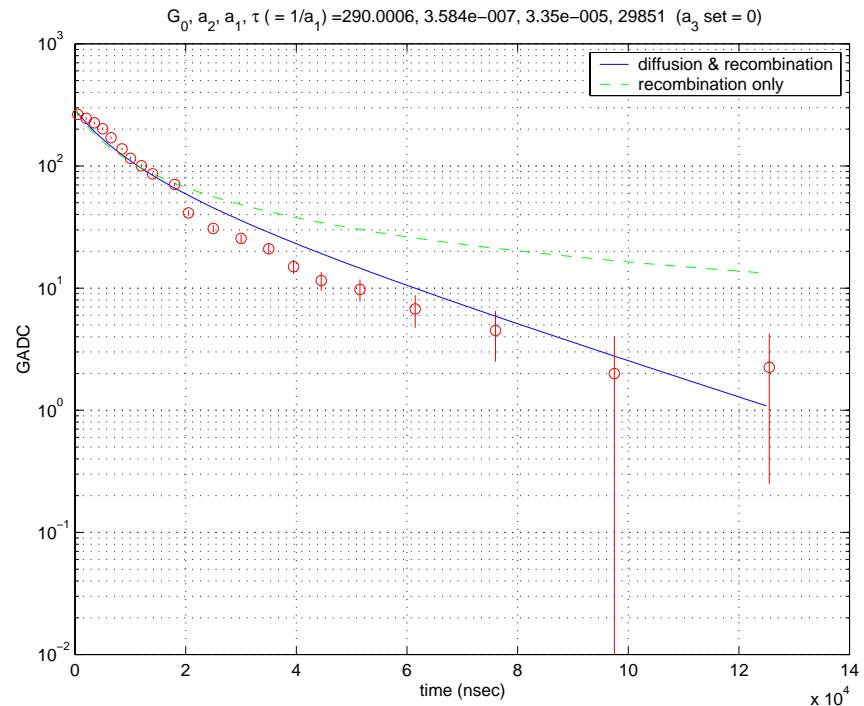
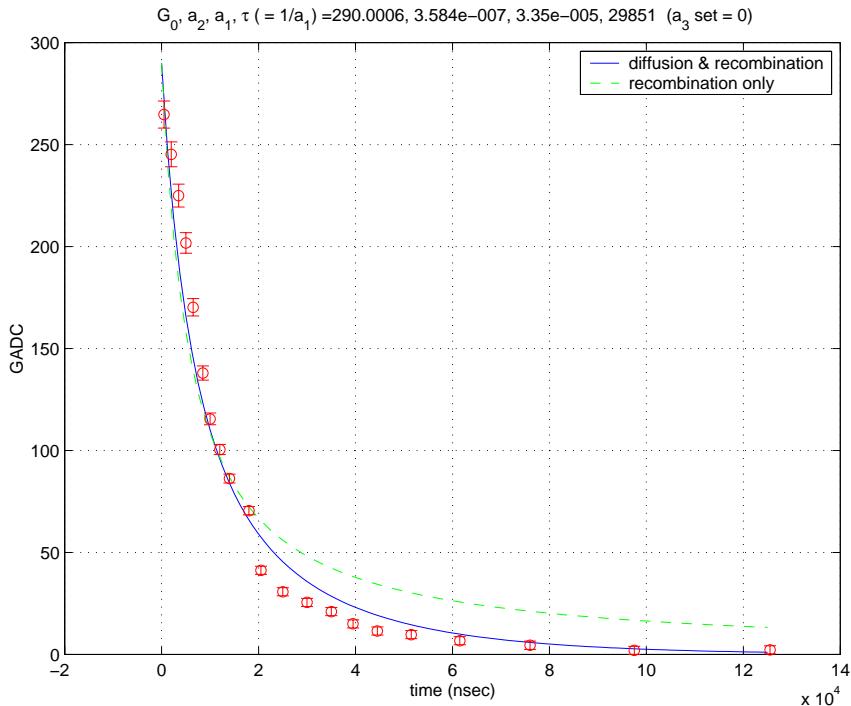


# Radiative Recombination Only

$$\frac{dn}{dt} = - \left( a_1 n + a_2 n^2 + a_3 n^3 \right)$$

$$a_3 = 0 \Rightarrow \frac{1}{n} = \left( \frac{1}{n_0} + \frac{a_2}{a_1} \right) \exp(a_1 t) - \frac{a_2}{a_1}$$

$a_1 \equiv \frac{1}{30\mu s}$  constraint on fit for large t



# Radiative Recombination Only

$$\frac{1}{n} = \left( \frac{1}{n_0} + \frac{a_2}{a_1} \right) \exp(a_1 t) - \frac{a_2}{a_1}$$

$$G_0 = 290 \text{ GADC}$$

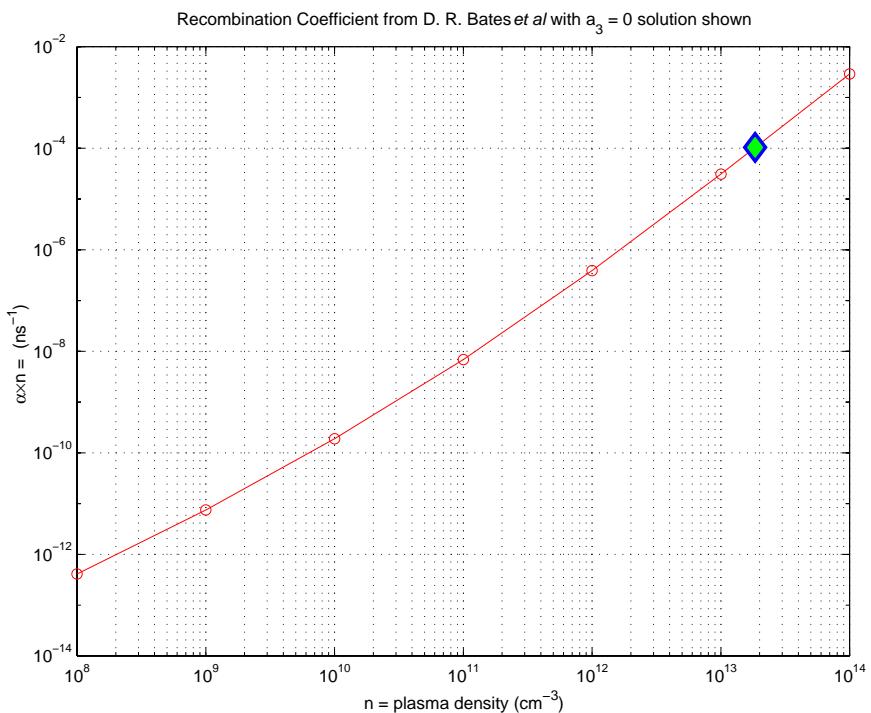
$$a_2 = 3.58 \times 10^{-7} (GADC - ns)^{-1}$$

$$a_1 = 3.35 \times 10^{-5} \text{ ns}$$

Due to recombination alone at  
 $t=0$

$$-\frac{1}{n_0} \frac{dn}{dt} \Big|_{t=0} = a_2 G_0 = 1.04 \times 10^{-4} \text{ ns}^{-1}$$

Conclusion = Initial assumption  
that  $a_3 = 0$  is not correct



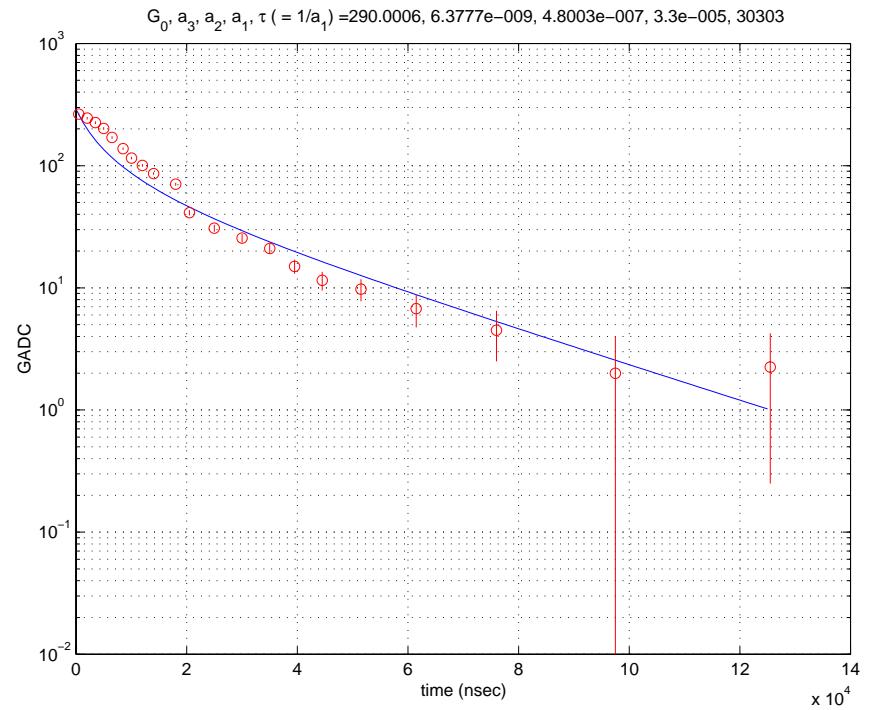
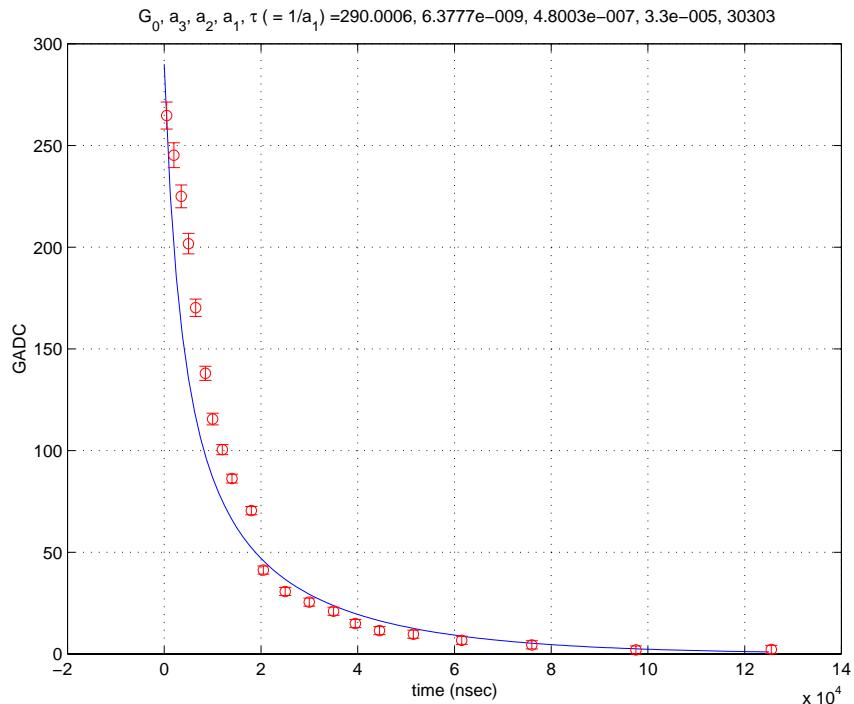
# Radiative & Collisional Recombination

$$\frac{dn}{dt} = - \left( a_1 n + a_2 n^2 + a_3 n^3 \right)$$

$a_1 \cong \frac{1}{30\mu s}$  constraint on fit for large t

$$a_2 = 0 \Rightarrow \frac{1}{n^2} = \left( \frac{1}{n_0^2} + \frac{a_3}{a_1} \right) \exp(2a_1 t) - \frac{a_3}{a_1}$$

$a_2 \neq 0$  &  $a_3 \neq 0$  is algebraically messy



# Radiative & Collisional Recombination

$$G_0 = 290 \text{ GADC}$$

$$a_2 = 4.80 \times 10^{-7} (GADC - ns)^{-1}$$

$$a_3 = 6.38 \times 10^{-9} (GADC^2 - ns)^{-1}$$

$$a_1 = 3.3 \times 10^{-5} \text{ ns}^{-1}$$

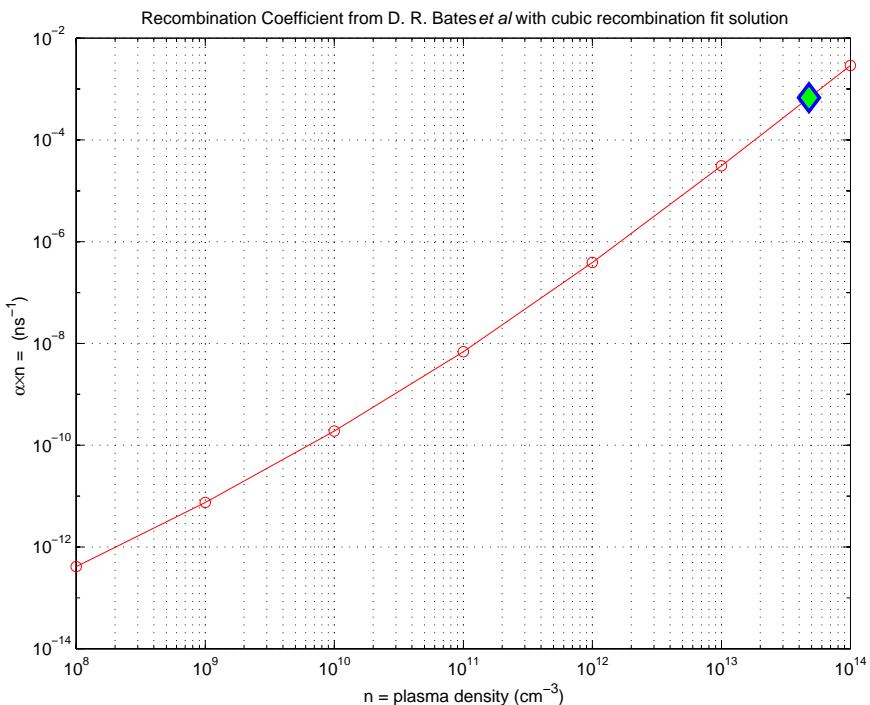
$$\tau = \frac{1}{a_1} = 3 \times 10^4 \text{ ns}$$

Cubic term ( $a_3$ ) dominates at E162 plasma density

Due to recombination alone at t=0

$$-\frac{1}{n_0} \frac{dn}{dt} \Big|_{t=0} = a_2 G_0 + a_3 G_0^2 = 6.7 \times 10^{-4} \text{ ns}^{-1}$$

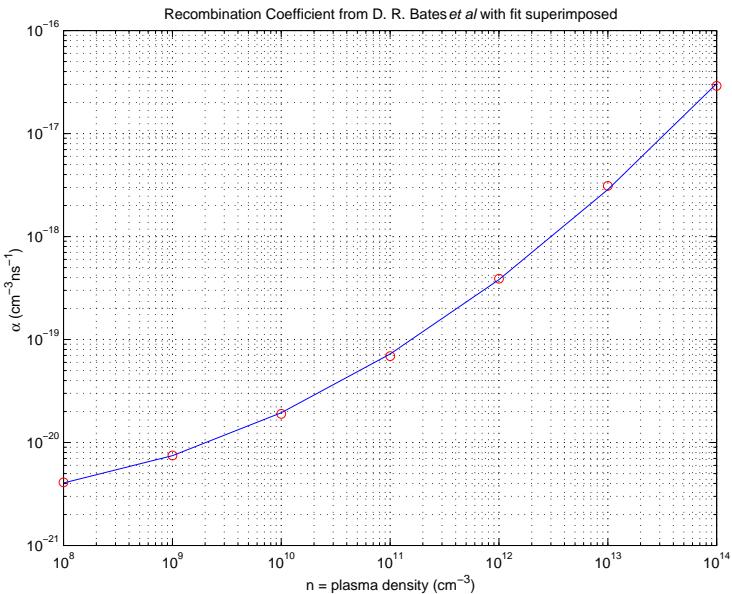
$$n_0 = 4.8 \times 10^{13} \text{ cm}^{-3}$$



# Radiative & Collisional Recombination

$$\frac{dn}{dt} = -\left(a_1 n + \alpha(n)n^2\right)$$

$\alpha$  can be fit with a polynomial



$$\begin{aligned}\ln(\alpha) &= 0.033146 \times \ln(n)^2 \\ &\quad - 1.03288 \times \ln(n) - 39.1767\end{aligned}$$

Take plasma density to be proportional to the GADC

$$n = CG$$

$$\frac{dG}{dt} = -G(a_1 + \alpha(CG)CG)$$

Solve by Runge-Kutta integration with the initial value  $G = G_0$  where  $G_0$ ,  $a_1$  and  $C$  are iterated.

# Radiative & Collisional Recombination

$$G_0 = 330.5$$

At  $t = 0$ ,  $n = 2.47 \times 10^{13} \text{ cm}^{-3}$

$$C = 7.46 \times 10^{10}$$

$$a_1 = 5 \times 10^{-5} \text{ ns}^{-1}$$

$$\tau = 20 \mu\text{s}$$

Fit with  $\tau = 30 \mu\text{s}$  was not good

