Target Boiling Study for Ar(e,e`p)

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What do we Mean by Target "Boiling"?:

When the beam passes through the target, the local temperature fluctuations could cause a variation in the target density. This density variation is called "Boiling", and it increases with increasing current.

The target density changes with current as follows:

$$\rho = \rho_0(1 - B \times I)/100$$

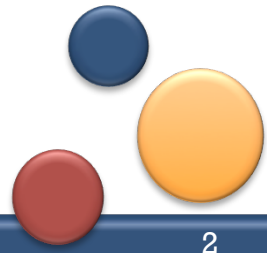
where *I is the beam current, B* is the target boiling factor, and ρ_0 is the nominal target density at $I = 0$.

Motivation of this Study:

- Perform boiling target study on both Ti and Ar targets for Ar(*e*, *e`p*) experiment.

Method:

- **Yield Analysis:** Charge yield vs. Beam current
- **Scaler Analysis:** Scaler counts vs. Beam current



Extracting the Charge Yield:

We can calculate the total charge using:

$$Q = (a \times counts) + (b \times time)$$

where Q is the charge, a & b are constants.

The charge yield is given by:

$$Yield = \frac{No.of\ events \times PS}{Charge \times efficiencies \times LiveTime}$$

Analysis Steps:

- Calculate the Live Time LT of each run

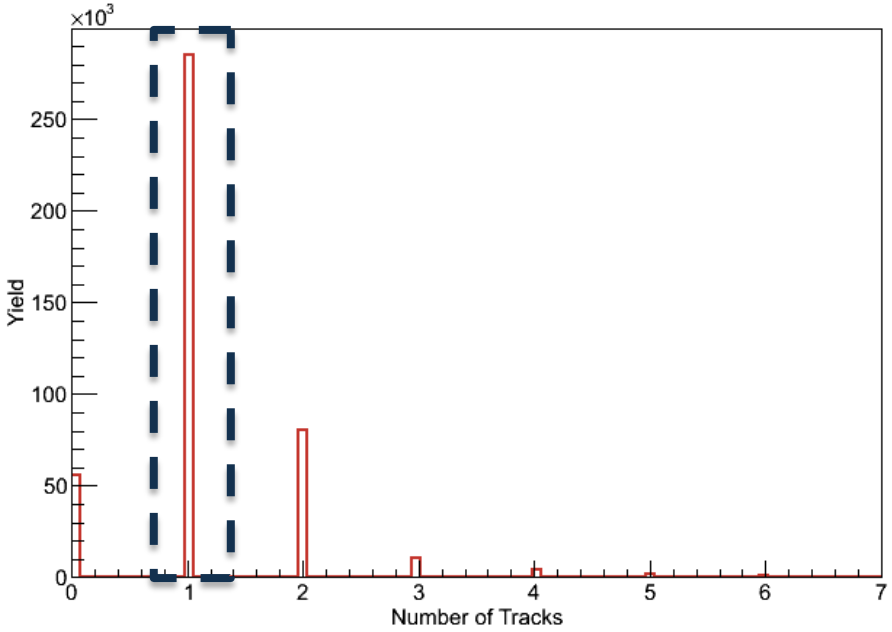
$$LT_{T_i} = \frac{PS_{T_i} . N_{T_i}^{DAQ}}{N_{T_i}^{scaler}}$$

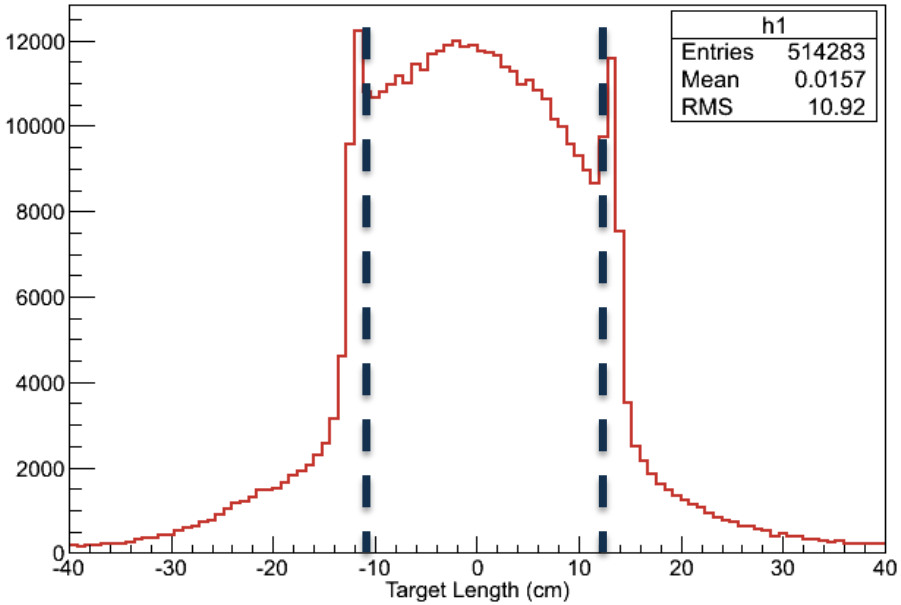
where PS_{Ti} is the pre-scaler factor of the trigger i, N^{DAQ} and N^{scaler} are total numbers of trigger events and scaler counts respectively for the trigger i.

- Apply cuts:

- One track cut
- Cut on target length
- Beam trip cut
- PID Cut
- Trigger Cut (Single trigger of LHRS in this study)

Events Selection:



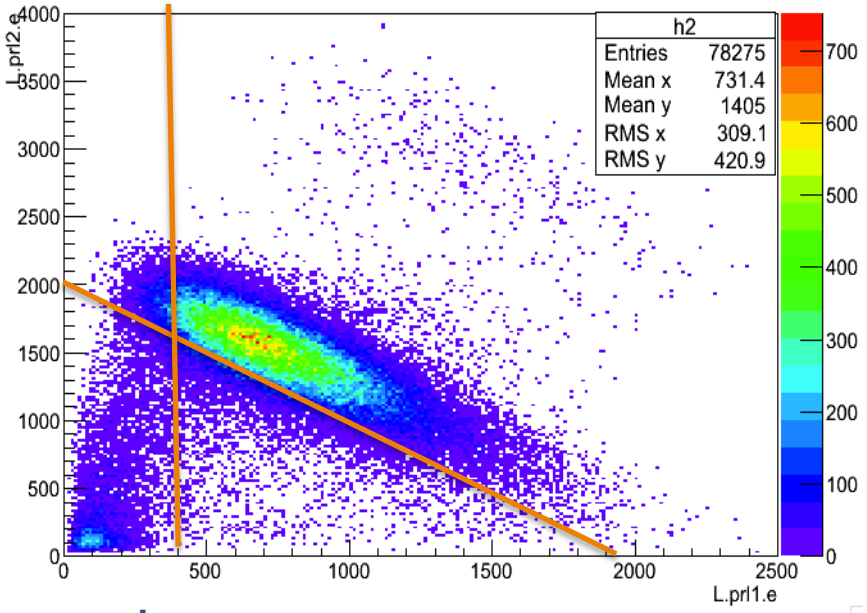


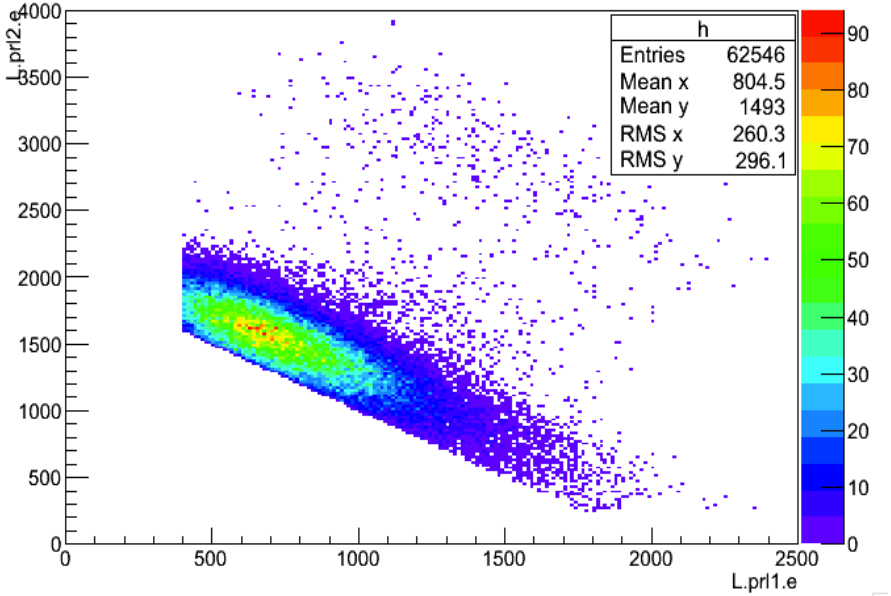
Selecting Events with only one track in the VDC's

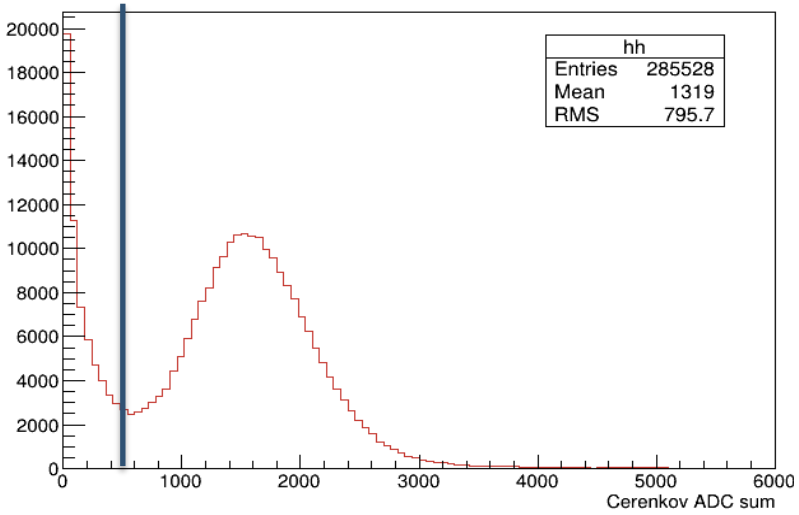
Cut on Ar Target Length (-11.5 to 12.5)

Events Selection:

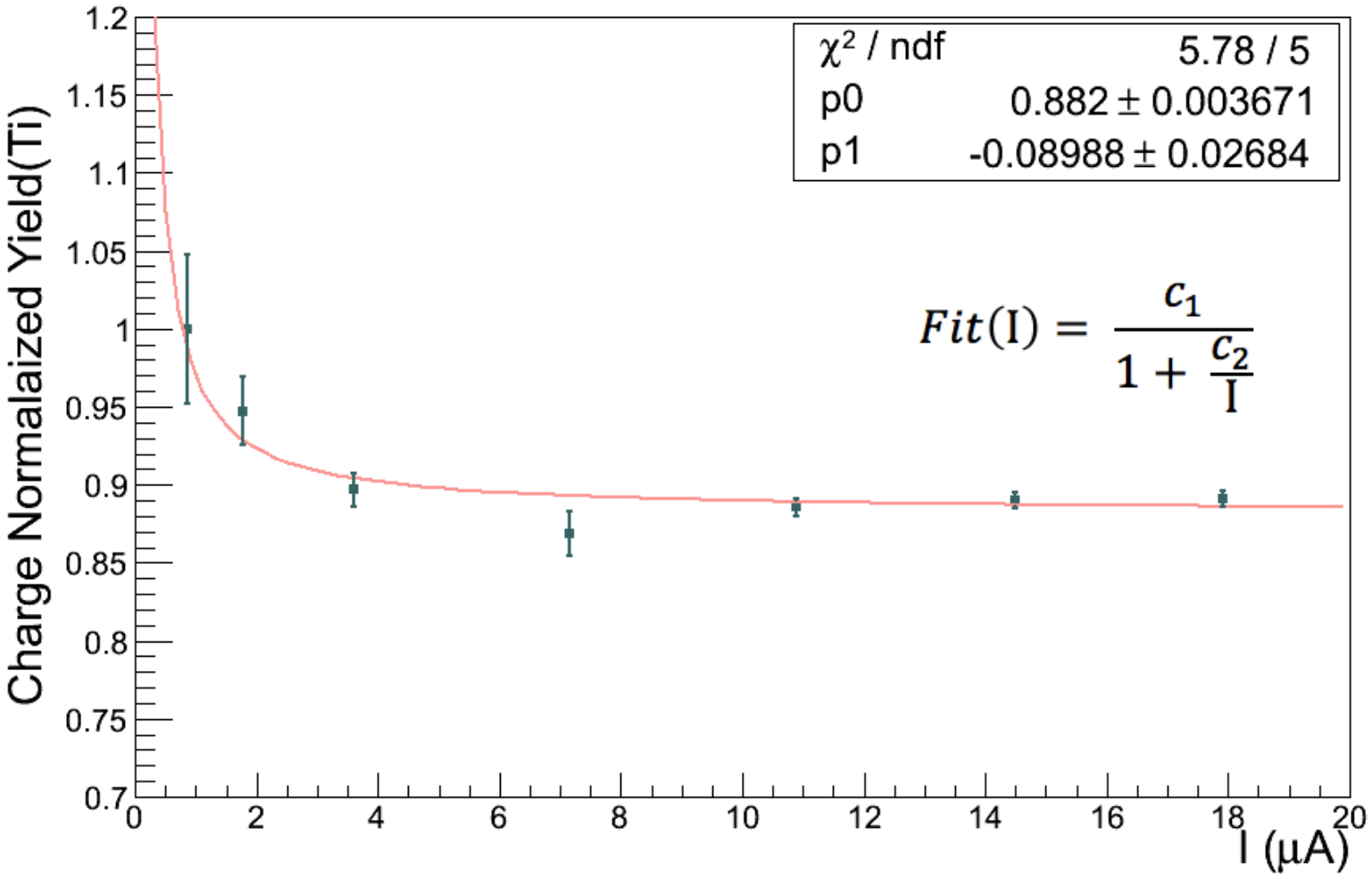
Events from single trigger



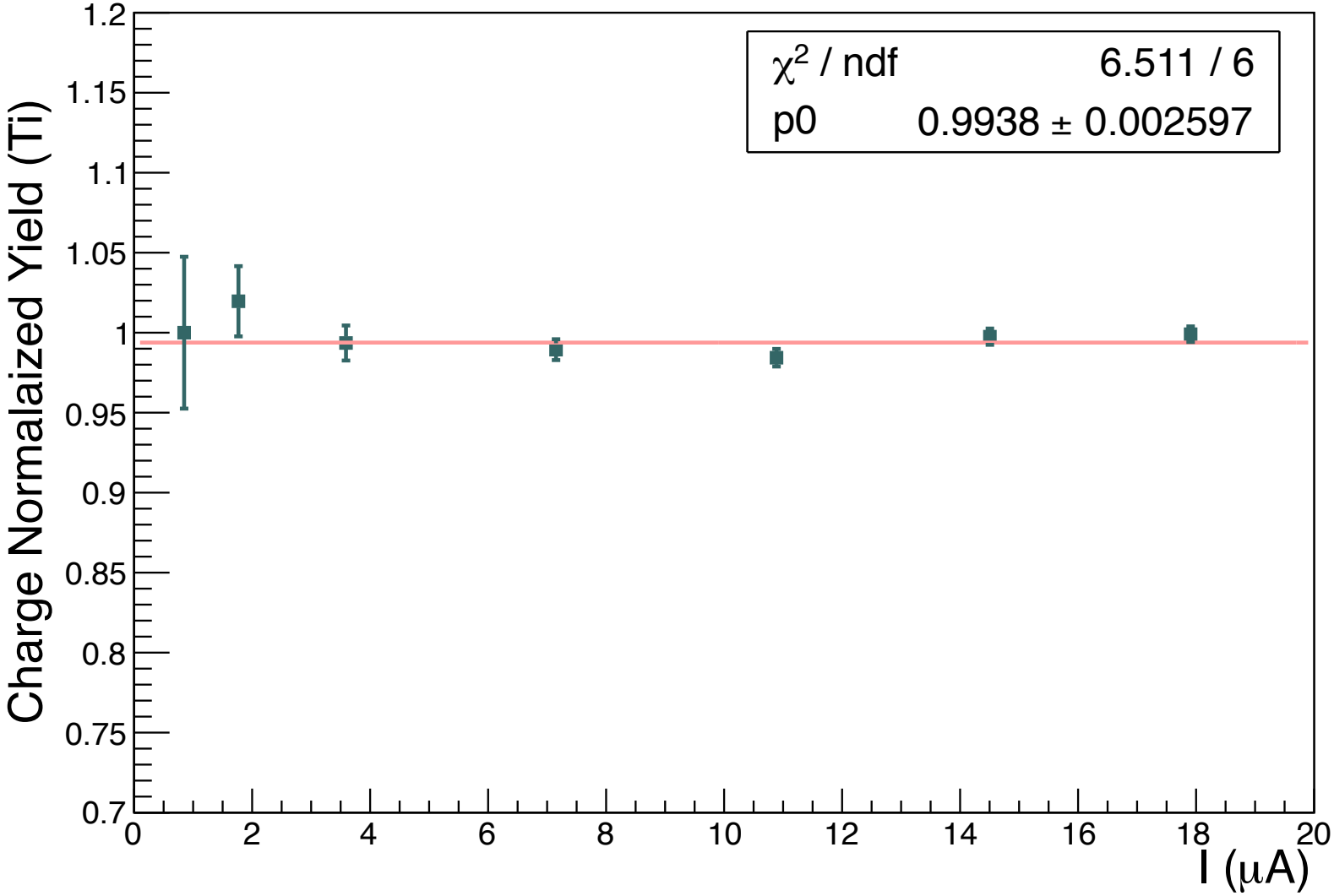


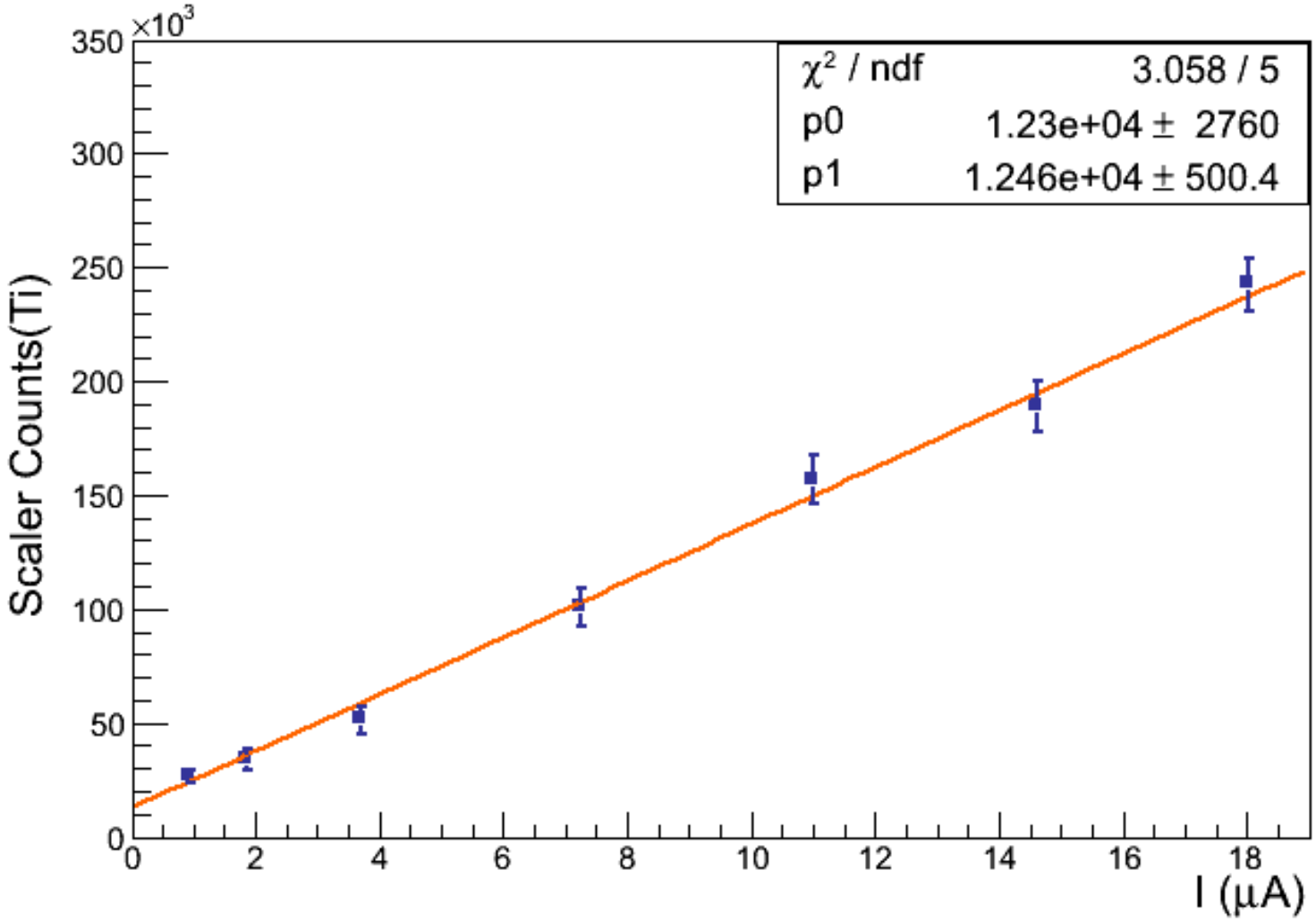


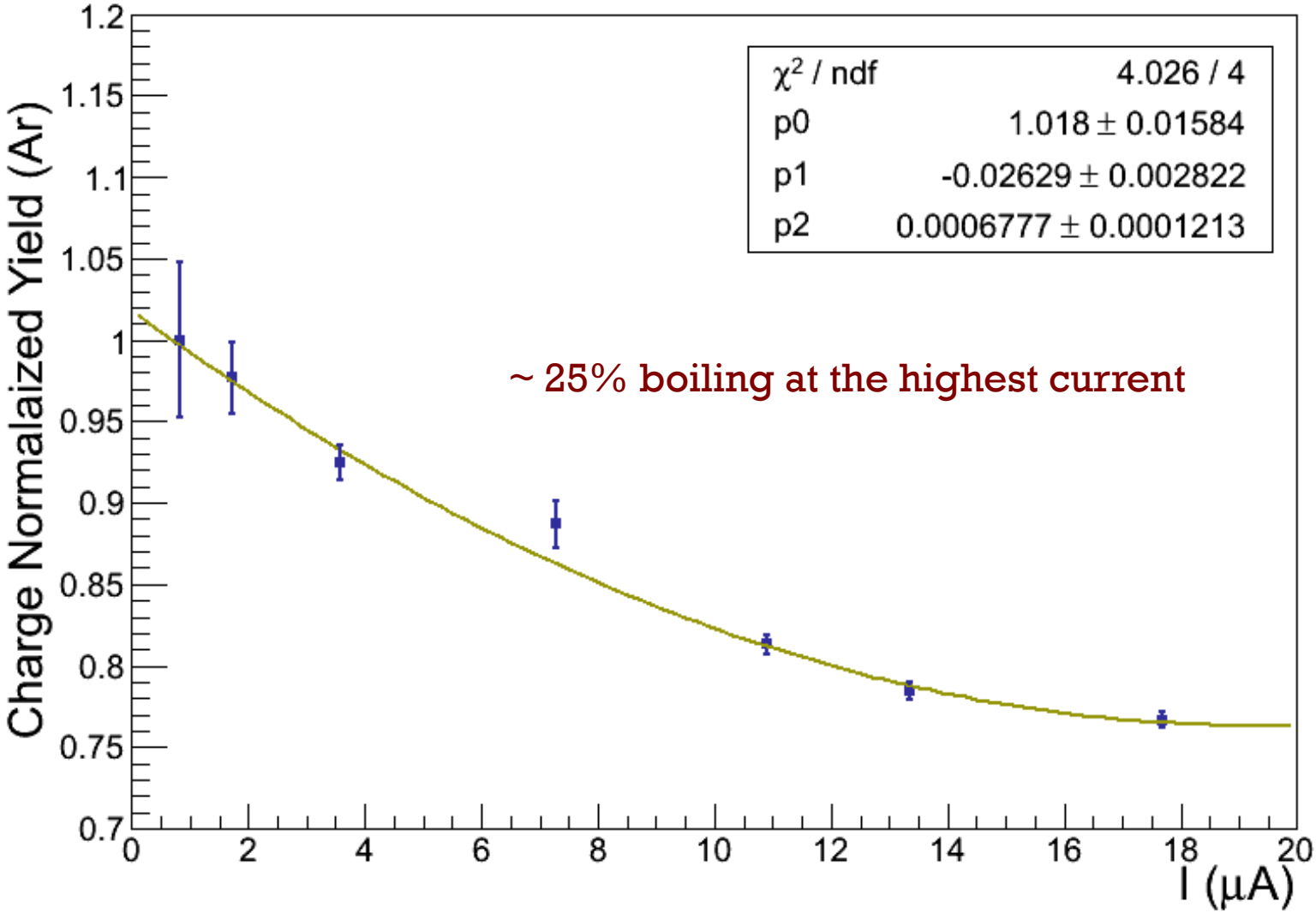
Particle Identification (PID) Cut

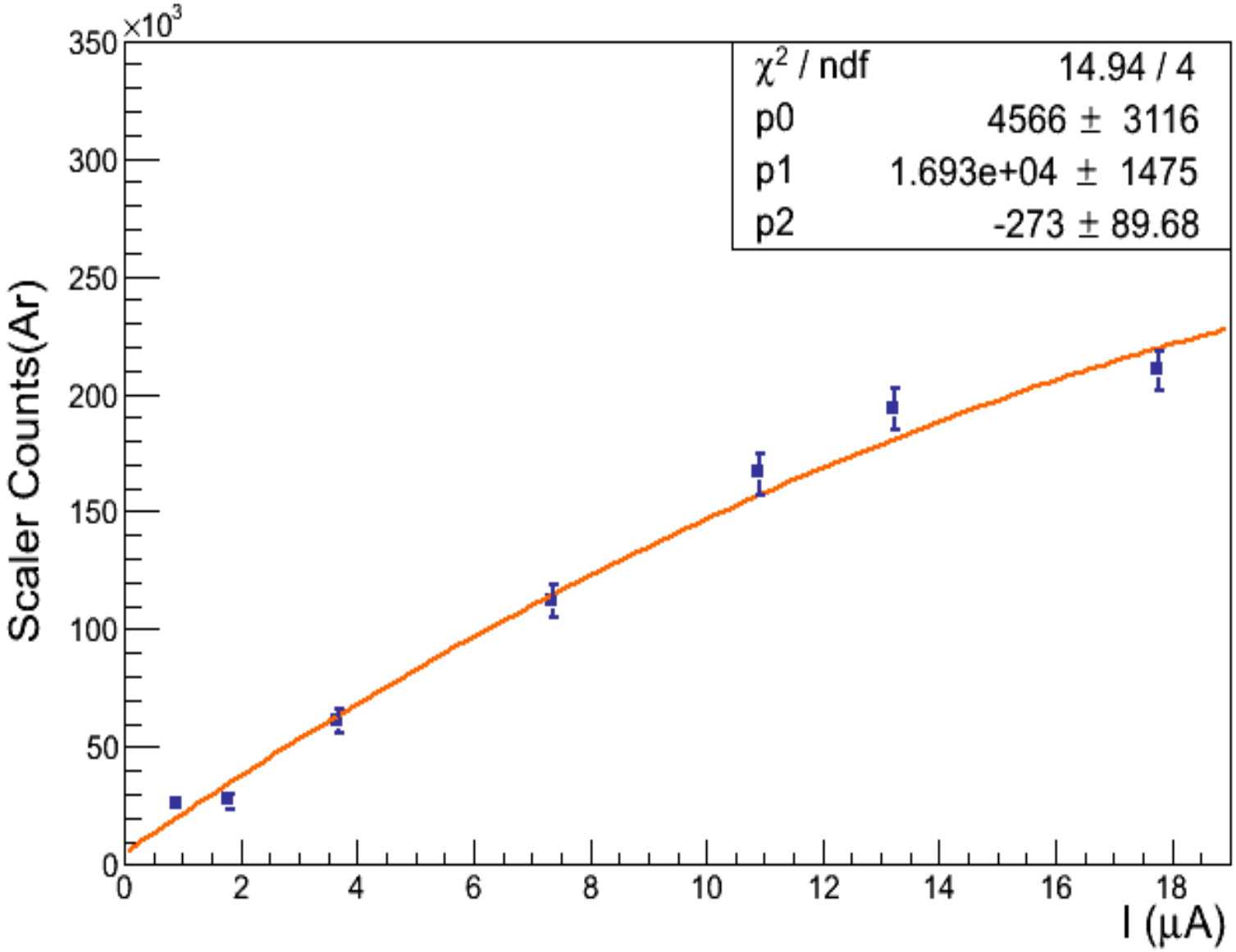

Charge Normalaized Yield(Ti)
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
0.75
0.7
0
2
4
6
8
10
12
14
16
18
20
I (μA)
χ² / ndf 5.78 / 5
p0 0.882 ± 0.003671
p1 -0.08988 ± 0.02684
$Fit(\mathrm{I}) = \frac{c_1}{1 + \frac{c_2}{\mathrm{I}}}$

Results for Ti




×10^3
350
300
250
200
150
100
50
0
Scaler Counts(Ti)
χ² / ndf 3.058 / 5
p0 1.23e+04 ± 2760
p1 1.246e+04 ± 500.4
0
2
4
6
8
10
12
14
16
18
I (μA)


Charge Normalaized Yield (Ar)
I (μA)
χ² / ndf 4.026 / 4
p0 1.018 ± 0.01584
p1 -0.02629 ± 0.002822
p2 0.0006777 ± 0.0001213
~ 25% boiling at the highest current

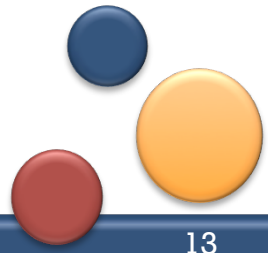

×10^3
350
300
250
200
150
100
50
0
Scaler Counts(Ar)
χ² / ndf 14.94 / 4
p0 4566 ± 3116
p1 1.693e+04 ± 1475
p2 -273 ± 89.68
0
2
4
6
8
10
12
14
16
18
I (μA)

Results:

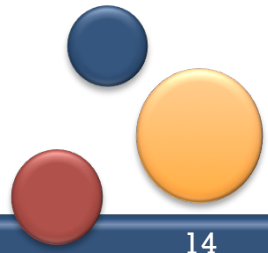
- After performing the target boiling study the following result was obtained: the Argon target boils up to 24% at high current (18 uA)
- The change in Argon density "seems to be" quadratic not linear- with beam current.
- Further study(?): The dependence on target length and width.

Acknowledgment

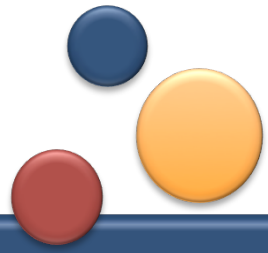
Great Thanks to Eric Christy, David Meekins and Douglas Higinbotham for their supervision and help throughout this work.

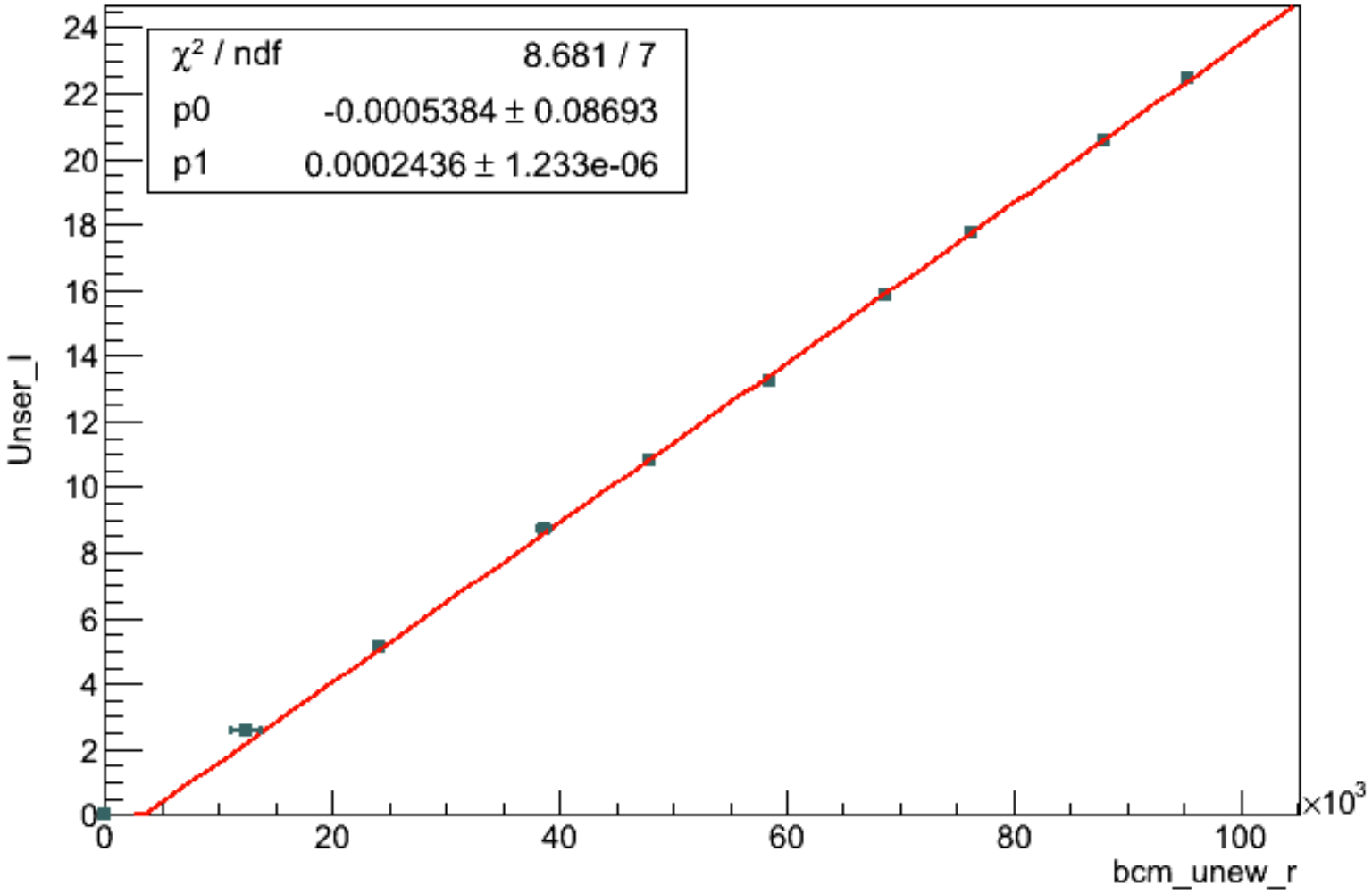


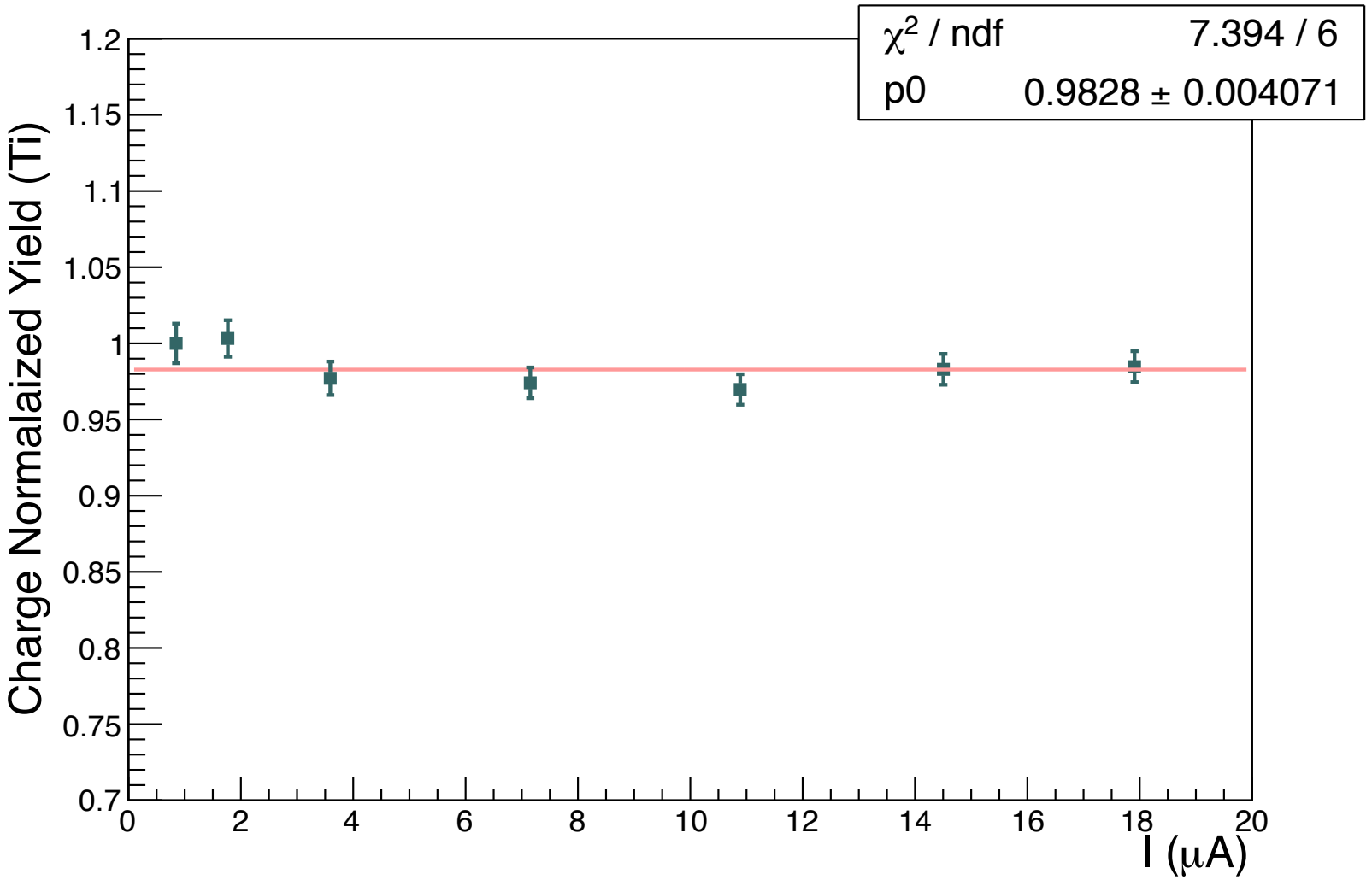
Thanks!



Backup Slides




χ² / ndf 8.681 / 7
p0 -0.0005384 ± 0.08693
p1 0.0002436 ± 1.233e-06
Unser_I
bcm_unew_r
×10³
0
20
40
60
80
100
2
4
6
8
10
12
14
16
18
20
22
24


χ^2 / ndf 7.394 / 6
p0 0.9828 ± 0.004071
Charge Normalaized Yield (Ti)
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
0.75
0.7
0
2
4
6
8
10
12
14
16
18
20
I (μA)