Update cross section of $e^+ e^- \to \pi^+ \pi^- J/\psi$

Jiang Houbing Liu Zhiqing Huang Xingtao

Shandong university

Motivation

- We plan to update the $e^+ e^- \to \pi^+ \pi^- J/\psi$ cross section with new XYZ data , to precisely measure Y(4260) parameters;

- We might have a chance to study Y→ $\pi^{\pm} Z_c(3900)^{\mp}$ at BESIII;

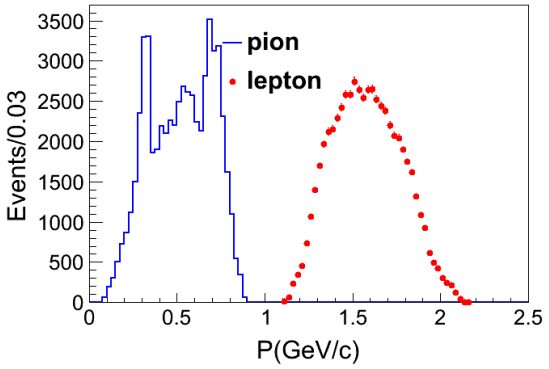
Last group meeting:

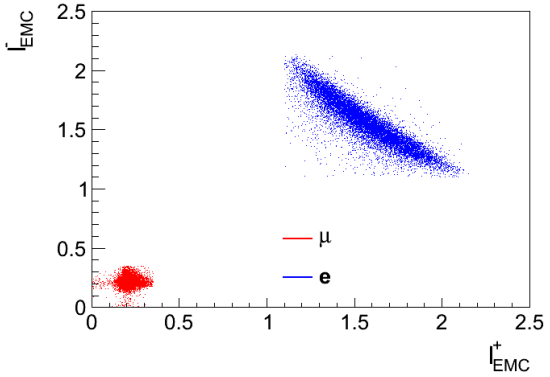
@4230	σ_{dress} $(\mu\mu)$ pb	σ_{dress}(ee) pb
My results	84.98±1.89	84.34 ± 2.26
Zhiqing's	85.3± 2.0	84.8± 2.4
Difference (%)	0.38	0.55

In the same Boss version(664p01) , our results are almost identical. The little difference come from the different order of selection.

❑ Initial Selection

- Charged track :
  - ➢ Rxy<1cm, |Rz| <10cm ; |cosθ|<0.93;
  - ➢ charged track =4 ; total charge =0;
  - ➢ identify charged track:
    - P>1.06 GeV leptons
    - P<=1.06 GeV pion





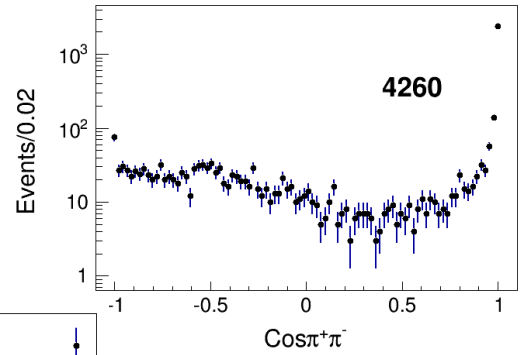
  - ➢ identify leptons:
    - E_emc < 0.35 GeV muon;
    - E_emc > 1.1 GeV electron;
  - ➢ Vertex and 4C kinematic fit ;

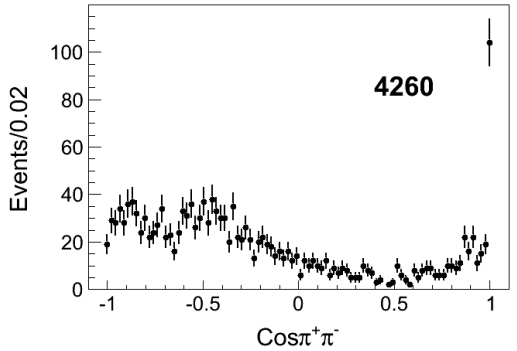
Some review

❑ Further selection:

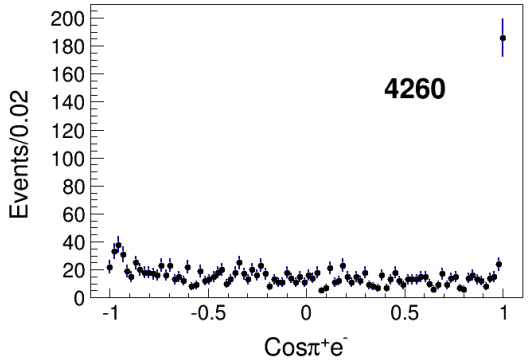
Obviously, there are large gamma conversion events

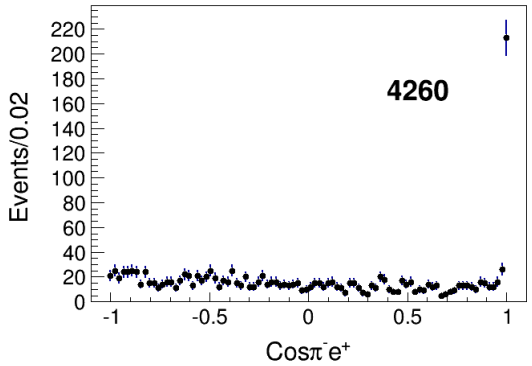
- To suppress gamma conversion events
  - ➢ let $\cos(\pi^+\pi^-) < 0.98$;

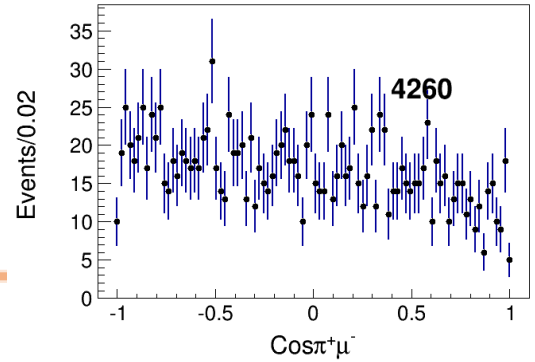


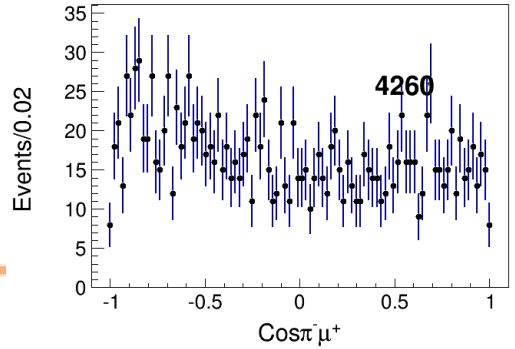


- Check others angle distribution:





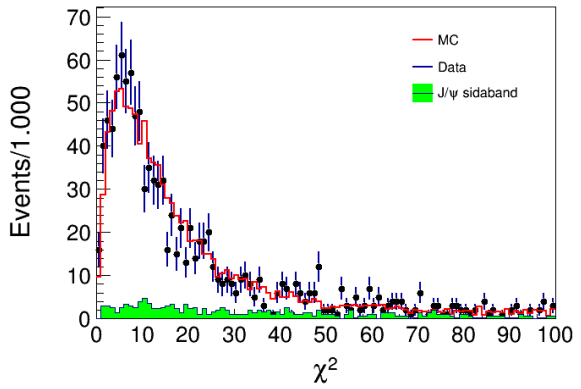




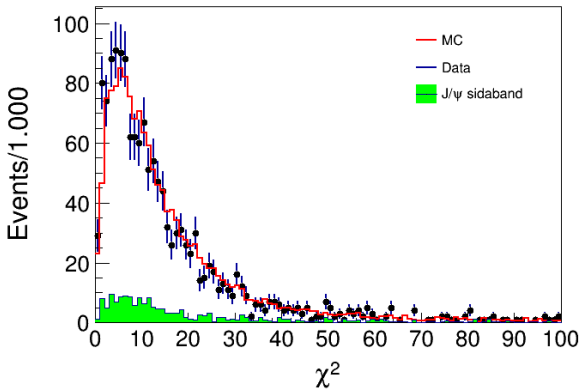
Some review

- still have large gamma conversion events in ee channel , let cos ($\pi^+ e^-$) <0.98&&cos ($\pi^- e^+$) <0.98;

- After above cut(MC after PULL distribution correction):



$J/\psi \to e^+ e^-$



$J/\psi \to \mu^+ \mu^-$

- let $\chi^2_{4c} < 60$;

DATA SET

- boss version boss703;
- DATA xyz data;
- MC of $e^+ e^- \to Y(4260) \to \pi^+ \pi^- J/\psi$ MassH2;

$\sqrt{s}$
4180
4190
4200
4210
4220
4237
4246
4270
4280

$\sqrt{s}$
3810
3900
4009
4230
4260
4310
4390
4420
4470
4530
4575
4600

Cross Section Measurement

We use the fllowing formula:

$$\sigma^{\mathrm{dress}} = \frac{N^{\mathrm{sig}}}{\mathcal{L}_{int}(1+\delta)\epsilon\mathcal{B}}$$

And $$(1+\delta) = \frac{\sigma^{obs}}{\sigma^{\mathrm{dress}}_{\mathrm{fit}}} = \frac{\int \sigma^{\mathrm{dress}}_{\mathrm{fit}}(s(1-x))F(x,s)dx}{\sigma^{\mathrm{dress}}_{\mathrm{fit}}(s)}.$$

- Using Zhiqing`s fit result as input lineshape to get radiative correction factor
- For XYZ DATA, the luminosity less than 150 pb-1, we get the cross section by combine $J/\psi \to e^+e^-$ and $J/\psi \to \mu^+\mu^-$ two channel.
- For others XYZ DATA , we get the cross section by two channel respectively.

Cross Section summary (new XYZ DATA)

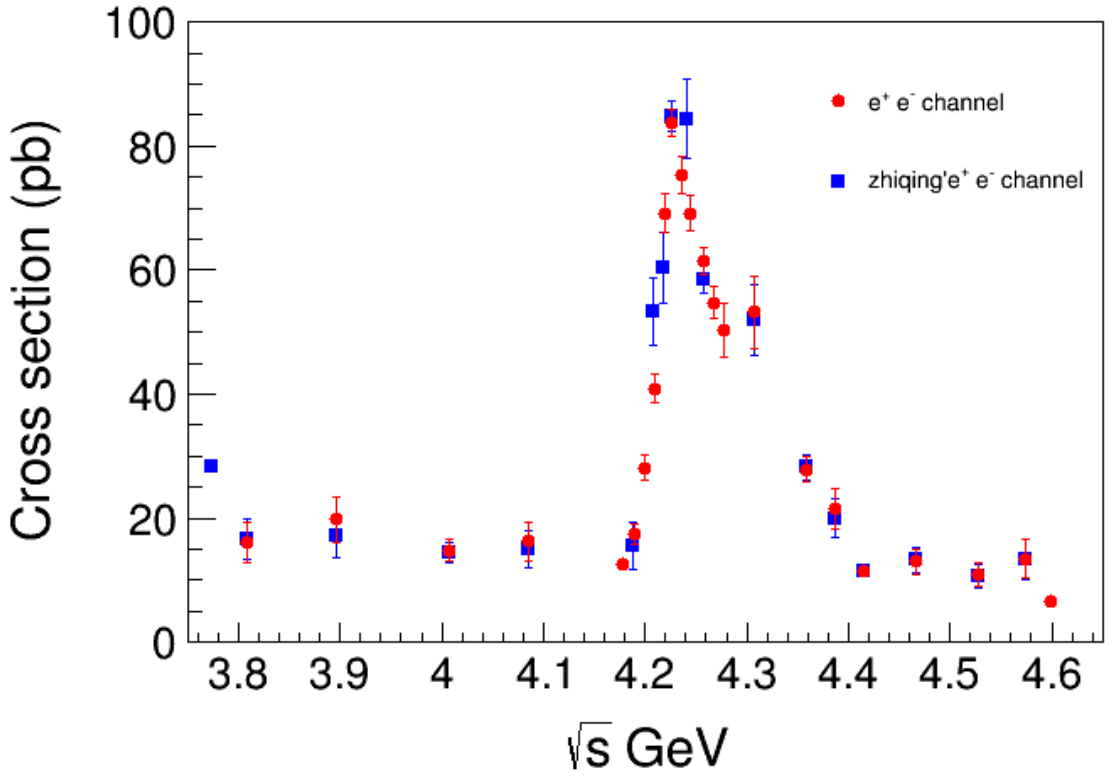
$\sqrt{s}$	L(pb-1)	N_ee	N_uu	ϵ_ee	ϵ_uu	$1+\delta$	$\sigma(ee)$	$\sigma(\mu\mu)$
4180	3194.5	678.23+/-33.69	995.13+/-37.94	0.3156	0.449	0.897298	12. 55+/0.62	12.97+/0.49
4190	522.5	149.62+/-14.30	203.70+/-35.84	0.3214	0.4651	0.851375	17.52+/1.67	16.67+/2.91
4200	524.6	249.18+/-17.92	350.34+/-21.12	0.3506	0.5020	0.805116	28.18+/-2.03	27.72+/-1.67
4210	518.1	344.50+/-20.34	556.52+/-25.60	0.3585	0.5098	0.758923	40.93+/-2.42	46.57+/-2.14
4220	514.3	579.97+/-25.53	814.74+/-30.31	0.3696	0.5351	0.738883	69.14+/-3.04	67.21+/2.50
4237	530.6	699.85+/-28.04	1089.53+/-34.98	0.3722	0.5398	0.788486	75.28+/-3.02	80.94+/-2.60
4246	537.4	680.72+/-27.80	981.89+/-34.98	0.3751	0.5314	0.817645	69.16+/-2.83	70.55+/-1.34
4270	529.7	525.78+/-24.99	779.50+/-30.34	0.3484	0.4992	0.87252	54.69+/-2.60	56.68+/-2.20
4280	175.5	158.84+/-13.78	251.74+/-17.09	0.3427	0.4876	0.880072	50.25+/-4.36	56.07+/-3.81

Cross Section summary (old XYZ DATA)

$\sqrt{s}$	L(pb-1)	N_ee	N_uu	ϵ_ee	ϵ_uu	$1+\delta$	$\sigma(ee)$	$\sigma(\mu\mu)$
3810	50.54	32.91+/-6.63		0.3918		0.8692	16.02+/-3.23	
3900	52.61	42.55+/-7.67		0.3923		0.8723	19.80+/-3.57	
4009	482.0	127.00+/-14.41	229.68+/-17.59	0.3258	0.4655	0.910784	14.87+/-1.68	18.86+/-1.44
4230	1100.9	1582.17.+/-42.24	2284.87+/-50.42	0.3831	0.5450	0.758923	83.76+/-2.34	85.16+/-1.88
4260	828.4	929.22+/-33.01	1320.79+/-39.06	0.3546	0.5019	0.738883	61.57+/-2.19	61.93+/1.83
4310	45.08	103.26+/-11.35		0.4023		0.8964	53.23+/-5.85	
4390	55.57	52.8057+/-8.20		0.3155		1.1747	21.49+/-3.336	
4420	1090.7	219.32+/-18.16	344.32+/-22.43	0.2368	0.3466	1.23561	11.51+/-0.95	12.37+/-0.80
4470	111.09	61.20+/-9.70		0.2790		1.2660	13.07+/-2.07	
4530	112.12	50.45+/-8.92		0.2763		1.2580	10.85+/-1.92	
4575	48.93	26.46+/-6.15		0.2683		1.2505	13.51+/-3.14	
4600	586.9	64.64+/-10.40	90.09+/-15.49	0.221533	0.3207	1.24274	6.70+/-1.08	6.47+/-1.11

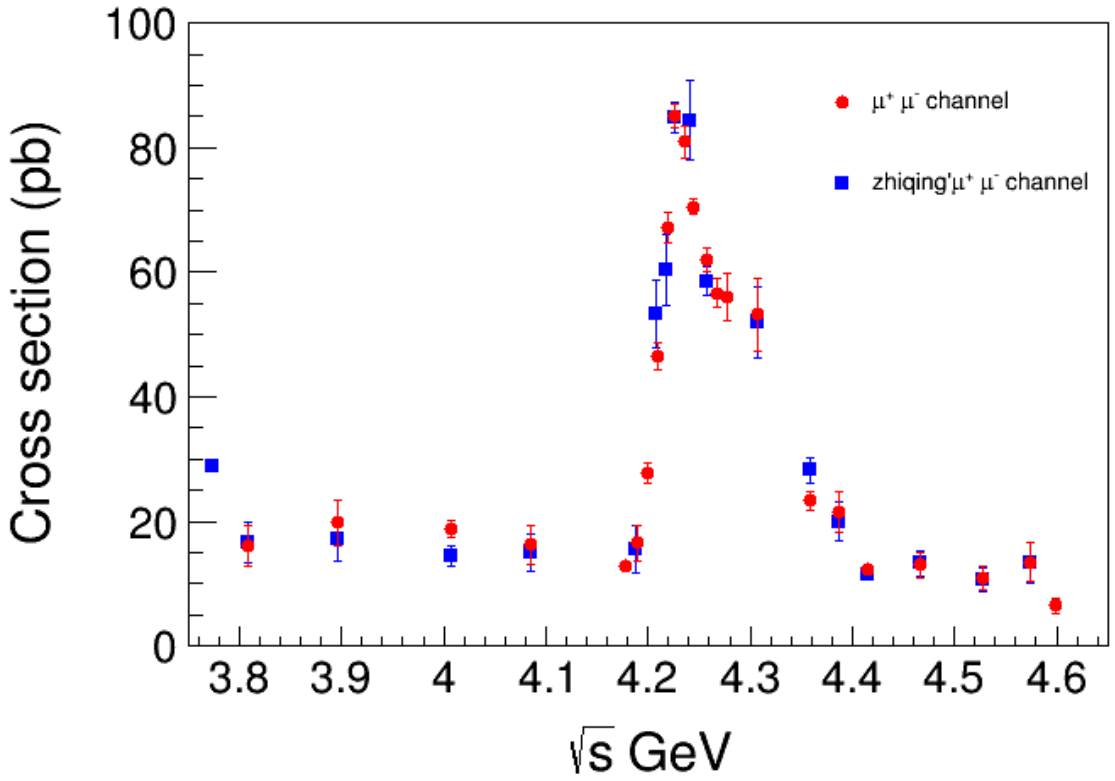
Cross Section result

- $J/\psi \to e^+e^-$ channel



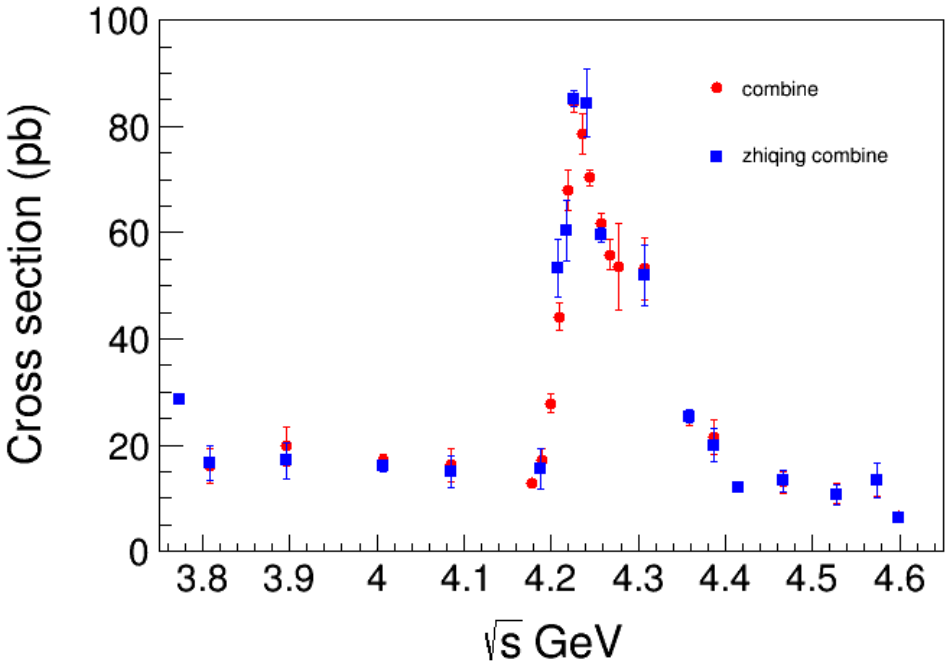
Cross Section result

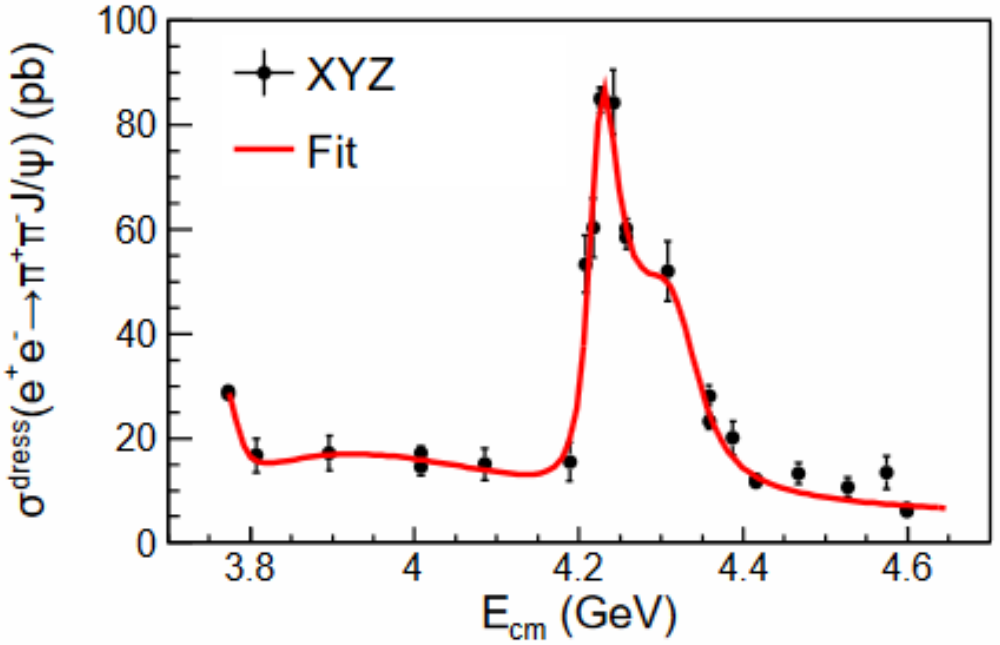
- $J/\psi \to \mu^+\mu^-$ channel



Cross Section result

- Combine two channel





Zhiqing`s Fit Result

Summary

- We measure $e^+ e^- \to \pi^+ \pi^- J/\psi$ cross section using xyz data , the result consistent with zhiqing` previous measurements ;

- We will use these result to do next work…

Thanks!

BACK UP

Cross Section summary (Longzhou`s)

Energy	Events_ee	Events_mm	Ee_efficiency	Mm_efficiency	1+delta	Luminosity(pb-1)	Cross_section_ee(pb)	Cross_section_mm(pb)
4180	602+/-28	994+/-41	30.92%	47.98%	0.8301	3194.5 ±0.2 ±31.9	12.30+/-0.57	13.11+/-0.54
4190	139+/-13	221+/-19	31.96%	48.85%	0.8266	522.5±0.1±3.4	16.86+/-1.58	17.57+/-1.5
4200	234+/-17	355+/-22	32.74%	49.29%	0.8221	524.6±0.1±2.5	27.76+/-2.02	28.02+/-1.74
4210	343+/-20	577+/-27	32.75%	49.01%	0.8137	518.1±0.1±1.8	42.09+/-2.4	46.85+/-2.19
4220	555+/-24	840+/-32	33.26%	49.56%	0.8119	514.3±0.1±1.9	66.93+/-2.89	68.1+/-2.59
4237	679+/-27	1083+/-36	34.17%	50.57%	0.8057	530.6±0.1±2.4	78.08+/-3.10	85.67+/-2.87
4246	638+/-27	969+/-34	33.96%	50.59%	0.8092	537.4±0.1±2.6	72.35+/-3.06	73.89+/-2.59
4270	489+/-24	745+/-31	33.69%	50.41%	0.8235	529.7±0.1±2.8	55.73+/-2.74	56.84+/-2.37
4280	150+/-13	249+/-18	32.70%	49.50%	0.8238	175.5±0.1±0.9	53.13+/-4.61	58.37+/-4.22

He said ISR factor need to be updated;

Every energy point generator 10000 simulation events

Xs_tot(On)	cms	Xs_tot(OFF)	cms	1+δ
13.82079390	4.17830000	15.40267277	4.17830000	0.897298
16.54743791	4.18880000	19.43612818	4.18880000	0.851375
22.49975765	4.19890000	27.94598160	4.19890000	0.805116
34.95760907	4.20920000	46.06210326	4.20920000	0.758923
51.92172639	4.21870000	70.27057162	4.21870000	0.738883
62.79641811	4.23570000	79.64177475	4.23570000	0.788486
57.86289282	4.24380000	70.76776418	4.24380000	0.817645
46.94788287	4.26680000	53.80722509	4.26680000	0.87252
44.82429619	4.27770000	50.93251724	4.27770000	0.880072