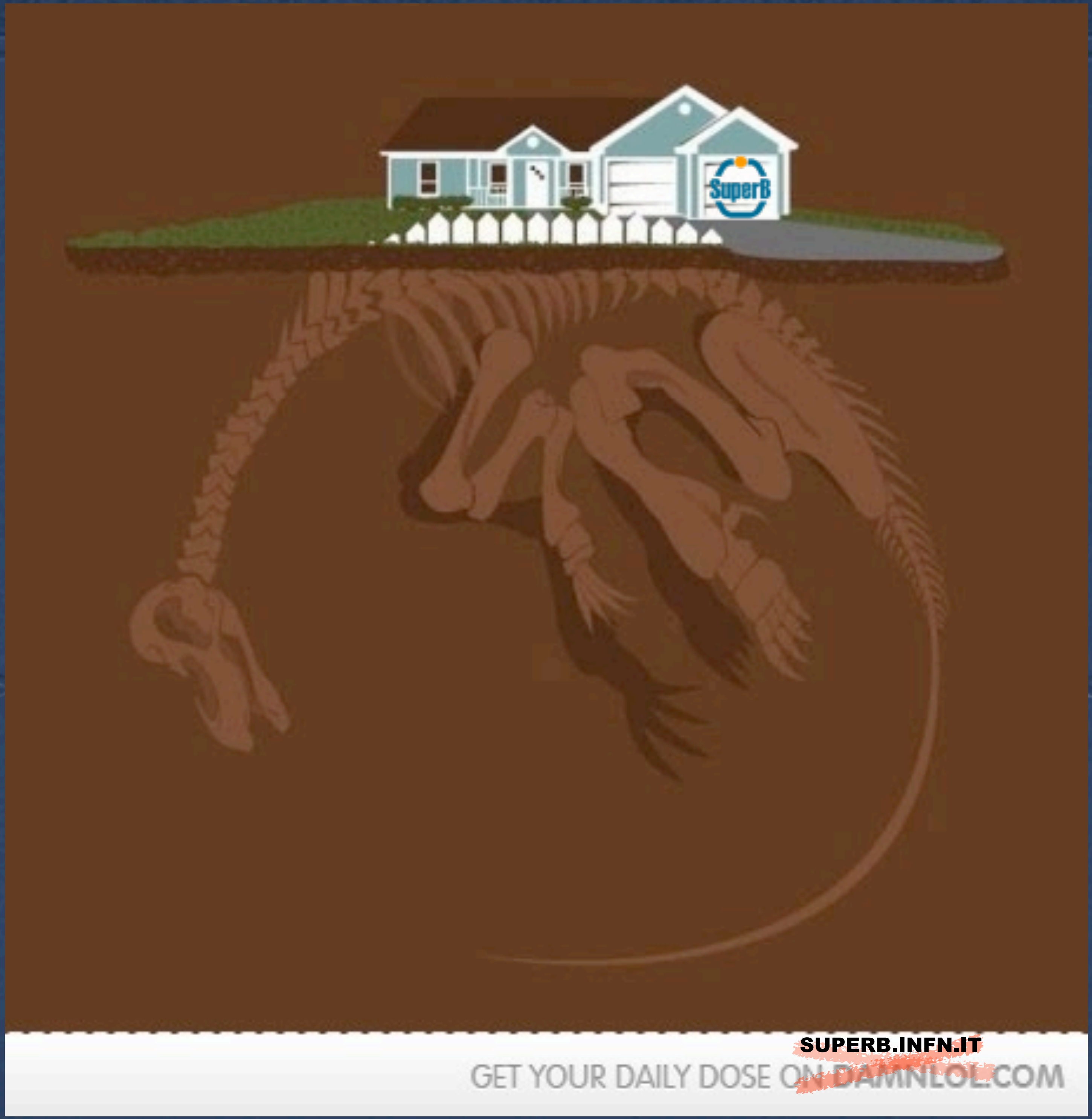
Backgrounds: What Lies Beneath



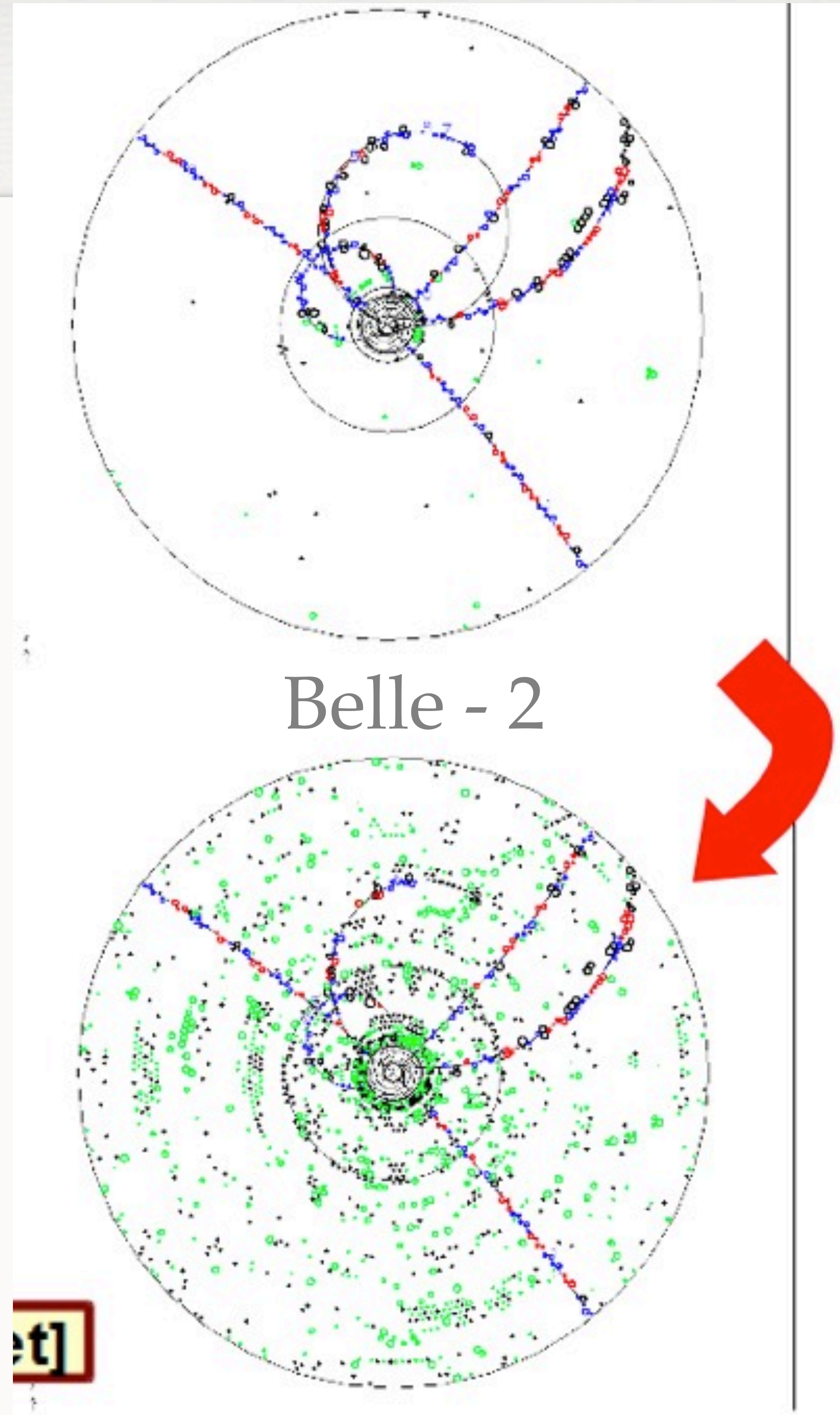
E.Paoloni (INFN & Università di Pisa)
for the MDI & background sim. Task Force

BACKGROUND & PERFORMANCES

- Background effects on performances can be categorized in
  - Instantaneous ones (depending on the instantaneous rate):
    - Pattern recognition confusion
    - Resolution deterioration
  - Long term ones (depending on the integrated doses):
    - Detector aging => performances degradation
    - + backgrounds : (

Tracking

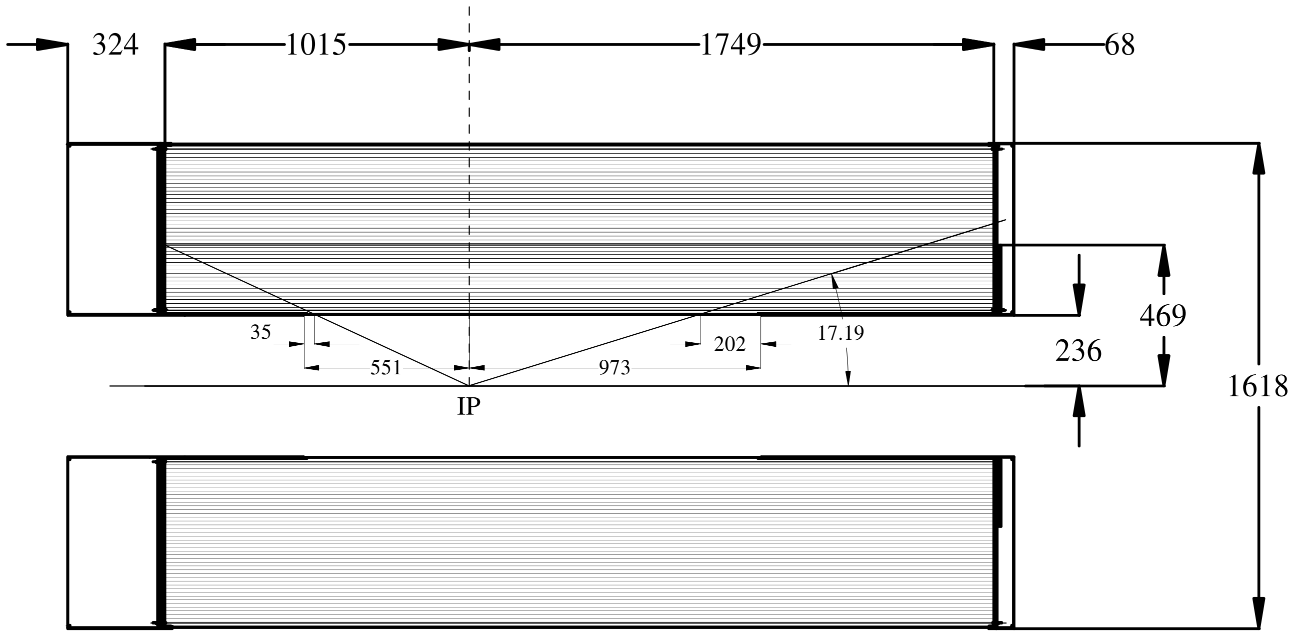
- Instantaneous ones:
  - Hit shadowing (SVT DCH) => hit efficiency
  - Pattern recognition => tracking efficiency
- background hit misassignment => resolution degradation

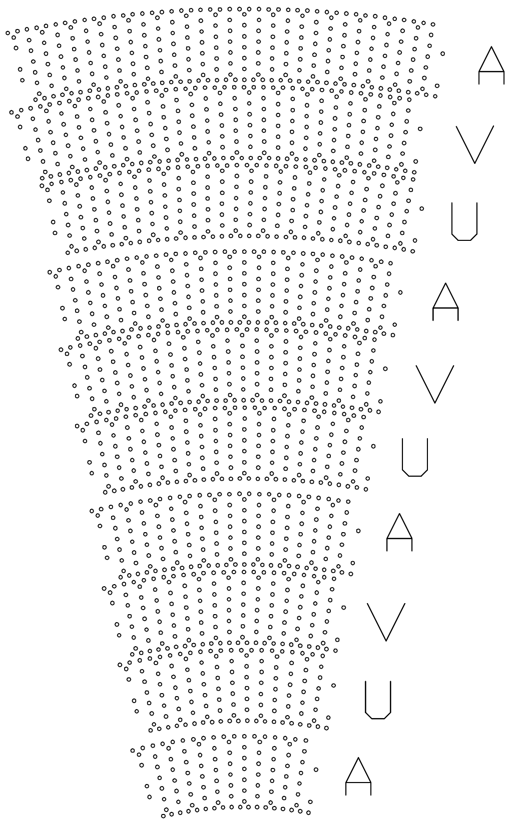


BaBar Experience (2005)

Drift Chamber design and operation

- Main tracking device in BaBar surrounding SVT
- 2.8m length, 1.6m diameter, 7104 sense wires
- 40 axial and stereo layers of 1-2cm hex cells
- Gas: 80:20 He:C_4H_{10}, 4000 ppm H_2O vapor
- Operating voltage: 1930V





Reconstruction

- Single hit resolution 125 μm
- Momentum resolution, p_T : $0.45\% + 0.15\%\ p_T/(\text{GeV}/c)$
- Tracking efficiency : $>$95% matching with SVT tracks
- $\mathrm{d}E/\mathrm{d}x$ resolution $\approx 7.5\%$

Tracking at high luminosity

- Mix Monte Carlo $B \to D^{(*)} D^{(*)}$ with real random-trigger data
- Multiple triggers overlaid to match luminosity extrapolations
- Evaluate physics quality relative to current performance

$100 \text{ x } 10^{34}$
(?? x bkg)

Compared to design 3×10^{33} $\mathcal{L}$	2×10^{34} ($3\times$ bkg)	4×10^{34} ($5\times$ bkg)	4×10^{34} ($10\times$ bkg)
Tracking eff. (%)	$98.6 \pm 0.1 \pm 0.7$	$97.4 \pm 0.1 \pm 1.0$	
Momentum $\sigma(p)/p = 4.7 \times 10^{-3}$	$+4.2 \times 10^{-5}$	$+5.5 \times 10^{-5}$	
$D^0 \to K^+\pi^-$ (%)	96.0 ± 0.5	95.5 ± 0.5	80 ± 3
D^0 Mass $\sigma = 6.5 \pm 0.2$ MeV/c^2	6.5 ± 0.2	6.4 ± 0.2	7.0 ± 0.3
$D^* \to D^0\pi$ (%)	84.4 ± 1.1	75.0 ± 1.3	*25* ± 2
D^* Mass $\sigma = 0.80 \pm 0.03$ MeV/c^2	0.97 ± 0.04	1.50 ± 0.08	3.2 ± 0.8

$$\text{Occupancy}(\%) = 0.61 + 0.17\, I_{LER} + 3.97\, I_{HER} + 0.42\, \mathcal{L} + 0.21\, I_{LER}\ (\text{beam} - \text{beam}) + 0.03\, \mathcal{L}\ (\text{trickle inj.})$$

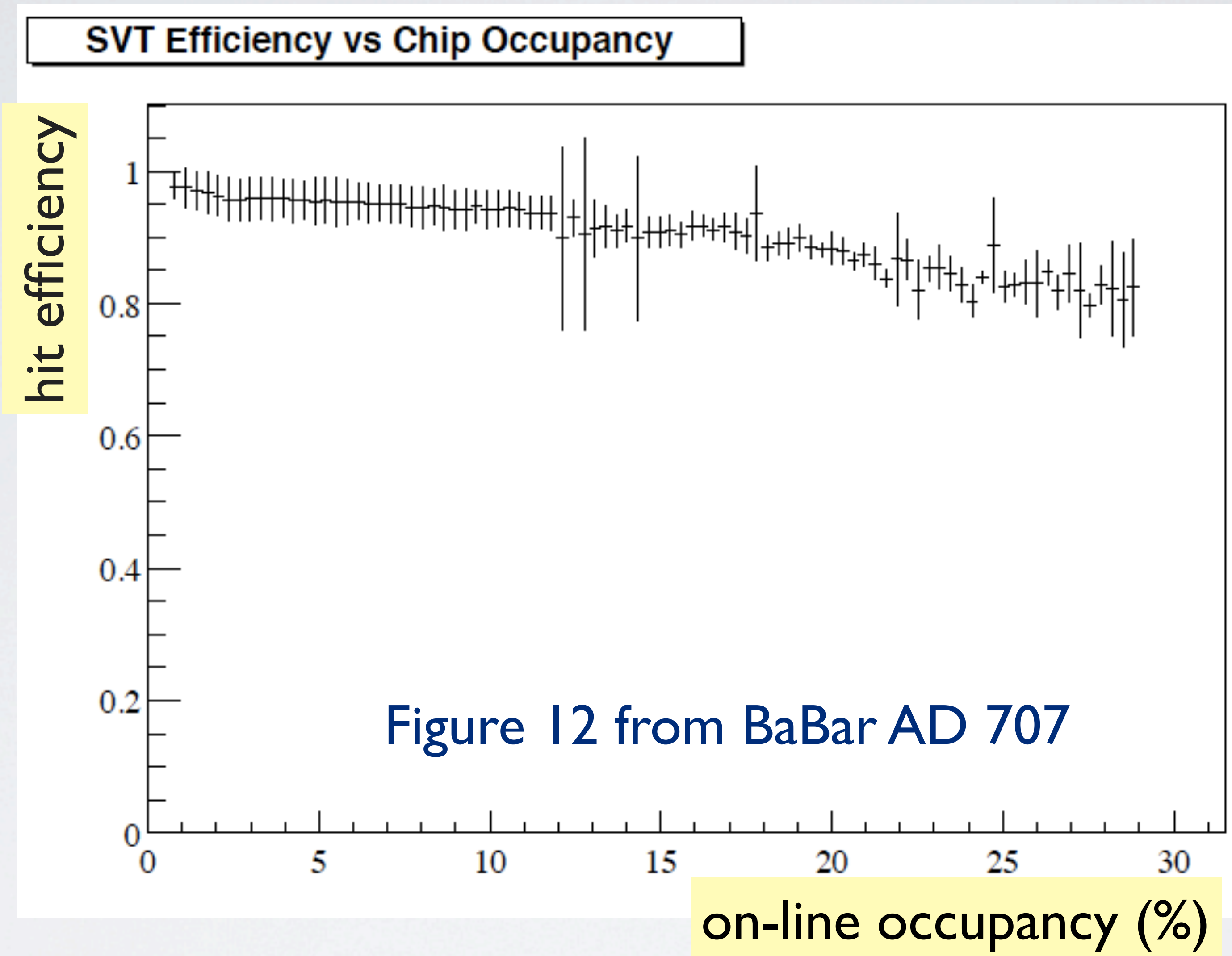
DCH Notables Figures of Merit

- Track reconstruction efficiency as a function of pt
- Track parameters resolution
- dE/dx resolution
- How are they affected by backgrounds conditions?

SVT STUDIES

- So far Isabelle Ripp-Baudot evaluated the effect of the background on a “SvtTrkHitAdd” like algorithm assuming DCH performances comparable to the BaBar one

study of tracking performances with BaBar data

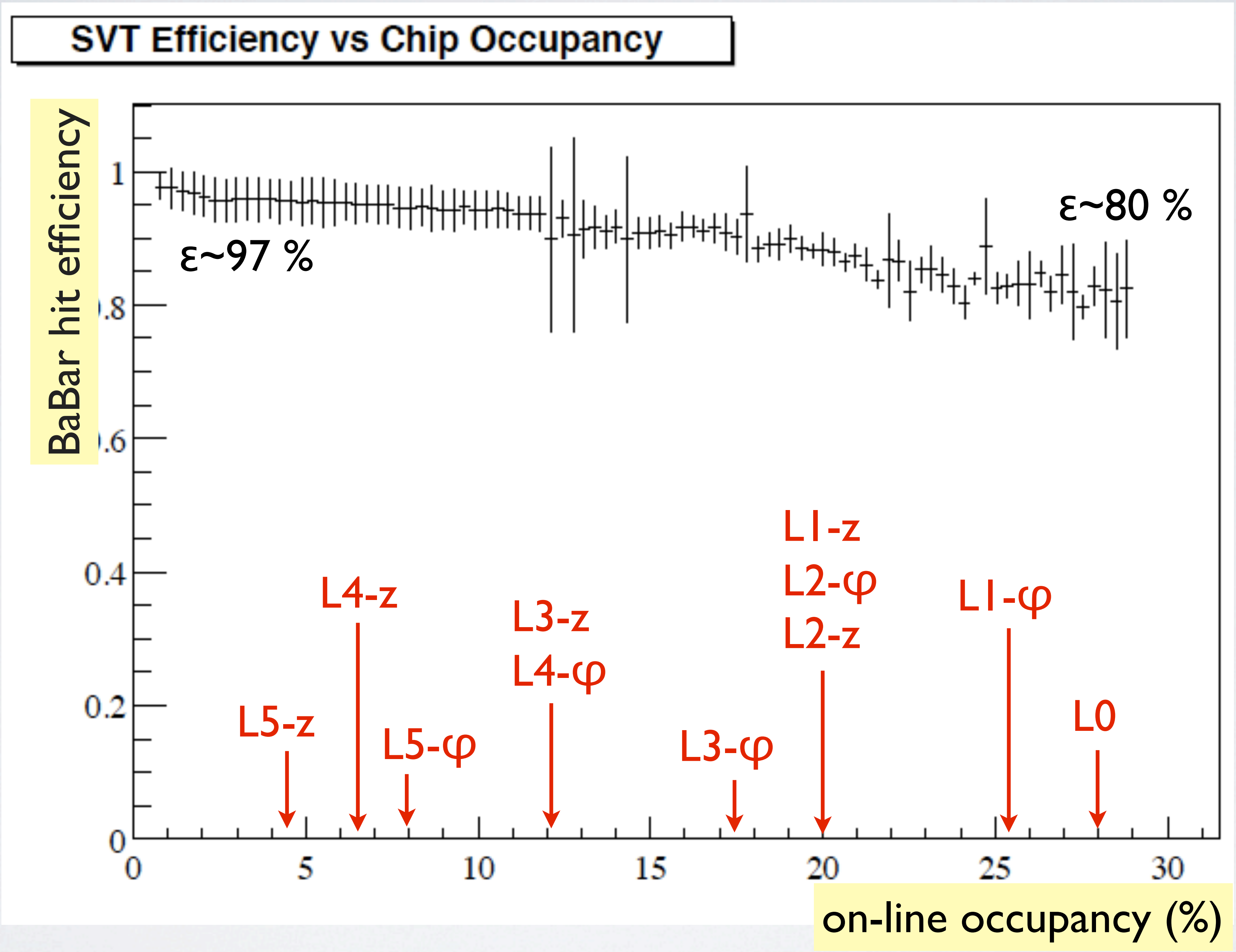


BaBar AD 707: Final Report of the SVT Long Term Task Force (2004):
Study with BaBar dimuon data taken between Jan. and June 2003 (instantaneous luminosity increasing), of hit efficiency as a function of chip on-line occupancy.

➢ how to translate this BaBar study to SuperB?

Isabelle

on-line occupancy (3)



➛ **on-line occupancy in SuperB is 2 to 10x higher than in BaBar.**

Isabelle

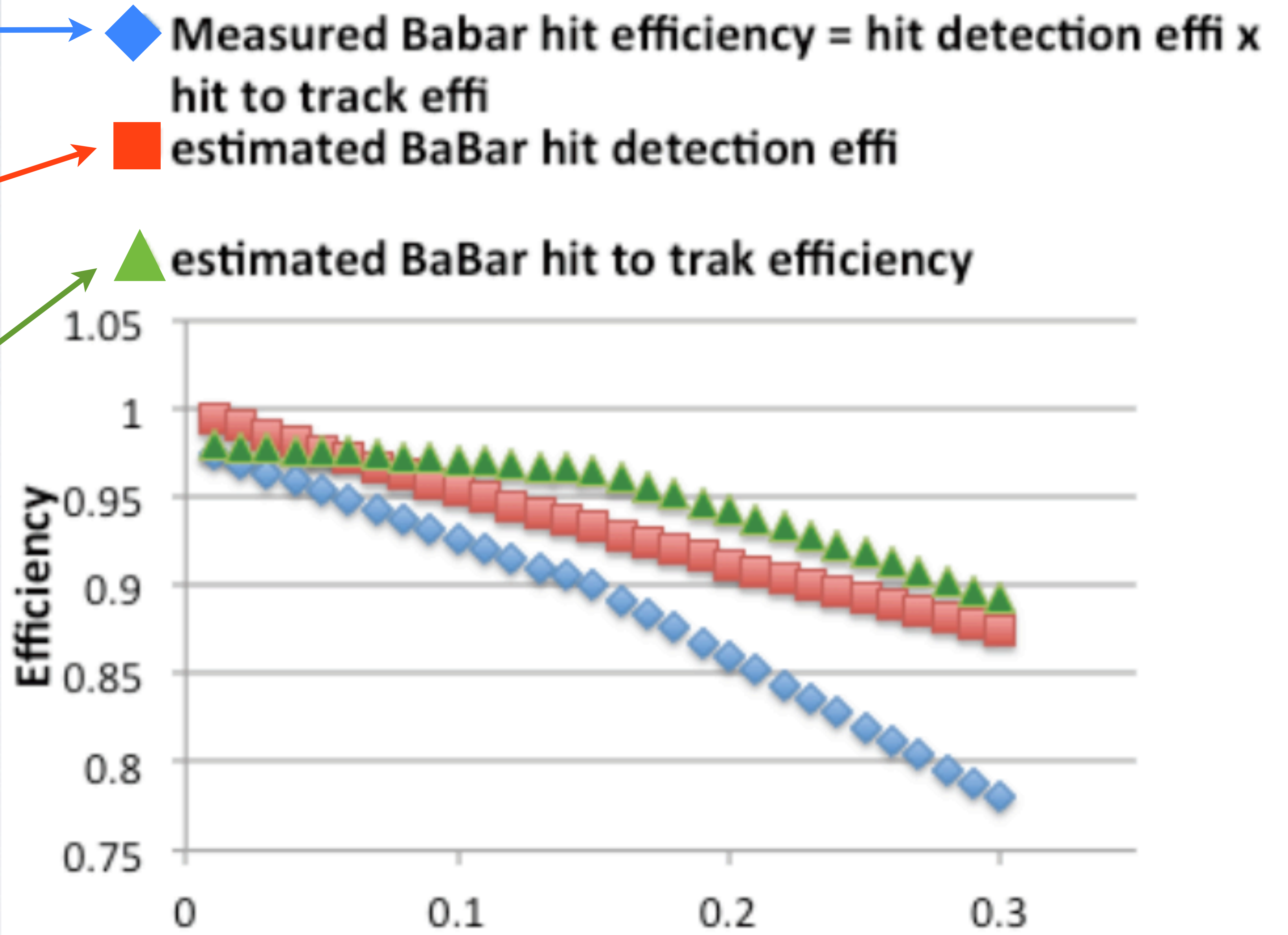
estimation of BaBar hit detection efficiency (2)

measured y-axis of figure 12 from BAD 707

estimation of shadowing $1 / (1 + R_{lost})$

obtained through:

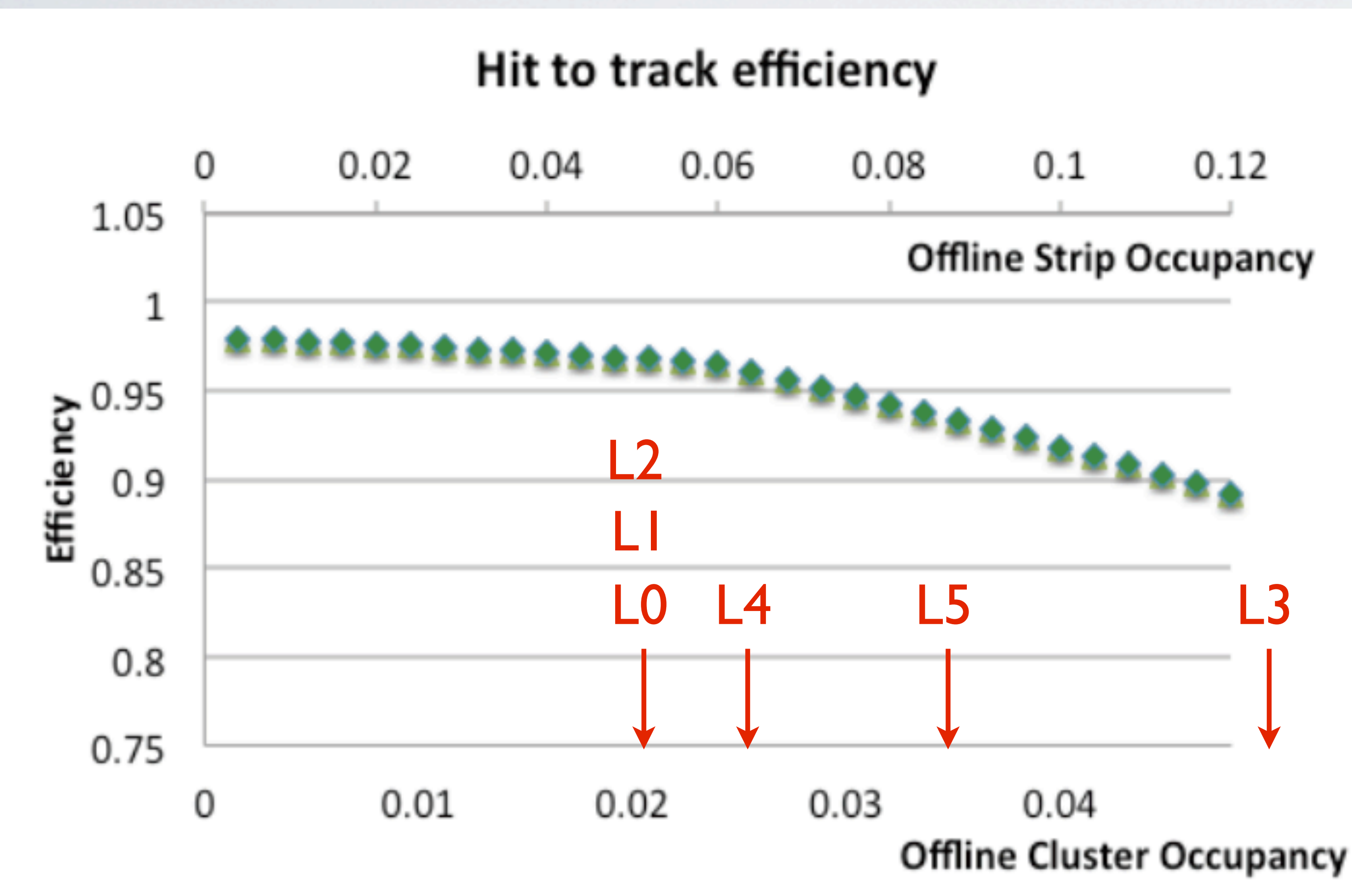
▲ = ◆ / ■



from Giuliana

hit-to-track matching efficiency as a function of off-line cluster occupancy (2)

And then see where SuperB Layers are on this curve:



Layer	View	Strip rate with renormalized area KHz estimates	time window [illegible] used by neri) ns	offline cluster occupancy (x5 included)
0	1	9.32E+02	100	0.023
0	2	9.32E+02	100	
1	phi	8.479E+02	150	0.022
1	z	6.700E+02	150	
2	phi	6.649E+02	150	0.019
2	z	6.652E+02	150	
3	phi	5.770E+02	250	0.050
3	z	3.942E+02	250	
4	phi	1.241E+02	460	0.025
4	z	6.643E+01	460	
5	phi	8.034E+01	800	0.034
5	z	4.361E+01	800	

Giuliana

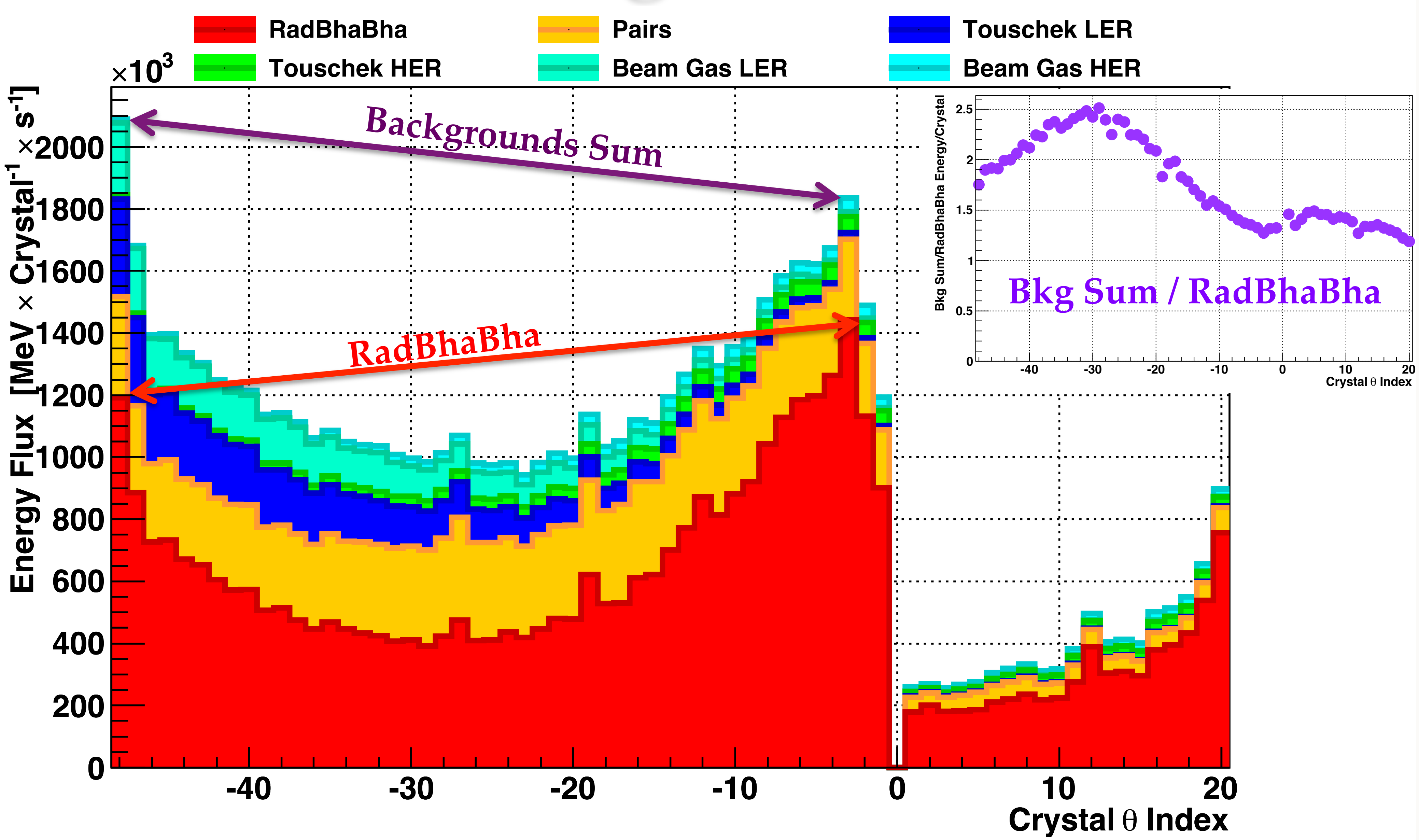
Isabelle

estimation of SuperB hit efficiency

Layer	on-line strip occupancy (x5 included)	off-line cluster occupancy (x5 included)	hit detection efficiency (simulation) (x5 included)	hit-to-track matching efficiency (estimation from off-line cluster occ.)	total hit efficiency
0 φ	0.28	0.023	0.96	0.96	0.92
0 z	0.28		0.96		0.92
1 φ	0.25	0.022	0.88	0.96	0.84
1 z	0.20		0.89		0.85
2 φ	0.20	0.019	0.89	0.97	0.86
2 z	0.20		0.89		0.86
3 φ	0.20	0.050	0.77	0.88	0.68
3 z	0.17		0.86		0.76
4 φ	0.12	0.025	0.89	0.96	0.85
4 z	0.07		0.93		0.89
5 φ	0.08	0.034	0.86	0.93	0.80
5 z	0.04		0.91		0.85

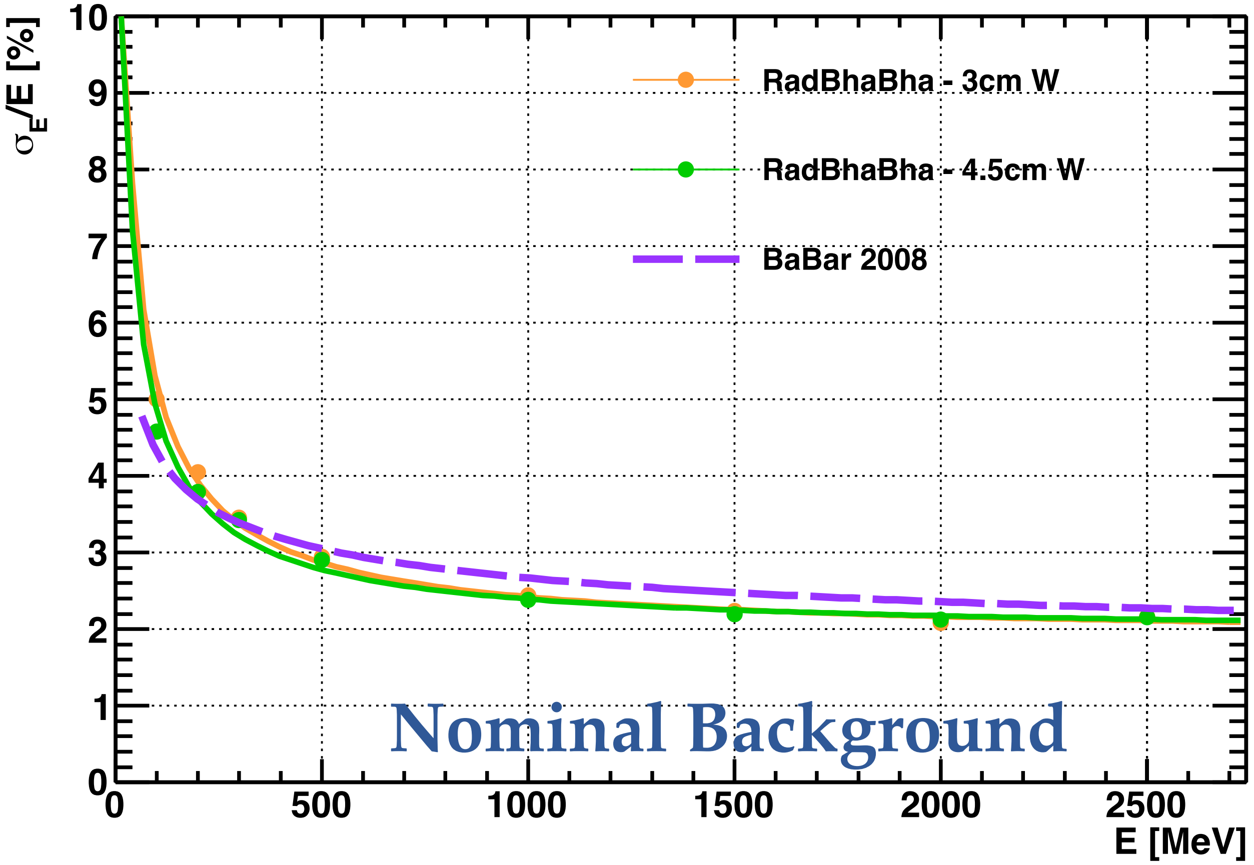
EMC STUDIES (STEFANO G.)

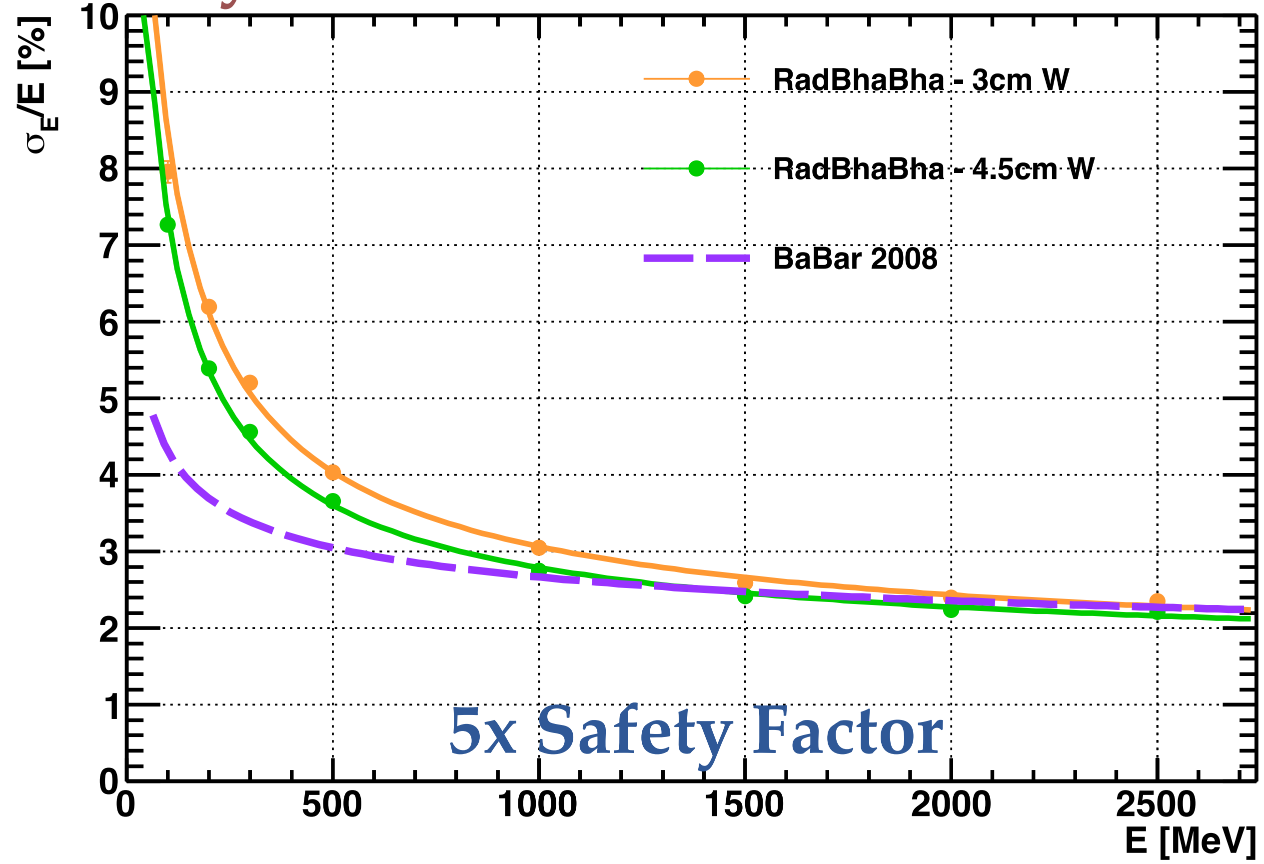
Sum of Bkgs - 45 mm W

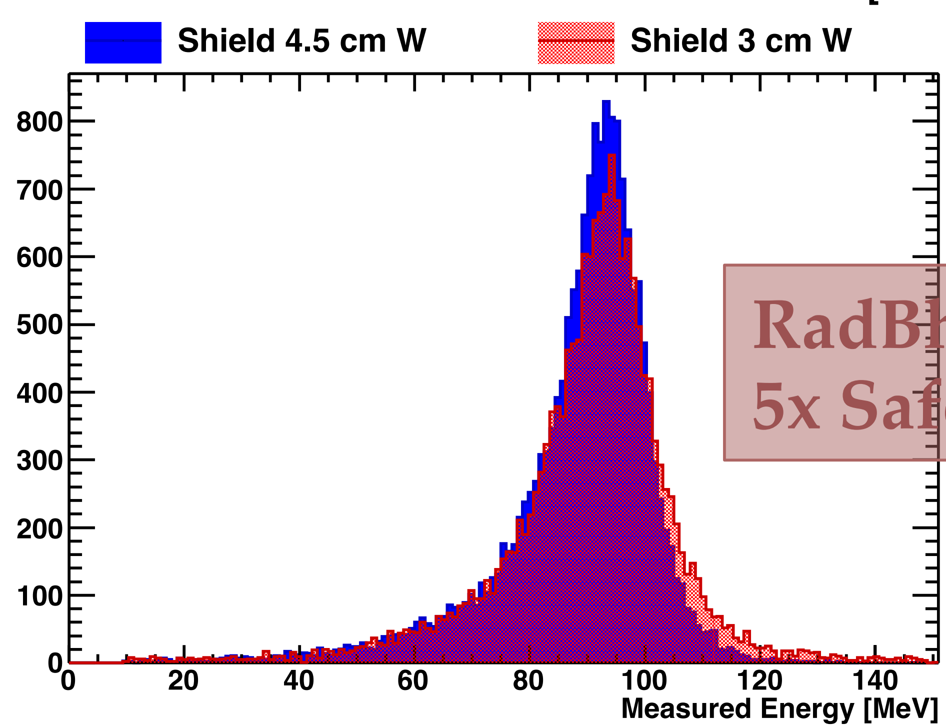


Barrel Resolution vs Shield

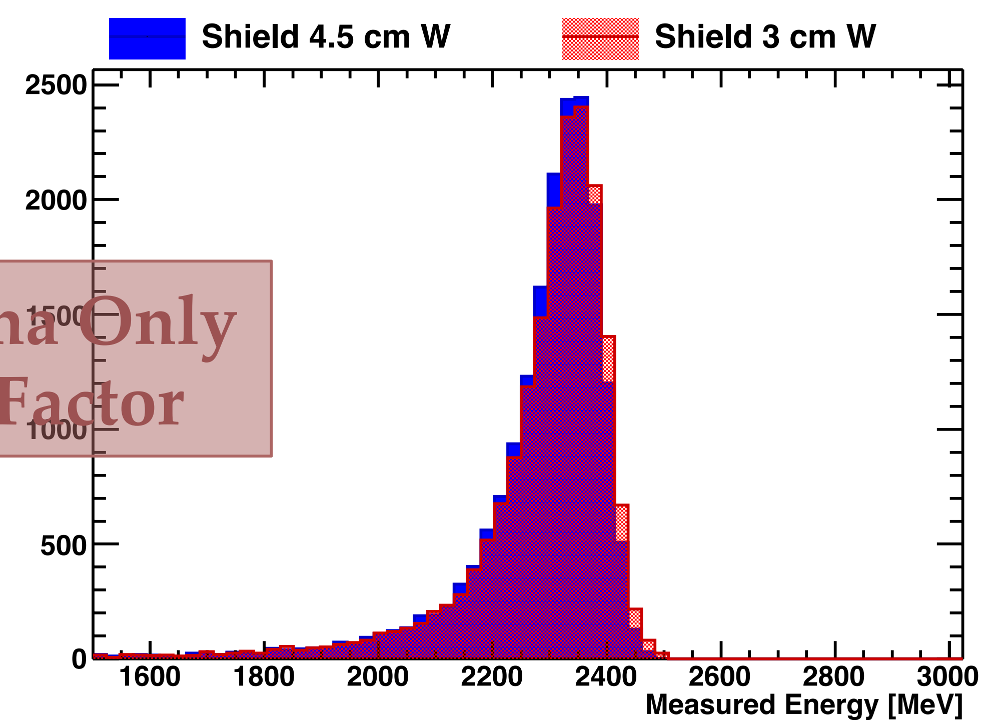
RadBhaBha Only





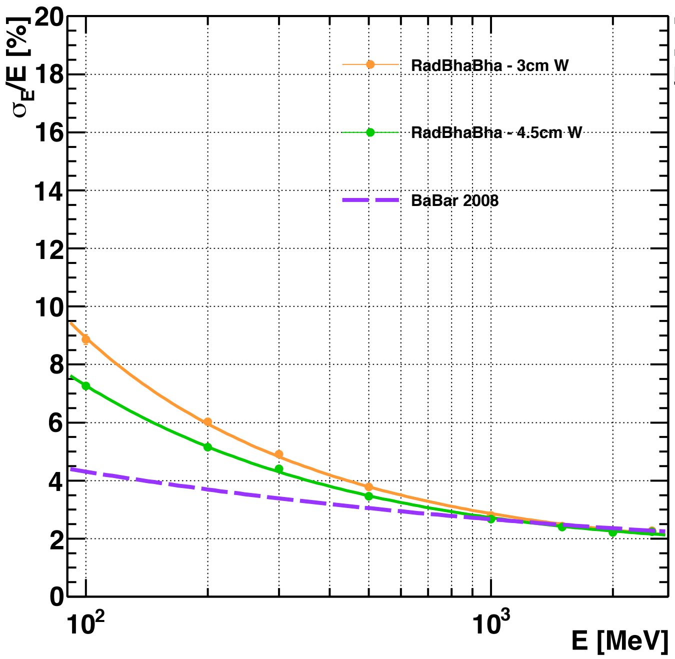


RadBhaBha Only
5x Safety Factor

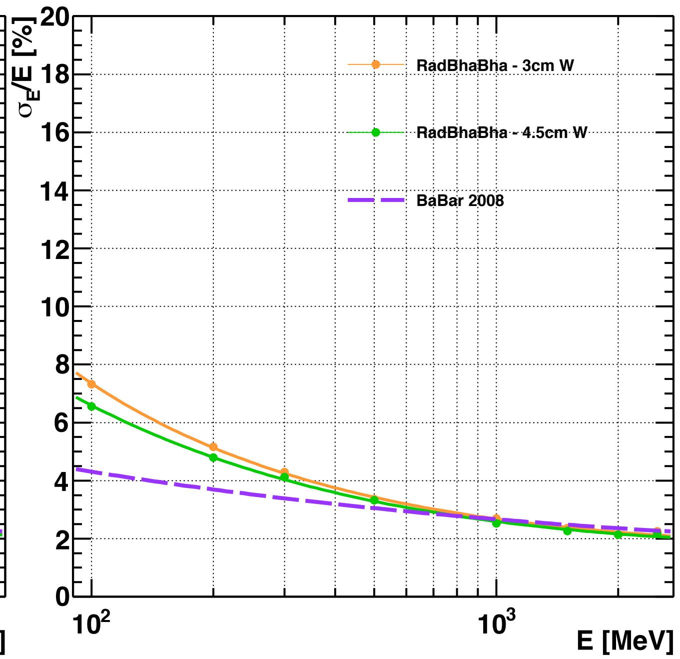


Shield Effect vs Theta (x5)

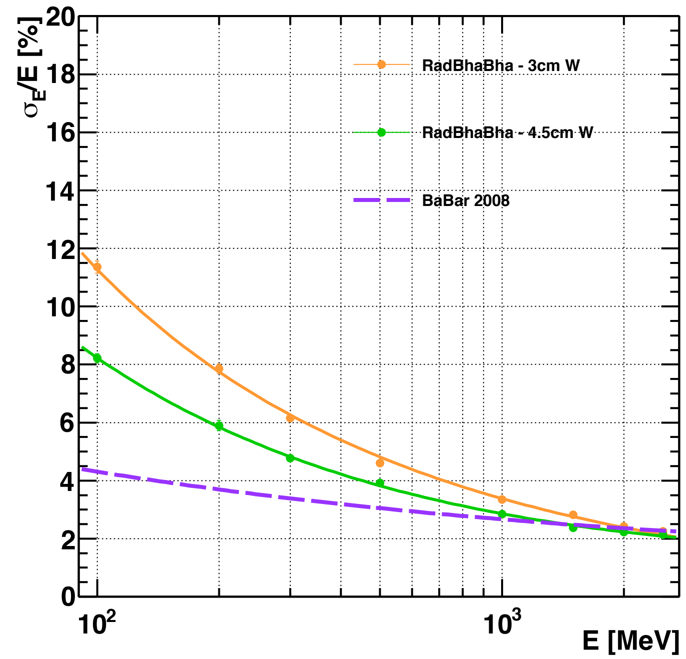
Theta 100-140



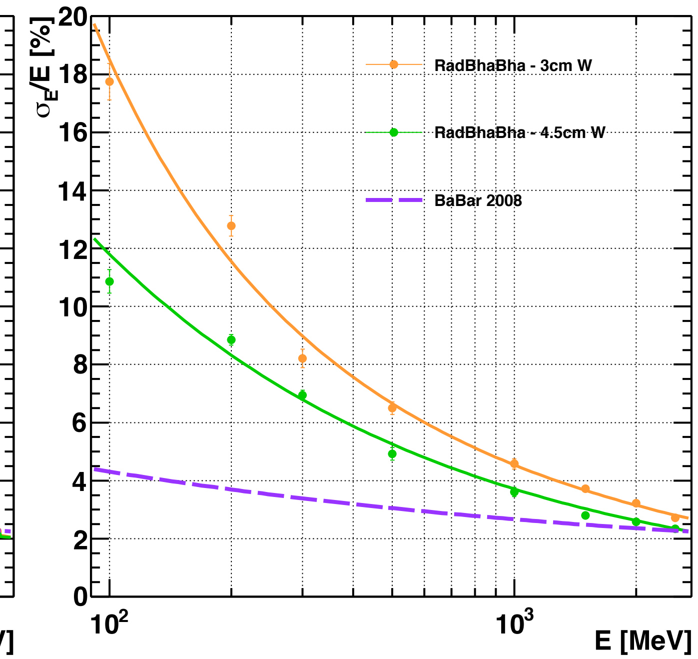
Theta 60-100



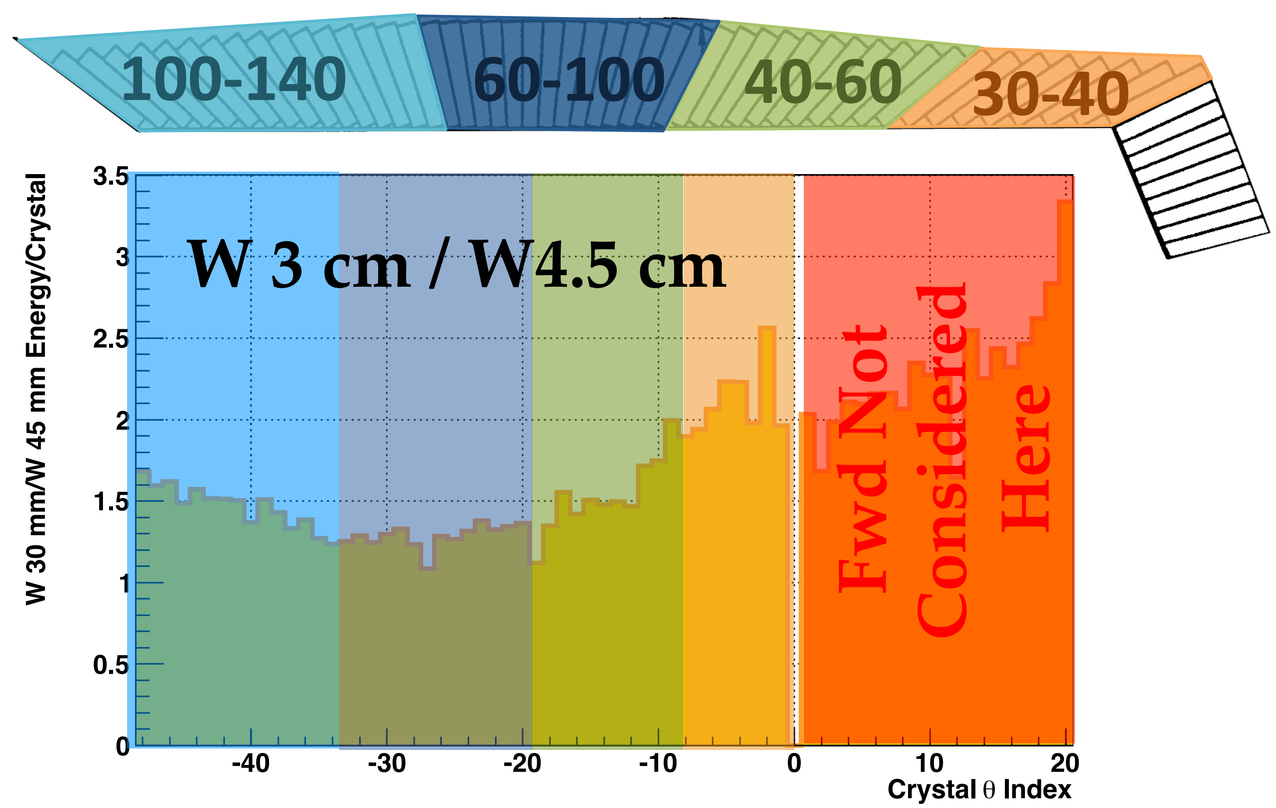
Theta 40-60



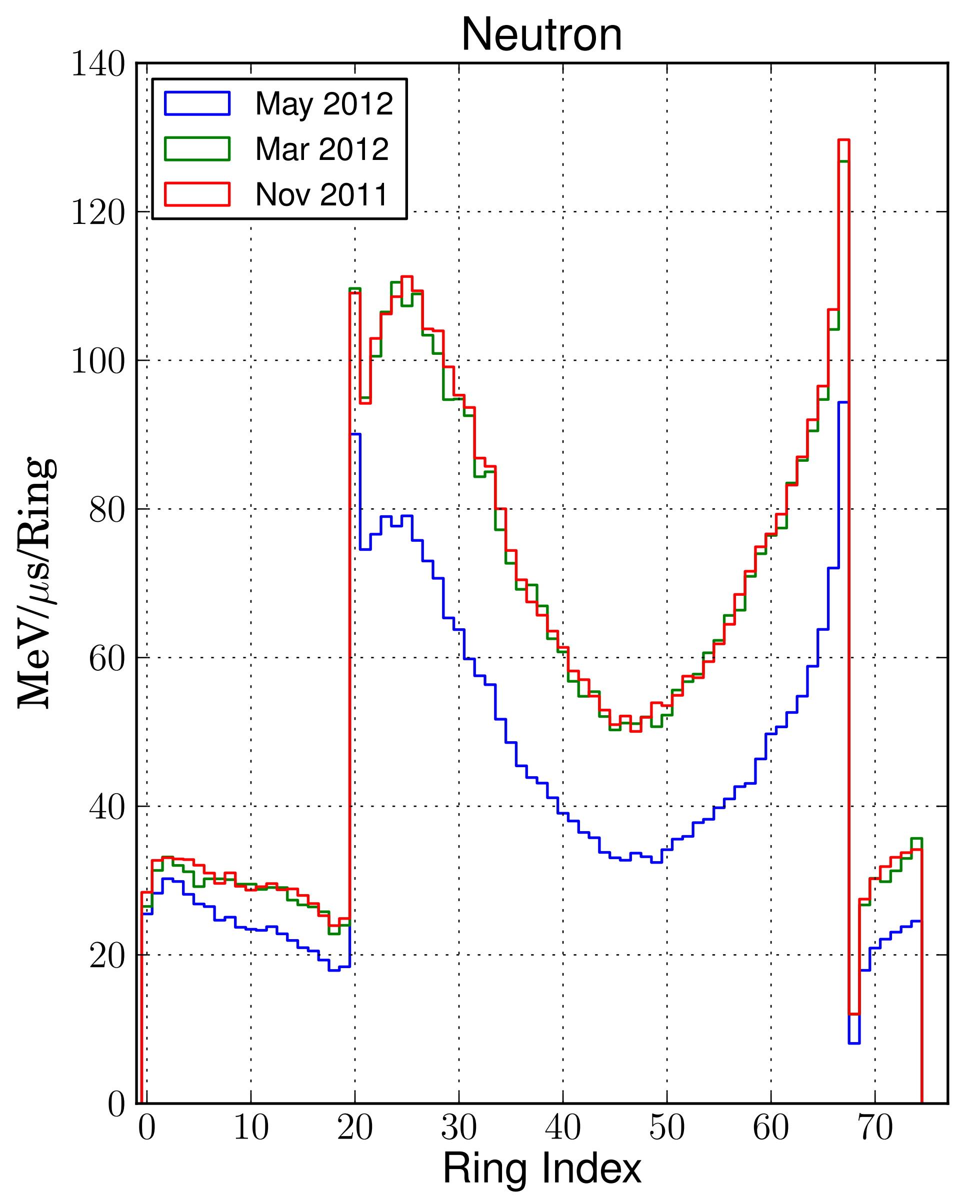
Theta 30-40

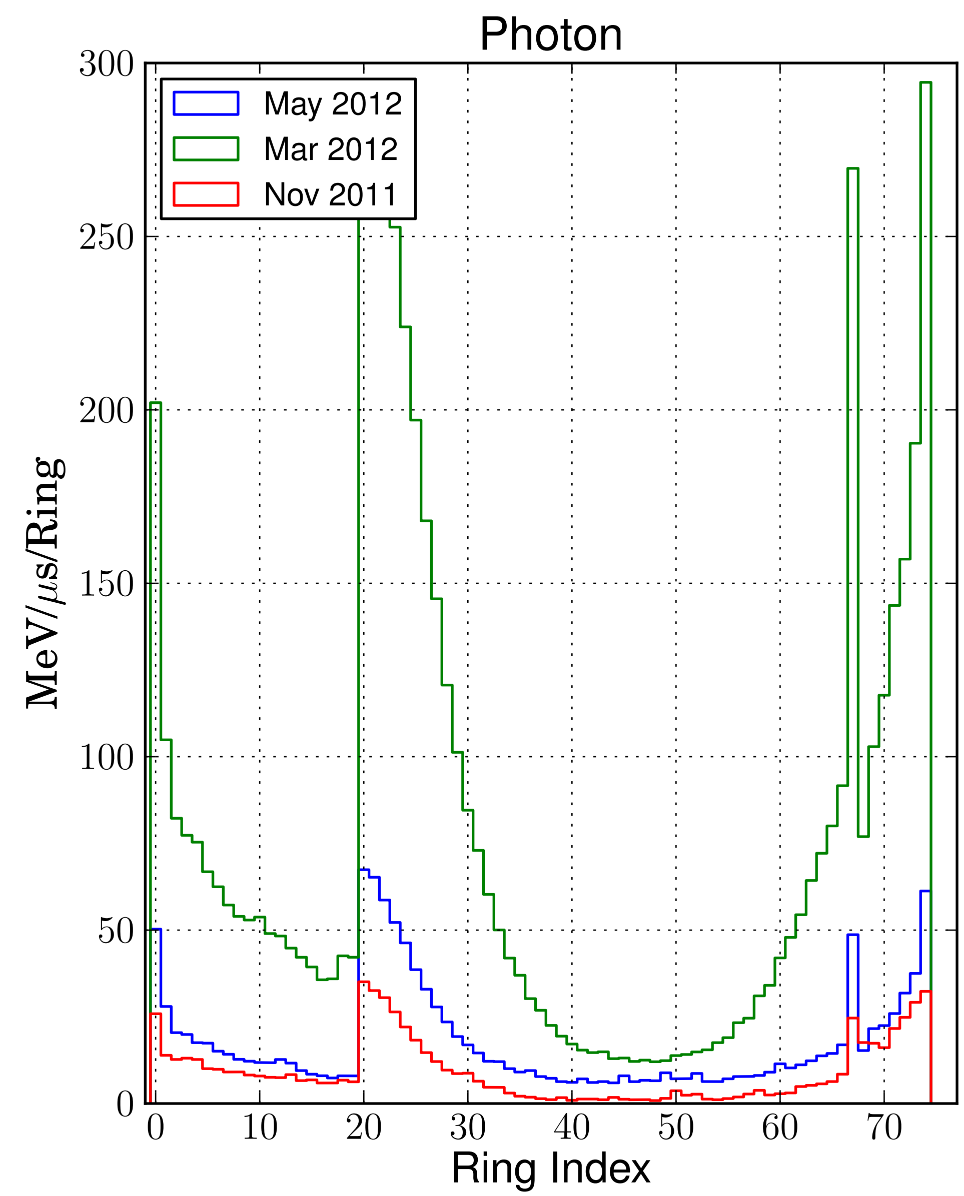


- ✓ Large performance improvement in fwd region
- ✓ Small effect in central barrel region
- ✓ More uniform Barrel performance across θ angles



Energy flux per ring



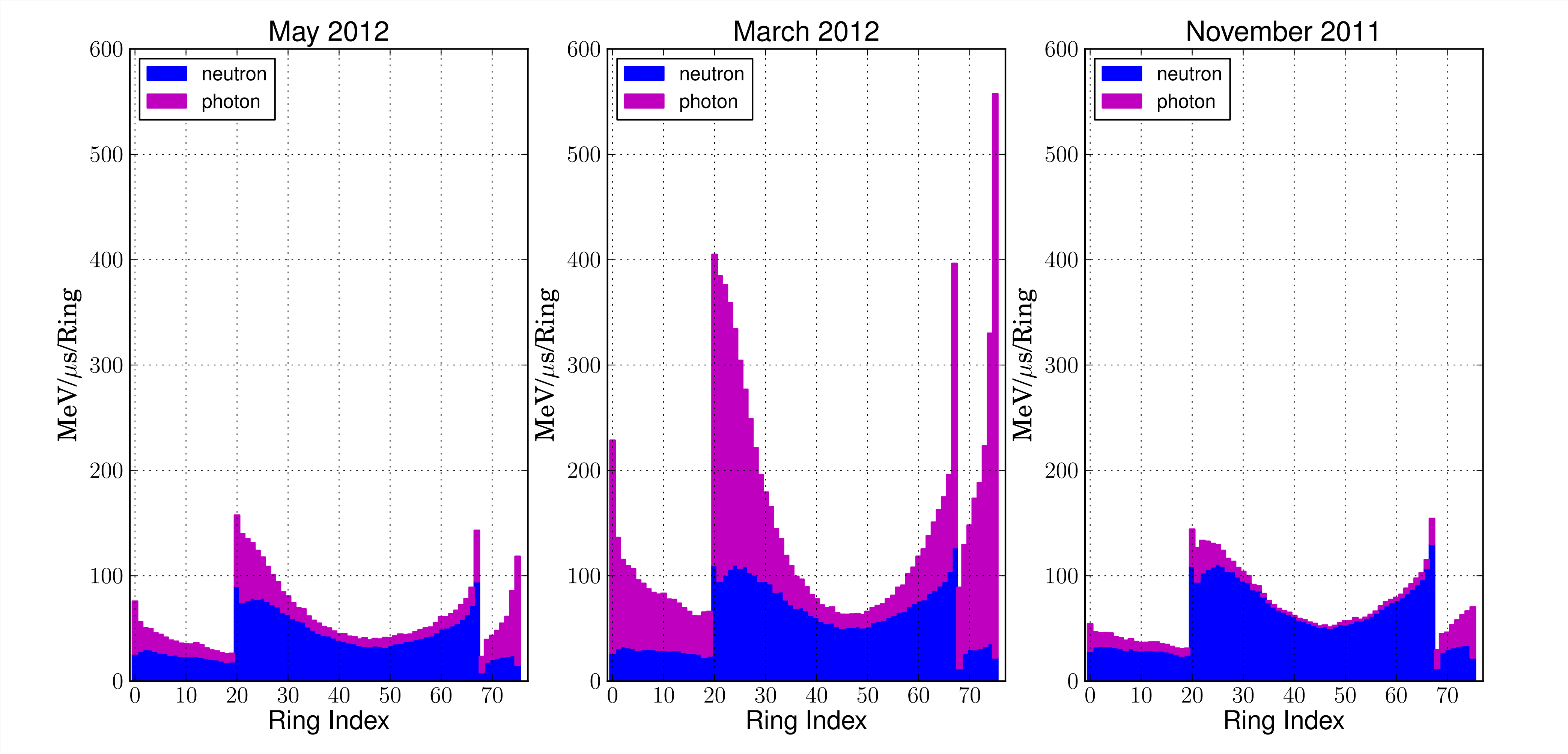


Neutron energy flux reduced by 20% –30% with new shielding

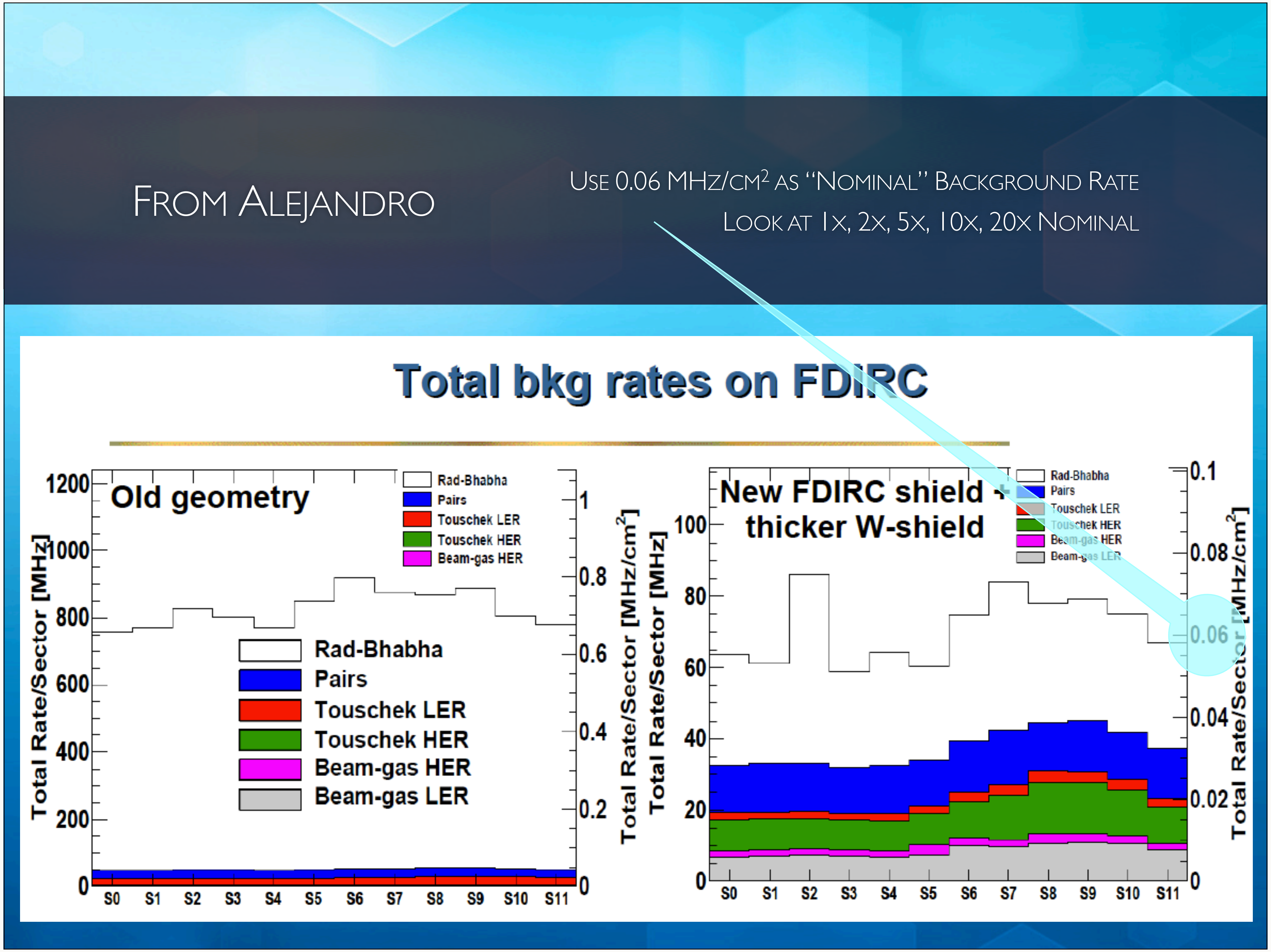
Photon energy flux reduced by ~4x with new shielding

EMC Performances

- Stefano is working on the determination of the EMC angular resolution in presence of background
- Energy resolution can be improved by reducing the neutron flux

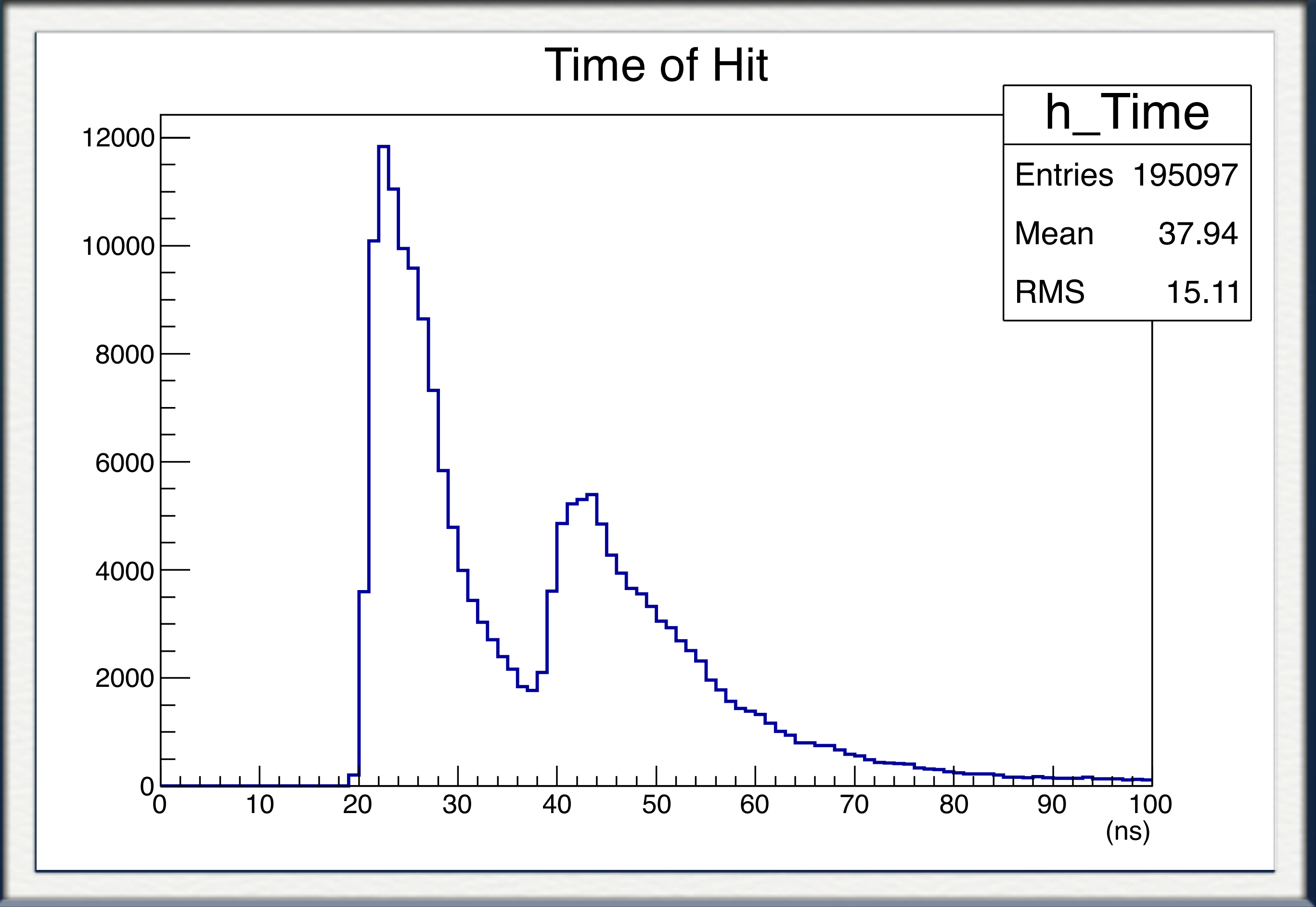


FDIRC (D. Roberts)



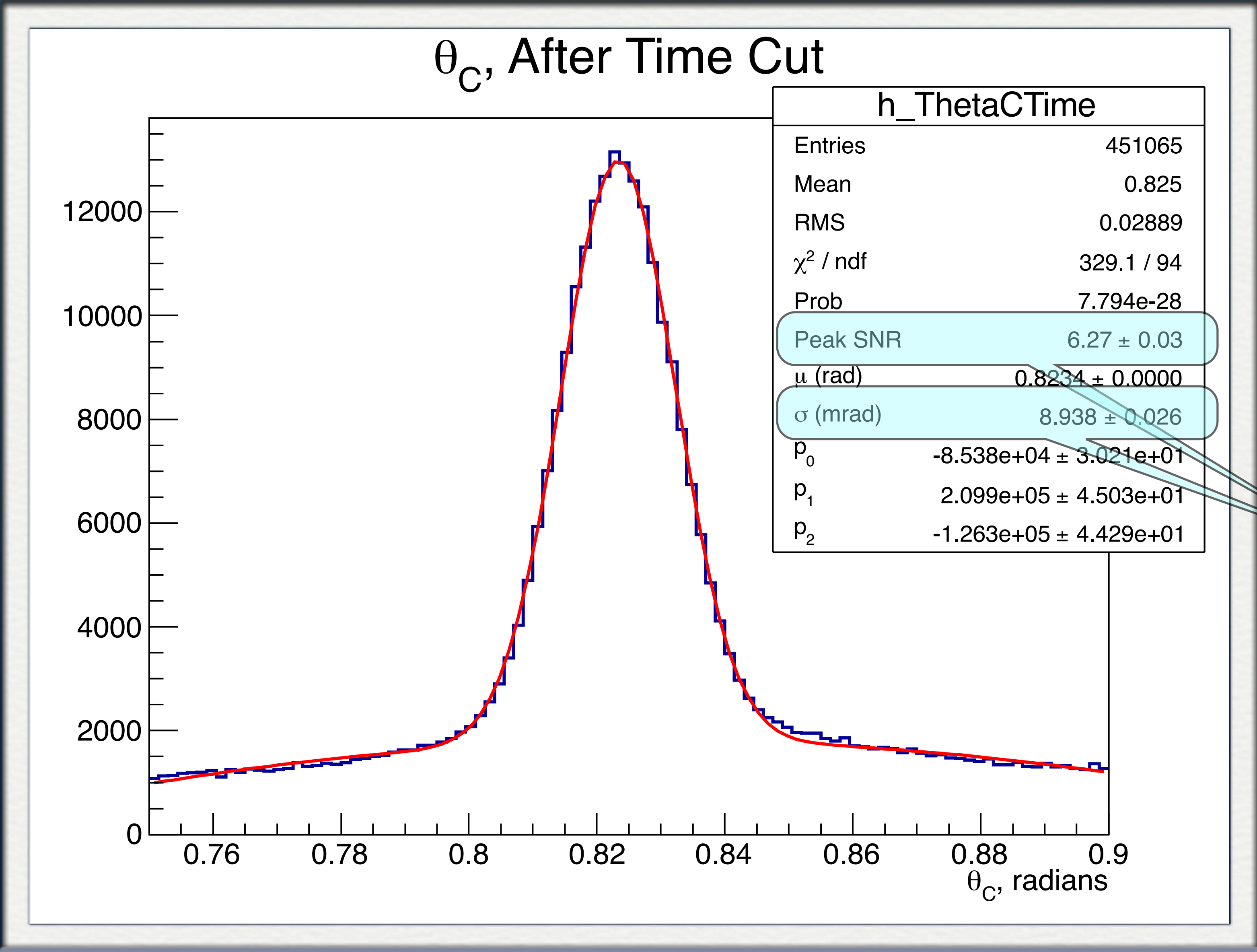
Simulation Parameters

- Background hits:
  - Randomly distributed over detector plane in Space
  - Uniformly random in Time from -25ns to 500ns
- Hits "Masked" if there is another hit <25ns earlier in the same pixel
- Simulated 10,000 cosmic tracks
- Used "Abs(Kx), Abs(Ky)" version of Photon Dictionary
- Full FDIRC (48 tubes in a sector)



Doug

Single Photon Resolution



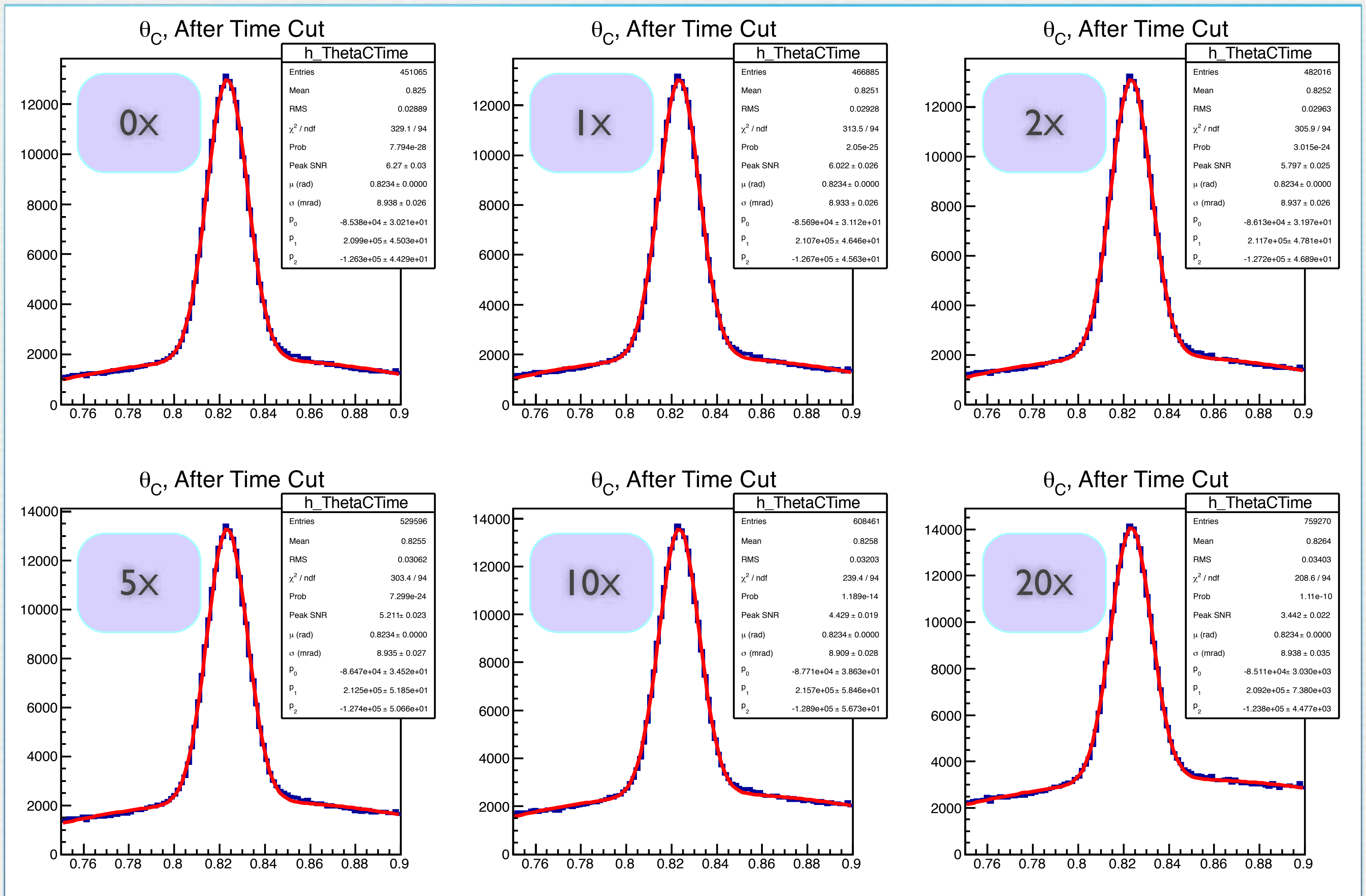
- No Background
- Fit to a Gaussian plus 2^{ND} order polynomial
- Look at σ and Peak Signal-to-Noise Ratio
- Tails come from ambiguities

Doug

Line Shape vs. Background

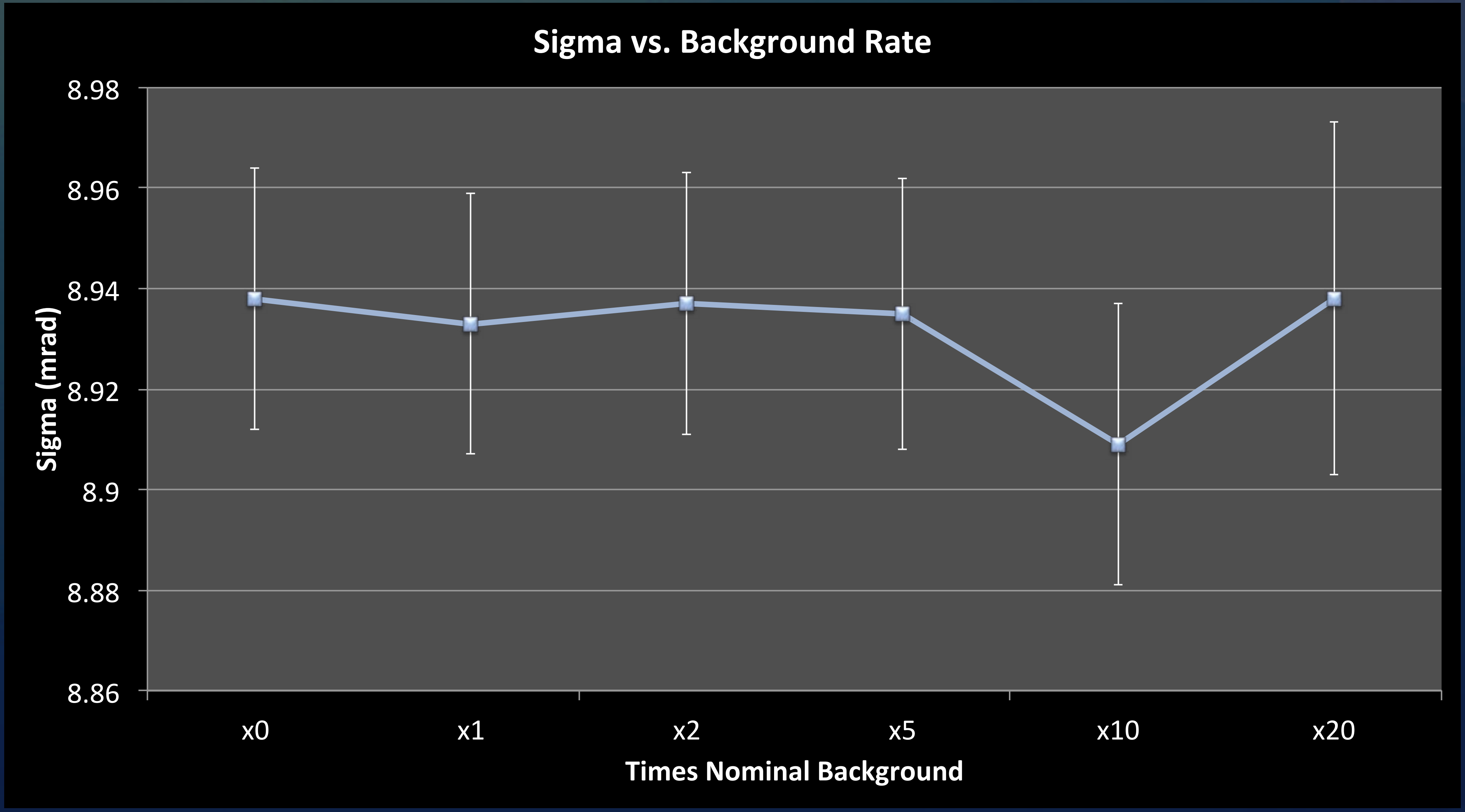
No effect on sigma

Begin to notice effect on SNR at 10x and 20x nominal rate



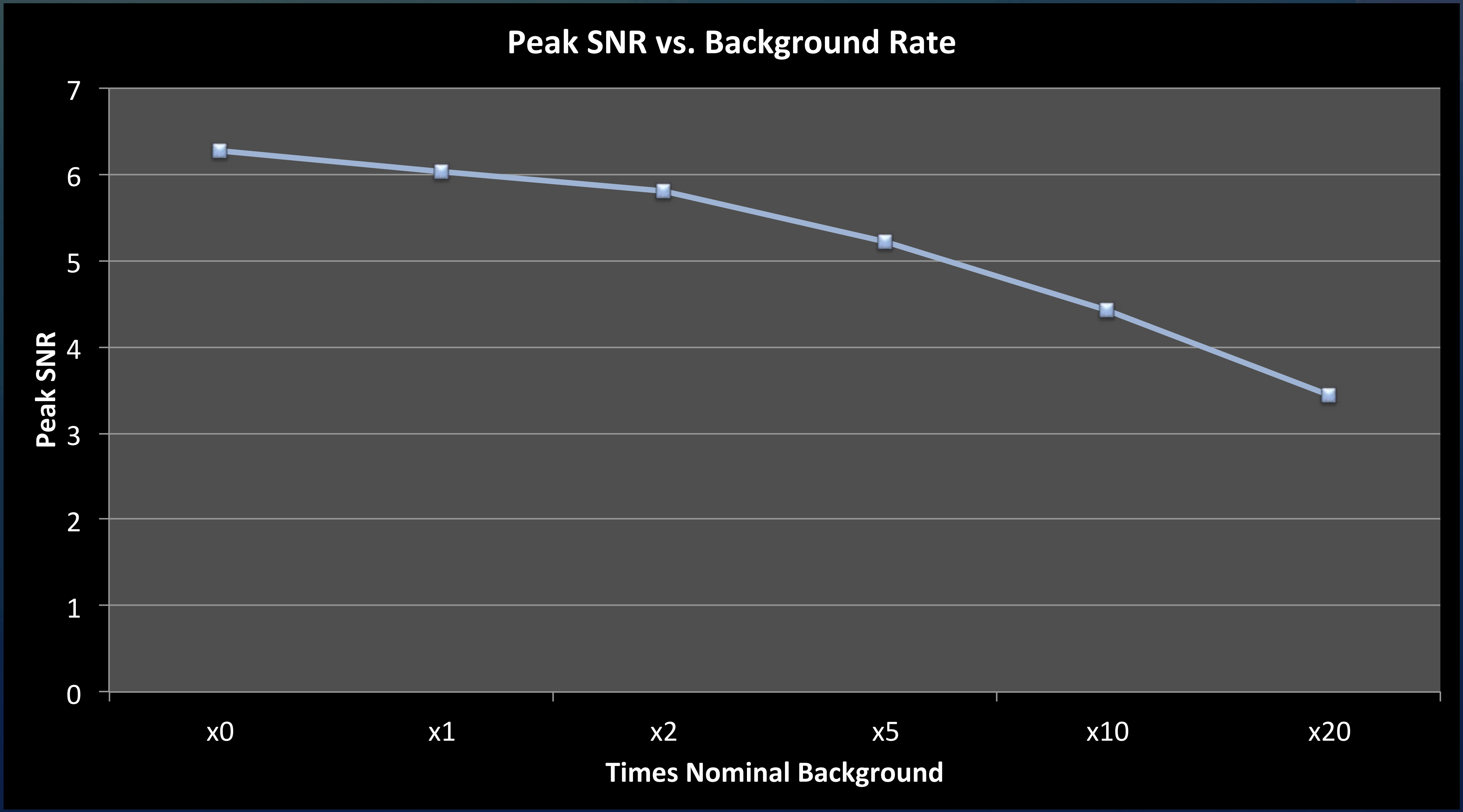
Doug

Sigma vs. Background Rate



Doug

Peak SNR vs. Background Rate



Doug