Influence of Low-P Parametersets on ILD?

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ILC RDR Parameter Sets

Low-P Parameter Set:

- Half the number of bunches
- Less RF needed
- Luminosity recovered by squeezing bunches harder at the IP
- Beamstrahlung losses larger (factor 2)
- Pair backgrounds larger
- Potential large cost savings!
- E. Paterson:
  - Low P looks interesting if one makes maximum use of lower power in beam in all systems from beginning to end.
    - **This includes installed electrical distributions, cryo-systems, RF power, Beam dumps etc etc**

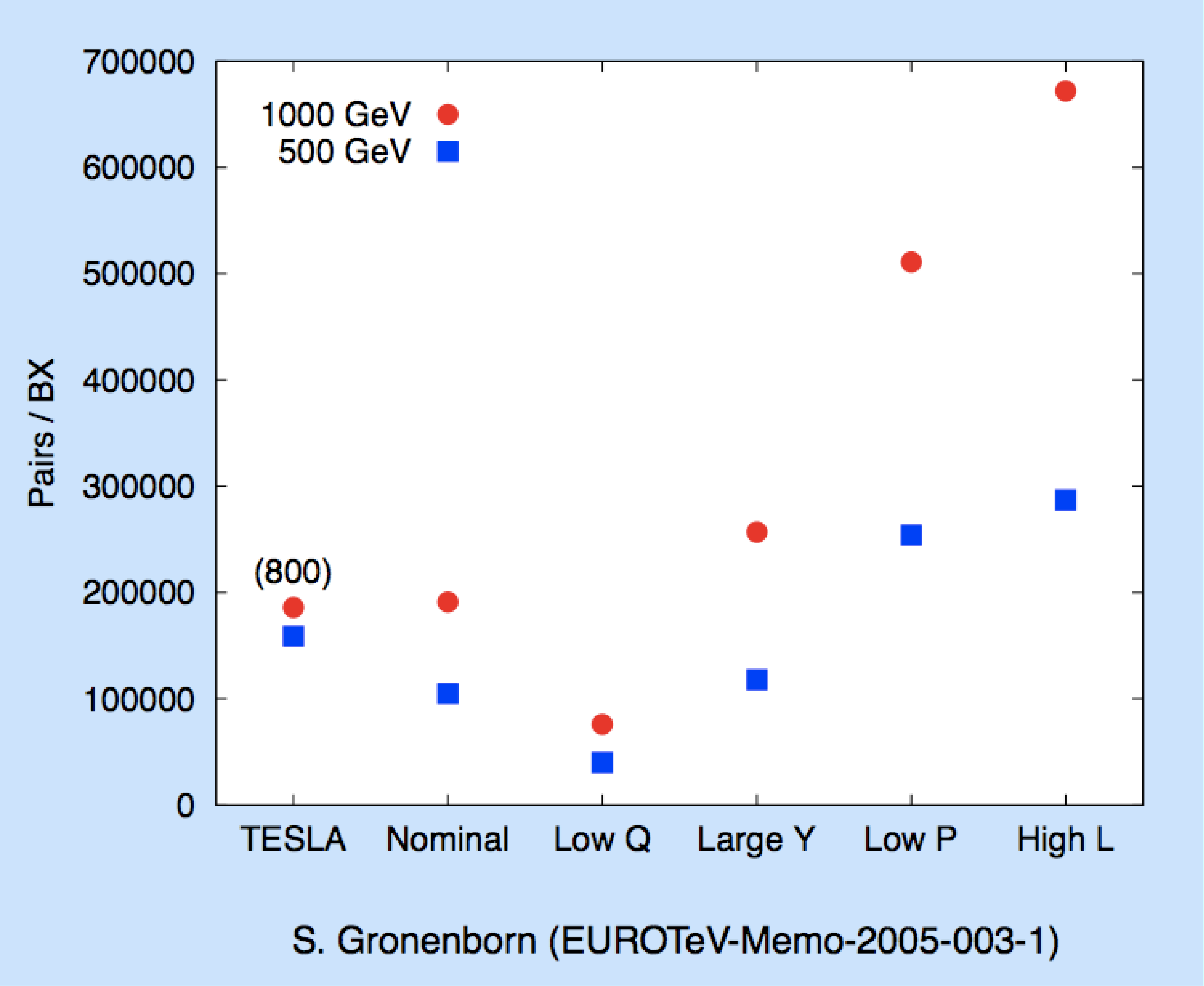
TABLE 2.1-2
Beam and IP Parameters for 500 GeV cms.

Parameter	Symbol/Units	Nominal	Low N	Large Y	Low P
Repetition rate	f_{rep} (Hz)	5	5	5	5
Number of particles per bunch	N (10^{10})	2	1	2	2
Number of bunches per pulse	n_b	2625	5120	2625	1320
Bunch interval in the Main Linac	t_b (ns)	369.2	189.2	369.2	480.0
in units of RF buckets		480	246	480	624
Average beam current in pulse	I_{ave} (mA)	9.0	9.0	9.0	6.8
Normalized emittance at IP	$\gamma\epsilon_x^*$ (mm·mrad)	10	10	10	10
Normalized emittance at IP	$\gamma\epsilon_y^*$ (mm·mrad)	0.04	0.03	0.08	0.036
Beta function at IP	β_x^* (mm)	20	11	11	11
Beta function at IP	β_y^* (mm)	0.4	0.2	0.6	0.2
R.m.s. beam size at IP	σ_x^* (nm)	639	474	474	474
R.m.s. beam size at IP	σ_y^* (nm)	5.7	3.5	9.9	3.8
R.m.s. bunch length	σ_z (μm)	300	200	500	200
Disruption parameter	D_x	0.17	0.11	0.52	0.21
Disruption parameter	D_y	19.4	14.6	24.9	26.1
Beamstrahlung parameter	Υ_{ave}	0.048	0.050	0.038	0.097
Energy loss by beamstrahlung	δ_{BS}	0.024	0.017	0.027	0.055
Number of beamstrahlung photons	n_γ	1.32	0.91	1.77	1.72
Luminosity enhancement factor	H_D	1.71	1.48	2.18	1.64
Geometric luminosity	$\mathcal{L}_{geo}$ $10^{34}/\mathrm{cm}^2/\mathrm{s}$	1.20	1.35	0.94	1.21
Luminosity	$\mathcal{L}$ $10^{34}/\mathrm{cm}^2/\mathrm{s}$	2	2	2	2

- ILC GDE studies for the Minimal Machine will take Low-P parameters into account

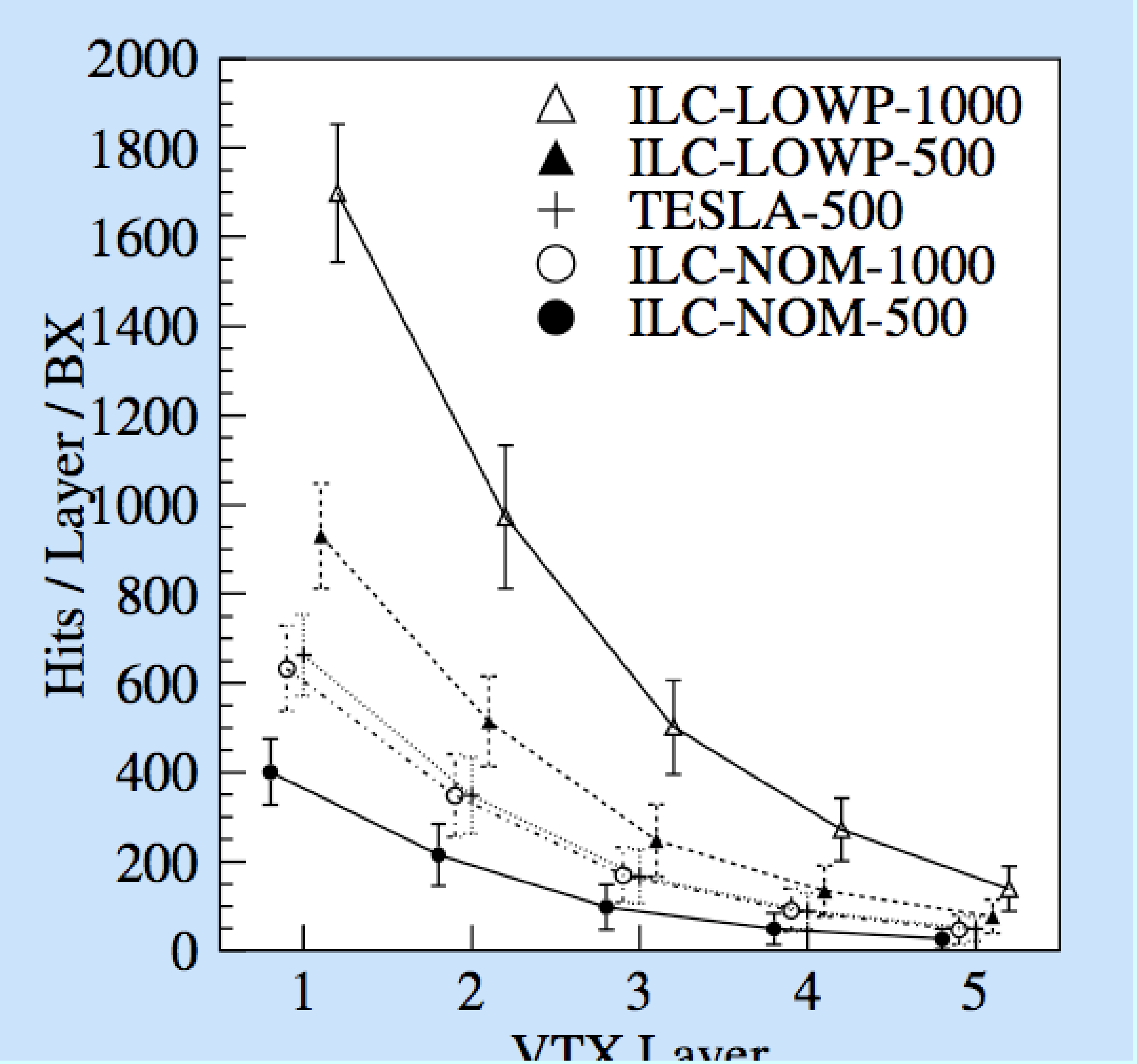
Low-P Background Numbers

- Number of produced pairs per BX is ~2 times larger than at nominal ILC parameters (here w/o travelling focus)



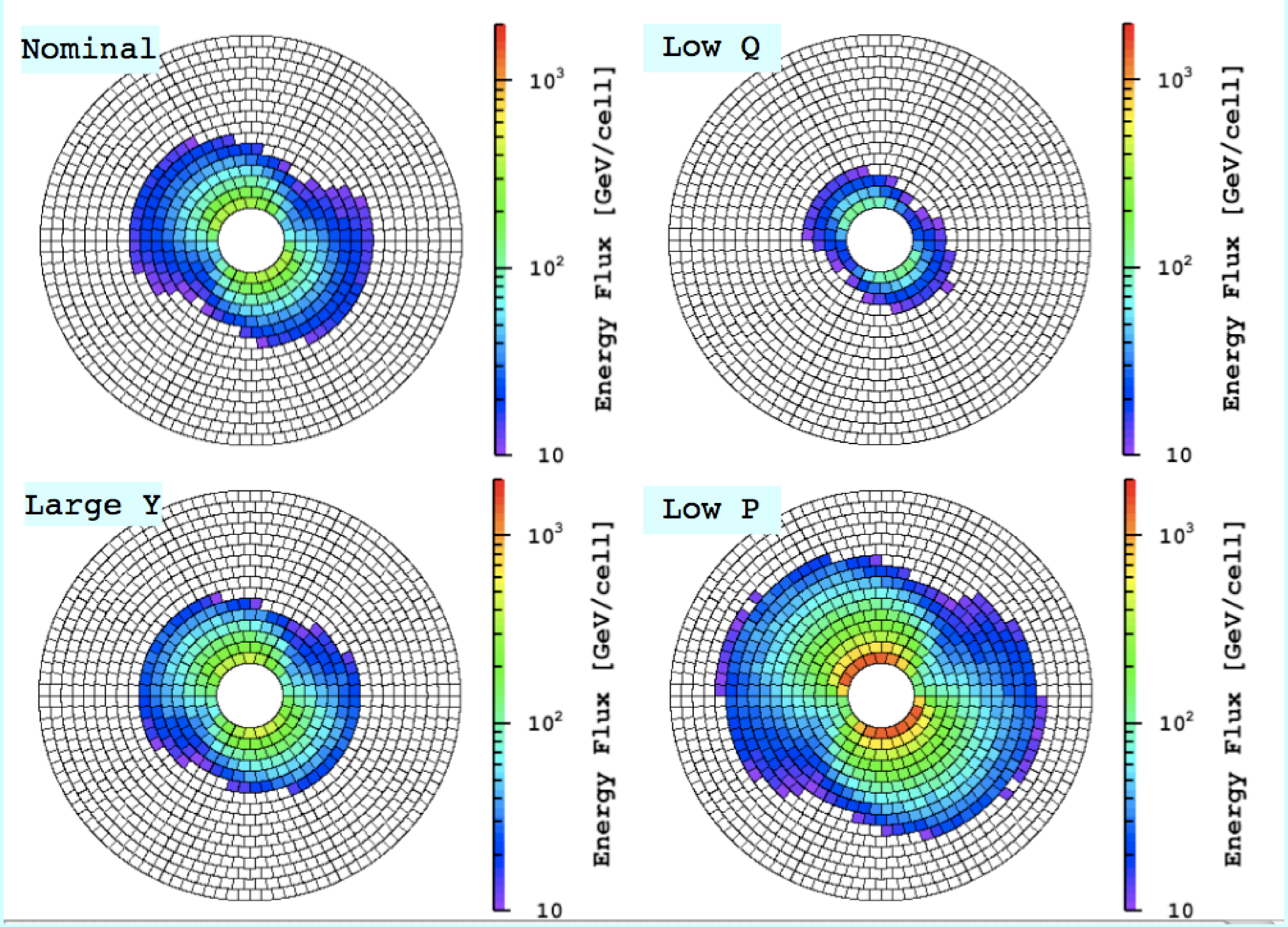
Impact on Subdetectors

- Total number of hits on vertex detector is 2.5 times larger than at nominal ILC parameters
- But the number of bunches per train is only half!
- Integrated backgrounds depend on integration times:
  - full bunch train: background numbers per readout are roughly the same
  - couple of bunches: integrated numbes scale with bunch distance times (370/480)
  - but backgrounds per luminosity will stay at 2.5!
  - What are the relevant numbers?

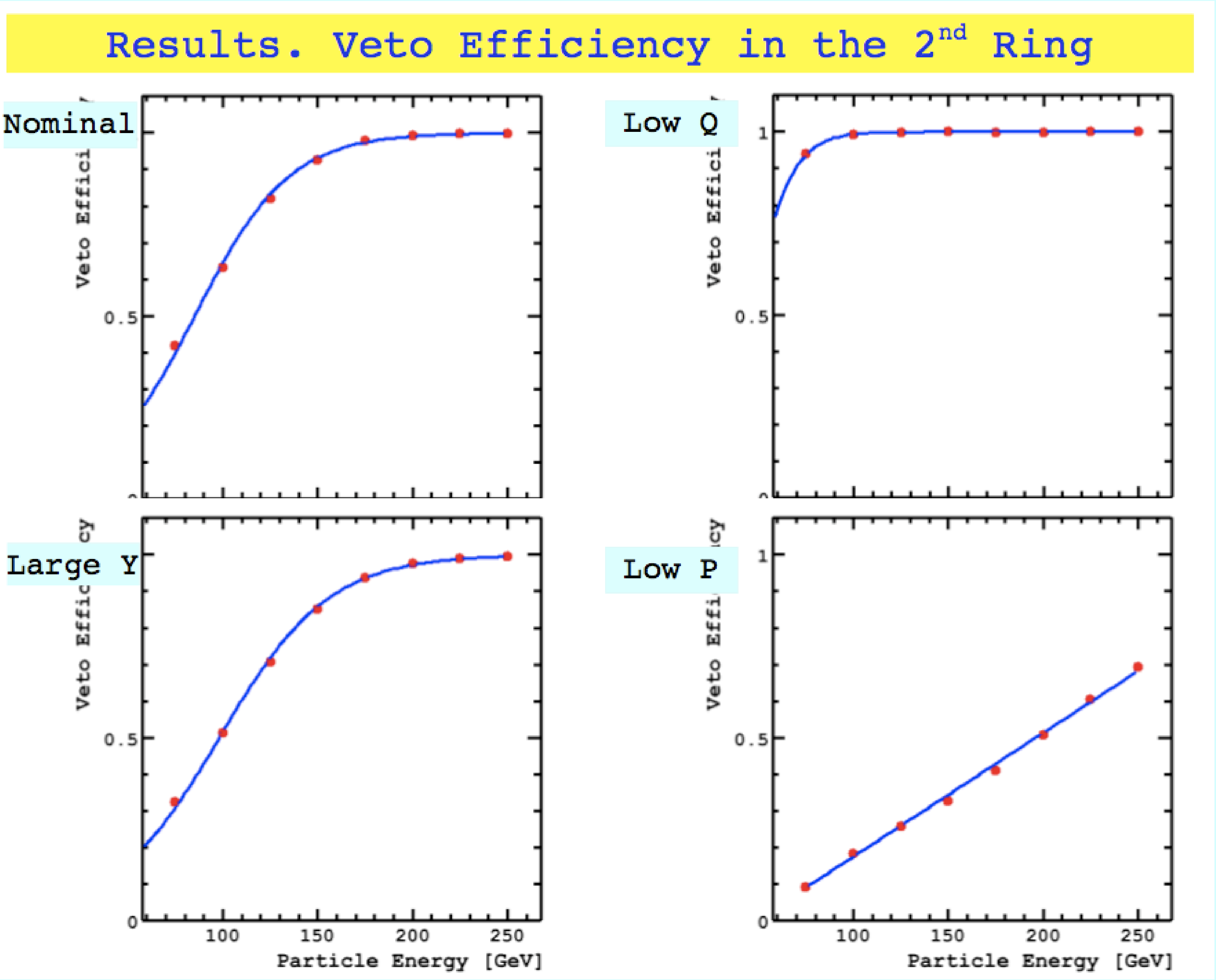


Impact on Subdetectors

- Detectors which will be read out every BX will see more backgrounds. Example Beamcal:



2 Gamma Veto in Beamcal



Example: Stau Pair Production

- Analysis by V. Drugakov, shown at LCWS2006:

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After all cuts applied except veto (L=500fb^-1):
  2-photon events ~ 2.7·10^5
  SUSY events ~ 20
SUSY analysis is done by Z.Zang(LAL)
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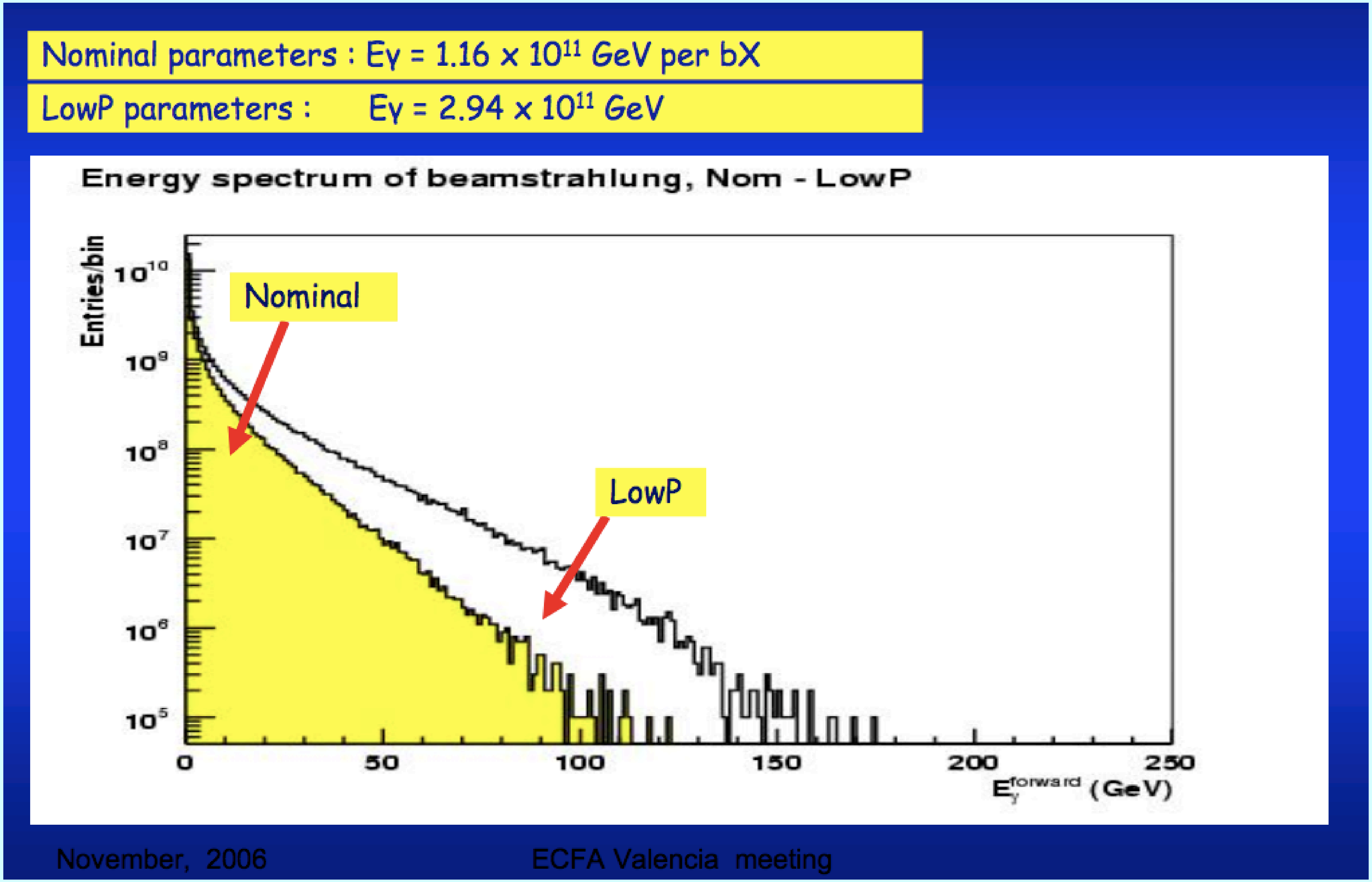
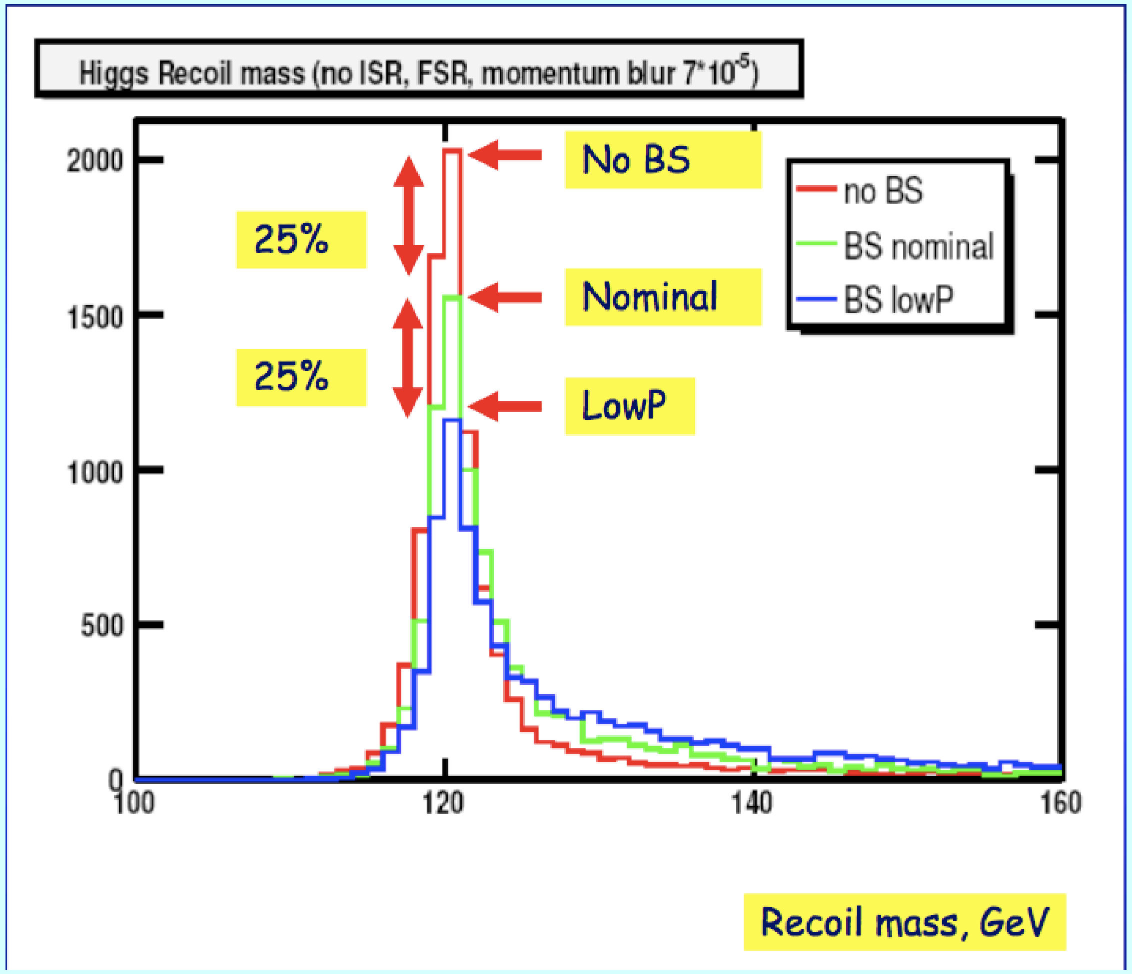
Number of unvetoed **2-photon events:**

Veto Energy Cut, GeV	75	50
Nominal	45	5
Low Q	40	0.1
Large Y	50	9
Low P	364	321

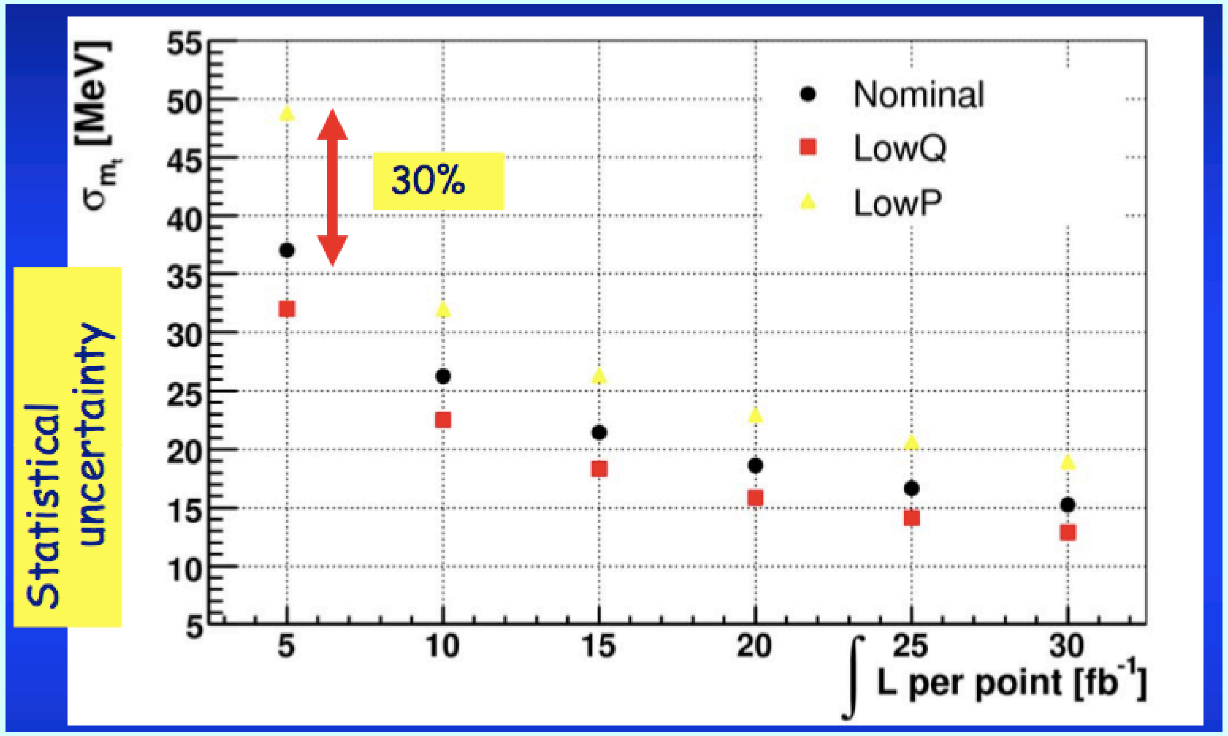
Dilution of Luminosity Spectrum



- Example Higgs Recoil Mass:

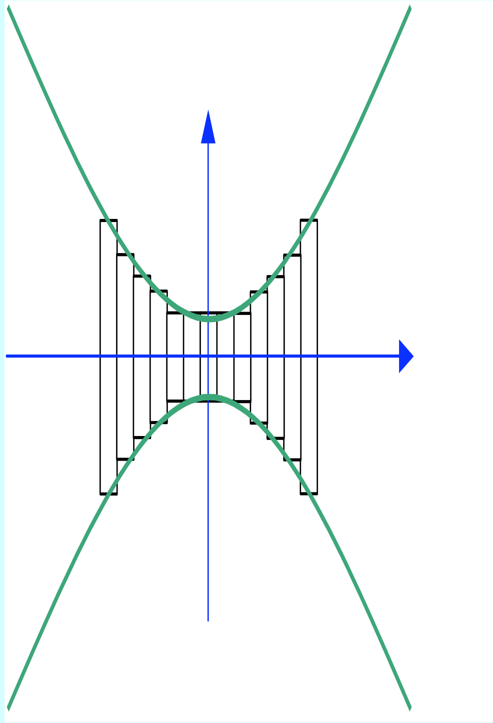


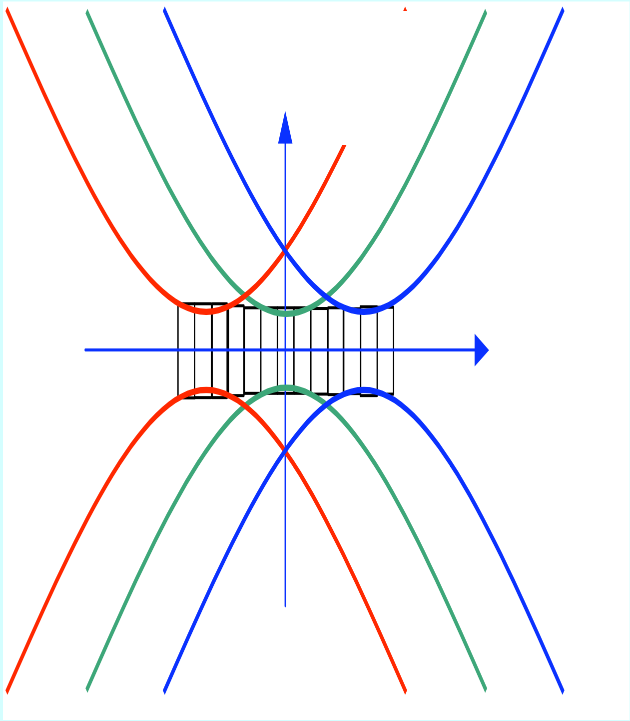
- Example top threshold scan:



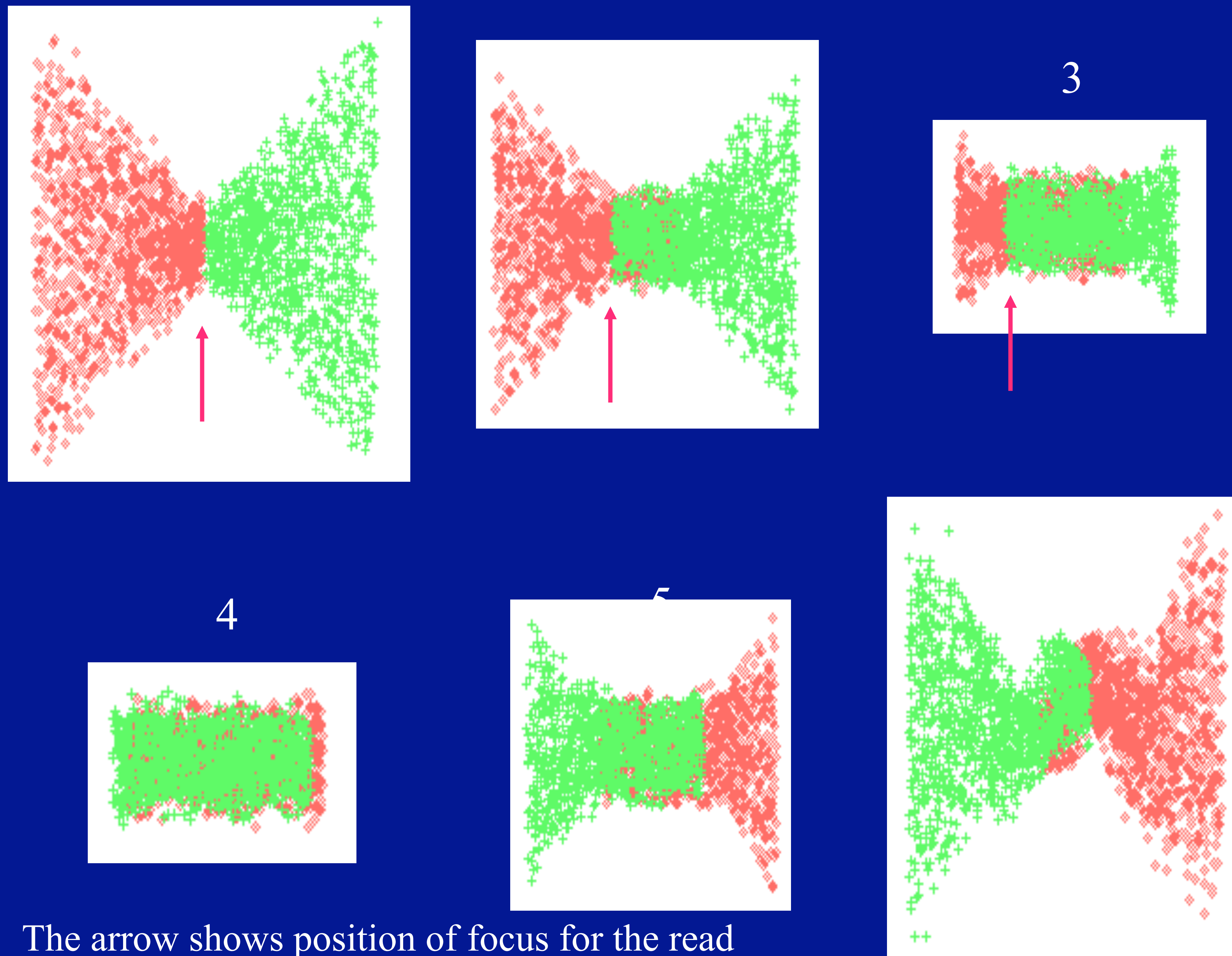
Travelling Focus Concept

- Idea:
  - Arrange for finite chromaticity at the IP
  - Create z-correlated energy spread along the bunch
- Beats the hourglass effect at the IP, increases luminosity!
- Could help to ease the effects of the Low-P parameters by allowing for larger bunch length
- Needs more studies





Travelling Focus Concept



The arrow shows position of focus for the read beam during travelling focus collision

Low-P and Travelling Focus

- Preliminary study (A. Seryi):

	Nom. RDR	Low P RDR	new Low P
Case ID	1	2	3
E CM (GeV)	500	500	500
N	2.0E+10	2.0E+10	2.0E+10
n_b	2625	1320	1320
F (Hz)	5	5	5
P_b (MW)	**10.5**	**5.3**	**5.3**
$\gamma\varepsilon_X$ (m)	1.0E-05	1.0E-05	1.0E-05
$\gamma\varepsilon_Y$ (m)	4.0E-08	3.6E-08	3.6E-08
βx (m)	2.0E-02	1.1E-02	1.1E-02
βy (m)	4.0E-04	2.0E-04	2.0E-04
Traveling focus	No	No	**Yes**
Z-distribution *	Gauss	Gauss	Gauss
σ_x (m)	6.39E-07	4.74E-07	4.74E-07
σ_y (m)	5.7E-09	3.8E-09	3.8E-09
σ_z (m)	3.0E-04	2.0E-04	**3.0E-04**
Guinea-Pig δE/E	0.023	0.045	0.036
Guinea-Pig Lumi ($cm^{-2}s^{-1}$)	**2.02E+34**	**1.86E+34**	**1.92E+34**
Guinea-Pig Lumi in 1%	1.50E+34	1.09E+34	1.18E+34

Summary and Questions

- Low-P parameter set will give ~2 times more backgrounds per BX
  - Integrated number of backgrounds depends on integration times
  - Subdetectors read out per BX will not benefit from increased bunch spacing
  - Clear problem for the forward calorimeters
  - Anywhere else? Background tolerances are usually larger than factor of 2
- Diluted Luminosity Spectrum has impact on physics!
  - Could be recovered by longer running times
- Travelling focus concept might improve Low-P
  - But if this is true, then the travelling focus could be applied to the nominal ILC parameters and should give a luminosity increase by a factor of 2 without major drawbacks (background)
- GDE will study the Minimal Machine and Low-P seems to be attractive for cost saving reasons
- Big question: what is the gain in physics reach worth?