Crossing-angle-or-not physics implications

report from 19-01-04 phone-meeting

cold half-angle = 10, 4, 1, 0.3,…… 0 mrad

warm half-angle = 10, 4 mrad

technical issues	more IP tuning	optics design constraints
	crab-cavity req.	beam(strahlung) extraction
	SC mini-quad.	electrostatic separators
	backgrounds	collimation

→ worse at 1 TeV

physics issues evaluated	hermetic $\gamma\gamma$ veto	post-IP diagnostics
	(track impact par. dilution)	for energy and
	$\vec{B}$ and $\vec{P}$ not //	polarization

no killer arguments either way → quantify impact

Bottom-line on crossing-angle-or-not physics implications

Head-on quantifiably better for some physics aspects

Crossing-angle attractive to enable good spent beam diagnostics

Overall physics balance slightly favors head-on geometry

Both are acceptable for physics

Driving issues mainly on technical side $\rightarrow$ two main risk factors:

- head-on: constrained extraction may limit luminosity and / or energy, work needed on electrostatic separators
- crossing-angle: very small quads (SC, tunable permanent magnet) complicated crab-crossing tuning and requirements

TESLA has more flexibility : head-on, crossing-angle magnitude

Hybrid schemes combining virtues of both may be possible in TESLA

$\Longrightarrow$ { 0.3 mrad vertical angle (Brinkman)
1 mrad horizontal angle (Napoly).

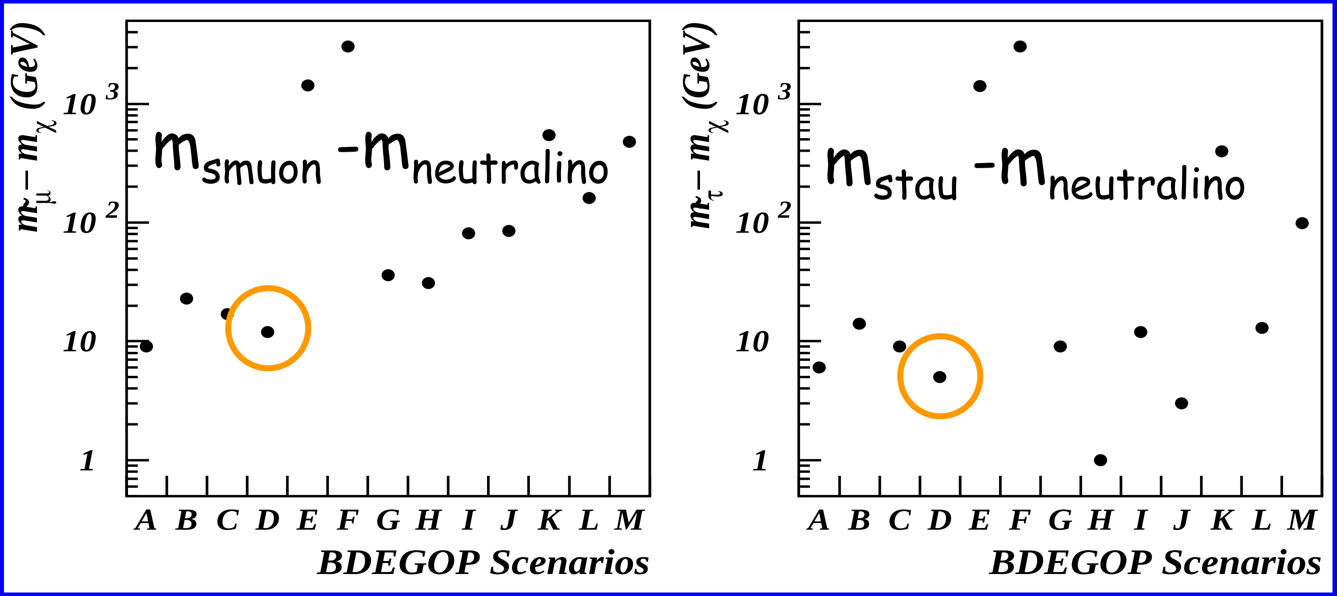
$\rightarrow$ talk by R. Appleby

Not a LC technology choice driver - Background pile-up matters more

SUSY dark matter motivation for low angle veto

- Some popular dark matter SUSY explanations need the LSP χ^0 to be quasi mass-degenerate with the lightest sleptons $\tilde{\tau}$, $\tilde{\mu}$,…

  $\rightarrow$ co-annihilation mechanism
- mSUGRA + new dark matter constraints from WMAP cosmic microwave background measurements point in this direction
- Scenarios considered also relevant more generally in the MSSM



Acceptable solutions in mSUGRA

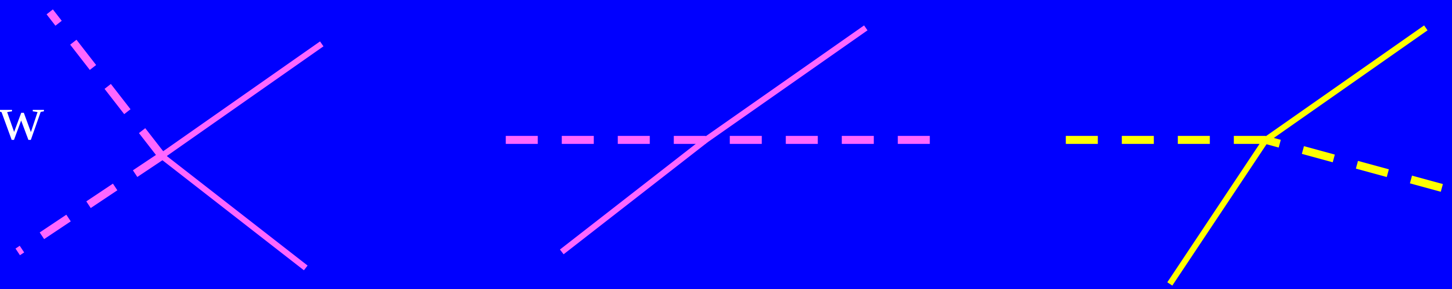
M. Battaglia et al. hep-ph/0306219

$\Delta M = 5$ GeV

efficient / hermetic $\gamma\gamma$ veto crucial for $\tilde{\tau}$ measurement

signal	major background
$ee \to \tau\,\chi^0\,\tau\,\chi^0$	$ee \to (e)(e)\,\tau\,\tau$, $e\,(e)\,(\tau\to\mu)\,\tau$
$\sigma \sim 10$ fb	$\sigma \sim 10^6$ fb

Transverse view



$\gamma\gamma$ veto crucial to detect sleptons in highly mass-degenerate SUSY scenarios $\to$ spectator e (~10mrad) , μ (~20mrad)

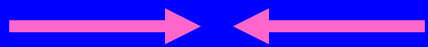
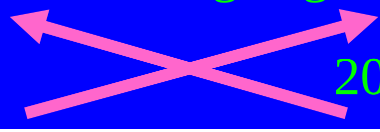
- Important LC channel, complementary to LHC

$\to$ talk by Z. Zhang

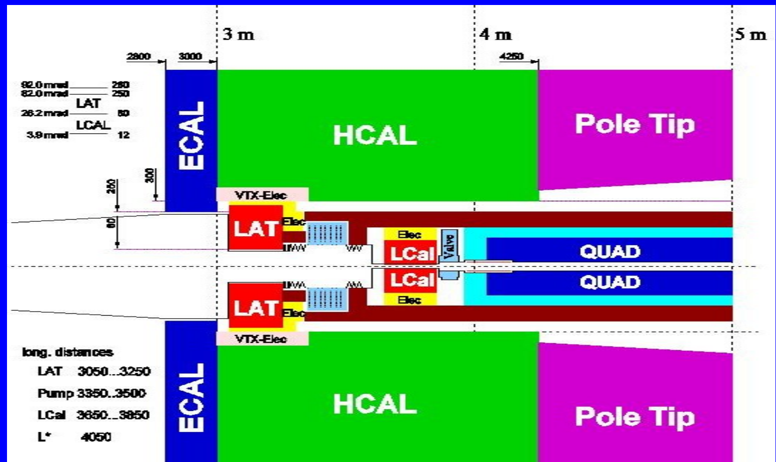
- Precise slepton masses $\leftrightarrow$ dark matter $\leftrightarrow$ constraints from Planck

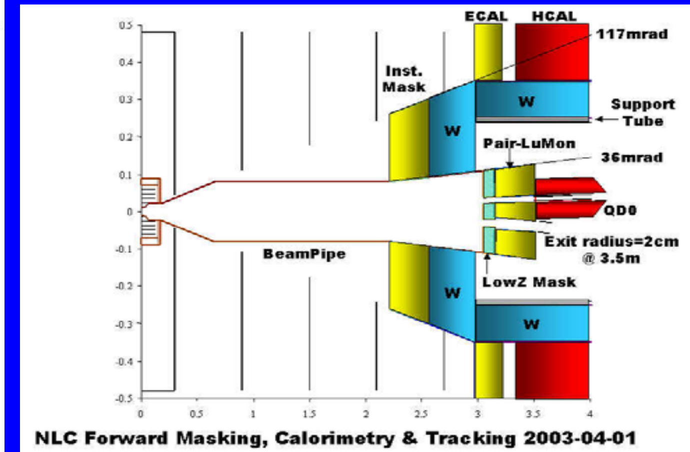
(luminosity & energy strategy) (LC / LHC $\leftrightarrow$ cosmology)

Forward region geometries

	TESLA	NLC / JLC-X
bunch separation	337 ns	1.4 ns
	head-on or crossing angle	crossing angle
IP geometry		 20(7) mrad

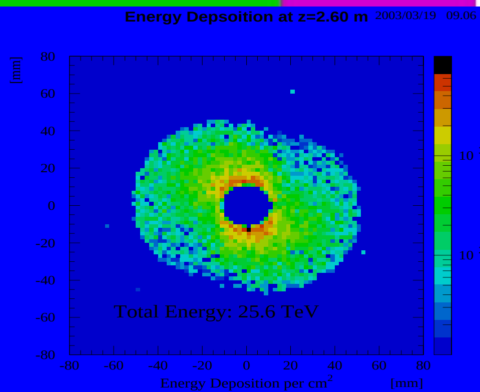
forward region



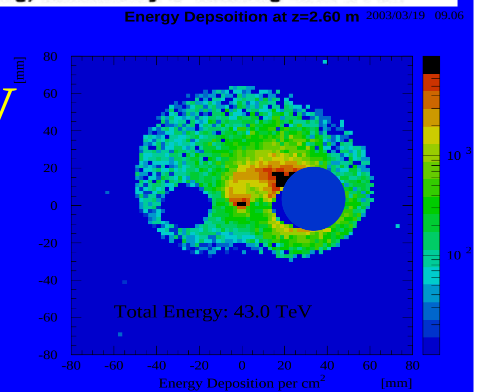


calorimetry
at low angle
1. luminosity
2. veto

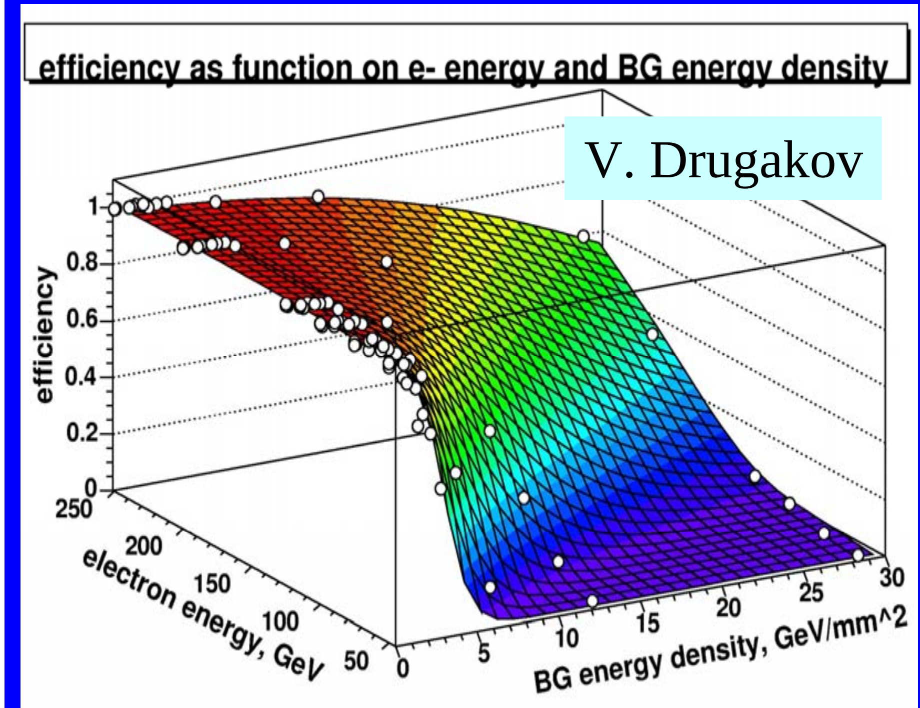
~ 25 TeV
from e^+e^-
pairs
(~ 3 GeV)

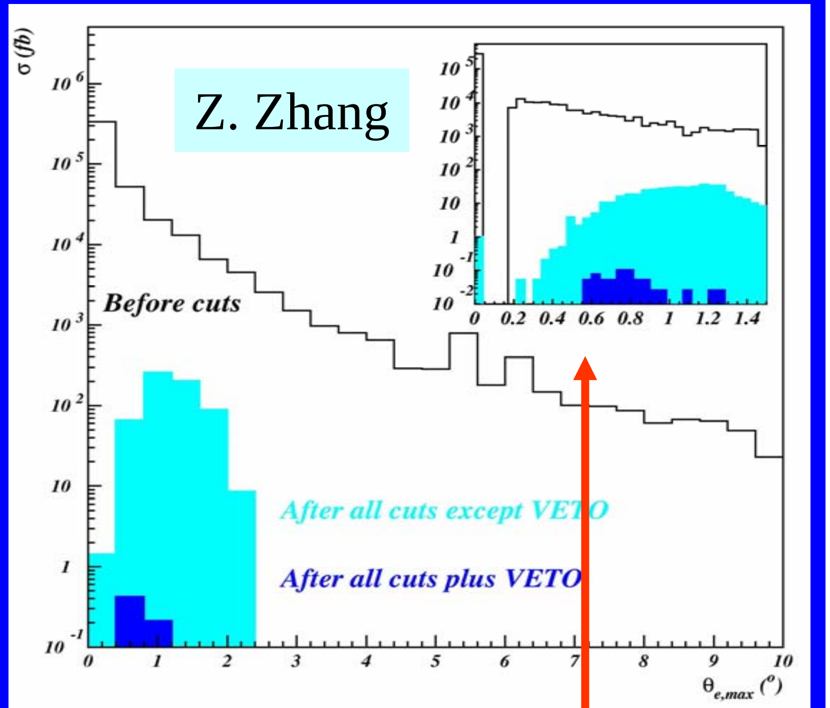


~ 43 TeV
$\times$ n
bunches
$\Delta t_{readout}$?



Importance of high veto efficiency (BeamCAL)





only one crossing

→ no pile-up

$ee \to \tau\, \chi^0\, \tau\, \chi^0$

$\sigma \sim 10$ fb

$ee \to (e)(e)\, \tau\, \tau$

$\sigma \sim 10^6$ fb

$\Delta M \sim 5$ Gev

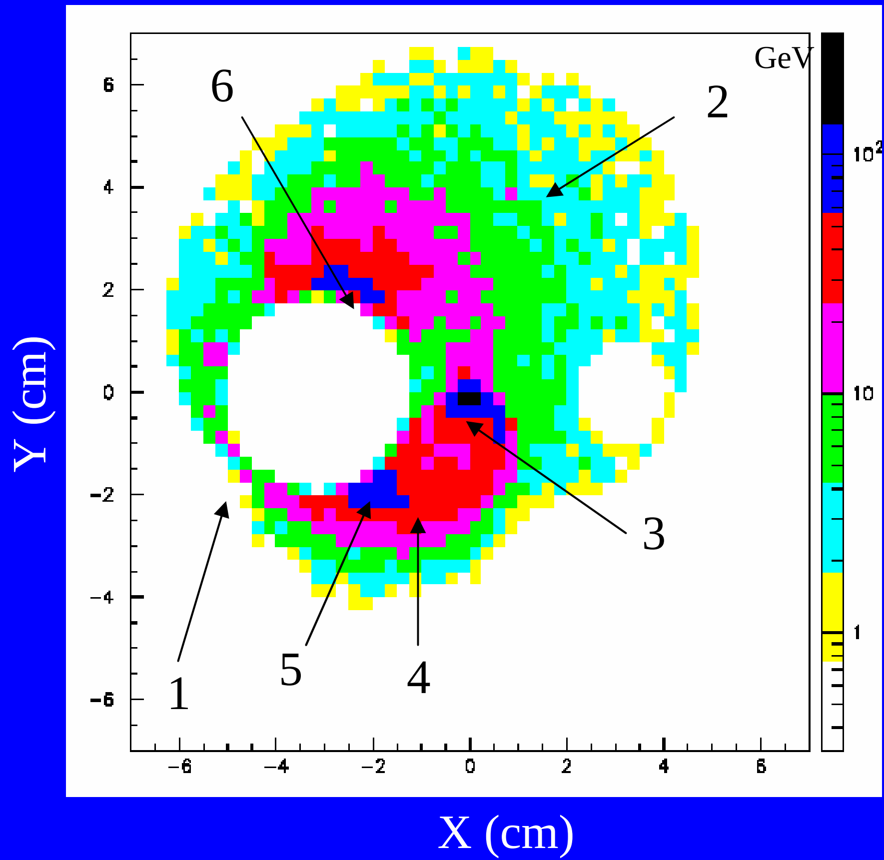
$\Rightarrow \sim 10$ mrad

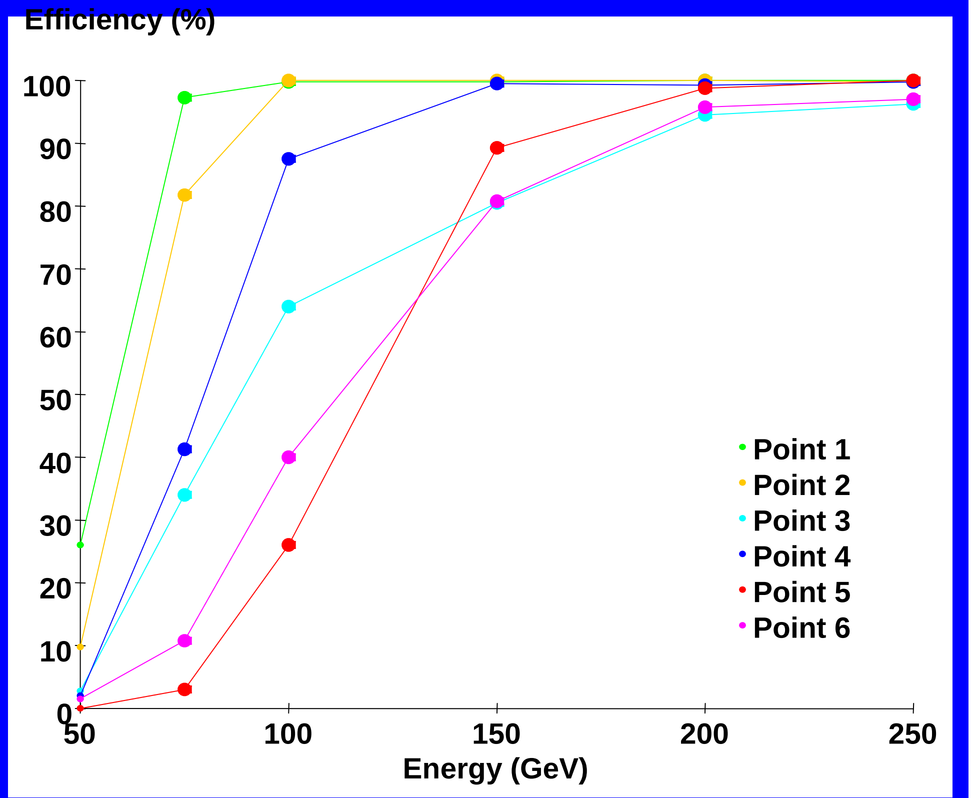
analysis $\Rightarrow$ $\sigma \sim 1$ fb — $\sigma \sim 600$ fb — $< \varepsilon_{VETO} > \sim 0.999$

analysis + veto $\Rightarrow$ $\sigma \sim 1$ fb — $\sigma \sim 0.7$ fb — S/N ~ 1

More work on forward electron veto efficiency

N.Graf, T.Maruyama





Effect on pile-up on forward electron veto

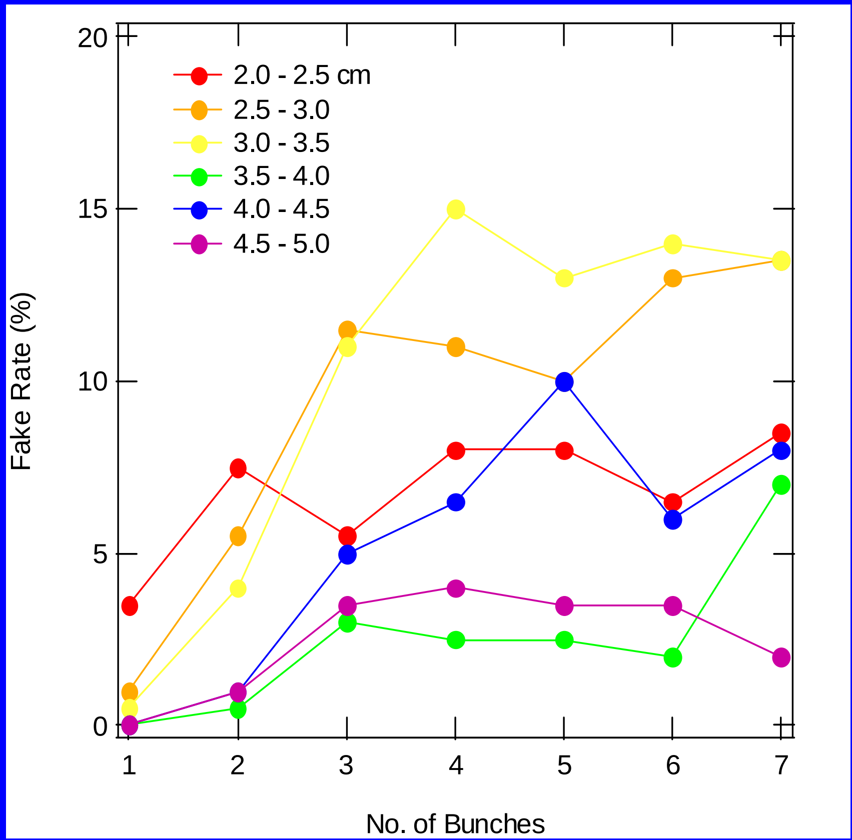
N.Graf, T.Maruyama

The detection efficiency
does not degrade quickly,
but the fake rake increases.

Fake rate (all cluster energies):

1 bx	5%
2	20
3	40
4	47

Fakes are concentrated in
hotspots, not uniform in phi.
Expect rejection to improve
with further study.



Luminosity Calorimeter Technologies with fast (~ 5 nsec) read-out

J.Hauptman

- SiW - Silicon-tungsten sampling calorimeter (current Si tech)
- Quartz Fiber – Cerenkov longitudinal sampling (CMS HF)
- Gas Cerenkov – Cerenkov longitudinal sampling (new)
- Parallel Plate Avalanche Ch – gas sampling (current)
- $PbWO_4$ – Continuous scintillating (CMS ECAL)

If choice is warm and if we want to maximize the reach of SUSY DM searches → need to do this R&D !