Highlights from the WG : Machine Detector (and Physics) Interface

Four main themes :

1. IR design and crossing-angle choices
2. Very forward instrumentation
3. Machine backgrounds
4. Energy precision, stability, calibration

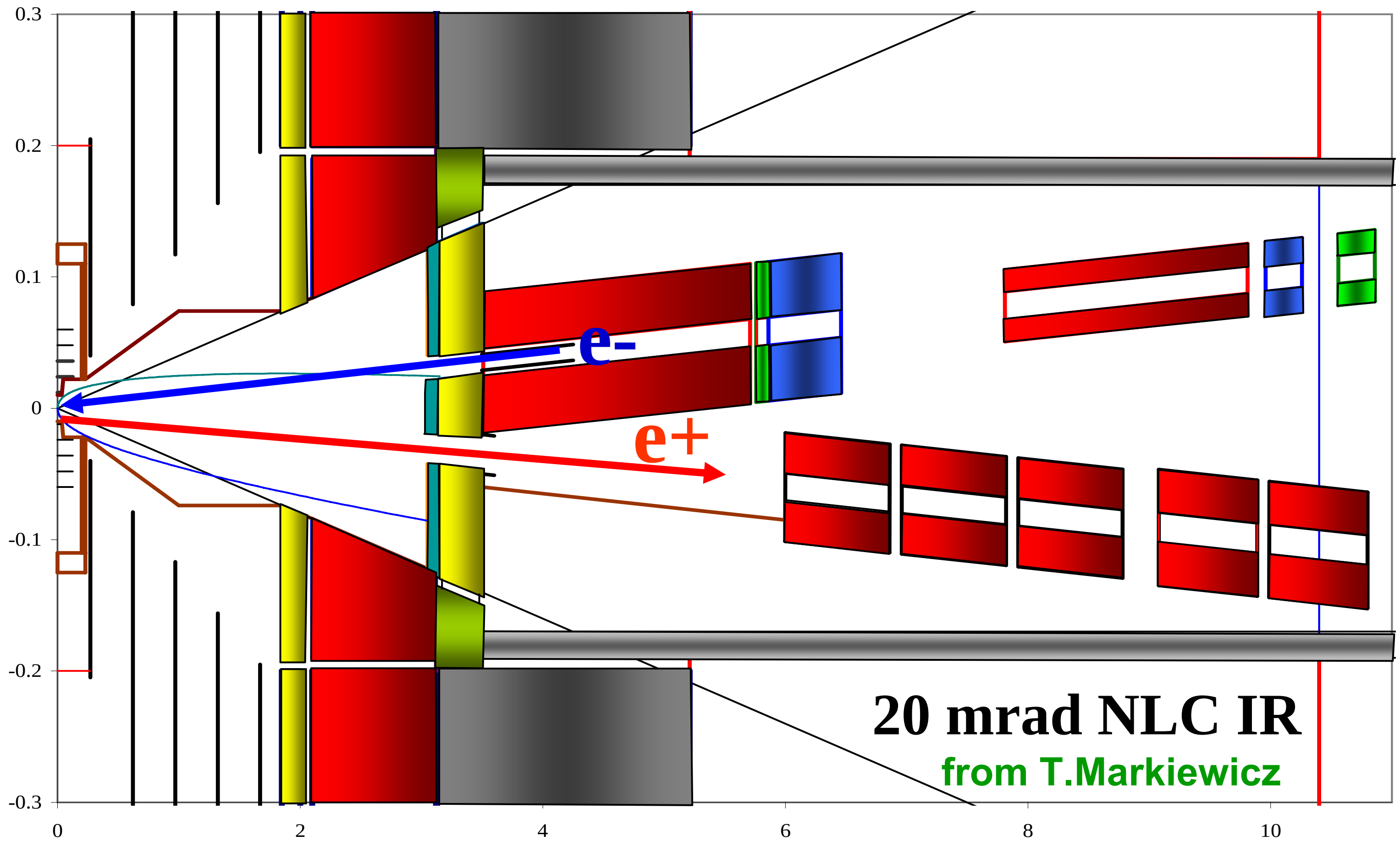
1. P. Bambade — Summary of crossing-angle-or-not January 19 workshop
2. R. Appleby — Alternative IR geometries for TESLA with small crossing angles
3. T. Aso — Study of beam background at GLC including estimation by the BDS simulation from the exit of the LINAC to the beam dump
4. A. Stahl — Beam-induced backgrounds in TESLA with l*=4.1m optics and new masking scheme, with/without 2*10mrad crossing-angle.
5. T. Markiewicz — IR design (collimation, backgrounds, crossing-angle)

6. K. Desch — Physics impact of beam-beam hadron background
7. W. Lohmann — Summary of Prague workshop on very forward instrumentation
8. V. Drugakov — Detection of very forward Bhabha events and electron ID algorithm
9. J. Hauptman — Detector technologies for forward calorimeters (quartz fiber–tungsten, Si–W, gas cherenkov–W, PbW04)
10. N. Delarue — Beamstrahlung monitor
11. H. Yamamoto — Pair (beam profile) monitor

12. M. Hildreth — Energy spectrometers
13. T. Barklow — Energy spread effects; energy precision
14. K. Kubo — Energy spectrum measurement at the extraction line
15. S. Boogert — Energy spectrum extraction from Bhabha events
16. All — Discuss future inter-regional collaboration & working groups

1 - IR design and X-ing angle

- **NLC-GLC** : X-ing angle mandatory to avoid parasitic crossings at every 20 cm (1.4 ns) or 40 cm (2.8 cm)



New Development : Compact SC Quad Design

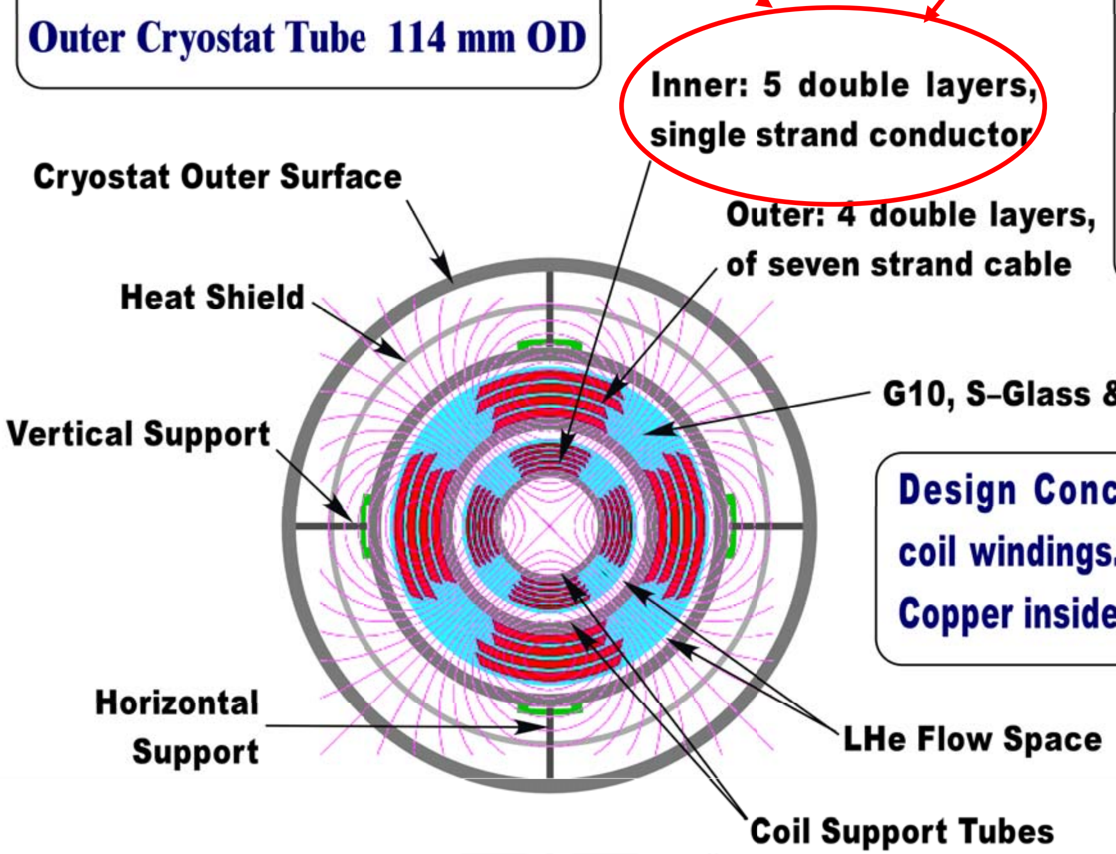
from BNL

Flexible cable
⇒ small bore radius

$\tau_{Quench} \sim L \sim N^2$
turns = N limited
by quench protection

Inner Beam Tube	20 mm ID
Outer Cryostat Tube	114 mm OD

QDO Coil Parameters	
Inner Quad	63 T/m
Outer Quad	81 T/m
Total Quad	144 T/m

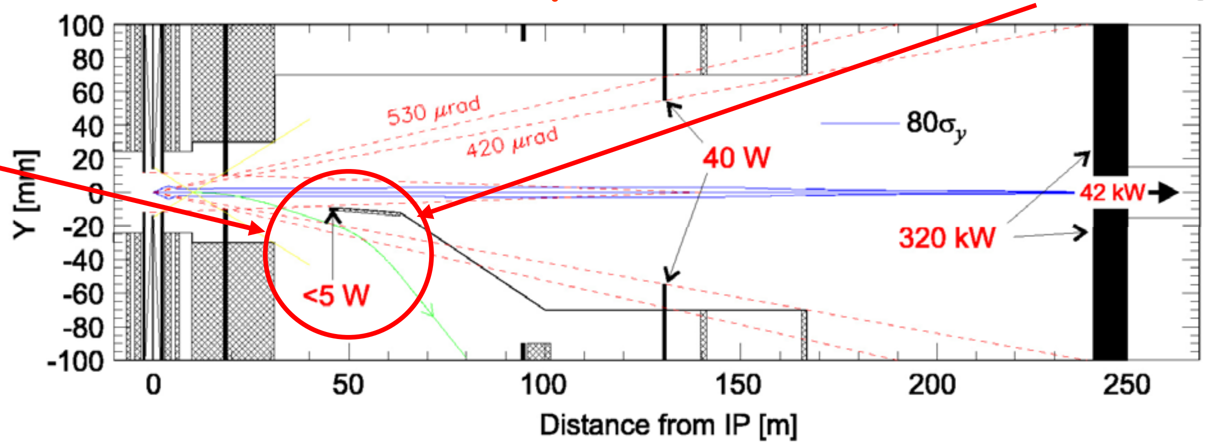


Design Concept: Two independent coil windings. Integrated helium flow. Copper inside inner coil support tube.

Crossing Angle Choices for TESLA

- **TESLA : problem with beam and γ losses in septum region**

~ 15 kW of beam
and beamstralung loss
in realistic conditions

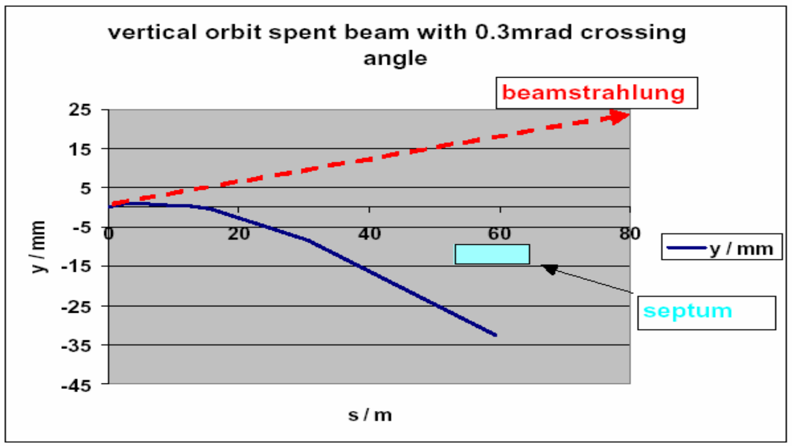


→ **3 options**

1. 300 μrad collision + quadruplet to reduce beam losses

Suggestion: vertical crossing angle ~0.3mrad at IP

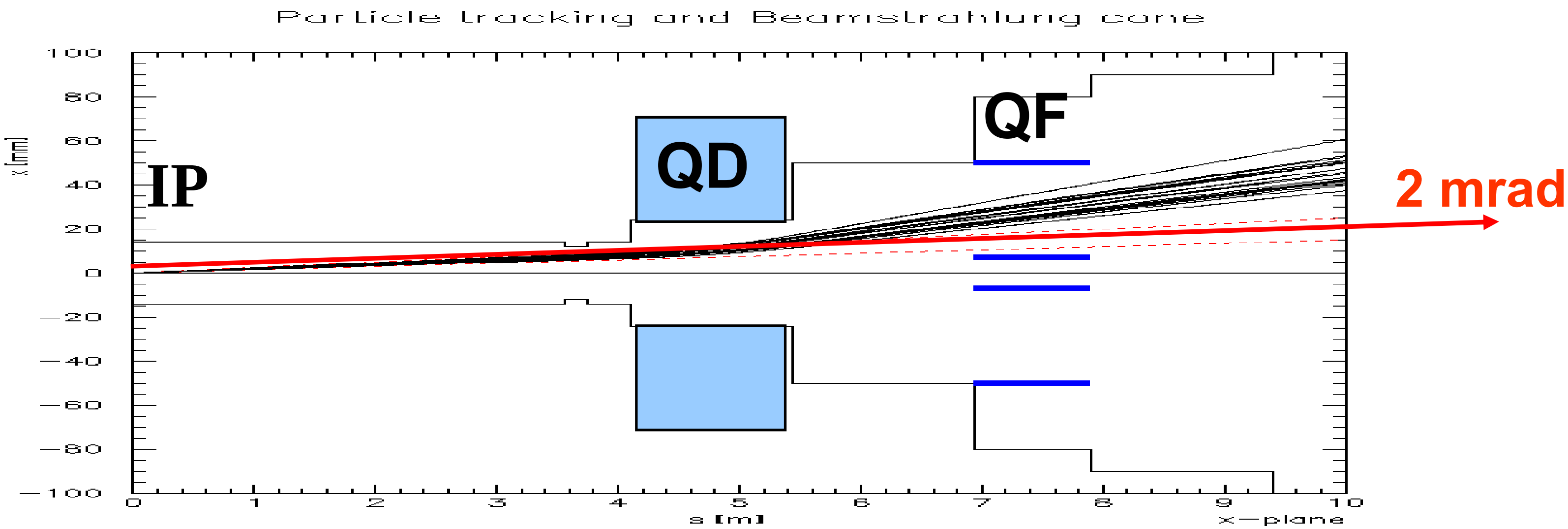
D. Angal-Kalinin, R. Appleby, R. Brinkmann



Not a choice if no progress
on 50 kV/cm reliable electro-static
separators (20-30 m long)

Crossing Angle Choices for TESLA (cont.[ed])

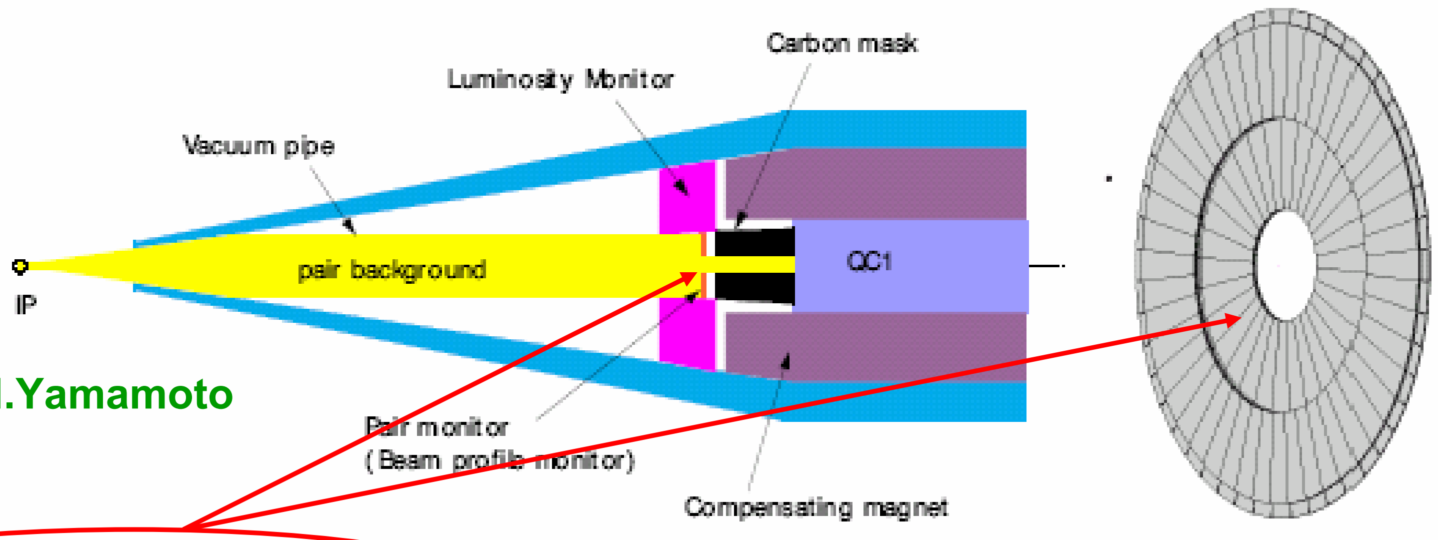
2. 2 mrad Xing angle : no electrostatic separators, 15% Lumi loss compensated by angular dispersion @ IP (~ crab-crossing)



3. 20 mrad Xing angle : NLC like final focus (cf. US-LC study), implies RF cavity crab crossing

⇒ Detector and Physics Implications (later)

2 - Very Forward Instrumentation

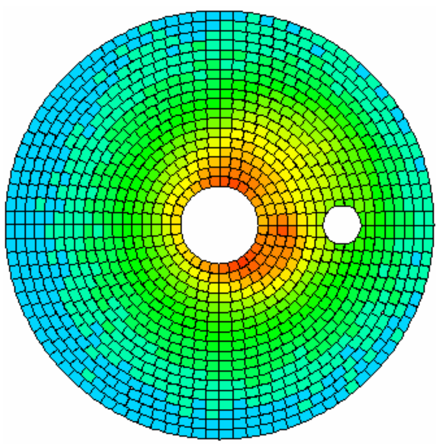


Forward Calorimeter has a dual function :

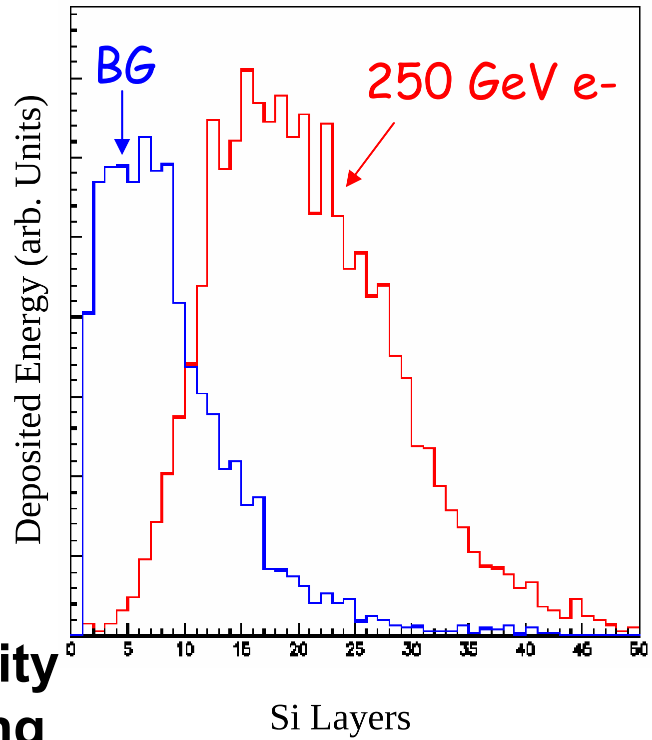
- MACHINE : Fast luminosity monitor, **keystone** of the collider (cf. SLC 1997 run). Can be used as a beam profile monitor
- DETECTOR : Low angle e± tagging : removes photon-photon background events

Highly Segmented Detector

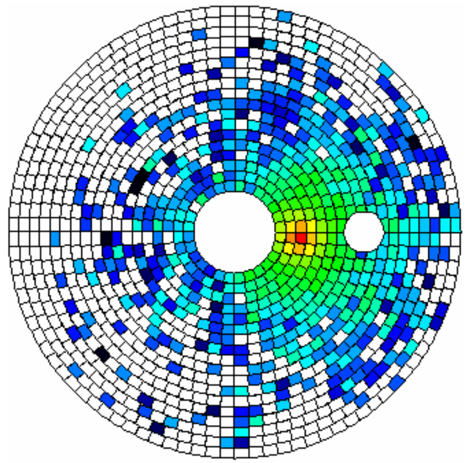
Pair Background



from N. Graf, T. Maruyama



250 GeV Electron



N_{tot} or E_{tot} ∝ Luminosity
⇒ fast machine tuning

σ_y	$\Delta\sigma_y$
3.5 %	11 %

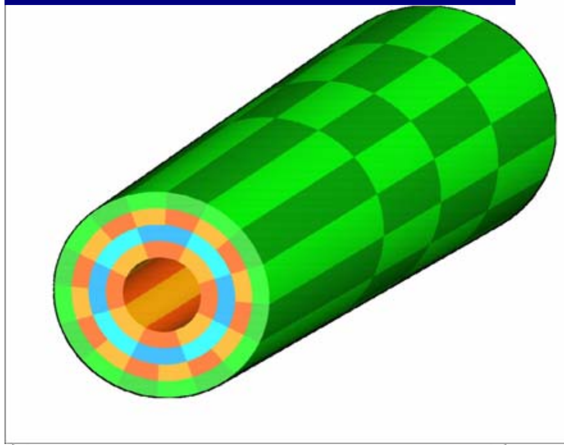
from A Stahl

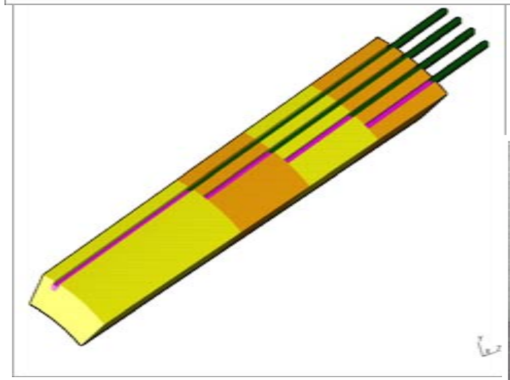
250 GeV Electron detection efficiency ~ 1

Detector Design

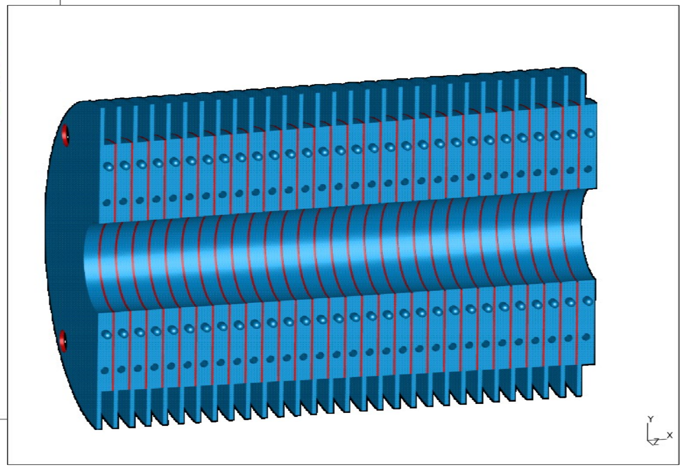
from W. Lohmann

Heavy crystals



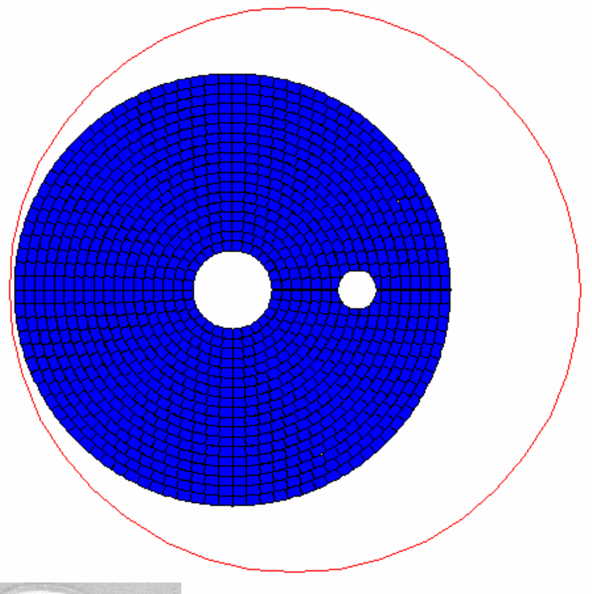


Diamond-W Sandwich

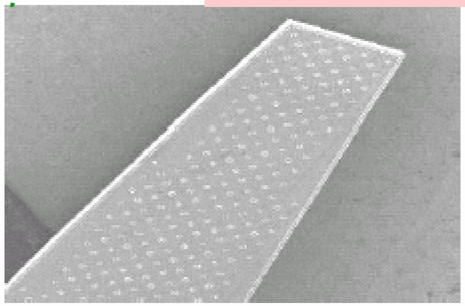


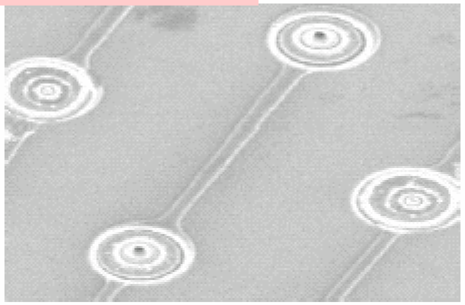
from N. Graf, T. Maruyama

Si W



3D Pixel Sensor





from H.Yamamoto

Technology Comparison made by J. Hauptman

3 - Machine and Beam-Beam Backgrounds

Impact on warm vs. cold technology choice ?

via

- Crossing angle : ~ 0 mrad vs. 7 mrad vs. 20 mrad
- Bunch Crossing : 1.4 ns vs. 2.8 ns vs 337 ns

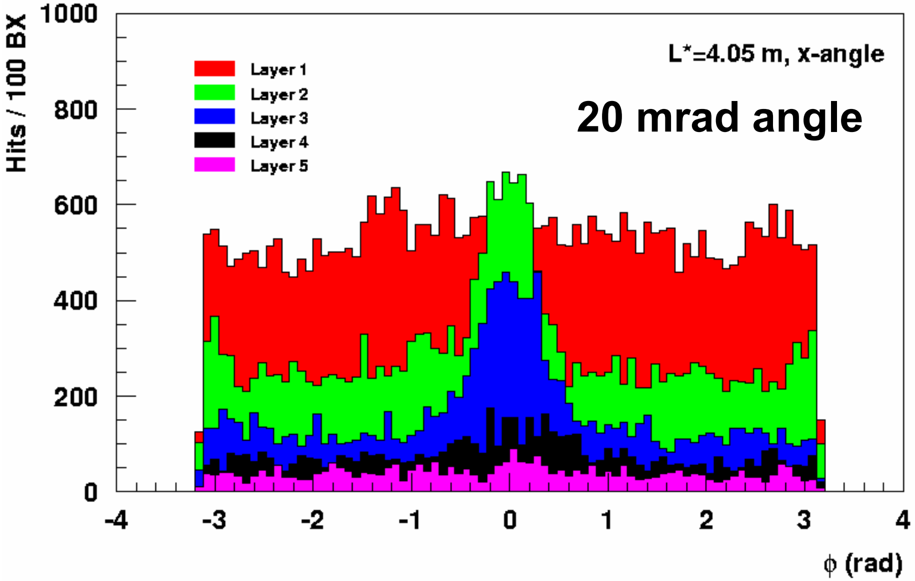
Hit density on Vertex Detector from e+e- pairs : contradicting studies ?

Hit density on 1st Layer
GLC study, from T. Aso

Crossing Angle	VTX Radius	Solenoid Field	Hit density /mm²/train
Head-on	15mm	4Tesla	0.99
7mrad	15mm	4Tesla	1.00
7mrad	24mm	3Tesla	0.38
20mrad	15mm	4Tesla	1.03
20mrad	15mm	3Tesla	1.71

Clear Dependence on VTX radius and B field.
No dependence on crossing angle.

Azimuthal dependence
TESLA study, from K. Büsser

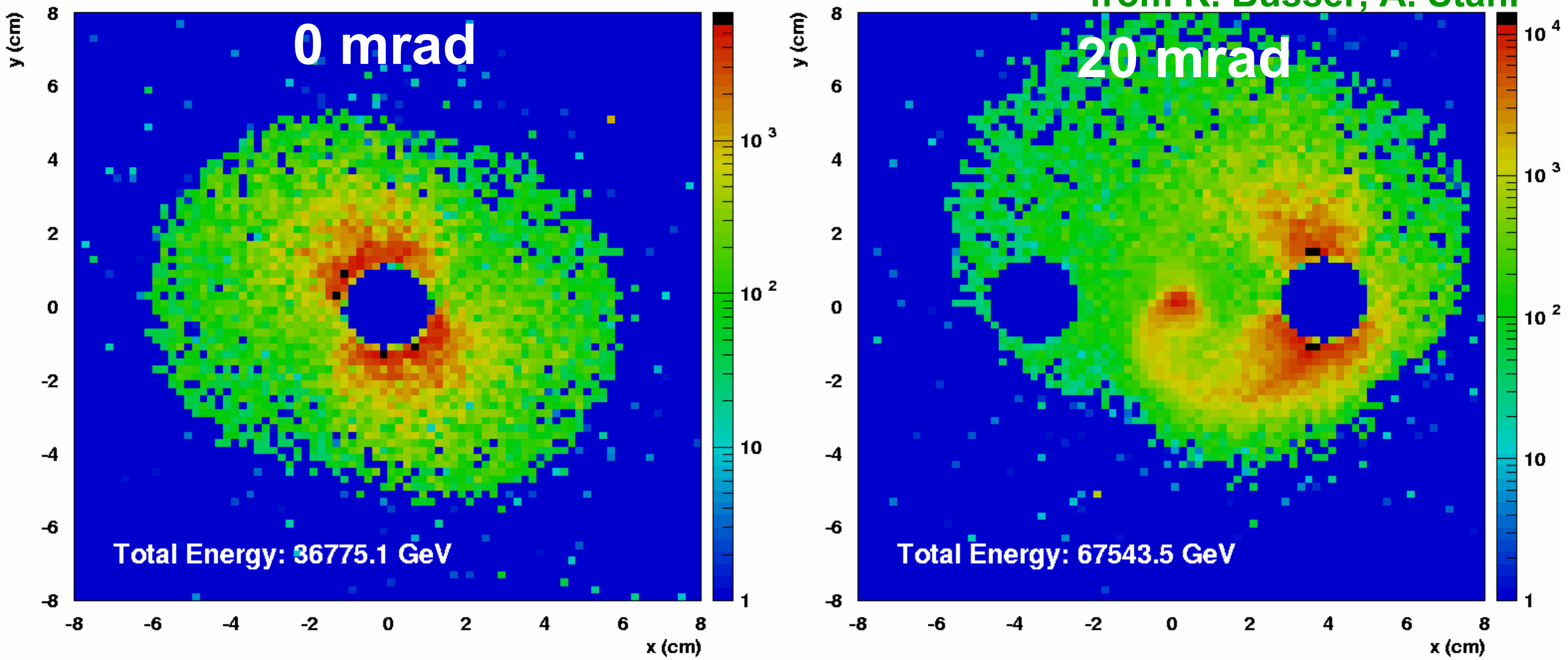


TPC occupancy 2 times larger from 0 to 20 mrad crossing angle but

All backgrounds so far studied are still on tolerable levels

Forward Beam Calorimeter

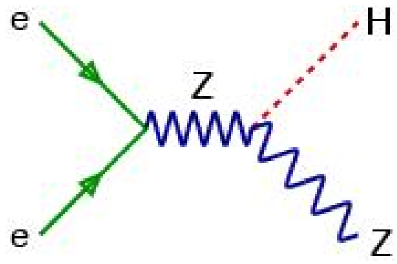
from K. Büsser, A. Stahl



- Energy deposition is twice as large in the 20 mrad x-angle case
  → **impact on e – tagging efficiency**
- Origin of azimutally asymmetric VTX pair hits

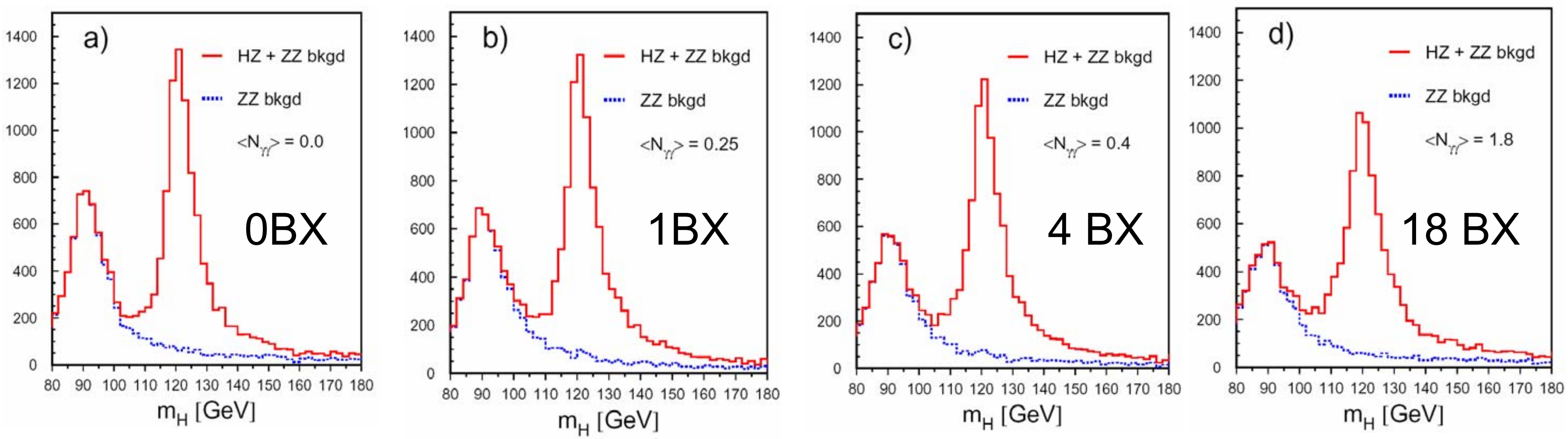
Bunch Crossing : $\gamma\gamma \rightarrow$ hadrons background

from K. Desch



Mass measurement of light Higgs boson (m_H=120 GeV)

$H \rightarrow bb$, $Z \rightarrow qq \Rightarrow$ 4 jets reconstruction



NLC, GLC and TESLA have about the same L / BX

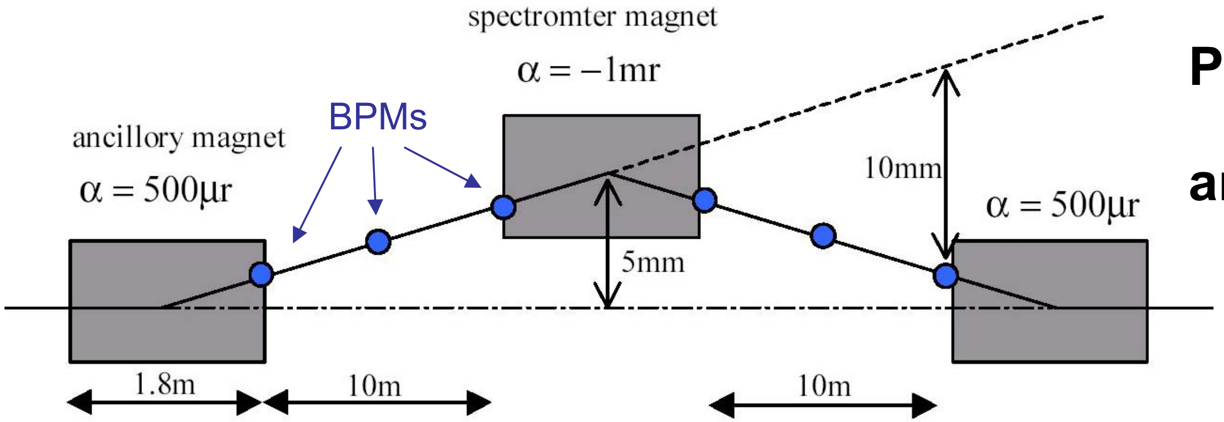
Integrating over several BX hadronic backgrounds reduces the resolution on Δm_H from 75 MeV (1BX) to 92 MeV (18 BX)

4 - Energy Precision

Beam instrumentation goals

- Top mass: 200 ppm (35 MeV)
- Higgs mass: 200 ppm (25 MeV for 120 GeV Higgs)
- W mass: 50 ppm (4 MeV) ??
- 'Giga'-Z A_{LR}: 200 ppm (20 MeV) (comparable to ~0.25% polarimetry)
  50 ppm (5 MeV) (for sub-0.1% polarimetry with e+ pol) ??

Progress on Spectrometer measurement : $\langle E_{beam} \rangle$

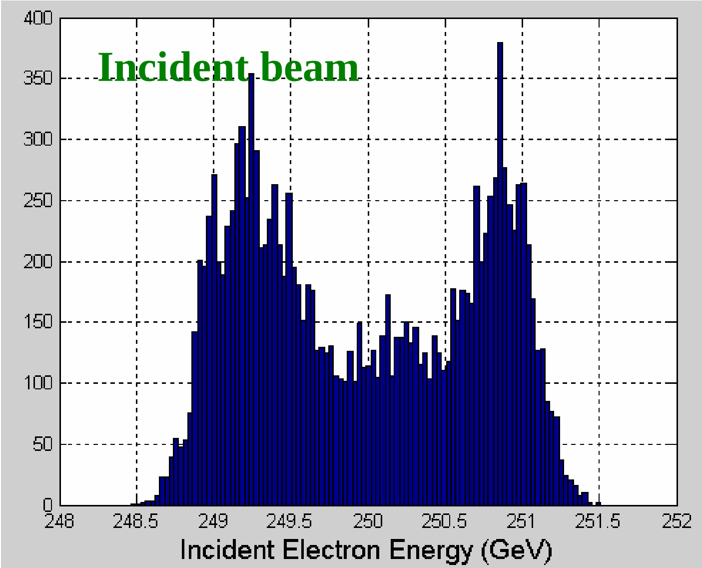


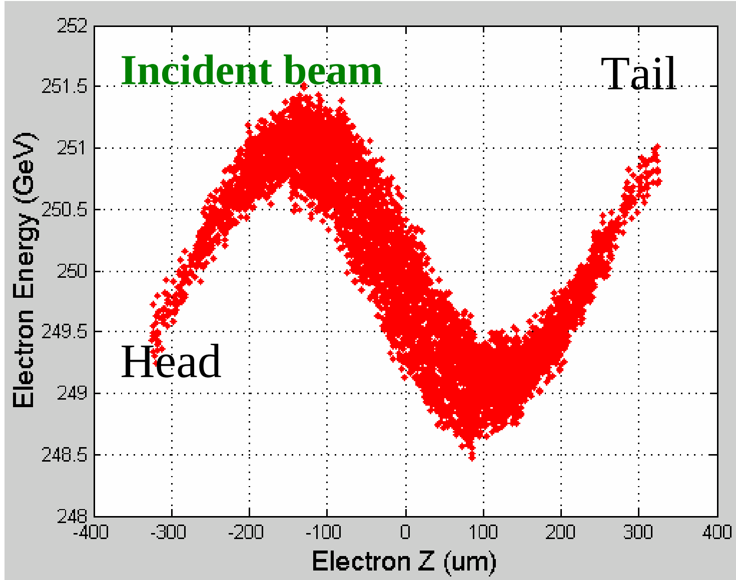
Progress at Zeuthen
from H.J. Schreiber
and at SLAC + …
from M. Hildtreth

BUT : Machine bias to E_{CM} measurement : $\langle \sqrt{s} \rangle_{lumi} \neq \langle E_{beam} \rangle$

Example of Lumi-weighted Energy Bias related to Beam Energy Spread at NLC-500

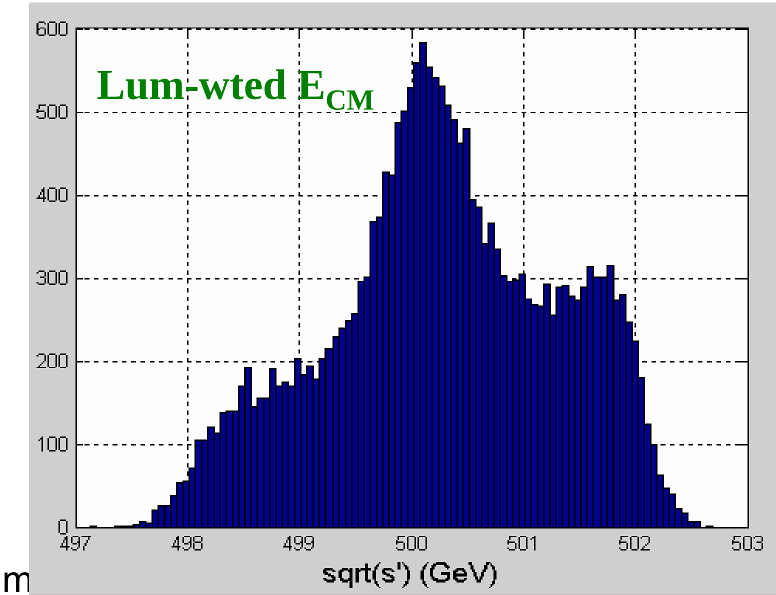
from T. Barklow, M. Woods





For energy bias study, turn off beamstrahlung and only consider beam energy spread.

$$\left\langle E_{CM}^{Bias} \right\rangle = \frac{\left\langle \sqrt{s'} \right\rangle - 500\,\mathrm{GeV}}{500\,\mathrm{GeV}} \approx 500\mathrm{ppm}$$



Bhabha acolinearity analysis alone won't help resolve this bias.

Kink instability and E_{CM} Bias

from T. Barklow, M. Woods

(larger for NLC) **Wakefields** + (larger for TESLA) **Disruption** → (comparable at NLC, TESLA) **Kink instability**

(larger for NLC) **E-Spread** + **E-z correlation** + (comparable at NLC, TESLA) **Kink instability** → (larger for NLC) **E_{CM} Bias**

$$E_{CM}^{Bias} = \frac{\langle E_1 \rangle + \langle E_2 \rangle - \langle E_{CM}^{lum-wt} \rangle}{\langle E_1 \rangle + \langle E_2 \rangle},$$

E_1 and E_2 are beam energies measured by the energy spectrometers

Summary of E_{CM}^{bias}

LC Machine Design	Collider Mode	$\langle E_{CM}^{bias} \rangle$ ($\Delta y = 0$)	$\sigma(E_{CM}^{bias})$ ($\Delta y = 0$)	$Max(E_{CM}^{bias})$ vary Δy, η_y
NLC-500	e^+e^-	+520 ppm	170 ppm	+1000 ppm
TESLA-500	e^+e^-	+50 ppm	30 ppm	+250 ppm

Conclusions

- Many studies attempting to address the Cold / Warm technology comparison
- Trans-oceanic collaborations
  (even trans-Channel !!)
- Proposal to convene a specialized MDPI workshop in fall 2004