Si-pixel Transition Radiation Detector
with separation of TR-photons and charge particle tracks by magnetic field

Proposal for the TESLA detector

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ECFA/DESY Physics and Detectors for a Linear Electron-Positron Collider

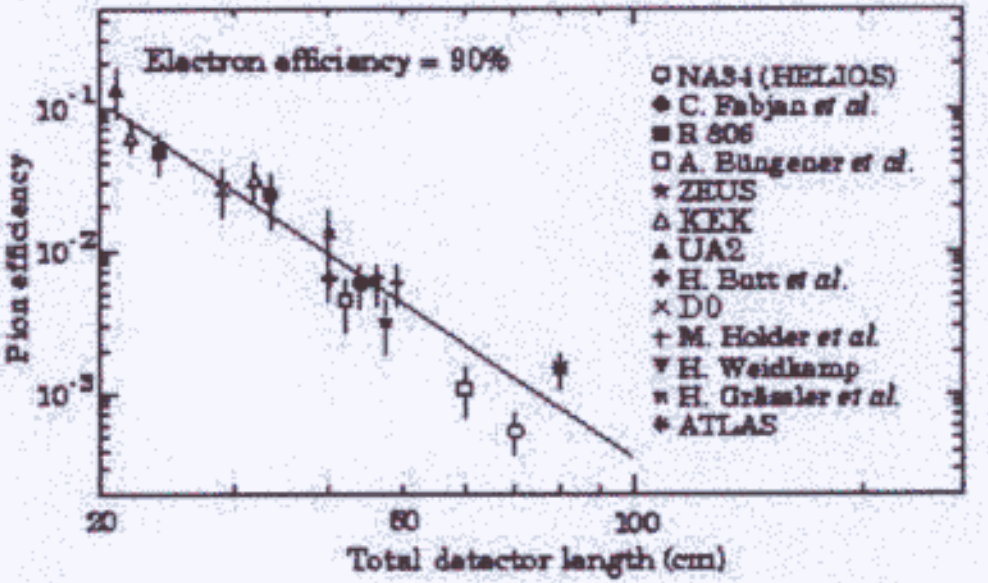
Particle ID, physics motivation

- Detection of High P_t inclusive isolated electrons with jet rejection.
- The detection of the electrons in jet (the tagging of b-jets using relative soft (p=5-40GeV/c) electrons.
- The identification of conversion photons and pi0/eta Dalitz decays.

Transition Radiation Detector
(traditional concept)

Traditional transition radiation detector in High Energy Physics has the limitation of rejection power due to major contribution of the ionization losses to the background for TR measurements.

To improve this is required multi layer structure of detector.



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Transition Radiation Detector
(new concept)

For spectrometers with high magnetic field , the new concept of Transition Radiation Detector with possibility of separation in space of the charged particle track and TR photons

The deflection distance between the particle track and TR photon is given by

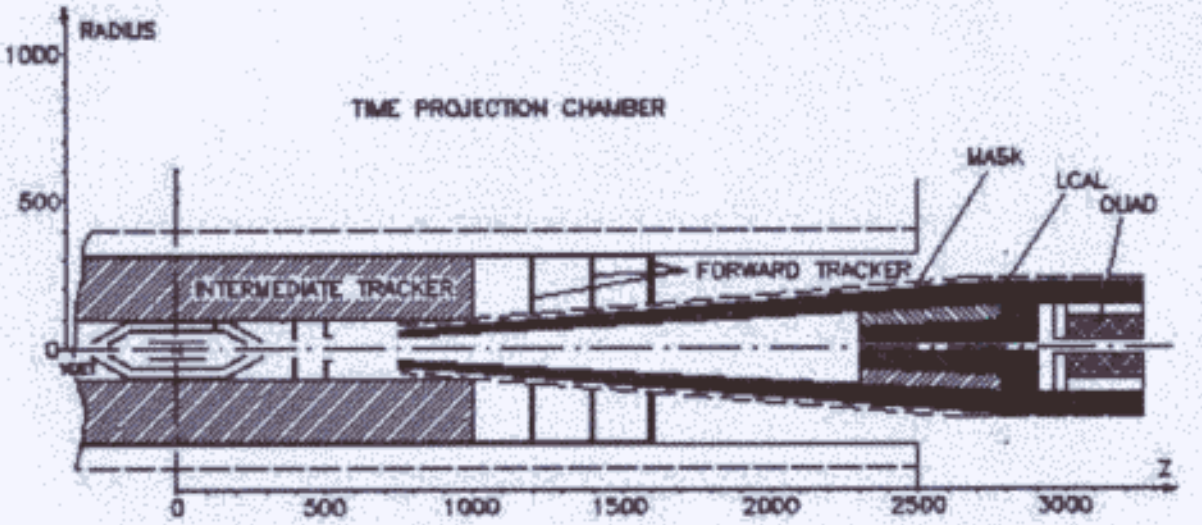
$$\delta \approx \frac{L^2 B}{p};$$

where: L is the particle path between TR radiator and detector;
B is magnetic field;
p is the momentum of the particle;

The completely separate detection of the TR photons and associated charged particle track is possible using a High Granularity Detector, Si-pixel or Si-strip detectors

Transition Radiation Detector for TESLA (new concept)

Subdetector	Radial extent		Longitudinal extent	
	r_{min} [cm]	r_{max} [cm]	z_{min} [cm]	z_{max} [cm]
Beam pipe		20		
Vertex detector	25	100		300 (including endcaps)
Forward tracker discs			at 600, 800, 1200, 1400, 1600	
Intermediate trackers	120	300		1000
Intermediate Si layer	300	320		1600
Main Tracker (TPC)	320	1700		2600
Sensitive volume	386	1626		2500
				2800
				3300
				3300
				4600
				5250
				5250
				7900
				9400
				2800
				1800
				2800
				1600



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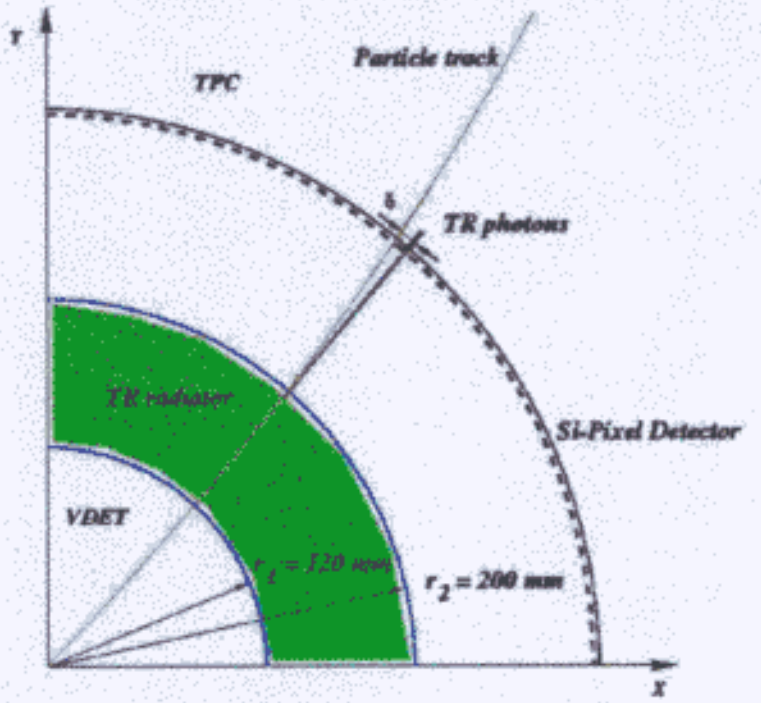
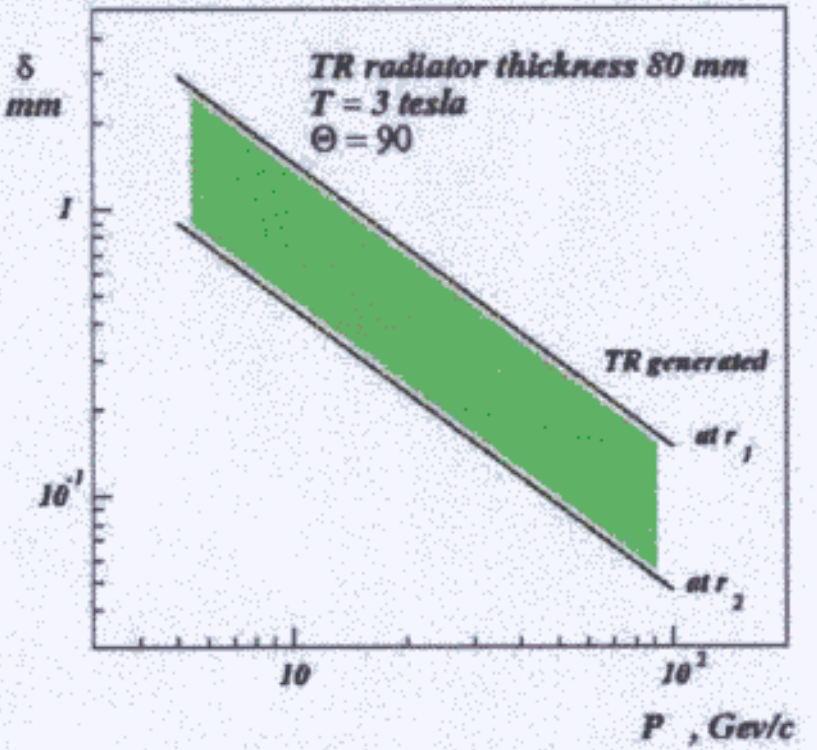
Transition Radiation Detector for TESLA (new concept)

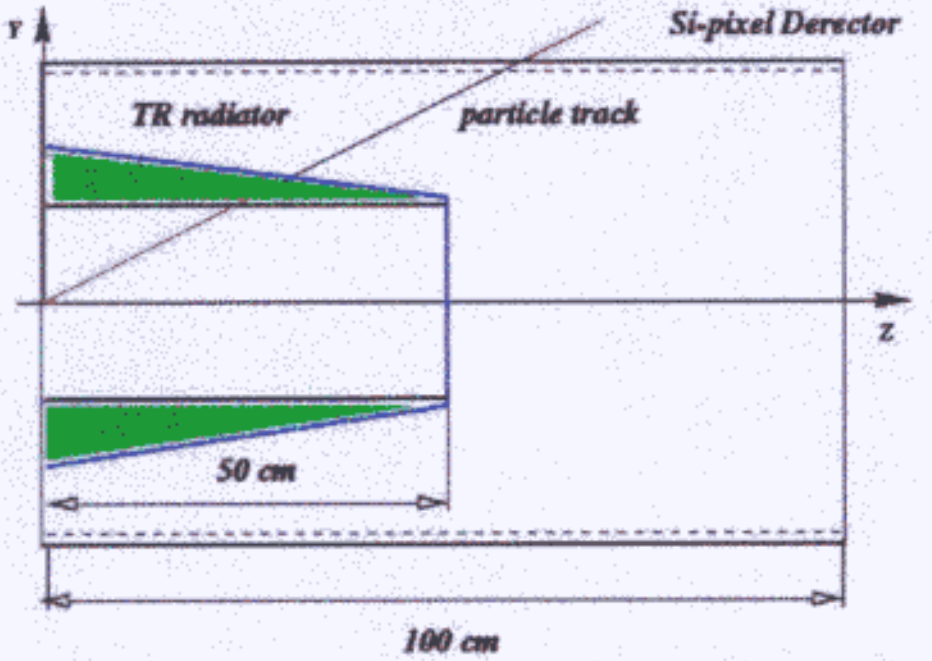




The value of separation between charge particle track and TR photons for present geometry

Transition Radiation Detector for TESLA (design)

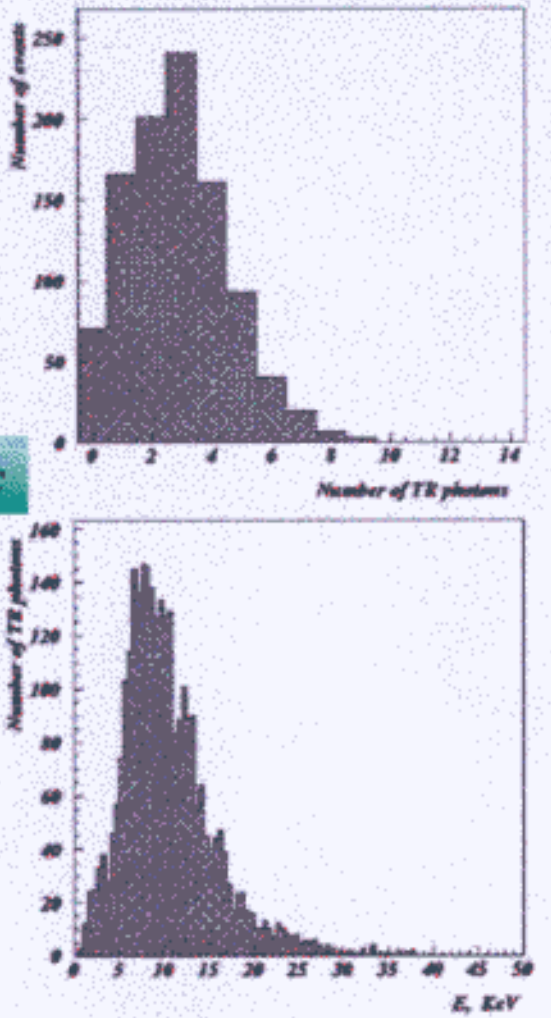
The proposed Transition Radiation Detector can be located in the intermediate gap between the Si Vertex Detector and TPC



- The TR radiator: 300 CH2 foil each 20 μm thick, the TR radiator thickness is about 1% of X0 at Z +-50cm;
- The charged particles and TR X-ray detector will use Si-pixel with a pixel size ~50 μm, thickness of 400 μm will be used in order to obtain a good absorption of TR X-rays, 5-30 keV;

Transition Radiation Detector for TESLA (Expected Performance)

e 30GeV/c



- The mean number of detected TR photons is ~3 per electron, that is the requirement of detectin at least one TR photon coresponds to electron efficiency 0.95;
- The mean TR detected photon energy is ~ 11 keV, to keep an electron efficiency of 90% is necessary to detect TR photons above threshold of 5-6 keV;
- There is no significant difference in TR yield for the different rapidity

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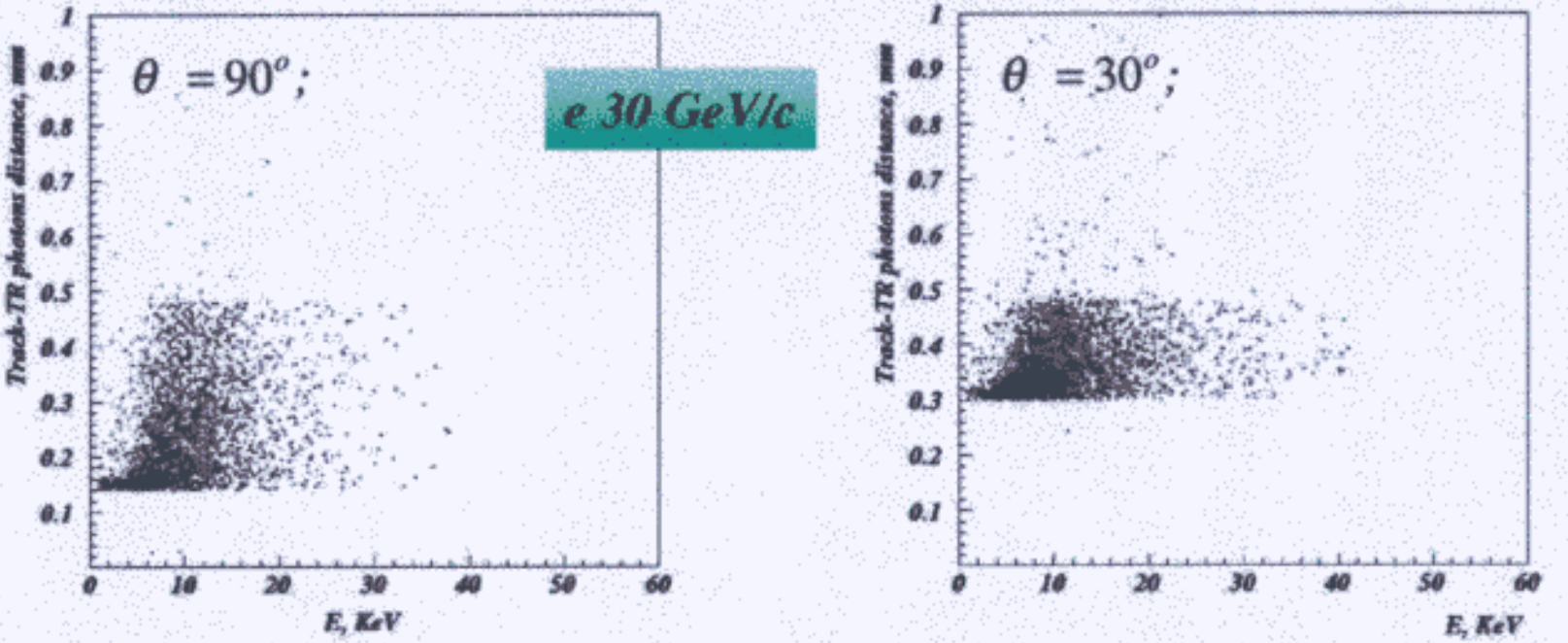
Transition Radiation Detector for TESLA (Expected Performance)



Two dimensional plots of distance between charge particle track and TR photons vs absorbed TR photons energy

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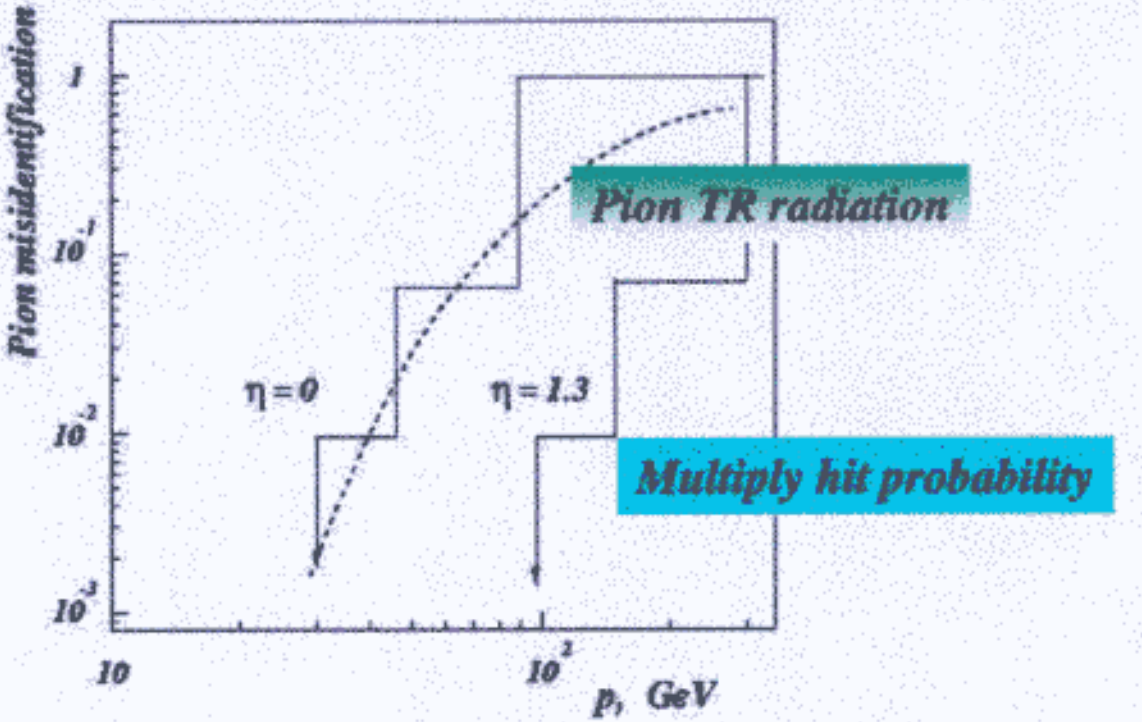
Transition Radiation Detector for TESLA (Expected Performance)

The probability of the pion misidentification which is determined by: at least one hit positioned in the region of charged particle track location - area ~1-5 mm**2;

- Coincidental charged perticle hit in Si-pixel, expected hit dencity even inside a high energy jet is 10^{-3}hits/mm^{2};
- Coincidental gamma hits originating from beam effects, estimation from background study (TPC) gives an upper limit less than 2*10^{-5} hits/mm^{2}*bunch.
- Two or three neighbouring Si-pixels can be triggered due to charge dividing -15% double hits and 2% triple or more hits.
- Charge sharing due to Lorentz angle.

Transition Radiation Detector for TESLA (Expected Performance)



Pion rejection factor of 6 to 100 or greater can be achived over a wide range of momentim up to 90 GeV/c for electron detection efficiency of more 90%;

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Transition Radiation Detector for TESLA

- The main purpose of the Si-pixel TRD in the TESLA detector is to provide electron identification inside hadron jets, complementary to the calorimeter;
- The possibility to predict the TR photon location relative to electron tracks, combined with small size of the TR photon envelope , makes Si-pixel TRD practically insensitive to the particle density inside the jet at hadron rejection factor up to 10^{-2}, for electron detection efficiency of more than 90%;
- The possibility of tracking with accuracy ~ 15 μm will be kept as intermediate tracking options .
- The test of Si-strip TRD with separation of TR photons and charged particle track is in progress.

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Si-pixel Transition Radiation Detector with separation of TR-photons and particle track by B-field. (Proposal for TESLA detector)

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Abstract

This proposal describes a Transition Radiation Detector (TRD) for the detector currently being planned for the TESLA Linear Collider. The principle of measurement is based upon the spacial separation between the trajectories of particles and their associated TR-photons, which is caused by the particle's deflection in the 3T magnetic field of the TESLA detector. Under this proposal the 5 - 30 keV Transition Radiation X-rays will be detected using a Si-pixel detector.

Pion rejection factors of 6 to 100 or greater can be achieved over a wide range of momenta up to 90 GeV/c, for an electron detection efficiency of $\geq 90\%$. Under these conditions a spatial resolution for the track of 15 μm is expected.

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