Single tagged 2-γ events with the electromagnetic detectors of L3

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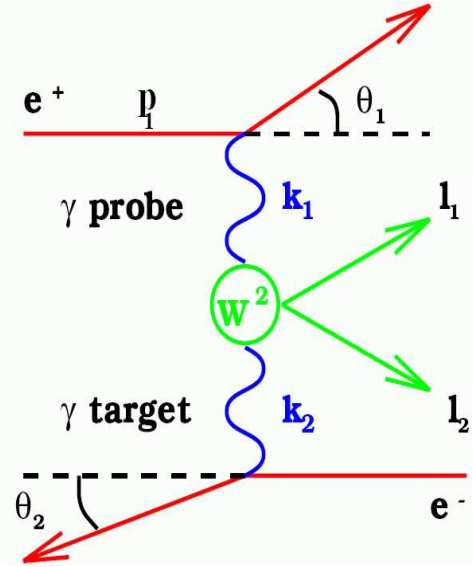
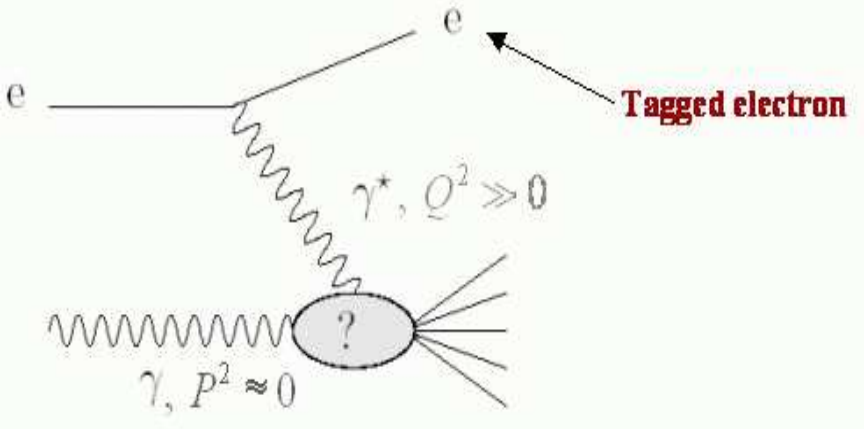
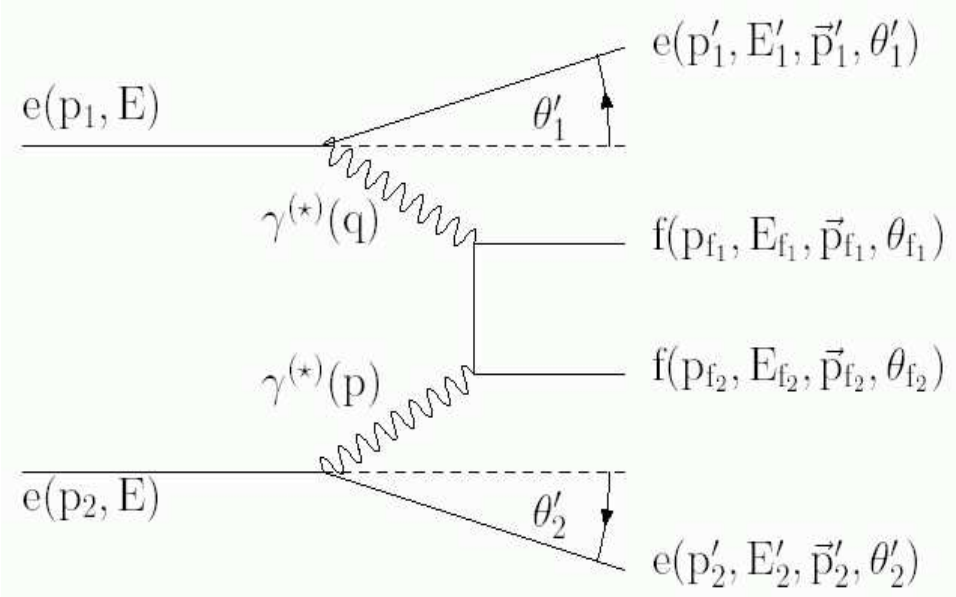
- Among others, investigation of the "structure" of photons
- *Hadronic* and *Leptonic* "structure"
- "Structure" is somewhat natural in Quantum-Field-Theorie (QFT), since a photon can fluctuate into various states
- Photon *interacts* with Photon: acting like projectile and target
- Reaction $\gamma\gamma \rightarrow$ hadrons allows to vary projectile's and target's "mass"





Kinematic variables for Two-Photon processes:



Four momentum transfer: $q = p'_1 - p_1$; $p = p'_2 - p_2$

"Mass" of photon: $\sqrt{q^2} = \sqrt{E_\gamma^2 - \vec{p_\gamma}^{\,2}} \rightarrow q^2 < 0$

A measure of virtuality of the photon: $Q^2 \equiv -q^2$

Structure Functions

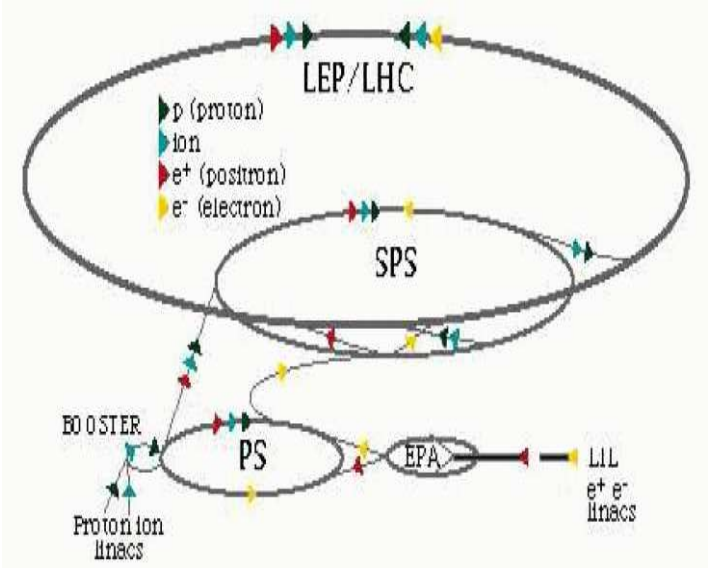
- Structure functions illustrate probabilities:
  → how are the "contents" of the photon distributed
- Structure functions can be extracted from experimentally accessible quantities:
  → Cross section (X-Sec):
    - count # of events you are interested in
    - compare it to the total # of events that happened
  → Check X-Sec's dependencies on the parameters

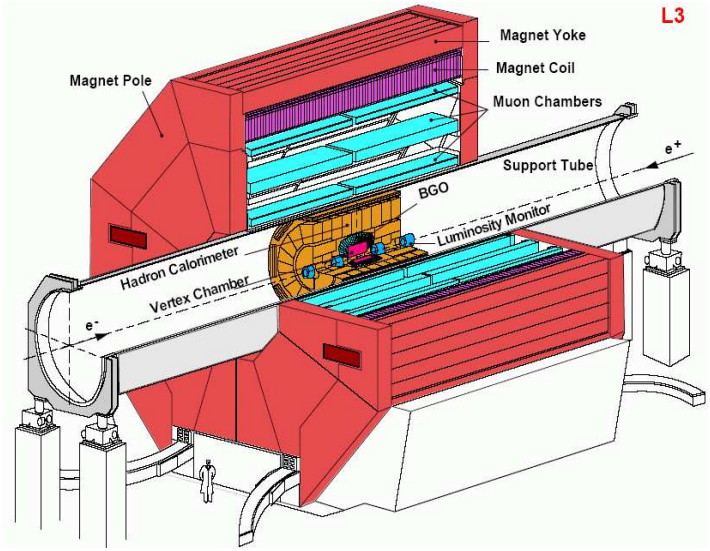
$$\frac{d^2\sigma^{e\gamma\to eX}}{dxdQ^2} =$$

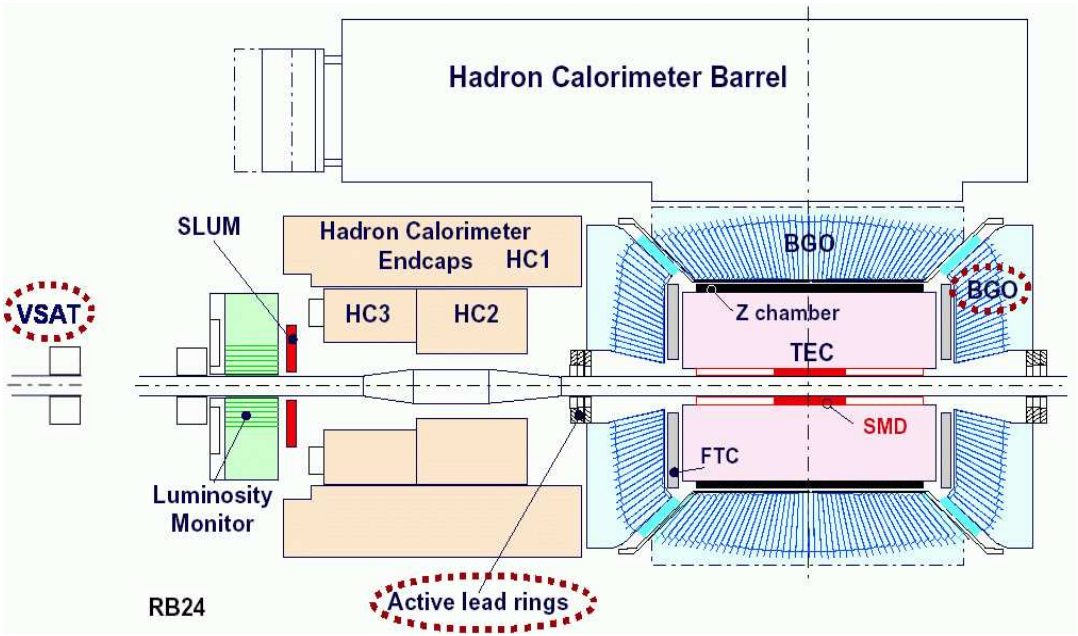
$$\frac{2\pi\alpha^2}{x\cdot Q^4}\cdot([1+(1-y)^2]F_2^\gamma(x,Q^2)-y^2F_1^\gamma(x,Q^2)$$

$$\frac{d^4\sigma^{e\gamma\to ell}}{dxdydzd\chi} =$$

$$\frac{2\pi\alpha^2}{Q^2}\frac{1+(1-y)^2}{xy}\cdot(A_1(x,z)+A_2(x,z)\cdot cos\chi+A_3(x))\cdot cos2\chi$$


LEP/LHC
p (proton)
ion
e+ (positron)
e- (electron)
SPS
BOOSTER
PS
EPA
LIL
e+ e-
linacs
Proton ion
linacs

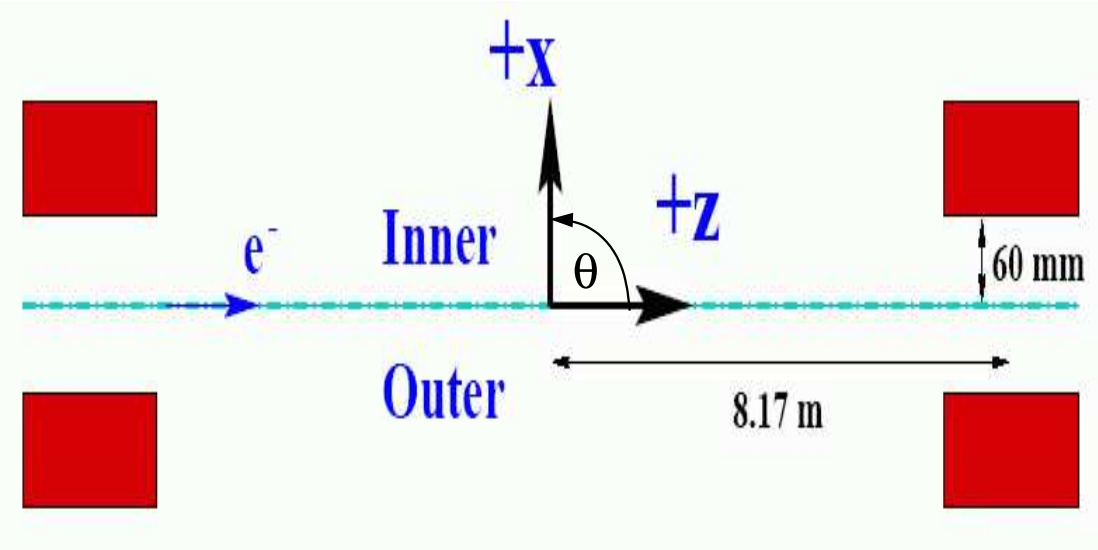

L3
Magnet Yoke
Magnet Coil
Muon Chambers
Magnet Pole
Support Tube
e+
BGO
Luminosity Monitor
Hadron Calorimeter
Vertex Chamber
e-


Hadron Calorimeter Barrel
SLUM
Hadron Calorimeter
Endcaps HC1
HC3
HC2
VSAT
BGO
BGO
Z chamber
TEC
SMD
FTC
Luminosity
Monitor
RB24
Active lead rings

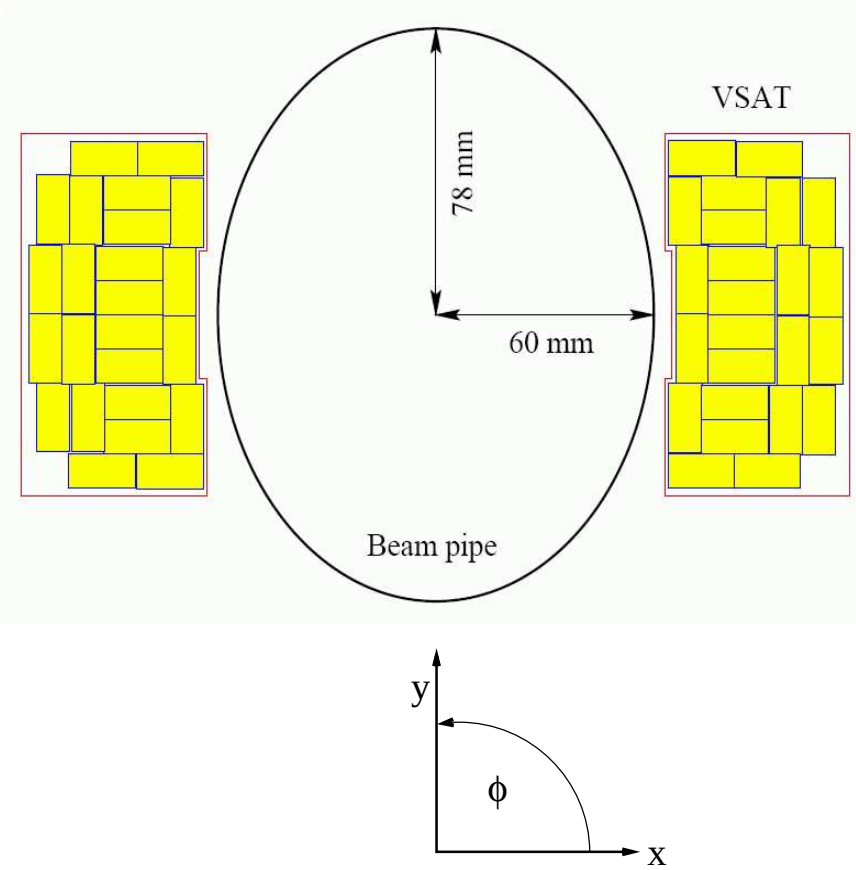
Very Small Angle Tagger (VSAT)

- VSAT consists of *four* boxes with 24 BGO crystals each.
- Positioned in the horizontal plane on each side of the beam pipe.
- Positioned behind the first quadrupole magnets.
- Quadrupole *changes* volume inside the beam pipe into horizontal ellipse overlaying the VSAT.

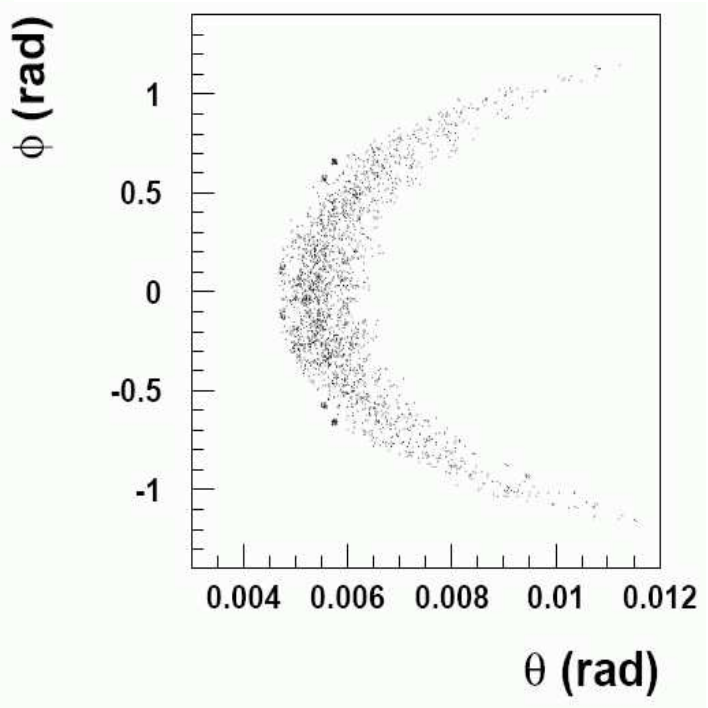
Coordinate system of VSAT boxes:



XY-view of the VSAT boxes:



VSAT acceptance:



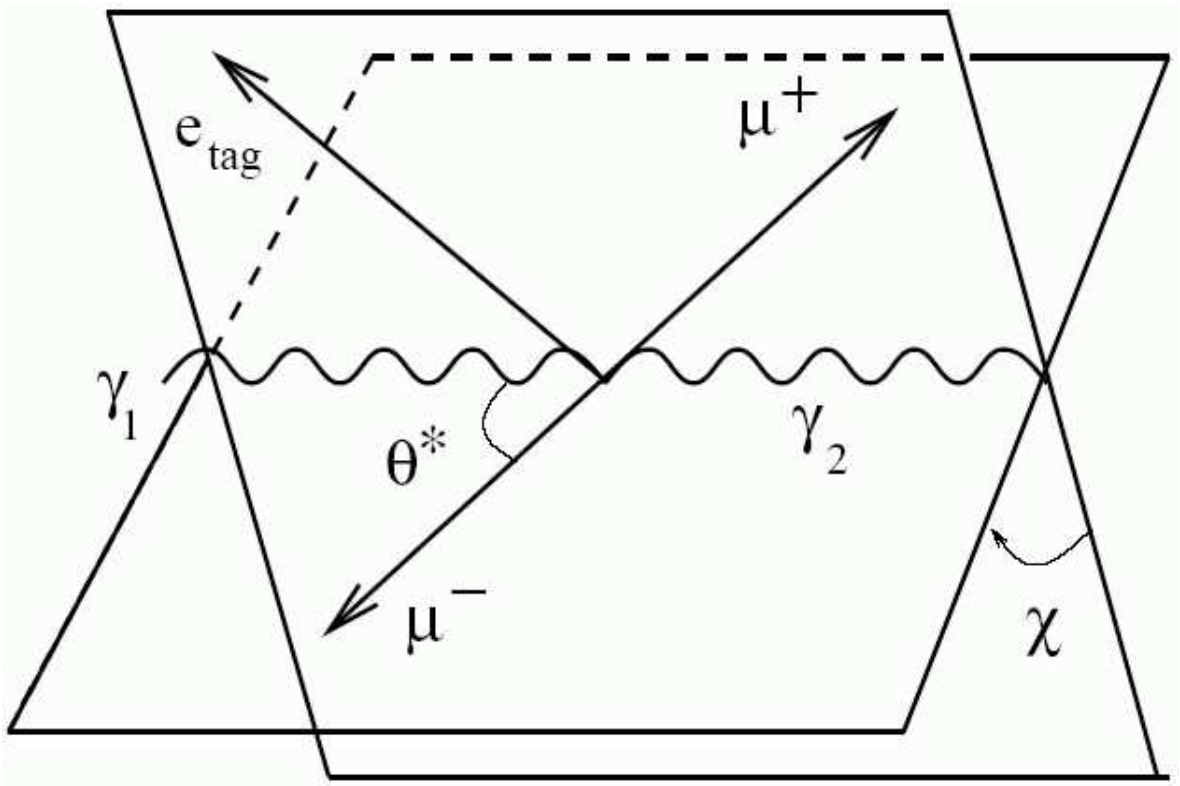
T. van Rhee et al., L3 Note 2117

Using Di-Lepton production

- Using lepton pairs to calibrate and align VSAT
  - $e^+e^- \rightarrow e^+e^-\gamma\gamma \rightarrow e^+e^-l^+l^-$ in single tag configuration
  - QED $O(\alpha^4)$
  - Using in particular $\mu^+\mu^-$
  - Using two-track information and identification of $\mu's$
  - Using VSAT energy-angle information
  - LEP2 data sample, $\sqrt{s} = 189\ GeV \rightarrow 209\ GeV$
- $Q^2 \simeq 2 \cdot E_{tag} \cdot E_{beam} \cdot (1 - cos\theta_{tag})$

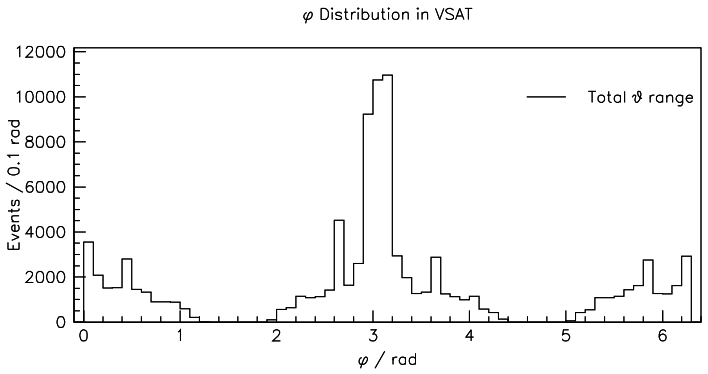
Di-Lepton Kinematics

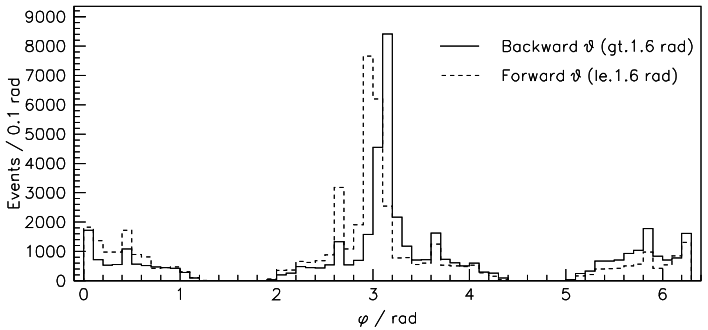
$$Q^2 = (\sum_{i=1}^{2} \vec{p}_{T,i})^2$$

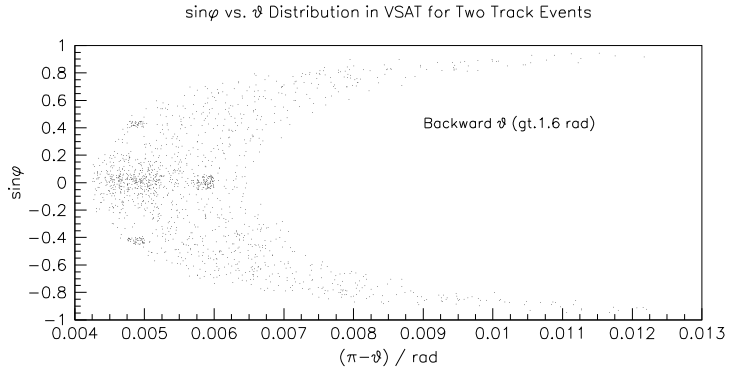


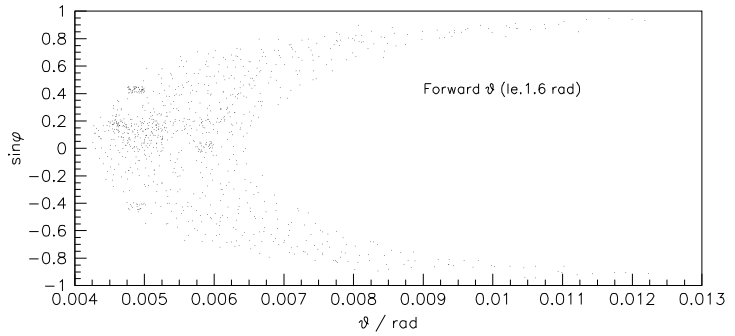
VSAT Misalignment ?

- Started selection of single tagged events for 1998-sample
- Excessive events at selected angles (ϕ)
- It shows assymmetry in ϕ between forward and backward VSAT



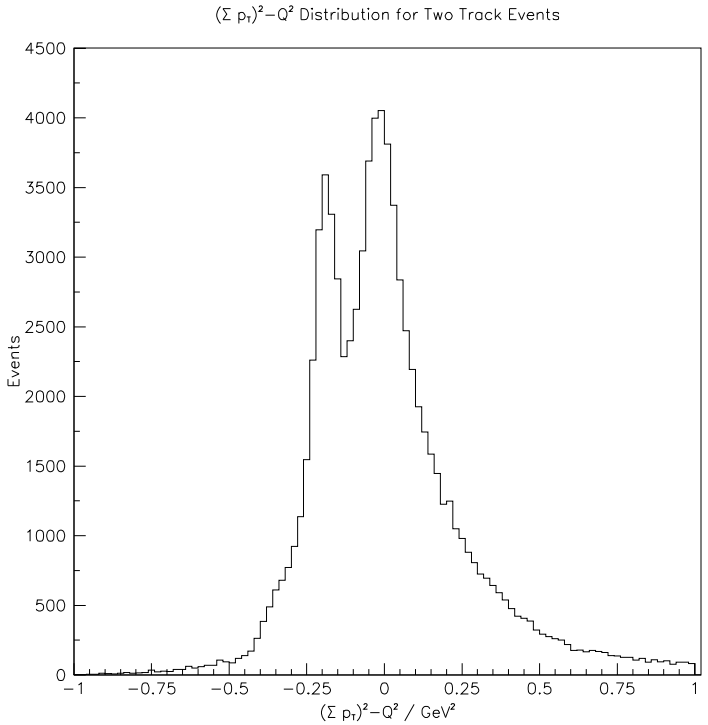


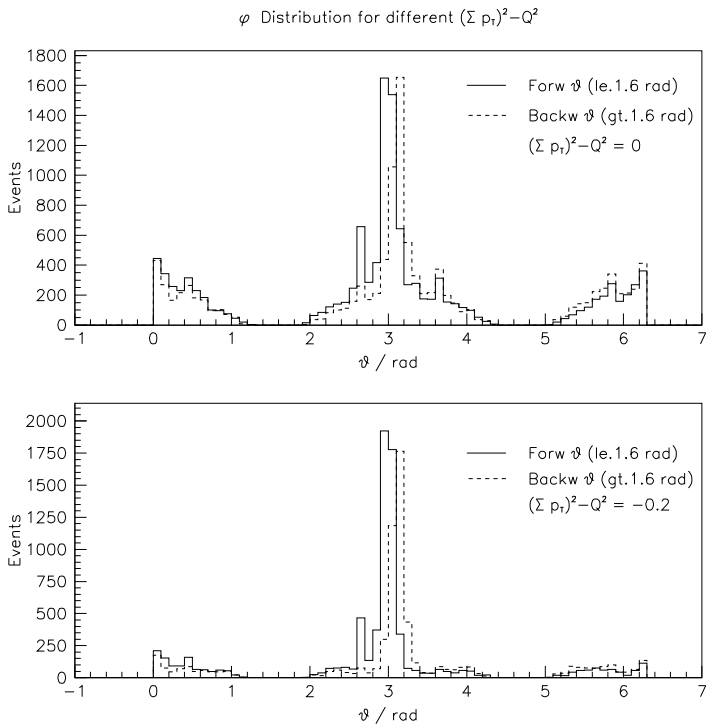




Off-Momentum Electrons ?

- Shows $(\sum_{i=1}^{2} \vec{p}_{T,i})^2 - Q^2 \neq 0$
- Region around $(\sum_{i=1}^{2} \vec{p}_{T,i})^2 - Q^2 \approx 0$ does not get rid of spikes in ϕ-distribution





Plans

- Subdivide $(\sum_{i=1}^{2} \vec{p}_{T,i})^2 - Q^2$ region into three regions:
  - $(\sum_{i=1}^{2} \vec{p}_{T,i})^2 - Q^2 \approx 0$
  - $(\sum_{i=1}^{2} \vec{p}_{T,i})^2 - Q^2 \approx -0.2$
  - Rest
- Investigation of the characteristics of the particular regions.
- Realignment with two muon tracks and reconstruction of the kinematics.
- VSAT Energy-calibration.

Outlook

- Continue with Di-Lepton events and measure *leptonic* $F_2^\gamma(x, Q^2)$ as well as $F_L^\gamma \propto \sigma_{TL}$ by means of azimuthal correlations in the $\gamma\gamma$-CM system $\rightarrow$ measuring the interference term A_2 from single tagged Two-Photon events.