Bremsstrahlung photons at PS
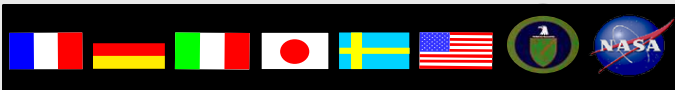## (created December 6, 2006)

Tomi Ylinen
Royal Institute of Technology (KTH)
Kalmar University

Information

- Runs used for analysis:

  Data:
  700001182 (v1r030603p9) – fullbrems γ
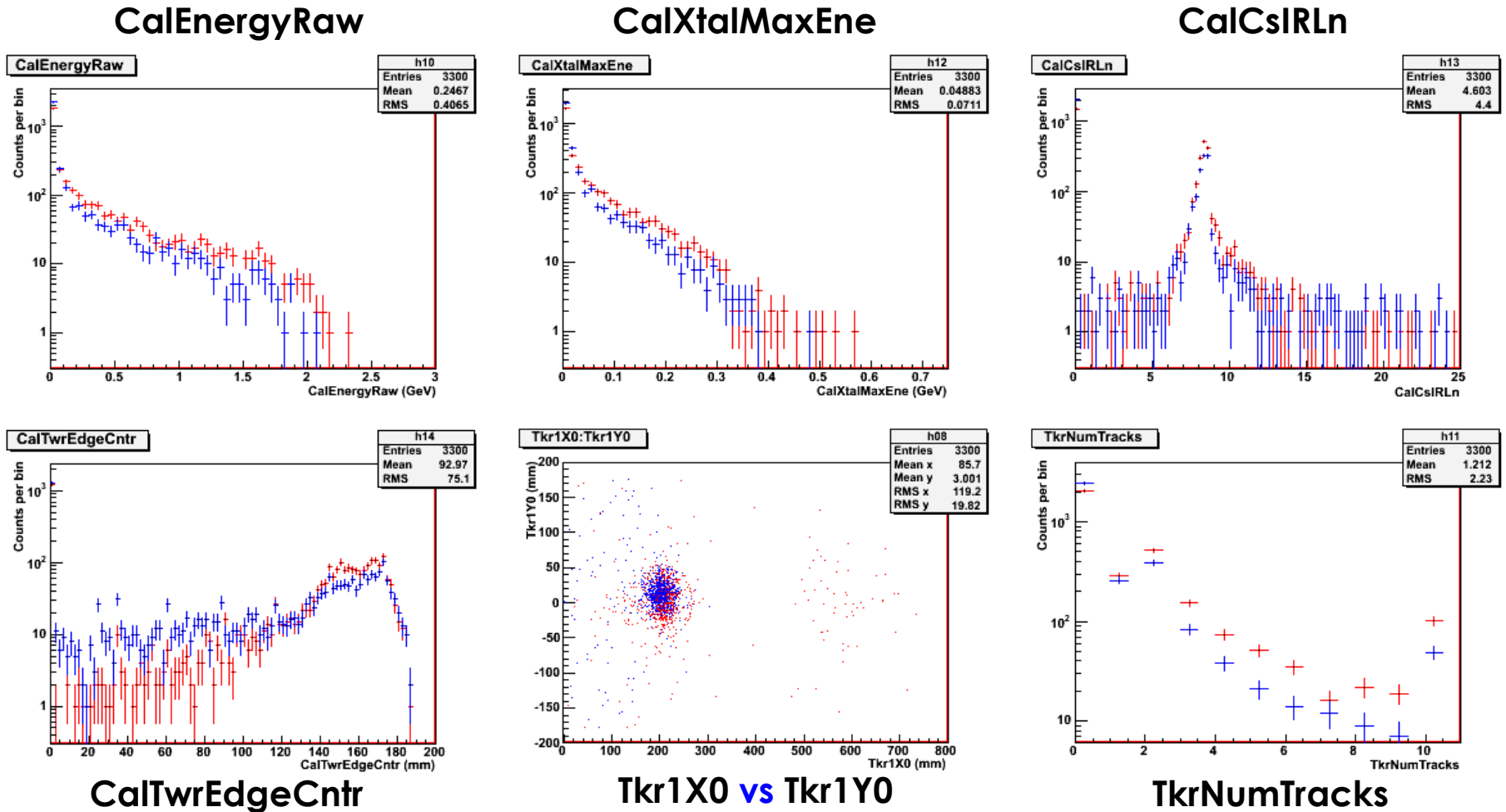 **2.5 GeV, 0 deg, xyz = [201, 0, 0]**

  MC:
  0129 (v5r3p4(?))– fullbrems γ
  2.5 GeV, 0 deg, xyz = [201, 13.9, -47.4]

  (note: not exactly the same position)

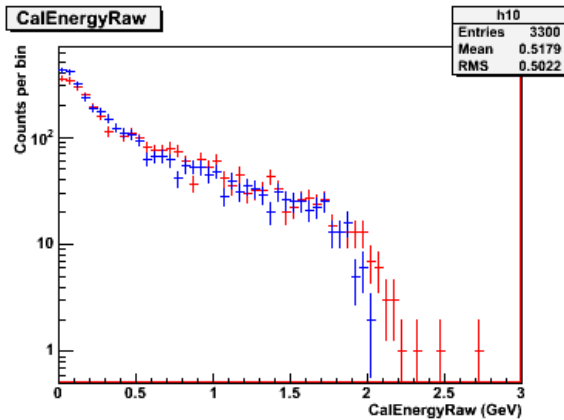- Distributions normalized by the number of counts
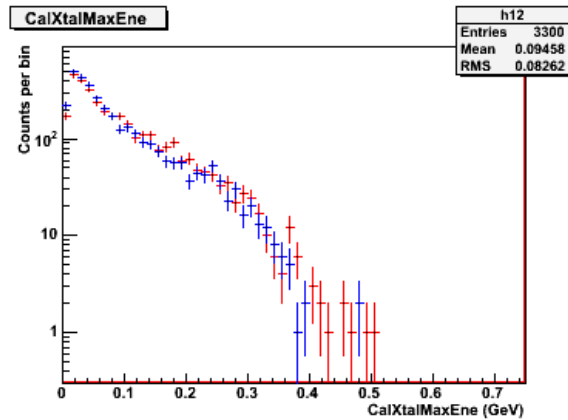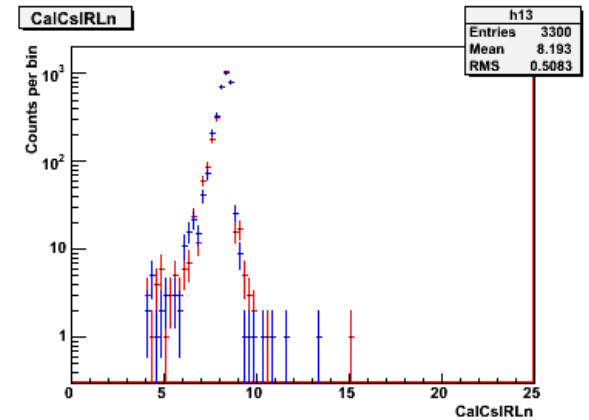
Variables used for cuts – before cut

CalEnergyRaw

CalXtalMaxEne

CalCsIRLn

CalTwrEdgeCntr

Tkr1X0 vs Tkr1Y0

TkrNumTracks

DATA
MC

Variables used for cuts – after cut

CalEnergyRaw $>$ 10 MeV

CalXtalMaxEne $>$ 5 MeV

CalCsIRLn $>$ 4 X_0
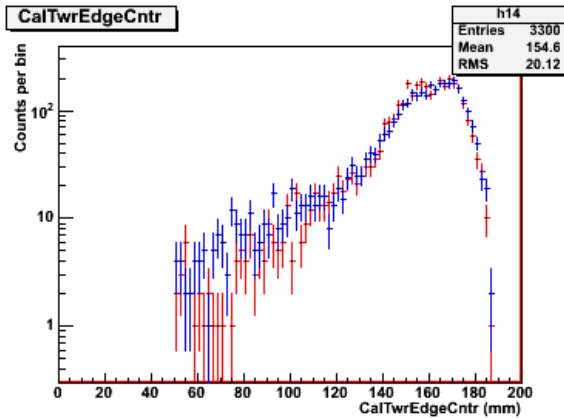
CalTwrEdgeCntr $>$ 50 mm
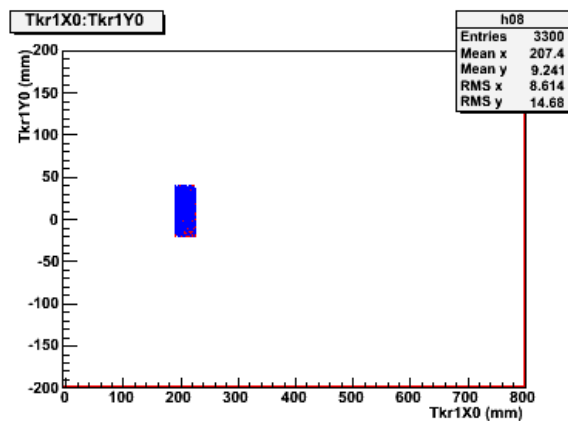
190 mm $<$ Tkr1X0 $<$ 225 mm
-20 mm $<$ Tkr1Y0 $<$ 40 mm
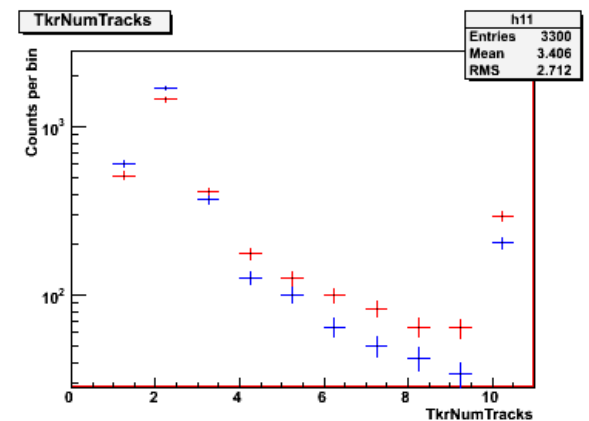
TkrNumTracks $>$ 0

■ **DATA**
■ **MC**

Events left: **3300**

Energy in calorimeter layers - qualitatively
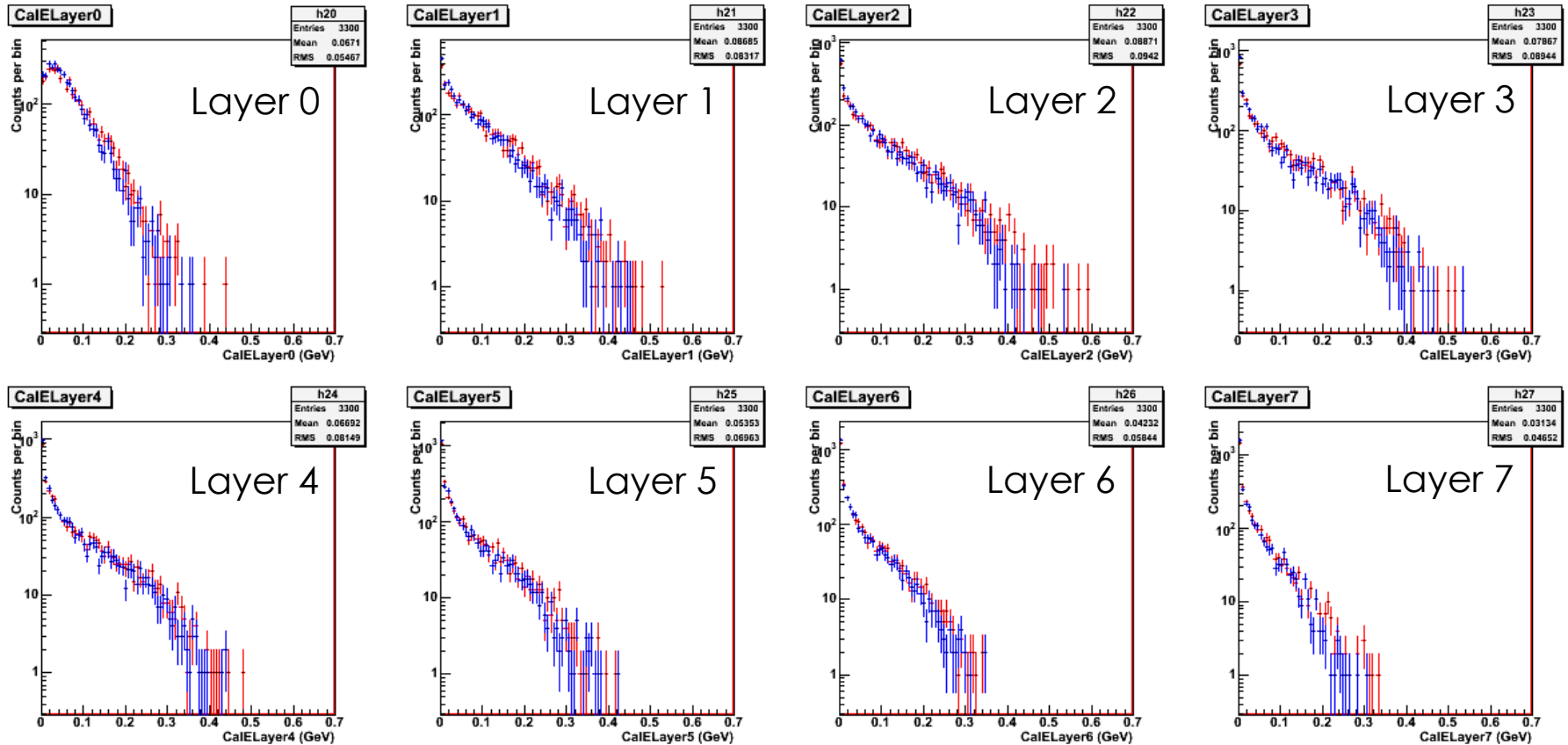
DATA
MC

Energy in calorimeter layers - quantitatively

Moments comparision between data and MC
~10 % difference → The calibration issue?

CalELayer	Mean (MeV)	RMS (MeV)
0	67.0997 60.6948	54.6750 50.2390
1	86.8539 76.5774	83.1665 76.3547
2	88.7056 77.5877	94.2034 85.9081
3	78.6671 70.0377	89.4300 85.4455
4	66.9250 59.5572	81.4859 76.4615
5	53.5314 47.8309	69.6341 65.3499
6	42.3209 37.2790	58.4369 53.6610
7	31.3352 27.2015	46.5152 41.2417
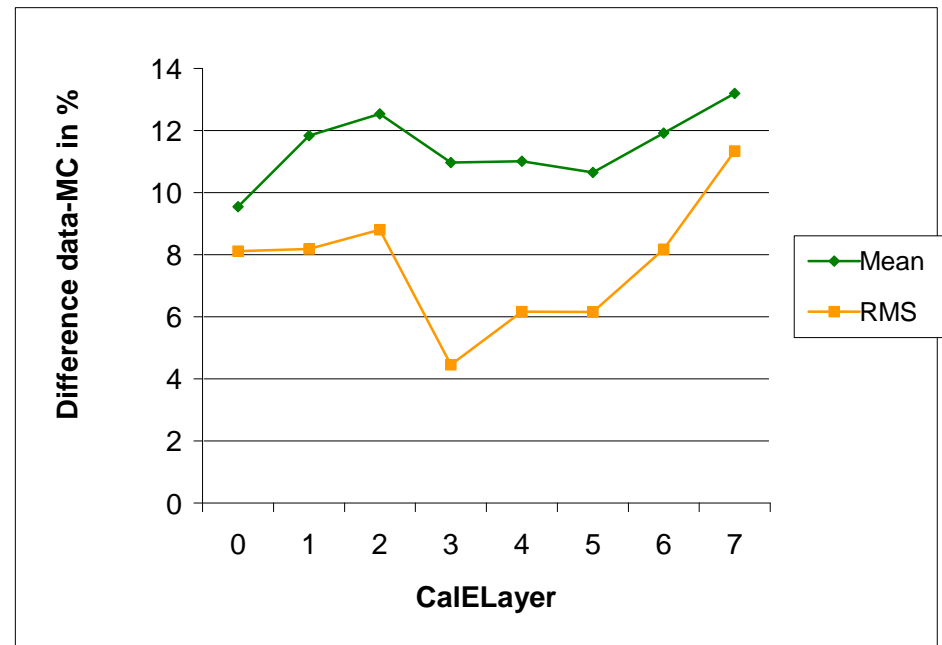
Position in TKR vs CAL - qualitatively
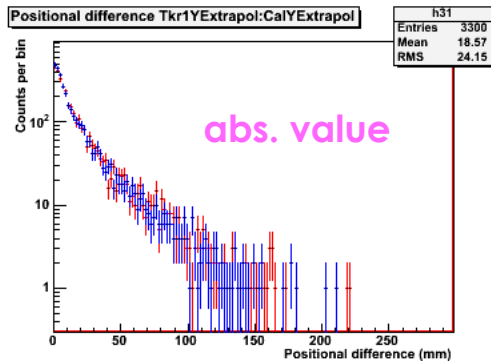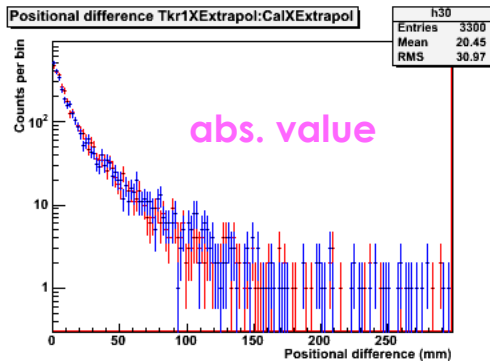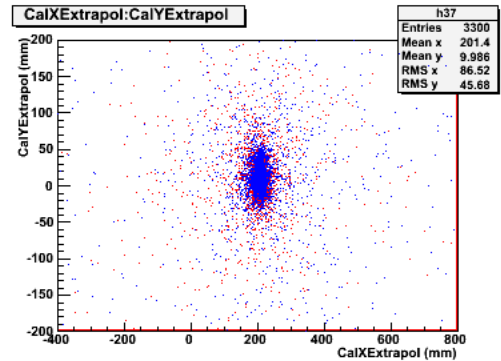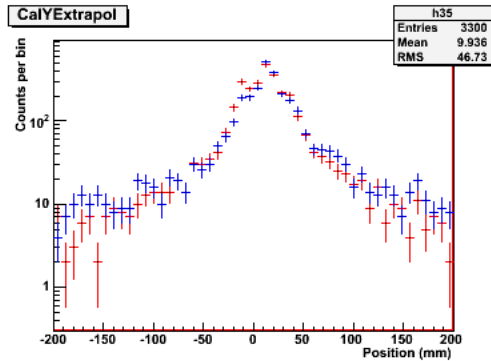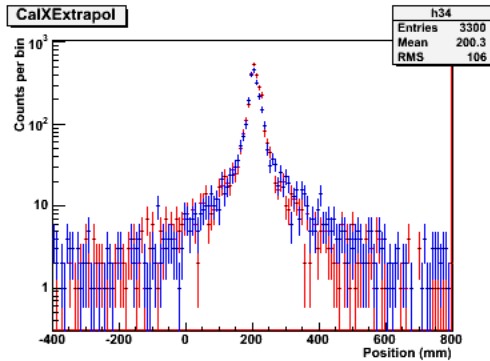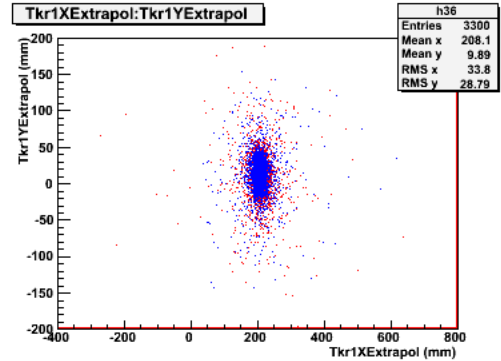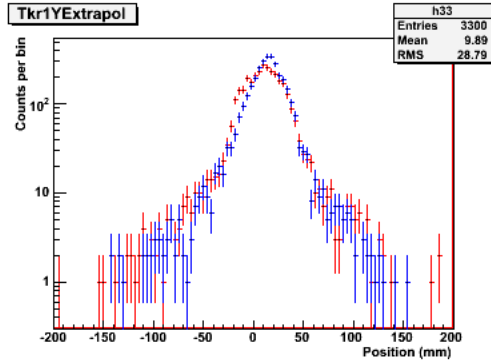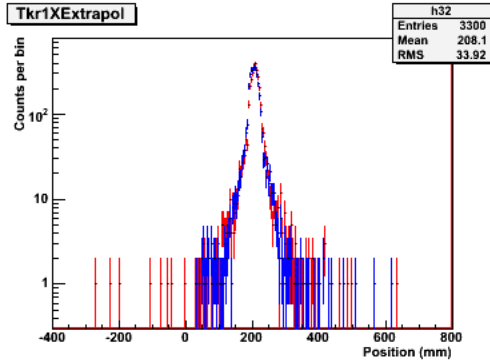
- Position from TKR and CAL cntr extrapolated to top of CAL

DATA
MC

Direction in TKR vs CAL - qualitatively

DATA
MC

clear difference
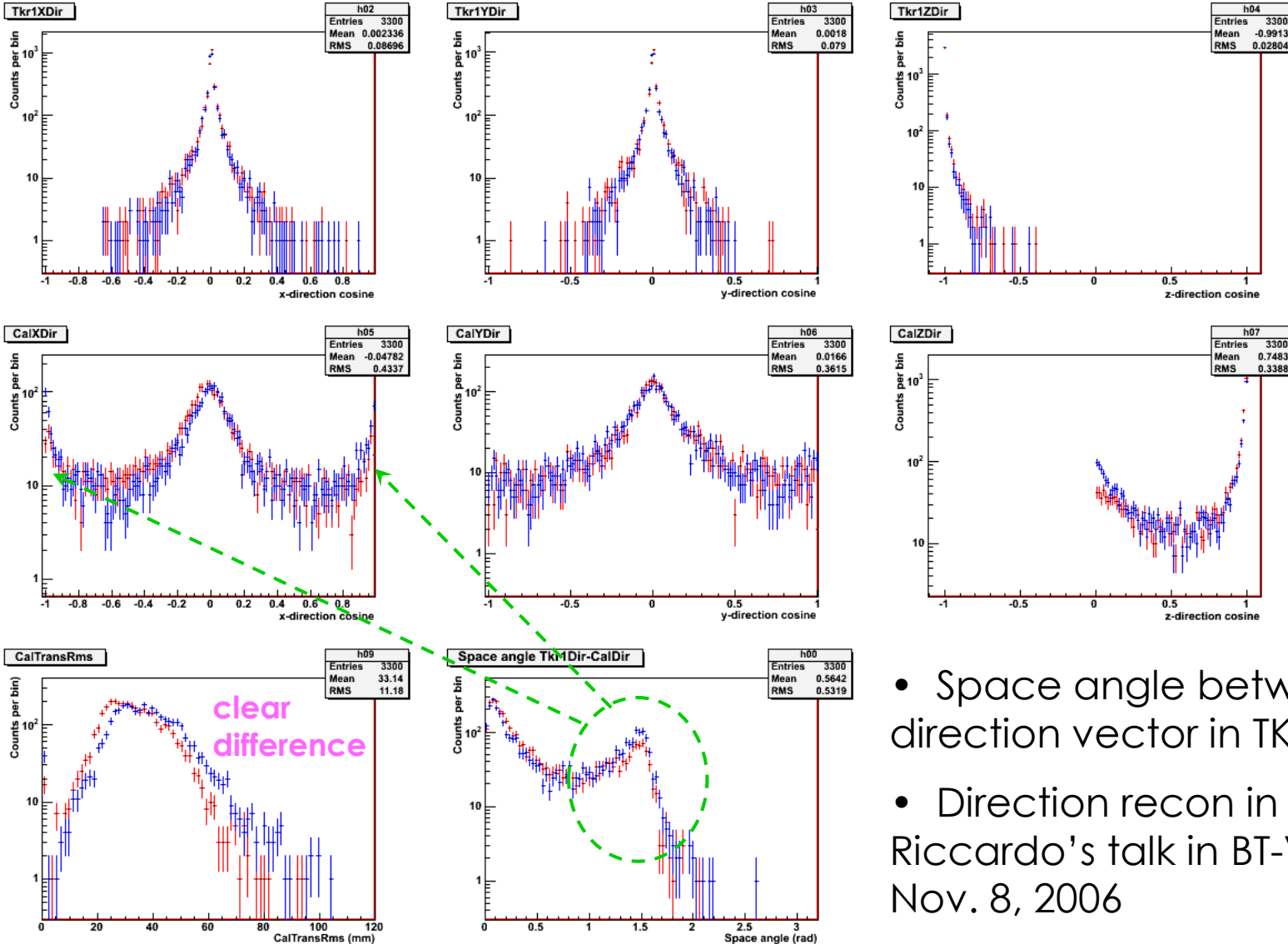
• Space angle between direction vector in TKR and CAL

• Direction recon in CAL fails!
Riccardo's talk in BT-VRVS
Nov. 8, 2006

CalTransRms
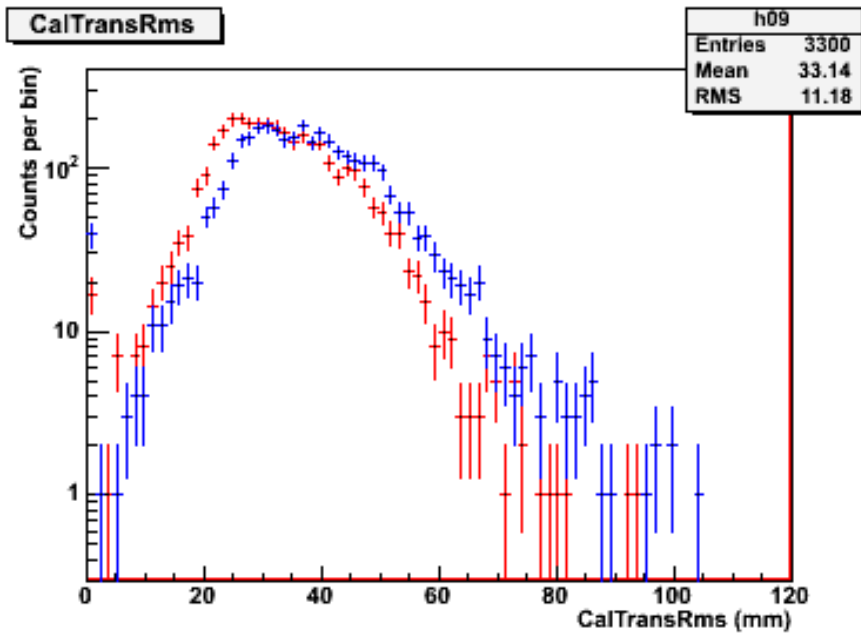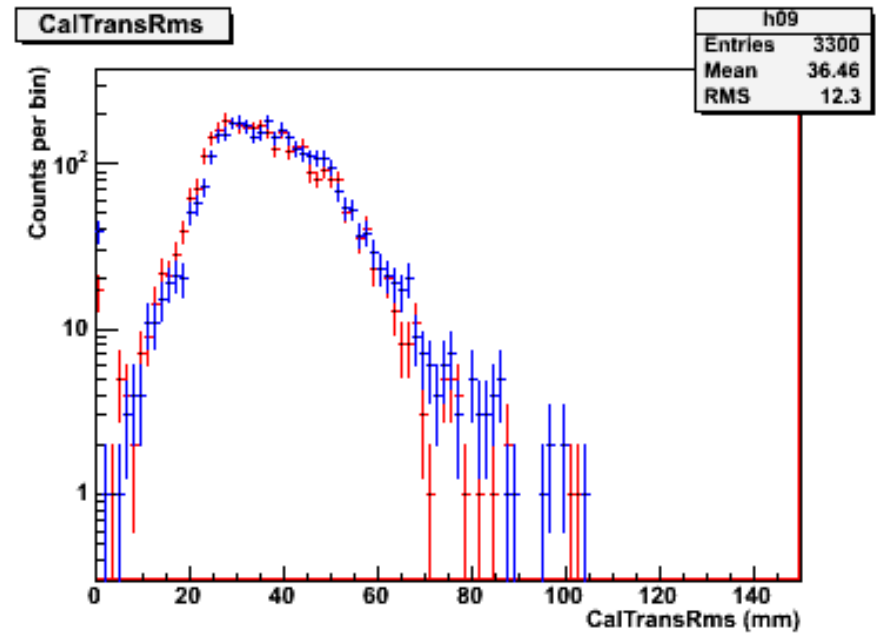
No scaling   🟥 **DATA**   Data scaled up by 10%
                    🟦 **MC**

- Shapes seem to be comparable

Position & direction - quantitatively

- 68% containment integrals of space angle and position distributions
- Kolmogorov statistical test for shape compatibility (0=bad, 1=good)

	Data 68%	MC 68%	Kolmogorov test
Direction	43.2392 ± 1.8655 deg	63.8477 ± 1.4993 deg	$3.7336 \cdot 10^{-13}$
Position X	18.1664 ± 0.5785 mm	18.6242 ± 0.6209 mm	0.445865
Position Y	18.0727 ± 0.5126 mm	17.1923 ± 0.5153 mm	0.315228

Summary/Conclusions

- The 10% difference in calorimeter layer variables. Calibration issue?

- Position reconstruction looks pretty good, shapes and quantiles are comparable

- Shapes are comparable in direction distributions but reconstruction in CAL is not working well. Perhaps related to presentation by **Riccardo** on BT-VRVS Nov. 8, 2006?
    - → moments analysis seems to cause a radical direction change

- Why do 80% of the fullbrems photon events have no track associated (i.e. TkrNumTracks==0)?

- In conclusion, photons seem to be pretty well modeled in Geant4

Extra slide

- Study the difference between the recorded particle position in TKR and recorded centroid position in CAL, extrapolated to the top of the CAL

    Tkr1[X/Y]0 – position at first hit in the TKR

    Cal[X/Y]Ecntr – recorded position of CAL energy centroid

- Difference distributions calculated as the absolute value of the position difference
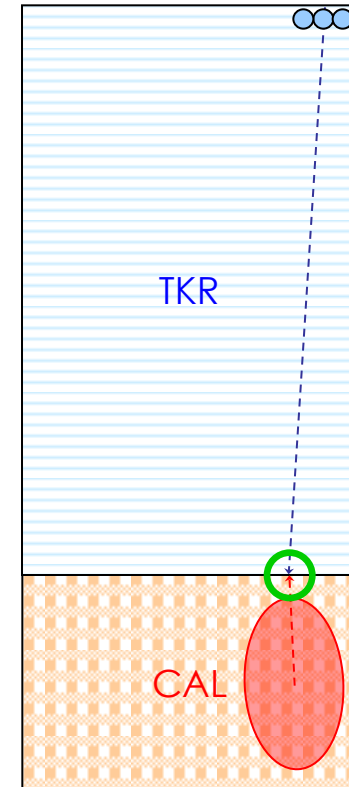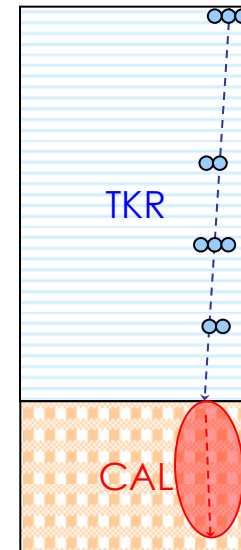

Simplified and exaggerated!

Extra slide

- Study the difference between the generated particle direction and the recorded particle direction in the calorimeter

  Tkr1[X/Y/Z]Dir – recorded particle
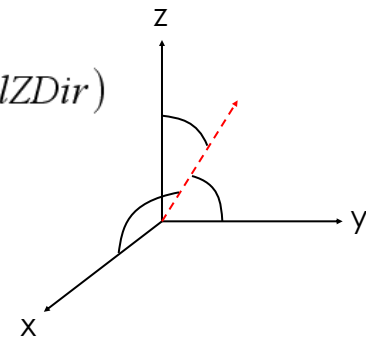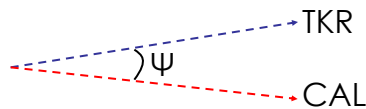 direction cosines
  in the TKR for best track

  Cal[X/Y/Z]Dir – recorded particle
  direction cosines
  in the CAL

TKR

CAL

Simplified and exaggerated!

- Space angle is given by

$$\psi = \pi - \arccos(Tkr1XDir \cdot CalXDir + Tkr1YDir \cdot CalYDir + Tkr1ZDir \cdot CalZDir)$$

TKR

ψ

CAL

z

y

x

Extra slide

- The 68% integral is done with **GetQuantiles(quantile)** in ROOT, which calculates a given fractional (quantile) integral starting from the left and gives the space angle corresponding to that fraction

- Error in counts is assumed to have binomial distribution

$$\Delta N = \sqrt{N_{tot} \cdot Quantile\left(1-Quantile\right)}$$

- New integrals are calculated for
  $$Quantile \pm \Delta N/N_{tot}$$

- Symmetric error is assumed
  $$Error = 0.5 \cdot ((Q+\Delta N/N_{tot}) - (Q-\Delta N/N_{tot}))$$

Angle between CalDir and McDir