# MIM fit on GPS data

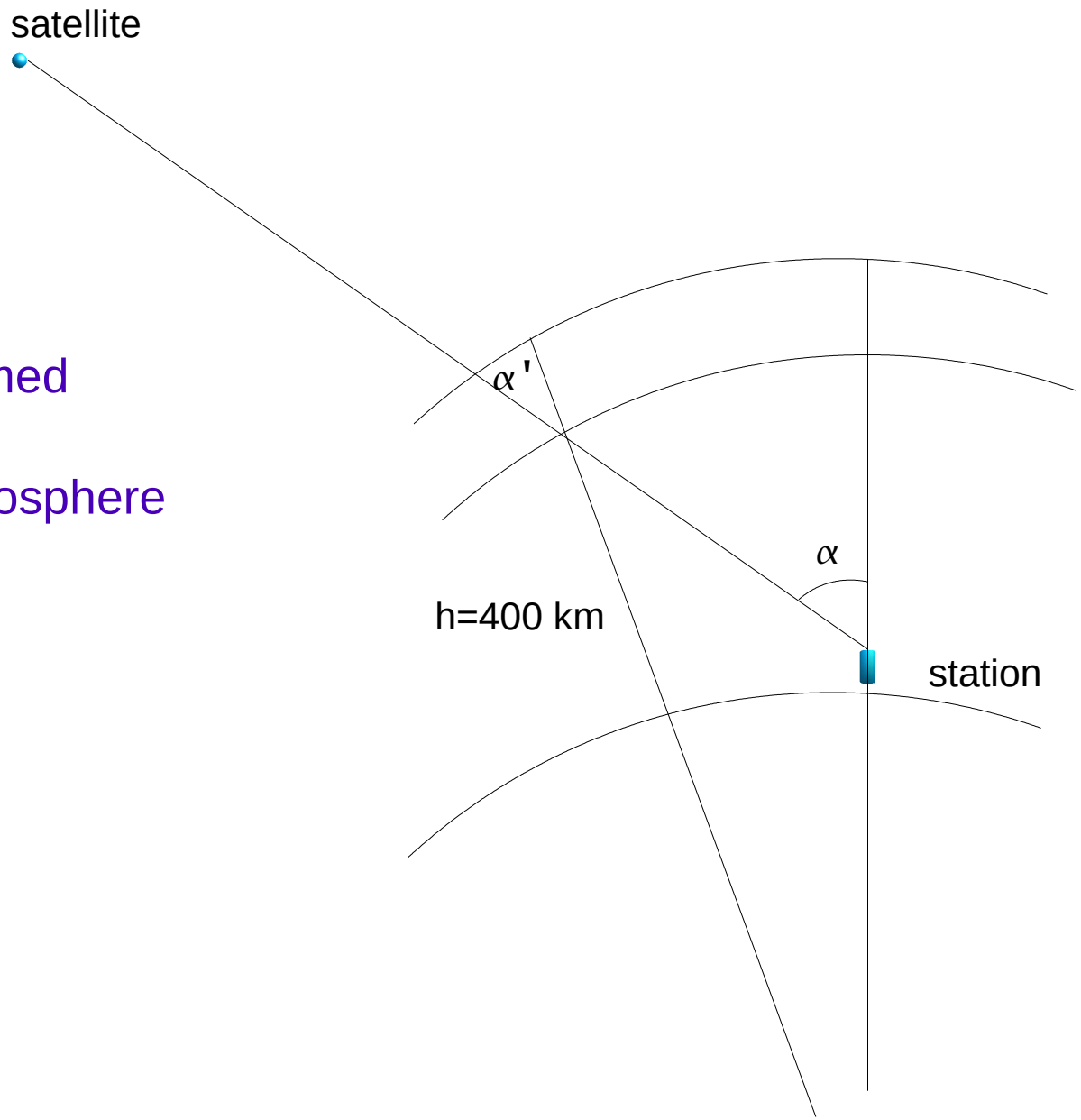
- 72 GPS stations (LA area):
  - select 5 stations (distance ~ 50 km)
  - 3 hrs. night period: flat ionosphere
    - 5 satellites
  - Separate bias for every station – sat combination
  - 2nd order MIM:

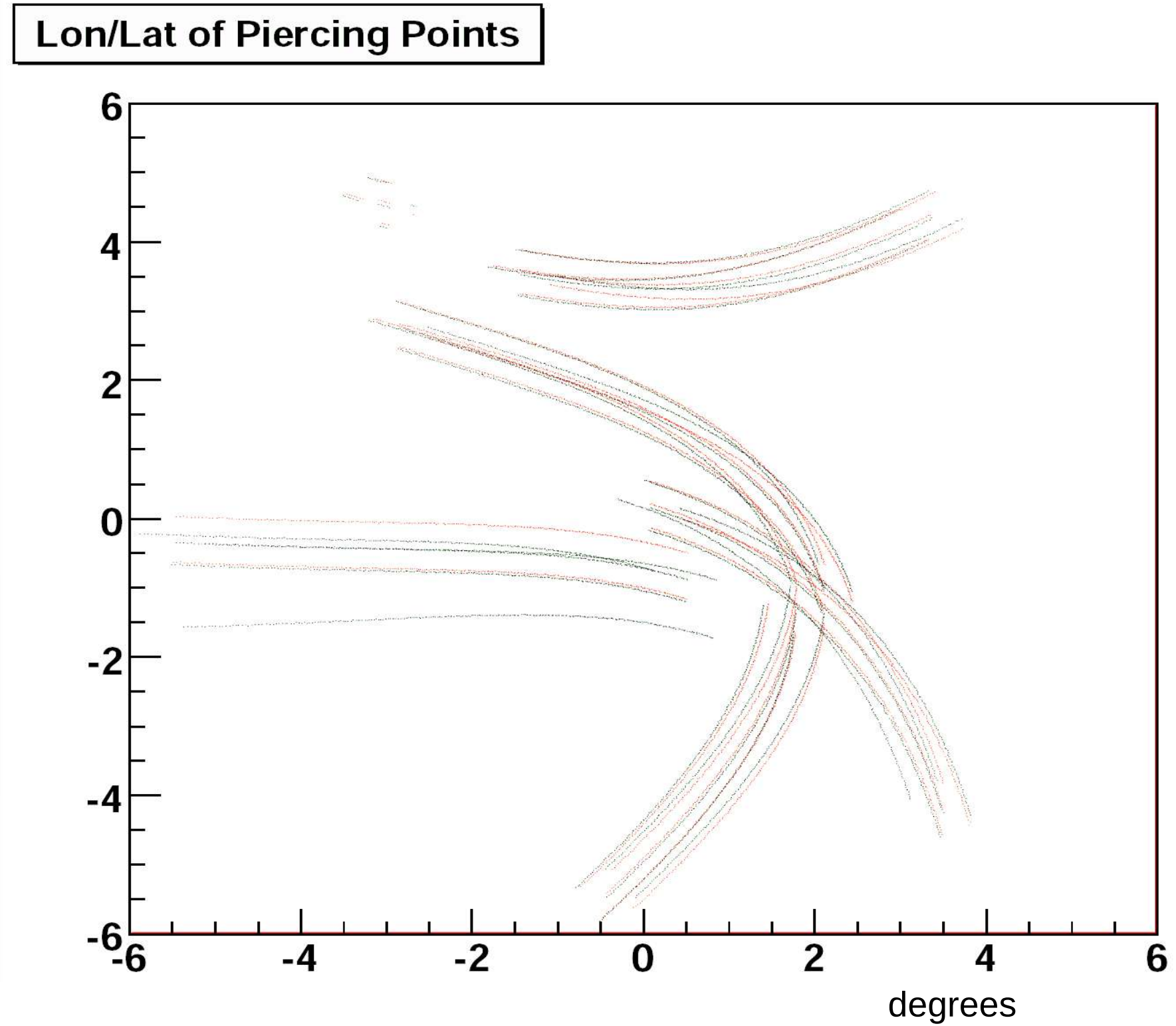
    $p_{00} + p_{01}\cdot lon + p_{02}\cdot lon^2 + p_{10}\cdot lat + p_{20}\cdot lat^2 + p_{11}\cdot lon\cdot lat$

    lon/lat of piercing point, rotated to reference station

# Piercing Points

spherical earth assumed
1/cos($\alpha$') correction
for thickness ionosphere
fixed h at 400 km
cut at $\alpha$> 60˚




Lon/Lat of Piercing Points
6
4
2
0
-2
-4
-6
-6
-4
-2
0
2
4
6
degrees

# MIM fit

- bias for every station – sat combination
- 2nd order MIM:

$$p_{00} + p_{01}\cdot lon + p_{02}\cdot lon^2 + p_{10}\cdot lat + p_{20}\cdot lat^2 + p_{11}\cdot lon\cdot lat$$

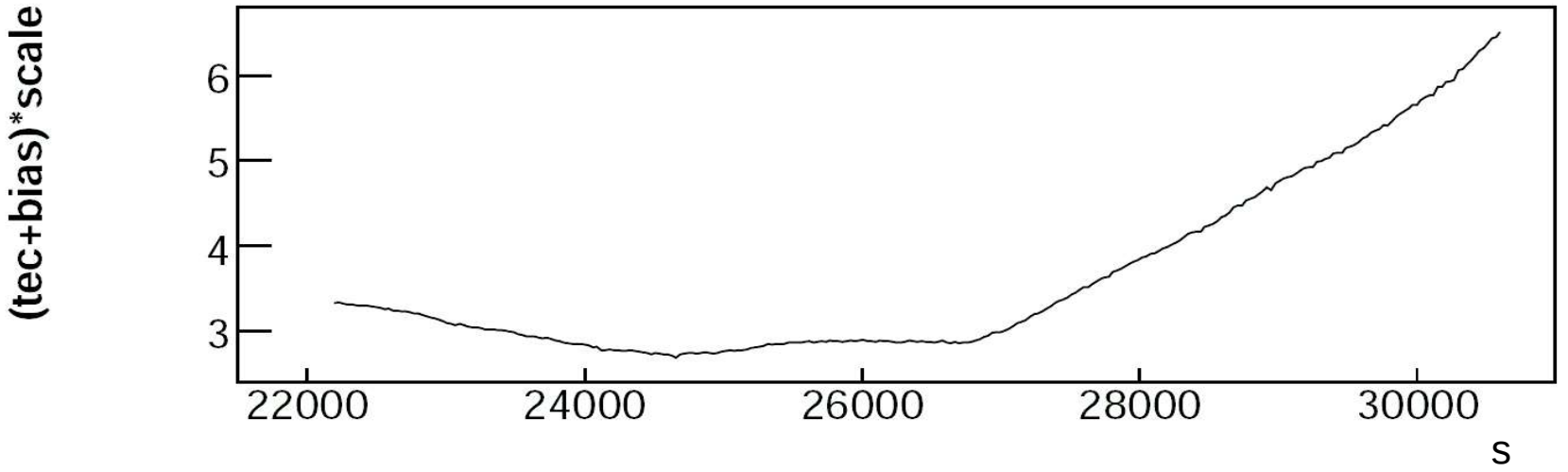
Separate MIM-parameters from bias via $1/\cos(\alpha')$ term:

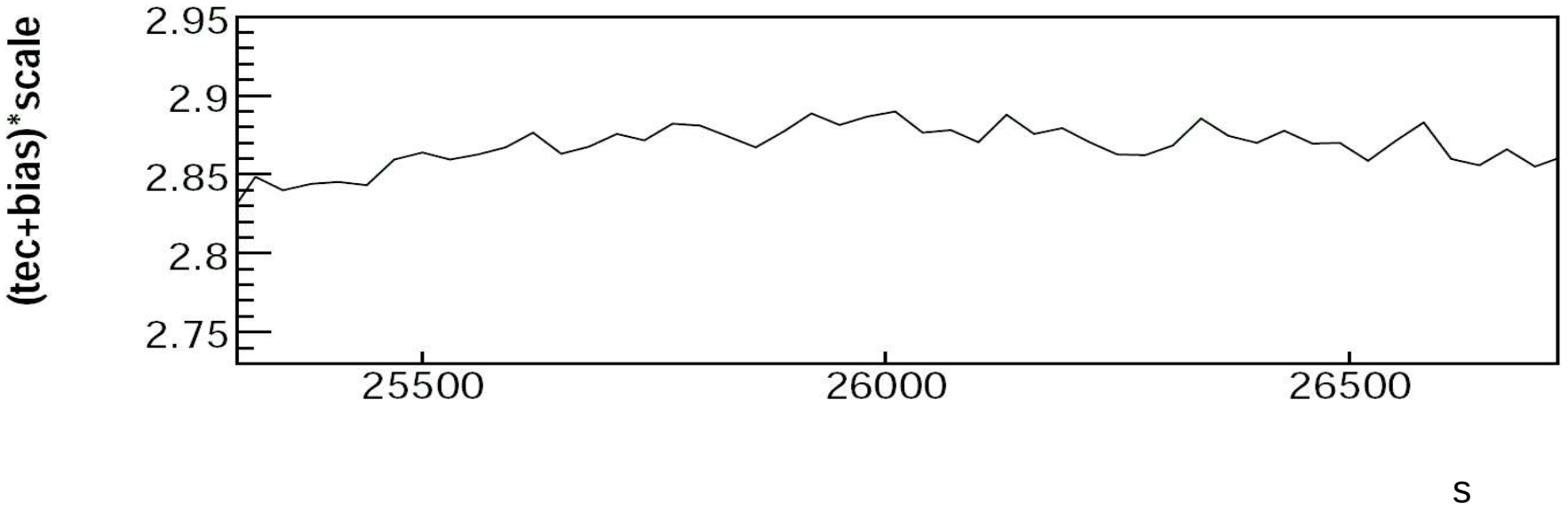
- Ionosphere $+\cos(\alpha')$: position + time dependent
- bias: constant
- simultaneous fit of MIM + bias possible over longer times

Residuals = $MIM(t)\cdot 1/\cos(\alpha'(t)) - TEC_{measured} - bias_{sat,station}$

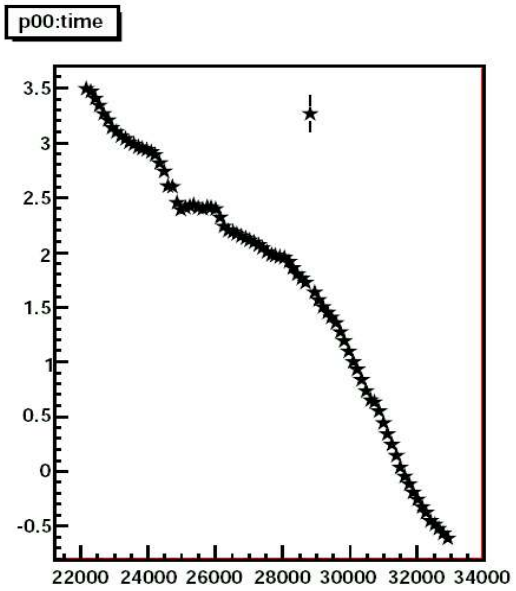
principle proved by MeqTree simulations

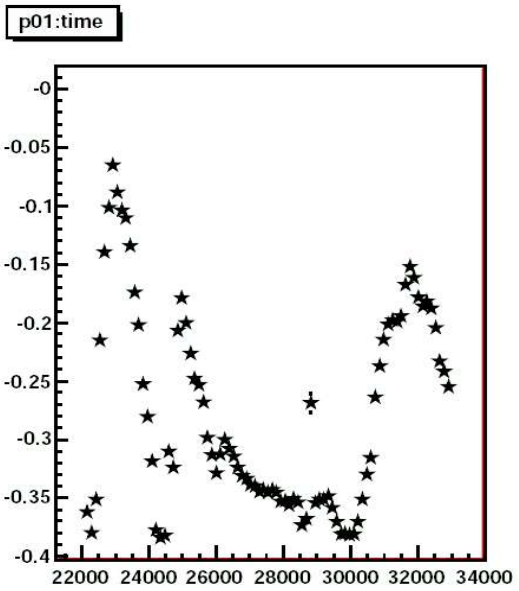
# TEC

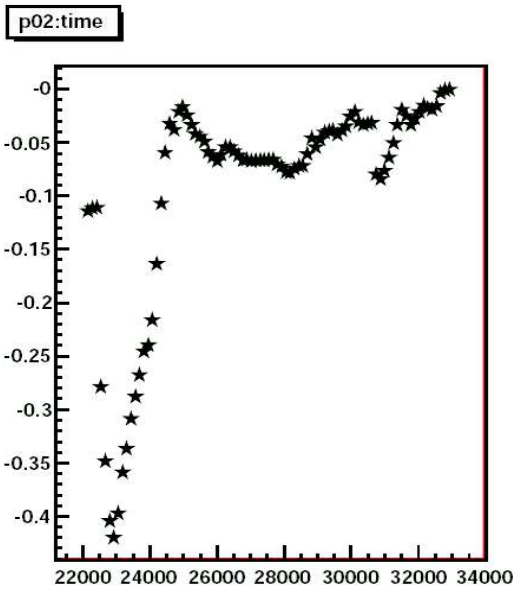

(tec+bias)*scale
6
5
4
3
22000
24000
26000
28000
30000
s

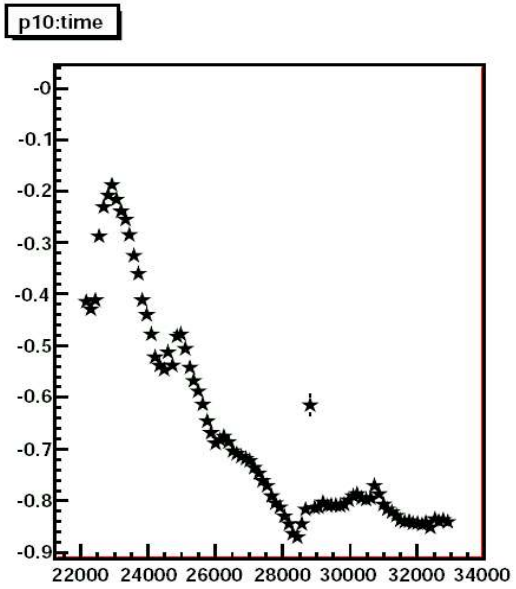

(tec+bias)*scale
2.95
2.9
2.85
2.8
2.75
25500
26000
26500
s

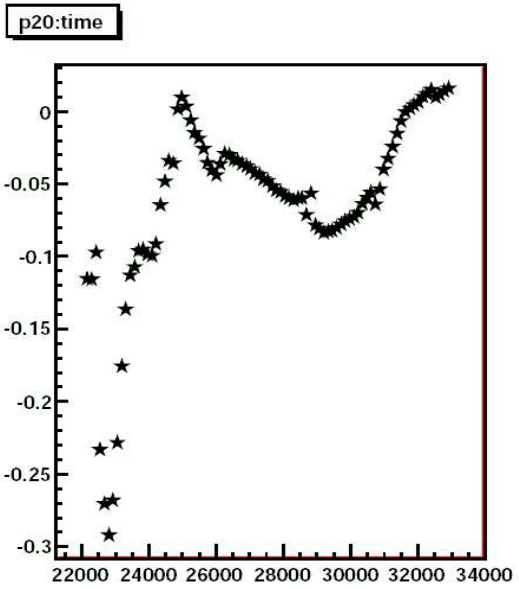
# MIM parameters

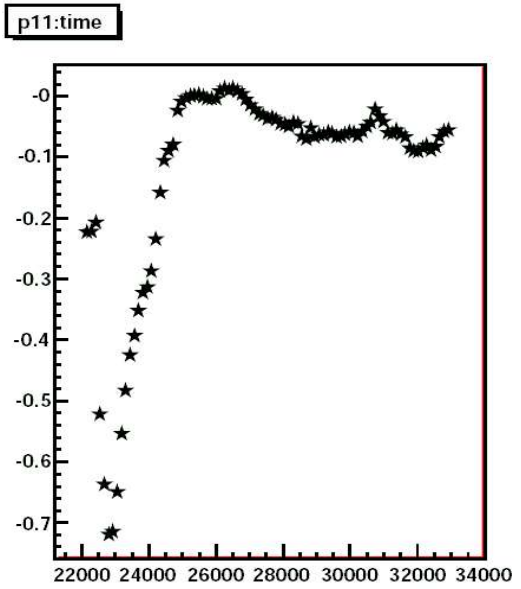


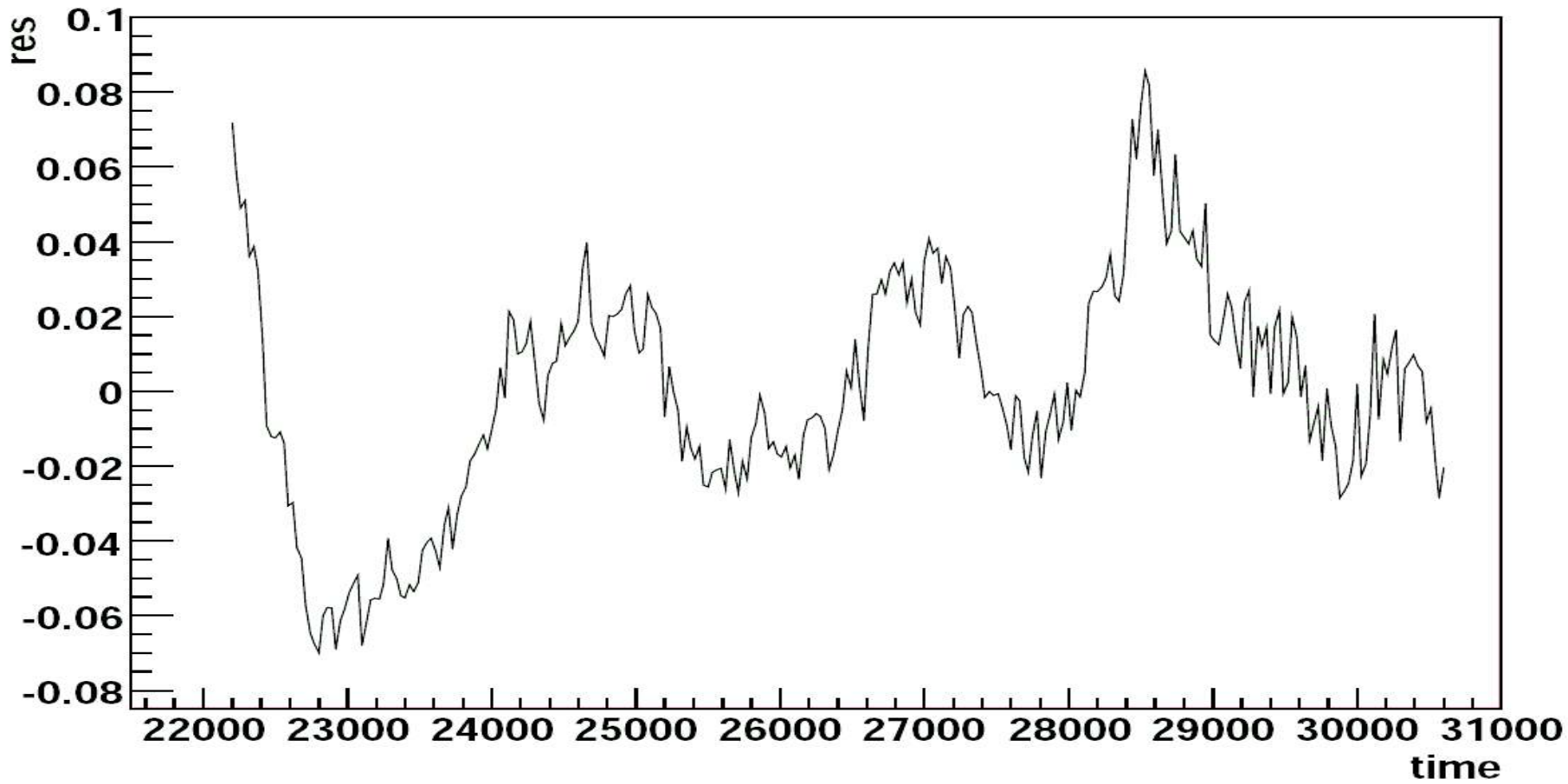



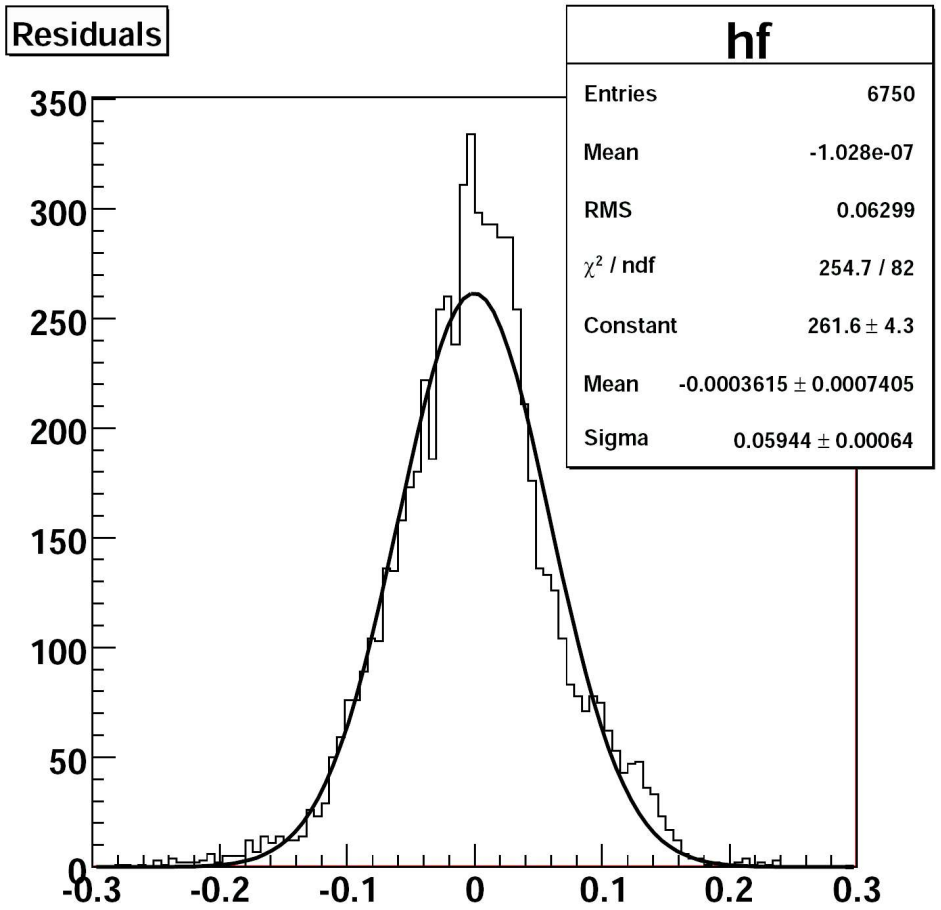

independent fit for every time slot

# Residuals

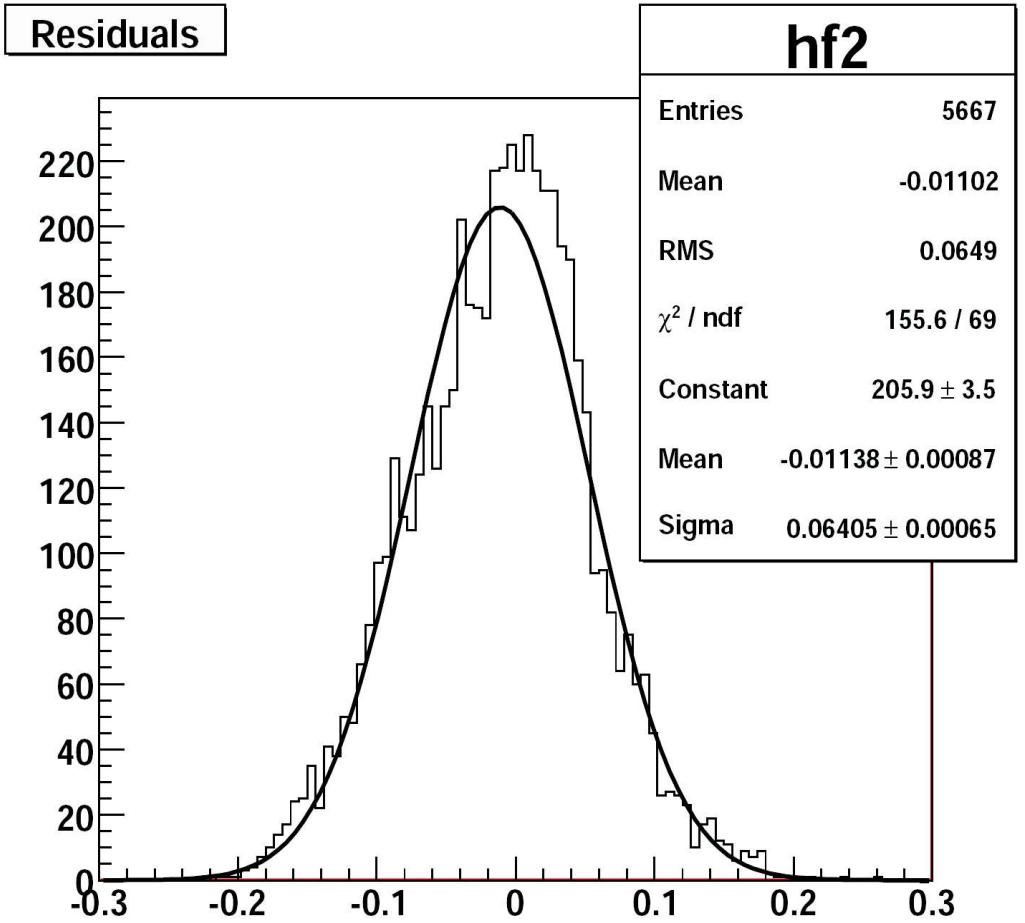



small scale fluctuations ~ 0.01 TEC

# Residuals




5 selected stations




5 stations NOT used for MIM fit

# Outlook

- Measurement errors ~ 0.01 TEC

  = ~1 rad @ 75 MHz

- Can provide good starting point for LOFAR calibration
- Long baselines
- Next:
  - more parameters/different MIM
    - velocity vector ?
  - longer times
  - more stations/ check fit by excluding satellites