To analyse and plot Nr, the raw electron density

GUSDAP analysis can provide **Nr**, or raw density, which is not a density from an analysis of the incoherent scatter spectrum, but a density derived from power profiles or near-zero-lag data. Nr plots have no gaps plots caused by low signal-to-noise ratio or spectra that cannot be fitted. They are now made regularly for these programs: beata, arc1, cp1l, bella, tau1, tau7, tau8 and for ESR folke, steffe, ipy, taro, tau0. The analysis should be made with the parameter **analysis_ppshortlags=1**; which may not have been done for early analyses. The default value is zero. Setting it to one means that the first non-zero lag is used together with any zero lags if they exist, to calculate a pseudo or effective zero lag. Nowdays this parameter is set in the **ana_def.m** file, but in early analyses this was not the case and so older data may need re-analysis with this parameter set. One can tune this analysis parameter **analysis_ppshortlags**. For example setting it to higher values like **2** will increase the maximum height for which Nr can be plotted, however the estimate of backscattered power gets increasingly underestimated. One can also set it to a fractional value like 1.5 or a value less than 1. The parameter `Maximum pp resolution` mentioned below determines over which height range these extra lag values should be taken.

The plotting can be done using **vizu**, within the guisdap analysis package.
Start Matlab using the guisdap script:

guisdap
(**VERBOSE** asks more questions concerning plot options than **verbose**)

A session is shown here for beata data with the important things in bold:
```
GUISDAP vs. 8.7 by EISCAT, Lehtinen&Huuskonen
>> vizu VERBOSE
Data path? [/analysis/results/] .
Status/Residual limits? [ 0 Inf ]
Maximum pp resolution (km)? [ Inf ]9
Start time? [ 2013 8 29 7 2 25 ]2013 8 29 7 0 0
  End time? [ 2013 8 29 10 54 56 ]2013 8 29 11 0 0
Altitude scale? [ 70 510 ]50,200
Parameters: Ne Te Ti Vi AE TT LL Rs O+ Co Nr Lf L1 Ls Pf P1
Choose? [Ne Te Ti Vi AE] Nr AE
Type of experiment? [CP] US
Gates? [ 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
25 26 27
 28 29 30 31 ]
Y parameter (Ran-1 Alt-2 Lat-3)? [ 2 ]
Y scale type? [linear]
AzEl screen values? [ -Inf Inf -Inf Inf ]
Scales (Ran Alt Ne Te Ti Vi Coll Comp Res)? [ 50 900 50 200 1e+10 1e+12 0
4000 0
 3000 -500 500 1 100000 0 1 0.1 10 ]
Scale (rawNe)? [ 1e+09 1e+12 ]
Scale (AzEl)? [ -30 360 ]
Strech secs? [ 65 ]
>>
>> vizu save Nr
```

Comments on the answers above:
- The **VERBOSE** option asks more questions concerning plot options than **verbose**
- `Data path? [/analysis/results/] .`   If you cd to the directory where the data is stored, using a dot for the answer chooses the current directory so there is no need to type

or cut and paste the directory name.

- Use <cr> for the default values
- **Maximum pp resolution (km)**? [Inf]**9** This value is important for the height resolution. Some experimentation may be needed, but 9 km is good for beata.
- **vizu save Nr**   This means a new plot file is created with '**_Nr**' in the filename, so as not to overwrite the default plot file name created when using 'vizu save' without any extra text.
- **Altitude scale**? [70 510]50,200   The altitude scale can be lower than the lower default offered, but usually does not go as high as the upper default value. I often use 50 km as the lower limit for beata even though 40 km could be used. In some programs there may be weak horizontal lines at the lowest altitudes which are likely to be ground clutter.
- **Scale (rawNe)** The density scale for the Nr plot can be changed here. This is particularly useful in heating experiments where HF-enhanced ion lines (HFIL) exist that have rather high values of 'equivalent electron density'. Then I often use **1e+09 1e+13** instead of the default and the HFIL stands out nicely from the background density values.

Other notes:

In some experiments horizontal lines appear which cannot be made to go away by using different values of maximum pp resolution. Beata VHF is like this, apparently because a true zero-lag exists there with high spatial resolution. To get rid of these lines a minimum pp resolution should also be set, but this is not implemented yet.

The middle panel below shows an example of Nr during a heating experiment.