Eccentricity vector estimation

- Three approaches may be adopted:
  - Indirect methods (e.g. Dawson and Johnston 2005, IERS Tech. Note 33; Sarti et al. 2004 J Geodesy)
  - Mixed methods (e.g. Nothnagel et al. 2002, EU TMR Report)
  - Direct method
- Different strategies:
  - Purely terrestrial observations (trilateration, triangulation, spirit levelling)
    - Sideshots on some targets
    - Redundant forward intersection on some targets
  - GPS based surveys
  - mixed

What to measure?

- A vector between two or more tracking points:
  - Space geodetic instrument reference point (S)
    - VLBI and SLR: based on fixed and moving axis
    - GPS and DORIS: Antenna Reference Point
  - Reference marker (M)
- Possible intra-technique eccentricities (between S and M): they must be measured

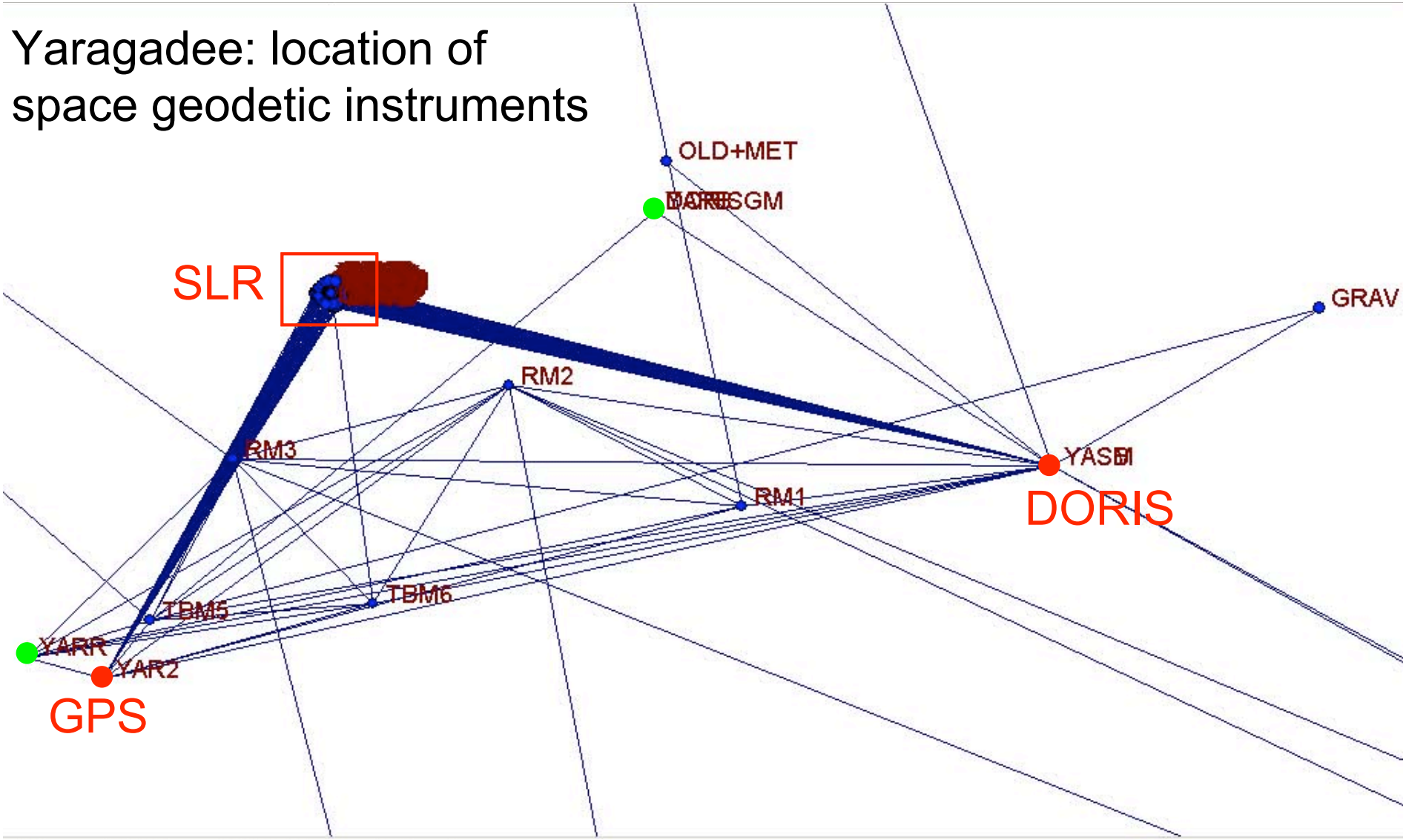
Indirect approach: observations

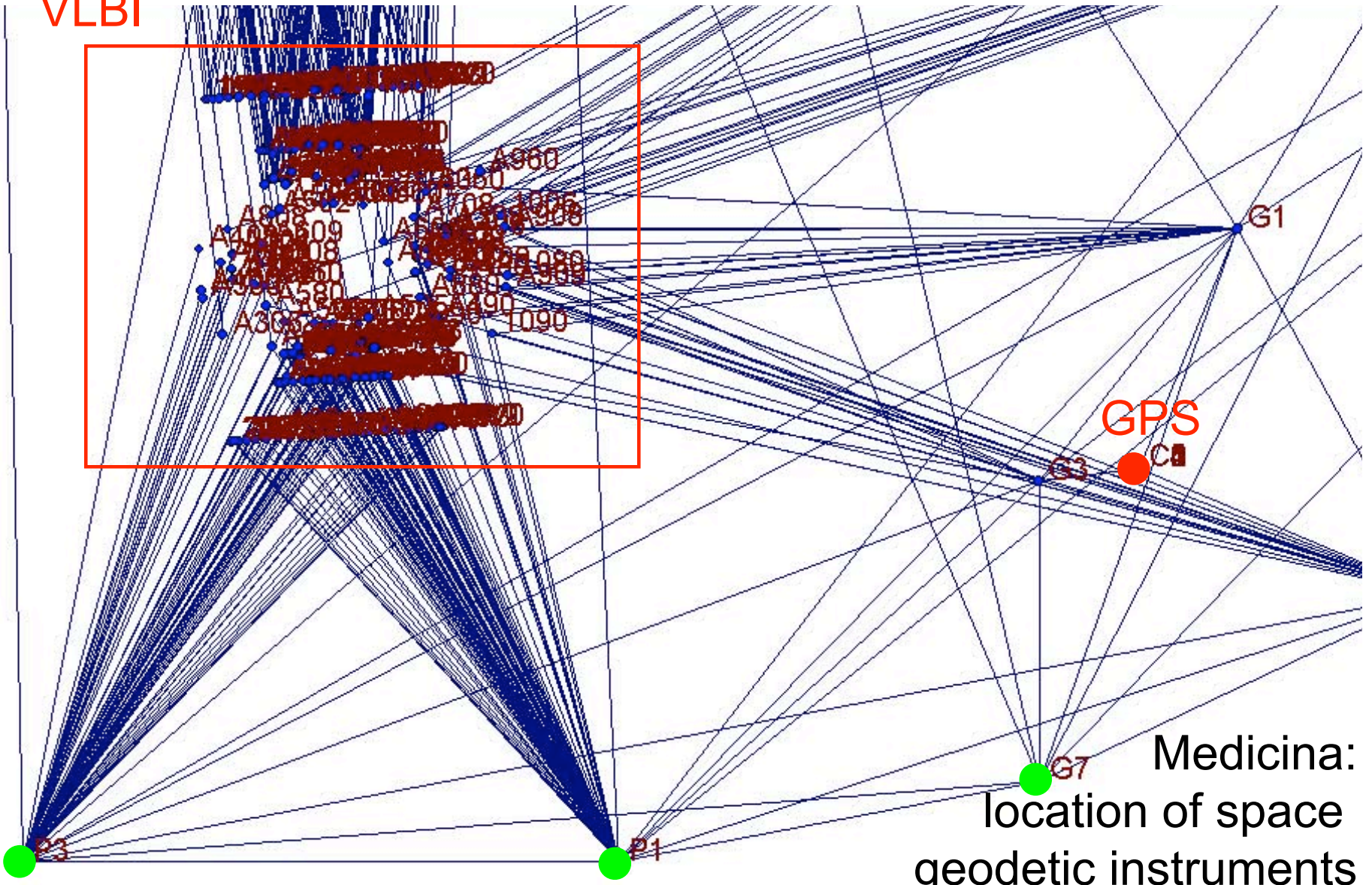
- Terrestrial observations
  - Targets' positions are recovered with angles, distances and height differences
  - Targets' positions are related to the RP with geometric models (conditioning)
- GPS observations
  - Markers are surveyed with GPS
  - A rapid static survey is performed and GPS antenna positions are related to the RP with geometric models (conditioning)

Indirect approach: software

- Axis and Clem&nt are post-processing software for indirect methods
- They are capable to estimate an eccentricity between any space geodetic instrument
- Their performances have been compared on different data sets

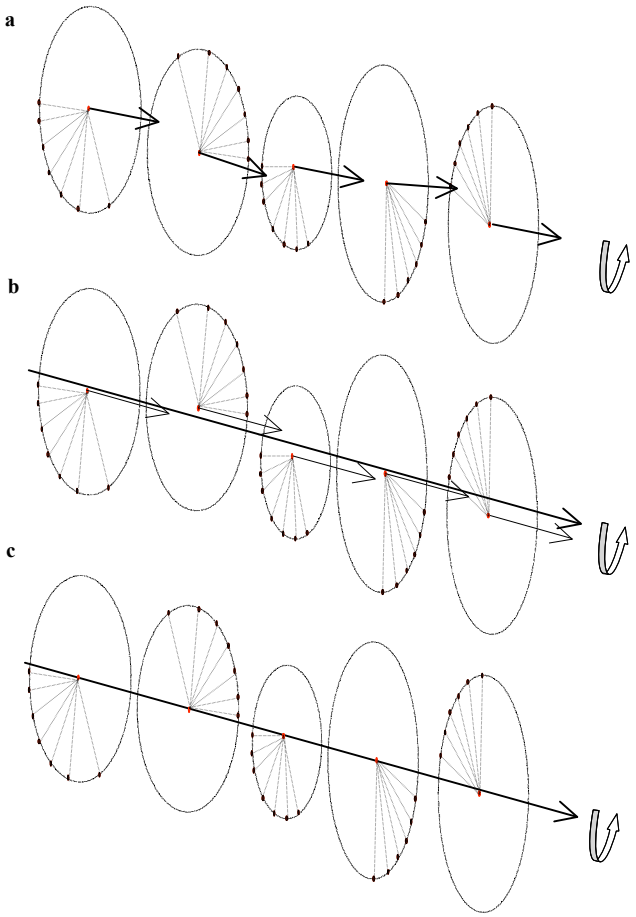
Yaragadee: location of space geodetic instruments



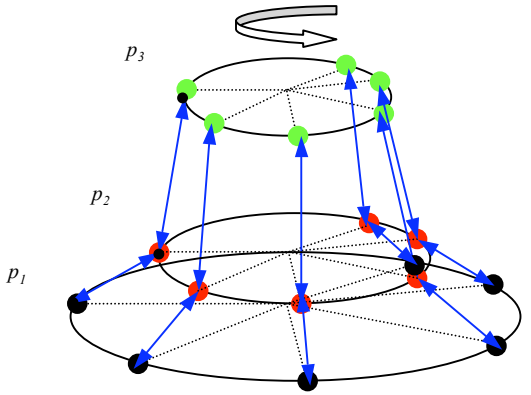

VLBI
GPS
G1
G3
G7
P1
P3
Medicina:
location of space
geodetic instruments

Indirect approach: software

- **Axis** and **Clem&nt** are post-processing software for indirect observations
- They are capable to estimate an eccentricity between any space geodetic instrument
- Their performances have been compared on different data sets
- The geometric conditioning can be varied



Realization of the axes
(SLR and VLBI)



Additional ancillary conditions
(SLR and VLBI)

Indirect approach: software

- **Axis** and **Clem&nt** are post-processing software for indirect observations
- They are capable to estimate an eccentricity between any space geodetic instrument
- Their performances have been compared on different data sets
- The geometric conditioning can be varied
- The degree of conditioning is important (Dawson et al. 2007, J Geodesy)

Error Invariant Point w.r.t theoretical value			
East mm (1σ)	**North mm (1σ)**	**Up mm (1σ)**	**Model**
0.8 (1.0)	0.2 (1.1)	3.4 (3.9)	**Axis[a]**
0.2 (0.8)	0.2 (0.9)	1.2 (1.7)	**Axis[b]**
-0.1 (0.8)	0.2 (0.8)	0.1 (0.9)	**Axis[c]**
0.0 (1.4)	0.1 (1.4)	2.1 (1.7)	**Clem&nt[a]**
0.0 (1.4)	0.1 (1.4)	2.1 (1.8)	**Clem&nt[b]**
0.0 (1.4)	0.1 (1.4)	0.3 (1.4)	**Clem&nt[c]**

a = indipendent circles

b = a + common normal vector

c = a + b + co-linearity

Indirect approach: software

- **Axis** and **Clem&nt** are post-processing software for indirect observations
- They are capable to estimate an eccentricity between any space geodetic instrument
- Their performances have been compared on different data sets
- The geometric conditioning can be varied
- The degree of conditioning is important (Dawson et al. 2007)
- Their output is a SINEX file
- Both software are based on rigorous statistic methods and allow precise estimation of the eccentricity
- **Axis** and **Clem&nt** results are consistent!