



## The EuroSDR network on Digital Camera Calibration and Validation



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## Phase II Active Participants



| #  | Code   | Institutions                                       |
|----|--------|--|
| 1  | ICC    | Institute Cartographic Catalunya, Barcelona, Spain |
| 2  | ICV    | Institute Cartographic Valenciano, Valencia, Spain |
| 3  | LM     | Lantmatäriet, Gävle, Sweden                        |
| 4  | itacyl | ITACYL, Valladolid, Spain                          |
| 5  | inpho  | inpho, Stuttgart, Germany                          |
| 6  | CSIRO  | CSIRO Information Sciences, Wembley, Australia     |
| 7  | DLR-O  | DLR, Oberpfaffenhofen, Germany                     |
| 8  | DLR-B  | DLR, Berlin, Germany                               |
| 9  | Anhalt | University of Applied Science, Anhalt, Germany     |
| 10 | HfT    | University of Applied Science, Stuttgart, Germany  |

## Phase II Active Participants



| #  | Code    | Institutions                             |
|----|---------|--|
| 11 | UoL     | University of Leon, Spain                |
| 12 | IPI     | IPI, University of Hannover, Germany     |
| 13 | ETH     | ETH Zürich, Switzerland                  |
| 14 | UoP     | University of Pavia, Italy               |
| 15 | UoN     | University of Nottingham, England        |
| 16 | Ingr.ZI | Intergraph ZI, Aalen, Germany            |
| 17 | Vexcel  | Vexcel, Graz, Austria                    |
| 18 | Leica   | Leica Geosystems, Heerbrugg, Switzerland |

▶ The whole EuroSDR network email list includes 60 entries

## Phase II Data request



| Phase II Data Set | # Requests | Participant<br>(w/o manufacturer)          |
|-------------------|------------|--|
| ADS               | 5+1        | UoP, DLR-B, DLR-O, ETH, inpho              |
| DMC               | 8+1        | ICC, IPI, Anhalt, inpho, HfT, ETH, UoL, LM |
| UltracamD         | 7+1        | UoN, ICV, itacyl, inpho, ETH, CSIRO, IPI   |

light grey: very recent data request

## Experimental Phase II data



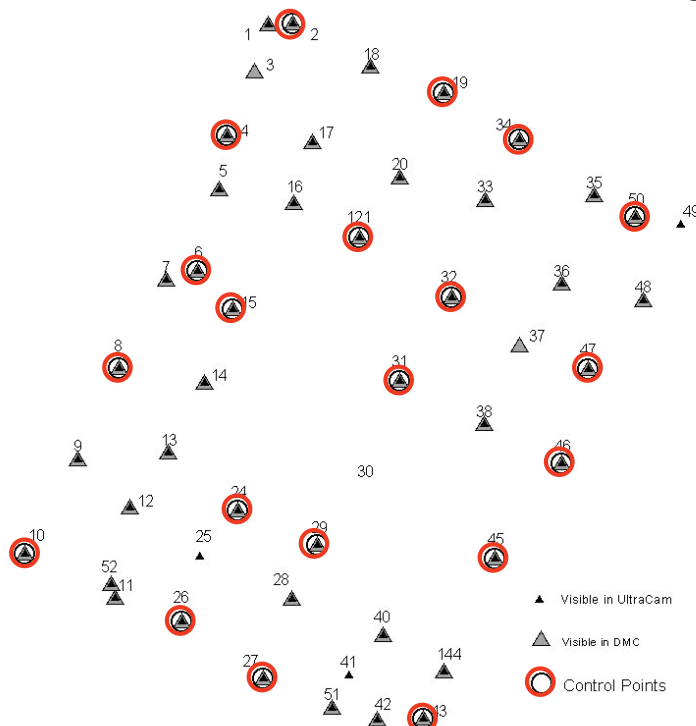
| #  | Altitude [m] | GSD [m] | # strips long/cross | % overlap long/cross | # Images / Data size [Gb] | Additional data |
|--|--------------|---------|---------------------|----------------------|---------------------------|-----------------|
| <b>ADS</b> Vaihingen/Enz, June 26, 2004          |              |         |                     |                      |                           |                 |
| <i>low</i>                                       | 1500         | 0.18    | 4 / 2               | 100 / 44             | 36 / 16.7                 | GPS/INS         |
| <i>high</i>                                      | 2500         | 0.26    | 3 / 3               | 100 / 70             | 36 / 9.8                  | GPS/INS         |
| <b>DMC</b> Fredrikstad, October 10, 2003         |              |         |                     |                      |                           |                 |
| <i>low</i>                                       | 950          | 0.08    | 5                   | 80 / 30              | 115 / 10.0                | -               |
| <i>high</i>                                      | 1800         | 0.15    | 3                   | 80 / 30              | 34 / 2.9                  | -               |
| <b>UltracamD</b> Fredrikstad, September 16, 2004 |              |         |                     |                      |                           |                 |
| <i>low</i>                                       | 1900         | 0.17    | 4 / 1               | 80 / 60              | 131 / 30.6                | GPS             |
| <i>high</i>                                      | 3800         | 0.34    | 2                   | 80 / 60              | 28 / 6.5                  | GPS             |



## Experimental Phase II data DMC and UCD flights



### Fredrikstad (DMC + UCD)



demanding data sets  
(image quality affects  
performance of point  
measurements)

object points

~ 20 control points  
~ 25 check points



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## DMC and UCD flights

### Image quality and point measurements

**DMC** low altitude flight, Oct 10  
sun-angle ~26deg @  $\Phi$  60deg

Solution Computation  
 Auto Compute  
 Adj. Disp. Photos Only  
 Good Solution (Sigma 0.1 um )  
 RMS X: 0.000, Y: 0.000, Z: 0.000  
 Max Res X: 0.000, Y: 0.000, Z: 0.000

Detail - :02~03 (6:1)

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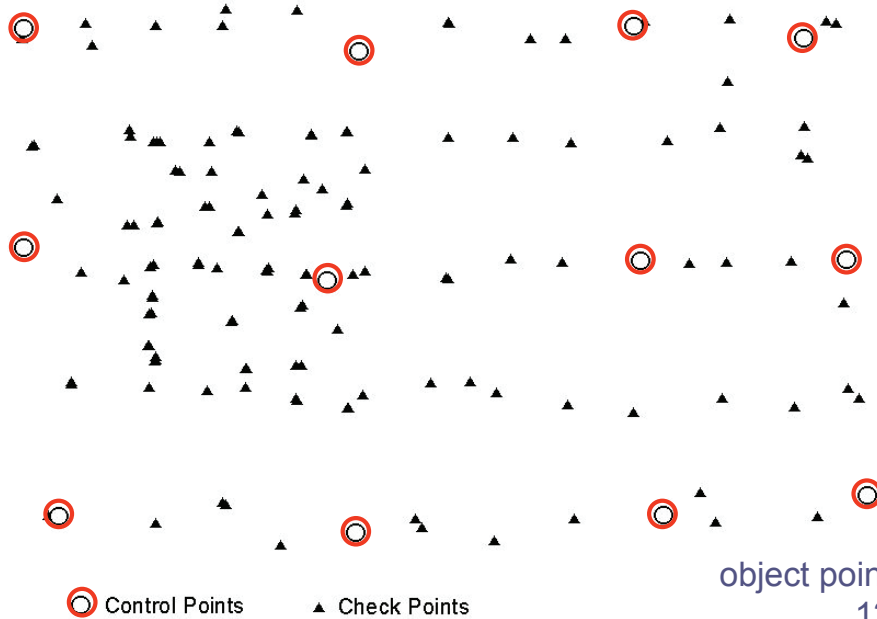
Detail - :02~03 (6:1)

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## Experimental Phase II data ADS flights

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### Vaihingen/Enz (ADS)



○ Control Points

▲ Check Points

object points

12 control points

>200 check points

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## Phase II

### Data request & return

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| Phase II Data Set | # Requests | Participant<br>(w/o manufacturer)          |
|-------------------|------------|--|
| ADS               | 5+1        | UoP, DLR-B, DLR-O, ETH, inpho              |
| DMC               | 8+1        | ICC, IPI, Anhalt, inpho, HfT, ETH, UoL, LM |
| UltracamD         | 7+1        | UoN, ICV, itacyl, inpho, ETH, CSIRO, IPI   |

light grey: very recent data request

| Phase II Data Set | # Results | Participant                   |
|-------------------|-----------|-------------------------------|
| ADS               | 3         | UoP, DLR-B, ETH               |
| DMC               | 4+1       | ICC, IPI, inpho, HfT, Ingr.ZI |
| UltracamD         | 4         | UoN, itacyl, inpho, CSIRO     |

Status: October 15, 2006

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## Remarks on data processing (1/2)

- typically two different flight heights processed independently
- only three participants used both heights for common adjustment (UCD (2x) and DMC (2x))
- standard and proprietary software packages used

| Process step                   | Software  |
|--------------------------------|---|
| Matching and point measurement | Manual, MATCH-AT, LPS, ISAT, Gpro, PhotoMod, others                     |
| Bundle adjustment              | Match-AT, ORIMA, InBlock, BLUH, PhotoMod, ACX-Geotex, IS-PhotoT, others |

- participants typically provided more than one solution, altogether 75 different solutions evaluated and results reported back to participants



## Remarks on data processing (2/2)

- Self-calibration was mostly applied for all image blocks
- but, almost each participant also provided solution w/o use of additional SC
- 2 participants used modified SC approaches taking the specific image geometry of large format DMC imagery into account

| Data set | Self-calibration parameter set (if applied)                                    |
|----------|--|
| DMC      | 12 Ebner per quadrant, BLUH DMC specific Ebner, Grün, Polynom, BLUH parameters |
| UCD      | Brown, Grün  |
| ADS      | Brown  |

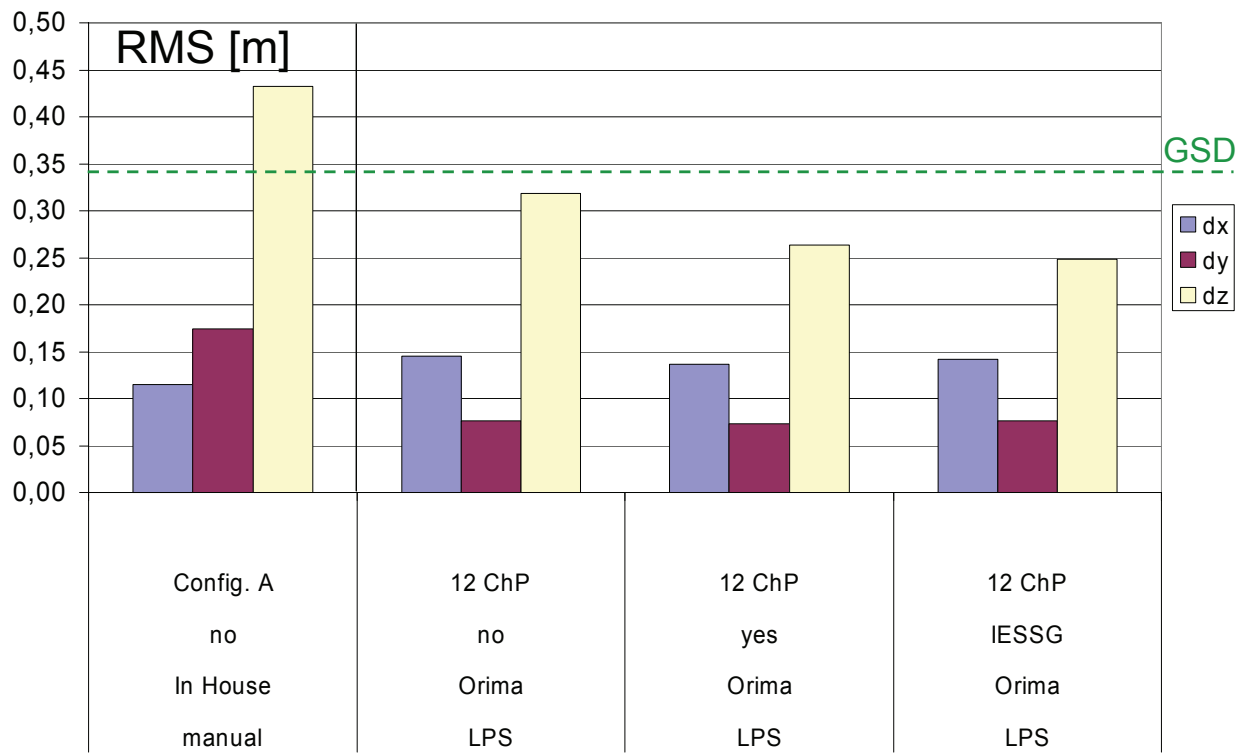




# UltracamD high

$h_g$  3800m, GSD 0.34m

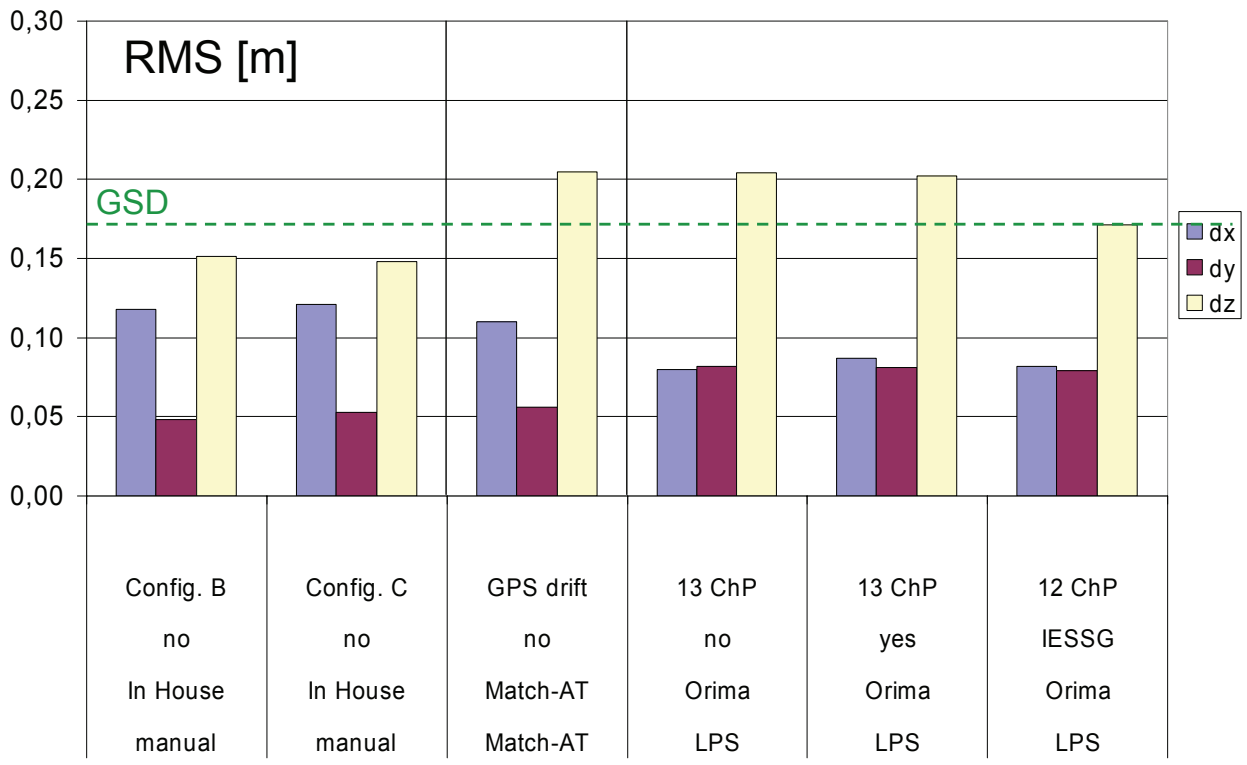
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# UltracamD low

$h_g$  1900m, GSD 0.17m

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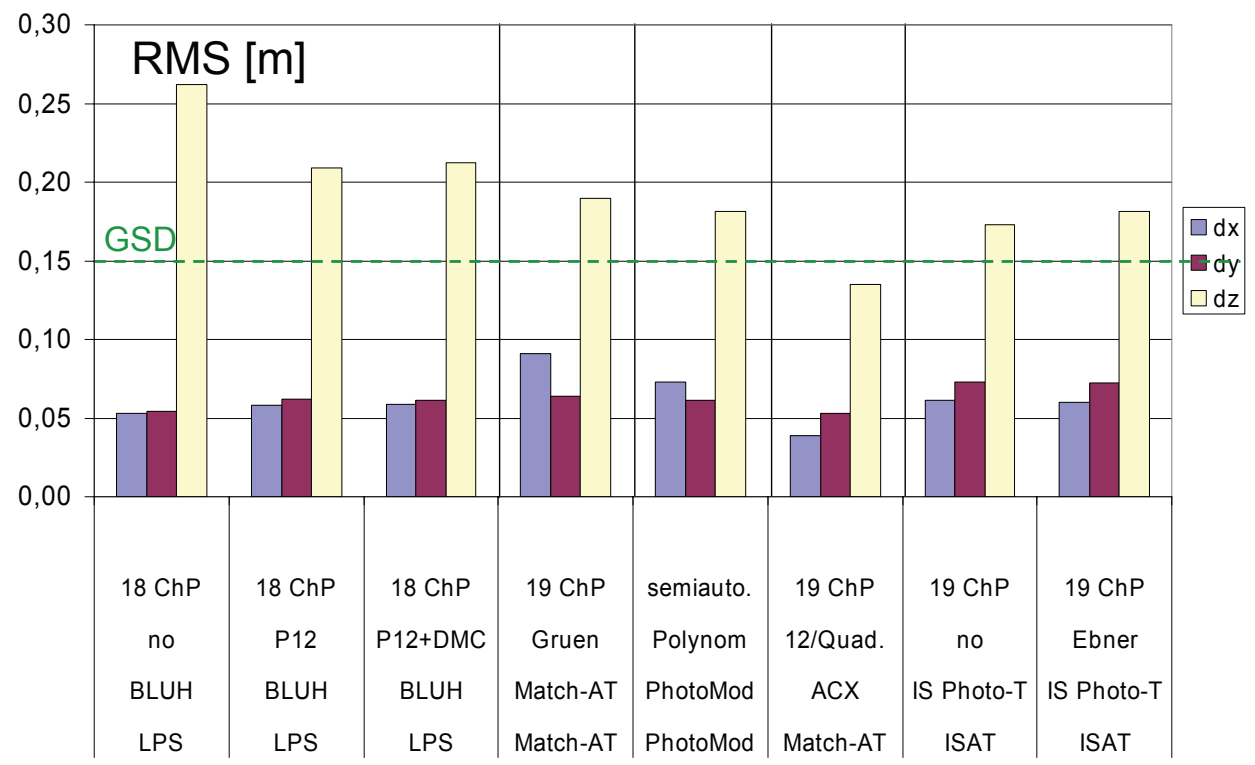




## DMC high

$h_g$  1800m, GSD 0.15m

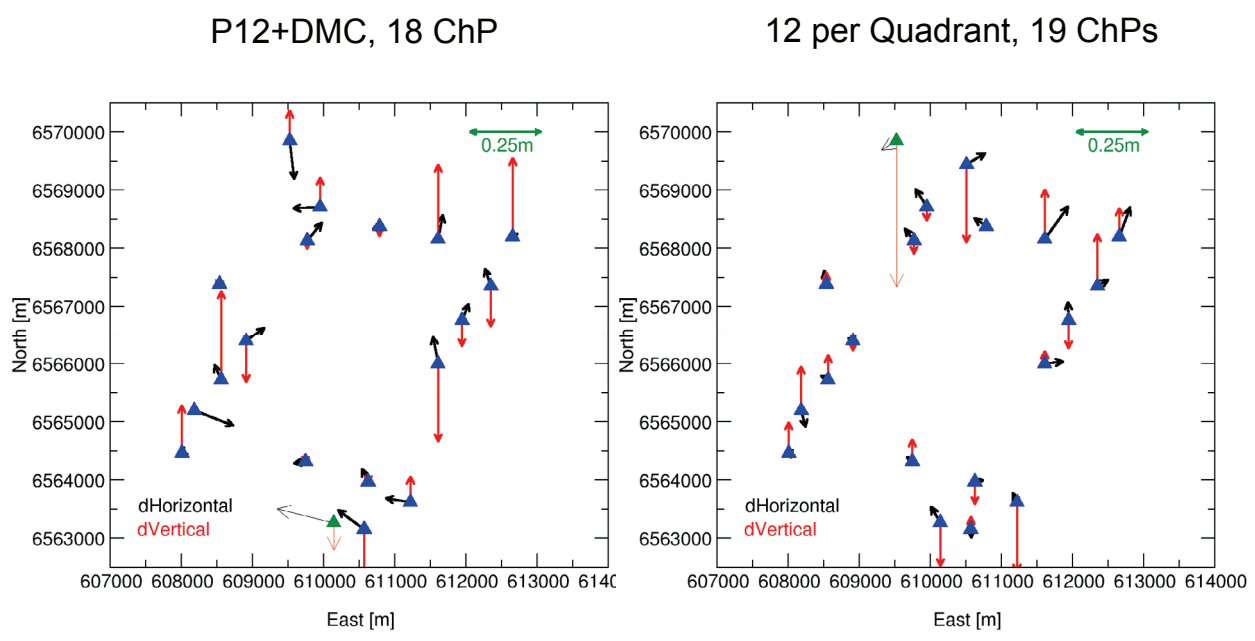
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## DMC high

$h_g$  1800m, GSD 0.15m

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Residuals from check point analysis

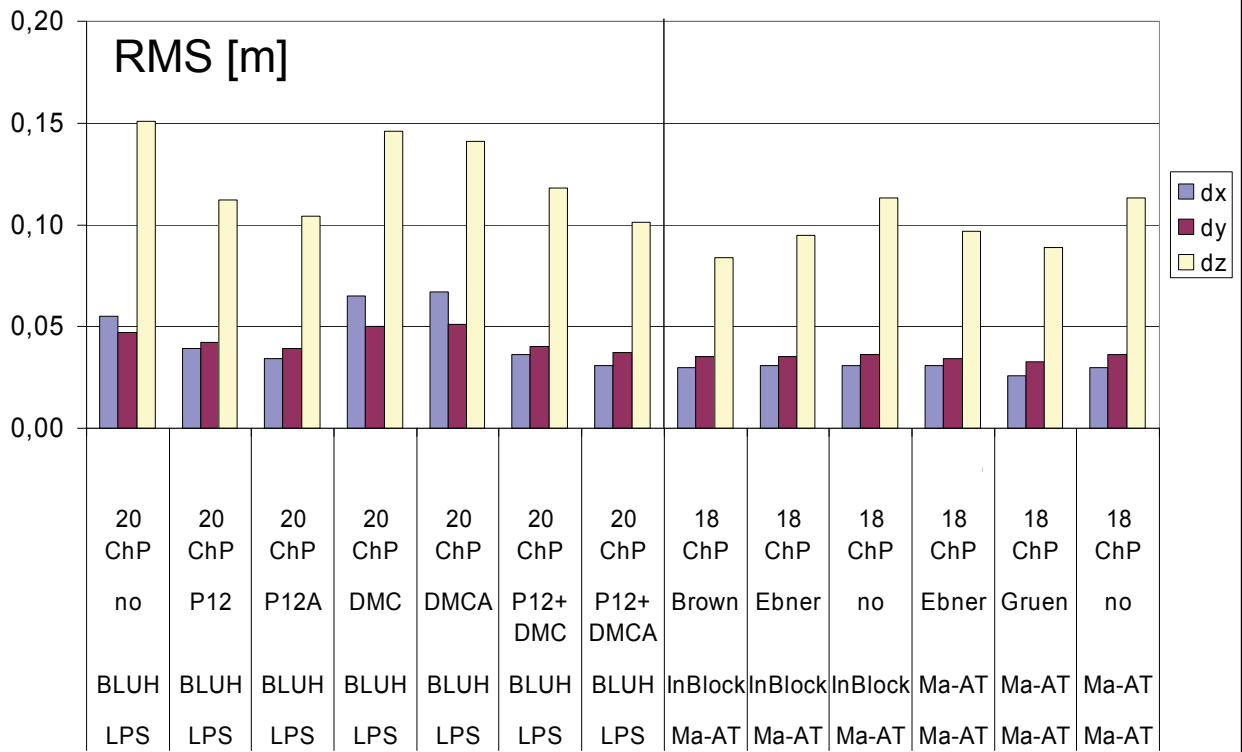




# DMC combined

$h_g$  1800m + 950m, GSD 0.15m + 0.08m

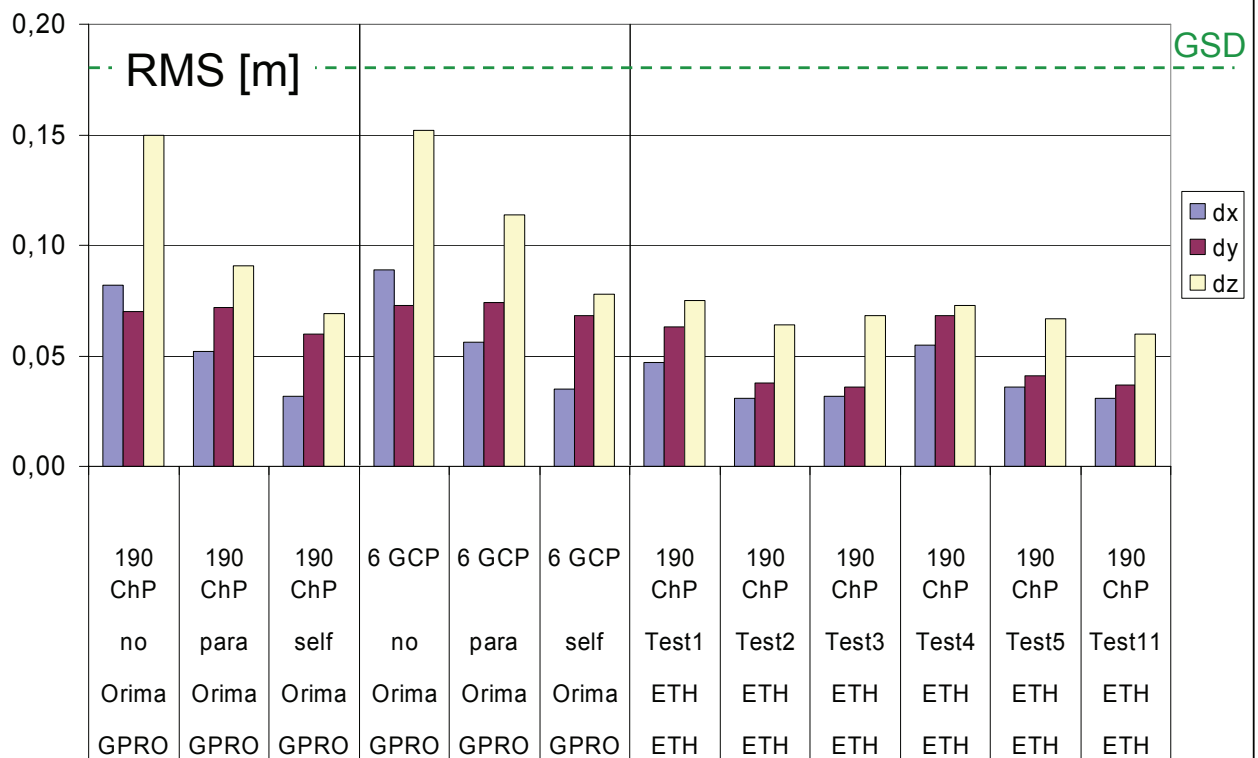
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# ADS low

$h_g$  1500m, GSD 0.18m non staggered

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## Preliminary conclusions



- non sufficient number of samples per data set to recommend most-optimal sensor related processing approach
- DMC and UCD data evaluation are influenced by image point identification errors in measurement (in some cases dominating error source), this also influences the comparison between different processing runs (i.e. applied model of SC)
- self calibration seems to be necessary to improve object space accuracy for all three camera types in all cases,
- for DMC data standard parameters seem to be sufficient to compensate for the dominating error sources, although the quadrant specific approach shows very reasonable results
- 2 participants mentioned, that systematic corrections for UCD are more significant compared to DMC
- ADS results are almost exceeding accuracy expectations (but note the different quality of data set)



## Open topics



- „reference solution“ missing so far
  - will be provided by pilot centre soon
- influence of errors in image measurement could not be separated from influence of different SC approaches
  - pilot centre will ask individual participants to repeat their calculation by using the same set of measured image coordinates
- future role of self-calibration ?
  - significant determination of additional parameters non trivial and complex task, requires certain block configuration (i.e. overlaps, GCP distribution, GPS and/or GPS/IMU)
  - does AT really have to compensate for „weaknesses“ in geometric digital camera design?
  - are the SC parameters also considered in the further processing chain (e.g. via correction grids)?
  - does the individual user pay for this additional effort?



## Schedule

- Final report including participants feed-back till **December 2006**
  
- other data sets from different sensors (i.e. medium format) ?
- new proposal ?
  - new project covering new aspects like radiometry, resolution, pan-sharpening, colour ? Who has expertise in that?
  - new data sets required for that, besides already distributed data (those data still should be accessible for future requests)
  
- other aspects besides  
European Digital Airborne Camera Certification ?!!
  
- Support ?

