Effect of missing orbit correctors

on quality of correction

W. Herr

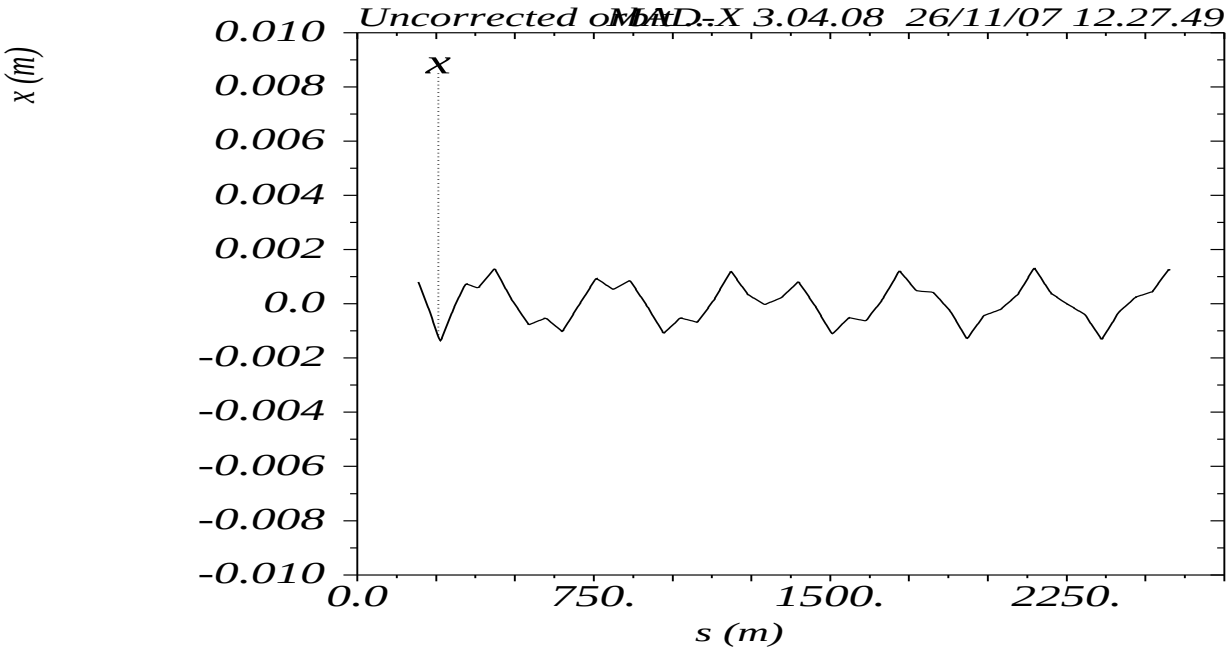
Missing correctors

- Missing correctors may degrade orbit correction performance, depending on:
  - Percentage of orbit correctors not available
  - Correlation between missing correctors (group)
  - Correction algorithms (MICADO, number of correctors used, SVD, conditioning ...)
- (Much) less important effect expected, compared to missing monitors (remember the LEP case !)

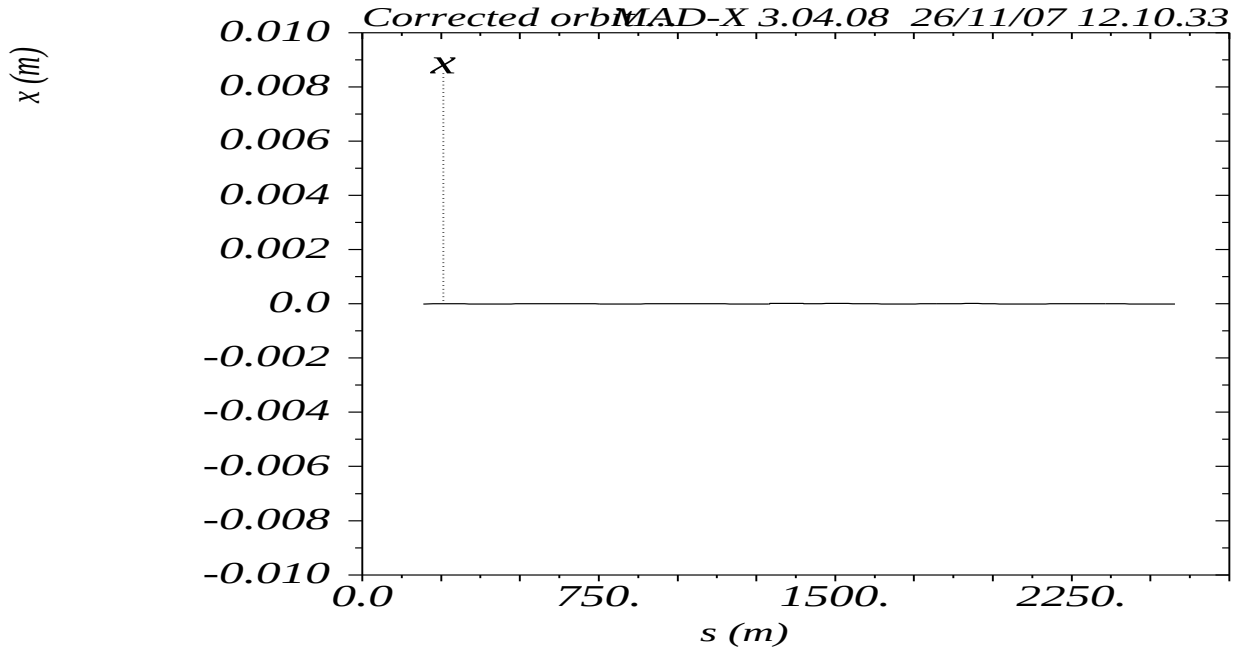
Example

- Three consecutive quadrupoles misaligned
  - 1. Corresponding correctors available
  - 2. Corresponding correctors not available

Quadrupoles misaligned

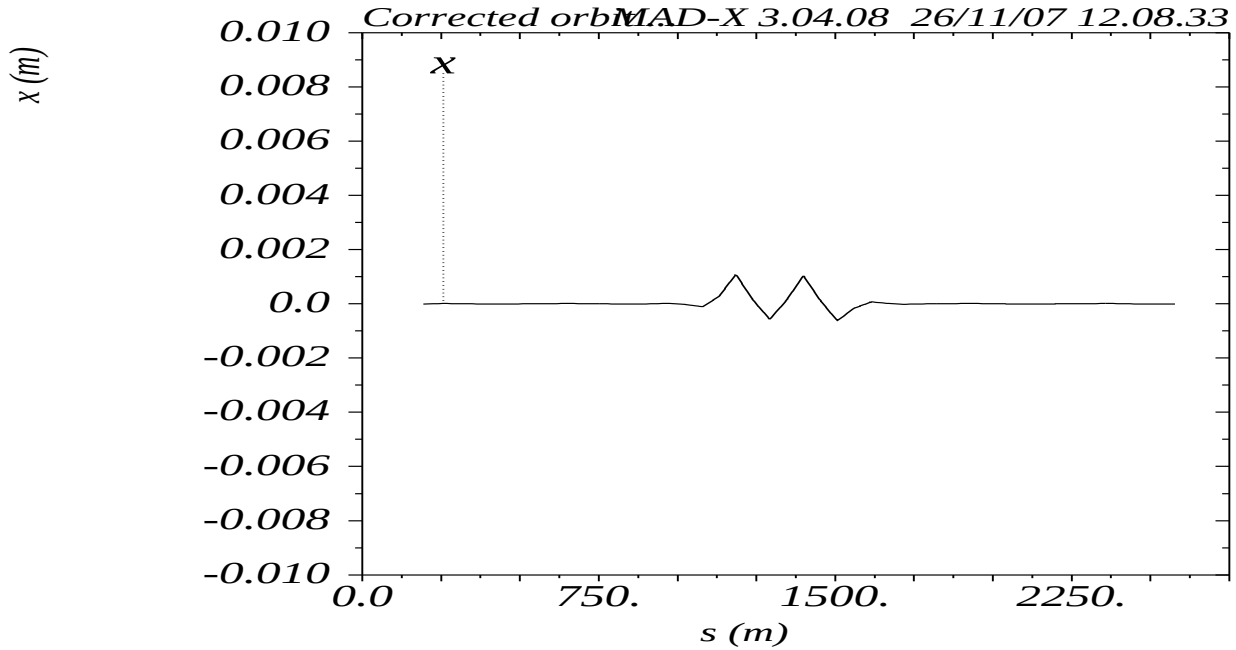


Quadrupoles misaligned



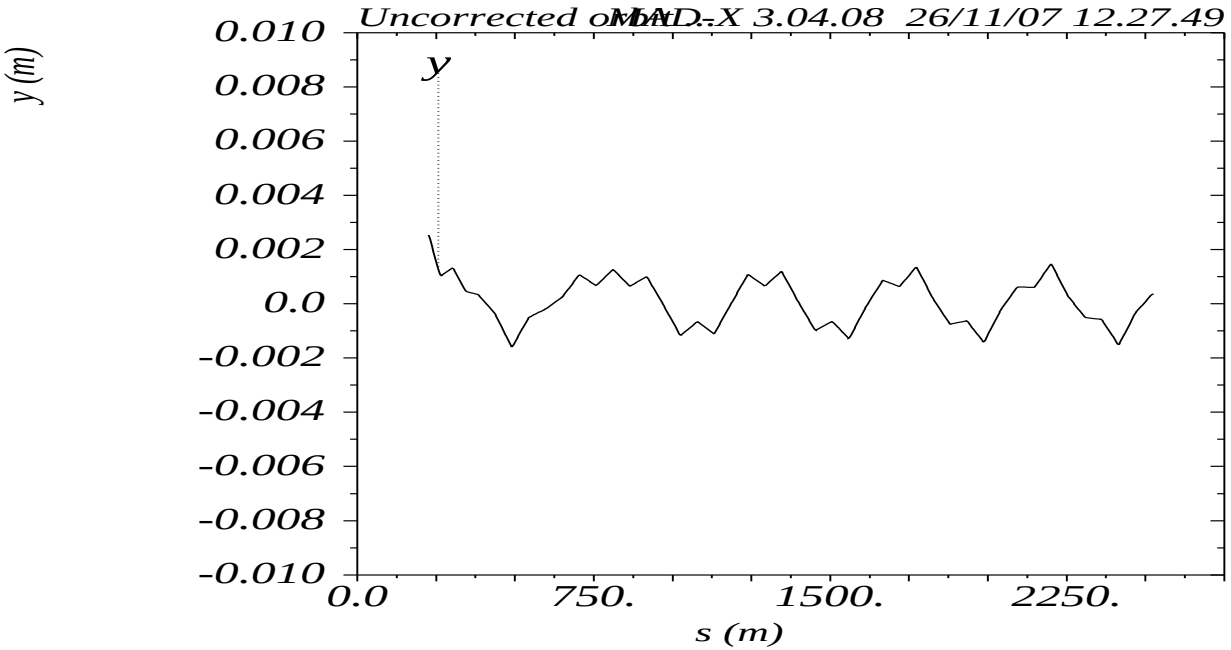
- Corresponding correctors available

Quadrupoles misaligned

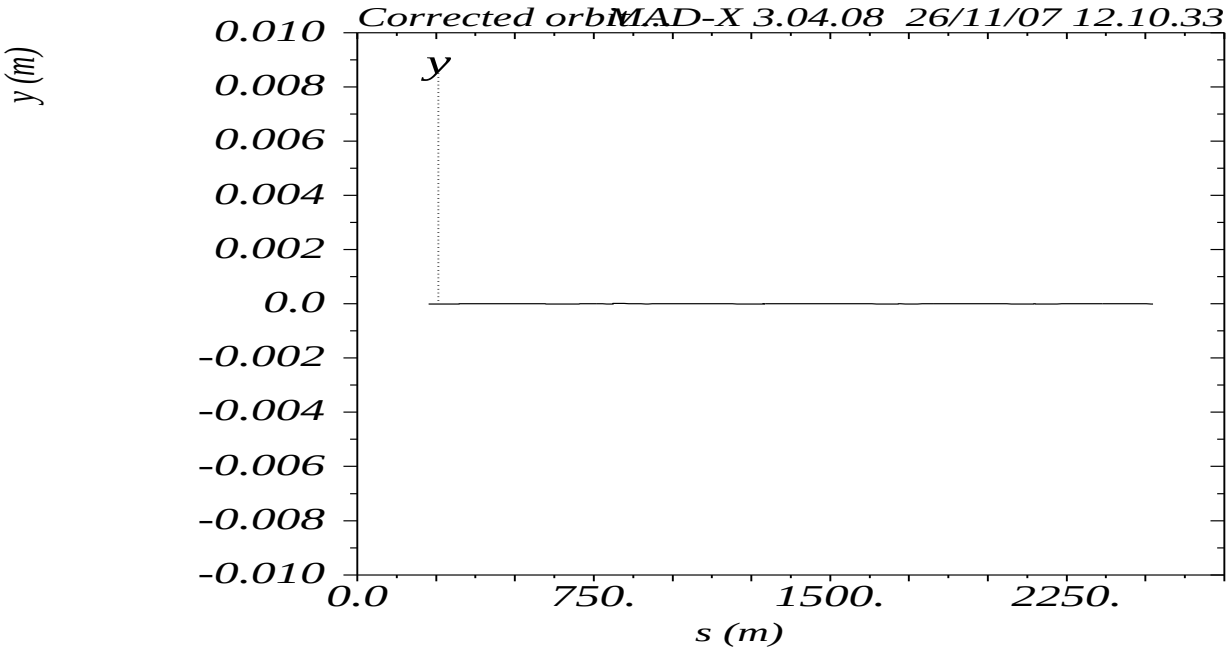


- Corresponding correctors not available

Quadrupoles misaligned

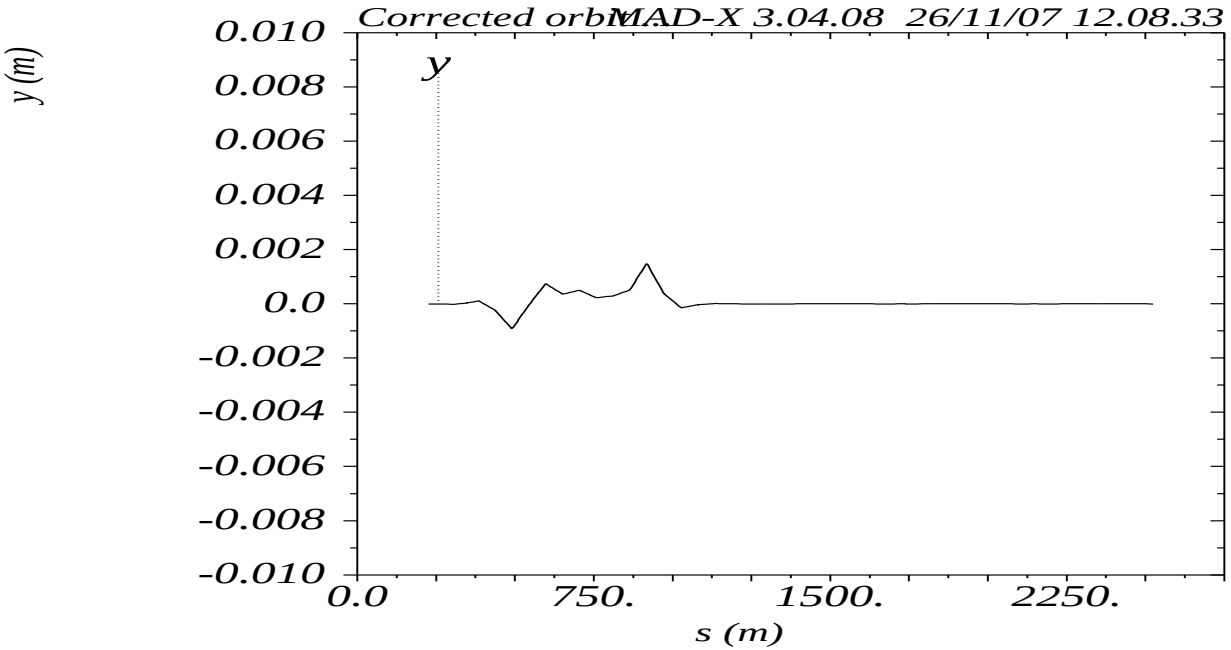


Quadrupoles misaligned



- Corresponding correctors available

Quadrupoles misaligned



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Observations - no surprises

- No local correction possible
- Local bumps produced, however:
  - → Orbit still kept small, no ill-conditioned problem

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- No local correction possible
- Local bumps produced, however:
  - → Orbit still kept small, no ill-conditioned problem
- A more quantitative study with MAD-X
- Beware: presently LHC orbit correction is rather tricky ...

Assumptions

- All monitors working
- Given percentage of orbit correctors not available
- Group of consecutive orbit correctors not available
- Unavailable correctors known to the system

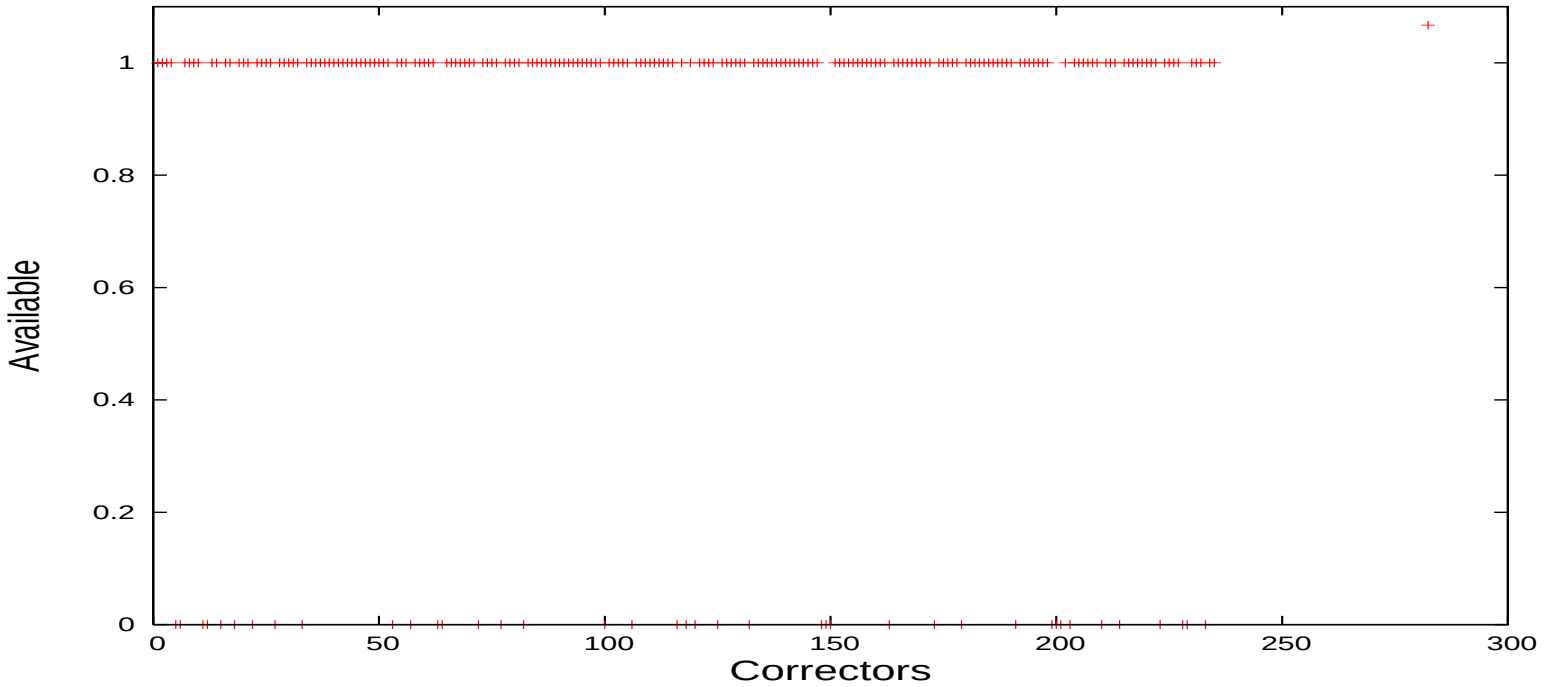
Implementation

Special options in MAD for CORRECT:

- **..,CORRON =** *real* **[0 ... 1.0], ...**
  - → **percentage of available correctors, default = 1.0**
- **..,CORRON = ..., CORNGE =** *int* **[≥1]**
  - → **length of missing group, default = 1**

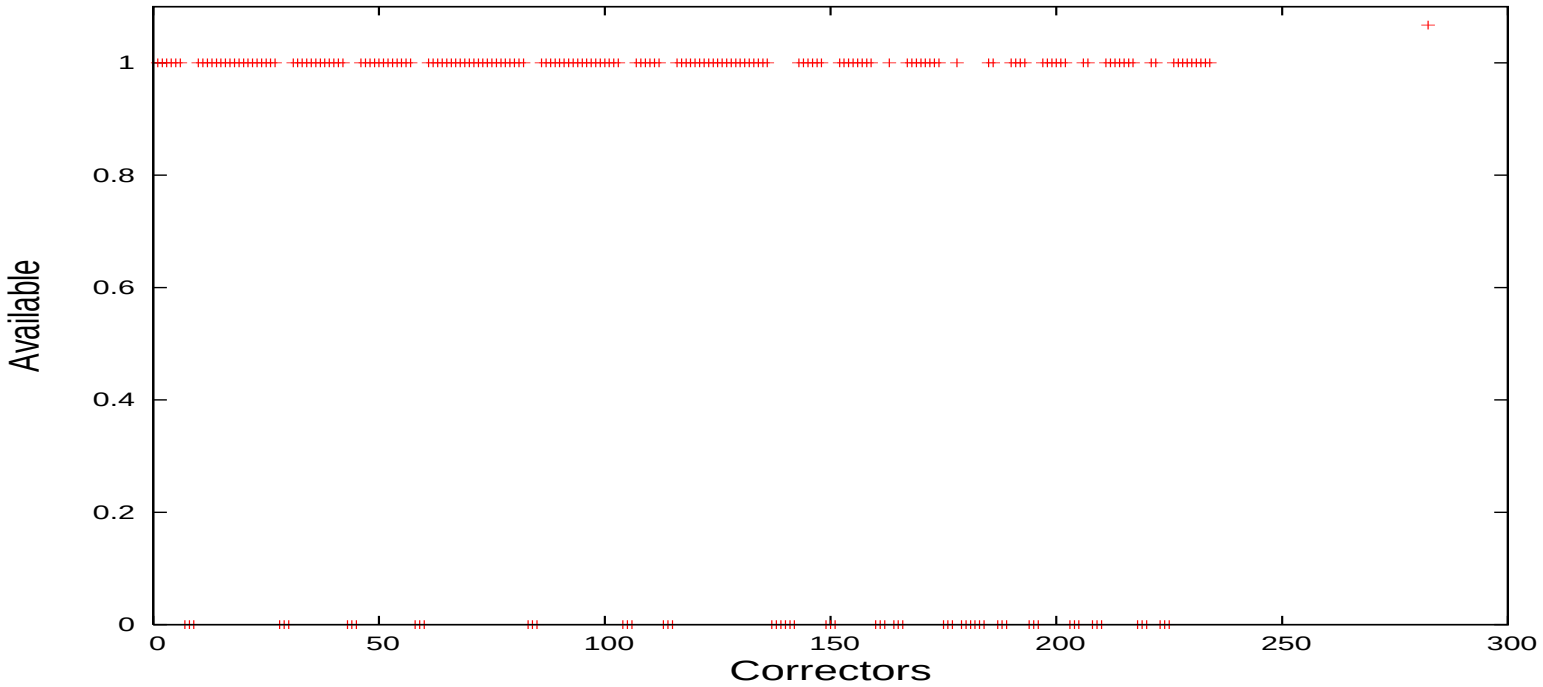
(equivalent exists for monitors)

corron=0.80, cornge=1



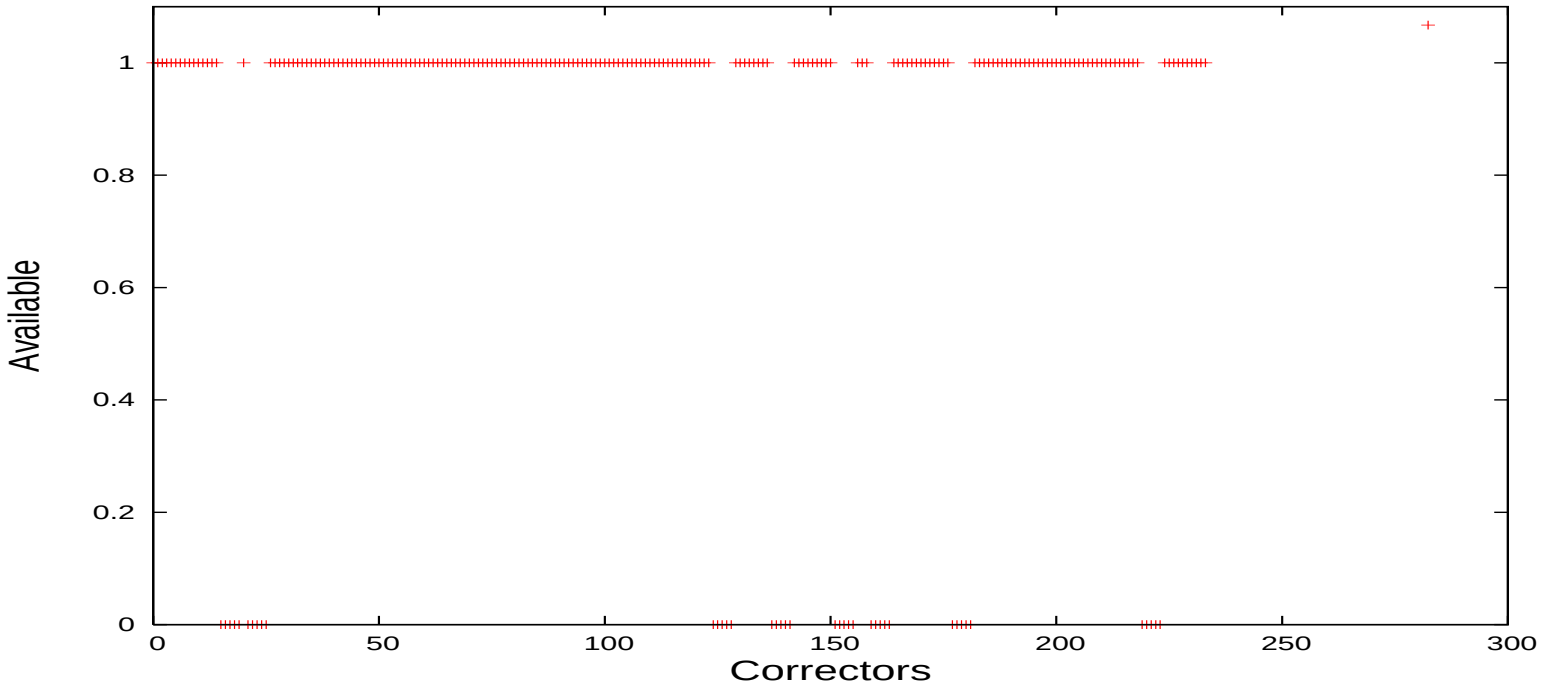
→ **80% available correctors, randomly distributed**

corron=0.80, cornge=3



→ **80% available correctors, in groups of 3**

corron=0.80, cornge=5

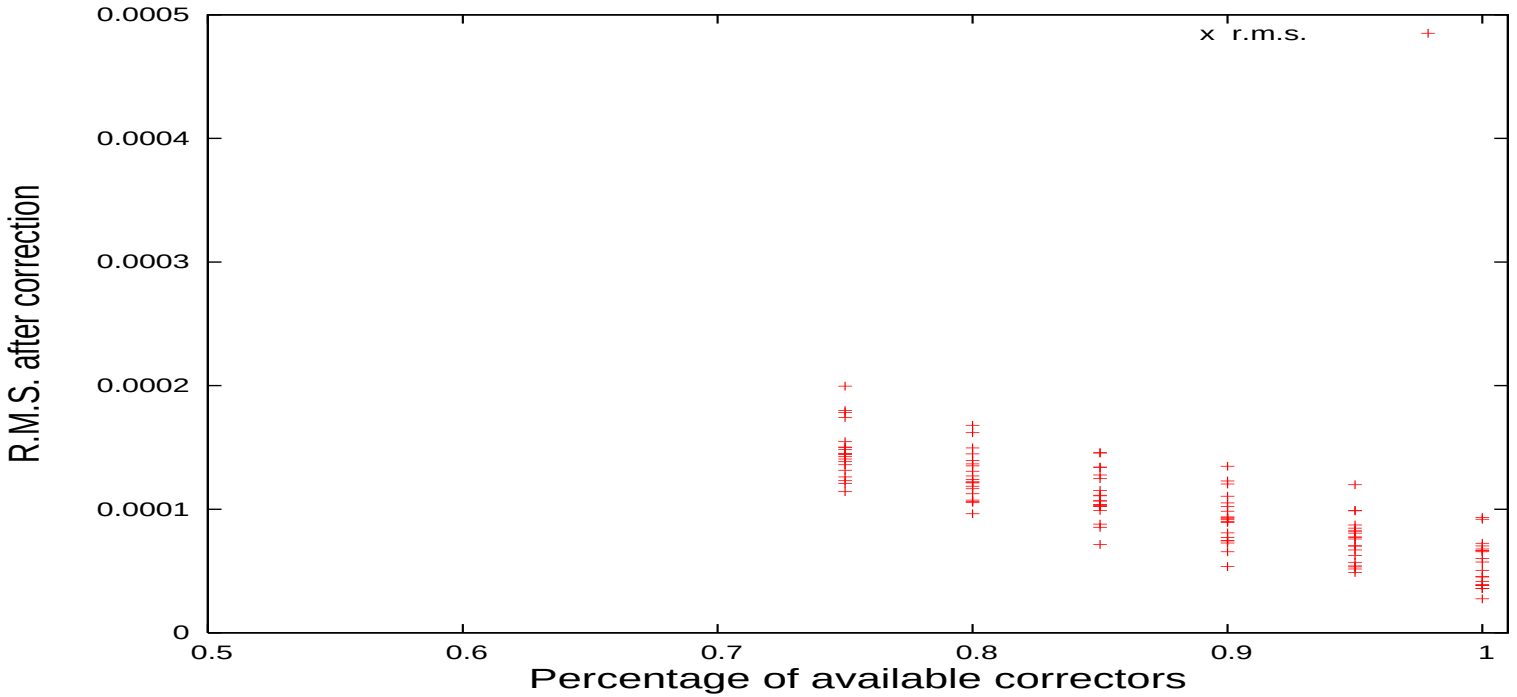


→ **80% available correctors, in groups of 5**

MAD simulation

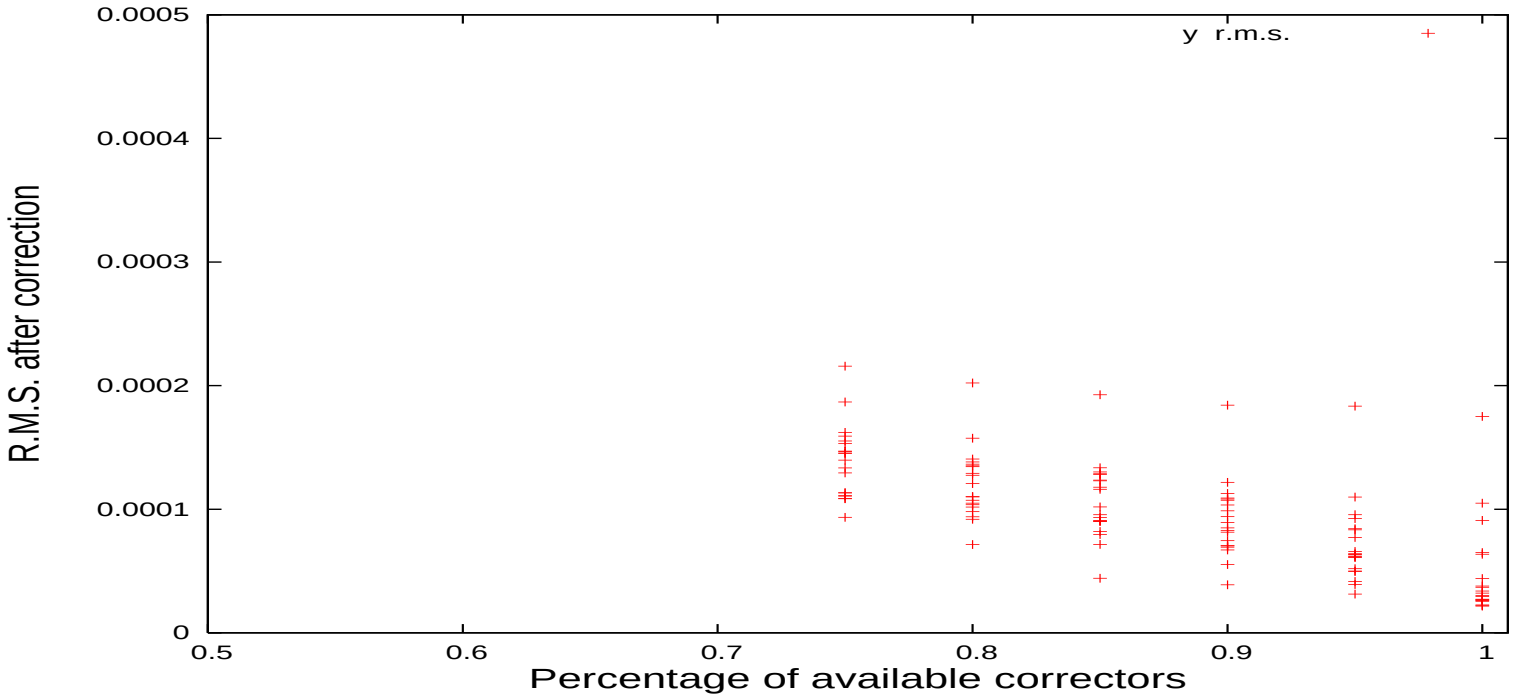
- **Procedure:**
  - **Single ring correction**
  - **Use 20 seeds for different orbit distortions (quadrupole misalignment, $\sigma_x = \sigma_y = 0.1$ mm)**
  - **For every seed increase percentage of missing correctors**
  - **Try different size of groups of missing correctors**
  - **Try different methods and options (MICADO, SVD, LSQ ..)**

Orbit r.m.s. with missing correctors



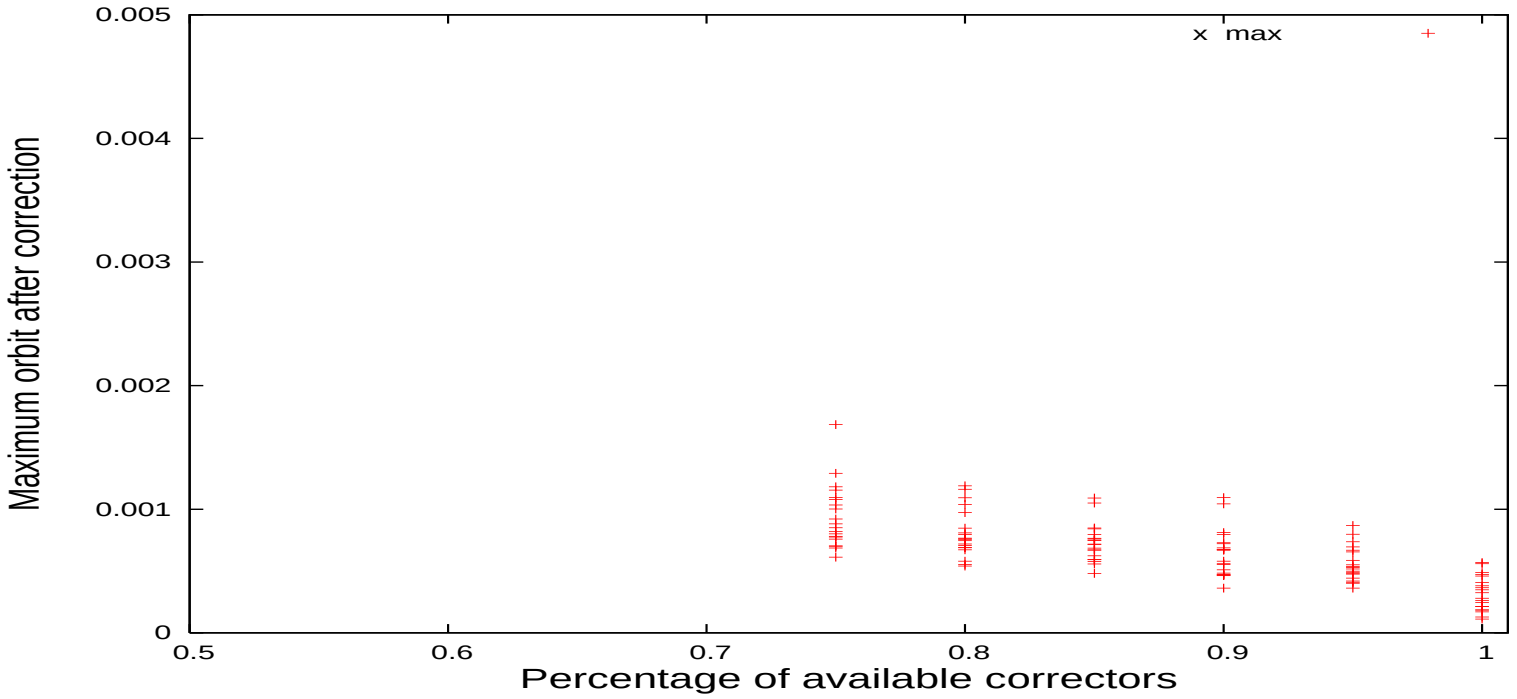
- **MICADO: all available correctors used**

Orbit r.m.s. with missing correctors



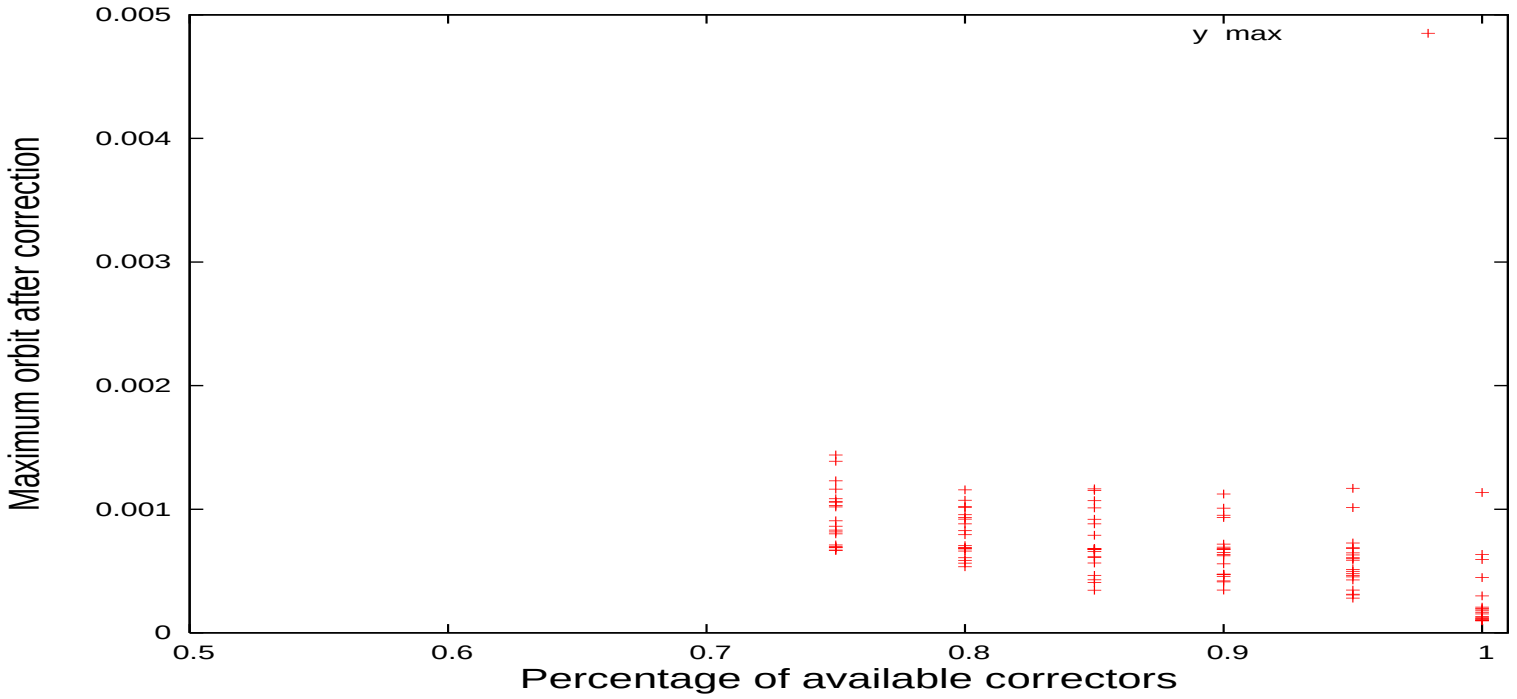
- **MICADO: all available correctors used**

Peak orbit with missing correctors



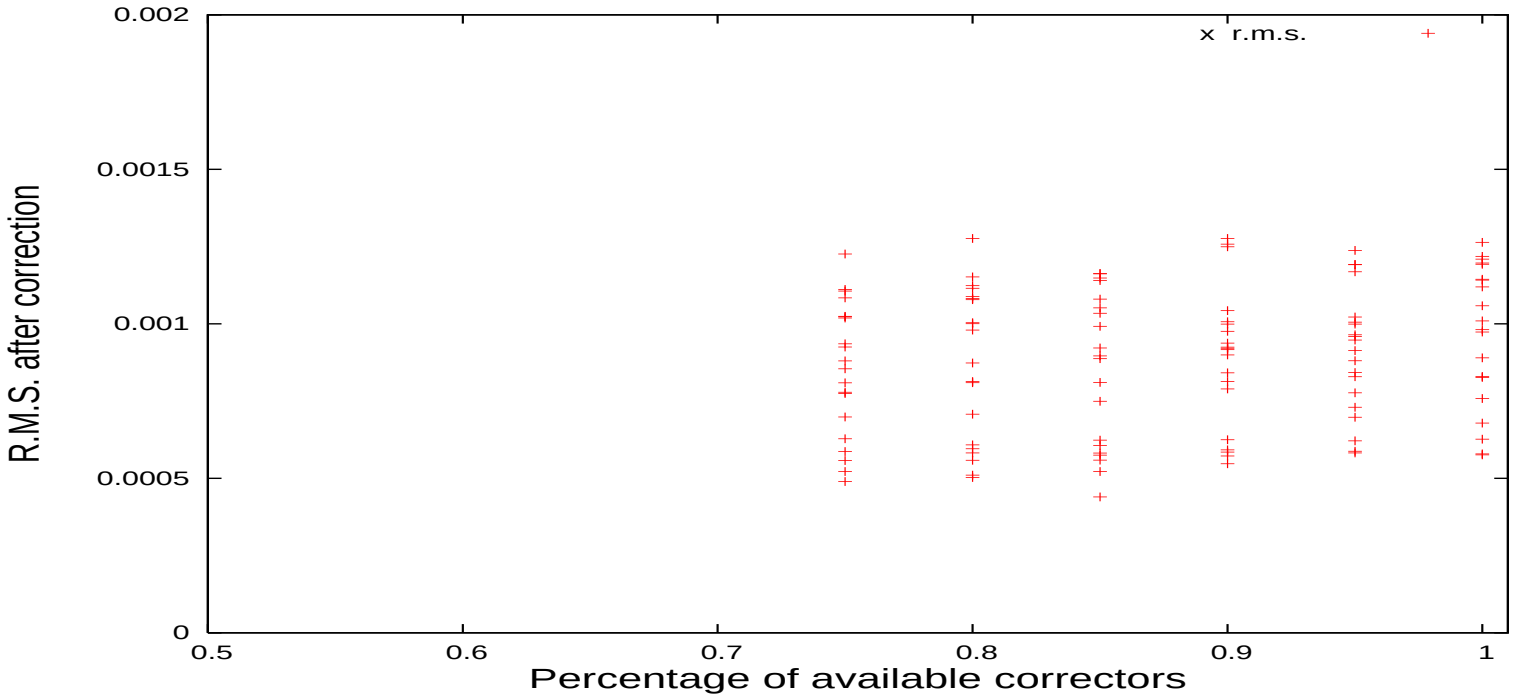
- **MICADO: all available correctors used**

Peak orbit with missing correctors



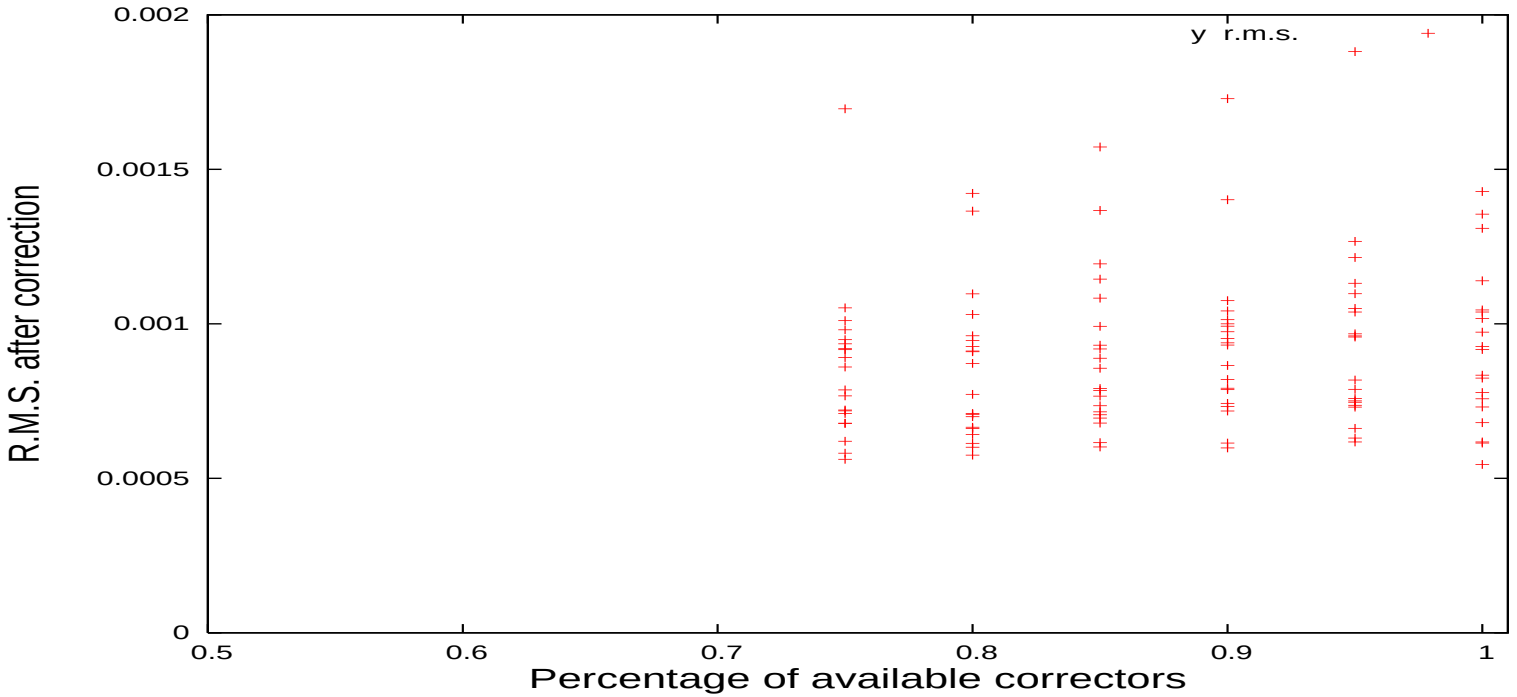
MICADO: all available correctors used

Orbit r.m.s. with missing correctors



- **MICADO: 50 correctors used**

Orbit r.m.s. with missing correctors



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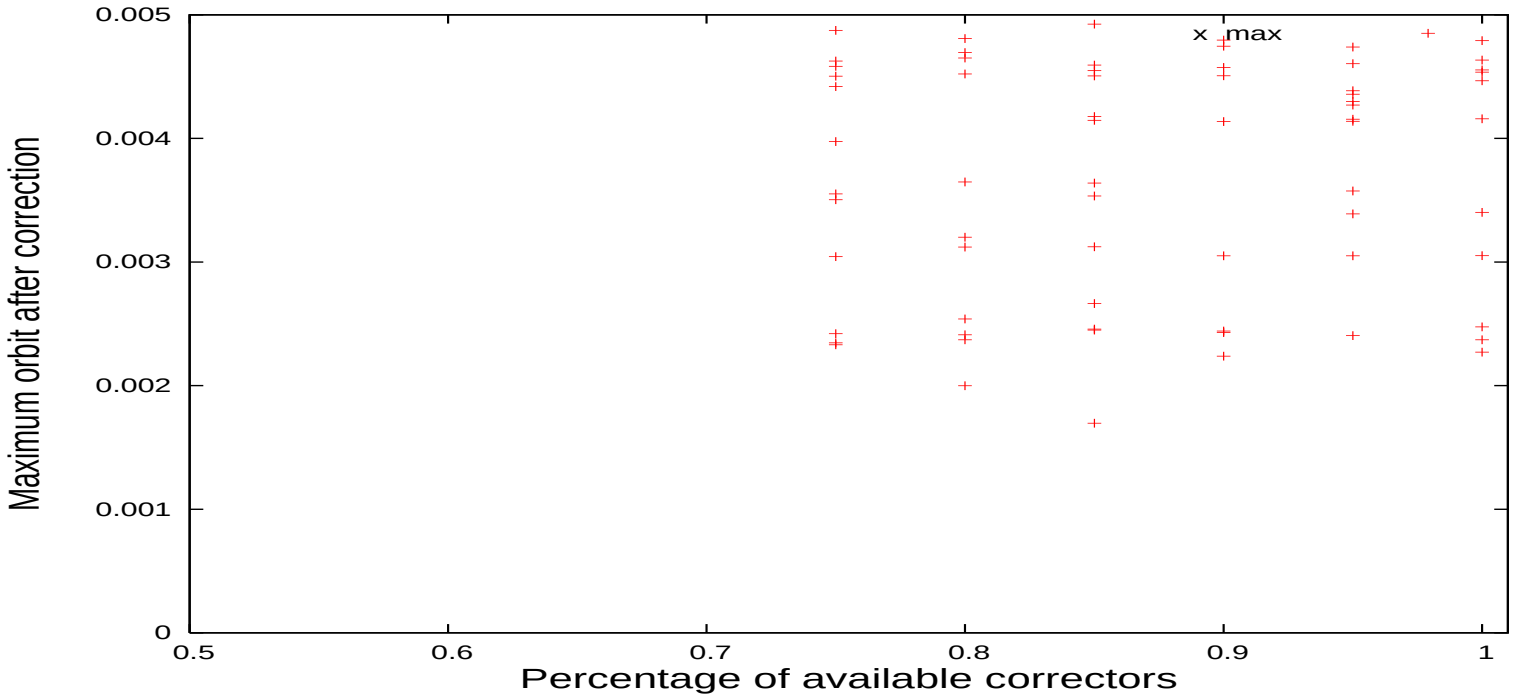

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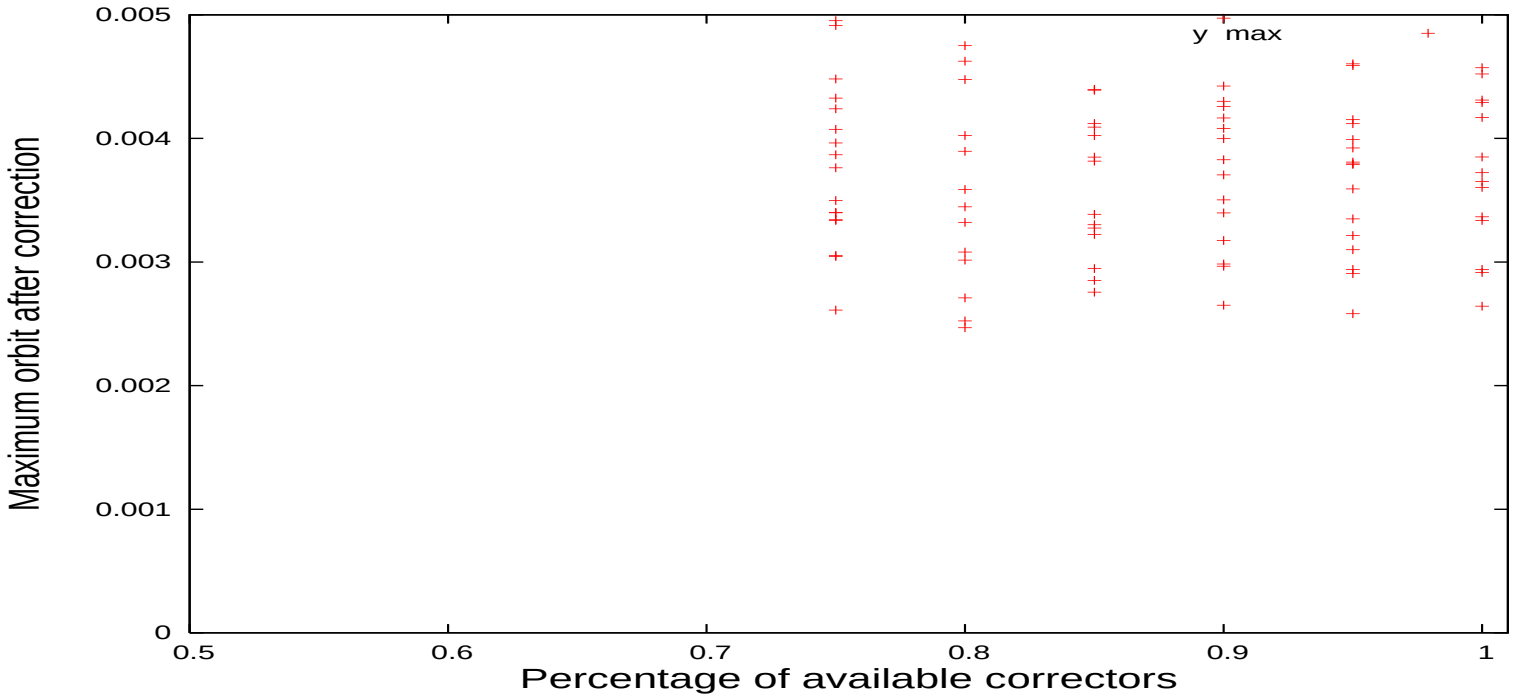

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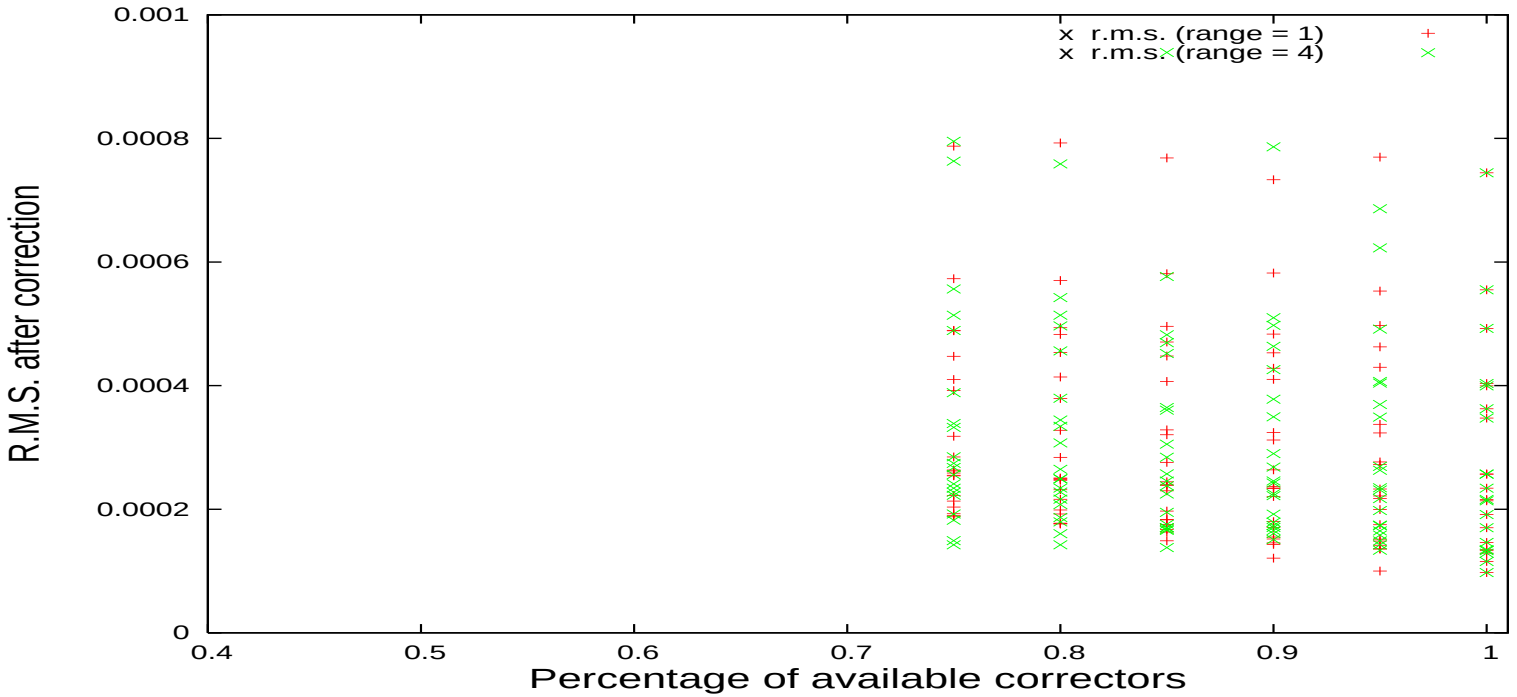
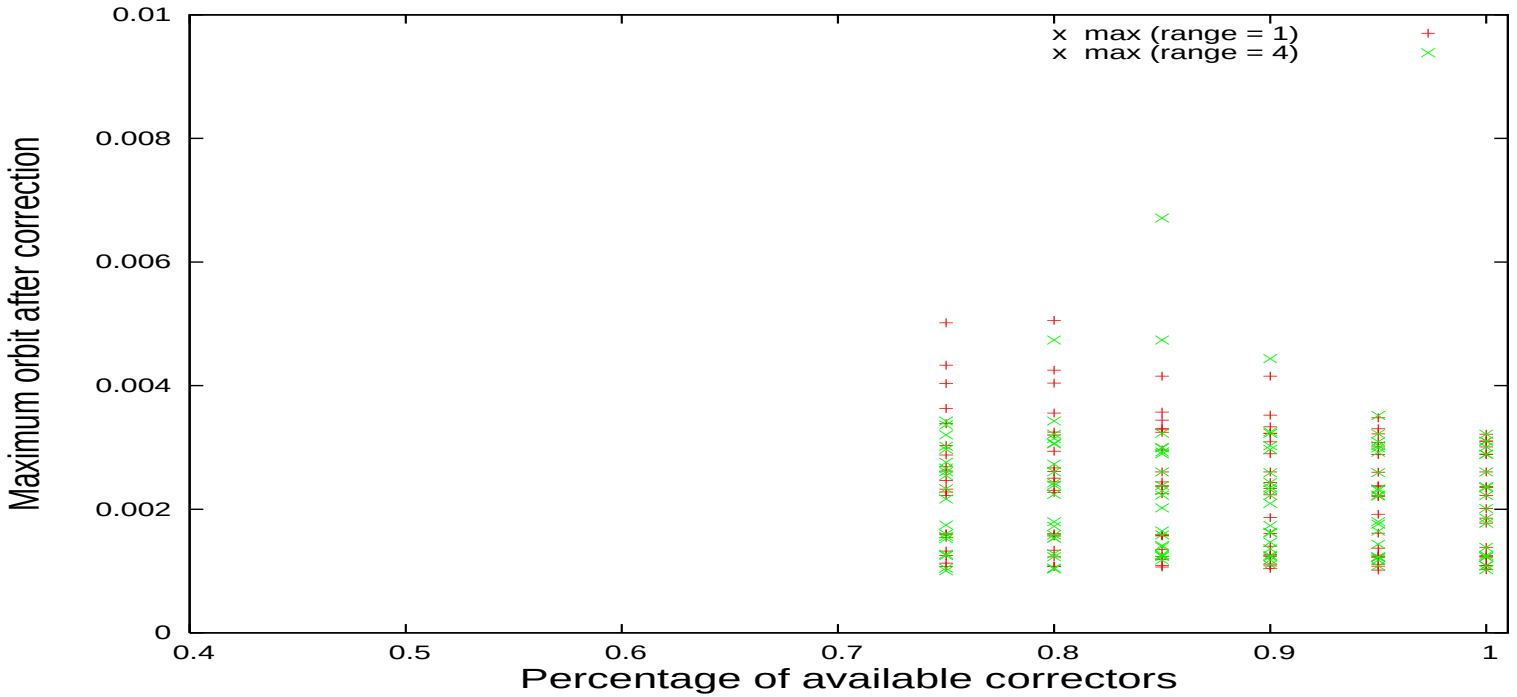
Orbit r.m.s. with missing correctors



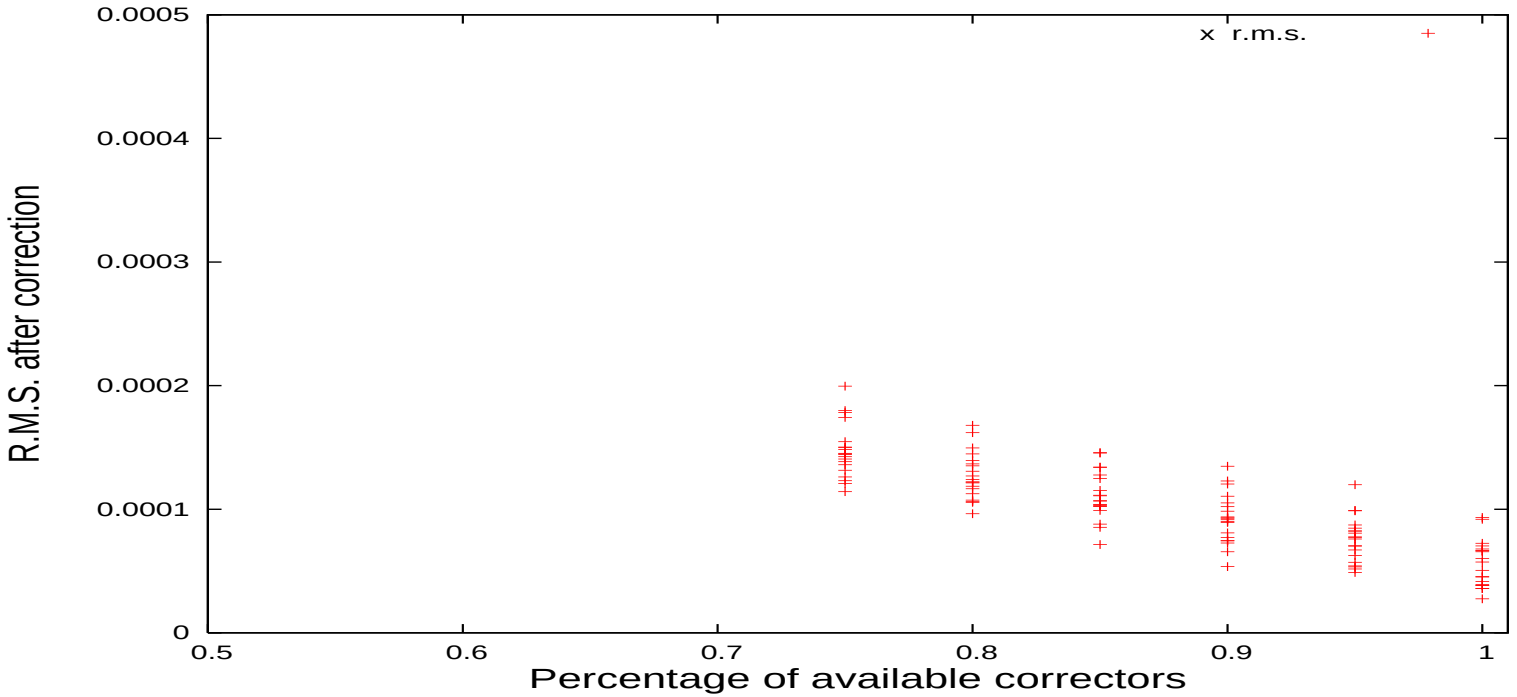
- **MICADO: all correctors used, range = 1, 4**

Peak orbit with missing correctors



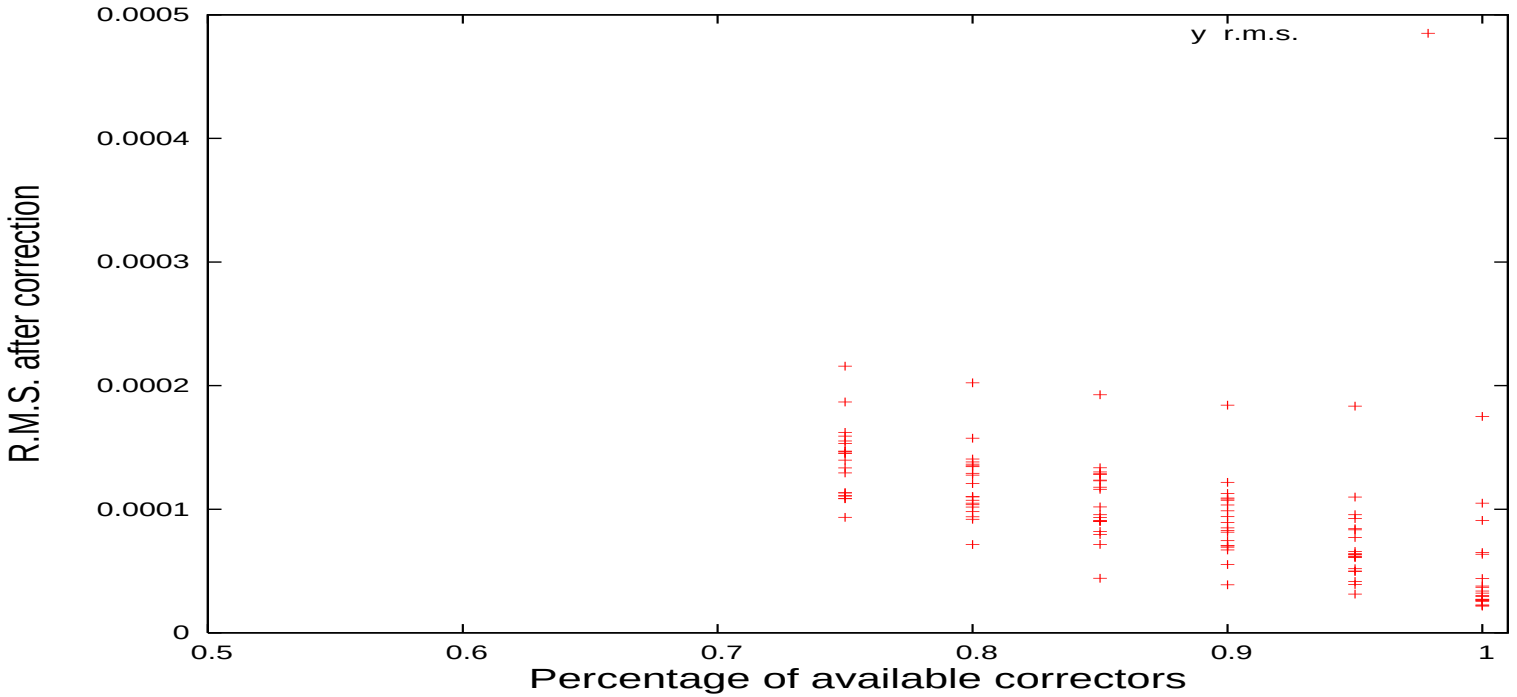
- **MICADO: all correctors used, range = 1, 4**

Orbit r.m.s. with missing correctors



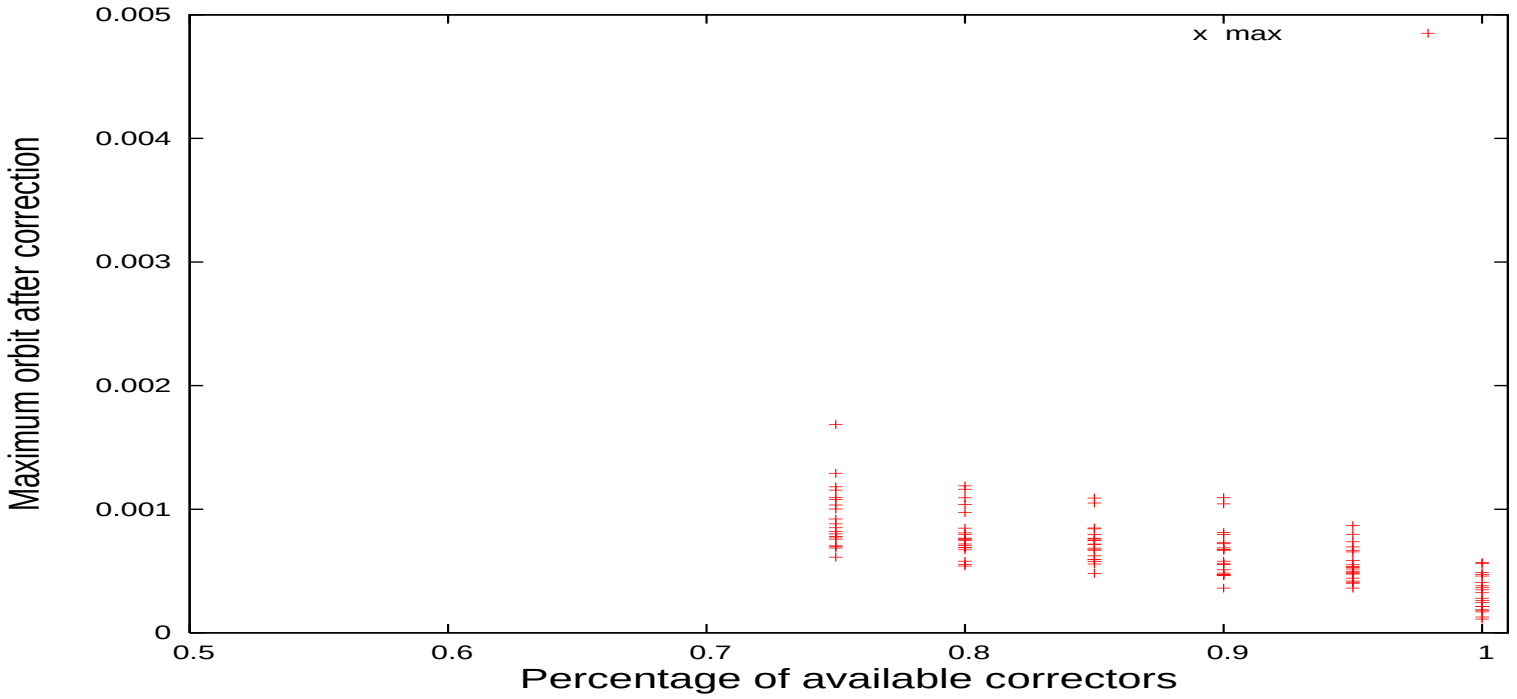
- **SVD: all correctors used**

Orbit r.m.s. with missing correctors



- **SVD: all correctors used**

Peak orbit with missing correctors



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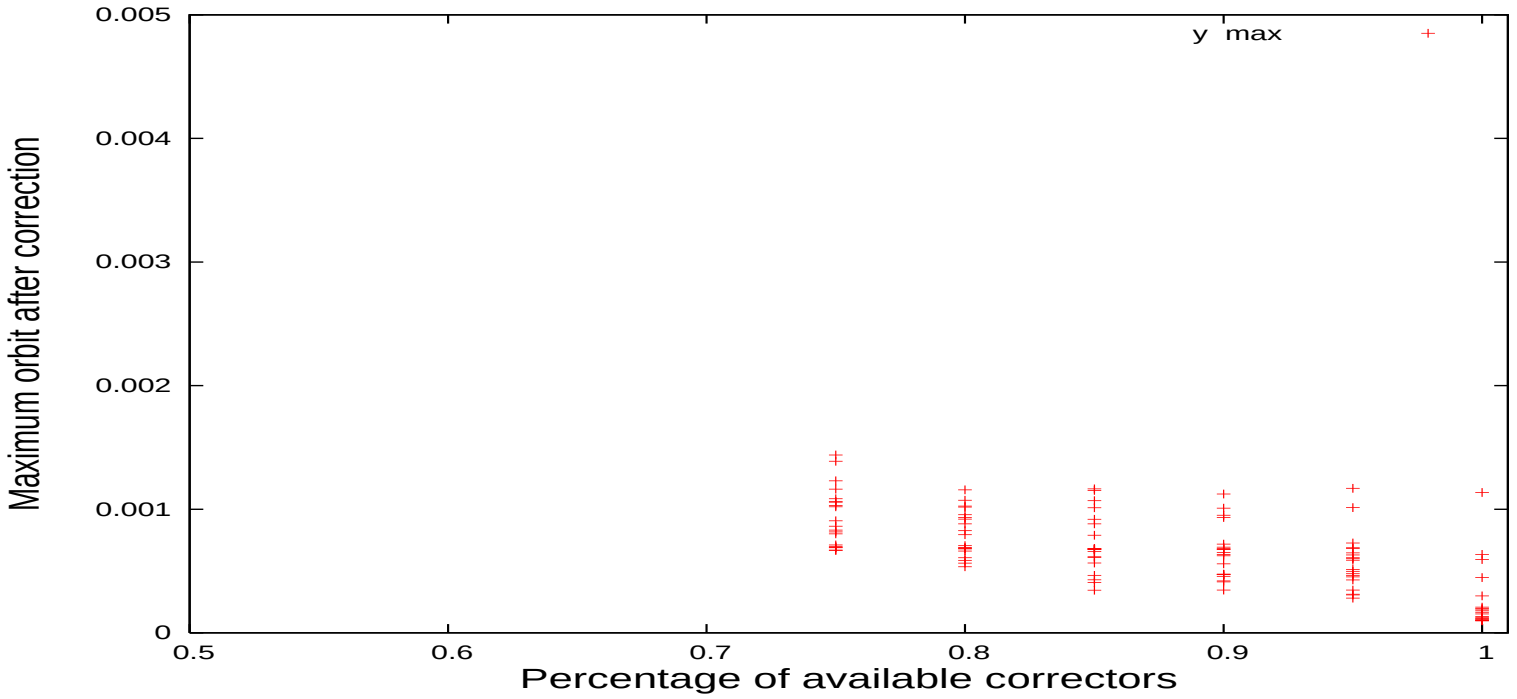

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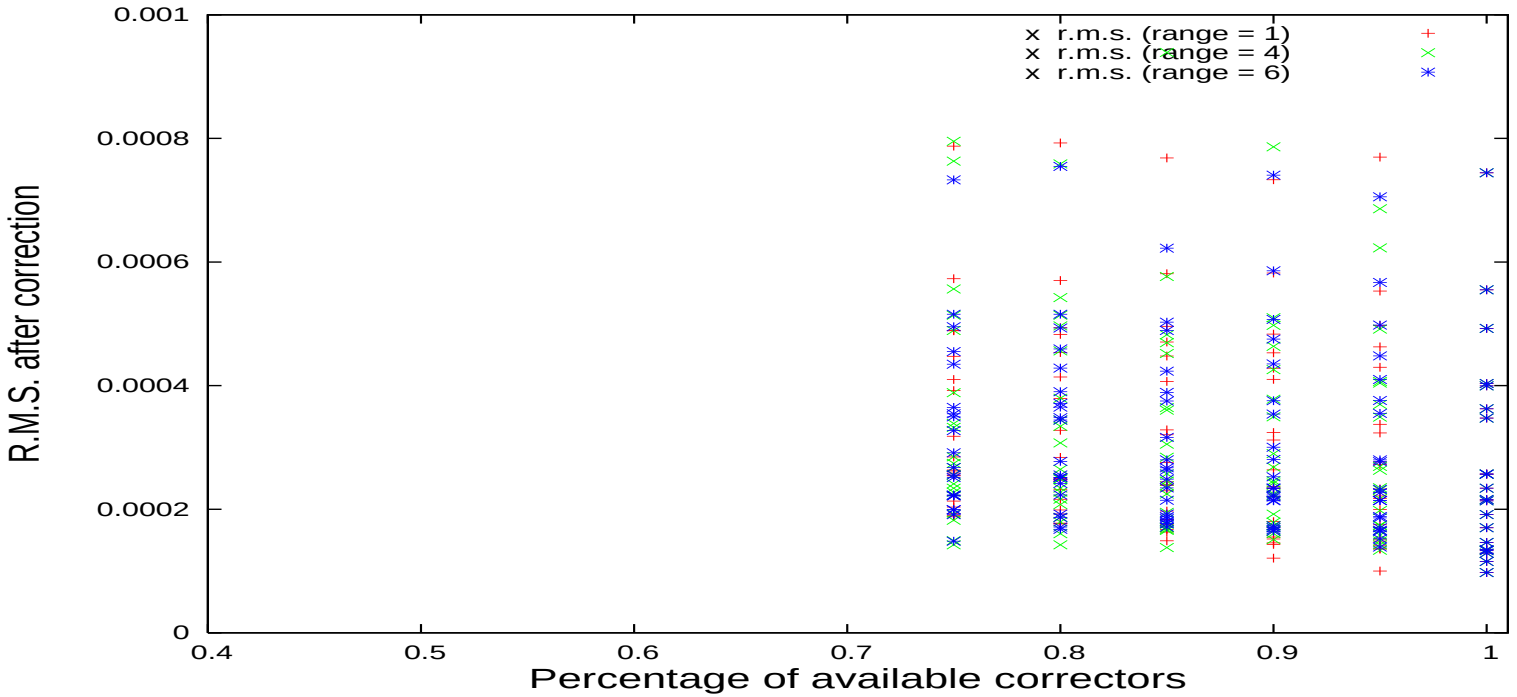
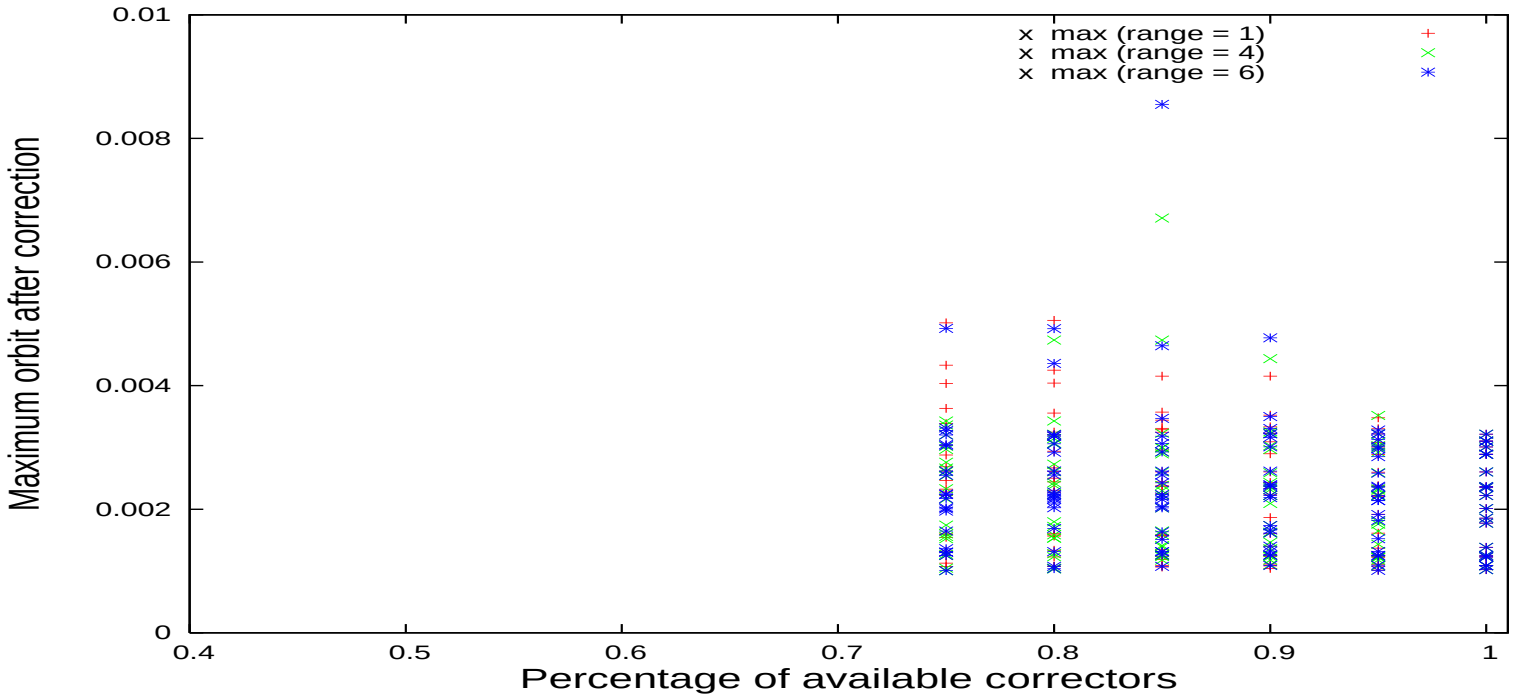
Orbit r.m.s. with missing correctors



- **SVD: all correctors used, range = 1, 4, 6**

Peak orbit with missing correctors



- **SVD: all correctors used, range = 1, 4, 6**

SUMMARY

- Effect of missing orbit correctors was studied
- Correction not local, small bumps $\Longrightarrow$
  - → Small increase of r.m.s. and peak orbit when all correctors used (for all methods)
  - → Effect is small for MICADO with limited number of correctors
  - → Small differences between randomly and grouped missing correctors (very different for monitors !)
- Special purpose correctors (e.g. crossing scheme) must always be available
- Unavailable correctors must be known to system