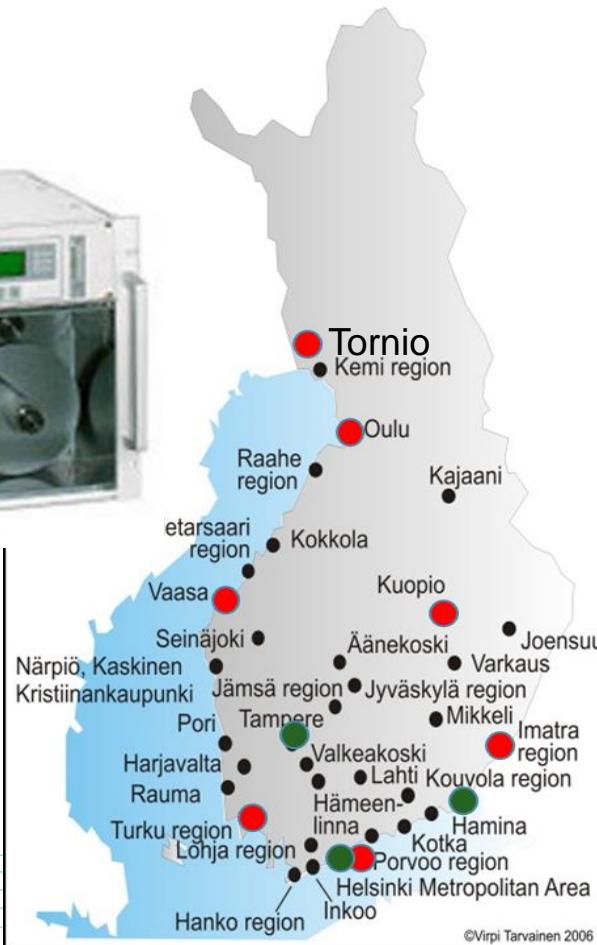




Hiukkasmittalaitteiden kalibrointikertoimien verifiointi



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Ilmakehän koostumuksen tutkimus
Ilmanlaatu
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Hiukkasmittalaitteiden kalibrointikertoimien verifiointi

Rinnakkaismittaukset vertailumenetelmän sekä ekvivalentin hiukkasanalysaattorin vä

- Kuopion vertailumittauksissa mukana olleet laitteet
- Vertailut tehdään yleisimmille hiukkasmittauslaitteille
- Vertailun kesto n. 55 vrk
- Tuloksissa verifioidaan kalibrointikertoimet eri puolilla Suomea (2 – 3 asemaa)
- Pääpaino PM10 hiukkaskokoalueelle
- Vertailu **ei muuta** ekvivalentisuuskertoimia

Vertailut HSY/Mäkelänkatu & Imatra/Mansikkala





MÄKELÄNKATU

Laitteen nimi
Malli
Sarjanumero

| | | | | | |
|------|------|-------|-------|-----------|----------|
| Teom | Teom | Teom | Teom | Thermo | Thermo |
| 1405 | 1405 | 1405D | 1405D | FH 62 I-R | FH62 I-R |

Laitteen korjauskerroin
Tiedonkeruujärjestelmän
kerroin

| | | | | | |
|----------------|----------------|--------------|--------------|----------------|----------------|
| 1.03 + 3.0 | 1.03 + 3.0 | 1.0 + 0 | 1.0 + 0 | 1 | 1 |
| 0.868y - 2.068 | 1.009y - 1.681 | ei korjausta | ei korjausta | 1.300y - 0.904 | 0.850y + 1.709 |

Näytепutken lämpötila

| | | | | | |
|------|------------|---------------------|-------------------------------|------|-------|
| 50 | 50 | 50 | 50 | 40 | 40 |
| PM10 | PM10+PM2.5 | PM10+PM2.5/PMcoarse | PM10+PM2.5/PMcoarse impaktori | PM10 | PM2.5 |

Inlet

| | | | | | |
|---------------|------------------|------------------|------------------|---------|---------|
| Teom (US-EPA) | Teomin oma inlet | Teomin oma inlet | Teomin oma inlet | Digitel | Digitel |
| | | | | | |

Inlet valmistaja

| | | | | | |
|--|--|--|--|--|--|
| | | | | | |
| | | | | | |

MÄKELÄNKATU

Laitteen nimi
Malli

| | | | | | |
|------------|-------------|-------------|--------------|--------------|---------------|
| Grimm PM10 | Grimm PM2.5 | Osiris PM10 | Osiris PM2.5 | Derenda PM10 | Derenda PM2.5 |
| Model 180 | Model 180 | | | APM-2 | APM-2 |

Sarjanumero
Laitteen korjauskerroin

| | | | | | |
|--|--|--|--|-------|-------|
| | | | | 20050 | 20050 |
| | | | | | |

Tiedonkeruujärjestelmän
kerroin

| | | | | | |
|----------------|----------------|--------------|--------------|--------------|--------------|
| 1 | 1 | 1 | 1 | | |
| 0.855y + 2.139 | 0.747y + 0.532 | ei korjausta | ei korjausta | ei korjausta | ei korjausta |

Näytепутken lämpötila

| | | | | | |
|--|--|--|--|--|--|
| | | | | | |
| | | | | | |

Inlet
Inlet valmistaja

| | | | | | |
|-----|-----|--|--|---------|---------|
| TSP | TSP | | | | |
| | | | | Derenda | Derenda |

KALLIO

Laitteen nimi
Malli

| | | | | | |
|------|------|------|--|--|--|
| Teom | Teom | Teom | | | |
| 1400 | 1400 | 1405 | | | |

Sarjanumero
Laitteen korjauskerroin

| | | | | | |
|--------------|--------------|----------------|--|--|--|
| 1.03 + 3.0 | 1.0 + 0 | 1.03 + 3.0 | | | |
| ei korjausta | 1.25y + 1.56 | 1.009y - 1.681 | | | |

Tiedonkeruujärjestelmän
kerroin

| | | | | | |
|------|------------|------------|--|--|--|
| 50 | 50 | 50 | | | |
| PM10 | PM10+PM2.5 | PM10+PM2.5 | | | |

Näytепутken lämpötila

| | | | | | |
|--|--|--|--|--|--|
| | | | | | |
| | | | | | |

Inlet
Inlet valmistaja

| | | | | | |
|---------------|------|------|--|--|--|
| Teom (US-EPA) | Teom | Teom | | | |
| | | | | | |

Mittausverkko

Asema
Laitteen nimi

| | | | | | | |
|----------------|-------------------|---------------|----------------|-----------------|---------------|-----------------|
| Turku Naantali | Imatra Mansikkala | Oulu Keskusta | Vaasa Keskusta | Tornio Puulusto | Tampere Epilä | Ref lab Ongoing |
| Environnement | TEOM | TEOM | Environnement | SHARP | Grimm | Grimm |

Malli
Sarjanumero

| | | | | | | |
|-------|------|-----------------|-------|------|-----|-----|
| MP101 | 1405 | 1405 | MP101 | 5030 | 180 | 180 |
| | | 1405A228891407. | | | | |

Laitteen korjauskerroin
Tiedonkeruujärjestelmän
kerroin

| | | | | | | |
|------|------------|------------|---|-------|---|----------------|
| 1 | 1.03 + 3.0 | 1.03 + 3.0 | 1 | 1 | 1 | 1 |
| 0,91 | 1 | 1 | 1 | 1,319 | 1 | 0.855y + 2.139 |

Näytепутken lämpötila

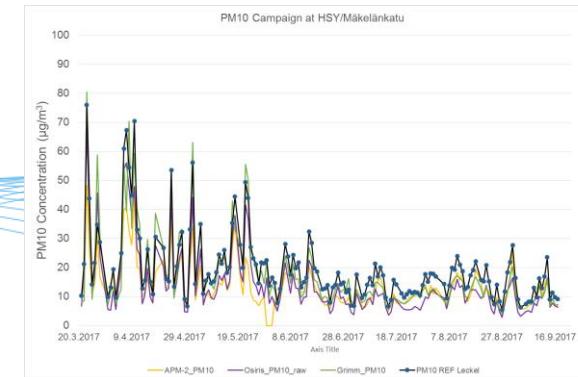
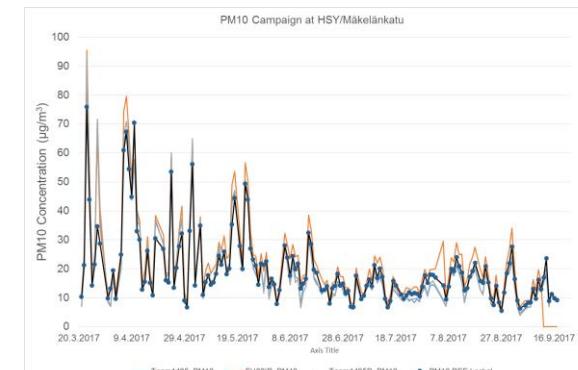
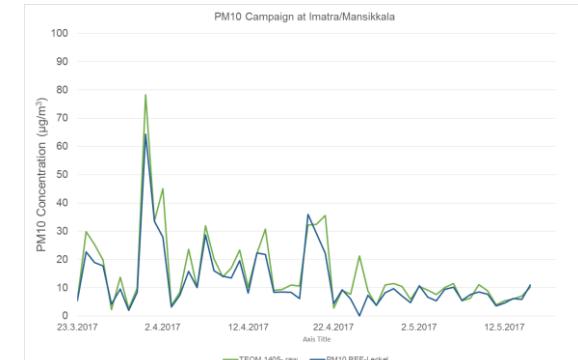
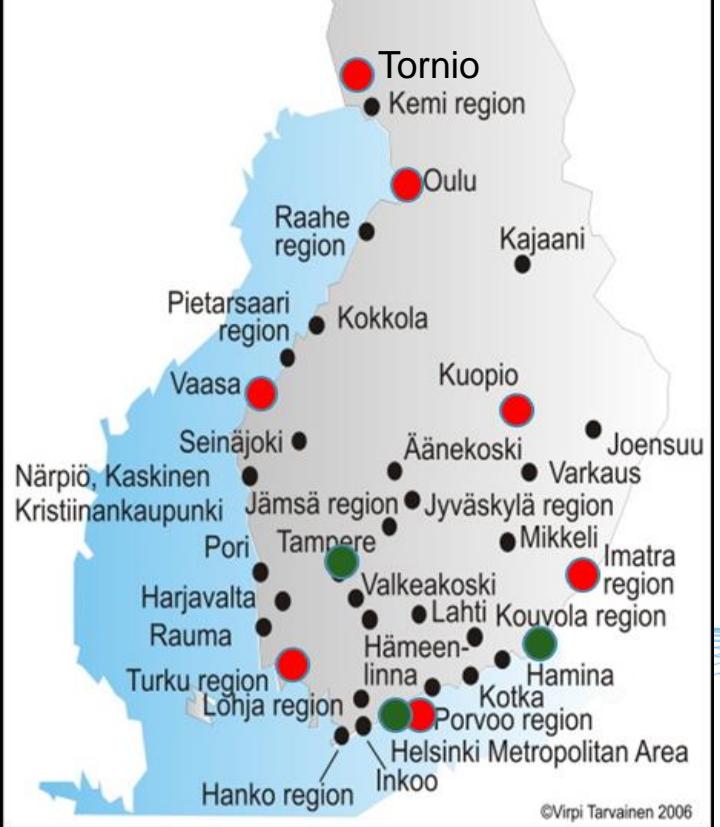
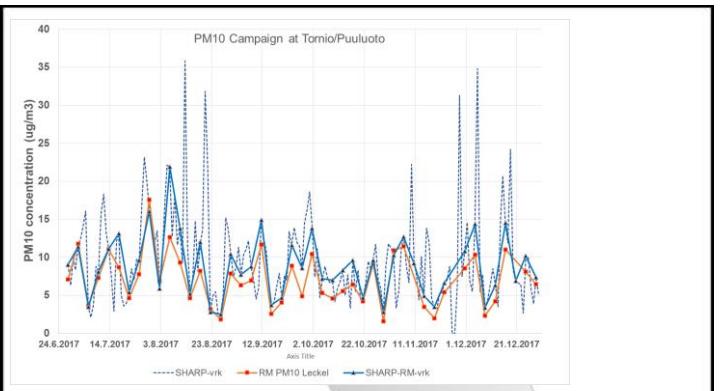
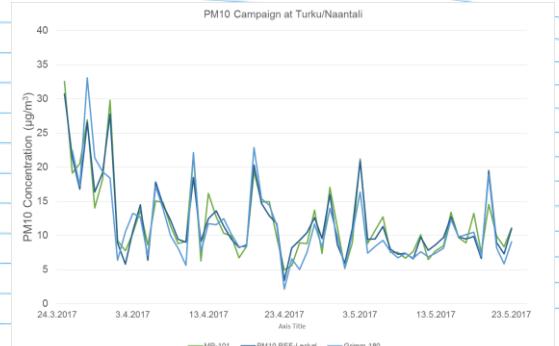
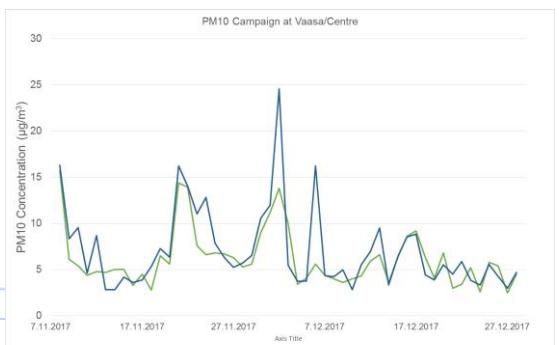
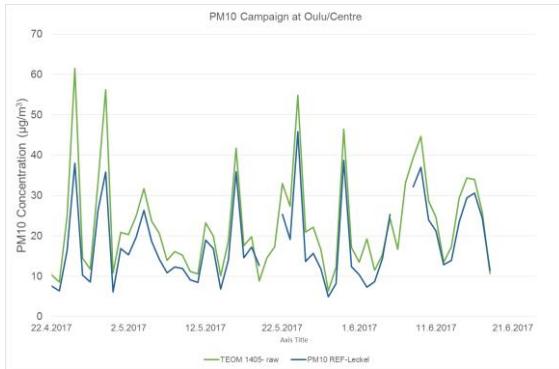
| | | | | | | |
|-------------------------|---------------|------|-------------------------|-----------|---------------|---------------|
| T _{ulko} + 5 C | Ei lämmitystä | 50 C | T _{ulko} + 5 C | 30 C | Ei lämmitystä | Ei lämmitystä |
| Esierotin | PM10 | PM10 | Esierotin | Esierotin | TSP | TSP |

Inlet
Inlet valmistaja

| | | | | | | |
|--------------------|---------------|---------------|--------------------|---------|-------|-------|
| Environnement S.A. | Teom (US-EPA) | Teom (US-EPA) | Environnement S.A. | Digitel | Grimm | Grimm |
| | | | | | | |

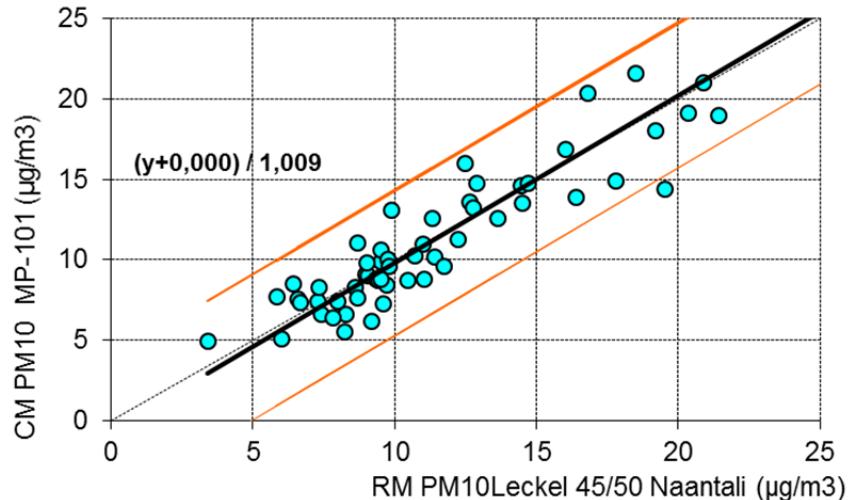


Hiukkasmittalaitteiden kalibrointikertoimien verifiointi: PM10

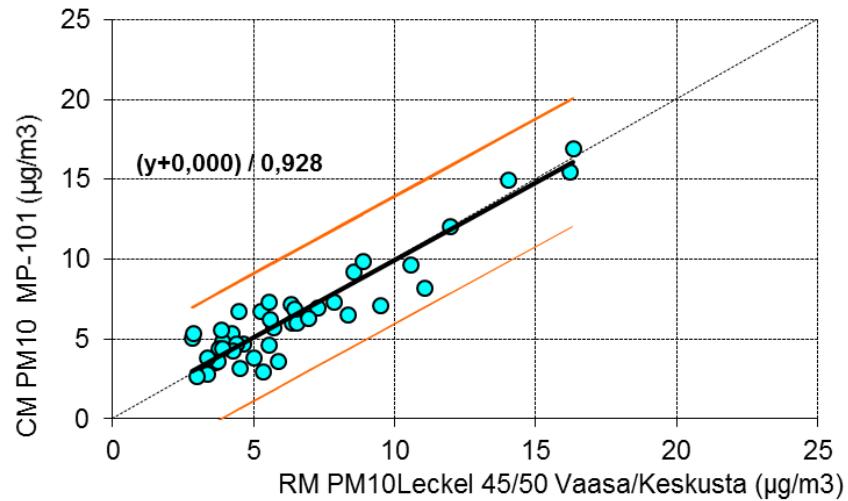




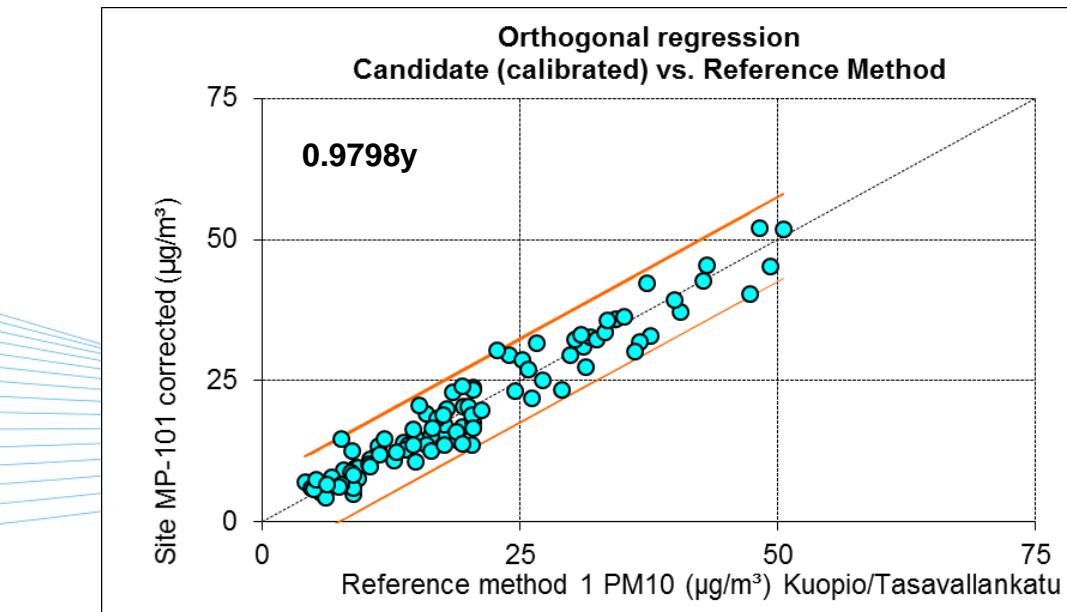
**Orthogonal regression
Candidate (calibrated) vs. Reference Method**



**Orthogonal regression
Candidate (calibrated) vs. Reference Method**



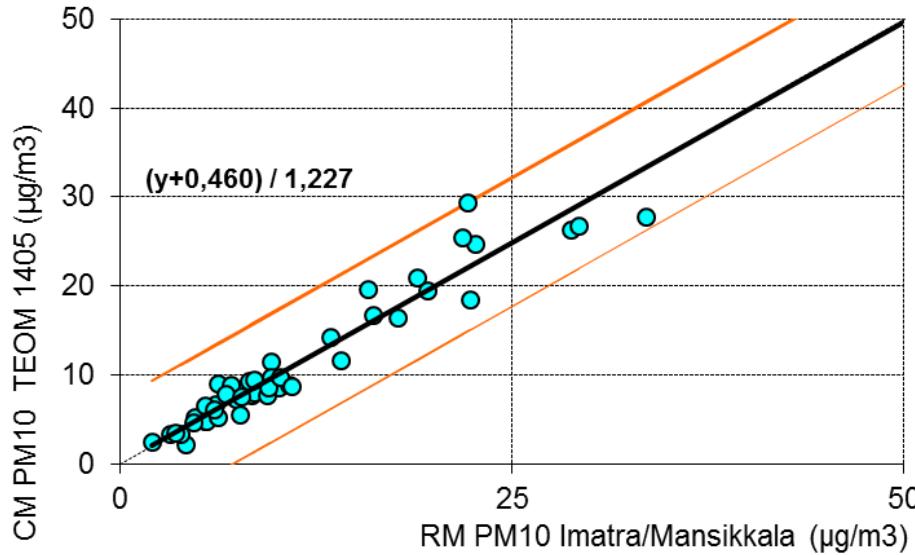
| Ongoing test PM ₁₀ | Criteria | Turku/Naantali MP-101 calib | Vaasa/keskusta MP-101 raw | Kuopio site/Tasavallankatu MP-101 calib |
|-----------------------------------|--------------------------|-----------------------------|---------------------------|---|
| Concentration range | $\mu\text{g}/\text{m}^3$ | 0 - 35 | 0 - 20 | 0 - 75 |
| Raw data | | | | |
| Slope | significant (Yes/No) | 1,0531 | 0,8926 | 0,97982 |
| Intercept | significant (Yes/No) | -0,6447 | 0,2866 | -0,70160 |
| Expanded relative uncertainty | $\leq 25\%$ | 10,4 % | 20,7 % | 13,0 % |
| Fail/Pass | $\leq 25\%$ | Pass | Pass | Pass |
| Calibrated data | | | | |
| Calibration: equation | | | $1,12y + -0,321$ | |
| Expanded relative uncertainty | $\leq 25\%$ | | 11,7 % | |
| Fail/Pass | $\leq 25\%$ | | Pass | |
| Calibration: slope through origin | | | $1,077y$ | |
| Expanded relative uncertainty | $\leq 25\%$ | | 8,6 % | |
| Fail/Pass | $\leq 25\%$ | | Pass | |
| Calibration equation | | | $0,91y$ | $0,91y$ |



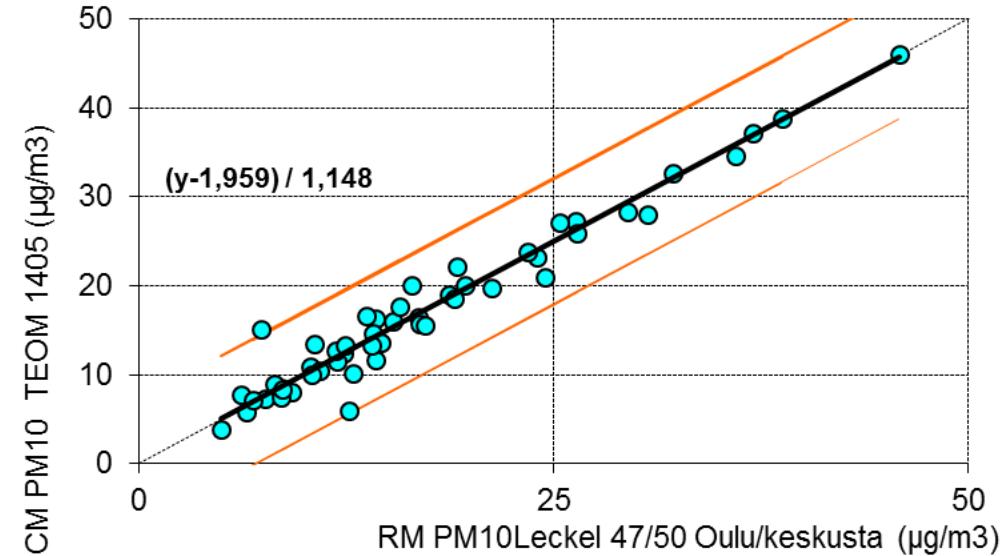


| Ongoing test PM ₁₀ | Criteria | Imatra/Mansikkala TEOM 1405 raw | Oulu/keskusta TEOM 1405 raw |
|-----------------------------------|----------------------|---------------------------------|-----------------------------|
| Concentration range | µg/m ³ | 0 - 75 | 0 - 55 |
| Raw data | | | |
| Slope | significant (Yes/No) | 1,2270 | 1,148 |
| Intercept | significant (Yes/No) | -0,5 | 2,0 |
| Expanded relative uncertainty | ≤ 25% | 44,6 % | 38,6 % |
| Fail/Pass | ≤ 25% | Fail | Fail |
| Calibrated data | | | |
| Calibration: equation | | 0,805y + 2,615 | 0,871y + -1,707 |
| Expanded relative uncertainty | ≤ 25% | 12,5% | 11,0 % |
| Fail/Pass | ≤ 25% | Pass | Pass |
| Calibration: slope through origin | | 0,83y | 0,808 |
| Expanded relative uncertainty | ≤ 25% | 9,3% | 12,0 % |
| Fail/Pass | ≤ 25% | Pass | Pass |
| Calibration equation | | | |

Orthogonal regression
Candidate (calibrated) vs. Reference Method



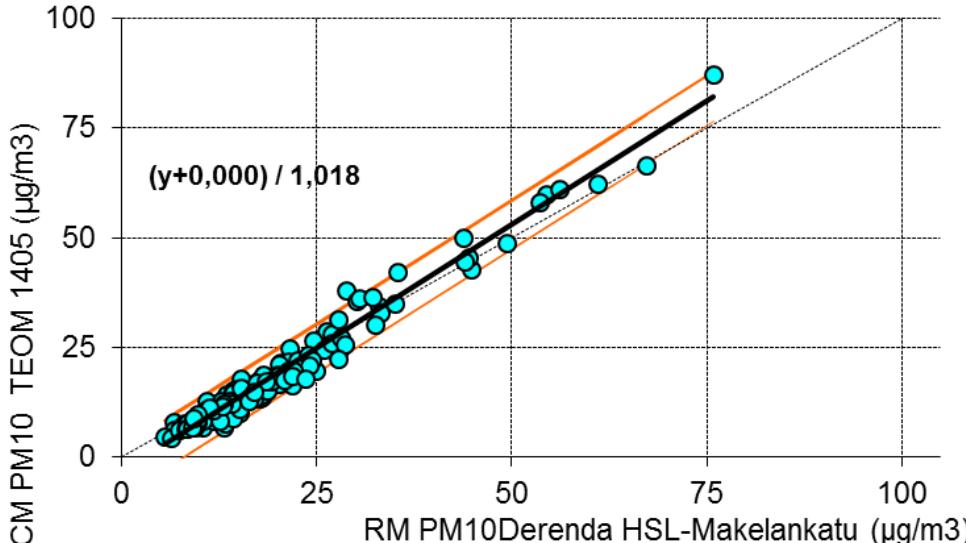
Orthogonal regression
Candidate (calibrated) vs. Reference Method



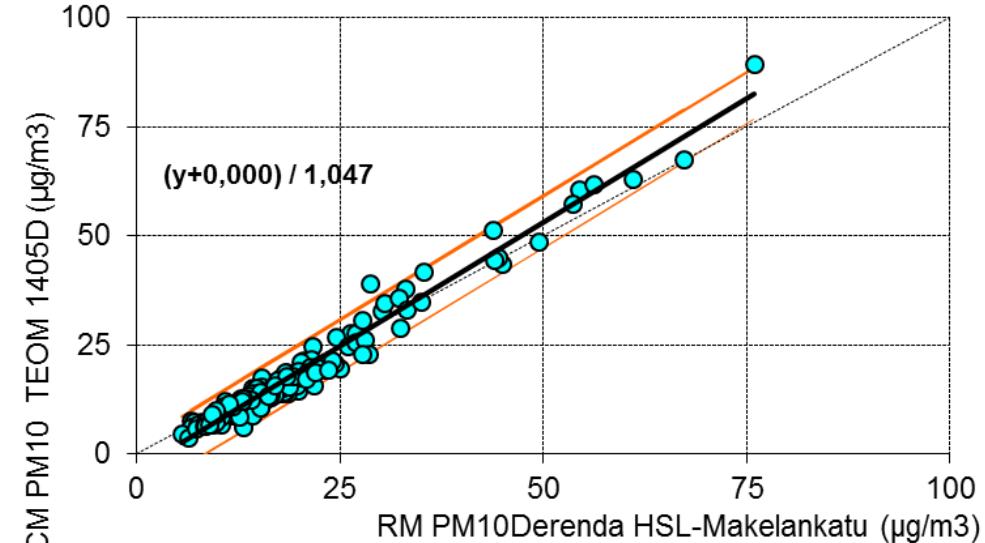


| Ongoing test PM ₁₀ | Criteria | HSY/Mäkelänkatu TEOM 1405 calib | HSY/Mäkelänkatu TEOM 1405D raw |
|-----------------------------------|----------------------|---------------------------------|--------------------------------|
| Concentration range | µg/m ³ | 0 - 90 | 0 - 90 |
| Raw data | | | |
| Slope | significant (Yes/No) | 1,1465 | 1,1931 |
| Intercept | significant (Yes/No) | -3,43 | 1,05 |
| Expanded relative uncertainty | ≤ 25% | 18,10 % | 25,00 % |
| Fail/Pass | ≤ 25% | Pass | Fail |
| Calibrated data | | | |
| Calibration: equation | | 0,872y + 2,992 | 0,838y + 3,291 |
| Expanded relative uncertainty | ≤ 25% | 8,75 % | 9,10 % |
| Fail/Pass | ≤ 25% | Pass | Pass |
| Calibration: slope through origin | | 0,982 | 0,955 |
| Expanded relative uncertainty | ≤ 25% | 15 % | 16 % |
| Fail/Pass | ≤ 25% | Pass | Pass |
| Calibration equation | | 0,868y - 2,068 | |

Orthogonal regression
Candidate (calibrated) vs. Reference Method

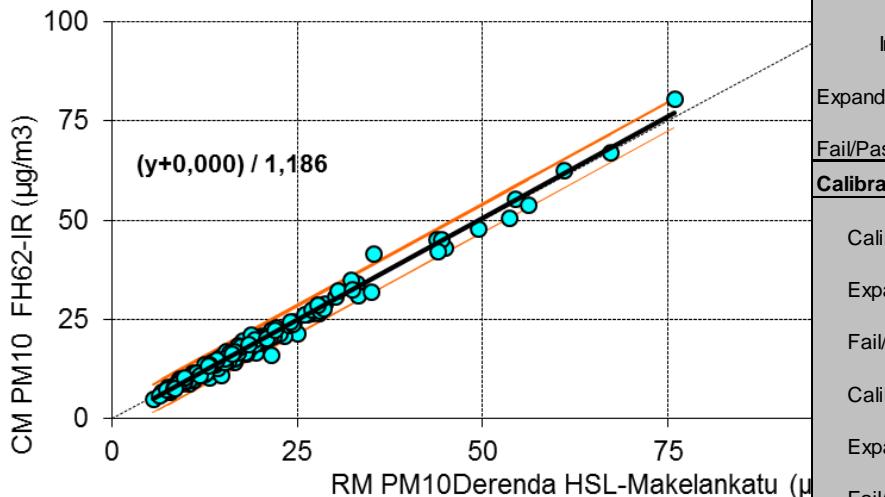


Orthogonal regression
Candidate (calibrated) vs. Reference Method



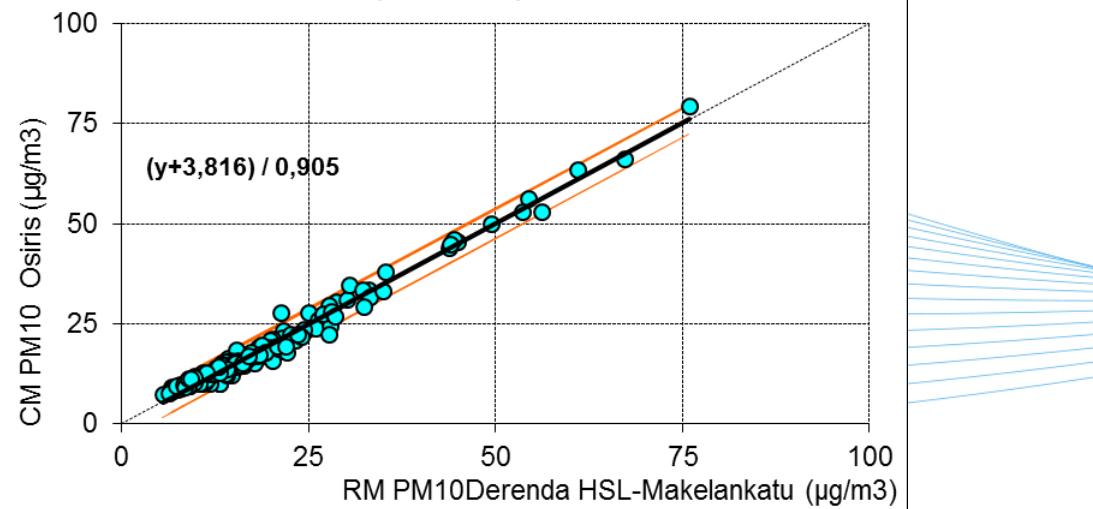


Orthogonal regression
Candidate (calibrated) vs. Reference Method

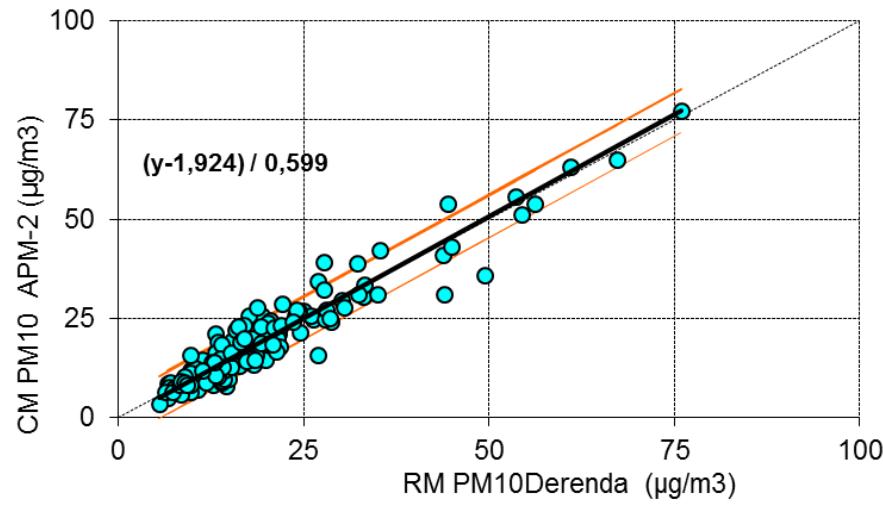


| Ongoing test PM ₁₀ | Criteria | HSY/Mäkelänkatu FH62-IR calib | HSY/Mäkelänkatu Osiris raw | HSY/Mäkelänkatu APM-2 raw |
|-----------------------------------|--------------------------|-------------------------------|----------------------------|---------------------------|
| Concentration range | $\mu\text{g}/\text{m}^3$ | 0 - 100 | 0 - 100 | 0 - 100 |
| Raw data | | | | |
| Slope | significant (Yes/No) | 1,2108 | 0,9051 | 0,5990 |
| Intercept | significant (Yes/No) | -0,6644 | -3,8164 | 1,9244 |
| Expanded relative uncertainty | $\leq 25\%$ | 39,9 % | 34,7 % | 73,1 % |
| Fail/Pass | $\leq 25\%$ | Fail | Fail | Fail |
| Calibrated data | | | | |
| Calibration: equation | | 0,826y + 0,549 | 1,105y + 4,216 | 1,669y + -3,213 |
| Expanded relative uncertainty | $\leq 25\%$ | 4,6 % | 6,8 % | 15,5 % |
| Fail/Pass | $\leq 25\%$ | Pass | Pass | Pass |
| Calibration: slope through origin | | 0,843y | 1,31y | 1,486y |
| Expanded relative uncertainty | $\leq 25\%$ | 5,0 % | 6,8 % | 15,8 % |
| Fail/Pass | $\leq 25\%$ | Pass | Pass | Pass |
| Calibration equation | | 1,300y - 0,904 | | |

Orthogonal regression
Candidate (calibrated) vs. Reference Method



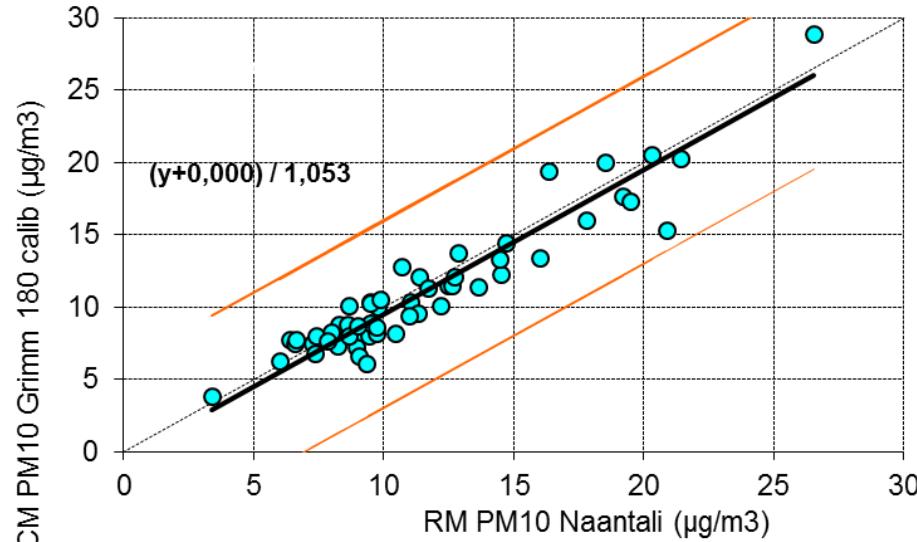
Orthogonal regression
Candidate (calibrated) vs. Reference Method



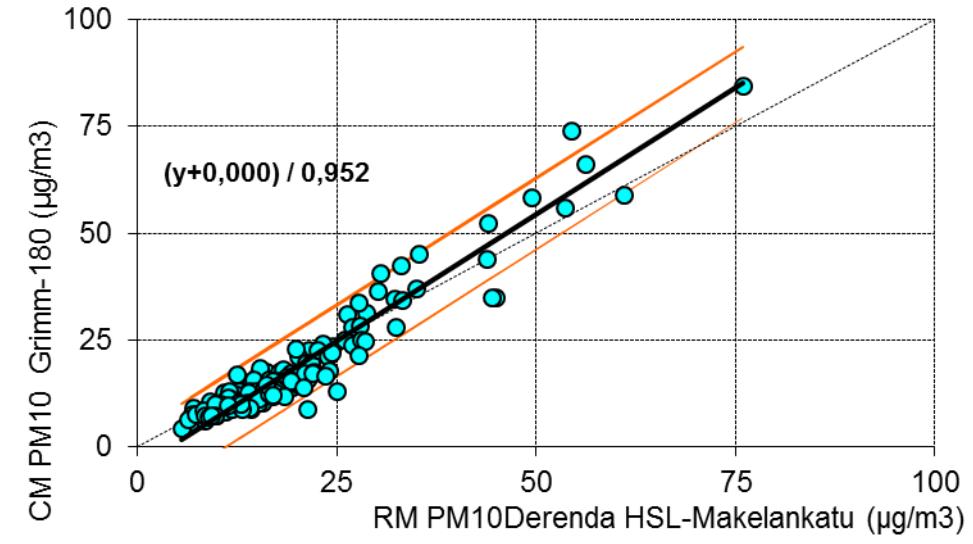


| Ongoing test PM ₁₀ | Criteria | Turku/Naantali Grimm 180 calib | HSY/Mäkelänkatu Grimm 180 calib |
|-----------------------------------|----------------------|-----------------------------------|------------------------------------|
| Concentration range | µg/m ³ | 0 - 35 | 0 - 100 |
| Raw data | | | |
| Slope | significant (Yes/No) | 1,0531 | 1,1264 |
| Intercept | significant (Yes/No) | -0,5317 | -4,5037 |
| Expanded relative uncertainty | ≤ 25% | 10,4 % | 16,0 % |
| Fail/Pass | ≤ 25% | Pass | Pass |
| Calibrated data | | | |
| Calibration: equation | | 0,888y + 3,998 | |
| Expanded relative uncertainty | ≤ 25% | | 13,8 % |
| Fail/Pass | ≤ 25% | | Pass |
| Calibration: slope through origin | | 1,051y | |
| Expanded relative uncertainty | ≤ 25% | | 13,8 % |
| Fail/Pass | ≤ 25% | | Pass |
| Calibration equation | | 0,747y + 0,532 | 0,747y + 0,532 |

Orthogonal regression
Candidate (calibrated) vs. Reference Method

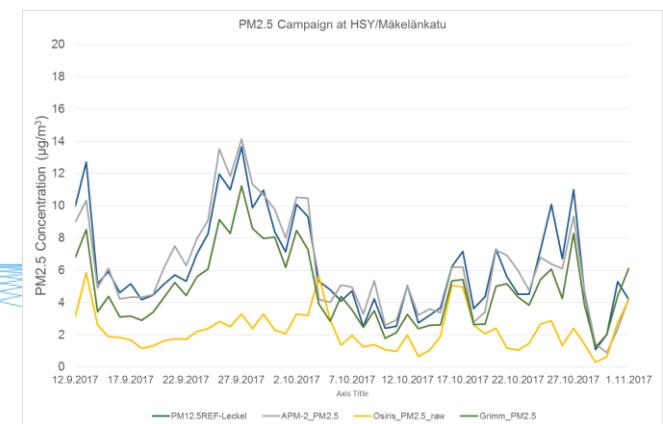
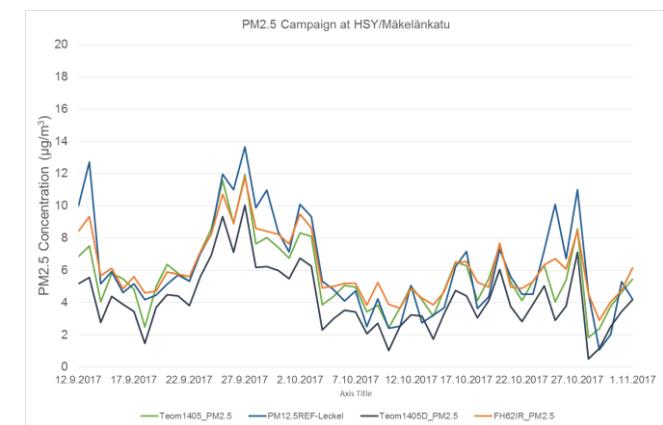
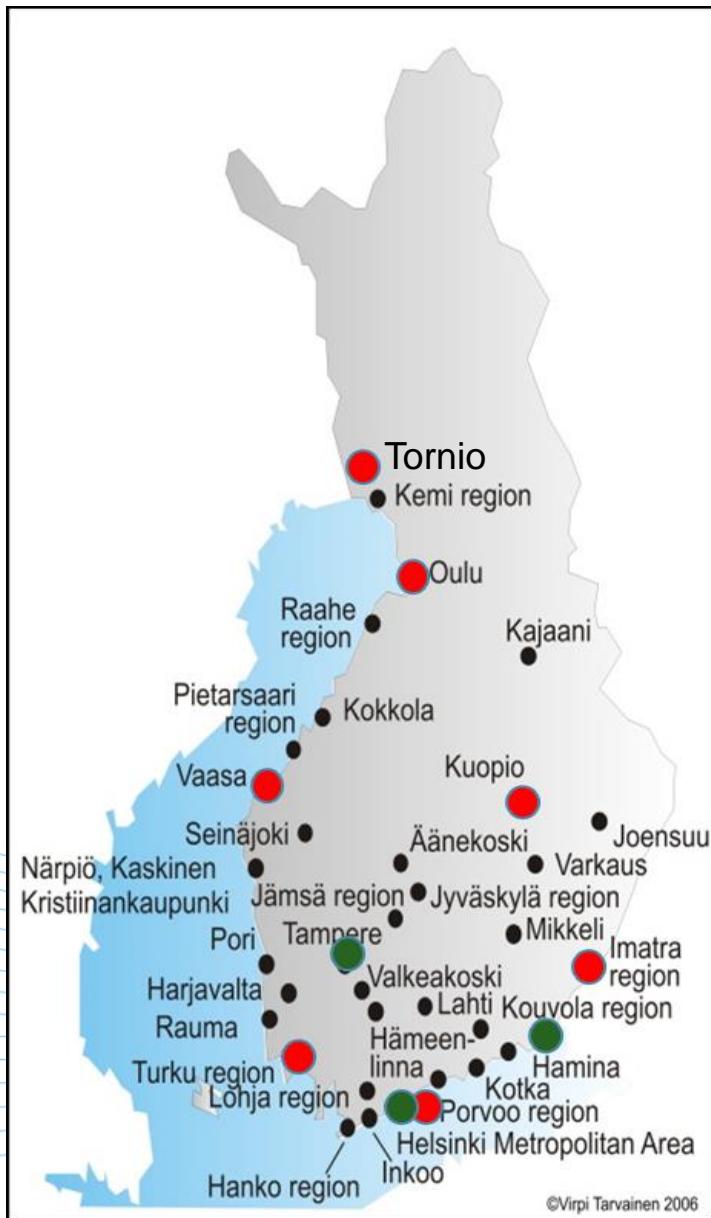
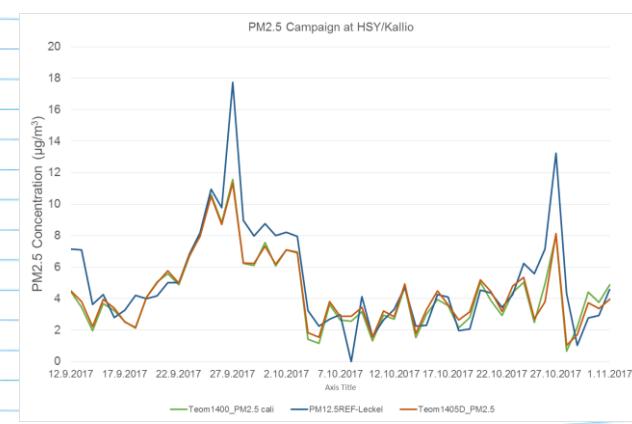
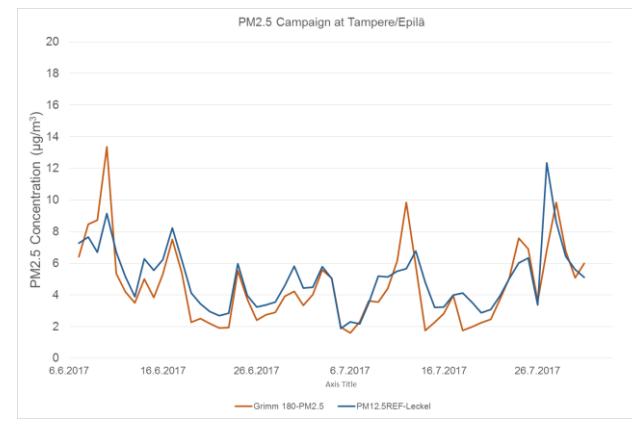


Orthogonal regression
Candidate (calibrated) vs. Reference Method





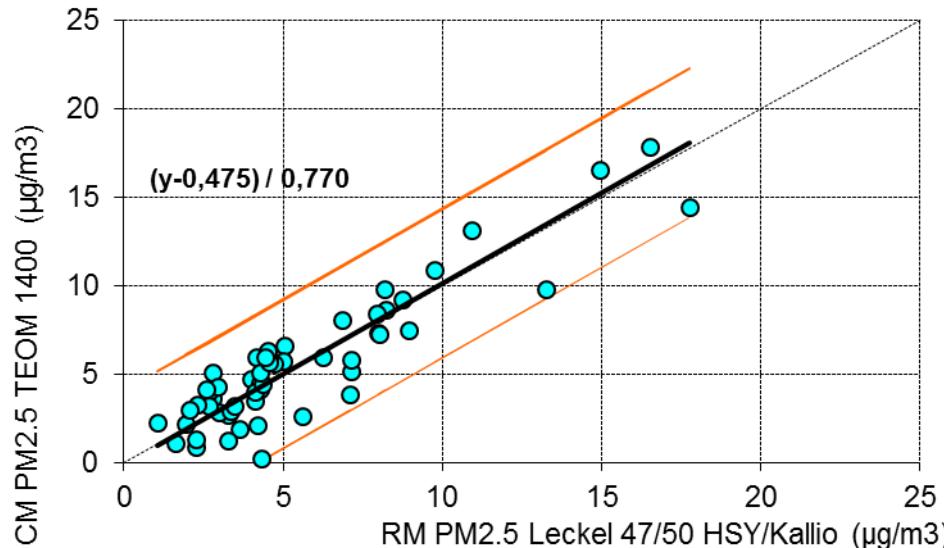
Hiukkasmittalaitteiden kalibrointikertoimien verifiointi: PM2.5



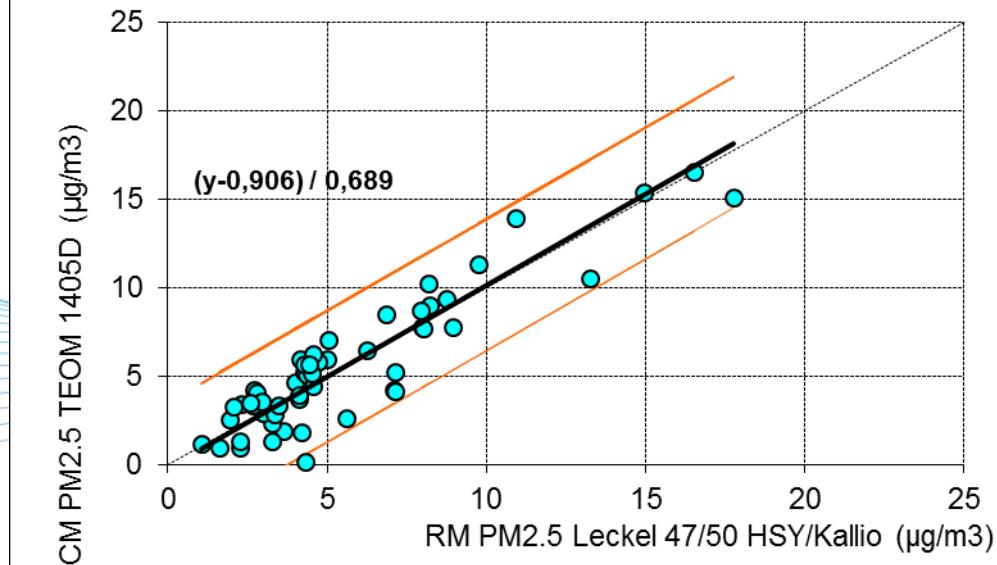


| Ongoing test PM _{2.5} | Criteria | HSY/Kallio TEOM 1400ab calib | HSY/Kallio TEOM 1405D |
|-----------------------------------|----------------------|---------------------------------|--------------------------|
| Concentration range | µg/m ³ | 0 - 20 | 0 - 20 |
| Raw data | | | |
| Slope | significant (Yes/No) | 0,7698 | 0,6887 |
| Intercept | significant (Yes/No) | 0,4753 | 0,9064 |
| Expanded relative uncertainty | ≤ 25% | 43,4 % | 56,6 % |
| Fail/Pass | ≤ 25% | Fail | Fail |
| Calibrated data | | | |
| Calibration: equation | | 1,299y + -0,618 | 1,452y + -1,316 |
| Expanded relative uncertainty | ≤ 25% | 13,9% | 13,6 % |
| Fail/Pass | ≤ 25% | Pass | Pass |
| Calibration: slope through origin | | 1,202y | 1,238y |
| Expanded relative uncertainty | ≤ 25% | 13,2% | 21,4 % |
| Fail/Pass | ≤ 25% | Pass | Pass |
| Calibration equation | | 1.009y - 1.681 | |

Orthogonal regression
Candidate (calibrated) vs. Reference Method

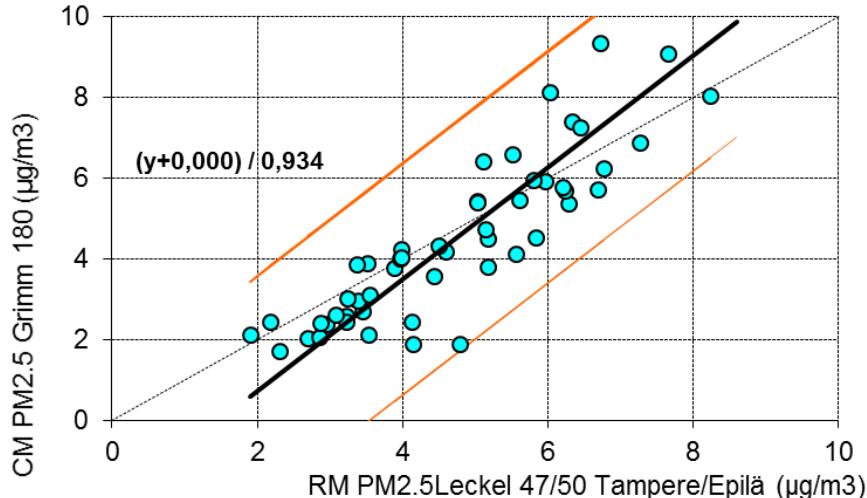


Orthogonal regression
Candidate (calibrated) vs. Reference Method



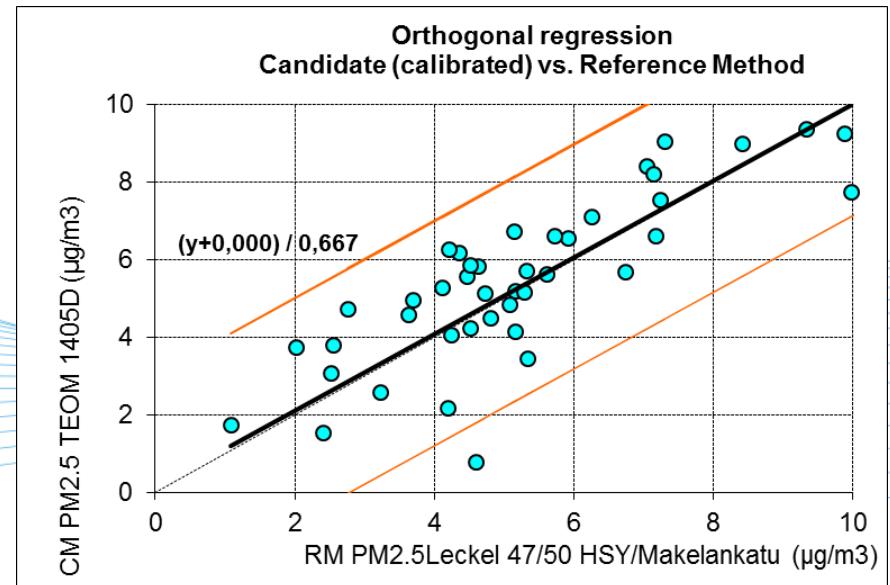
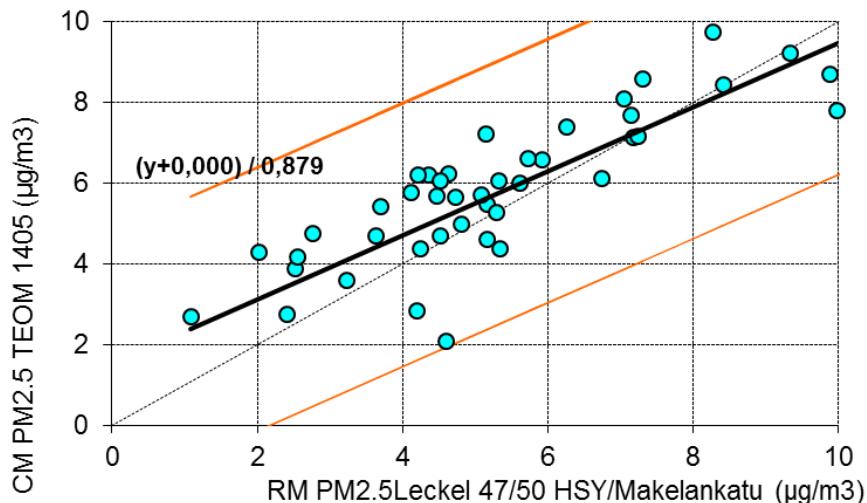


Orthogonal regression
Candidate (calibrated) vs. Reference Method



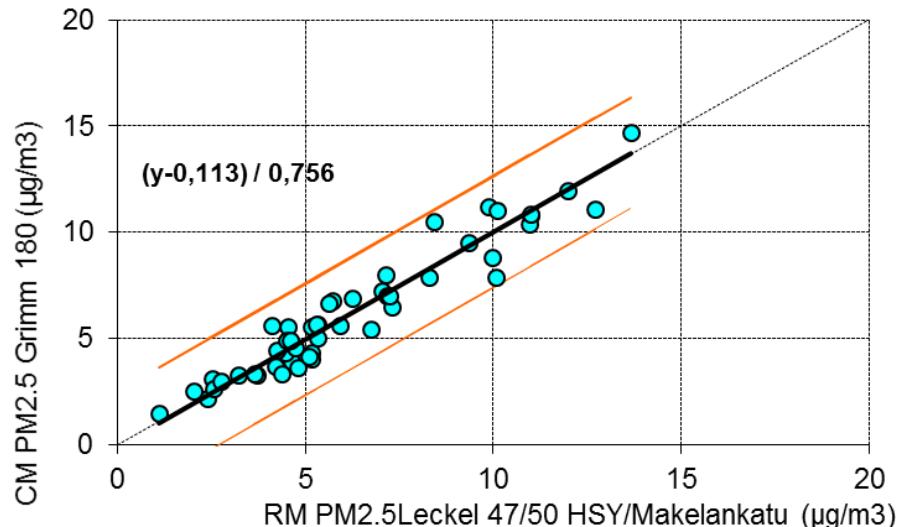
| Ongoing test PM _{2.5} | Criteria | Tampere/Epilä Grimm 180 raw | HSY/Mäkelänkatu TEOM 1405 calib | HSY/Mäkelänkatu TEOM 1405D |
|-----------------------------------|--------------------------|--------------------------------|------------------------------------|-------------------------------|
| Concentration range | $\mu\text{g}/\text{m}^3$ | 0 - 10 | 0 - 90 | 0 - 90 |
| Raw data | | | | |
| Slope | significant (Yes/No) | 1,2867 | 0,6833 | 0,6177 |
| Intercept | significant (Yes/No) | -1,88 | 1,4346 | 0,369 |
| Expanded relative uncertainty | $\leq 25\%$ | 45,0 % | 54,10 % | 72,20 % |
| Fail/Pass | $\leq 25\%$ | Fail | Fail | Fail |
| Calibrated data | | | | |
| Calibration: equation | | 0,777y + 1,461 | 1,464y + -2,1 | 1,619y + -0,597 |
| Expanded relative uncertainty | $\leq 25\%$ | 16,9% | 18,20 % | 19,90 % |
| Fail/Pass | $\leq 25\%$ | Pass | Pass | Pass |
| Calibration: slope through origin | | 1,071y | 1,138y | 1,499y |
| Expanded relative uncertainty | $\leq 25\%$ | 64,3% | 33 % | 11 % |
| Fail/Pass | $\leq 25\%$ | Fail | Fail | Pass |
| Calibration equation | | | | 1.009y - 1.681 |

Orthogonal regression
Candidate (calibrated) vs. Reference Method

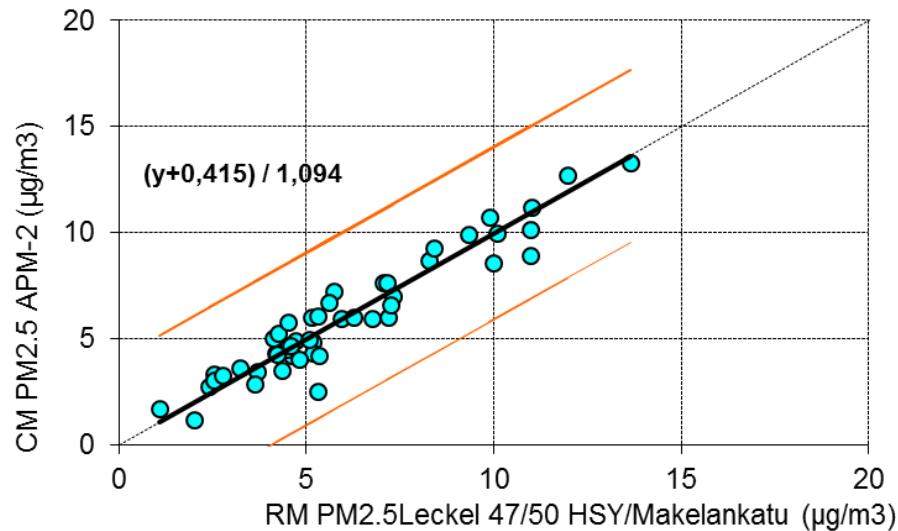




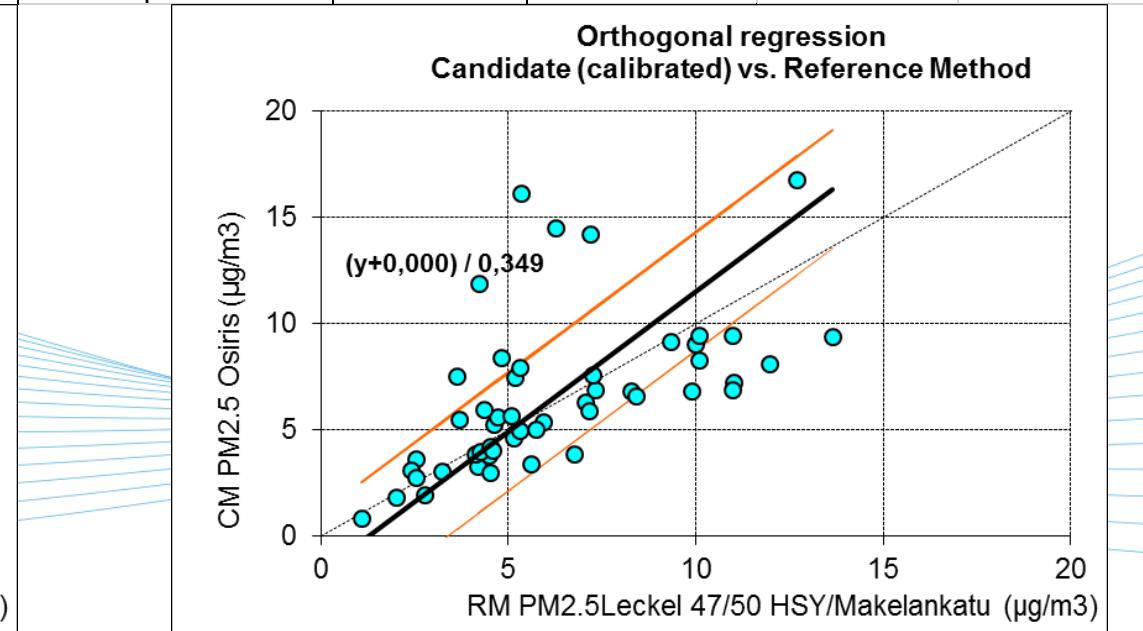
**Orthogonal regression
Candidate (calibrated) vs. Reference Method**



**Orthogonal regression
Candidate (calibrated) vs. Reference Method**

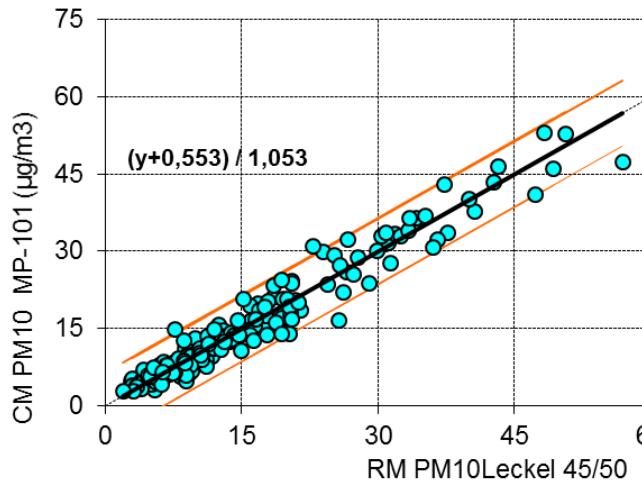


| Ongoing test PM _{2.5} | Criteria | HSY/Mäkelänkatu Grimm 180 calib | HSY/Mäkelänkatu APM-2 raw | HSY/Mäkelänkatu Osiris raw |
|-----------------------------------|--------------------------|---------------------------------|---------------------------|----------------------------|
| Concentration range | $\mu\text{g}/\text{m}^3$ | 0 - 20 | 0 - 90 | 0 - 90 |
| Raw data | | | | |
| Slope | significant (Yes/No) | 0,7555 | 1,0945 | 0,2616 |
| Intercept | significant (Yes/No) | 0,1129 | -0,4149 | 0,6477 |
| Expanded relative uncertainty | $\leq 25\%$ | 48,0 % | 16,80 % | 143,00 % |
| Fail/Pass | $\leq 25\%$ | Fail | Pass | Fail |
| Calibrated data | | | | |
| Calibration: equation | | $1,324y + -0,149$ | $0,914y + 0,379$ | $3,822y + -2,476$ |
| Expanded relative uncertainty | $\leq 25\%$ | 7,4% | 10,50 % | 177,70 % |
| Fail/Pass | $\leq 25\%$ | Pass | Pass | Fail |
| Calibration: slope through origin | | $1,298y$ | $0,964y$ | $2,867y$ |
| Expanded relative uncertainty | $\leq 25\%$ | 4,4% | 11 % | 58 % |
| Fail/Pass | $\leq 25\%$ | Pass | Pass | Fail |
| Calibration equation | | $0,855y + 2,139$ | | |



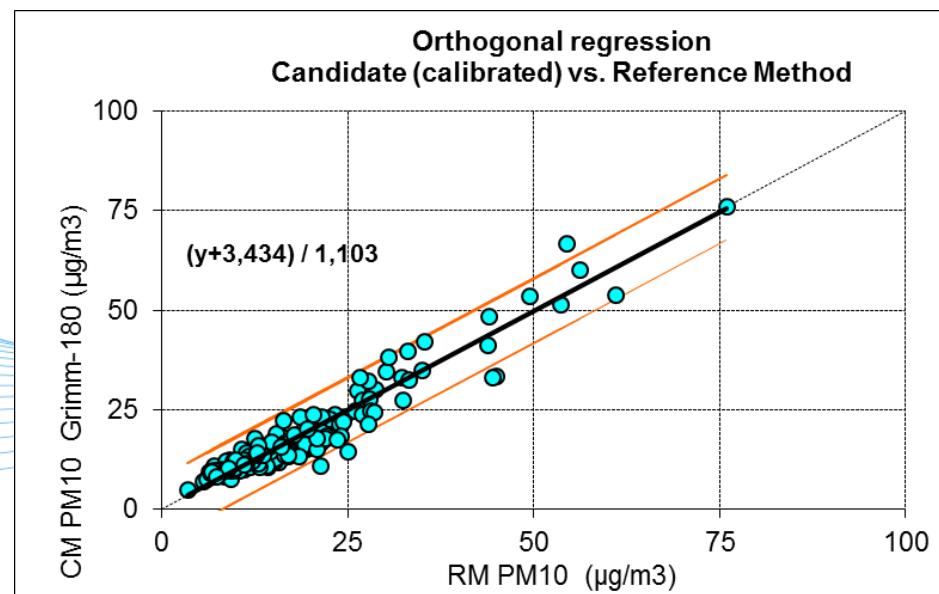
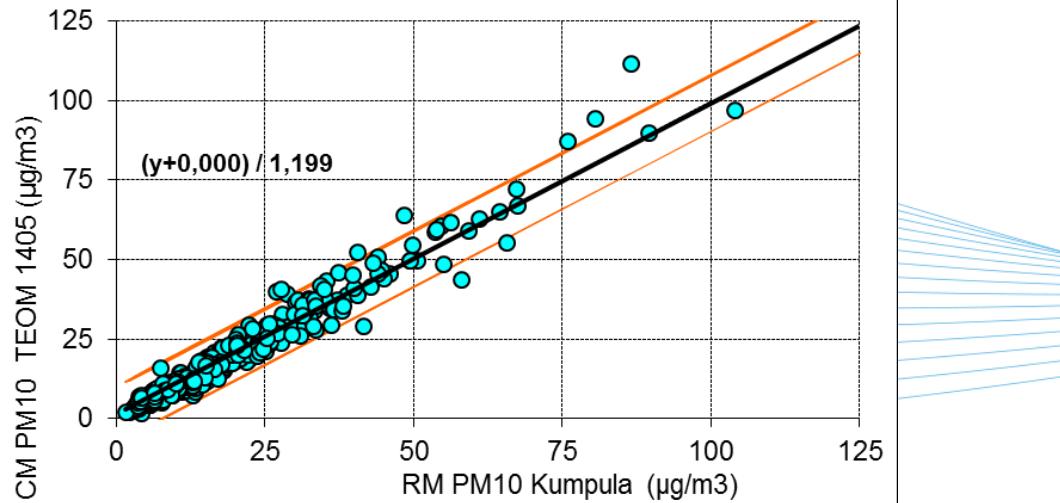


**Orthogonal regression
Candidate (calibrated) vs. Reference**



| Ongoing test PM ₁₀ | Criteria | Turku-Vaasa-Kuopio MP-101 calib | HSY/Make-HSY/Kal Kuopio-TEOM 1405 raw raw | Helsinki/Kumpula TEOM 1400 raw | Turku-HSY/Makel Grimm 180 calib |
|-----------------------------------|--------------------------|------------------------------------|---|-----------------------------------|------------------------------------|
| Concentration range | $\mu\text{g}/\text{m}^3$ | 0 - 75 | 0 - 75 | 0 - 75 | 0 - 75 |
| Raw data | | | | | |
| Slope | significant (Yes/No) | 1,0663 | 1,1740 | 0,9216 | 1,1026 |
| Intercept | significant (Yes/No) | -0,9594 | 1,4798 | 1,8063 | -3,4341 |
| Expanded relative uncertainty | $\leq 25\%$ | 14,5 % | 43,5 % | 10,3 % | 14,9 % |
| Fail/Pass | $\leq 25\%$ | Pass | Fail | Pass | Pass |
| Calibrated data | | | | | |
| Calibration: equation | | $0,938y + 0,9$ | $0,852y + -1,261$ | $1,085y + -1,96$ | $0,907y + 3,114$ |
| Expanded relative uncertainty | $\leq 25\%$ | 11,0 % | 13,1 % | 10,3 % | 12,9 % |
| Fail/Pass | $\leq 25\%$ | Pass | Pass | Pass | Pass |
| Calibration: slope through origin | | $0,977y$ | $0,834y$ | $0,943y$ | $1,045y$ |
| Expanded relative uncertainty | $\leq 25\%$ | 11,8 % | 12,8 % | 10,8 % | 21,7 % |
| Fail/Pass | $\leq 25\%$ | Pass | Pass | Pass | Pass |
| Calibration equation | | 0.91y | | | $0.747y + 0.532$ |

**Orthogonal regression
Candidate (calibrated) vs. Reference Method**





ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Hiukkasmittalaitteiden ekvivalenttisuuden osoitus ja kalibrointikertoimet

DEMONSTRATION OF THE EQUIVA-
LENCE OF PM_{2.5} AND PM₁₀ MEASUREMENT
METHODS IN KUOPIO 2014-2015

JARI WALDÉN
TUOMAS WALDÉN
SISKO LAURILA
HANNELE HAKOLA



WWW.FMI.FI

Täyttää
Vna 79/2017, §12, vaatimukset



| PM10 PM-analysaattori | < 325 µg/m ³ | | < 325 µg/m ³ | |
|------------------------------|------------------------------------|--|--|---|
| | Kalibrointiyhtälö PM ₁₀ | Suhteellinen laajennettu mittausepävarmuus U(%) | Kalibrointiyhtälö pakotettu 0-kautta PM10 | Suhteellinen laajennettu mittausepävar muus U(%) |
| BAM 1020 | 0,942y + 0,437 | 12,6% | 0,947y | 12,6% |
| GRIMM 180 | 0,855y + 2,139 | 17,0 % | 0,908y | 18,0 % |
| SHARP 5030 C-dust | 1,404y -2,750 | 17,2% | 1,362y | 17,3% |
| SHARP 5030 (beta) | 1,415y -2,233 | 12,8% | 1,380y | 13,0% |
| FH 62 IR | 1,300y -0,904 | 16,5% | 1,288y | 16,4% |
| TEOM 1405 | 0,868y -2,068 | 14,4% | 0,848y | 14,4% |
| MP101M | 0,811y + 2,311 | 11,0% | 0,830y | 12,1% |
| OSIRIS | 1,401y -0,153 | 15,7% | 1,398y | 15,7% |
| Dusttrak | 7,478y -76,819 | 402,3% | - | - |
| PM10 PM-analysaattori | < 100 µg/m ³ | | < 100 µg/m ³ | |
| | Kalibrointiyhtälö PM10 | Suhteellinen laajennettu mittausepävarmuus U(%) | Kalibrointiyhtälö pakotettu 0-kautta PM10 | Suhteellinen laajennettu mittausepävar muus U(%) |
| BAM 1020 | 0,858y + 1,919 | 10,3% | 0,913y | 11,7% |
| GRIMM 180 | 0,871y + 1,927 | 17,0 % | 0,922y | 17,9 % |
| SHARP 5030 C-dust | 1,486y -3,904 | 16,5% | 1,319y | 16,3% |
| SHARP 5030 (beta) | 1,489y -3,301 | 12,5% | 1,351y | 12,5% |
| FH 62 IR | 1,372y -1,850 | 17,1% | 1,297y | 12,6% |
| TEOM 1405 | 0,804y -0,623 | 13,6% | 0,788y | 13,0% |
| MP101M | 0,887y + 0,826 | 9,4% | 0,910y | 9,6% |
| OSIRIS | 1,338y + 0,57 | 15,3% | 1,363y | 15,7% |
| Dusttrak | 5,761y -55,073 | 1132,0% | 2,07y | 94,0% |

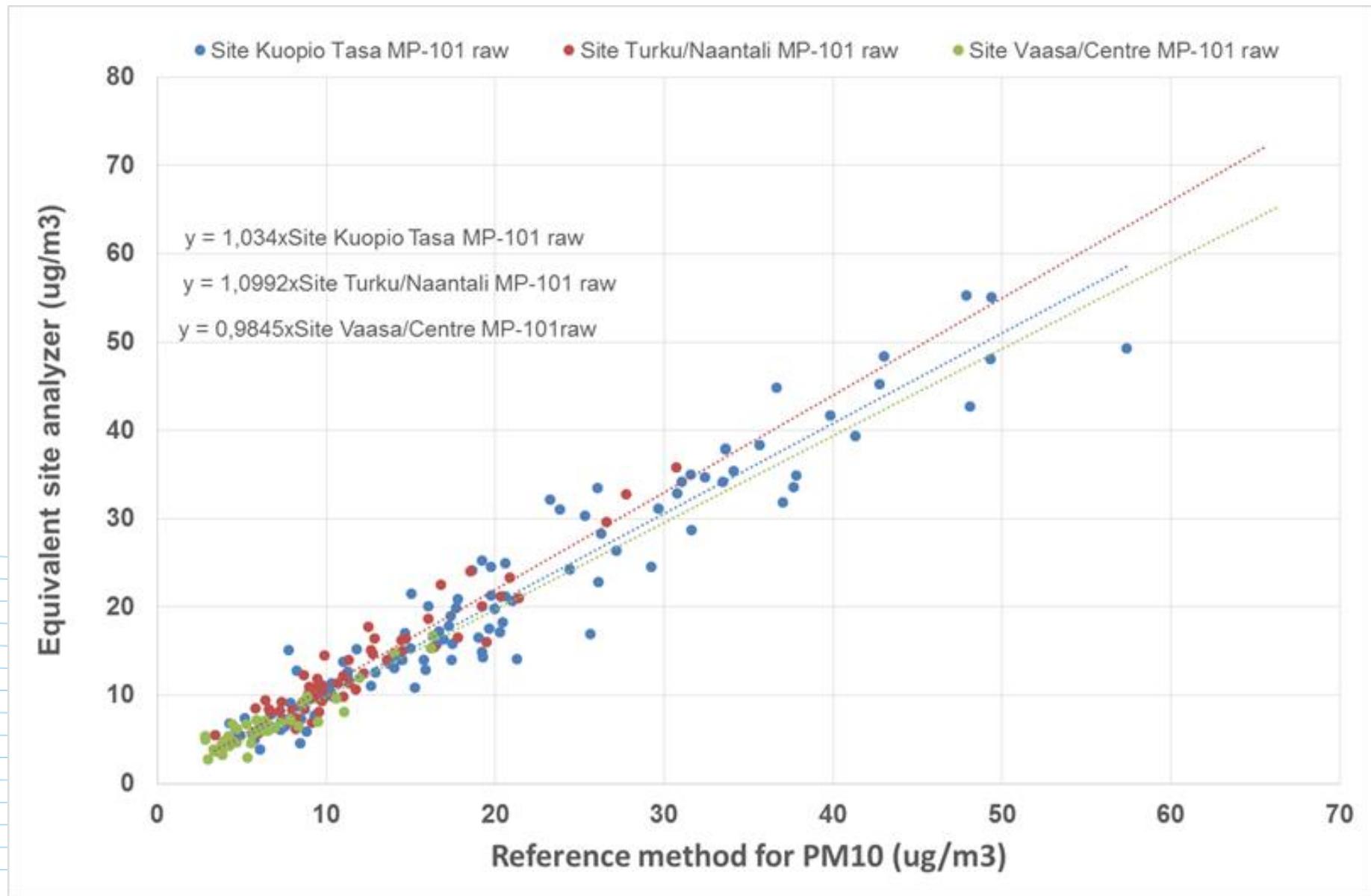


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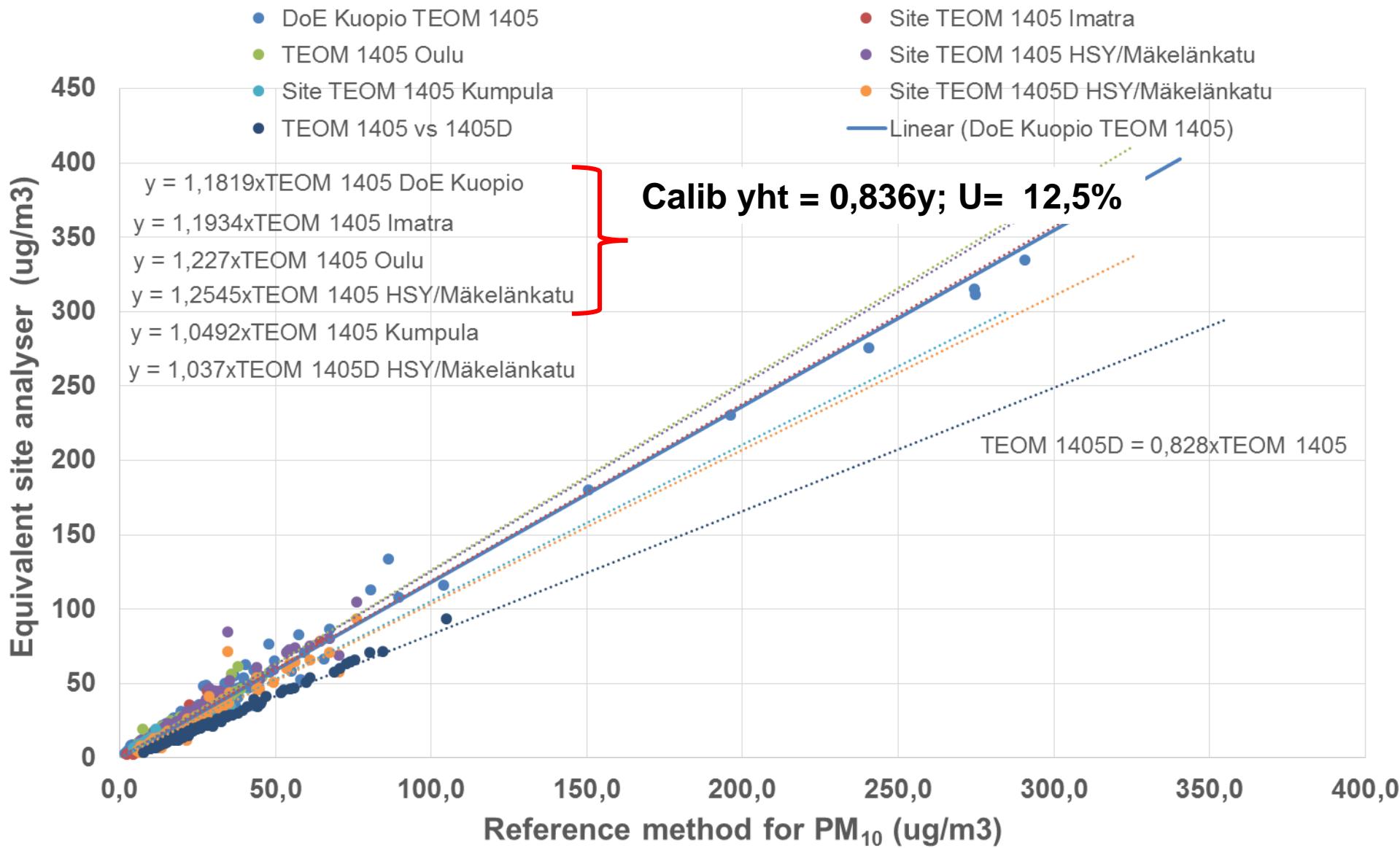
| PM10 | < 50 µg/m3 | | < 50 µg/m3 | |
|-------------------|------------------------|---|---|---|
| | Kalibrointiyhtälö PM10 | Suhteellinen laajennettu mittausepävarmuus U(%) | Kalibrointiyhtälö pakotettu 0-kautta PM10 | Suhteellinen laajennettu mittausepävarmuus U(%) |
| BAM 1020 | 0,844y + 2,072 | 9,5% | 0,921y | 13,3% |
| GRIMM 180 | 0,92y + 1,251 | 11,2 % | 0,975y | 13,0 % |
| SHARP 5030 C-dust | 1,375y -2,564 | 14,2% | 1,242y | 15,2% |
| SHARP 5030 (beta) | 1,421y -2,530 | 9,3% | 1,278y | 11,8% |
| FH 62 IR | 1,311y -1,193 | 16,2% | 1,247y | 15,2% |
| TEOM 1405 | 0,771y -0,149 | 10,6% | 0,766y | 9,9% |
| MP101M | 0,938y + 0,001 | 8,8% | 0,938y | 8,4% |
| OSIRIS | 1,290y + 0,886 | 13,6% | 1,343y | 15,4% |
| Dusttrak | | | | |

| PM2.5 | < 25 µg/m3 | | < 25 µg/m3 | |
|-------------------|-------------------------------------|---|--|---|
| | Kalibrointiyhtälö PM _{2.5} | Suhteellinen laajennettu mittausepävarmuus U(%) | Kalibrointiyhtälö pakotettu 0-kautta PM2.5 | Suhteellinen laajennettu mittausepävarmuus U(%) |
| BAM 1020 | 1,100y + 0,733 | 7,4% | 1,215y | 19,9% |
| GRIMM 180 (*) | 0,747y + 0,532 | 12,6 % | 0,780y | 12,3 % |
| SHARP 5030 C-dust | 0,854y + 1,187 | 7,3% | 0,998y | 24,9% |
| SHARP 5030 (beta) | 0,971y -0,003 | 0,2% | 0,971y | 0,2% |
| FH 62 IR | 0,850y + 1,709 | 17,3% | 1,097y | 51,8% |
| TEOM 1405 | 1,009y -1,681 | 8,8% | 0,821y | 31,4% |
| MP101M | 0,812y -0,306 | 8,9% | 0,780y | 31,4% |
| OSIRIS (*) | 3,324y -1,073 | 124,2% | 2,020y | 76,1% |
| Dusttrak (*) | 0,602y -1,002 | 37,9% | 0,550y | 143,9% |

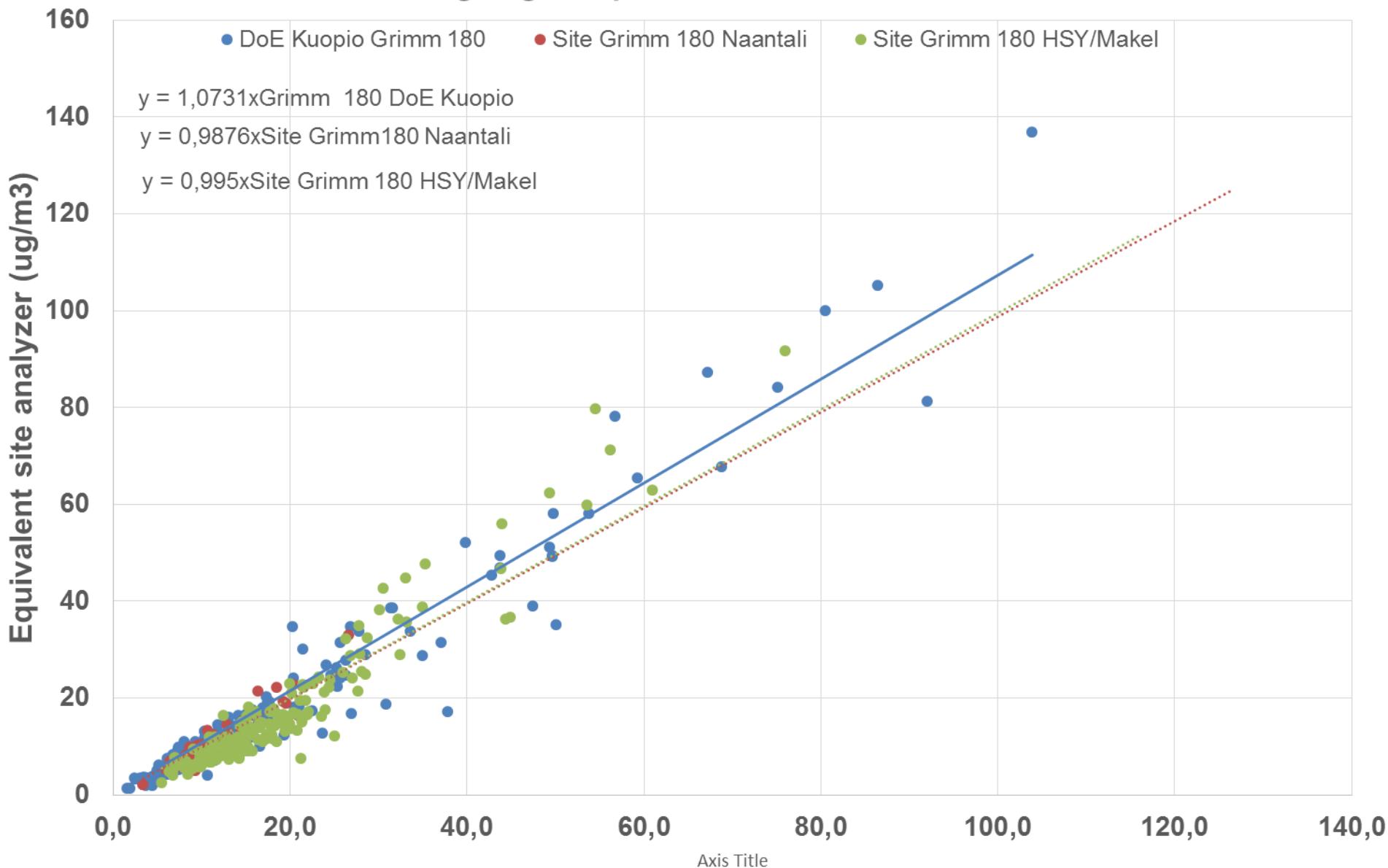
(*Mittausalue < 75 µg/m3)



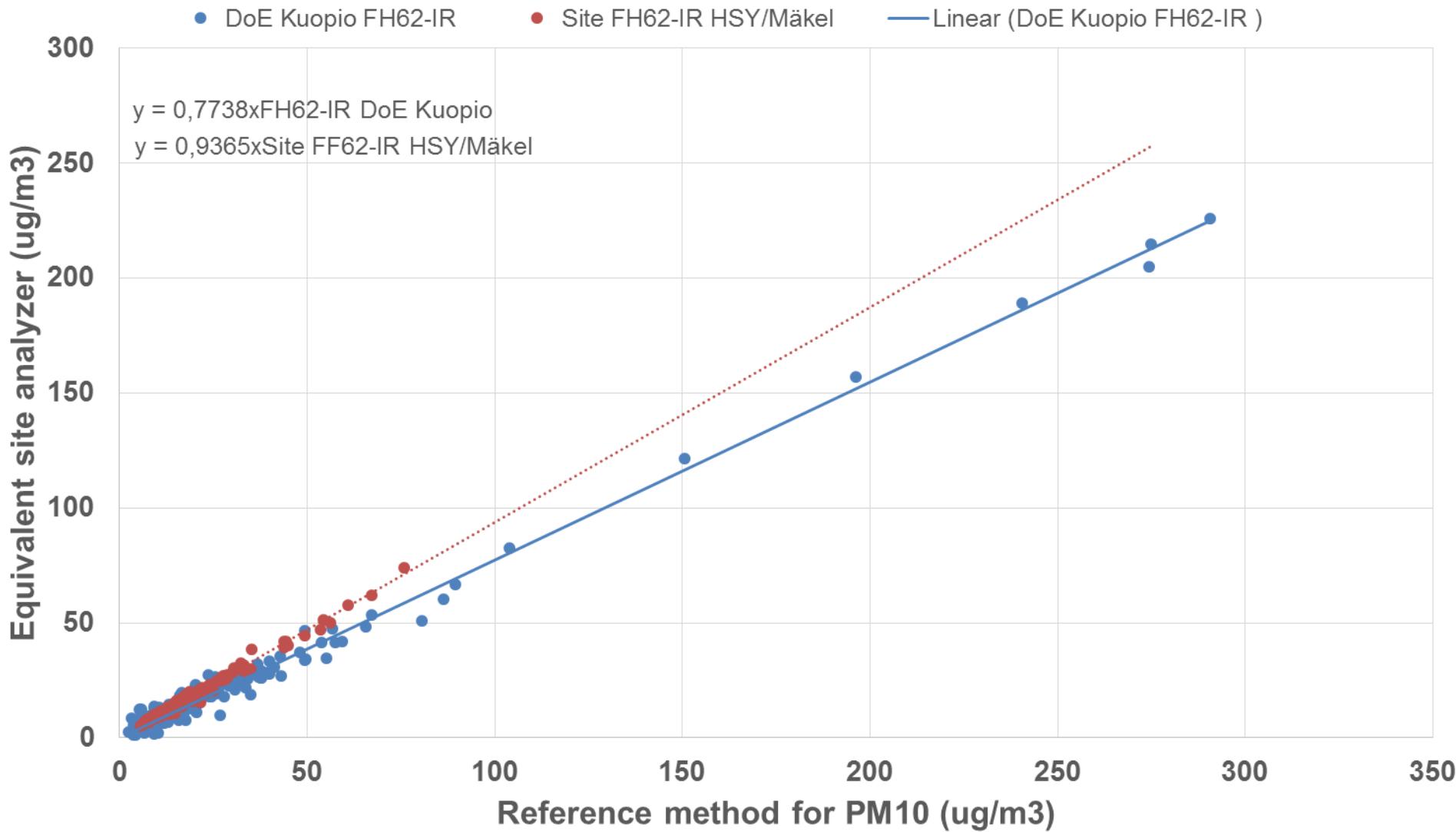
Ongoing comparison TEOM 1405 raw



Ongoing comparison Grimm 180 raw



Ongoing comparison FH62-IR raw



Yhteenveto hiukkasmittalaitteiden kalibrointikertoimet: **KÄYTTÄKÄÄ ALLAOLEVIA KERTOIMIA!**

| Ekvivalentti PM-analysaattori | PM10 | U(%) | PM2.5 | U(%) |
|-------------------------------|-------|-------|----------------|-------|
| BAM 1020 | 0,947 | 12,6% | 1,100y + 0,733 | 7,4% |
| GRIMM 180 | 0,975 | 13,0% | 0,780 | 12,3% |
| SHARP 5030 C-dust | 1,242 | 15,2% | 0,998 | 24,9% |
| SHARP 5030 (beta) | 1,278 | 11,8% | 0,971 | 0,2% |
| FH 62 IR | 1,247 | 15,2% | 0,850y + 1,709 | 17,3% |
| TEOM 1405 | 0,848 | 14,4% | 1,009y - 1,681 | 8,8 % |
| MP101M | 0,938 | 8,4% | 0,812y - 0,306 | 8,9% |
| OSIRIS | 1,343 | 15,4% | | |



Kiitokset

- YM rahoitus
- Yhteistyöstä ja avusta osallistuneet mittausverkot
- Ville Vieno, amk insinööri filtterien punnitus



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