2005 Update: Delaware's Experience with a Continuous PM2.5 Monitor: The Andersen BAM

In Search of FRM-Like Data – The search goes on . . .

Betsy Frey, Delaware Air Quality Mgmt

MARAMA Monitoring Meeting

November 16, 2005

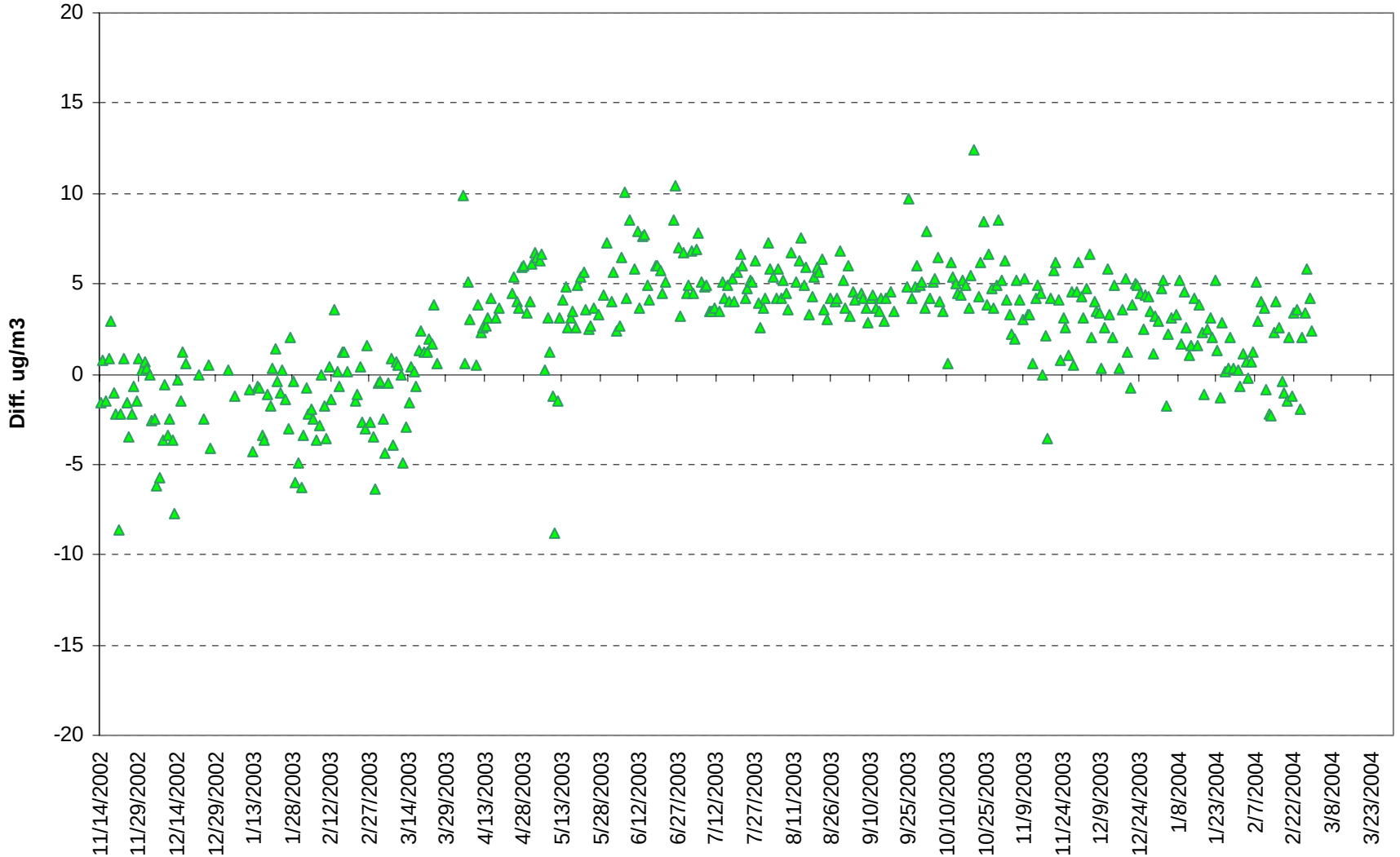
Andersen Series FH62 C14 Continuous Ambient Particulate Monitor, aka BAM

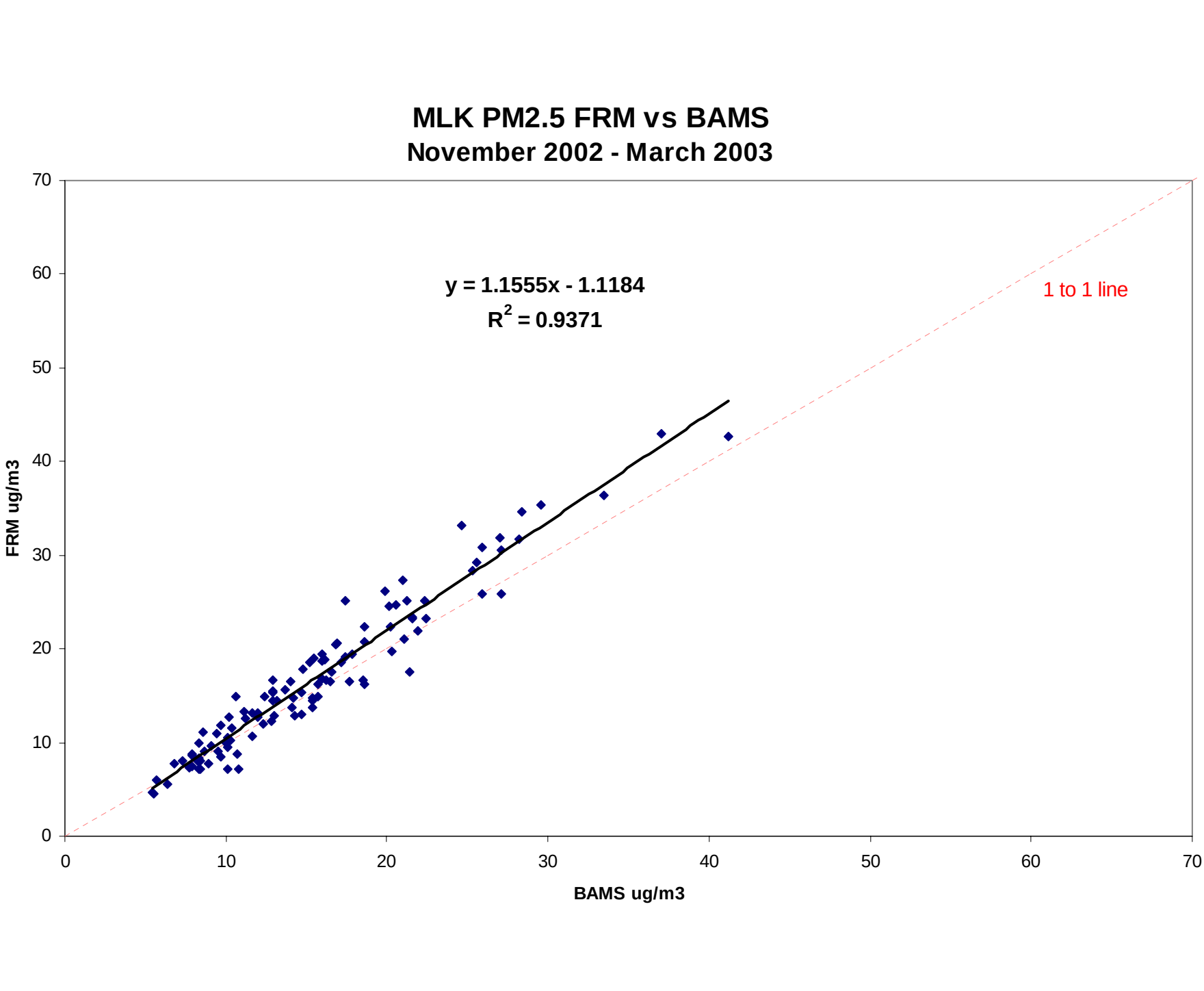
- Beta Attenuation Monitor
- Configuration:
  - SSC PM2.5 inlet
  - 35° C temp
  - No correction factor

BAM at two sites

- MLK site began November 2002
  - Collocated with:
    - two FRMS (daily and 1-in-6 days)
    - TEOM PM10 (converted back from PM2.5)
  - Located on top of shelter platform
- Killens Pond site began April 2003
  - Collocated with one 1-in-3 day FRM
  - Inlet on top, sampler inside station shelter

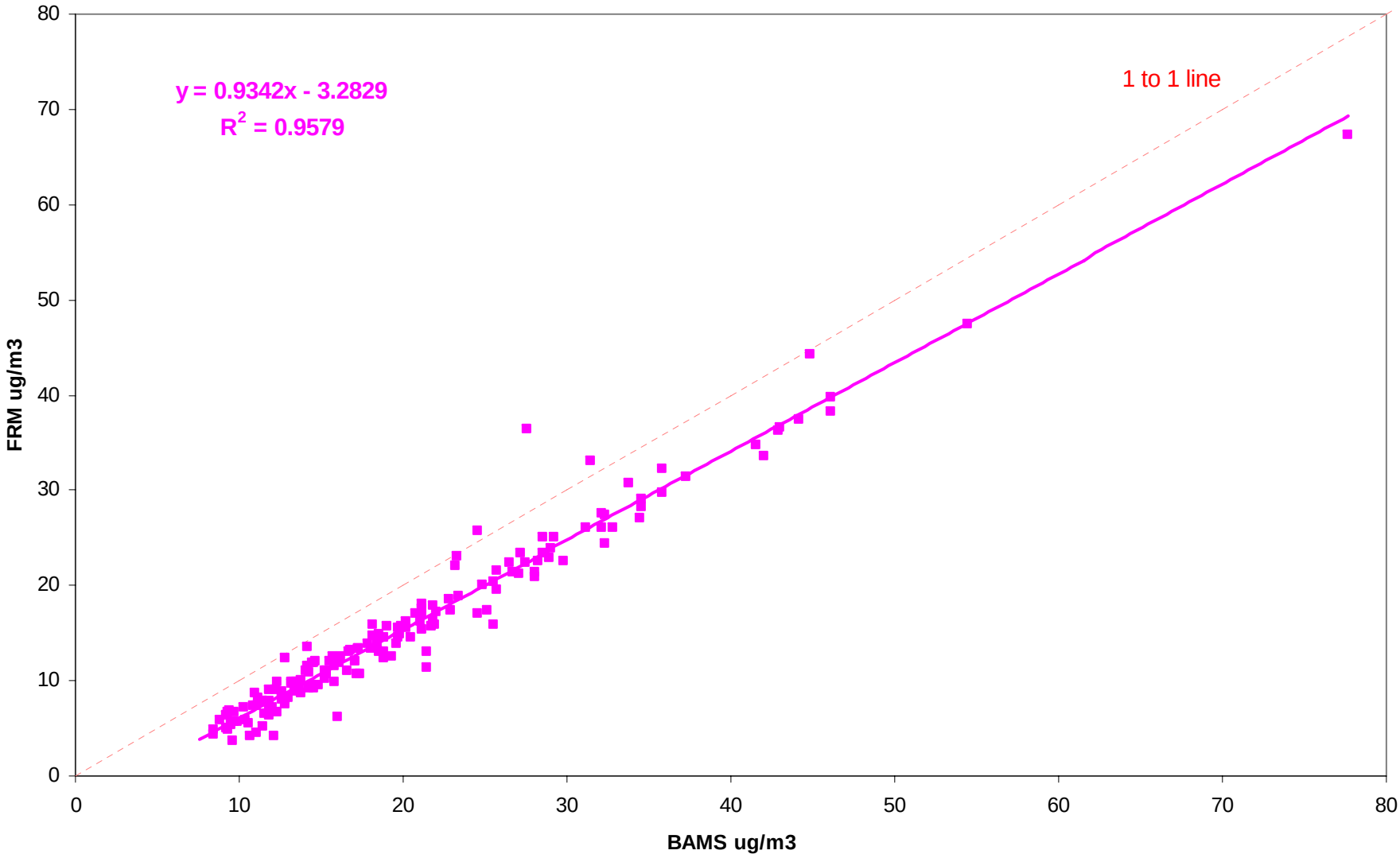
MLK Difference in ug BAMS - FRM




MLK PM2.5 FRM vs BAMS
November 2002 - March 2003
y = 1.1555x - 1.1184
R2 = 0.9371
1 to 1 line
FRM ug/m3
BAMS ug/m3
0
10
20
30
40
50
60
70

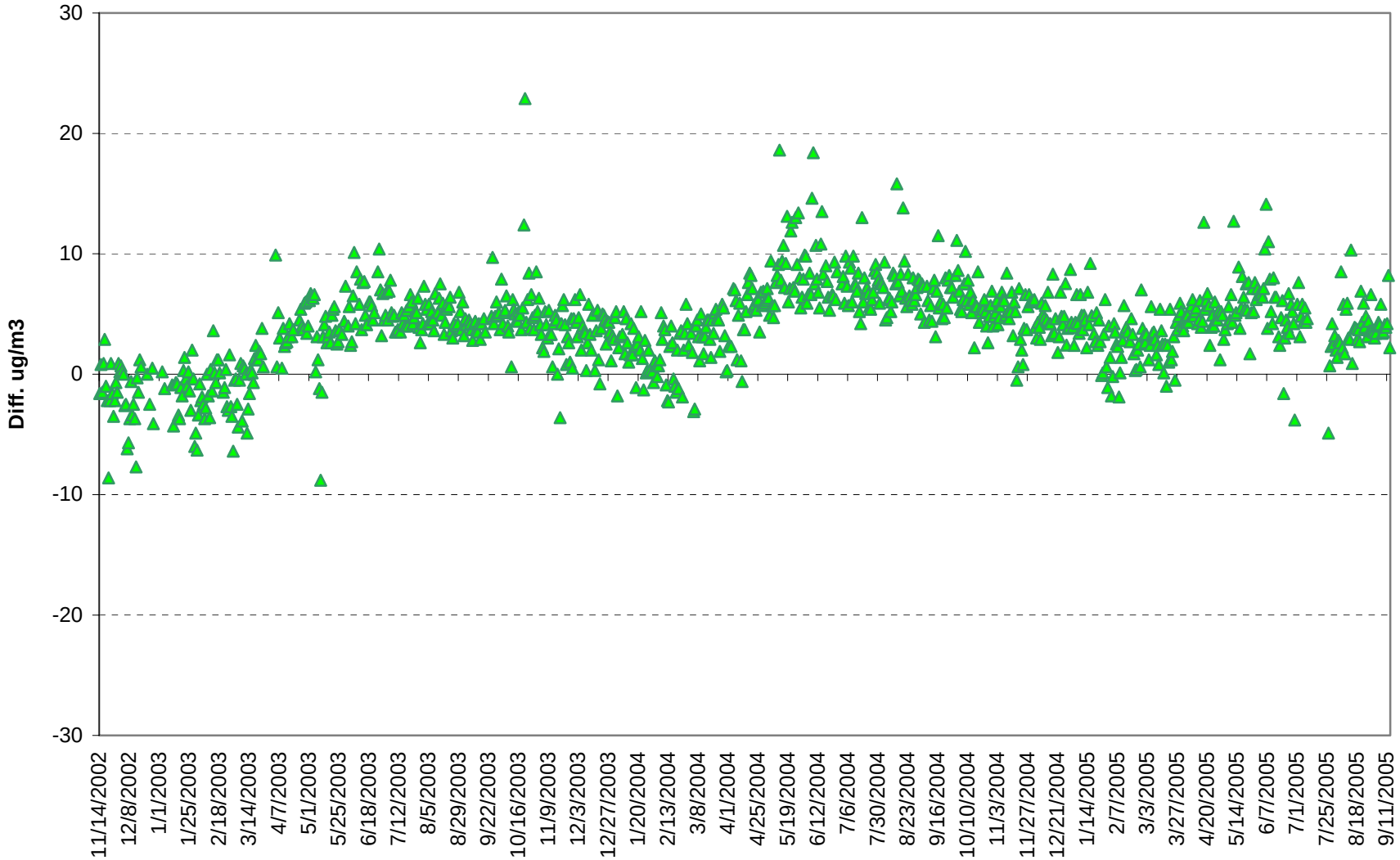
MLK PM2.5 FRM vs BAMS

April 1, 2003 - October 15, 2003



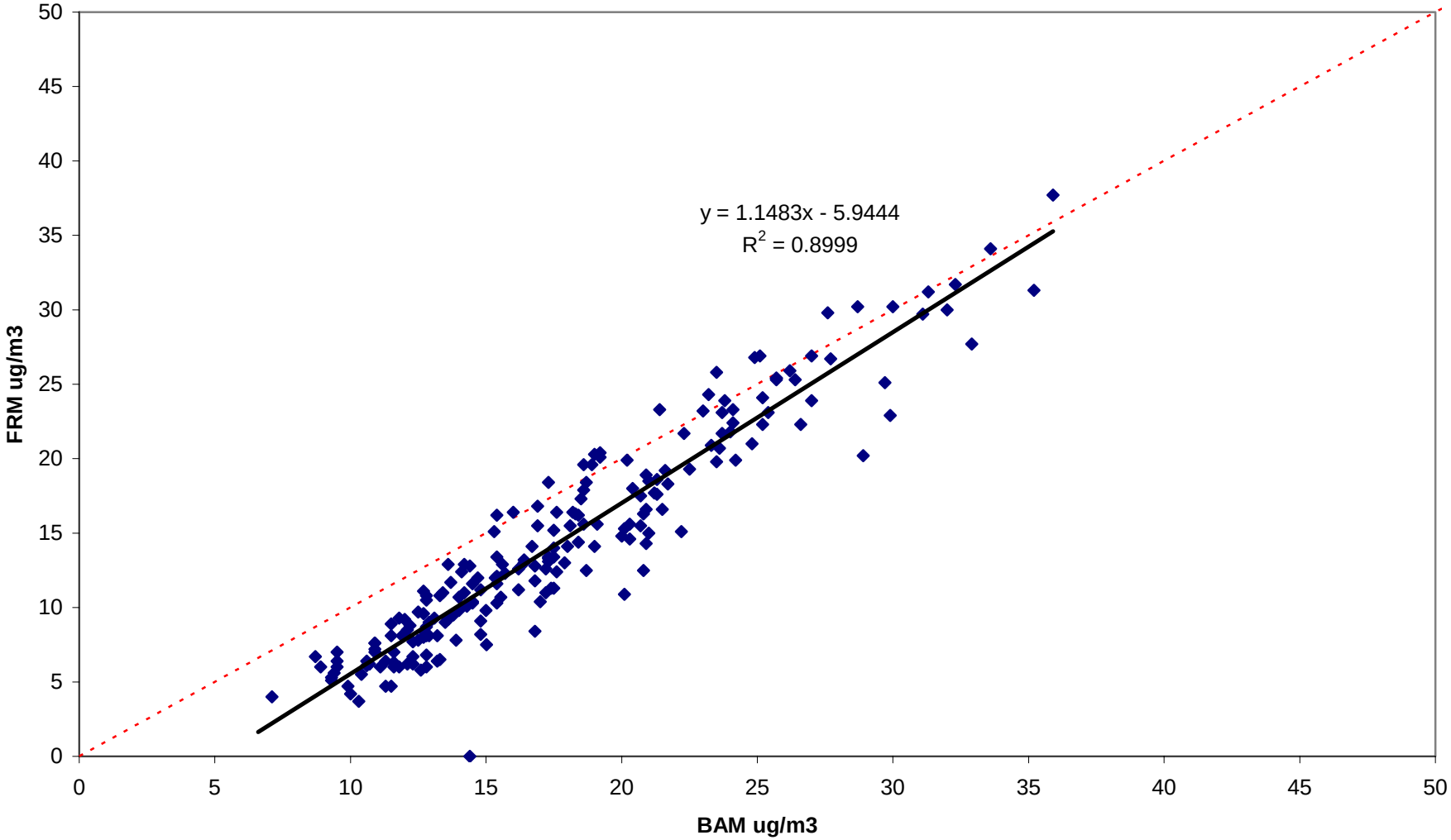
BAM Since 2003

- Continued operation at MLK, Killens
- Added Newark, Seaford
- Tried to add collocated BAM at MLK
  - Never stabilized
  - Returned to Thermo for repair or replacement
- Modified procedures for audit and operator checks


MLK Difference in ug BAMS - FRM
Nov. 2002 through September 2005
Diff. ug/m3
30
20
10
0
-10
-20
-30
11/14/2002
12/8/2002
1/1/2003
1/25/2003
2/18/2003
3/14/2003
4/7/2003
5/1/2003
5/25/2003
6/18/2003
7/12/2003
8/5/2003
8/29/2003
9/22/2003
10/16/2003
11/9/2003
12/3/2003
12/27/2003
1/20/2004
2/13/2004
3/8/2004
4/1/2004
4/25/2004
5/19/2004
6/12/2004
7/6/2004
7/30/2004
8/23/2004
9/16/2004
10/10/2004
11/3/2004
11/27/2004
12/21/2004
1/14/2005
2/7/2005
3/3/2005
3/27/2005
4/20/2005
5/14/2005
6/7/2005
7/1/2005
7/25/2005
8/18/2005
9/11/2005

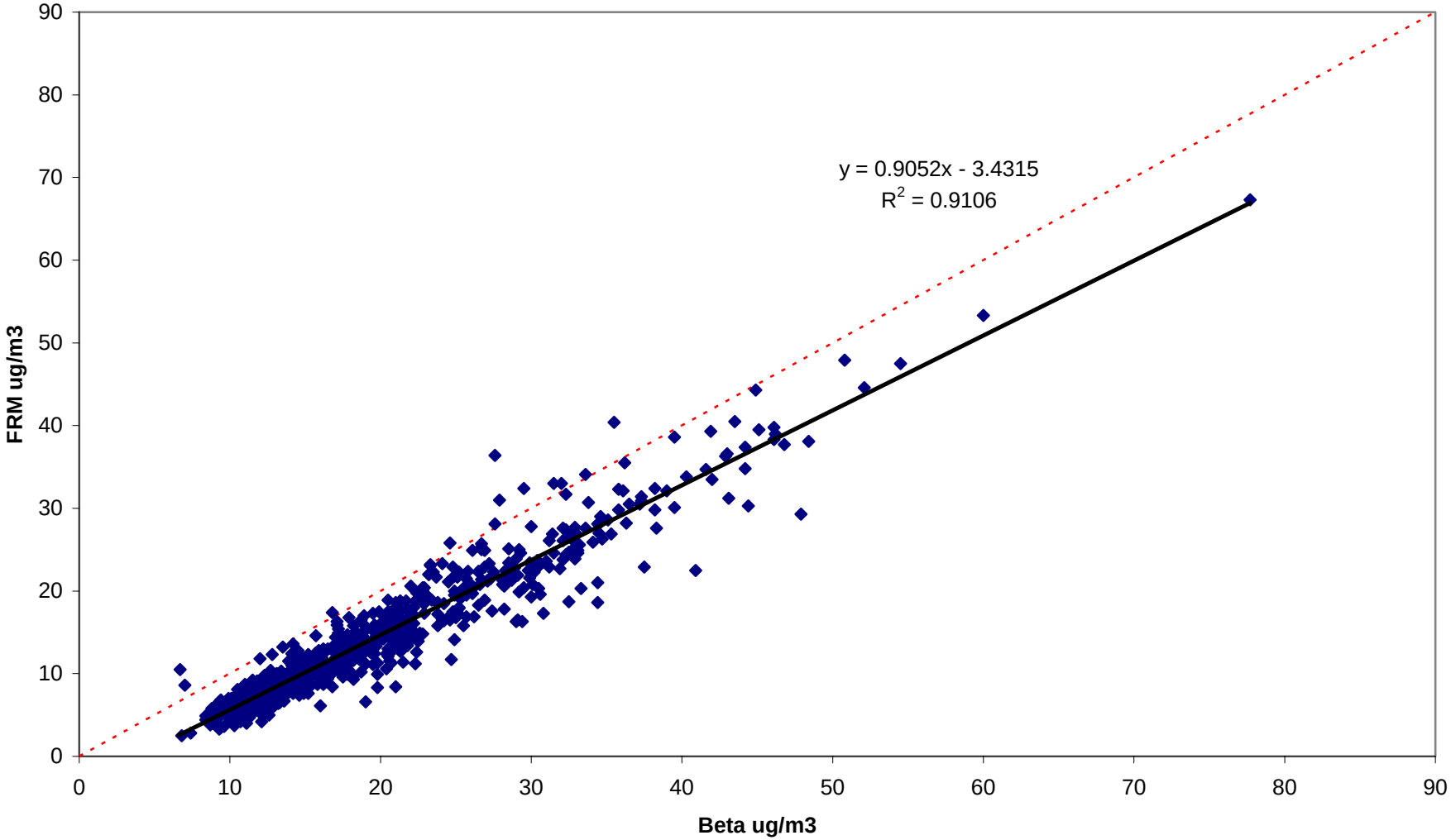
MLK PM2.5 Winter FRM vs BAM

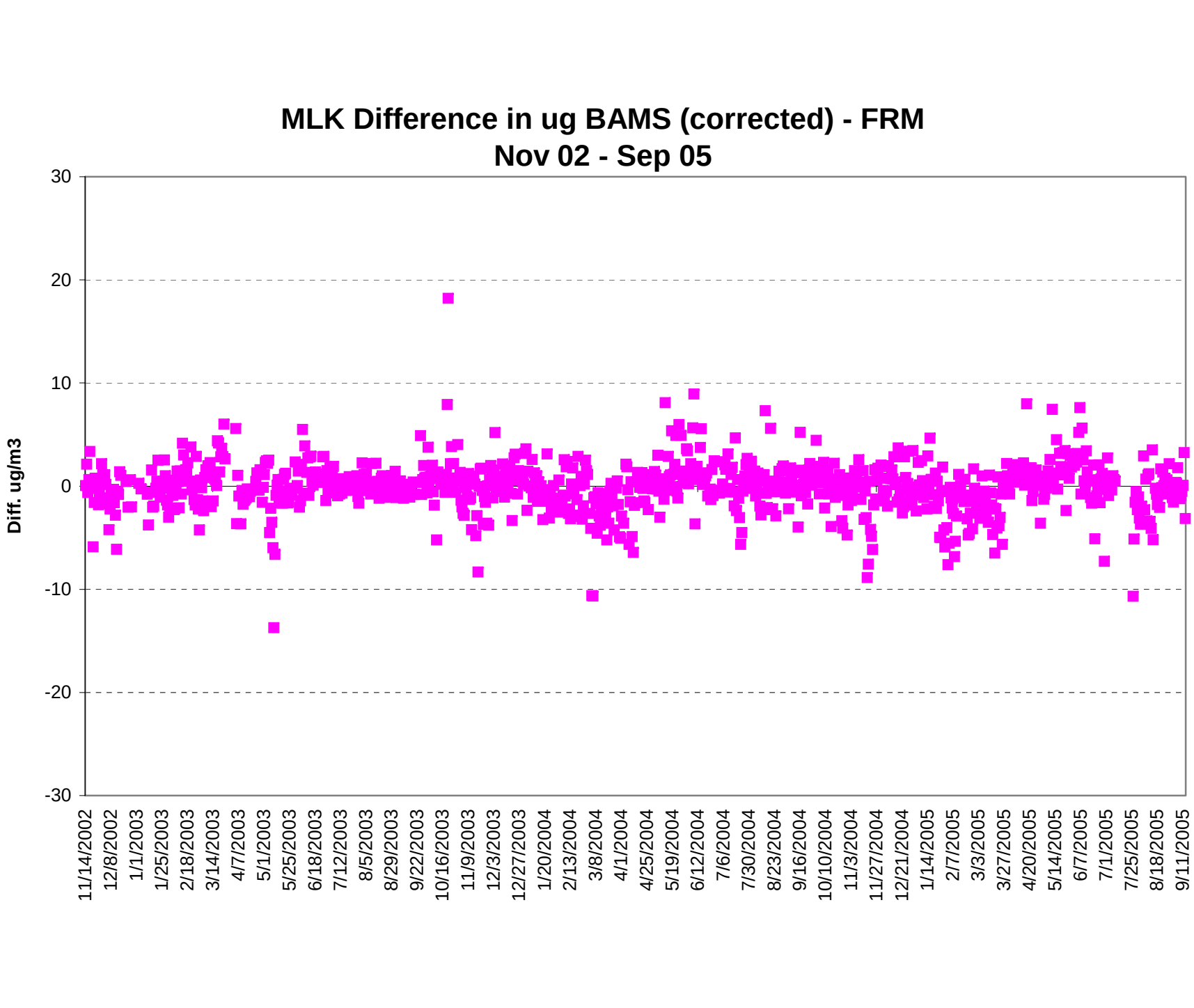
Dec. 03 - Feb 04, Nov 04 - Feb 05



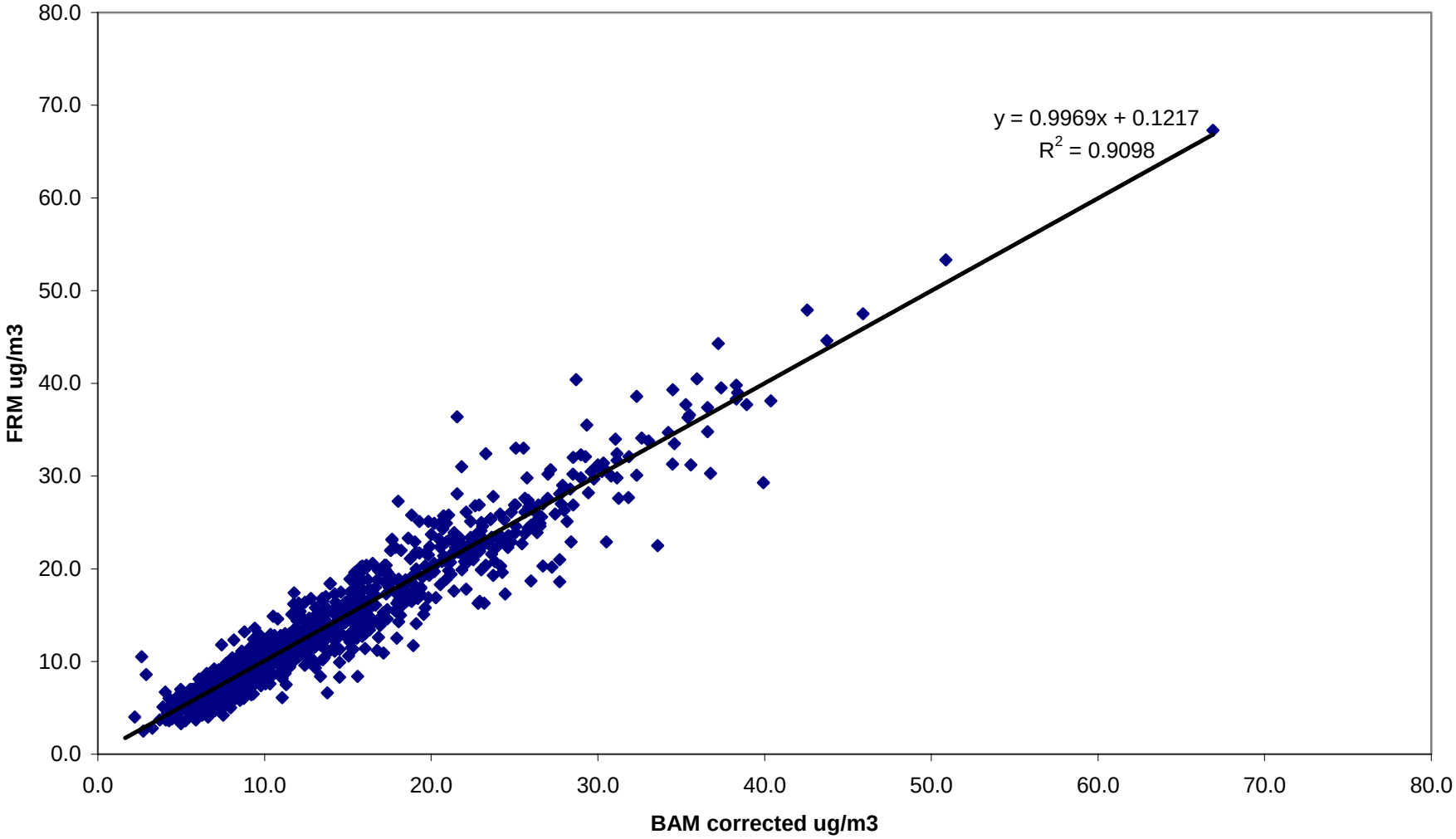
MLK PM2.5 FRM vs BAM

Mar - Oct 03, Mar - Nov 04, Mar - Oct 05




MLK Difference in ug BAMS (corrected) - FRM
Nov 02 - Sep 05
Diff. ug/m3
30
20
10
0
-10
-20
-30
11/14/2002
12/8/2002
1/1/2003
1/25/2003
2/18/2003
3/14/2003
4/7/2003
5/1/2003
5/25/2003
6/18/2003
7/12/2003
8/5/2003
8/29/2003
9/22/2003
10/16/2003
11/9/2003
12/3/2003
12/27/2003
1/20/2004
2/13/2004
3/8/2004
4/1/2004
4/25/2004
5/19/2004
6/12/2004
7/6/2004
7/30/2004
8/23/2004
9/16/2004
10/10/2004
11/3/2004
11/27/2004
12/21/2004
1/14/2005
2/7/2005
3/3/2005
3/27/2005
4/20/2005
5/14/2005
6/7/2005
7/1/2005
7/25/2005
8/18/2005
9/11/2005

2003 - 2005 MLK FRM vs BAM corrected using multi-year seasonal averages excludes winter 2002



Problem in July 2005

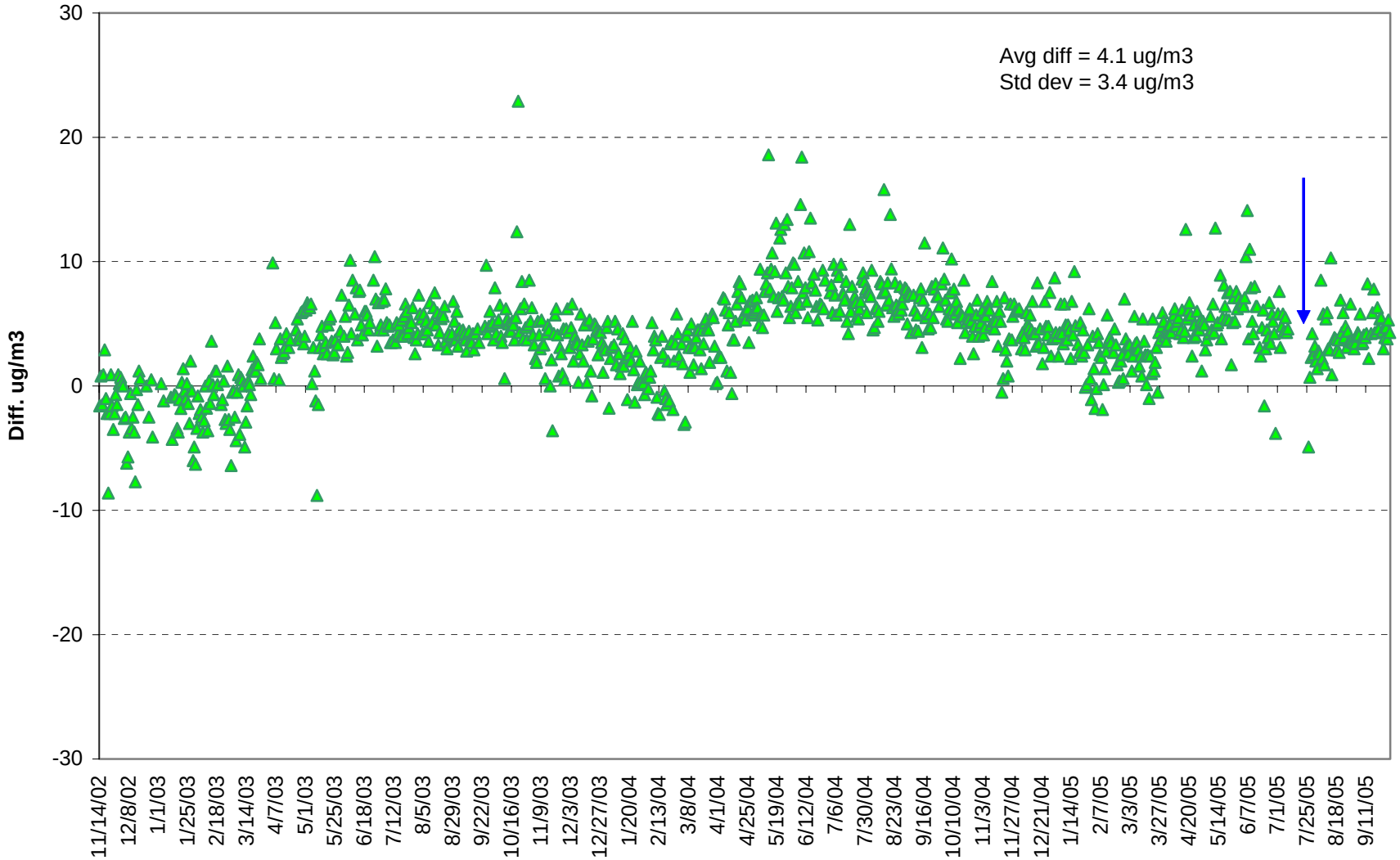
- Very high humidity - BAM spikes/drops, poor correlation with FRM
- Consult with Thermo – Kevin Goohs
- Recommendation – use seasonal heater tube temperature settings
  - Summer – 50 deg C
  - Spring and Fall – 35 deg C
  - Winter – 25 deg C
- These are temps for the inlet tube, not the aerosol

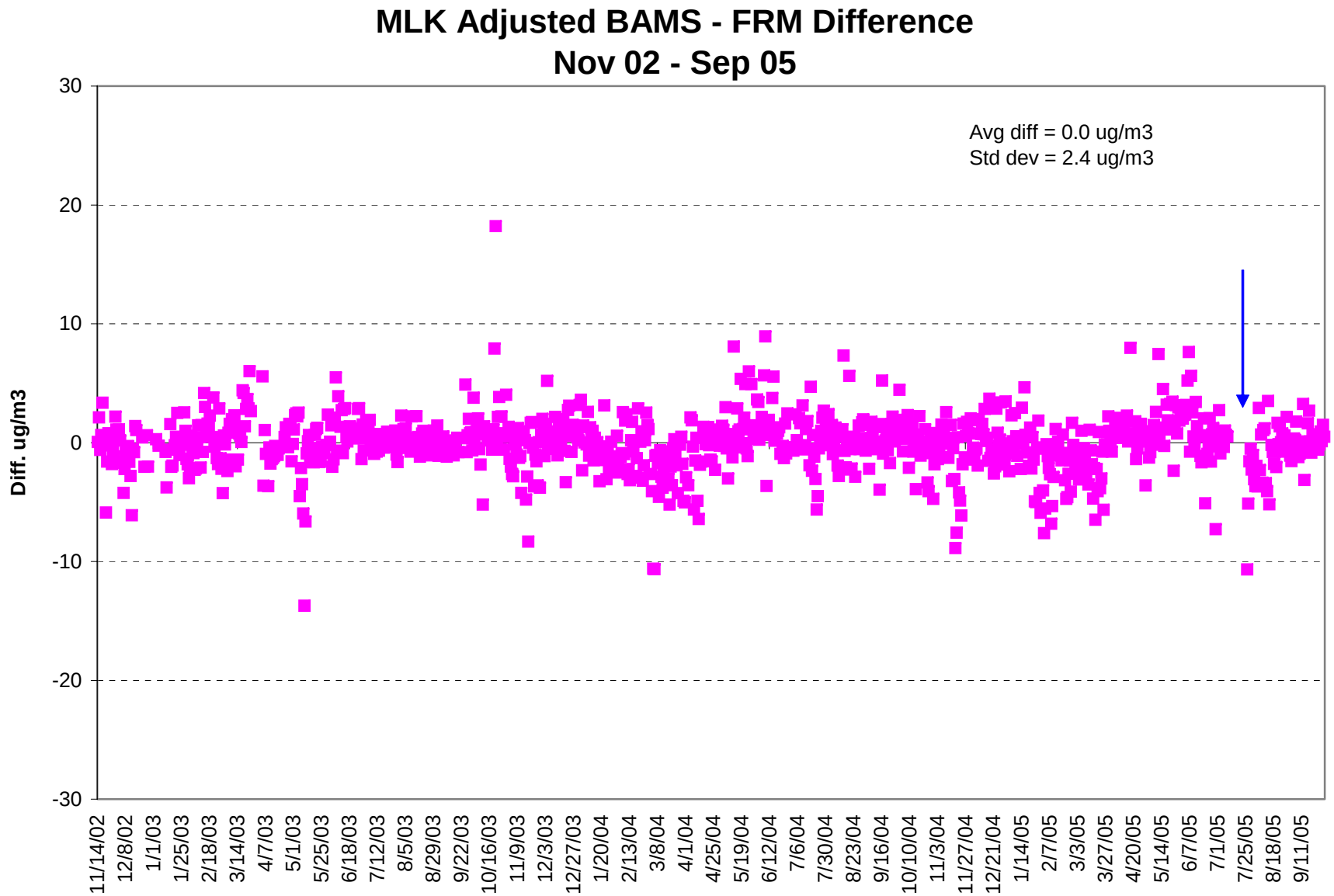
How is it going?

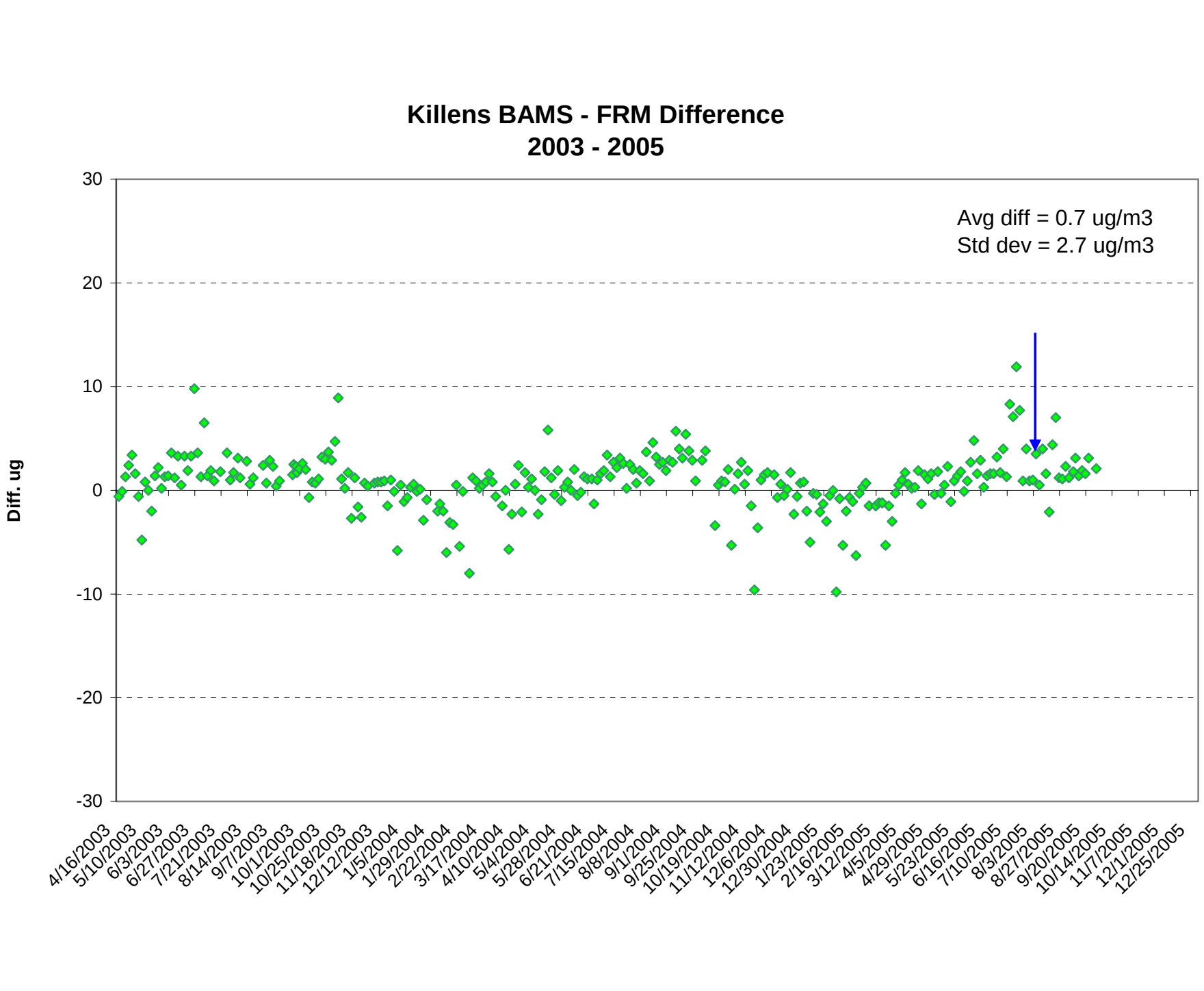
- Made adjustments last week of July 2005
- Improved stability (fewer spikes/drops)
- Slightly improved correlation with FRM
- Will run for one year and re-evaluate

MLK BAMS - FRM Difference

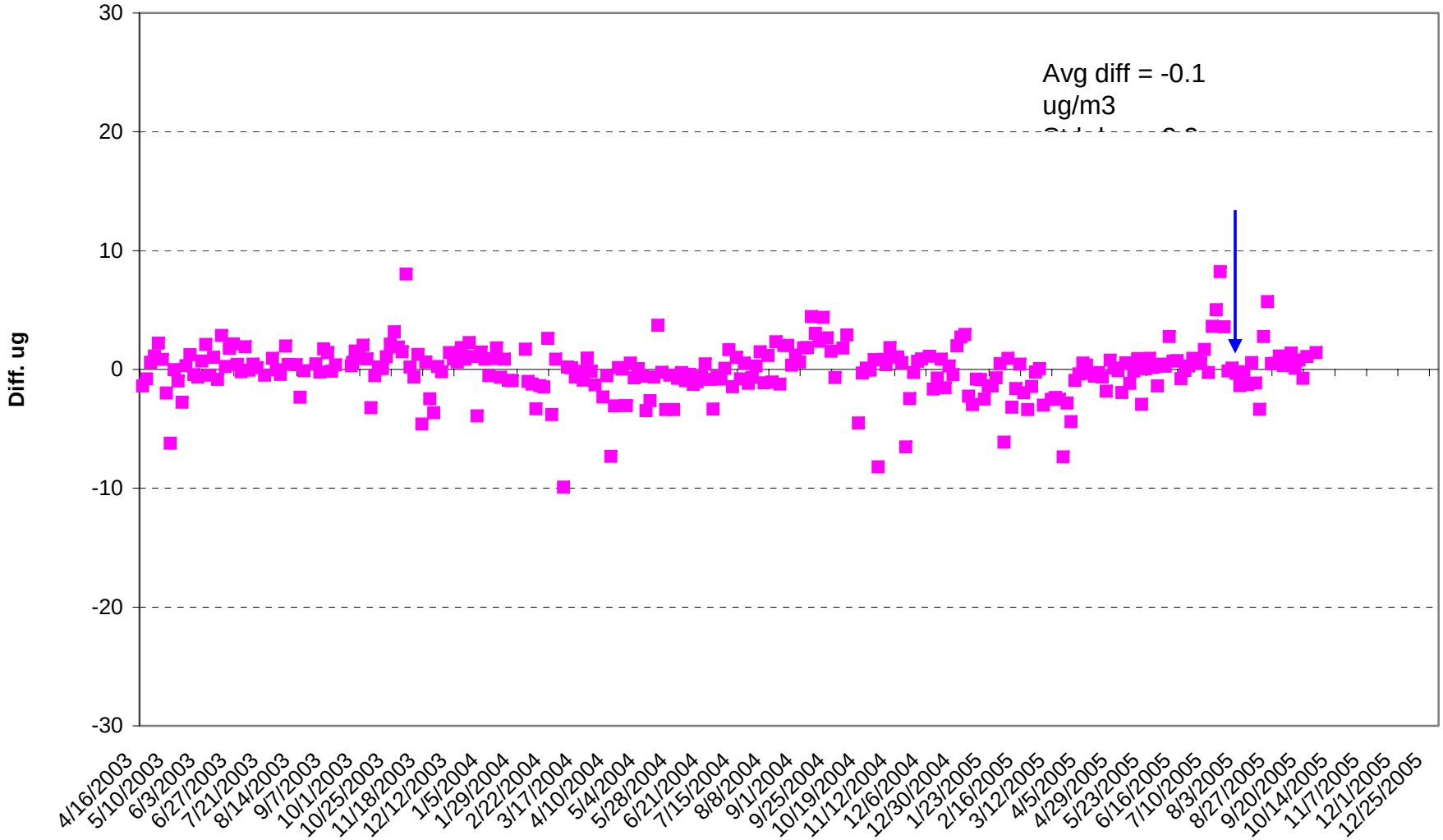
Nov. 2002 through September 2005




MLK Adjusted BAMS - FRM Difference
Nov 02 - Sep 05
Avg diff = 0.0 ug/m3
Std dev = 2.4 ug/m3
Diff. ug/m3
30
20
10
0
-10
-20
-30
11/14/02
12/8/02
1/1/03
1/25/03
2/18/03
3/14/03
4/7/03
5/1/03
5/25/03
6/18/03
7/12/03
8/5/03
8/29/03
9/22/03
10/16/03
11/9/03
12/3/03
12/27/03
1/20/04
2/13/04
3/8/04
4/1/04
4/25/04
5/19/04
6/12/04
7/6/04
7/30/04
8/23/04
9/16/04
10/10/04
11/3/04
11/27/04
12/21/04
1/14/05
2/7/05
3/3/05
3/27/05
4/20/05
5/14/05
6/7/05
7/1/05
7/25/05
8/18/05
9/11/05


Killens BAMS - FRM Difference
2003 - 2005
Avg diff = 0.7 ug/m3
Std dev = 2.7 ug/m3
Diff. ug
30
20
10
0
-10
-20
-30
4/16/2003
5/10/2003
6/3/2003
6/27/2003
7/21/2003
8/14/2003
9/7/2003
10/1/2003
10/25/2003
11/18/2003
12/12/2003
1/5/2004
1/29/2004
2/22/2004
3/17/2004
4/10/2004
5/4/2004
5/28/2004
6/21/2004
7/15/2004
8/8/2004
9/1/2004
9/25/2004
10/19/2004
11/12/2004
12/6/2004
12/30/2004
1/23/2005
2/16/2005
3/12/2005
4/5/2005
4/29/2005
5/23/2005
6/16/2005
7/10/2005
8/3/2005
8/27/2005
9/20/2005
10/14/2005
11/7/2005
12/1/2005
12/25/2005

Killens Adjusted BAMS - FRM Difference
2003 - 2005



Where are we now?

- Is the BAM data similar enough to the FRM data to replace an FRM?

Compare annual average NAAQS

		BAM	FRM	Adj BAM
1Q03		16.2	17.3	17.7
2Q03		18.9	14.6	14.4
3Q03		21.5	16.8	16.8
4Q03		17.4	13.1	13.5
	avg	18.5	15.5	15.6
1Q04		16.9	14.7	13.4
2Q04		22.7	15.5	16.0
3Q04		23.3	16.4	16.5
4Q04		18.2	13.0	12.7
	avg	20.3	14.9	14.6
1Q05		19.0	16.2	14.7
2Q05		18.1	12.5	13.5
3Q05		21.1	17.0	16.5
4Q05				
	avg	19.4	15.2	14.9
3-yr avg		**19.4**	**15.2**	**15.1**

Compare 24-hour NAAQS

	98th Percentiles		
	BAM	FRM	Adj BAM
2003	42.0	37.3	39.0
2004	42.5	33.8	33.2
2005	38.9	38.0	33.1
3-yr avg	**41.1**	**36.3**	**35.1**

Conclusion

- Andersen BAM –
  - Good for diurnal patterns
  - Generally consistent with FRM, especially for longer term averages, *but* not close enough for areas near the NAAQS
- May be affected by high ambient humidity; can compensate with heater tube temperature adjustment
- Current focus – precision (collocated BAM) and seasonal temperature adjustments

The Night Before Thanksgiving