# Motion Analysis of the 2009 Men's 100 m World Record
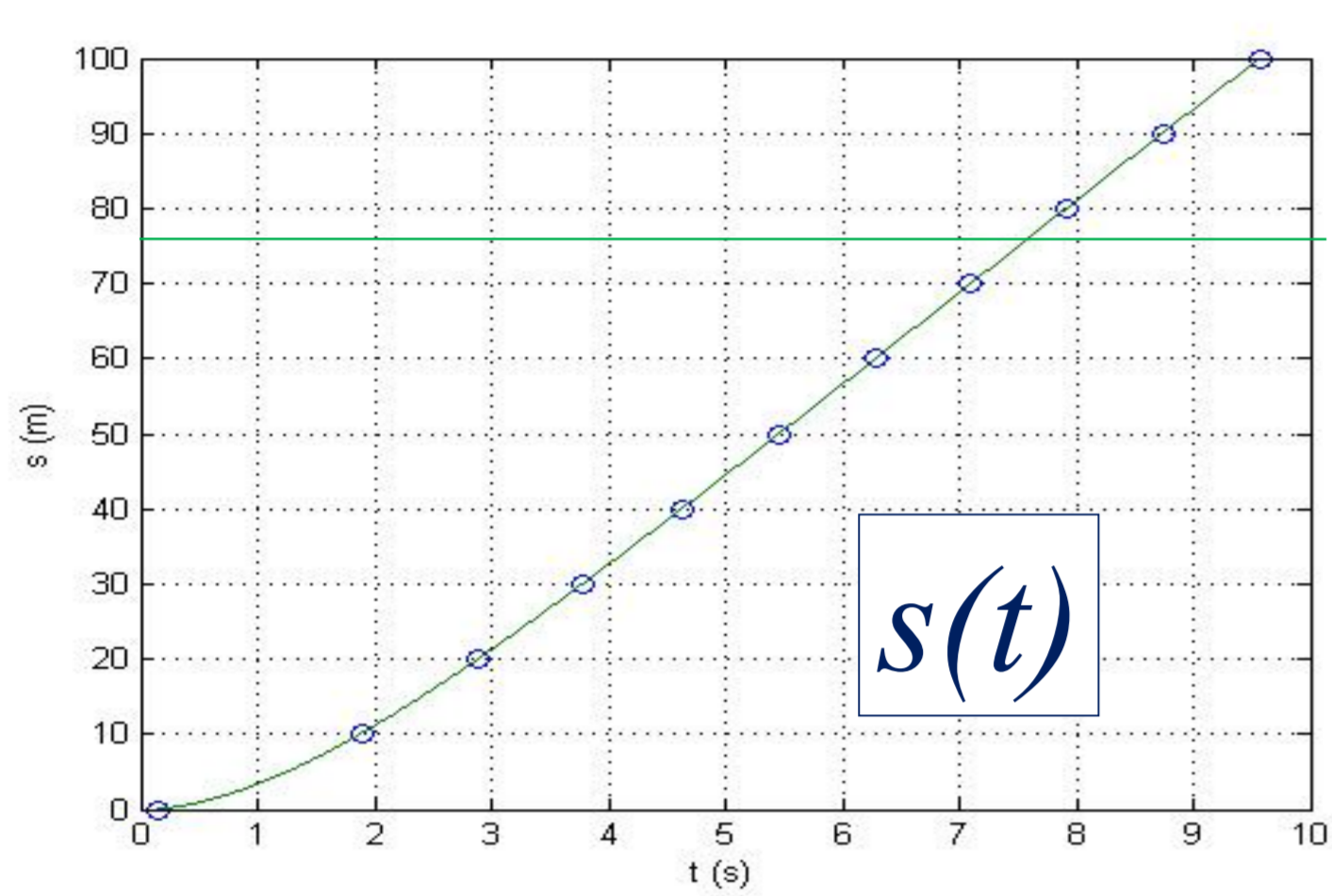
J.J.A.M. Sauren, Hogeschool Zuyd, Heerlen, The Netherlands

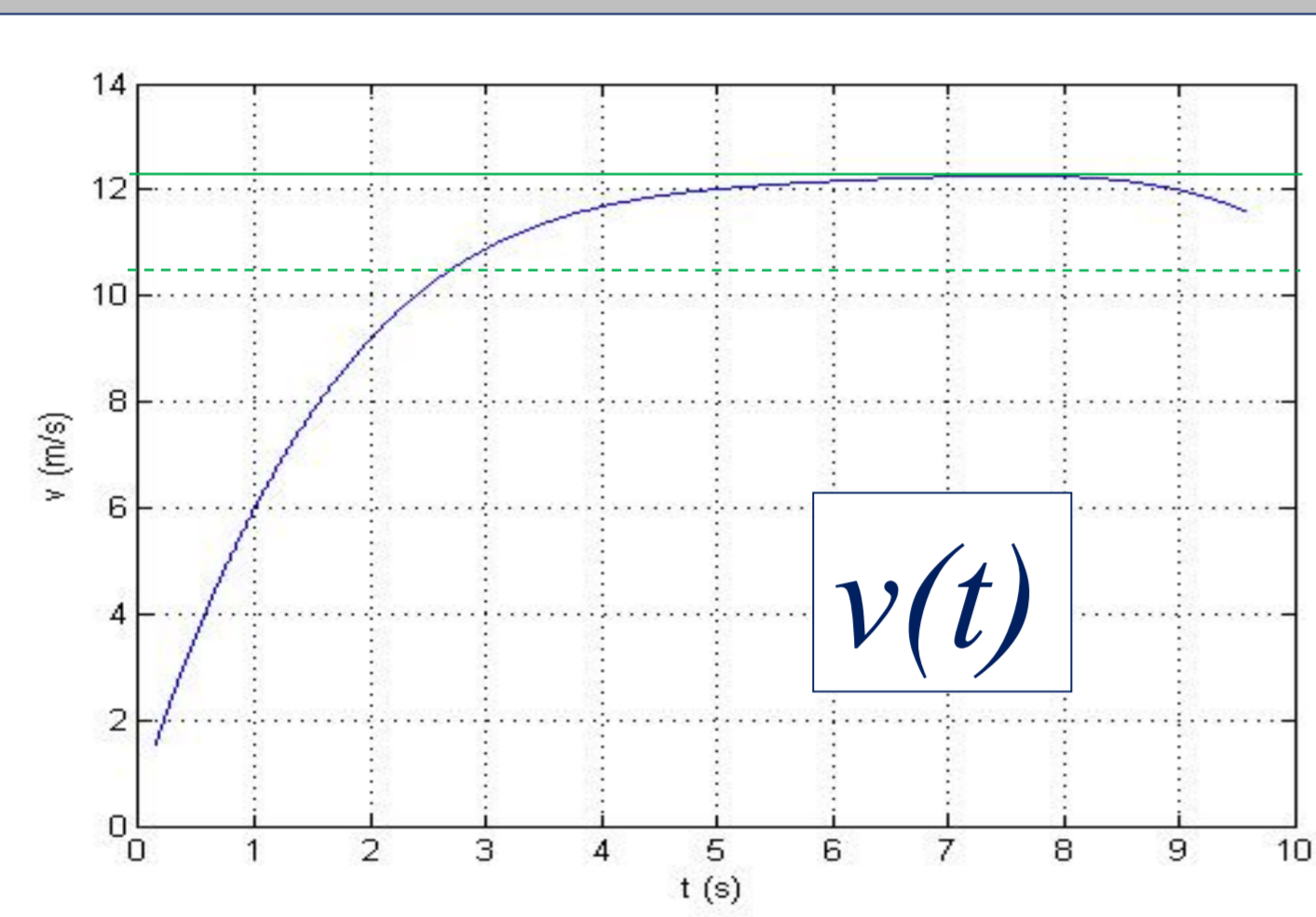B. Lieby and E. Schmidt, SRH Univ. of Applied Sciences, Heidelberg, Germany

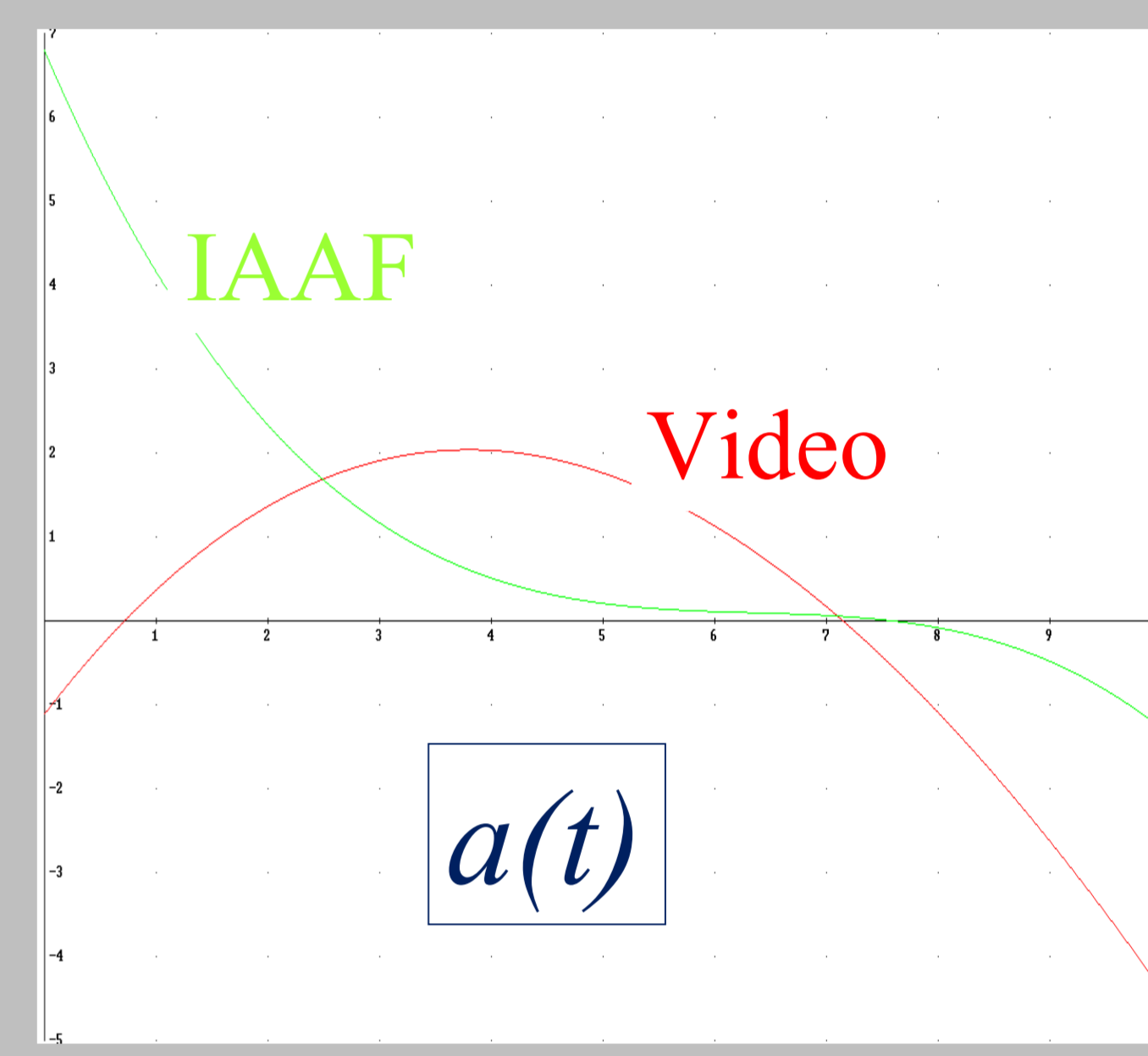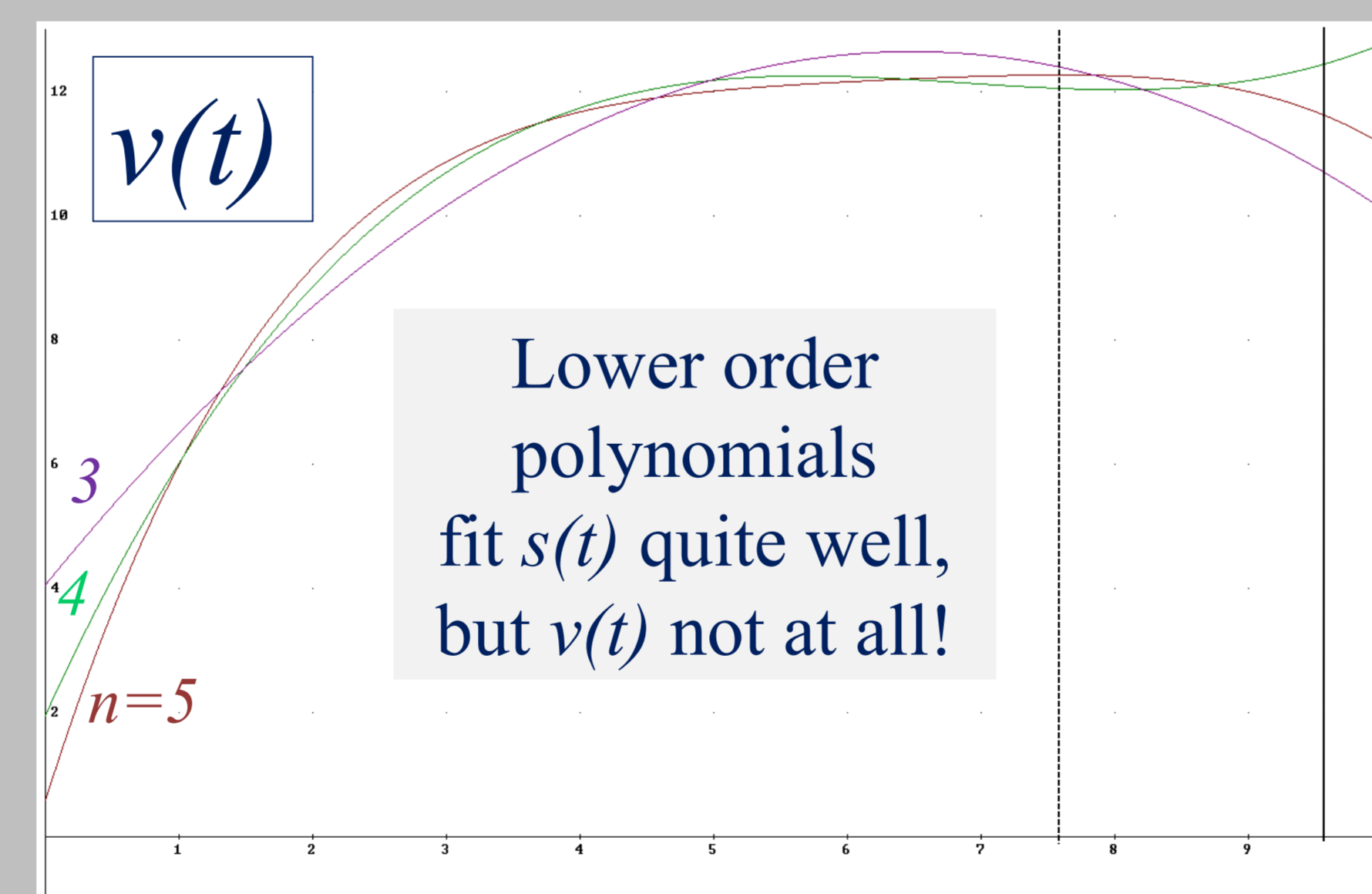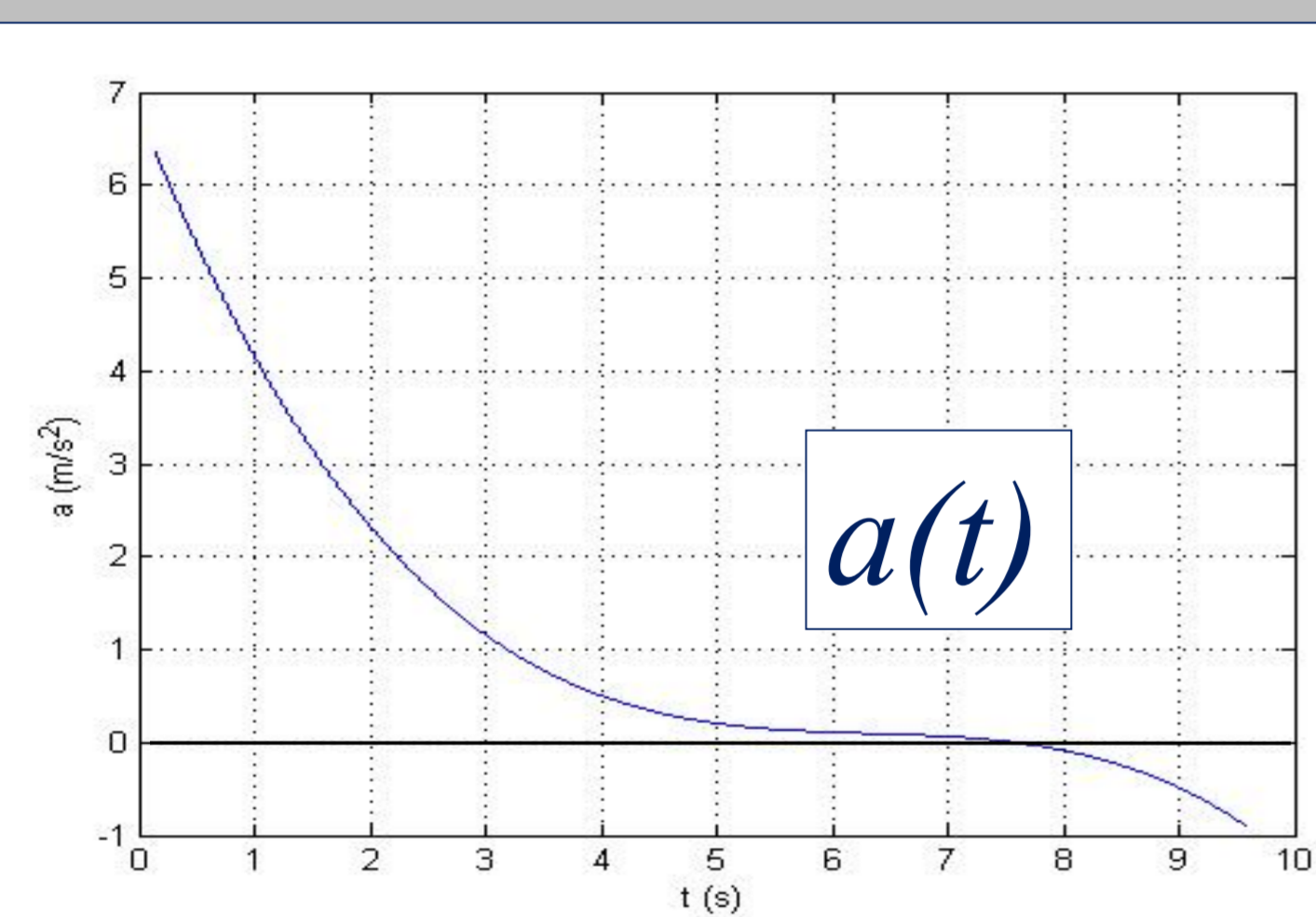## Evaluation of IAAF split timing data

Position / m	0 m	10 m	20 m	30 m	40 m	50 m	60 m	70 m	80 m	90 m	100 m
IAAF / s	0.146	1.89	2.88	3.78	4.64	5.47	6.29	7.10	7.92	8.75	9.58
Video, own / s	0.18?	1.81	3.31	4.18	5.03?	5.88	6.58	7.28	7.98	8.68	9.58

$s(t)$

$v(t)$

$a(t)$

IAAF data

Video data

$a(t)$
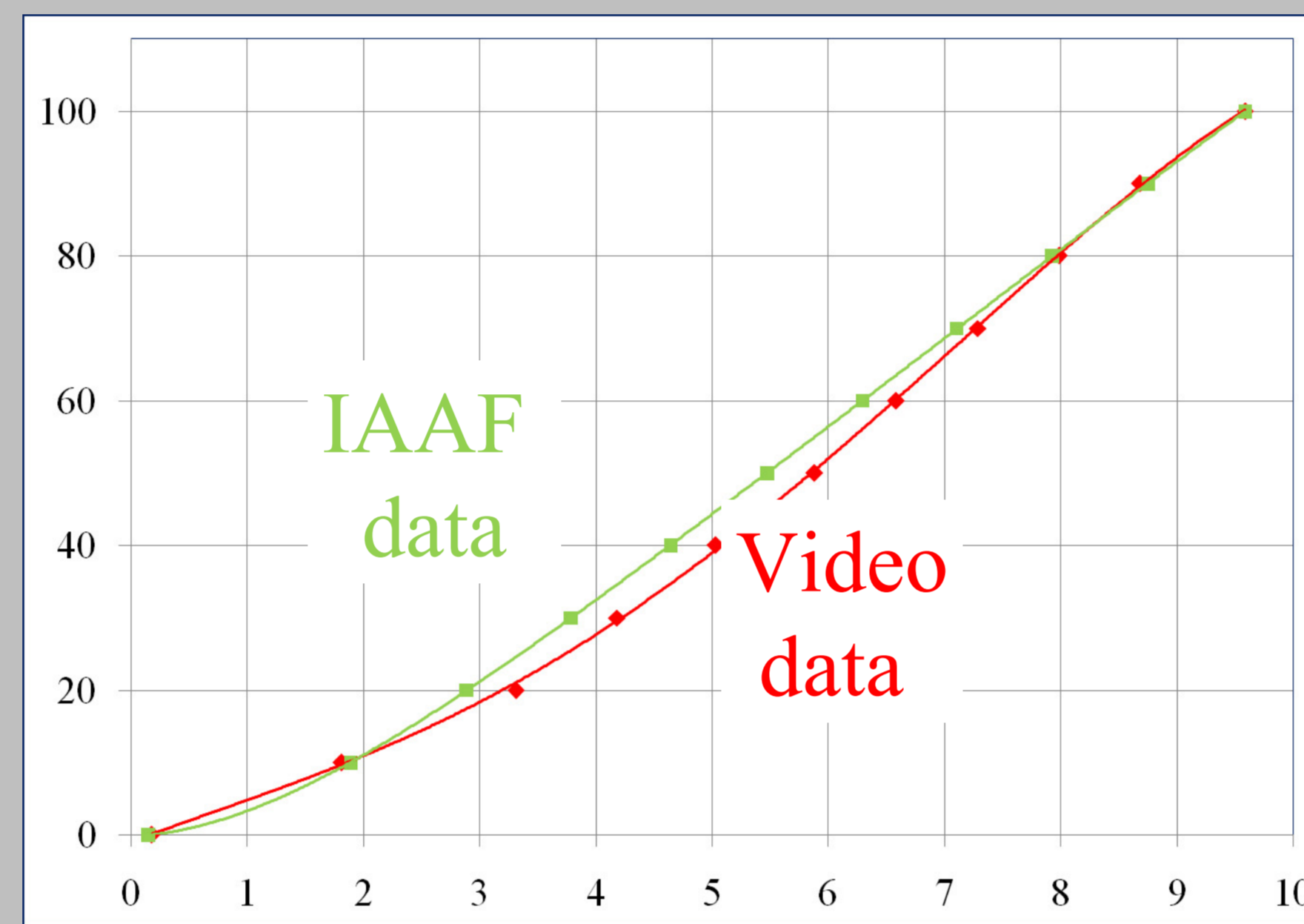
Video-based data show a complete lack of fit in $a(t)$, and must be erroneous

IAAF

Video

$a(t)$

Berlin Aug. 16th, 2009
Usain Bolt

If Bolt had not slowed down →

$t_{76\,m} = 7.60$ s
$v_{max} = 12.27$ m/s
$\Delta t_{opt} = 24$ m/12.27 m/s = 1.96 s
$T_{opt} = (7.60 + 1.96)$ s = **9.56 s**

$v(s)$

$v(t)$
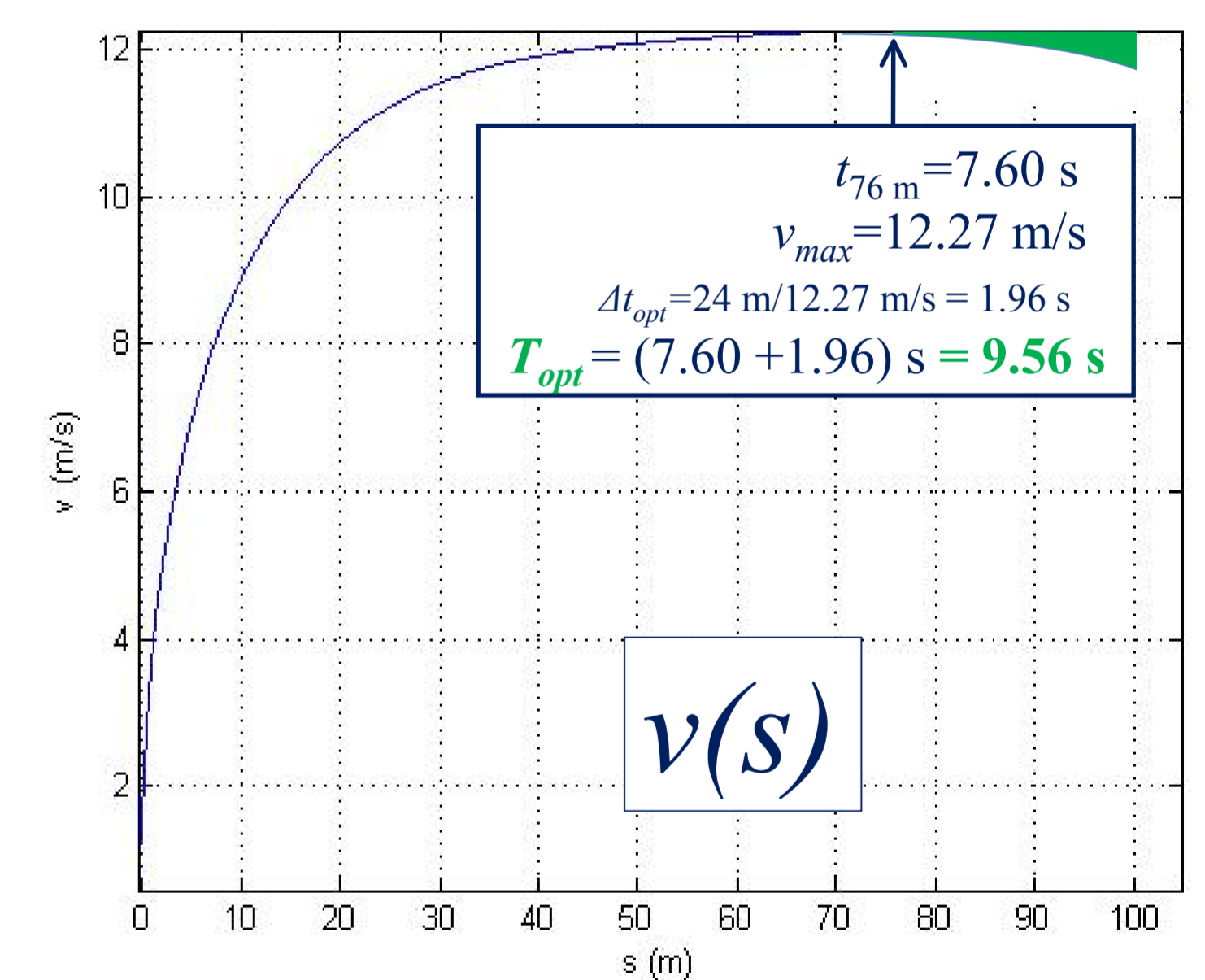
Lower order polynomials fit $s(t)$ quite well, but $v(t)$ not at all!

3
4
$n=5$

Polynomial coefficients

| $s = a_5 t^5 + a_4 t^4 + a_3 t^3 + a_2 t^2 + a_1 t + a_0$	
a_5	-0.0012685
a_4	+0.0402025
a_3	-0.515942
a_2	+3.39842
a_1	+0.5841
a_0	-0.165
r^2	0.9999958

Some characteristics

- start acceleration: 6.80 m/s²
- average speed: 10.44 m/s
- top speed: 12.27 m/s at 7.6 s and 76 m
- speed at finish: 11.16 m/s

Independent LAVEG speed measurement[1] for Bolt's race

http://berlin.iaaf.org/mm/document/development/research/05/31/54/200908170
73528_httppostedfile_analysis100mmenfinal_bolt_13666.pdf

berlin 2009
Scientific Research Project

Biomechanical analysis
12th IAAF World Championships in Athletics • Berlin, 15.–23.08.2009
100m men final: Usain BOLT (JAM) 9,58s – WR

$v(s)$
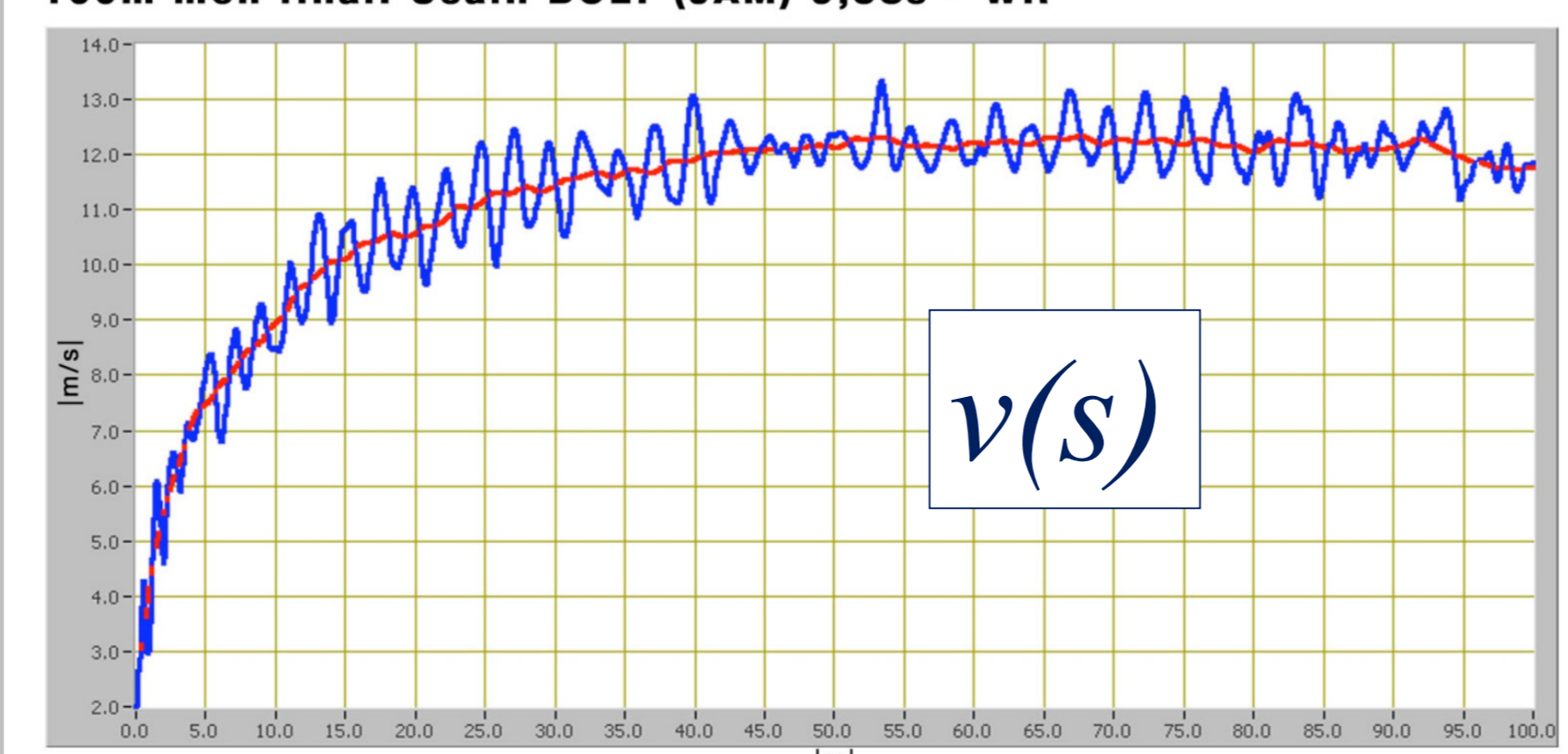
Discussion

- Split timing $s(t)$-data fitted very well and gave consistent $v(t)$-, $a(t)$-curves
- a video-based analysis failed for lack of on-track distance markers
- Bolt's run was near-perfect for him, and confirmed an extrapolation[2] of his Beijing 2008 world record (9.69 s)
- Powell (the second in that final) started faster by 0.012 s, but was beaten by Bolt's higher top speed
- improvements are expected to be
  - up to 0.05 s by faster start & acceleration
  - less than 0.05 s by maintaining the present-day top speeds to the finish line

[1] R. Góralczyk et al., J. Human Kinetics, **10**, 107 (2003)
[2] H.K. Eriksen et al., Am. J. Phys **77**, 324 (2009)