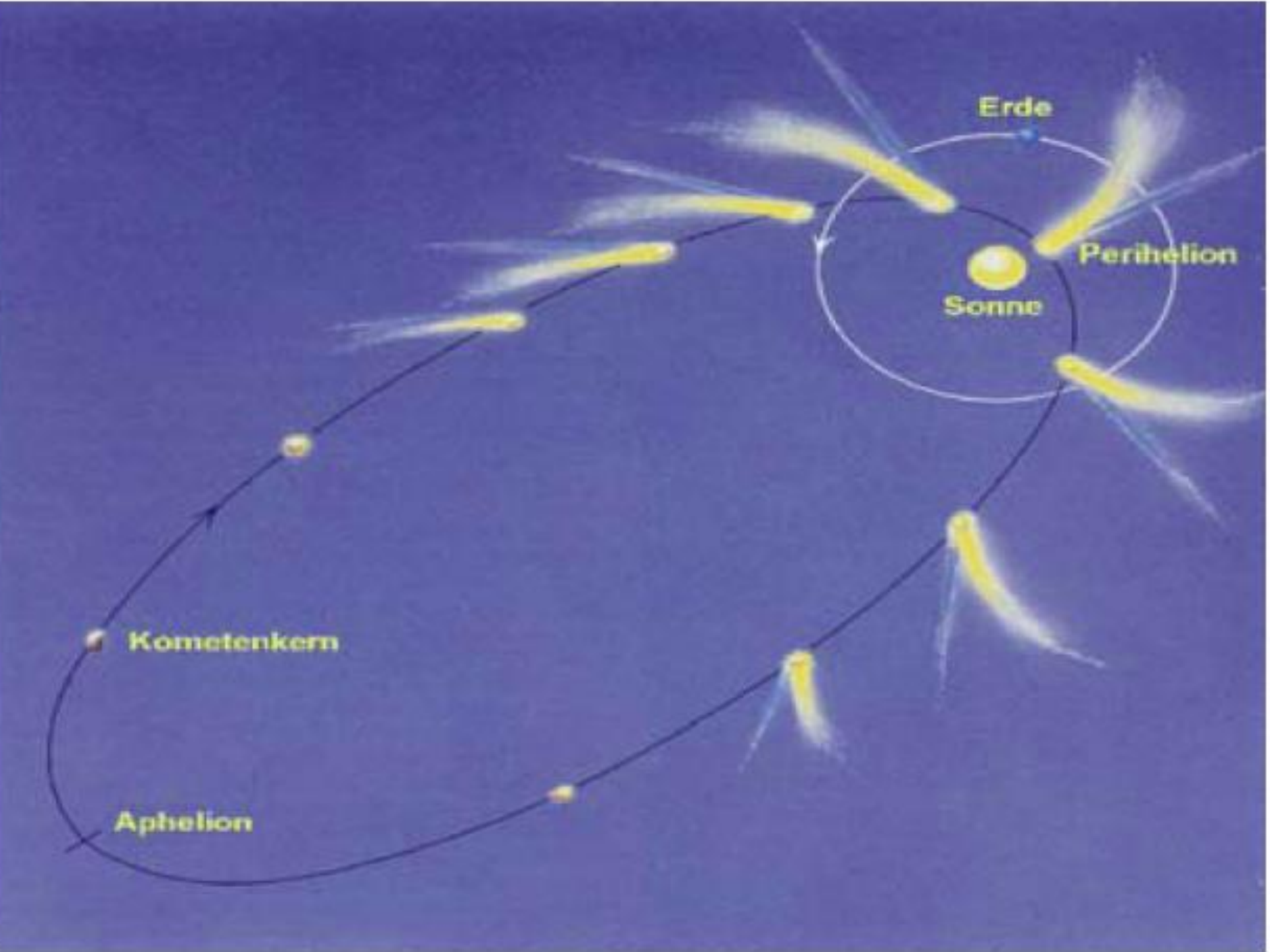
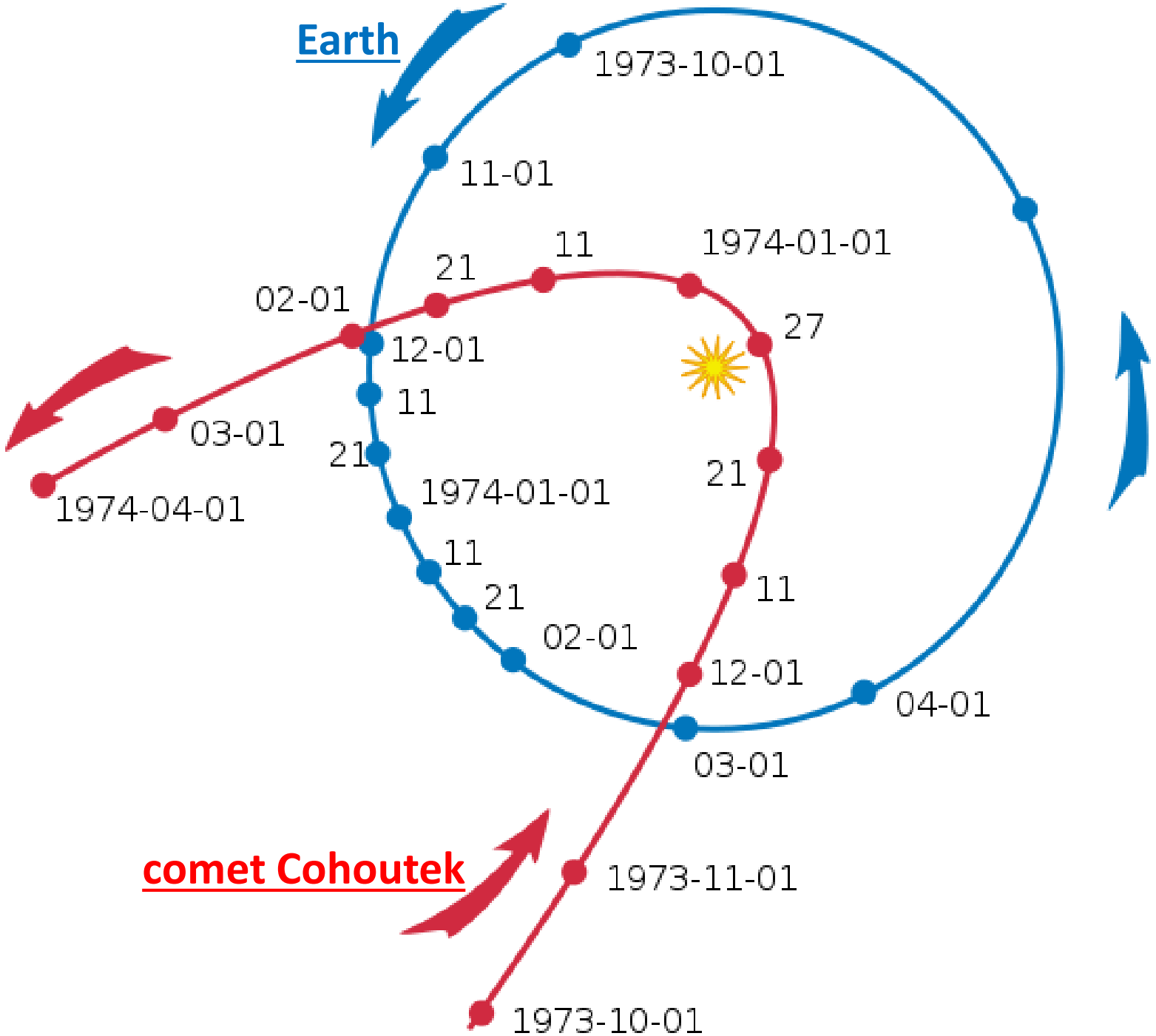
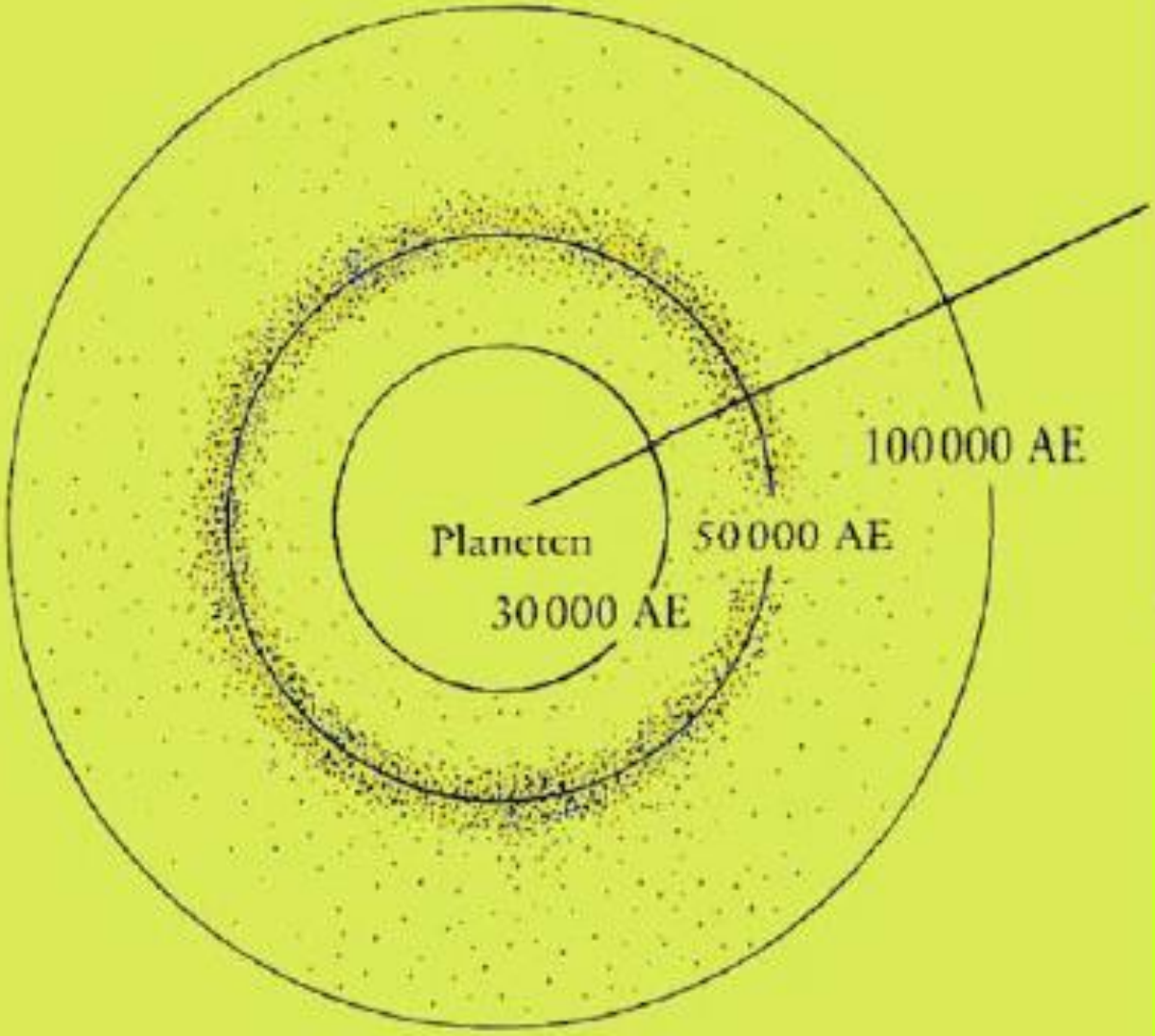

comet Lovejoy

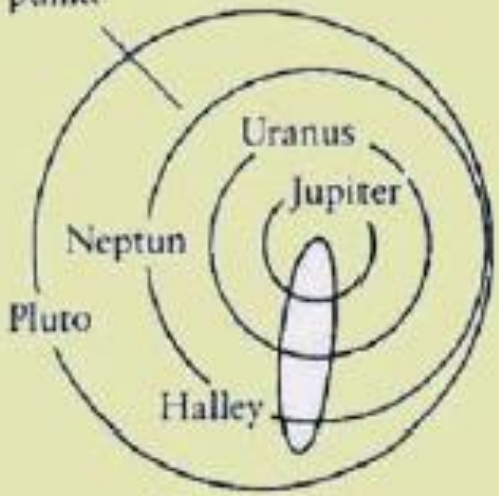

motion of
comet head
solar wind


Erde
Perihelion
Sonne
Kometenkern
Aphelion


Earth
1973-10-01
11-01
11
1974-01-01
21
02-01
27
12-01
11
03-01
21
1974-01-01
21
1974-04-01
11
11
21
02-01
12-01
04-01
03-01
comet Cohoutek
1973-11-01
1973-10-01



Kometenwolke

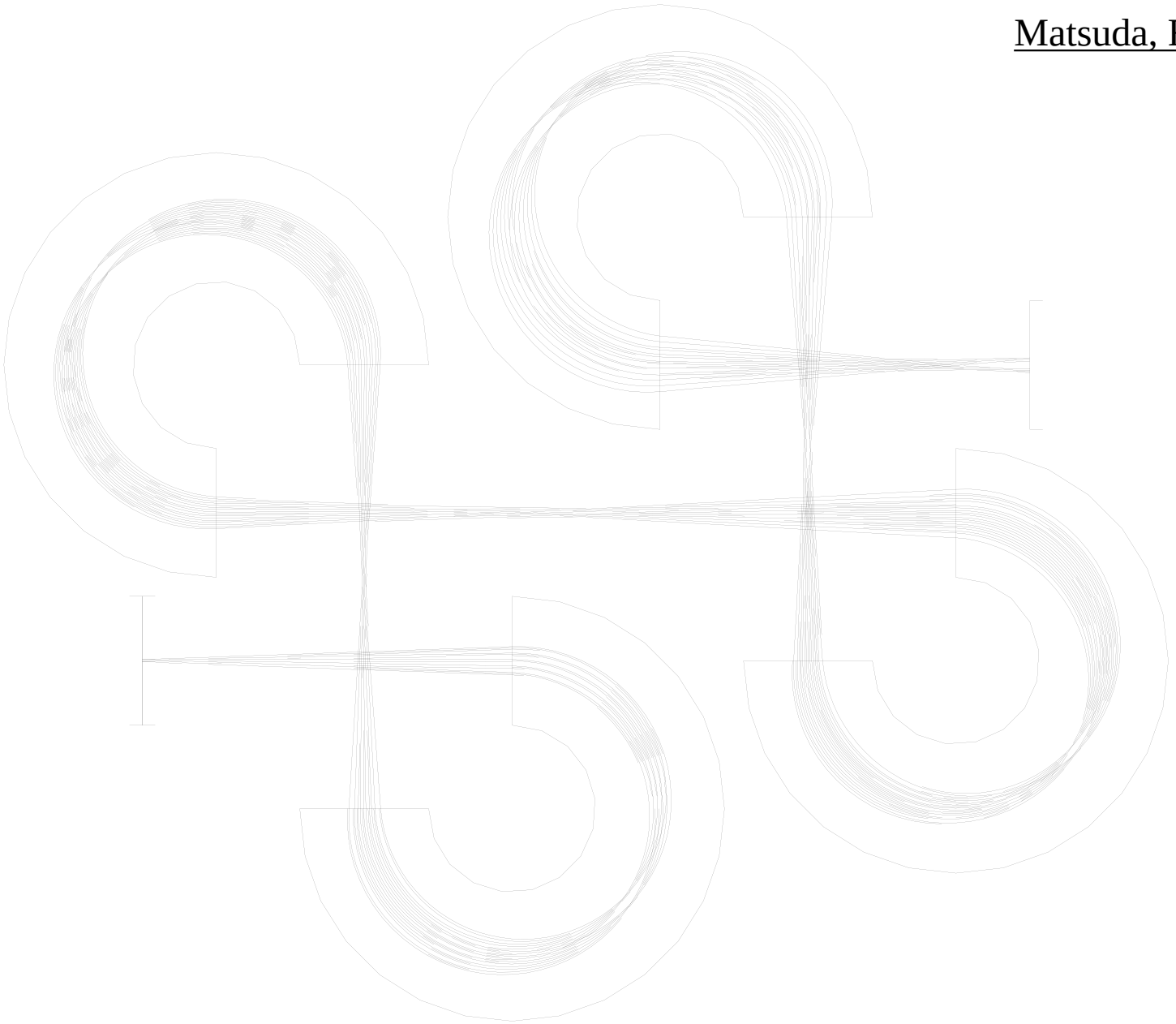


1000 fache
Vergrößerung

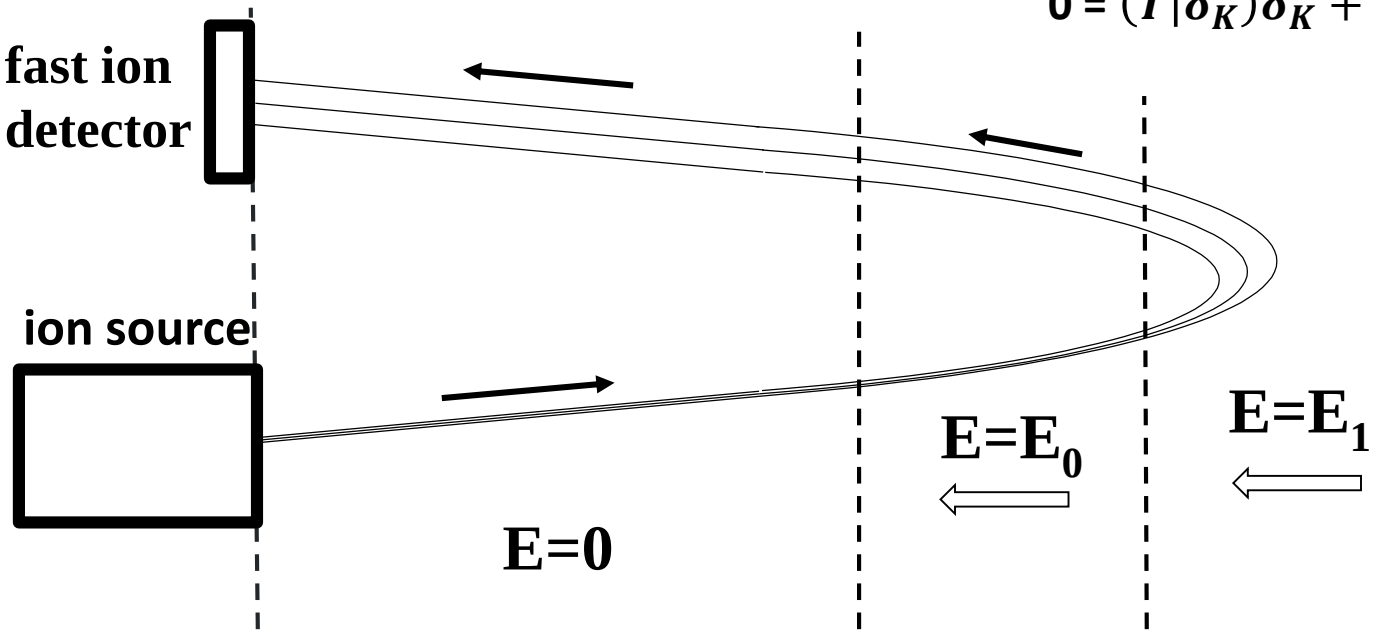

ROSETTA
PHILAE

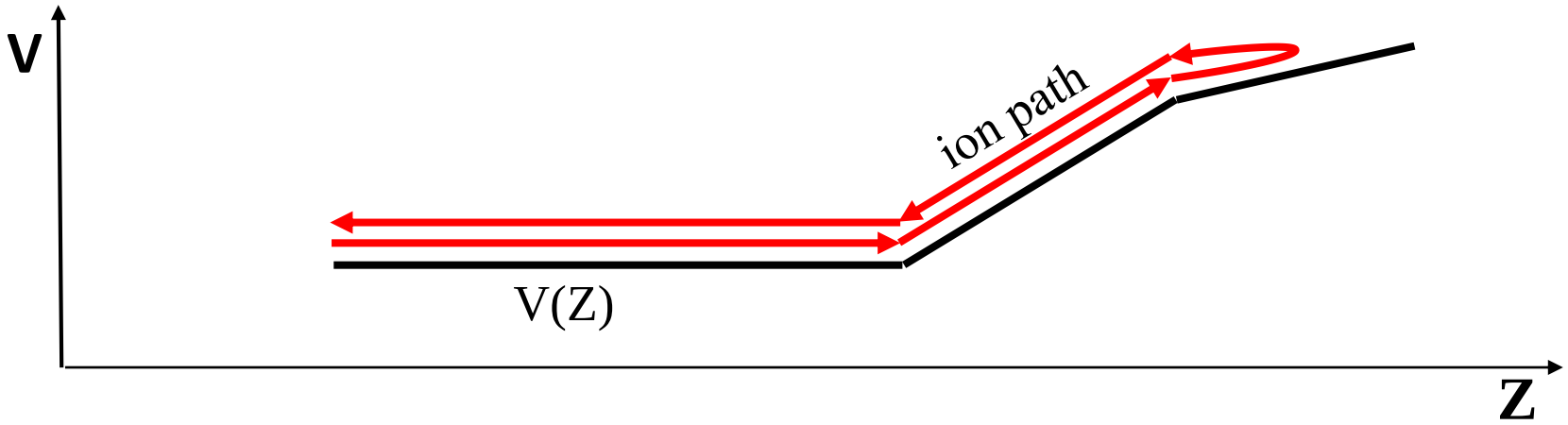
Wollnik 1978

Matsuda, Fujita 1980



$$0 = (T|\delta_K)\delta_K + \left(T\middle|\delta_K^2\right)\delta_K^2 + \ldots$$

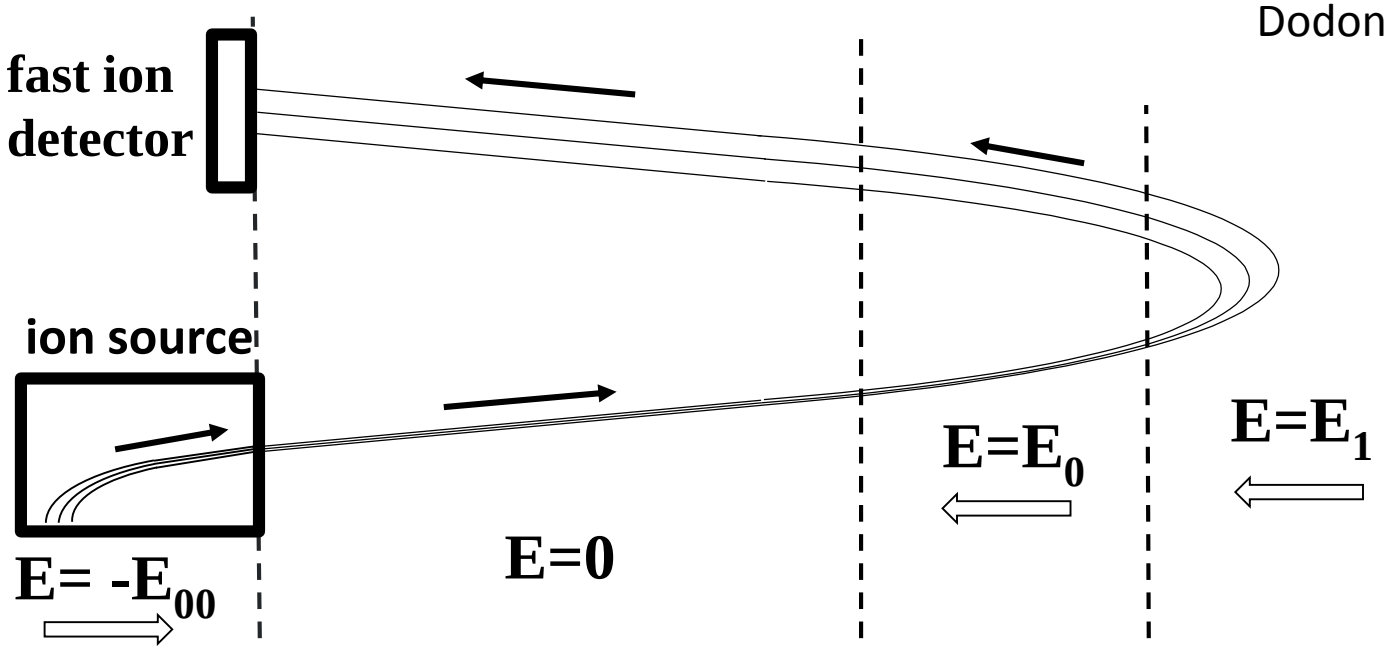


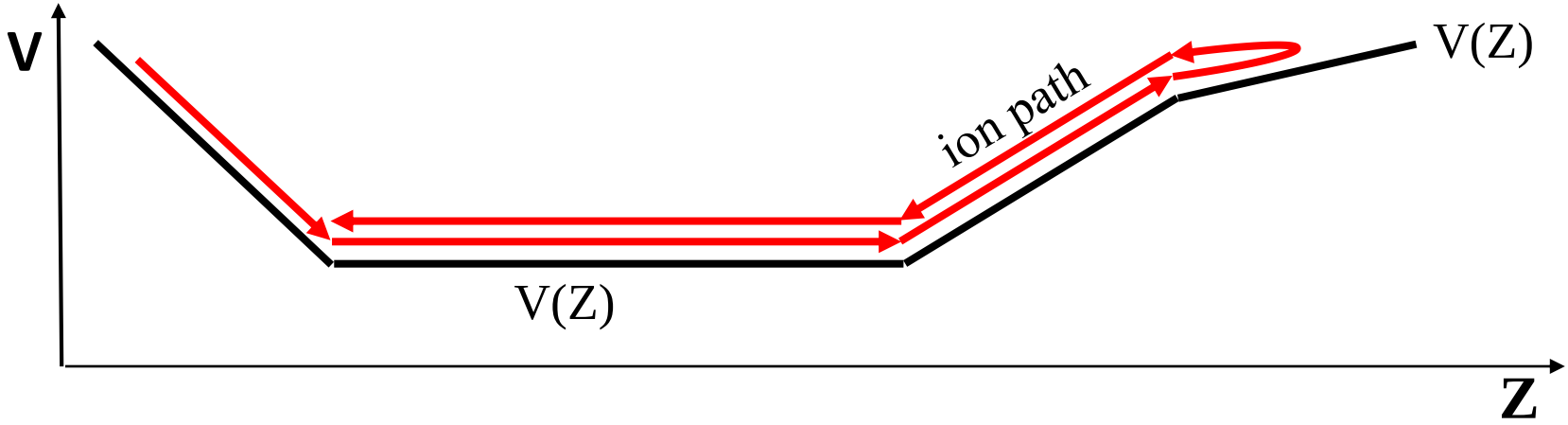


Mamyrin et al. Sov. Phys. JETP 37(1973)45

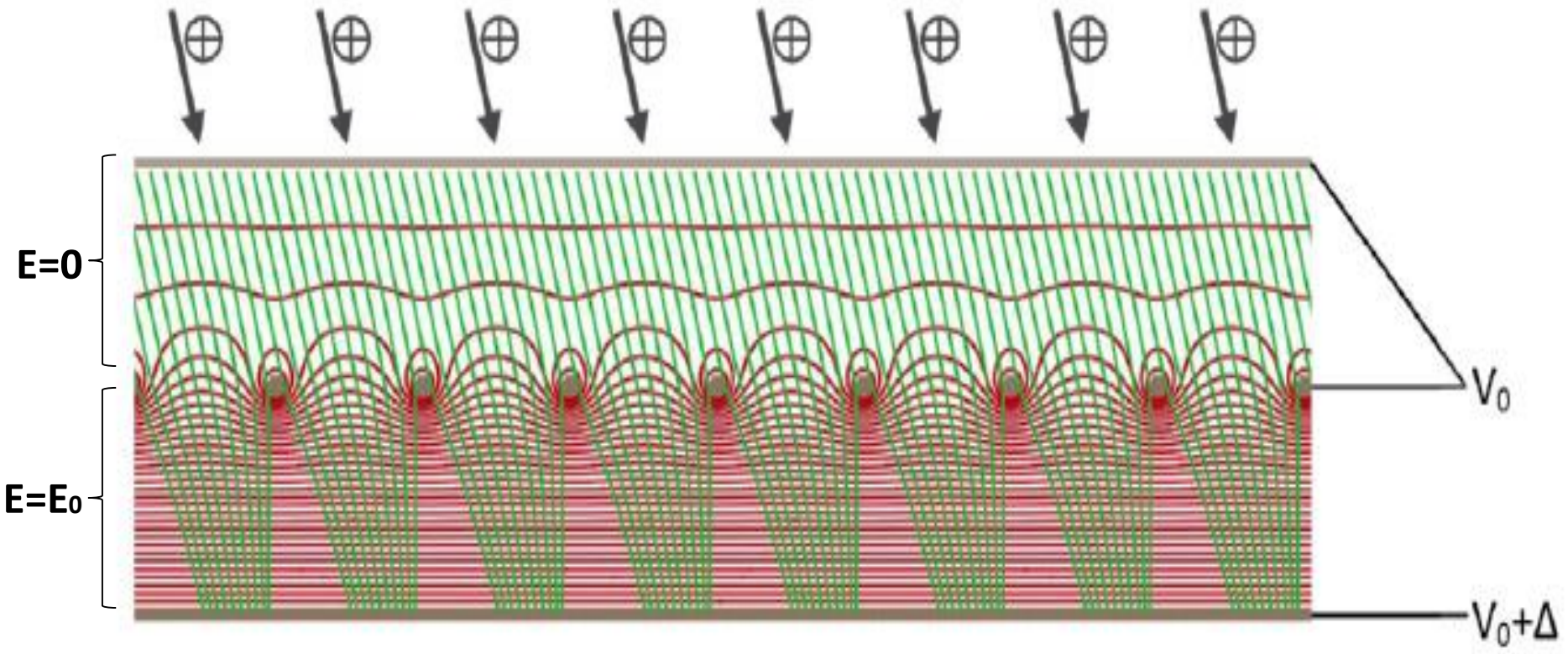
$$0 = (T|\delta_K)\delta_K + (T|\delta_K^2)\delta_K^2 + (T|\delta_K^3)\delta_K^3 \ldots$$

Dodonov, Wollnik 1994





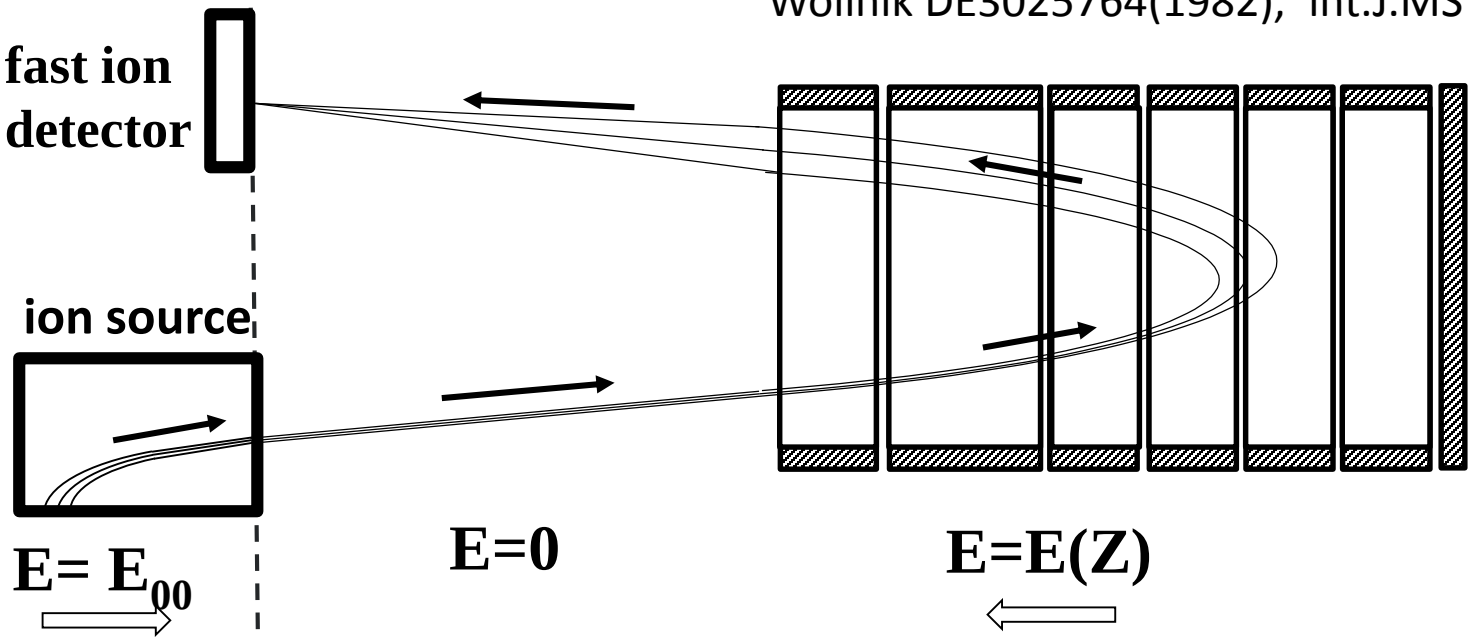
an ion beam passing through a grid that separates regions of two fields



Wollnik, Int.J.MS 186(2013)38

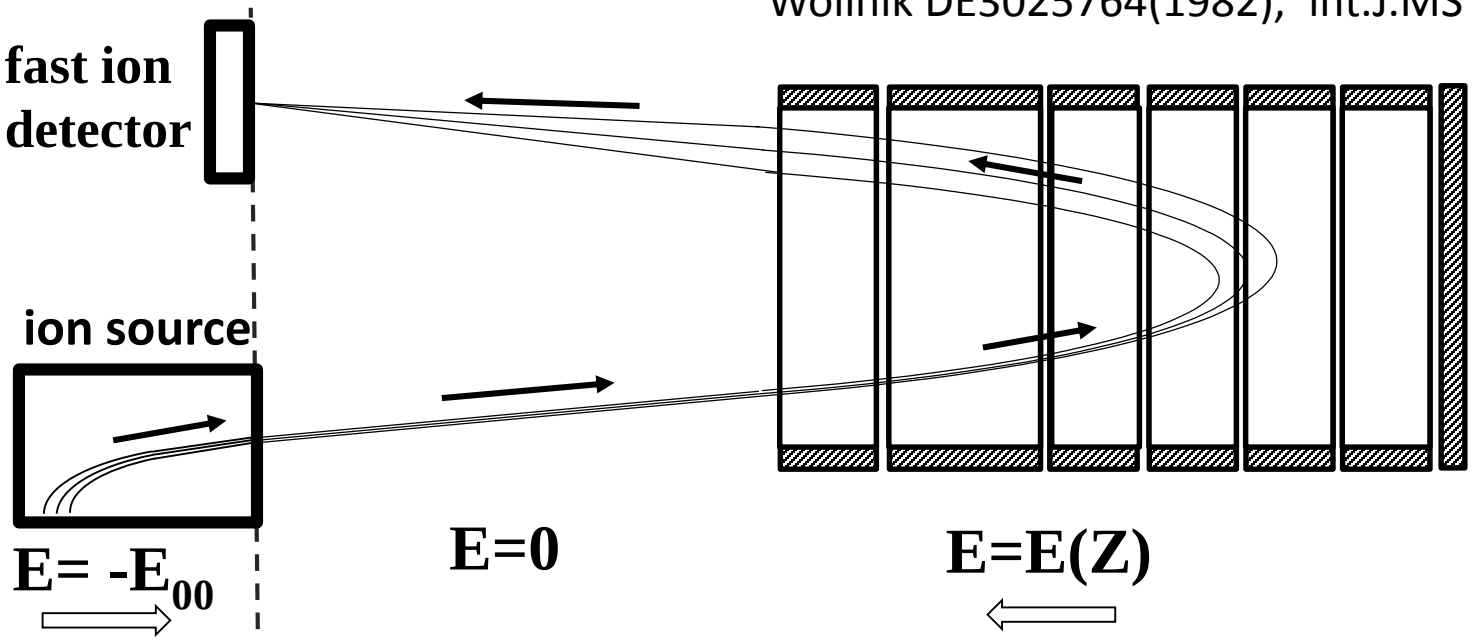
$$0 = (T|\delta_K)\delta_K + \left(T\middle|\delta_K^2\right)\delta_K^2 + \left(T\middle|\delta_K^3\right)\delta_K^3 + \ldots\ldots\ldots\ldots$$

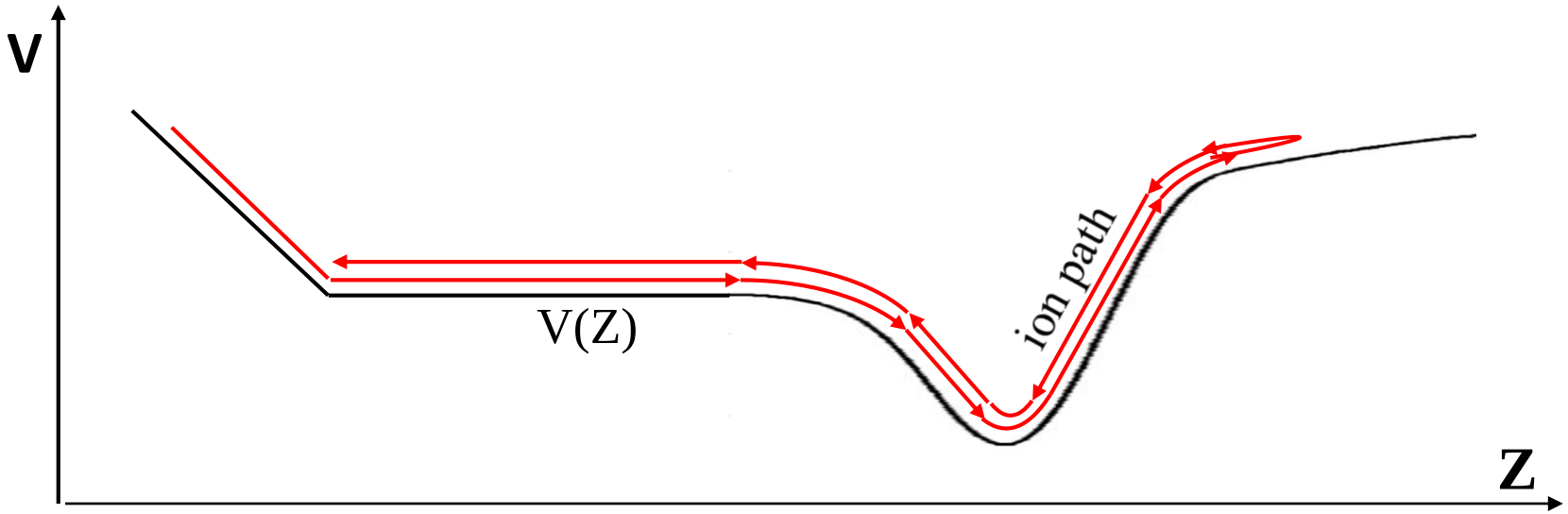
Wollnik DE3025764(1982), int.J.MS 131(1994)387



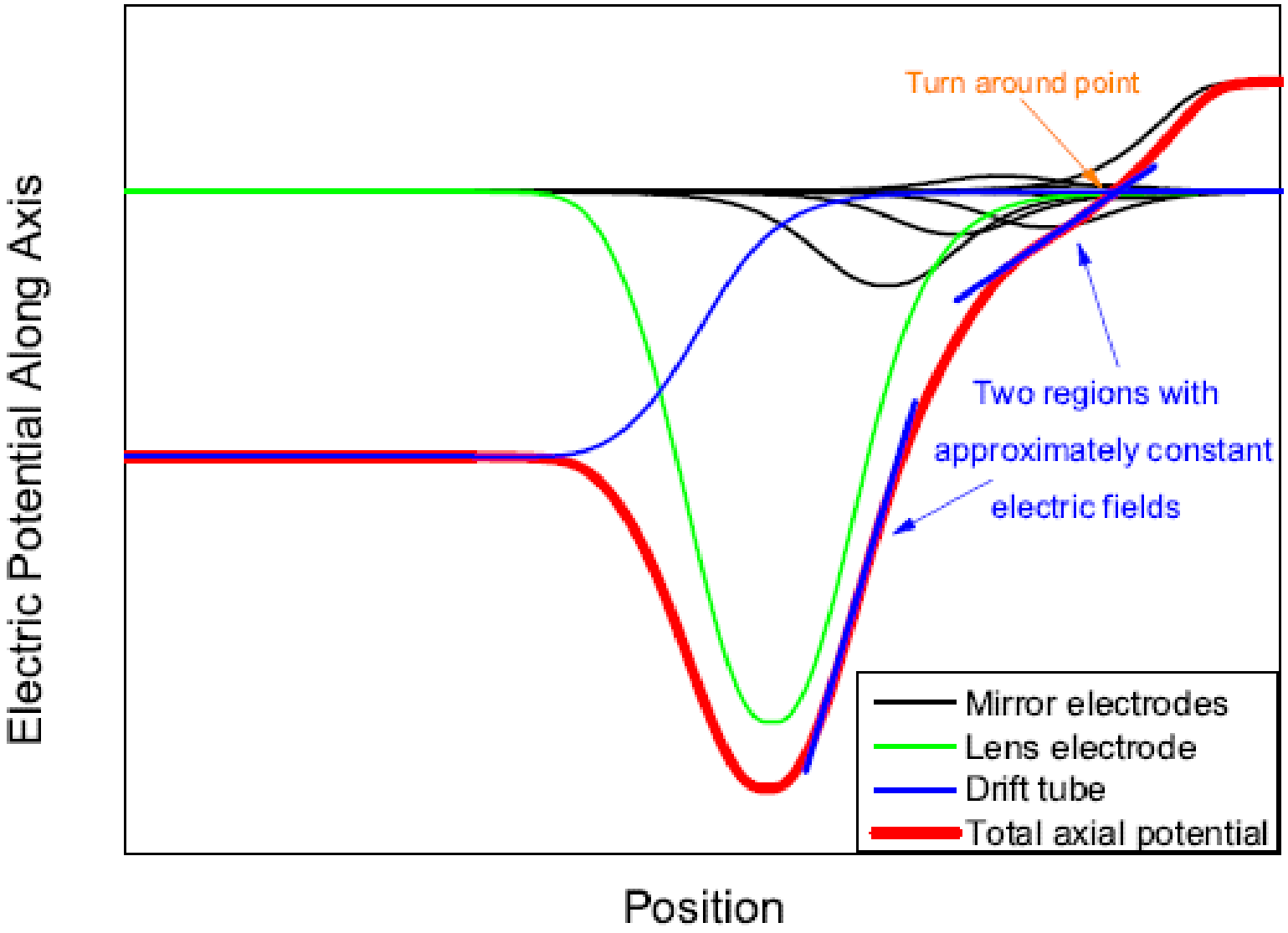
$$0 = (T|\delta_K)\delta_K + (T|\delta_K^2)\delta_K^2 + (T|\delta_K^3)\delta_K^3 + \ldots\ldots\ldots\ldots$$

Wollnik DE3025764(1982), int.J.MS 131(1994)387



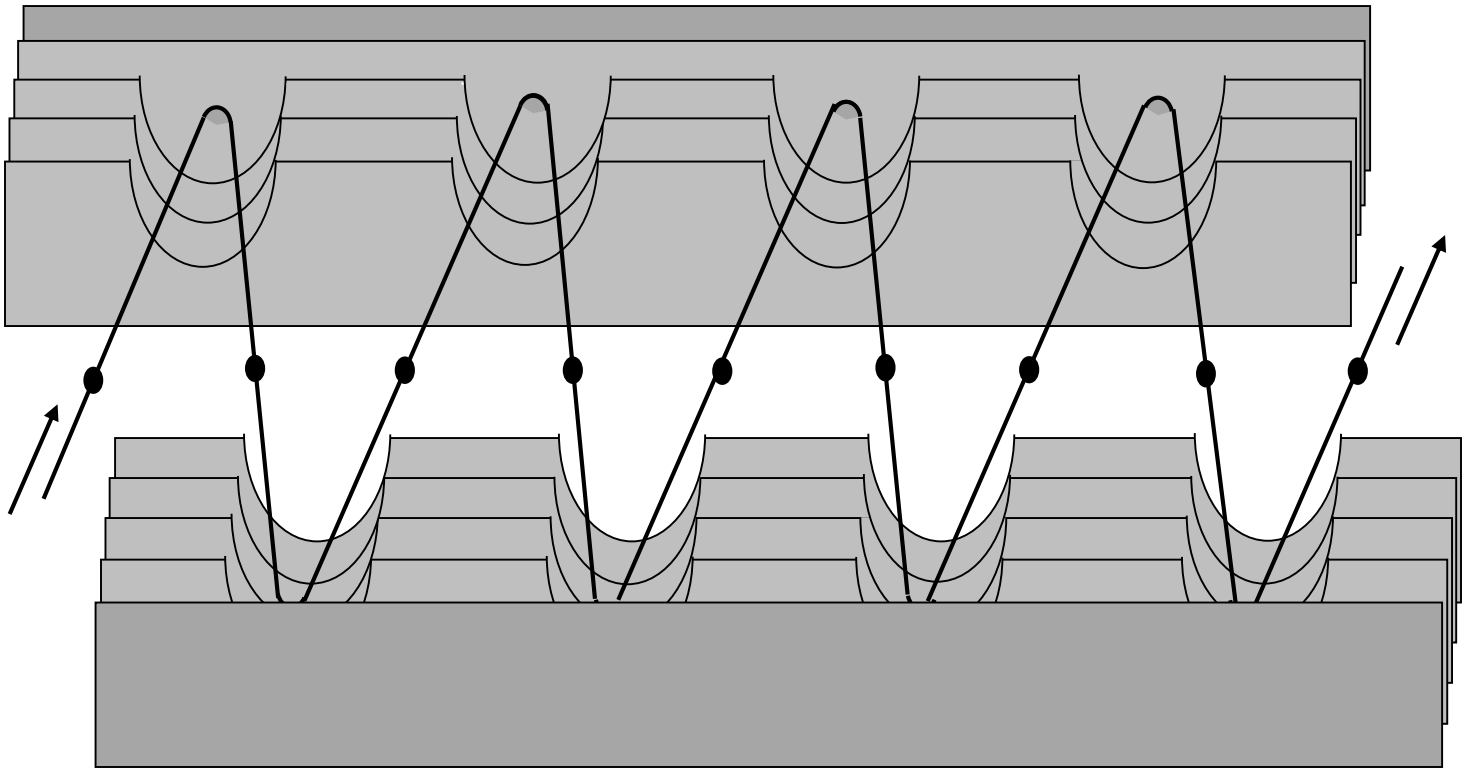


The design of a good ion mirror with only few electrodes



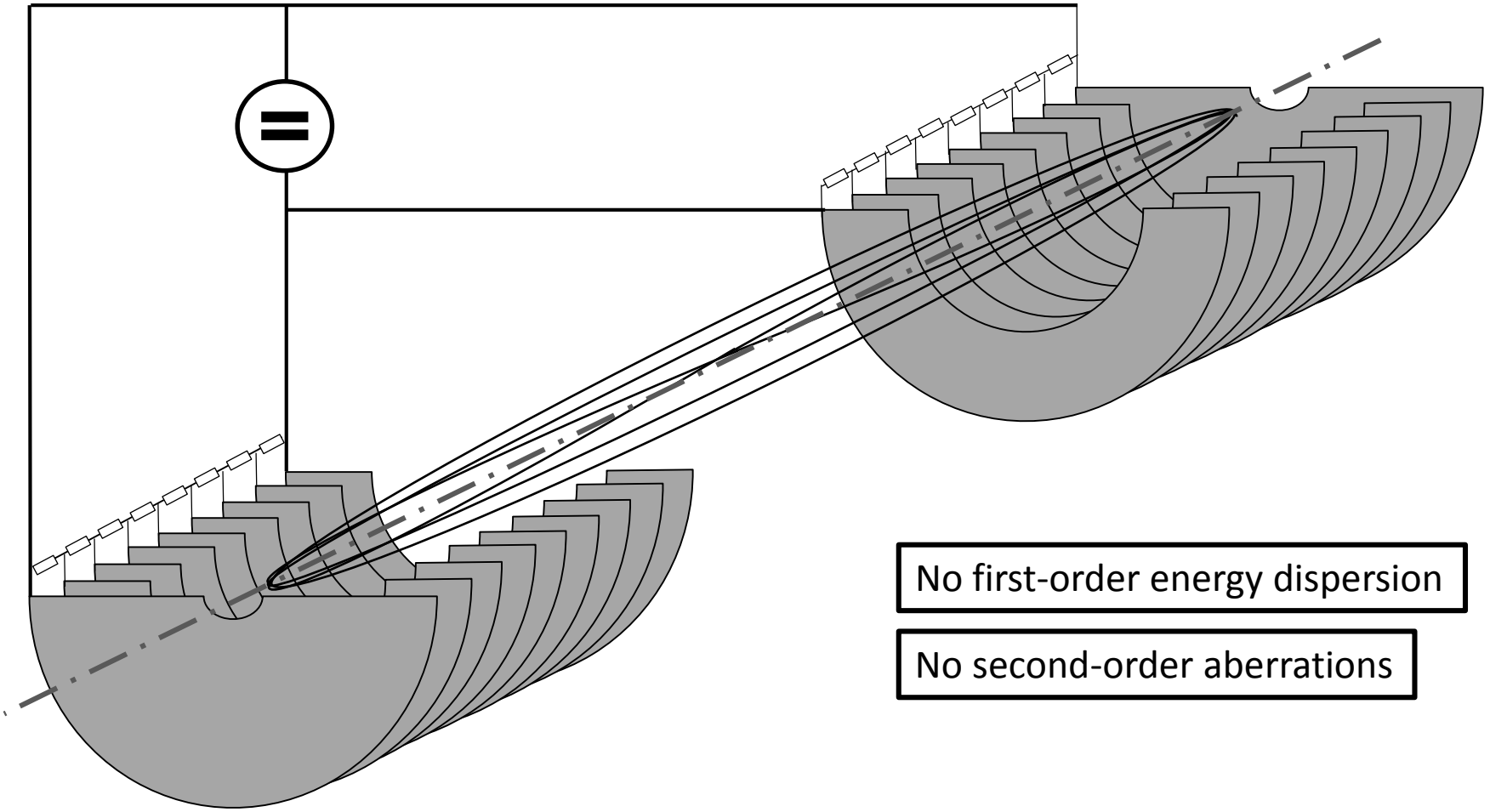
Multiple-reflection time-of-flight mass analyzer

Wollnik 1982



coaxial multi-reflection time-of-flight mass analyzer

Wollnik 1982

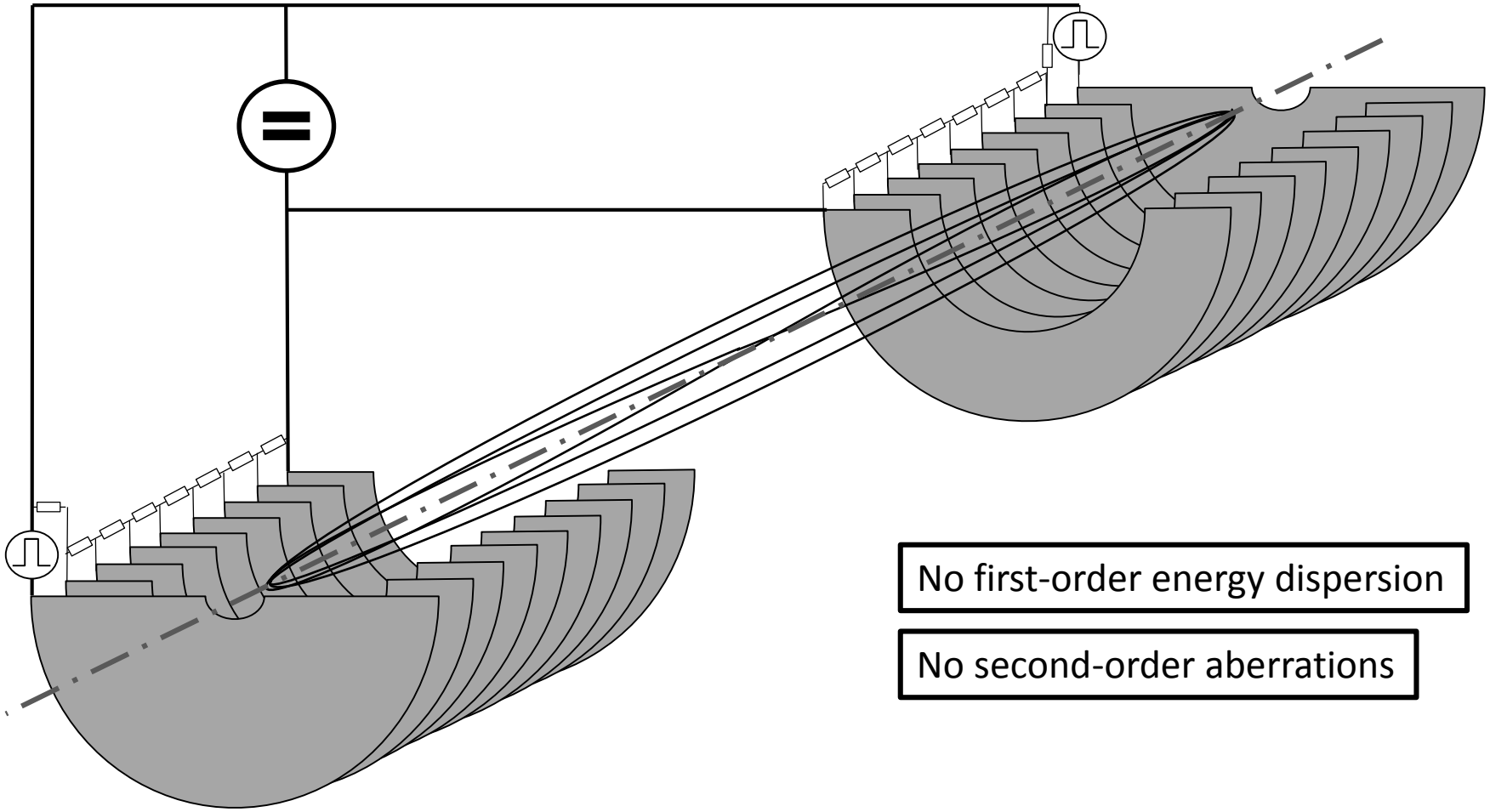


No first-order energy dispersion

No second-order aberrations

coaxial multi-reflection time-of-flight mass analyzer

Wollnik 1982

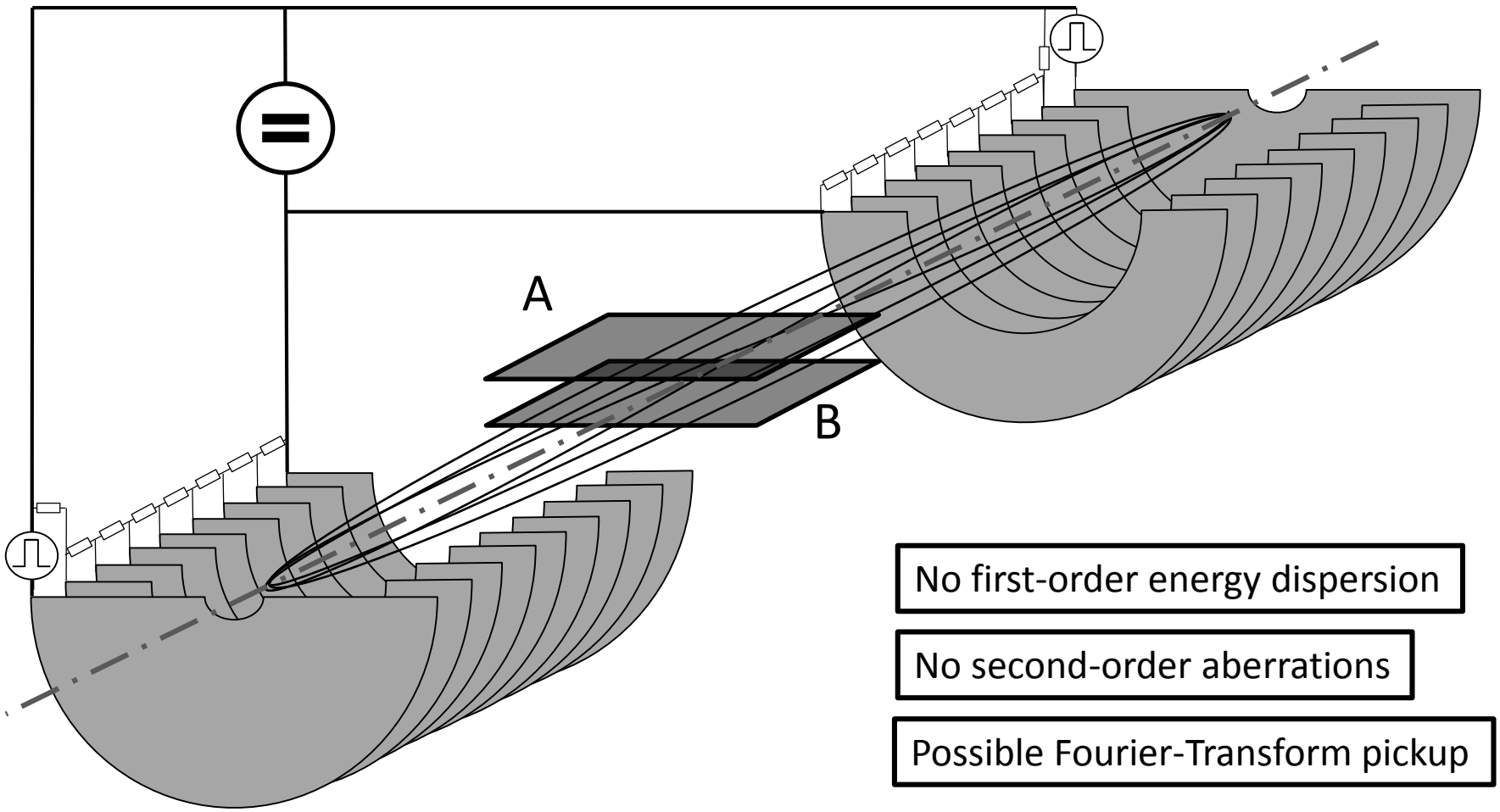


No first-order energy dispersion

No second-order aberrations

coaxial multi-reflection time-of-flight mass analyzer

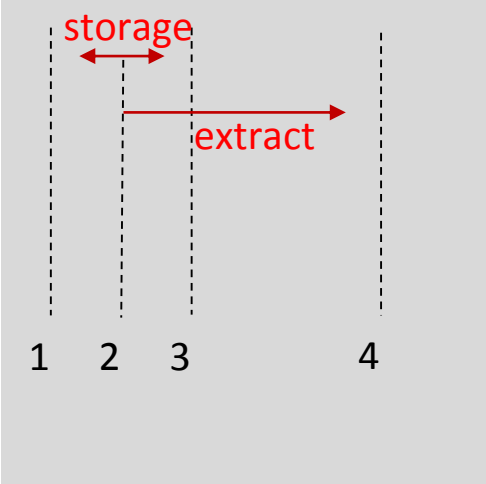
Wollnik 1982

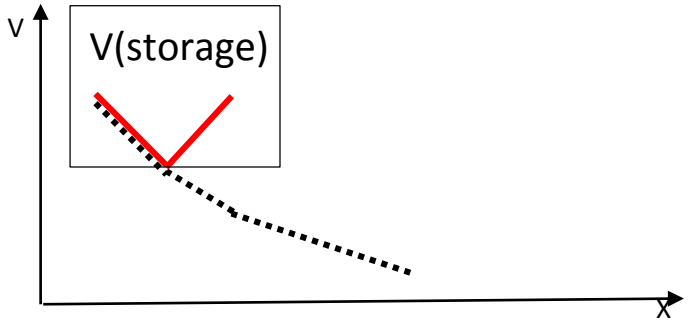


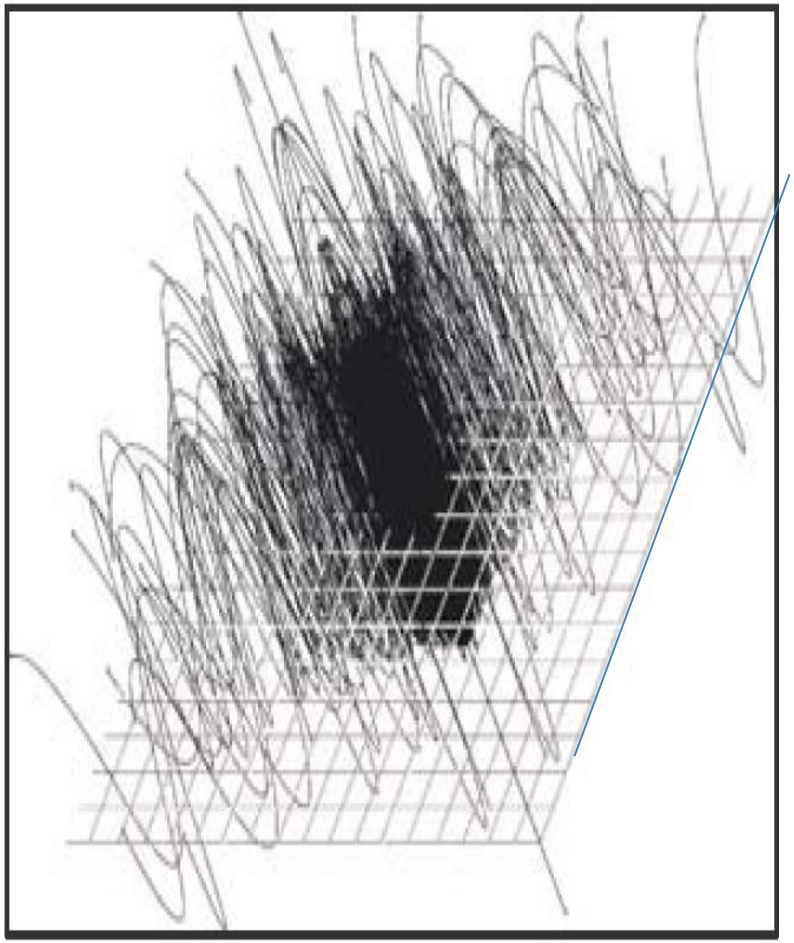
No first-order energy dispersion

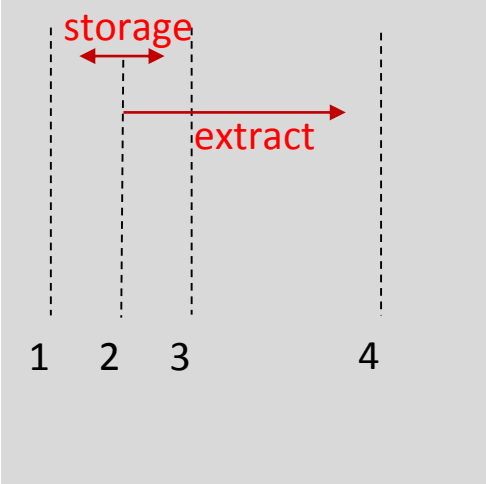
No second-order aberrations

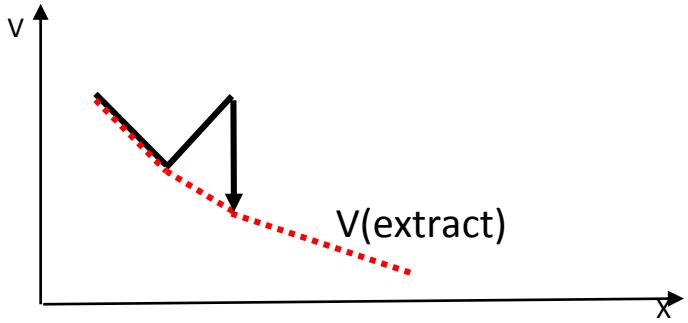
Possible Fourier-Transform pickup

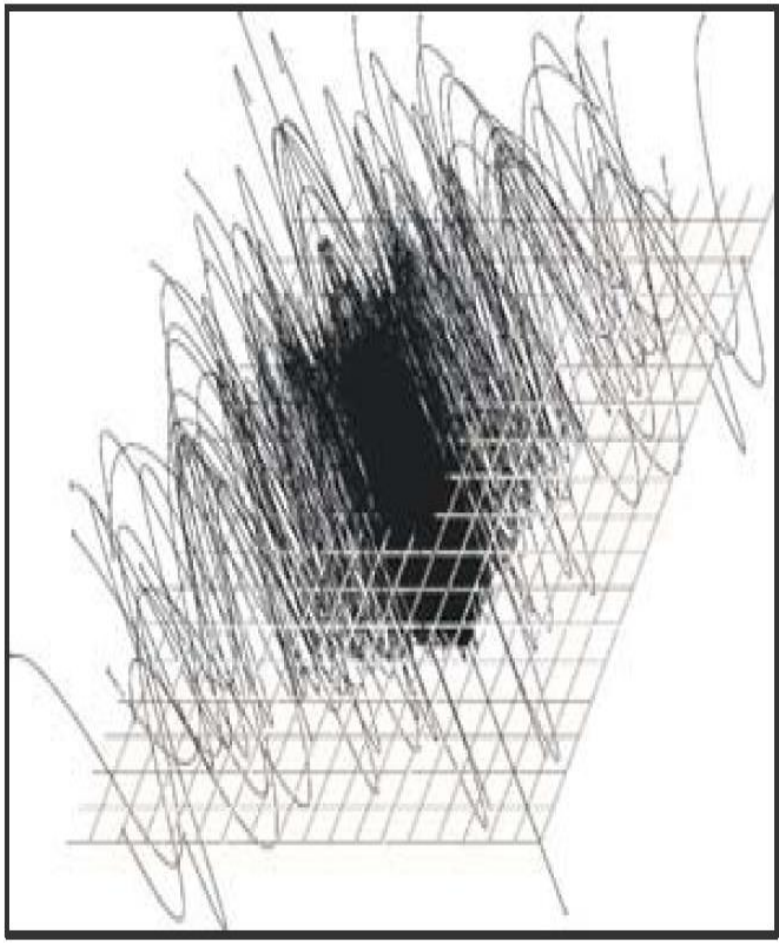

storage
extract
1
2
3
4


V
V(storage)
X

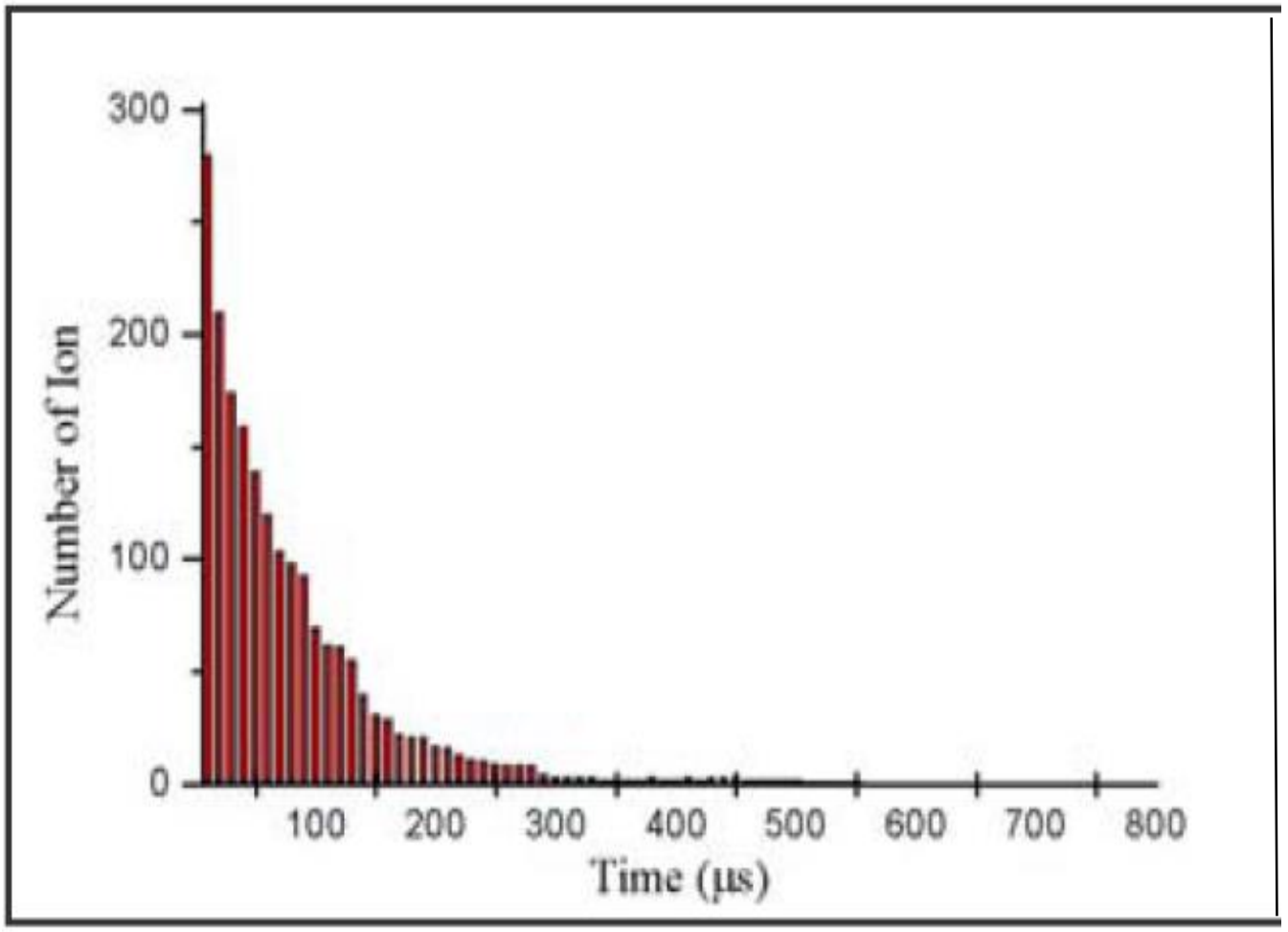



storage
extract
1
2
3
4

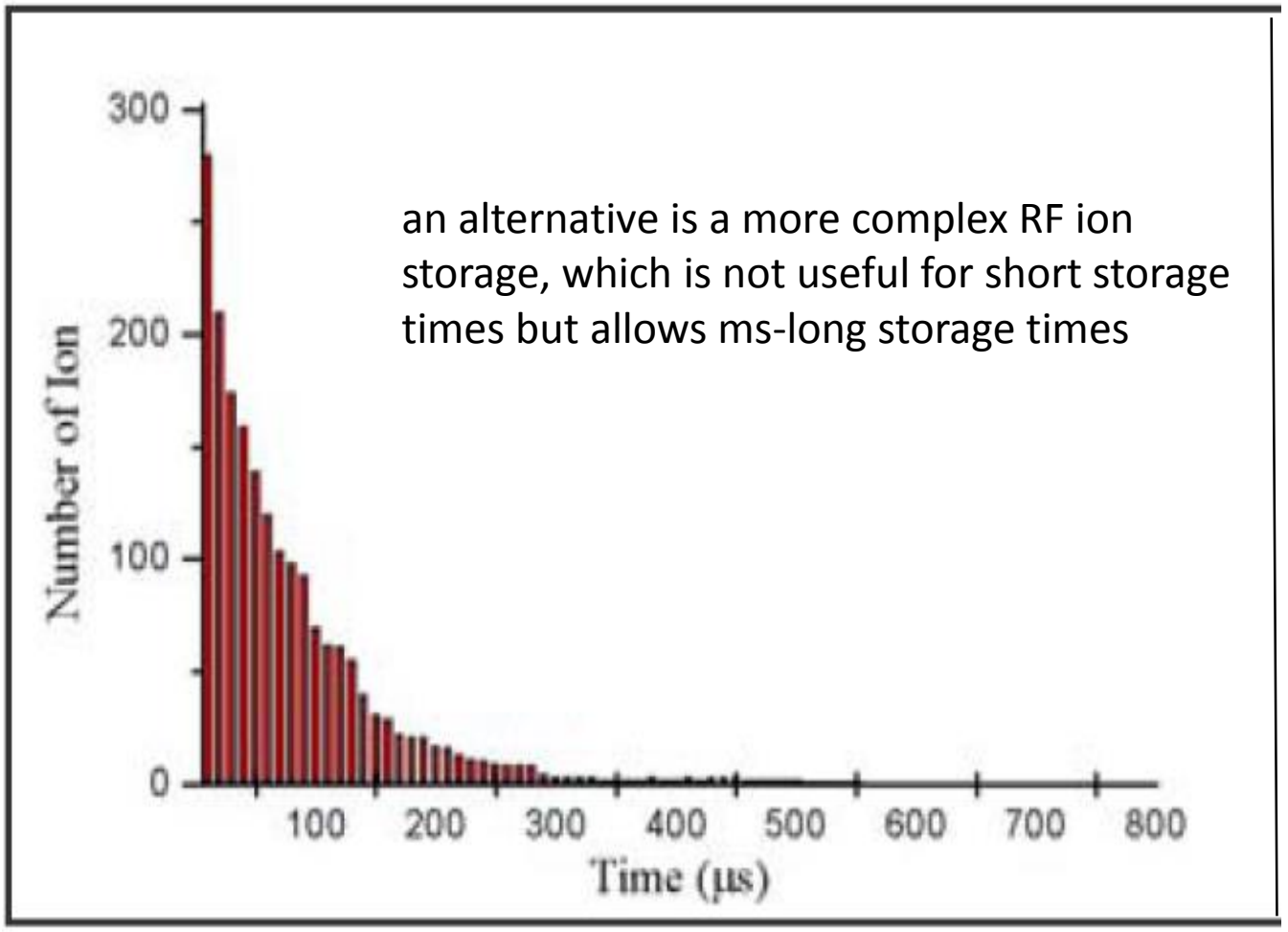

V
V(extract)
x



ion survival rate in a grid-storage



ion survival rate in a grid-storage

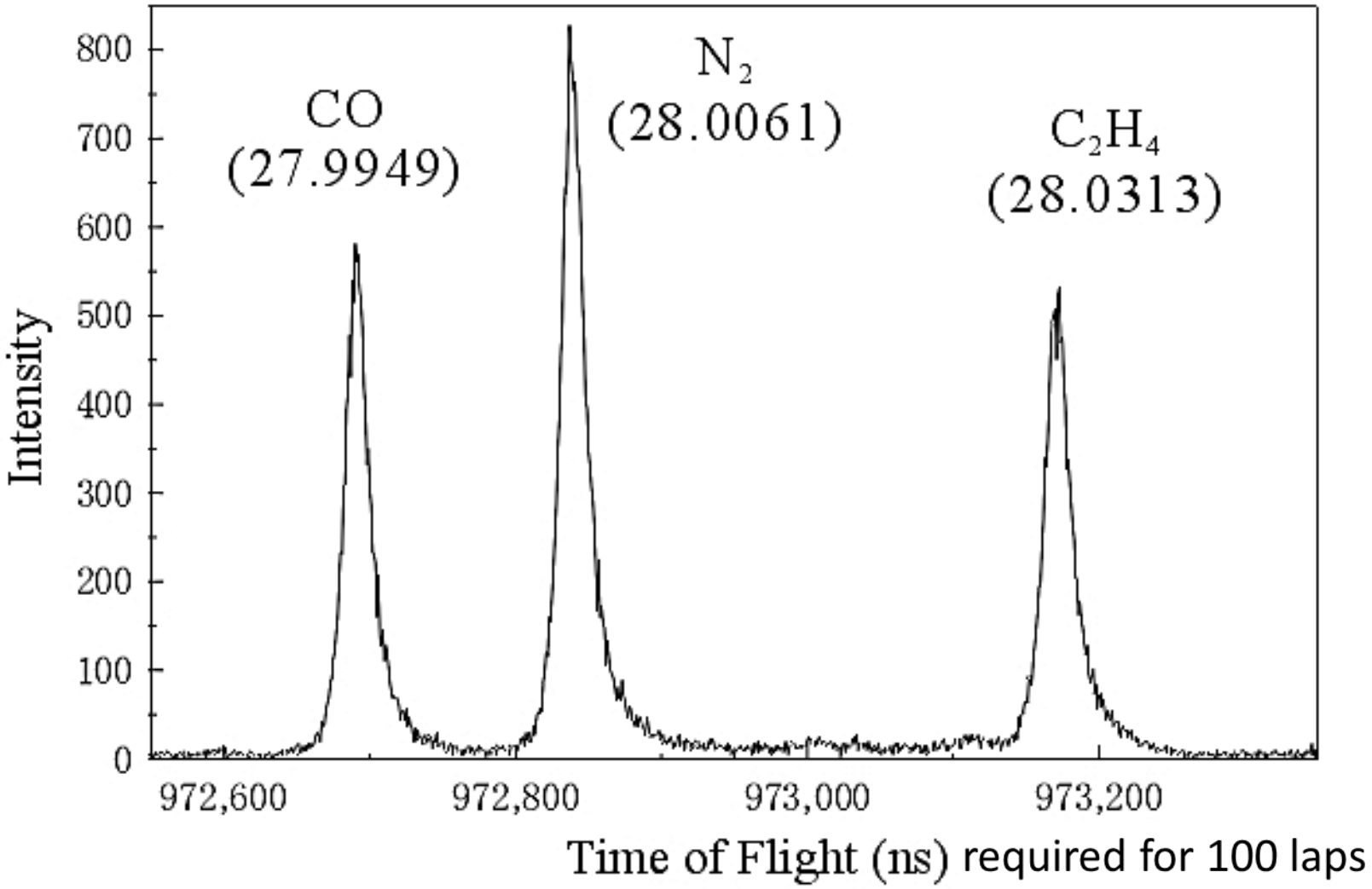


an alternative is a more complex RF ion storage, which is not useful for short storage times but allows ms-long storage times

mass spectrum of C0, N_2 and C_2H_4

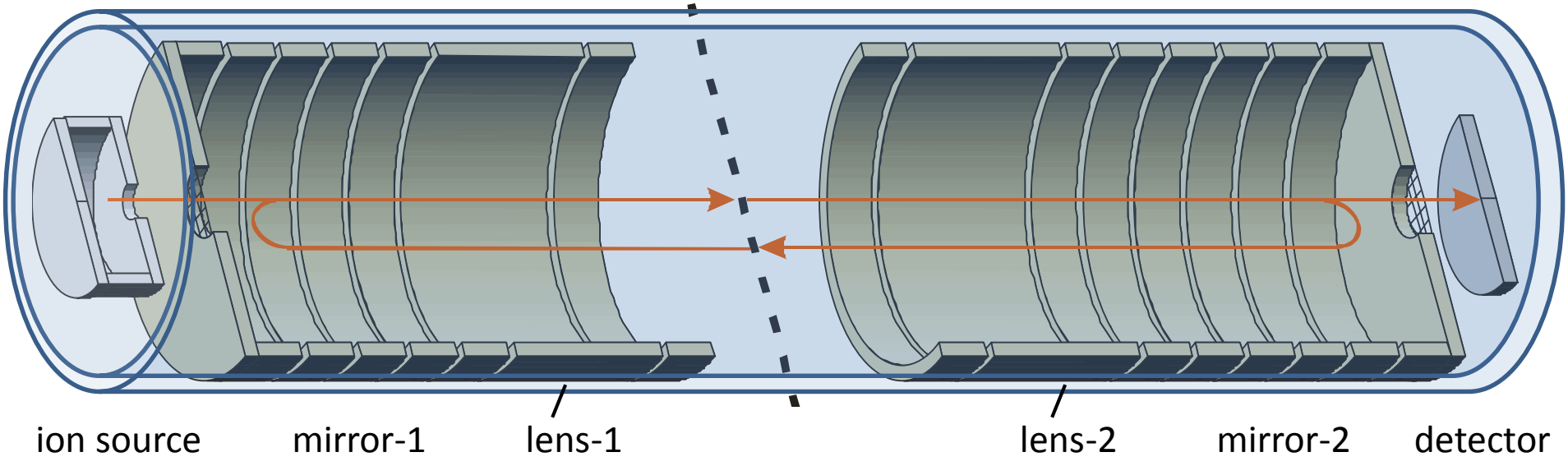
$R_m \approx 20,000$

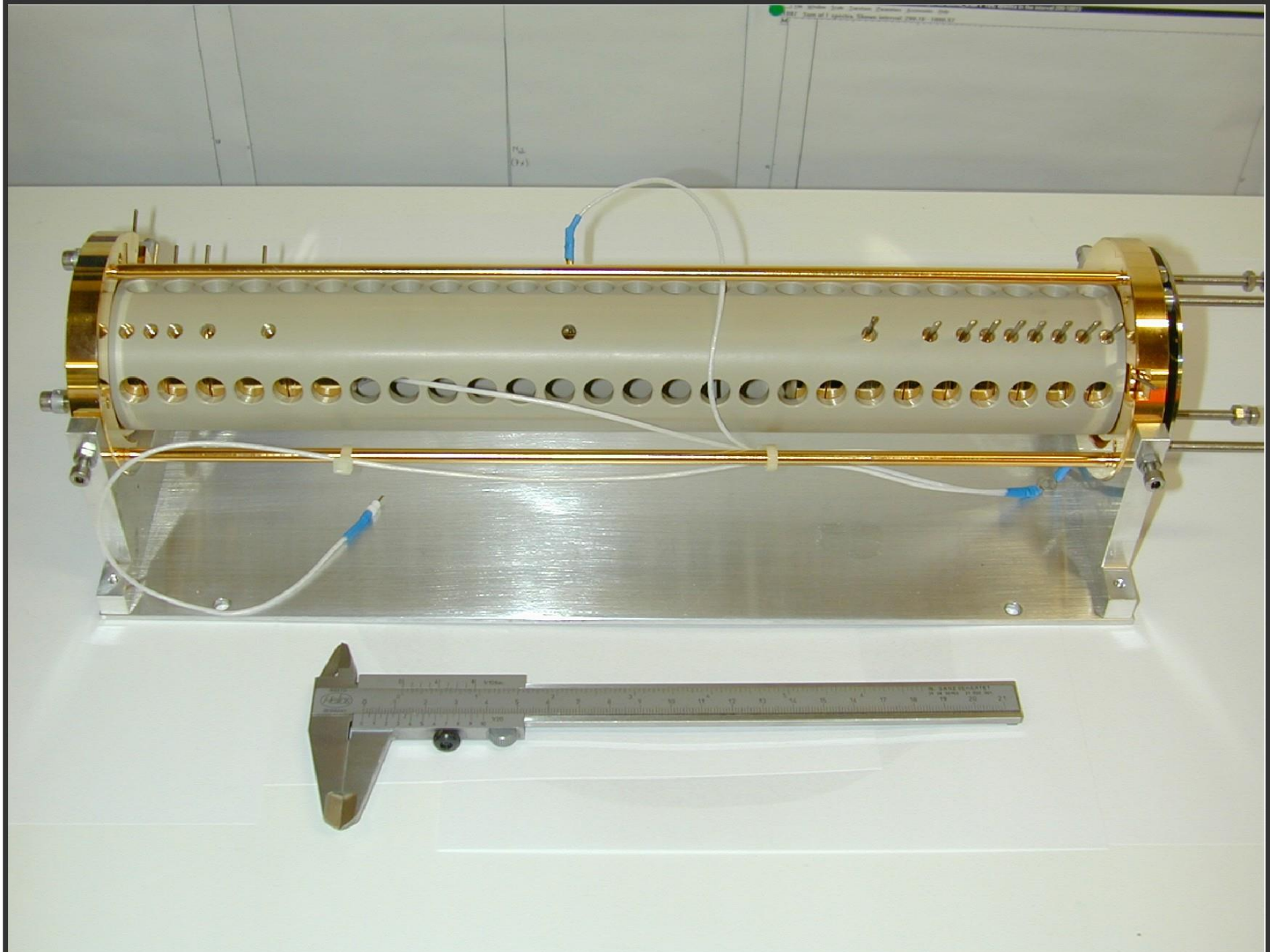
Ishida et al 2003

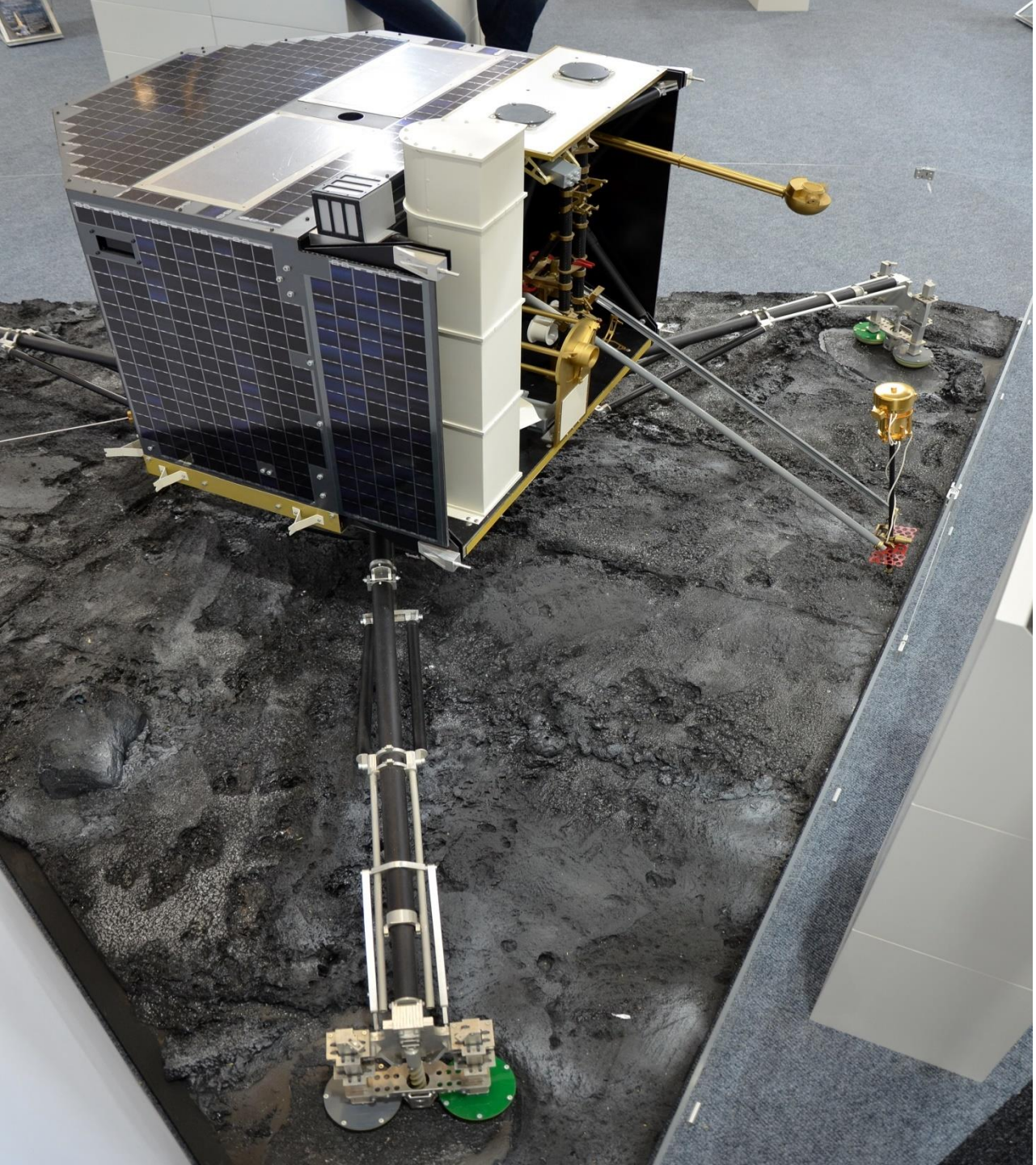


an MRTOF-MA for the ROSETTA comet misssion

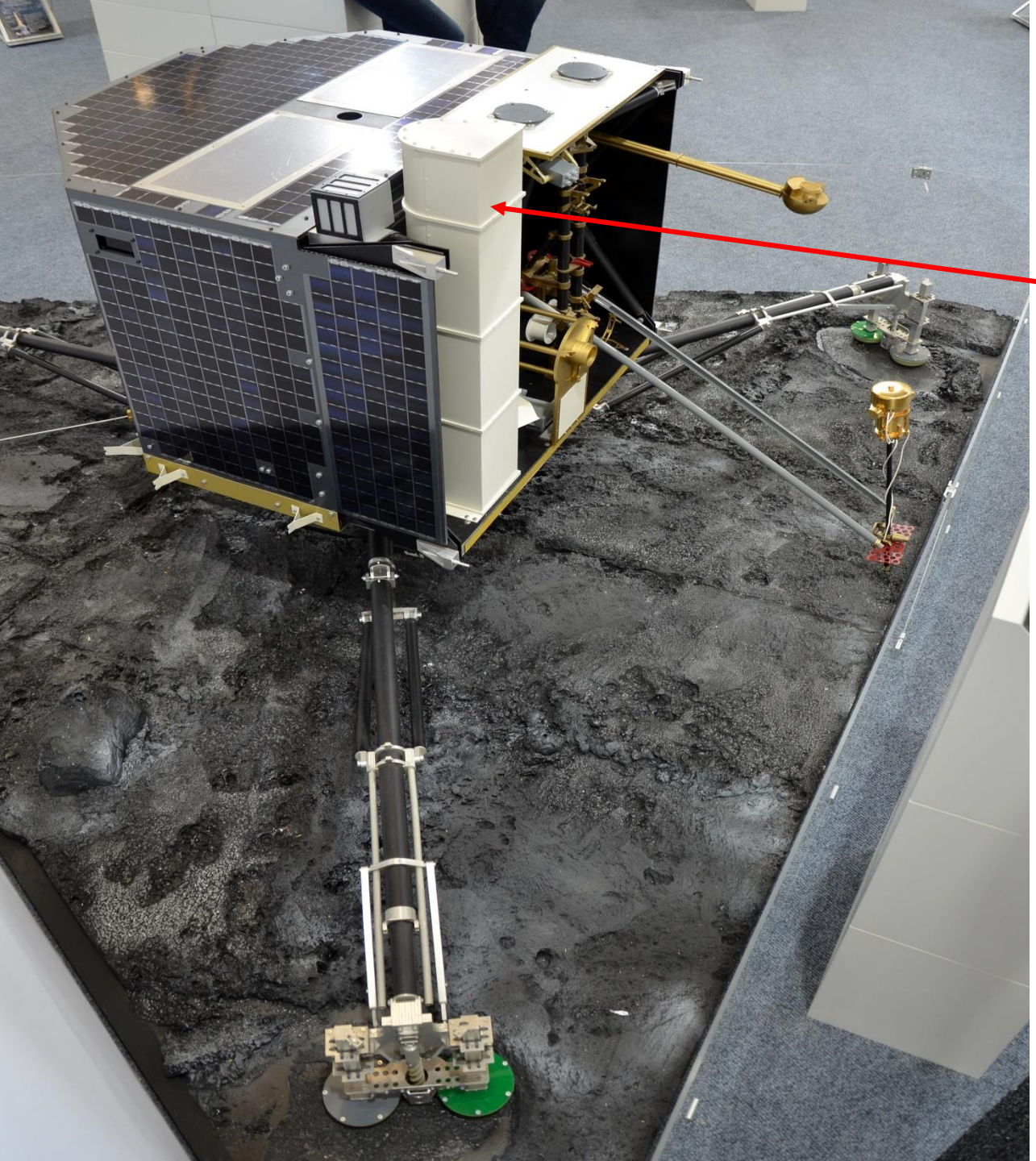
Wollnik DE30255764 (1982)
Wollnik, Casares int.J.MS 227(2003)217





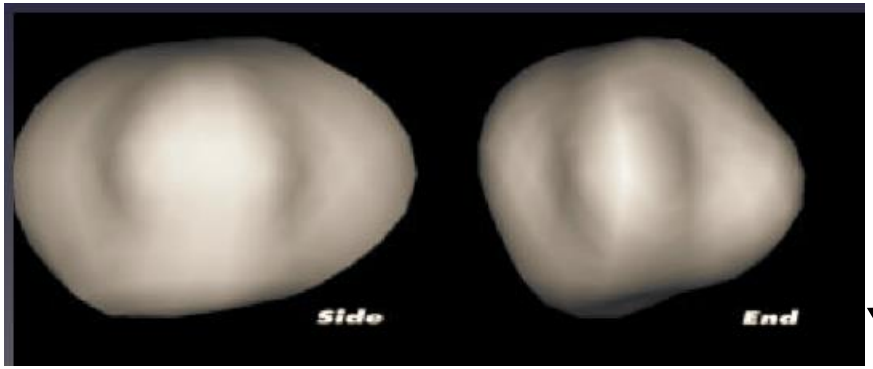


PHILAE
the ROSETTA lander



PHILAE
the ROSETTA lander

MRTOF-MA



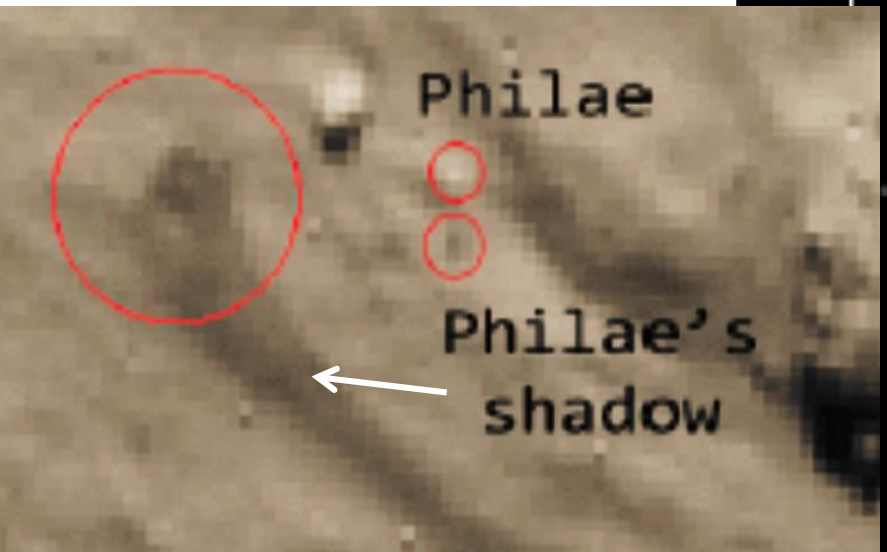
Comet: 67P Churyumov-Gerasimenko

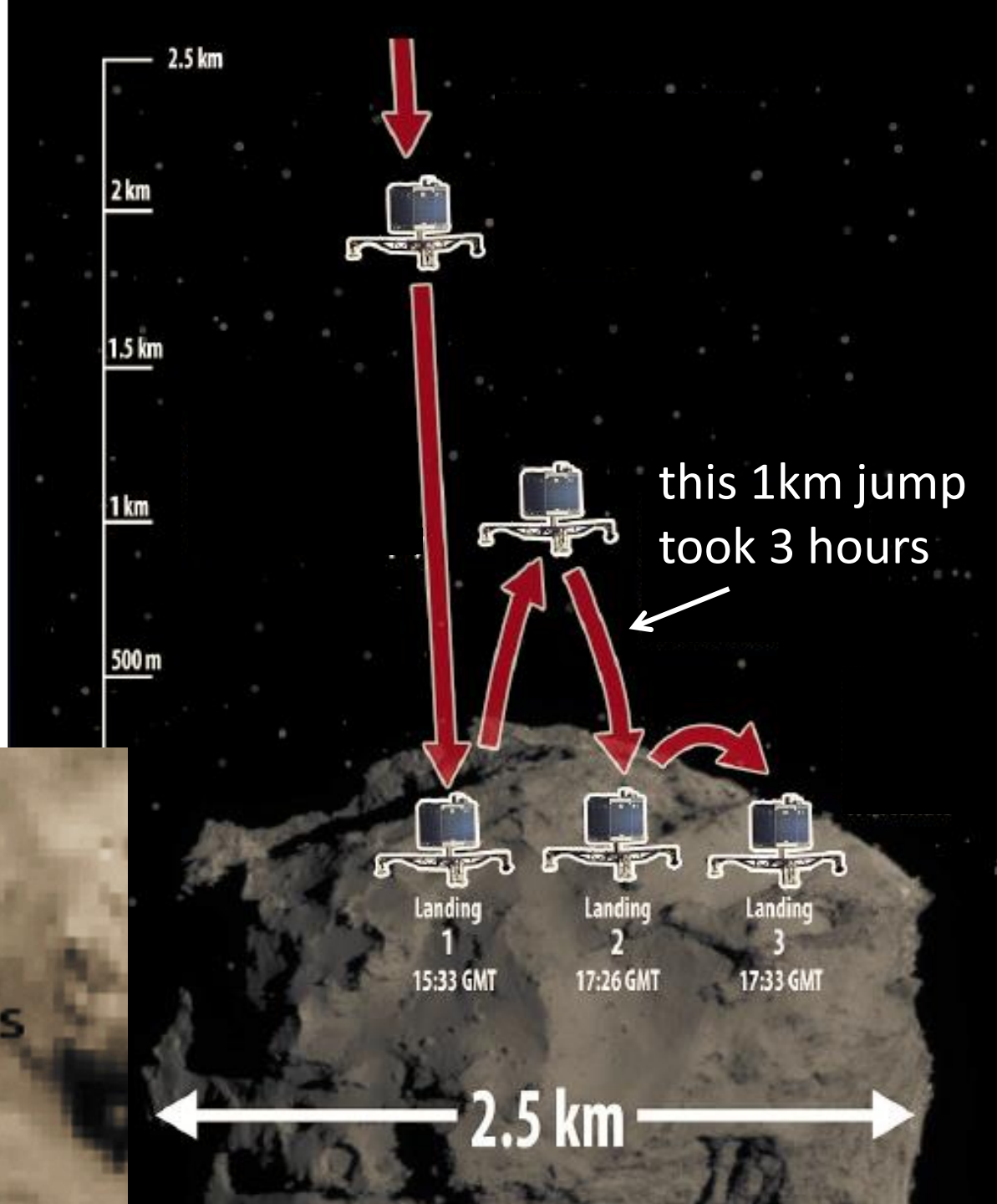
seen from 5AU by Hubble Telescope

seen from 285km by ROSETTA camera

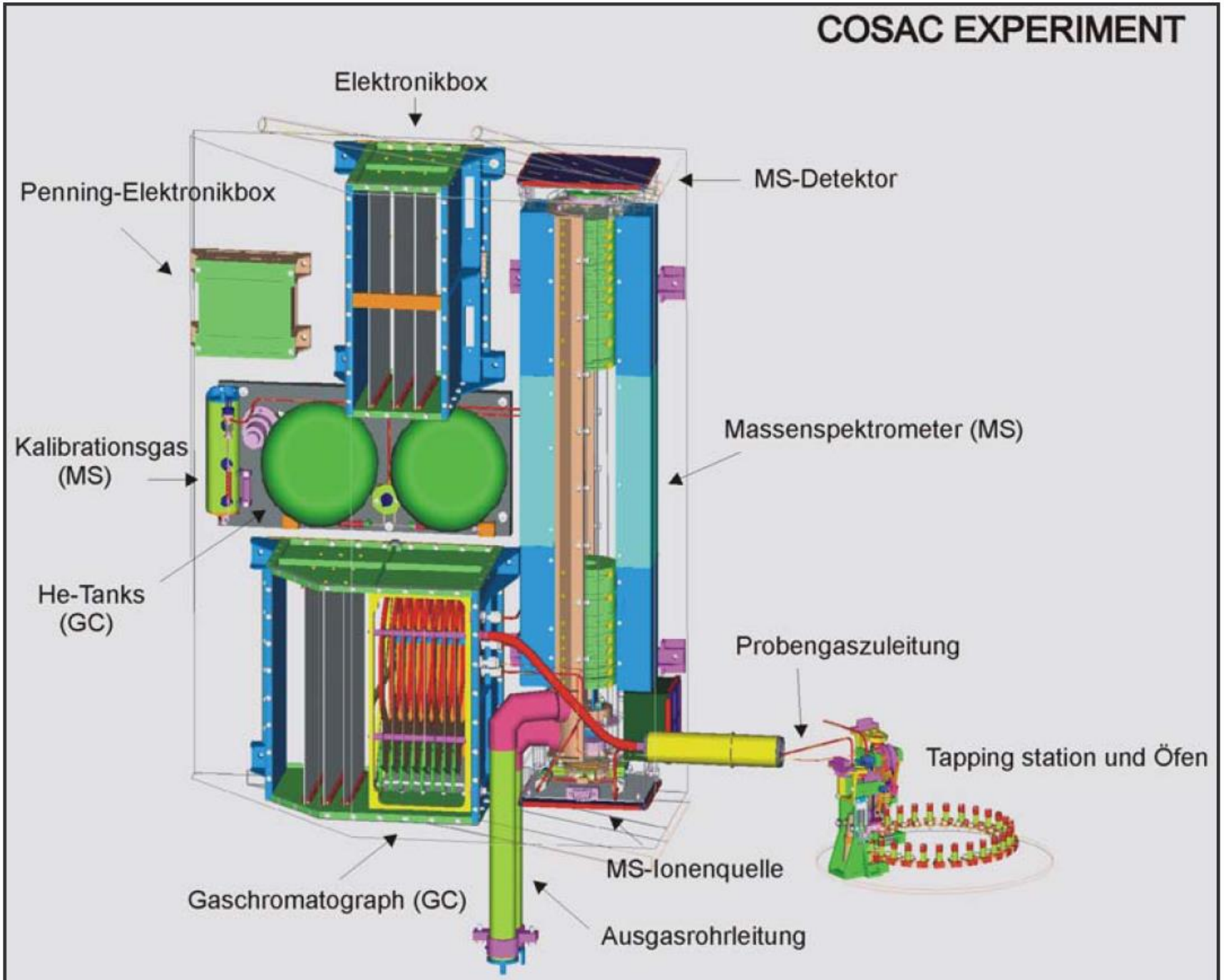
lander PHILAE started 22km from 67P

photo of 1st landing site

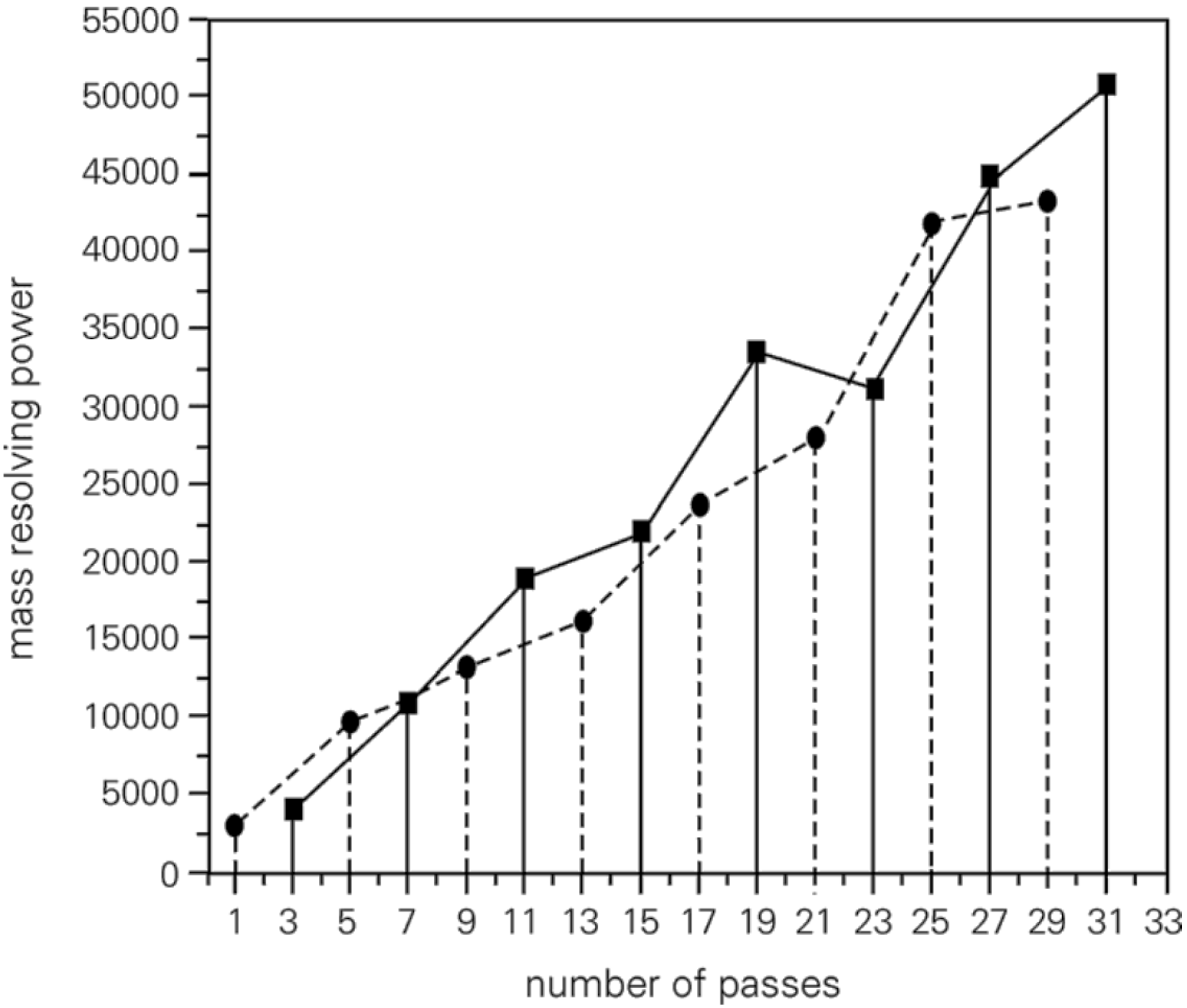


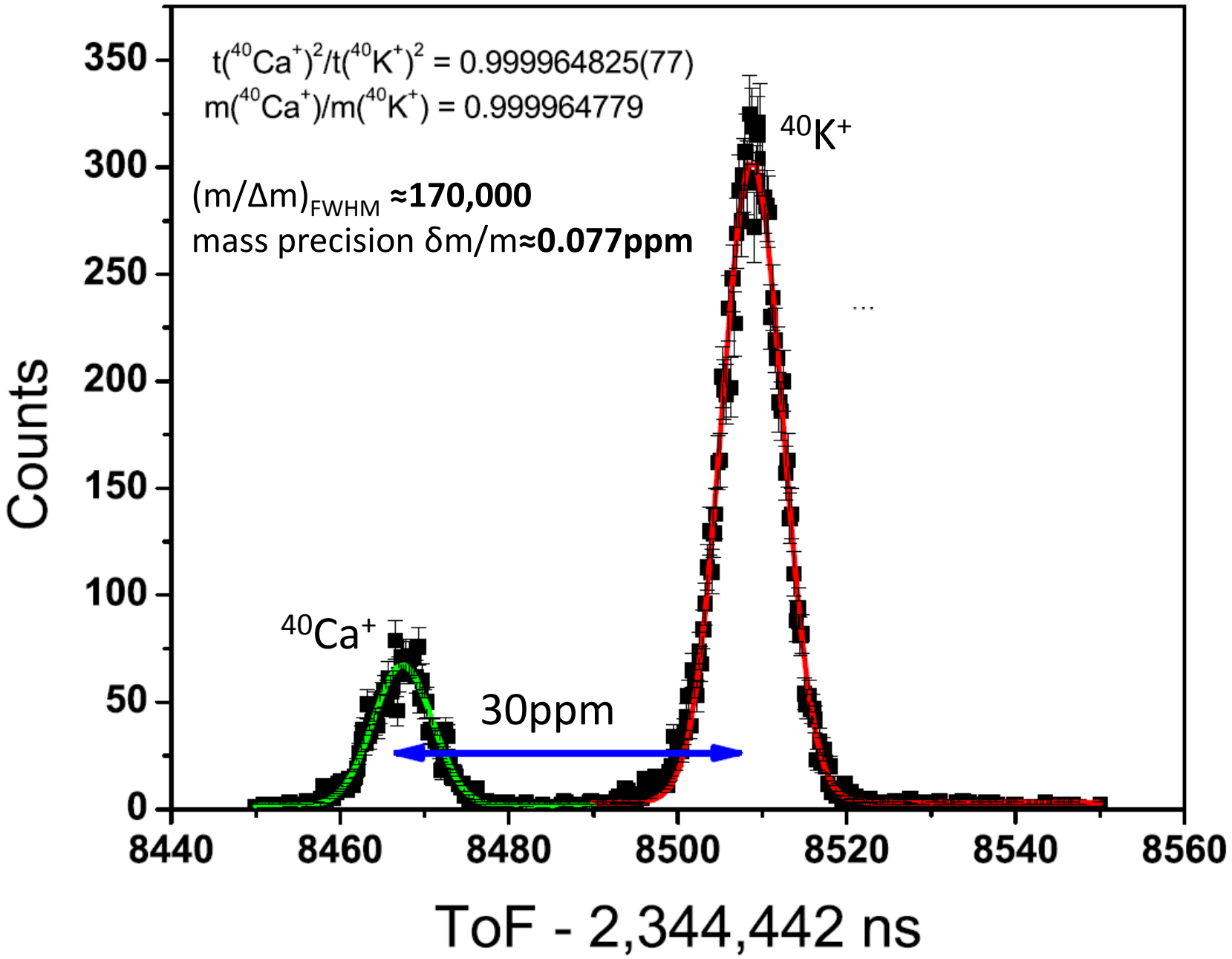


COSAC EXPERIMENT



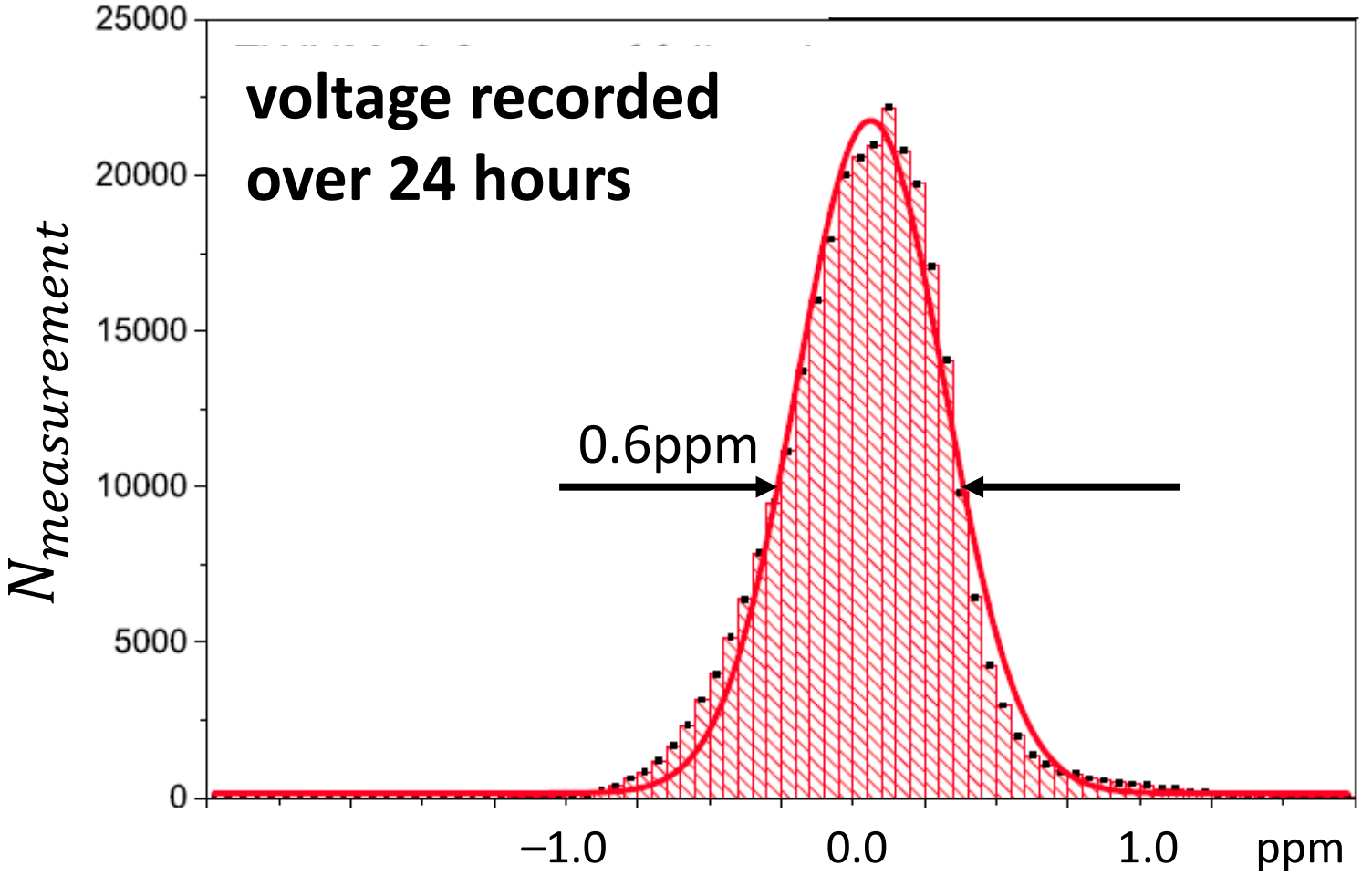
aberrations in a MRTOF-MA of fourfold symmetry

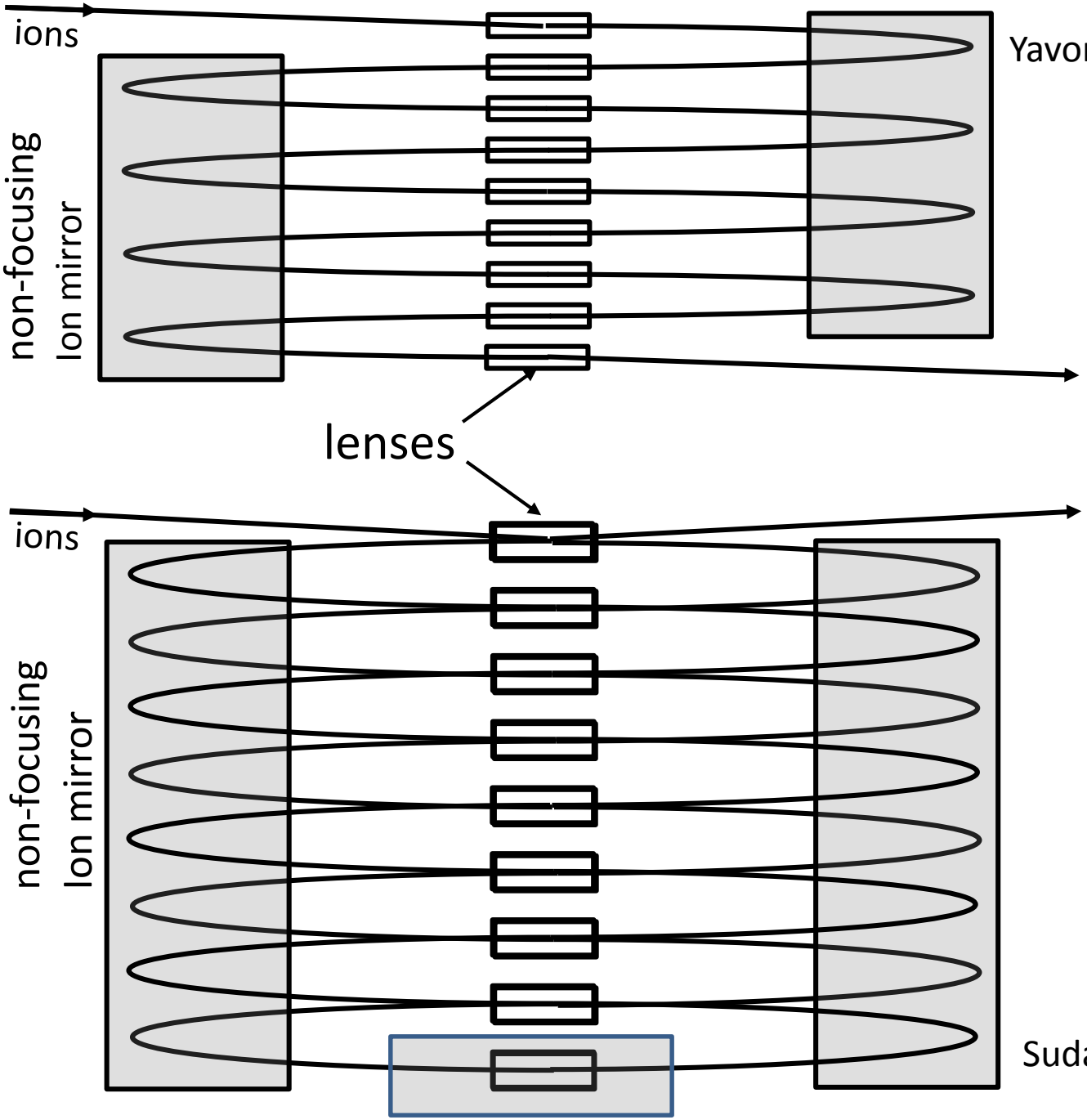




Schury et al. NIM B335(2014)39

voltage-supply with a stability of ≤1ppm





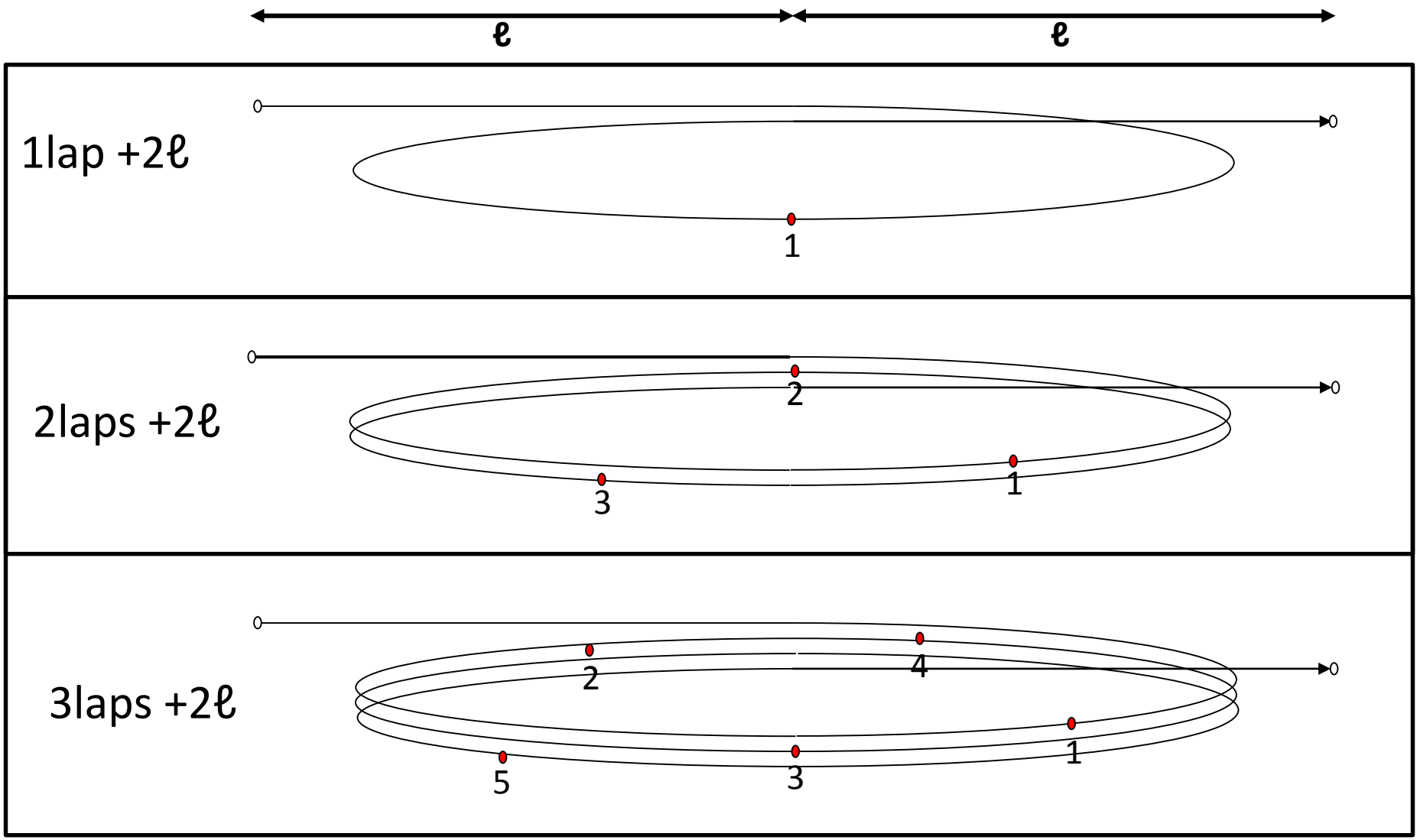
Yavor, Verentschnikov 2010

multi

TOF-MA

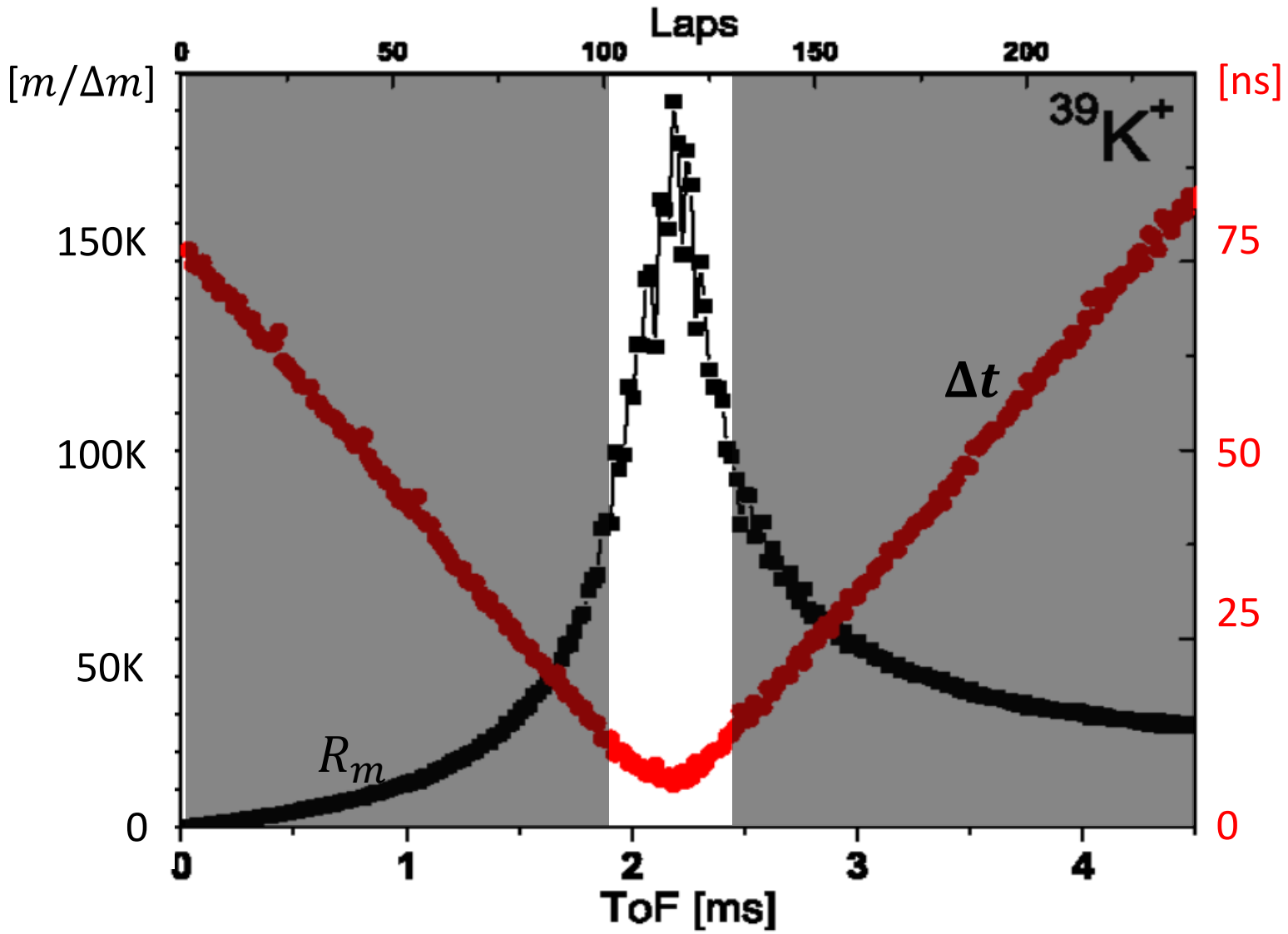
Sudakov 2006

Principle of N-pass TOF-MS with finite number of laps and shifted time focus



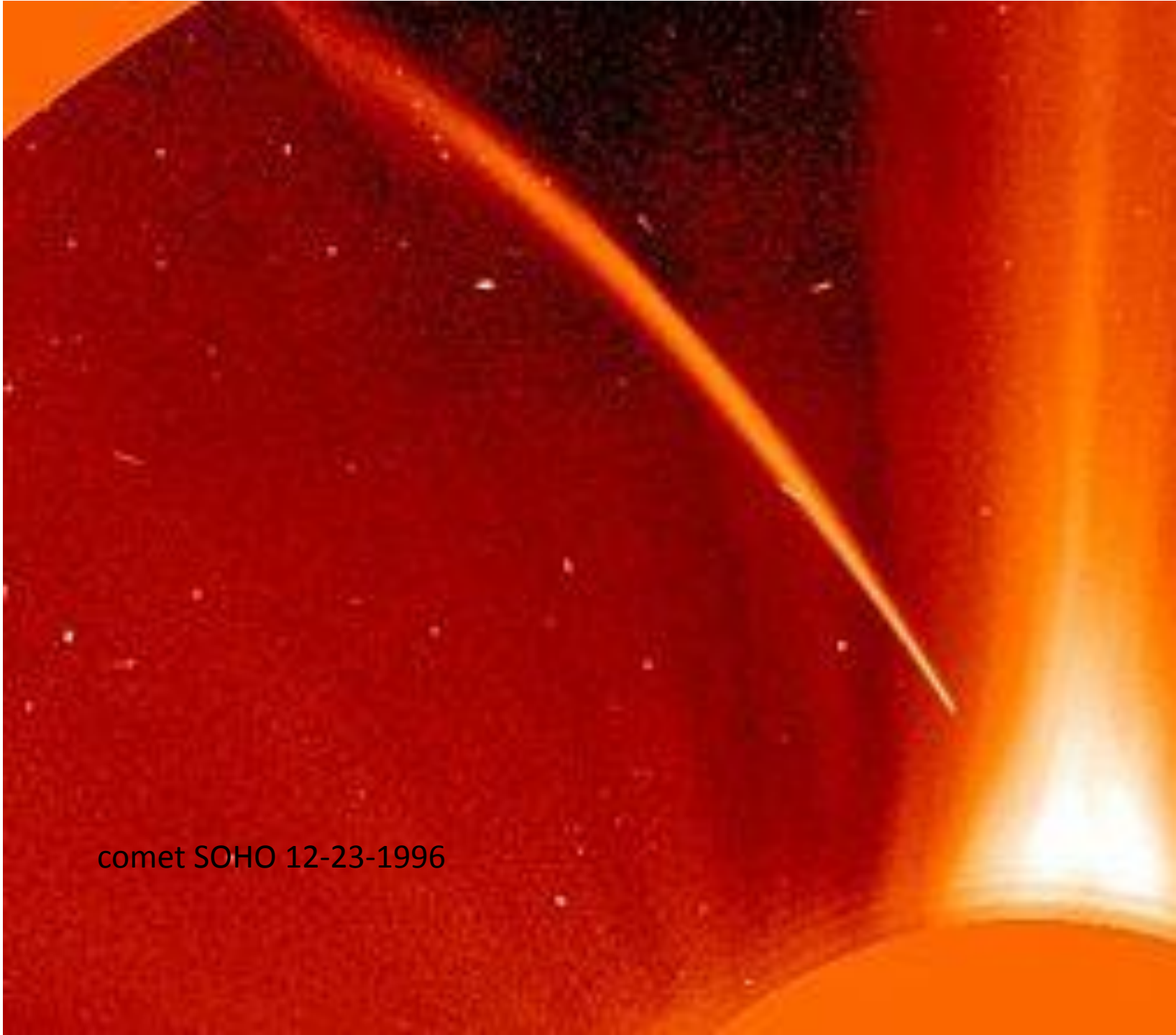
Casares 1997

resolving power as function of Lap# with $N_{lap\#-optimal} = 115$




Pluto
Neptune
Uranus
Saturn
Jupiter
Mars
Earth
Venus
Merkur


HALLEY’S COMET (≈15KM)



comet SOHO 12-23-1996