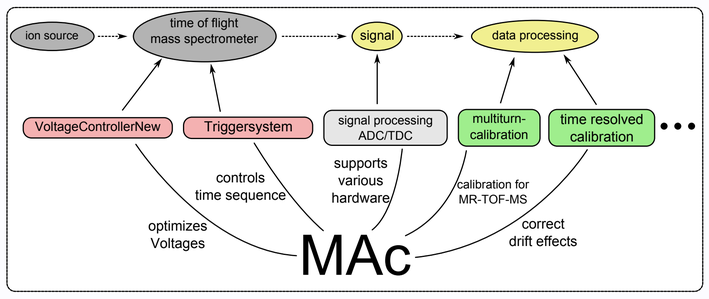
MAc, Software for data acquisition and hardware control of time-of-flight mass-spectrometers

Julian Bergmann[1], Alexander Pikhtelev[2], Samuel Ayet San Andres[3], Timo Dickel[1,3], Jens Ebert[1,4], Hans Geissel[1,3], Christine Hornung[1], Johannes Lang[1], Wayne Lippert[1], Christian Lotze[1], Wolfgang Plaß[1,3], Ann-Kathrin Rink[1] and Christoph Scheidenberger[1,3]

[1] JLU Gießen, Deutschland — [2]Institute of Energy Problems of Chemical Physics, Russian Academy of Sciences, Moscow, Russia — [3]GSI Darmstadt, Deutschland — [4]TU Darmstadt, Deutschland

1. MAc Software



- ➔ data acquisition
- ➔ data evaluation
- ➔ hardware control

Features:

+ ADC/TDC for large dynamic range
+ time sequence controller
+ multi-reflection calibration
+ voltage optimizer
+ time resolved calibration
+ spectra accumulation
+ automatic peak detection
+ import/export various file formats
+ data operations (e.g. smoothing)

2. Enlarging dynamic range using TDC and ADC simultaniously.

TDC:

+ detection of single Ions
− dead time effect

ADC:

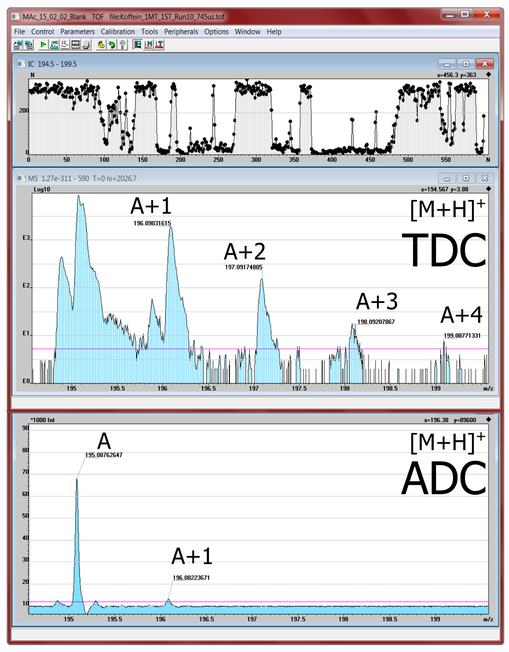
+ detection of high signal rates
− low intensity signals lost

Combined:

+ dynamic range > 4 Orders of magnitude
+ detection of high and low signal rates

MAc:

- ➔ common user Interface
- ➔ common calibration
- ➔ common file format and analysation tools



Example: Coffein (10^{-4} mol/l)

TDC (top):
+ A+1 to A+4

ADC (bottom):
+ A and A+1

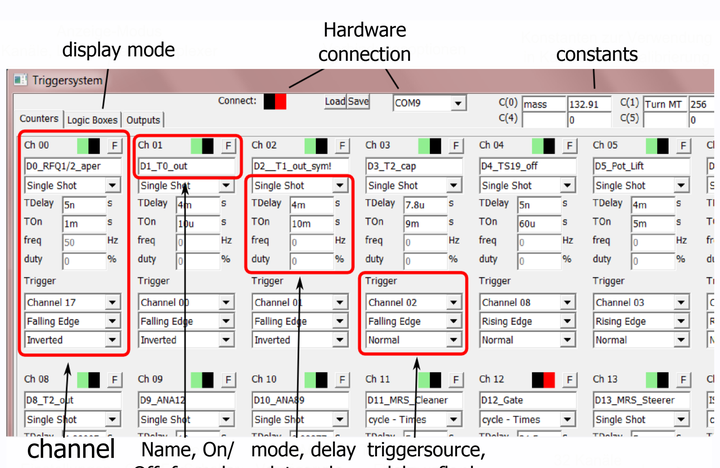
Device	Isotope	MAc	Literature	rel. Deviation
ADC	m195 / m196	9,374 79	9,457 79	0,008 78
TDC	m196 / m197	11,7599	11,7515	$7{,}1480 \cdot 10^{-4}$
	m197 / m198	5,629 95	19,1104	0,705 40
	m198 / m199	3,404 73	33,768	0,899 17

Excelent Isotop distribution

unresolve Isobars

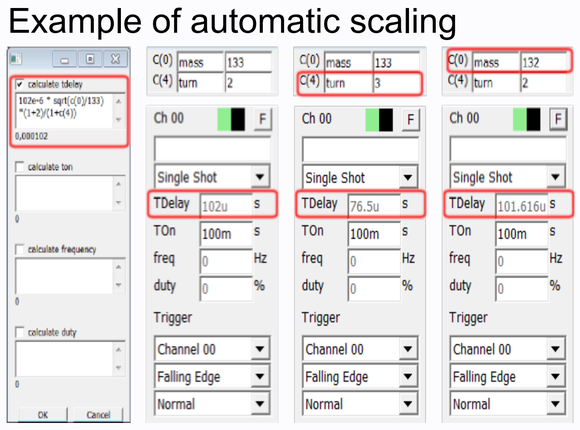
3. Time Sequence controller

- ➔ controls time sequences for traps, electrodes etc.
- ➔ multiple modes to set delays and duty cycles



+ link triggers for 32 channels to each other or up to 16 logic channel combinations
+ use formulars to calculate delay and duty cycles
  + link to other channel's times
  + use up to 8 constants
+ set times can be used in other MAc parts
  - ➔ calibration

Example of automatic scaling



4. Multiturn Calibration

Calibration Formular

$$m = a\frac{(t-t_0)^2}{(1+b\cdot N)^2}$$

$$a = \frac{2q\cdot U}{l_{detec}^2} \qquad b = \frac{l_{turn}}{l_{detec}}$$

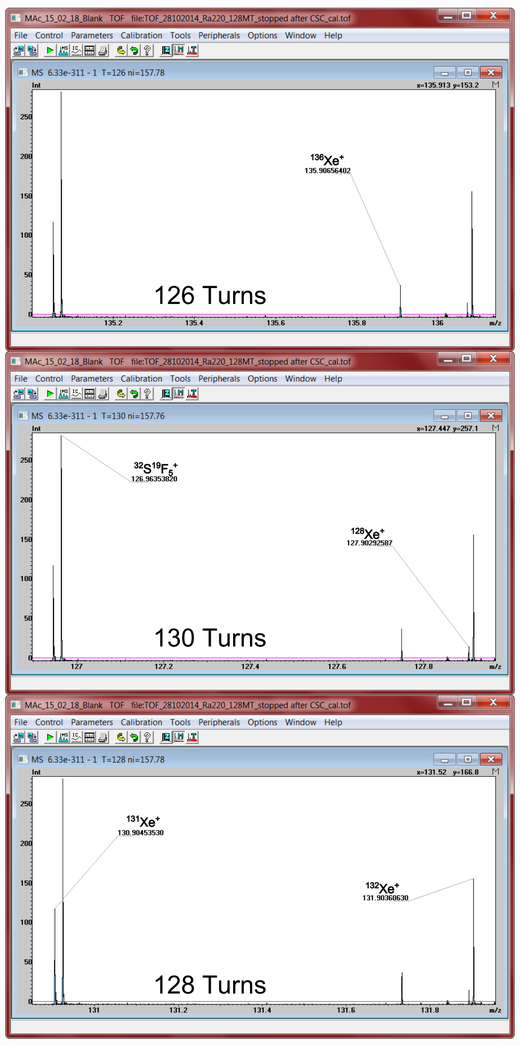
t_0: electronic delay time

+ ≤3 calibrants ➔ analytical
+ >3 calibrants
  - ➔ least square deviation minimizer
+ uses time sequence controller for trap extraction time
+ use and display for different turns in multiturn calibration
+ mass range greatly increased

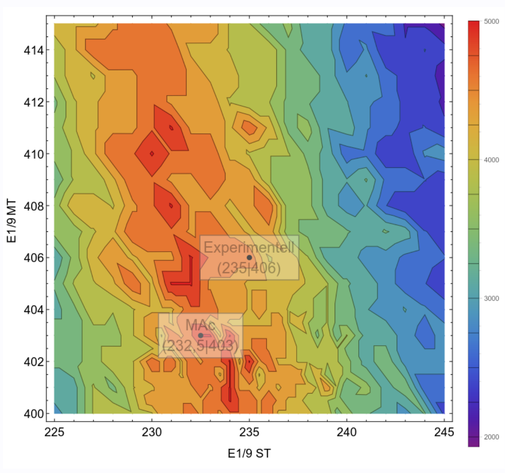
Example: Xe & SF6

+ between 126 and 130 Turns
+ precision of online identified masses of $4{\cdot}10^{-7}$

Time (µs)	Turns	Mass MAc (u)	Mass Lit (u)	$\frac{\text{Lit}-\text{MAc}}{\text{Lit}}$	Nuklid
49,3071469	130	127,9029259	127,9029822	$4,40 \cdot 10^{-07}$	$^{128}Xe^+$
46,5327600	126	135,906564	135,9066657	$7,48 \cdot 10^{-07}$	$^{136}Xe^+$



5. Voltage Optimizer



- ➔ connects to all available power suplies
- ➔ free choice for amount of channels
- ➔ from adjustable MIN to MAX all voltage combinations are testet
- ➔ automatic measurement taken for each combination
  + 20 measurements per minute
- ➔ R^2 + a I^2 automatically calculated
  + factor a to weight Intensity

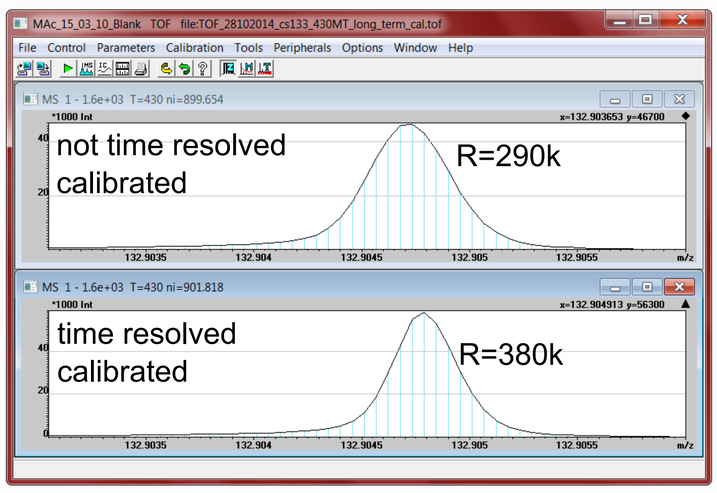
Conclusion:

Indespensable for preparing in-situ measurements e.g. for Ambiprobe MR-TOF-MS

6. Time resolved calibration

Problem:

- voltages can vary during measurement
- thus flight length varies during turns
- mass lines shift in time



Solution:

+ each spectra gets calibrated ➔ calibrant stays fixed in mass

MAc:

+ automatic detection of calibrant
+ correction of 2000 spectra in under 1 second
+ recalibrated data can be displayed and used inside MAc
+ ideally suited for long term or high resolution measurements

Poster Information

Euroschool on Exotic Beams 2016
Mainz, Germany, 28 August - 3 September
Participant: Julian Bergmann