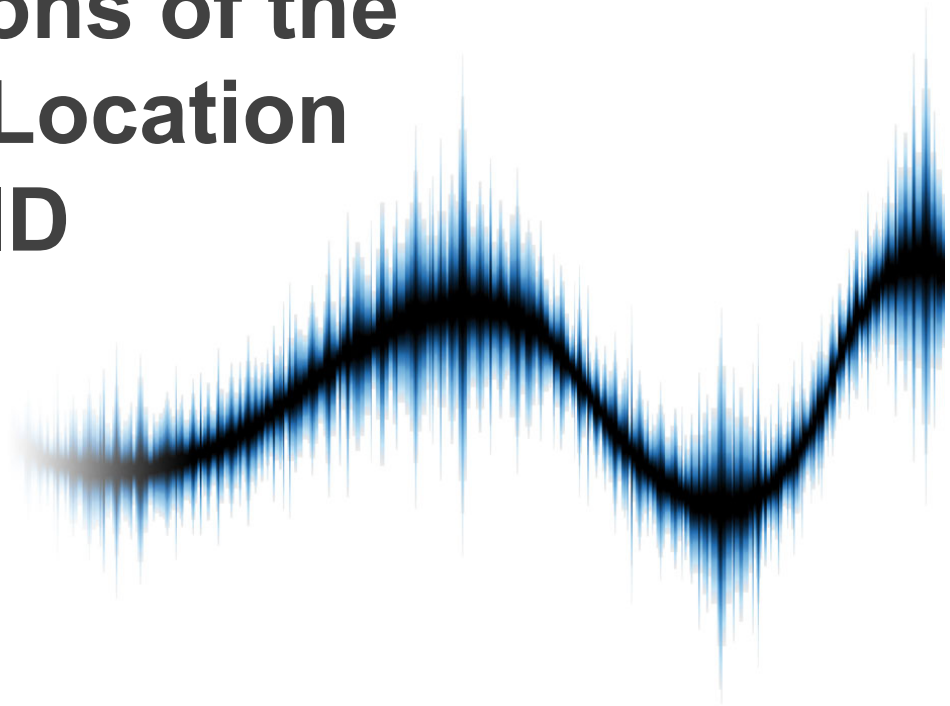
OVE Austrian Electrotechnical Association

Performance Evaluations of the European Lightning Location System EUCLID



W.Schulz
2011-10, ECSS

OVE Austrian Electrotechnical Association

EUCLID

European Cooperation for Lightning Detection

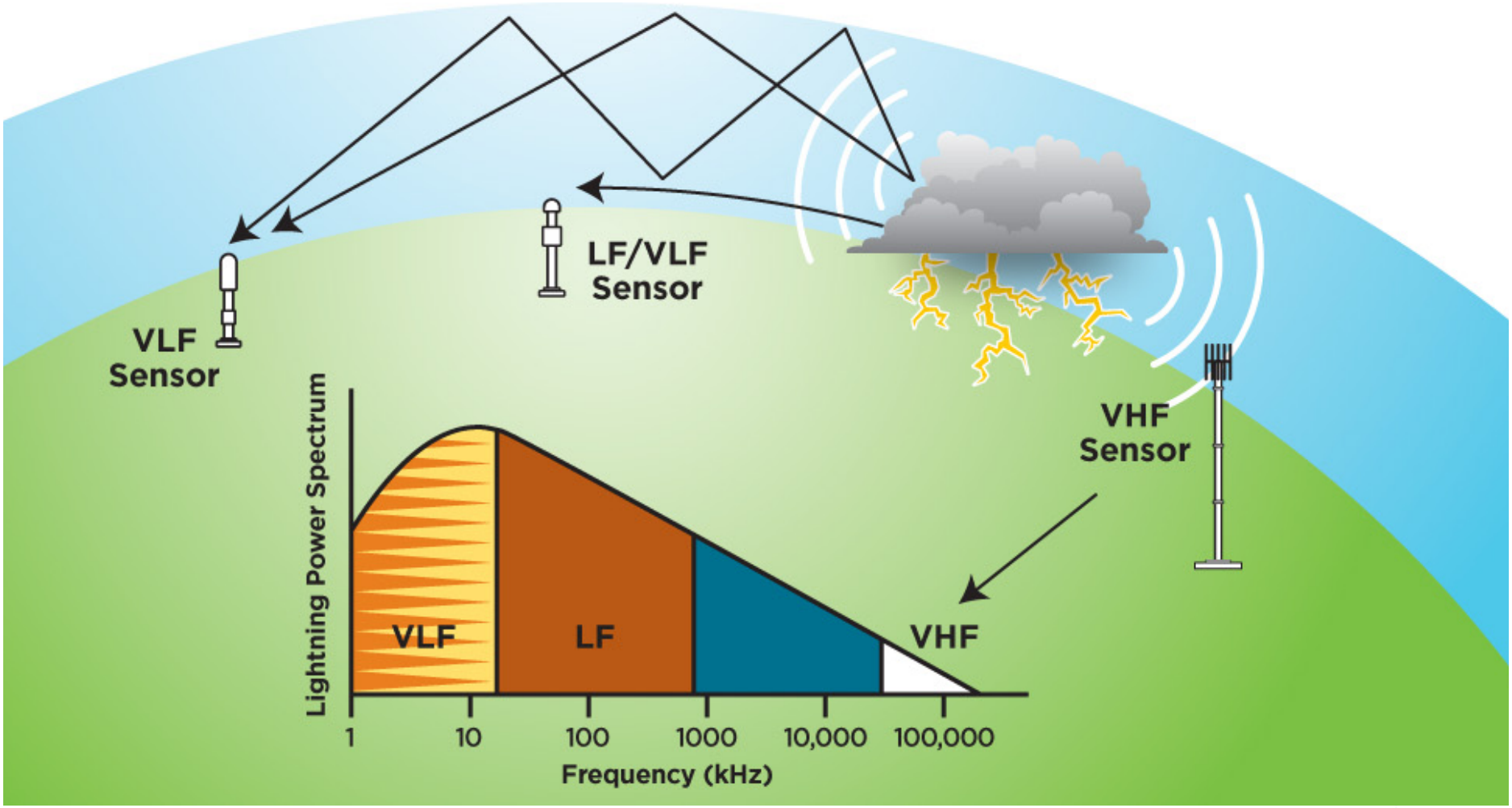
- 1999 Start with test of interconnection of LLS
- 1998 Start Gaisberg measurements
- 2001 Start of EUCLID operation
- 2002 Start video and E-field measurements

Outline

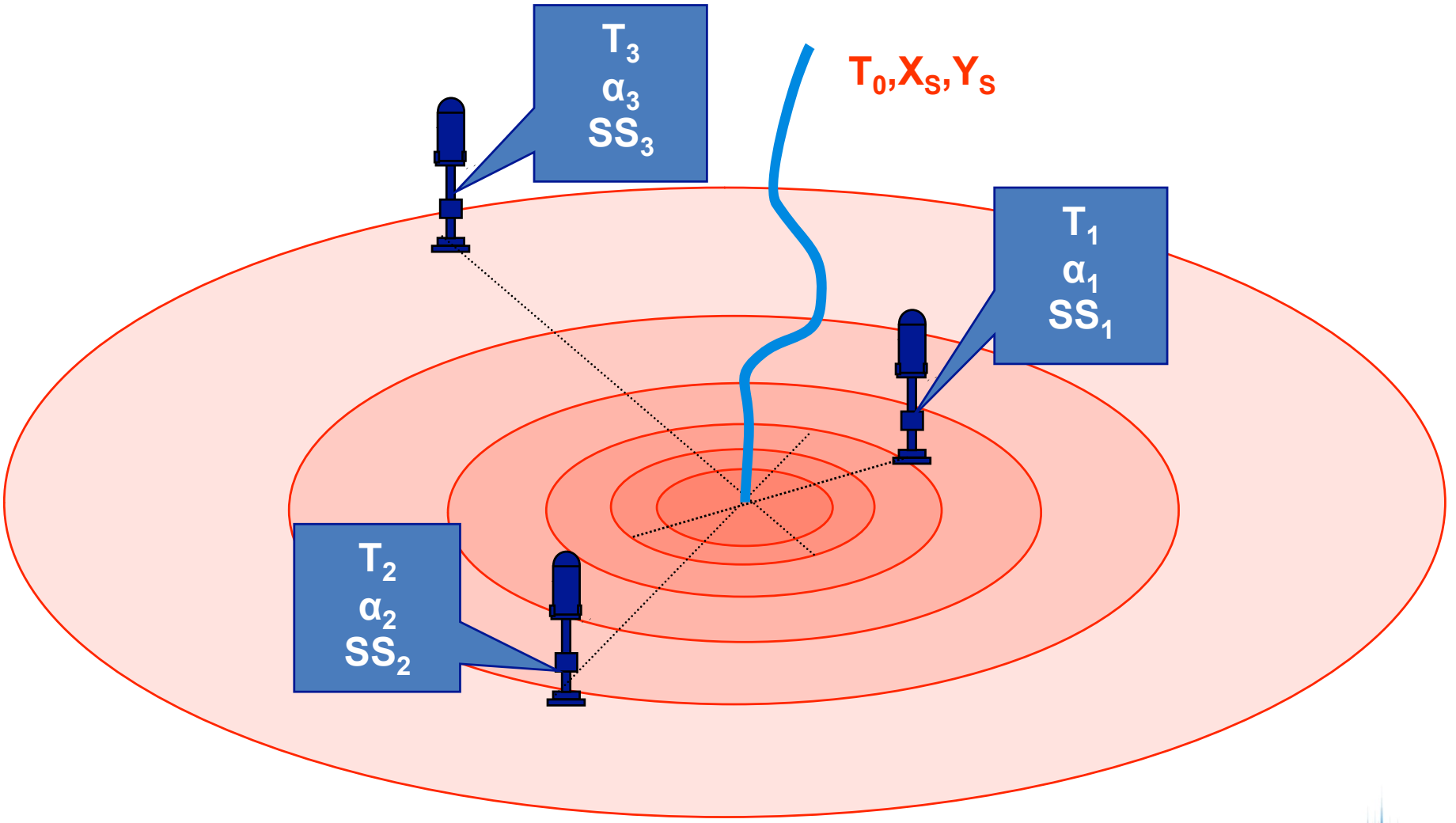
- Lighting Location Systems
- Performance Analysis based on ground truth data
  - Gaisberg Measurements
  - E-Field and Video Measurements

Lightning Location Systems

Frequency ranges of LLS operation



Sensor Reports to CP



Installed LF Sensors (in EUCLID)

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LPATS Sensor

IMPACT Sensor

LS 7000

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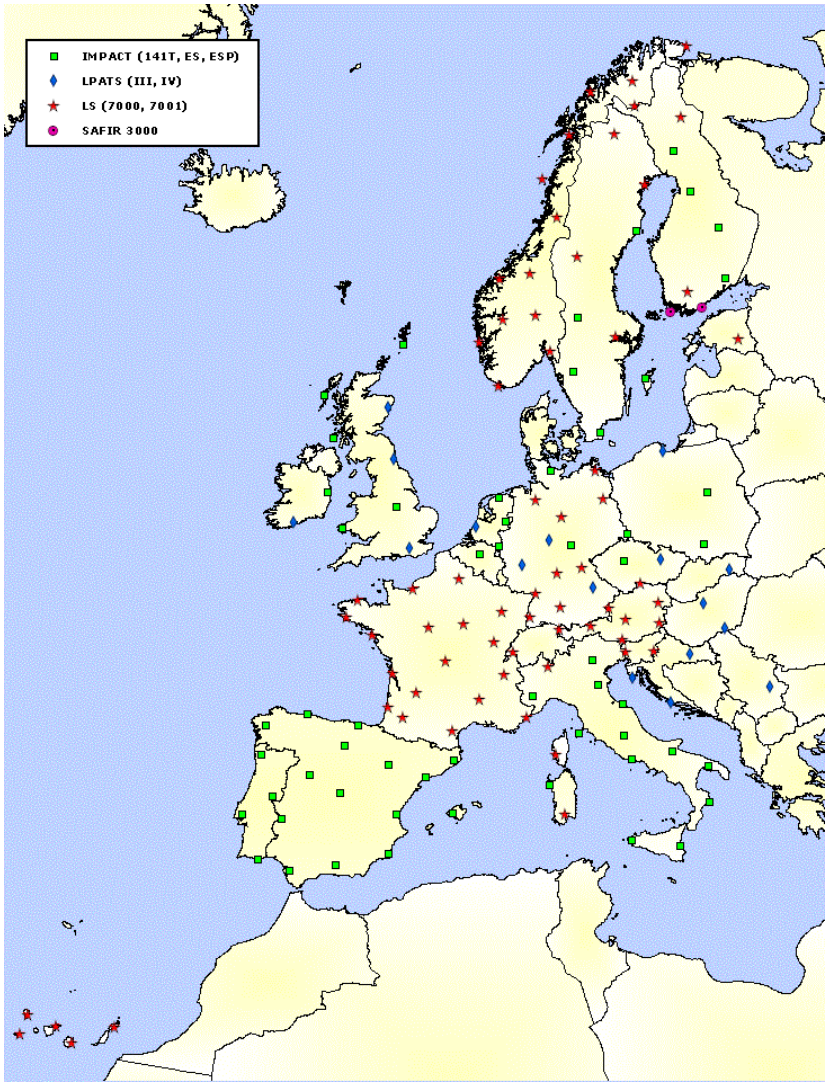
EUCLID Network (09/2011)



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LLS Performance Parameters

- Detection Efficiency
  - Flash DE
  - Stroke DE
- Classification of CG and IC lightning
- Location Accuracy
- Peak Current Estimate

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Ground truth data are needed to test and validate the performance of LLS

- Lightning to instrumented towers
- Triggered Lightning
- Video Studies

Each method has its own limitations

Gaisberg measurements

Research station Gaisberg

- Goals
  - Basic research, e.g. source of alpha pulses, field propagation, …
  - Validation of the LLS data
    - Detection efficiency
    - Location accuracy
    - Peak current accuracy

Tower Instrumentation

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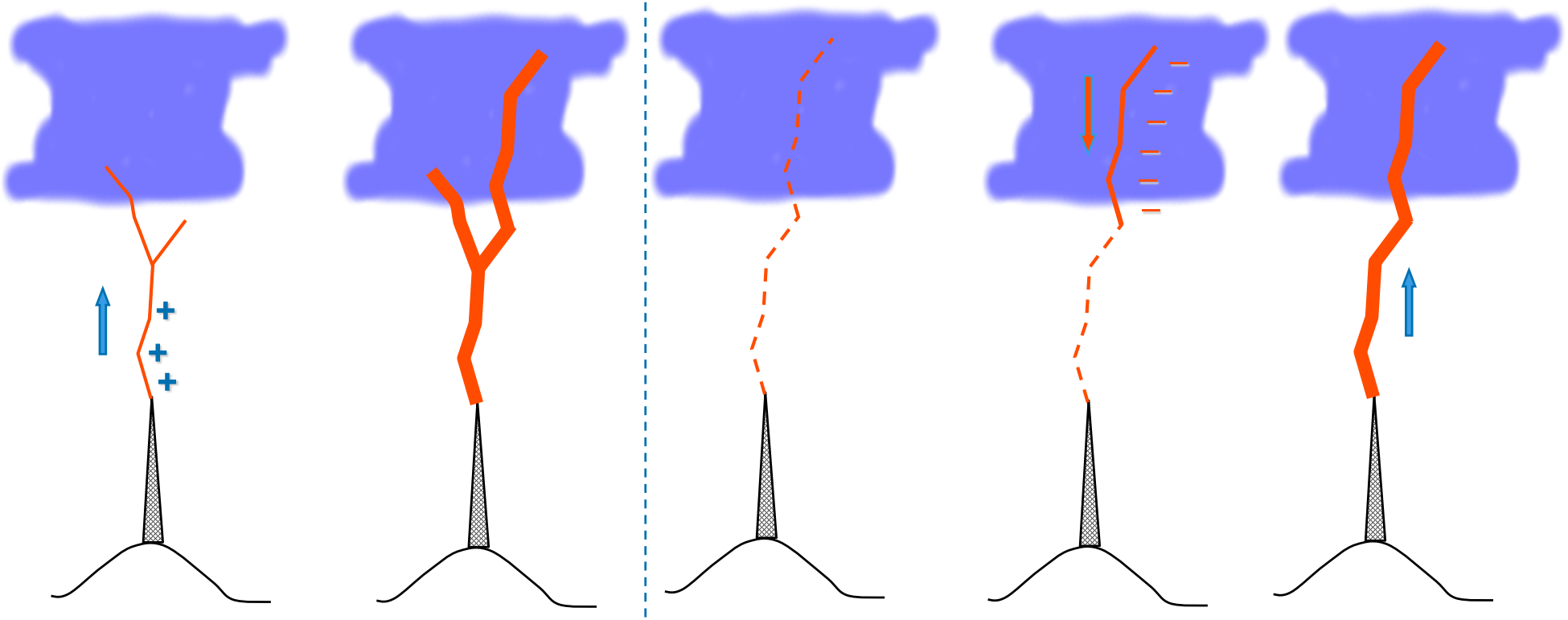
Tower triggered lightning



Upward pos. leader

Initial continuous current (ICC)

No-current interval

Downward neg. leader

Upward return stroke ß-Puls

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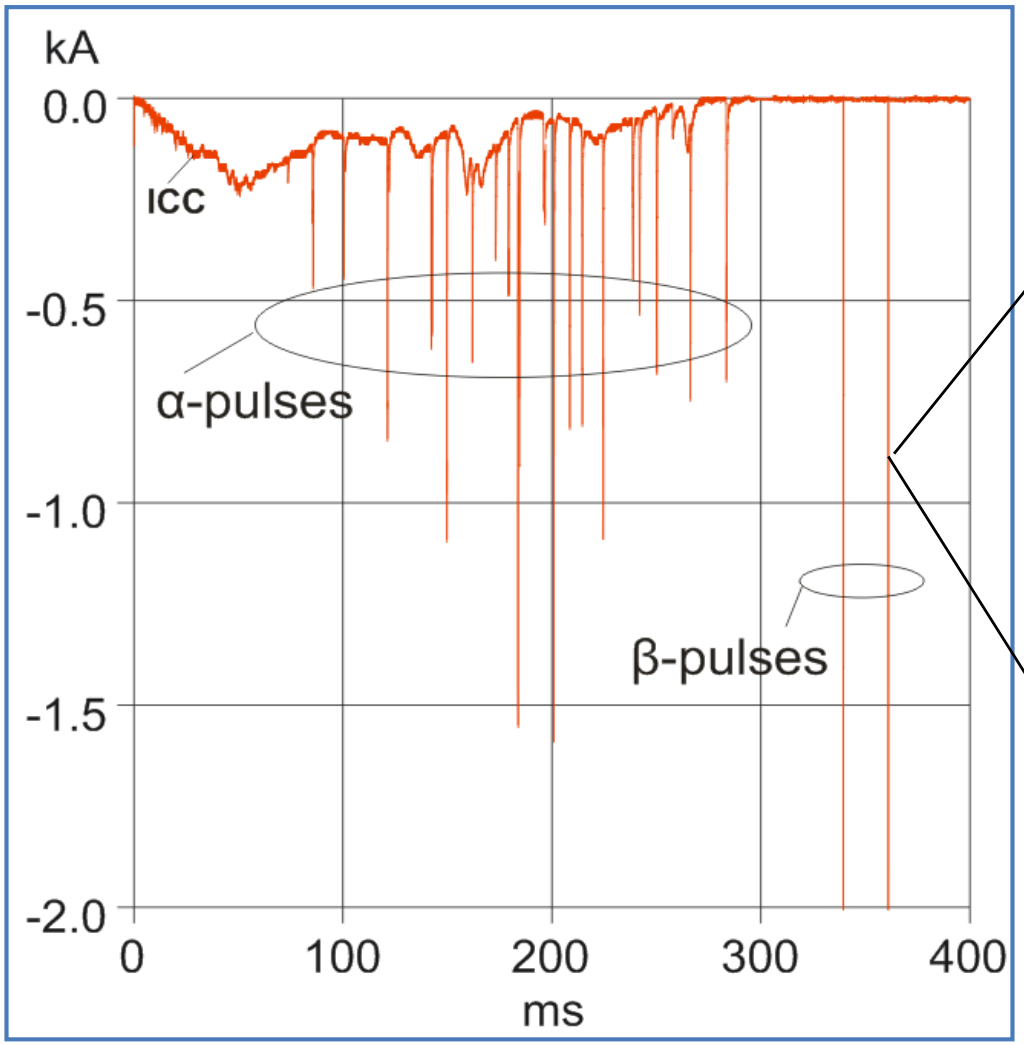
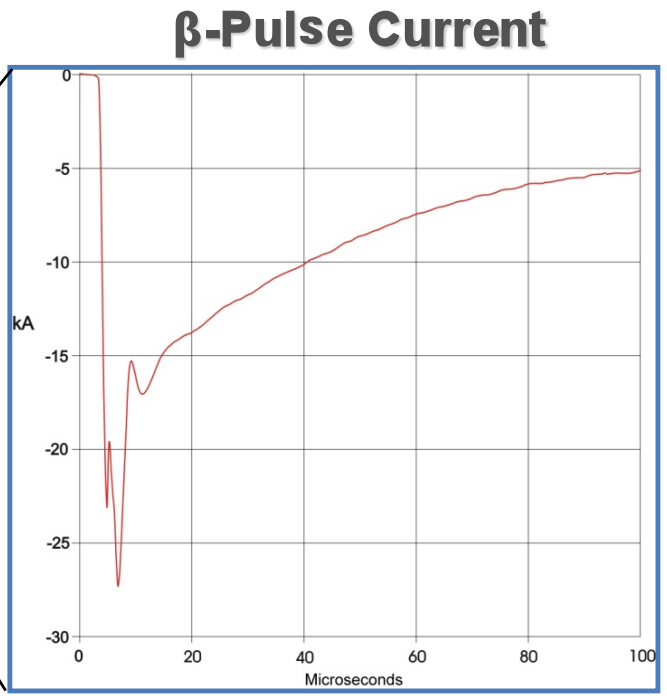
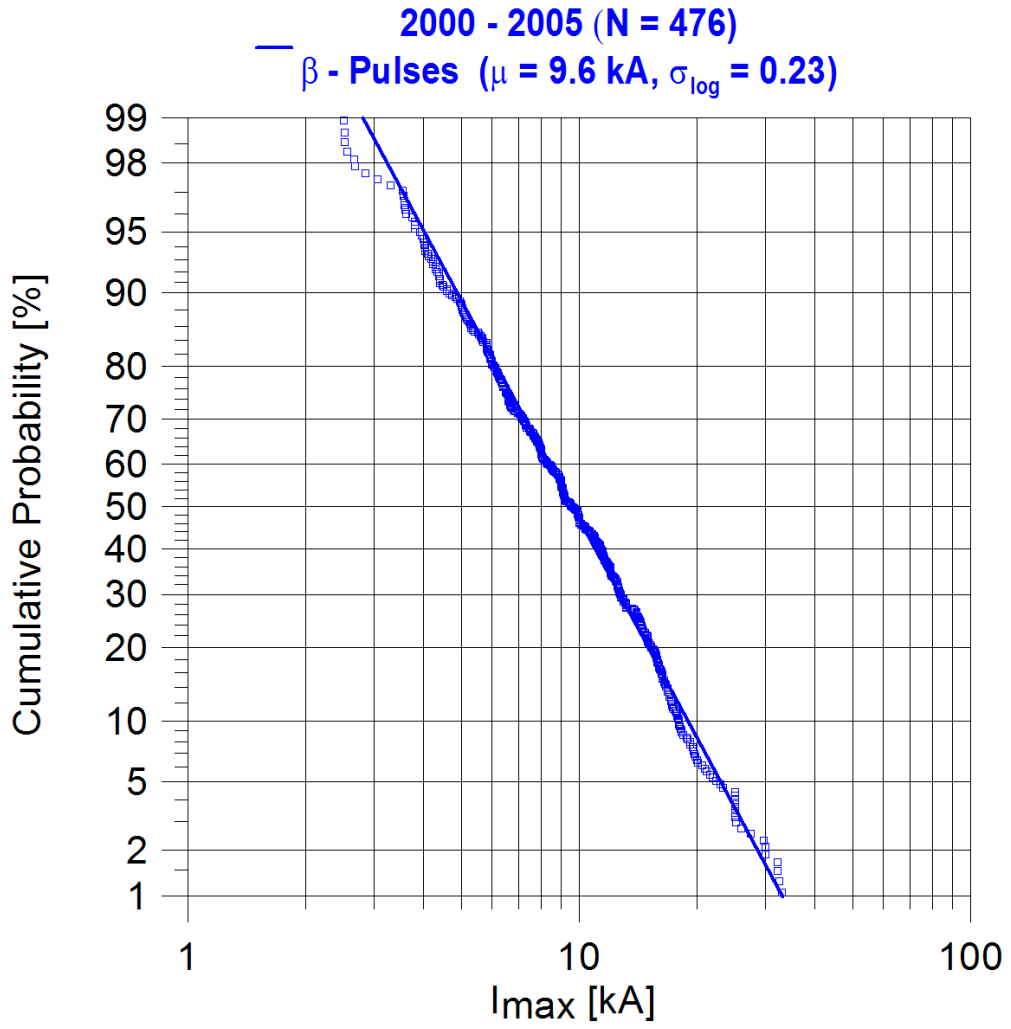
Initial Continuing Current (ICC) with α-Pulses and followed by β-Pulses





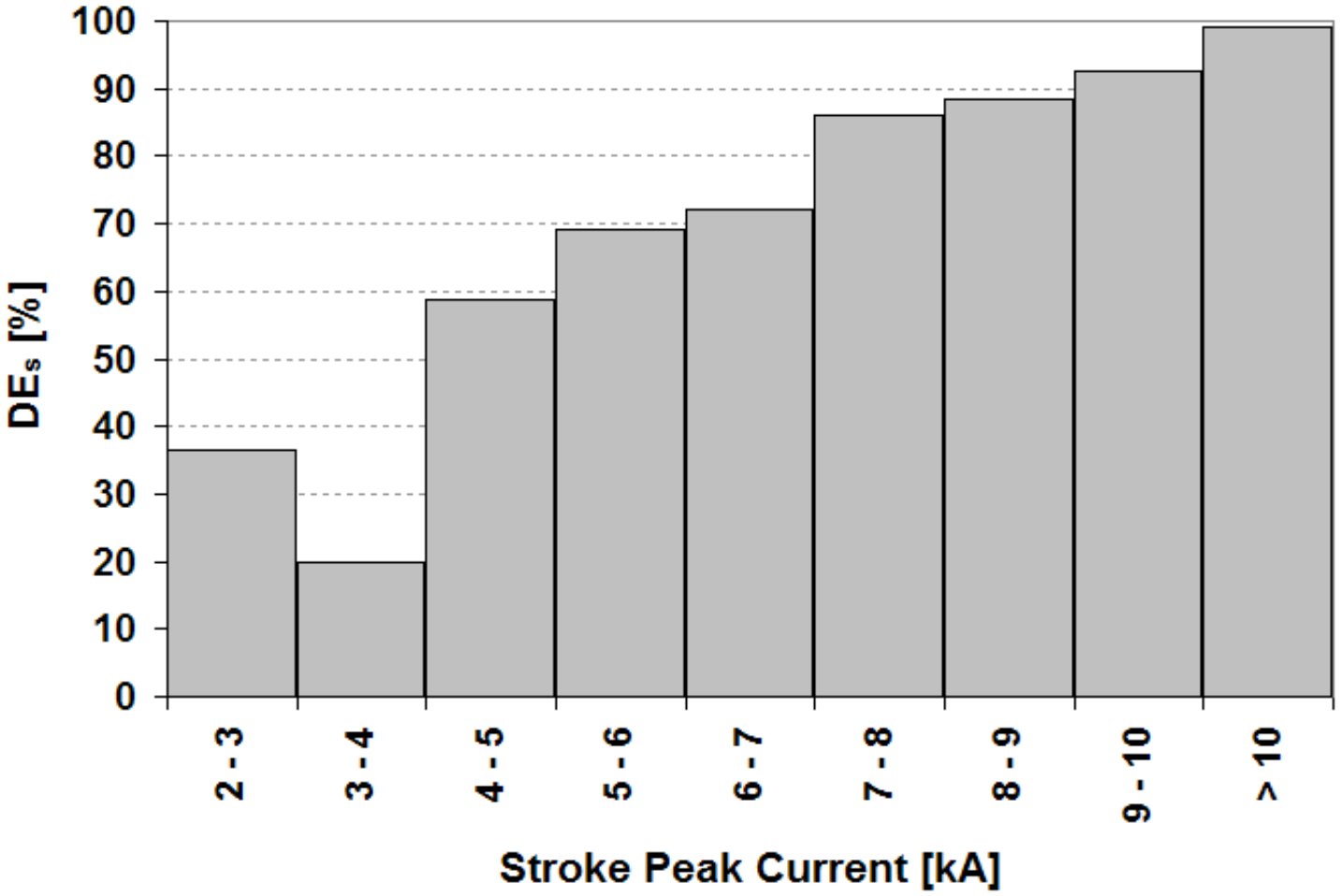
Peak current distribution of β-Pulses (subsequent strokes)



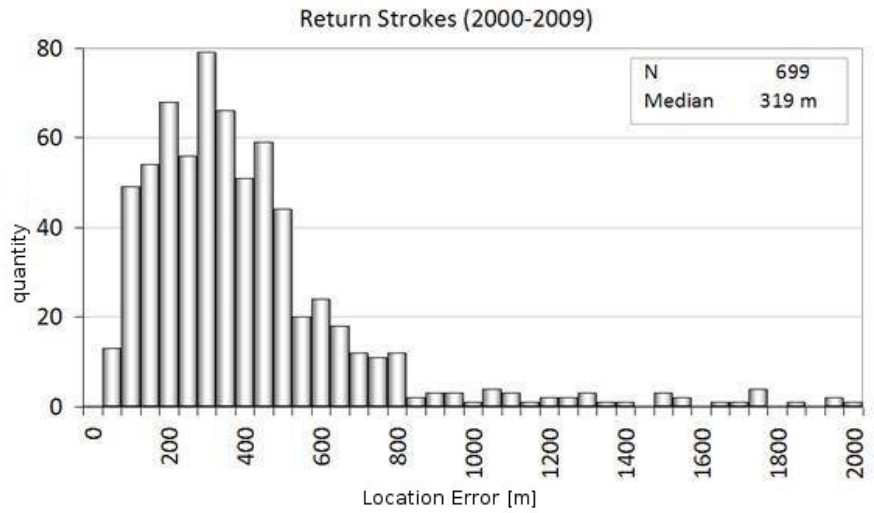
Stroke DE Gaisberg (2000 – 2005)

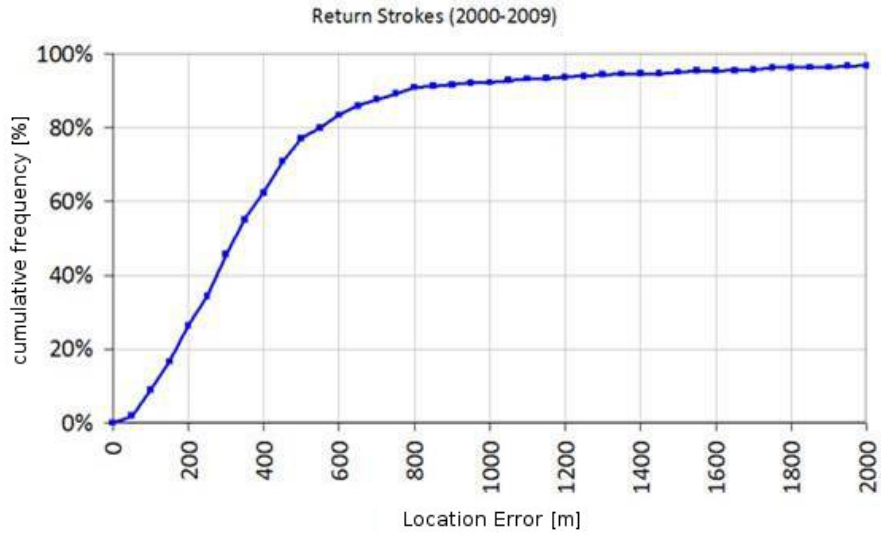
	GAISBERG	(LLS)	
I [kA]	N_β	N_β	(DEs)β[%]
2 - 3	11	4	36,4
3 - 4	15	3	20,0
4 - 5	29	17	58,6
5 - 6	39	27	69,2
6 - 7	43	31	72,1
7 - 8	43	37	86,0
8 - 9	35	31	88,6
9 - 10	40	37	92,5
> 10	221	219	99,1
SUM	476	406	85,3

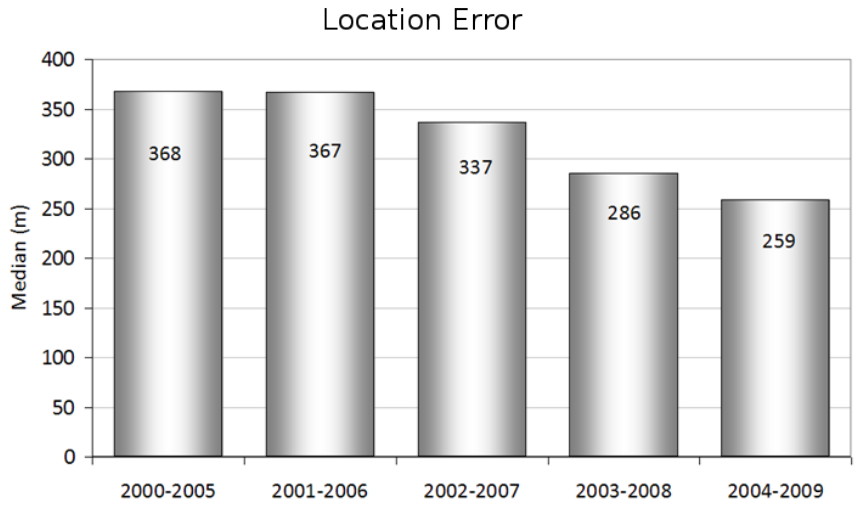
Stroke DE Gaisberg (2000 – 2005)



Location Accuracy







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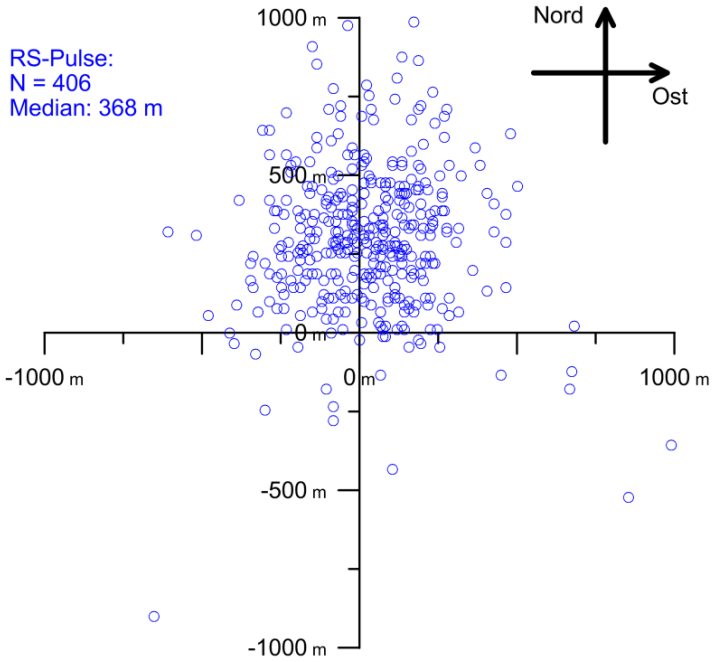
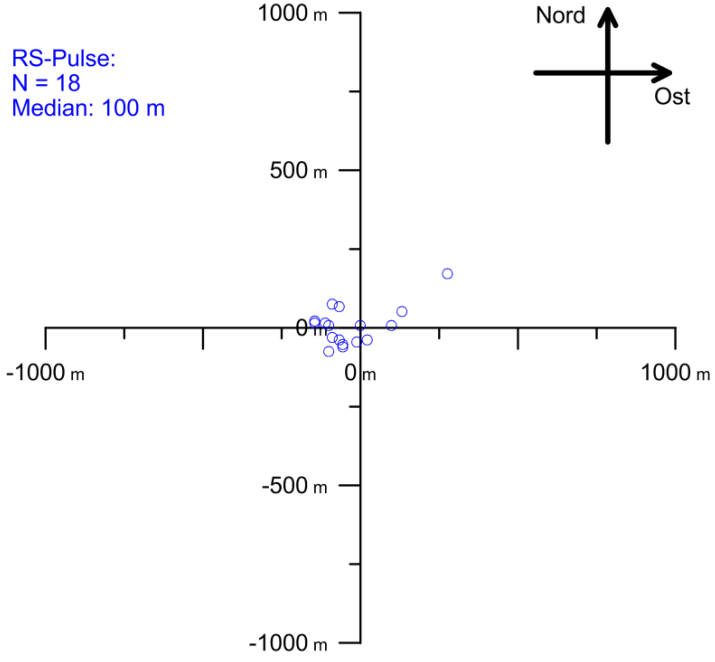
Location Accuracy

2000 - 2005



after 1.7.2011



E-Field and video measurements

Introduction E-Field and Video

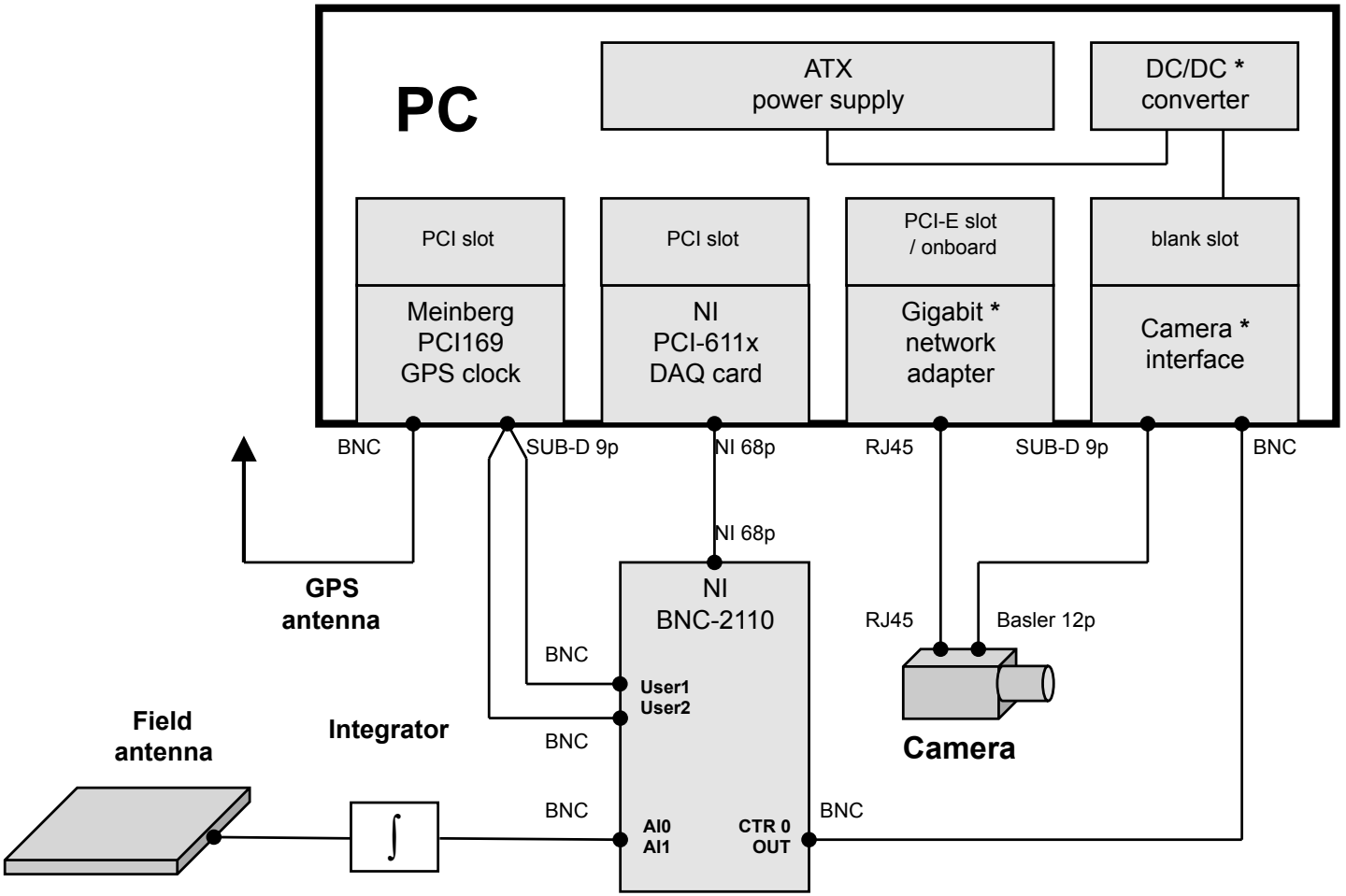
- Continuous E-field measurements
  - We do not miss any event
  - A lot of data
  - With field measurements alone sometimes uncertainty regarding categorization CC versus CG

- Camera measurements
  - Depending on the frames per second we do not miss any stroke
  - Categorization easy (for CG)
  - Thunderstorm must be close

FM-System (I)

- Basler Camera
  - Speed: 50, 100 or 200 fps
  - Monochrome (8 bit per pixel)
  - Resolution 640x480 (VGA)
  - Affordable price
- NI DAQ Card
  - PCI-6110 (4 channels)
  - PCI-6111 (2 channels)
  - 5 MS/s

FM-System (II)


PC
ATX
power supply
DC/DC *
converter
PCI slot
PCI slot
PCI-E slot
/ onboard
blank slot
Meinberg
PCI169
GPS clock
NI
PCI-611x
DAQ card
Gigabit *
network
adapter
Camera *
interface
BNC
SUB-D 9p
NI 68p
RJ45
SUB-D 9p
BNC
NI 68p
GPS
antenna
NI
BNC-2110
RJ45
Basler 12p
BNC
User1
User2
Field
antenna
Integrator
BNC
Camera
BNC
AI0
AI1
CTR 0
OUT
BNC

Estimation of Location Accuracy Flash #222



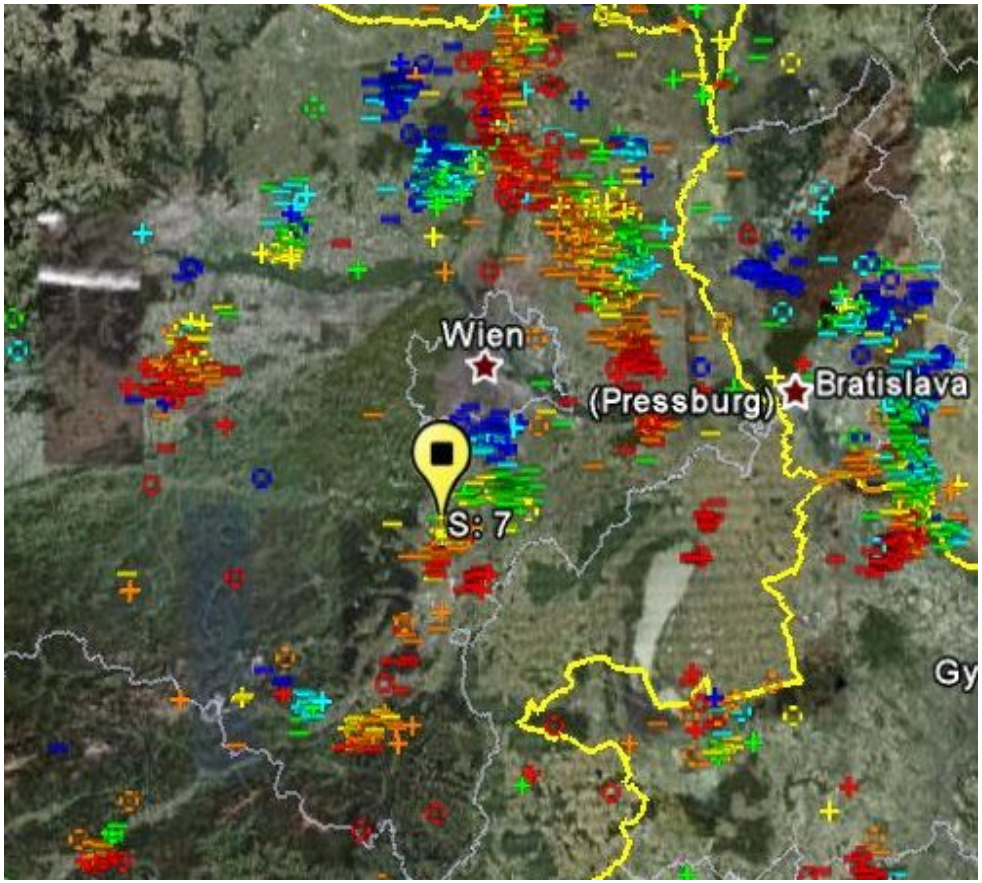






Measurements 2009

20090629



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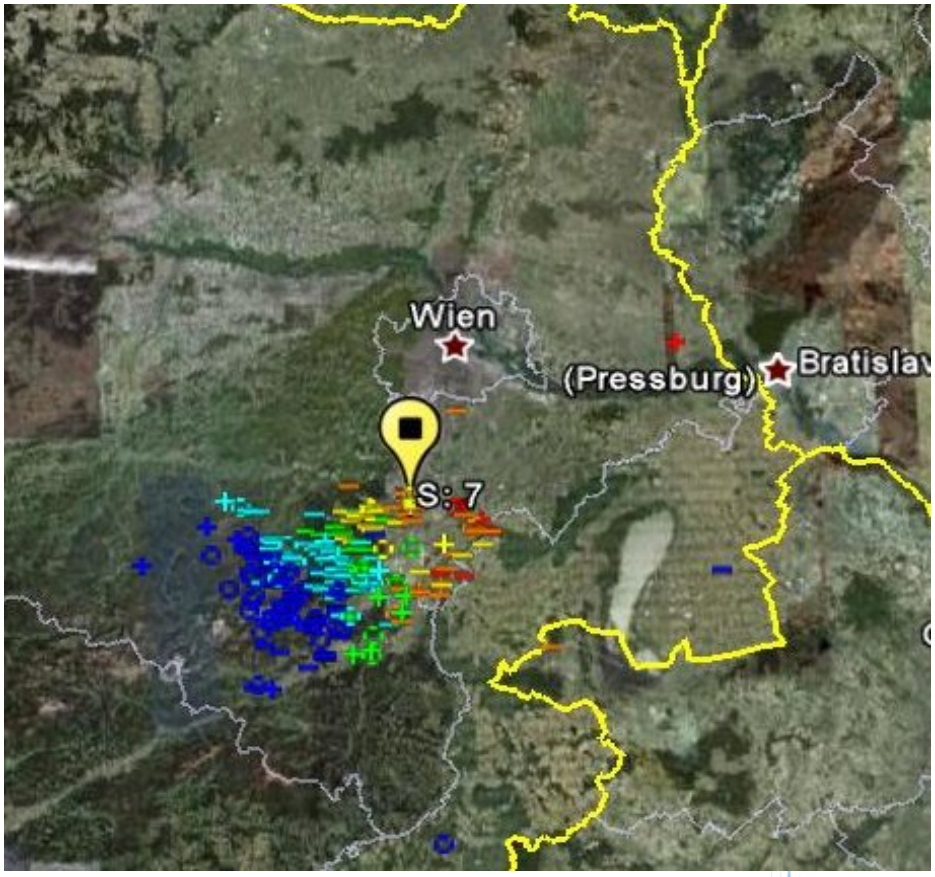

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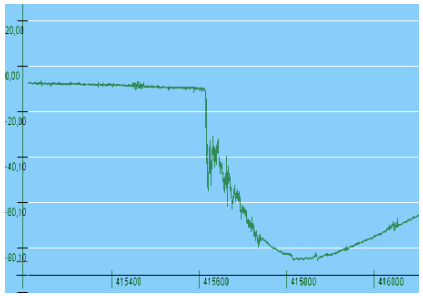
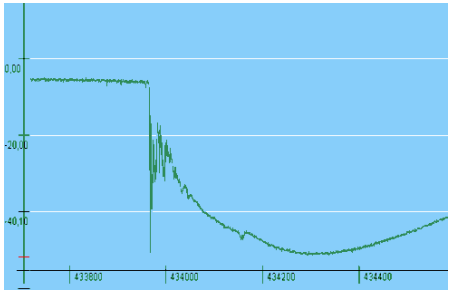
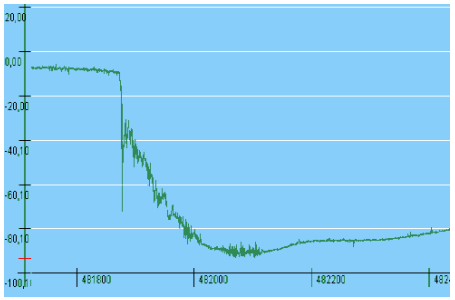
Flash #57 (03.08.2009 13:05:54)







Measurement locations 2010

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Number of flashes 2010

Date	Location	# negative Flashes	# positive Flashes	Total number of Flashes
27.05.2010	Graz/Platte	1		1
07.06.2010	Graz/Platte		2	2
12.06.2010	Liezen	12	1	13
13.06.2010	Arzberg/Schöckl	7	9	16
18.06.2010	Puch bei Weiz (Kulm)	9		9
01.07.2010	Maria Saal/ Magdalensberg	3		3
03.07.2010	Dellach im Gailtal	5		5
04.07.2010	Wernberg bei Villach		6	6
12.07.2010	Obervellach im Mölltal	4		4
13.07.2010	Murau	9		9
13.07.2010	Althofen	2		2
15.07.2010	Kalsdorf bei Graz	10	34	44
17.07.2010 bis 18.07.2010	Arzberg/Schöckl	2	20	22
18.07.2010	Hammersberg/Schöckl	35		35
10.08.2010	Assling	10		10
	Total	**109**	**72**	**181**

Comparison of Results for negative Flashes

	Gaisberg (2000-2005)	Video (2009)	Video (2010)
Number of Flashes	110	45	109
Flash DE	98%	98%	98%
Number of Strokes	476	135	407
Stroke DE	85%	84%	83%
Number of Strokes for Accuracy estimation	476	19	84
Location Accuracy (Median)	368m	440m	332m

Summary

- EUCLID – the only LLS in Europe validated with ground truth data
- DE results agree between tower and video measurements
- Stroke DE ~ 83% - 85 %
- Median location accuracy < 250m (currently)

Thank you for your attention!

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