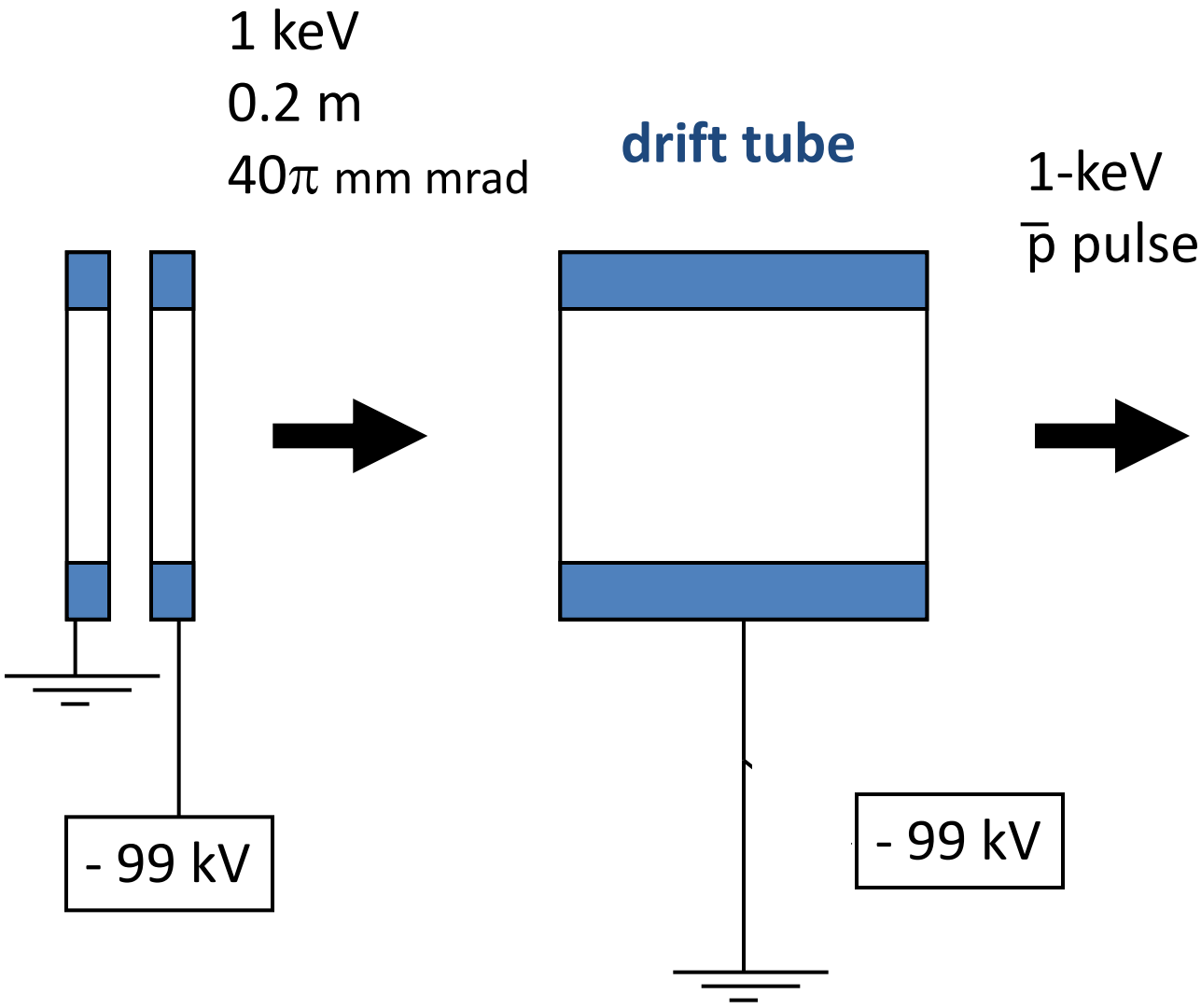
p-bar d-cel:
keV antiproton pulses

David Lunney
CSNSM (IN2P3-CNRS)
Université de Paris Sud, Orsay

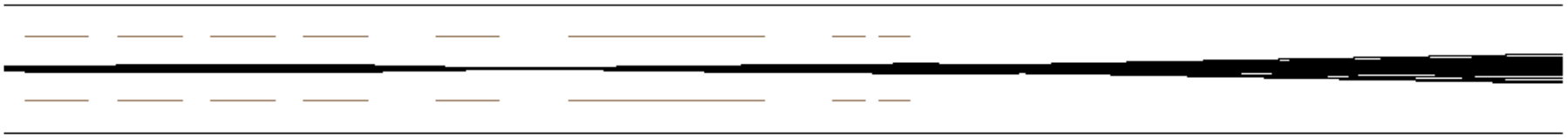
- introduction and concept
- p-bar d-cel simulations
- ISOLTRAP@ISOLDE
- consequences on GBAR layout

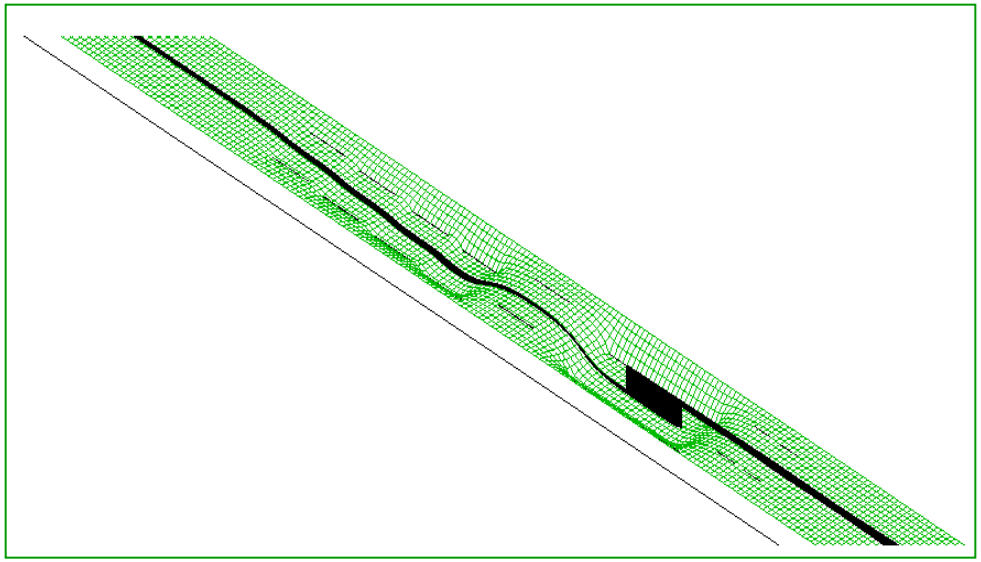
With crucial help from:
V. Manea, S. Cabaret, P. Dupré, S. Dephine (CSNSM)
and Robert Wolf (U. Greifswald)

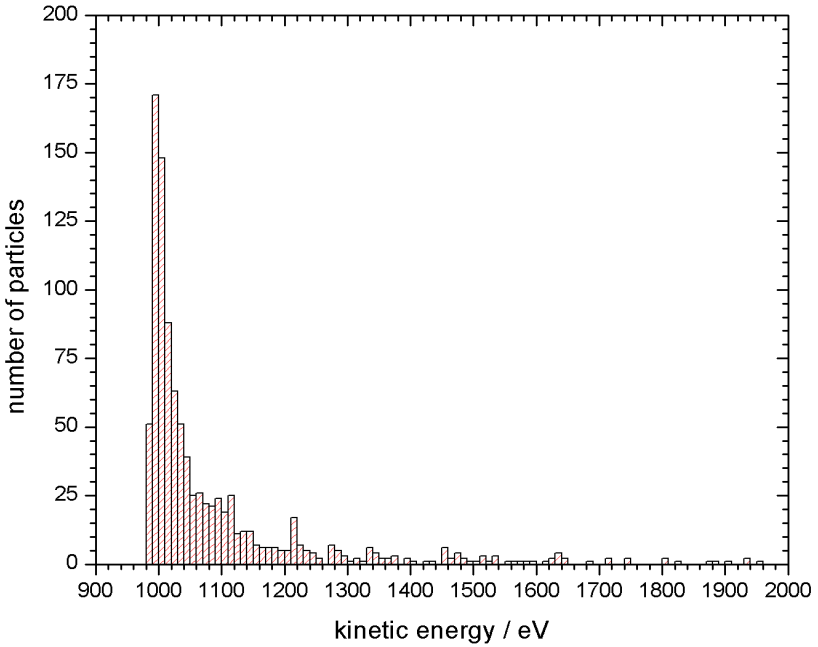
deceleration and pulsed drift tube: concept



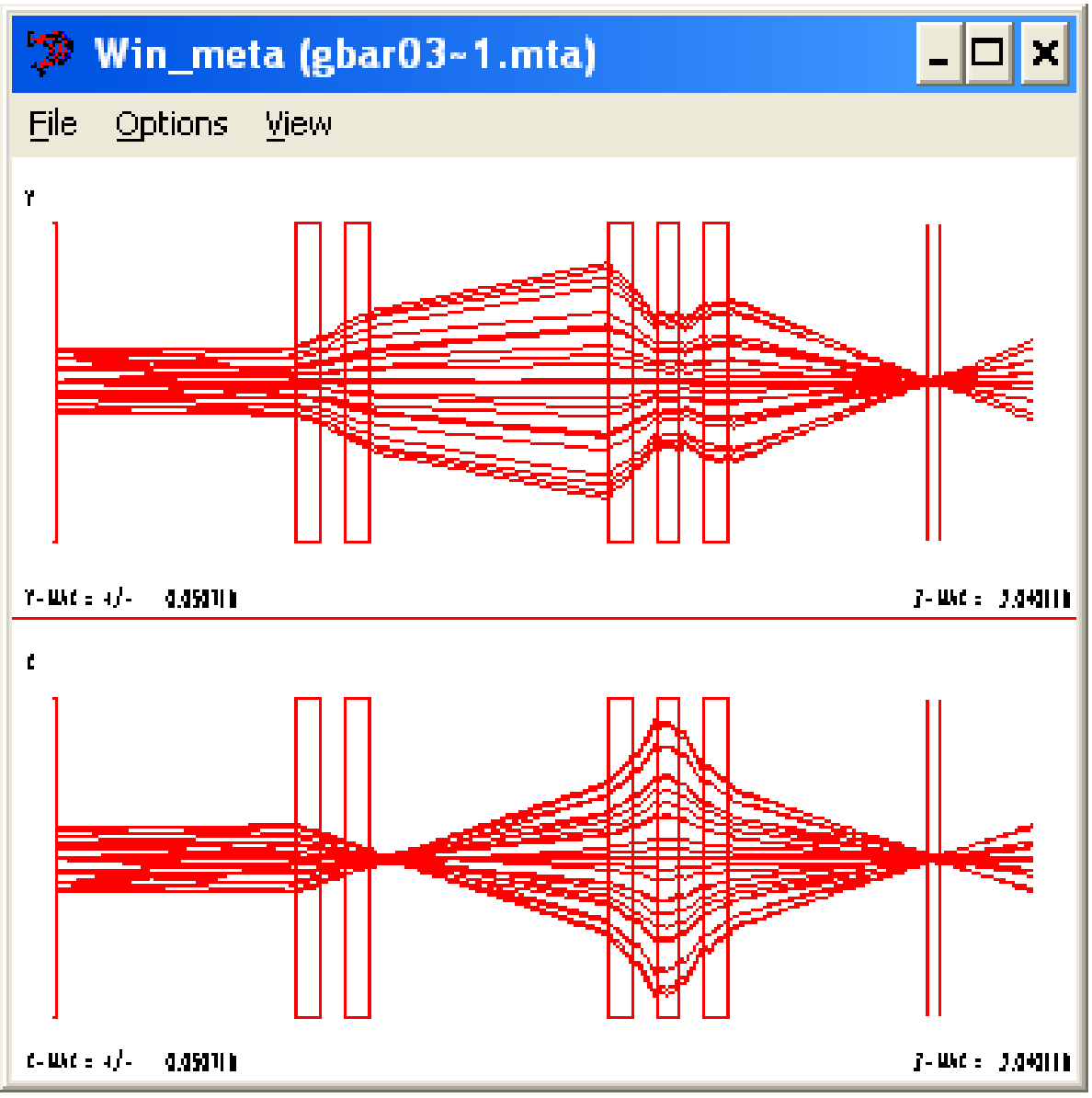
deceleration and pulsed drift tube: simulation

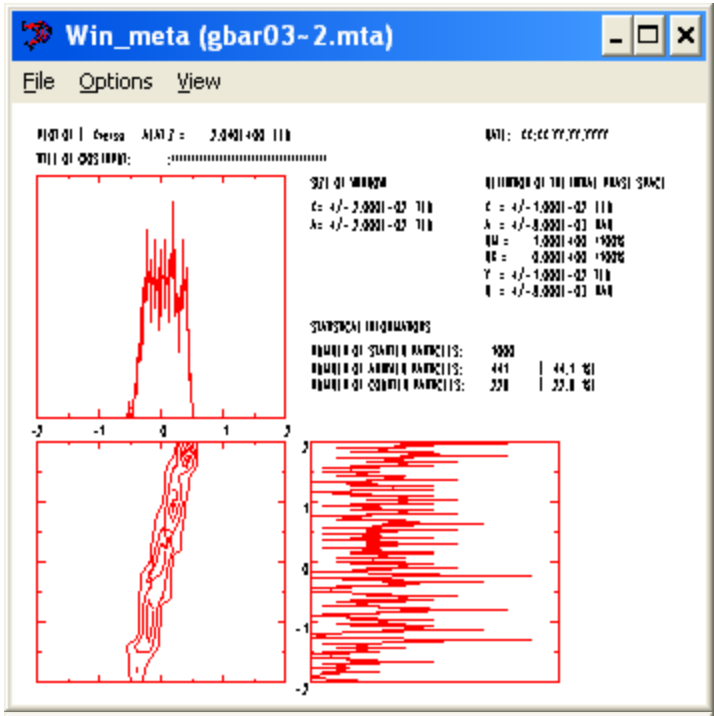


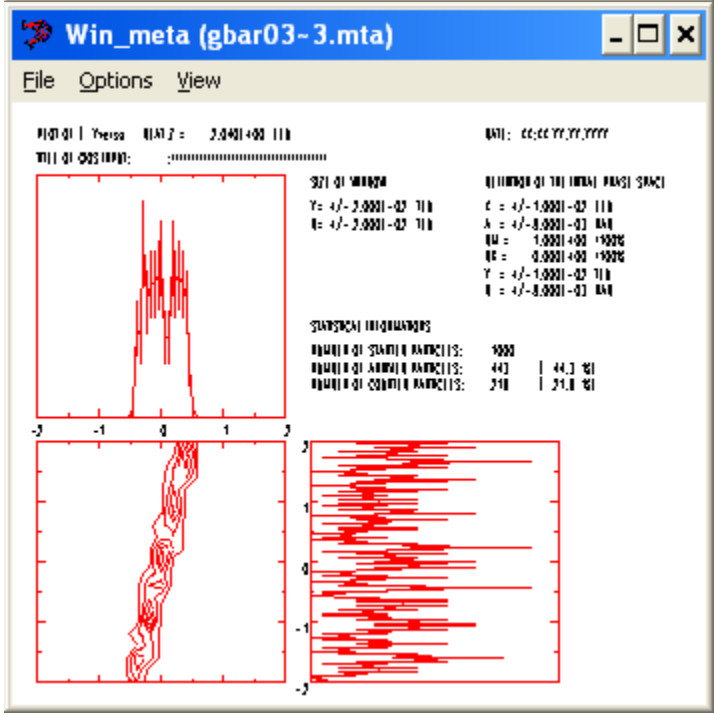




SIMION simulations by Vladimir Manea



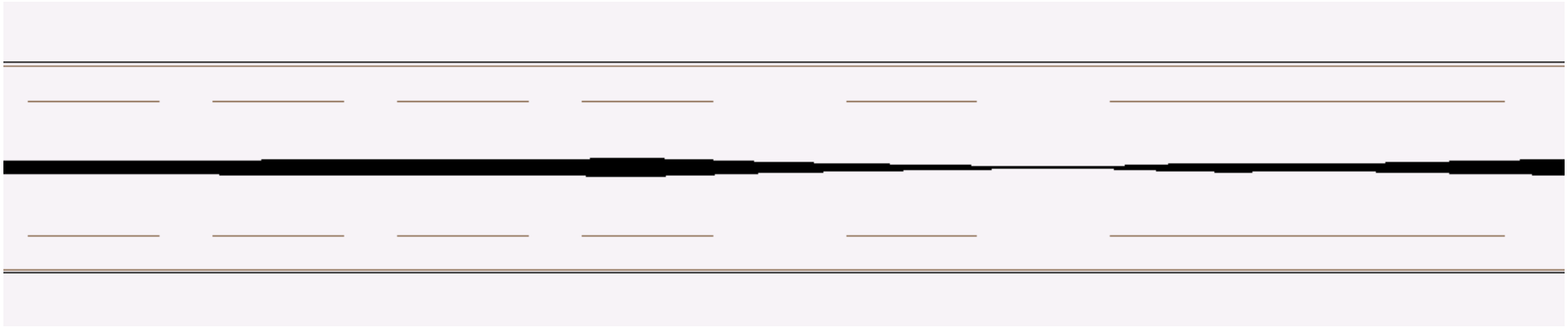




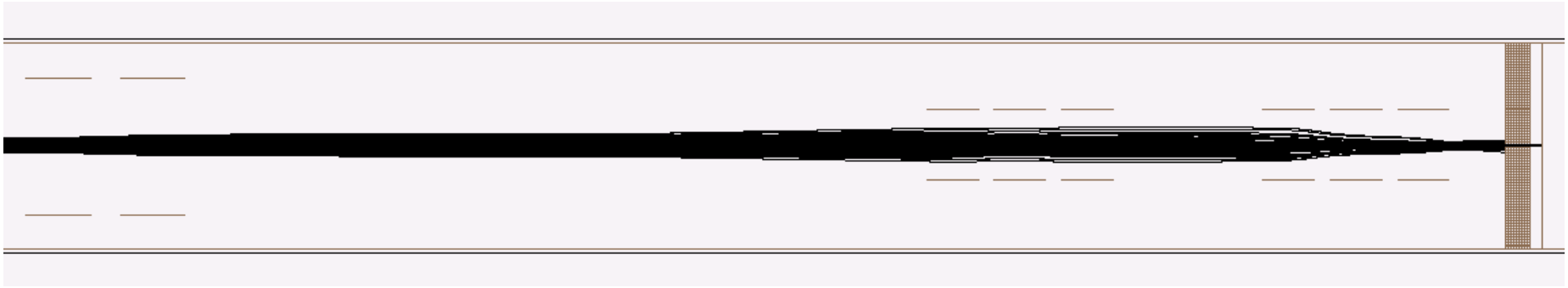
Transport from decelerator to reaction chamber (GIOS)

Full simulations of antiproton deceleration and focusing

Deceleration

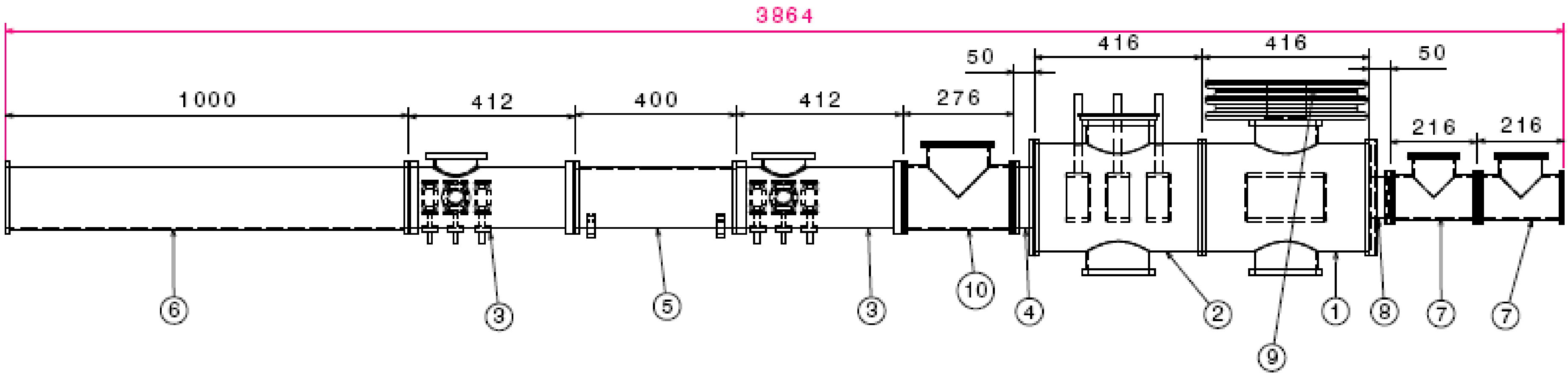


Focusing



- One single simulation of the 3 m path of the ions from the entrance to the deceleration setup to the injection into the positronium chamber.
- Optimization of the deceleration and focusing voltages, as well as of the setup geometry, for a maximum transport efficiency through the positronium chamber (preliminary value 15%).

SIMION simulations by Vladimir Manea



module pulsed drift + deccelerator + triplet + triplet

Nomenclature de sno105c1a002a

Numéro	Quantité	Référence	Nomenclature
1	1	sno106c1p006a	pulsed drift tube
2	1	sno106c1p007a	deccelerator electrodes
3	2	sno106c1p005a	triplet
4	1	sno106c1p008a	reduction 250/160
5	1	sno106c1p009a	tube triplet/triplet
6	1	sno106c1p010a	liaison triplet/positron
7	2	TeDN100ISOKa	
8	1	sno106c1p011a	reduction ISOK100/250
9	1	sno106c1p012a	isolant
10	1	te ISO K 160	te ISO K 160

Désignation : module pulsed drift + deccelerator + triplet + triplet

référence fichier : sno106c1a002a1

Tolérances générales :
- longueurs : JS10
- angles : +/- 1°
- état de surface : Ra 6.4

toutes dimensions en millimètres

Poids (kg) : XXX | Taille : A3 | Echelle : 0

Matière :
projet : Gbar
version :
traitement de surface : aucun

Centre de Spectrométrie Nucléaire et Spectrométrie de Masse
CSNSM
Stéphane CABARET
CSNSM
bâtiment 108
Rue Georges Clemenceau
Université Paris Sud 11
91405 ORSAY CEDEX
tél. : 00 33 (0) 1 69 15 52 21
fax : 00 33 (0) 1 69 15 50 08
stephane.cabaret@csnsm.in2p3.fr

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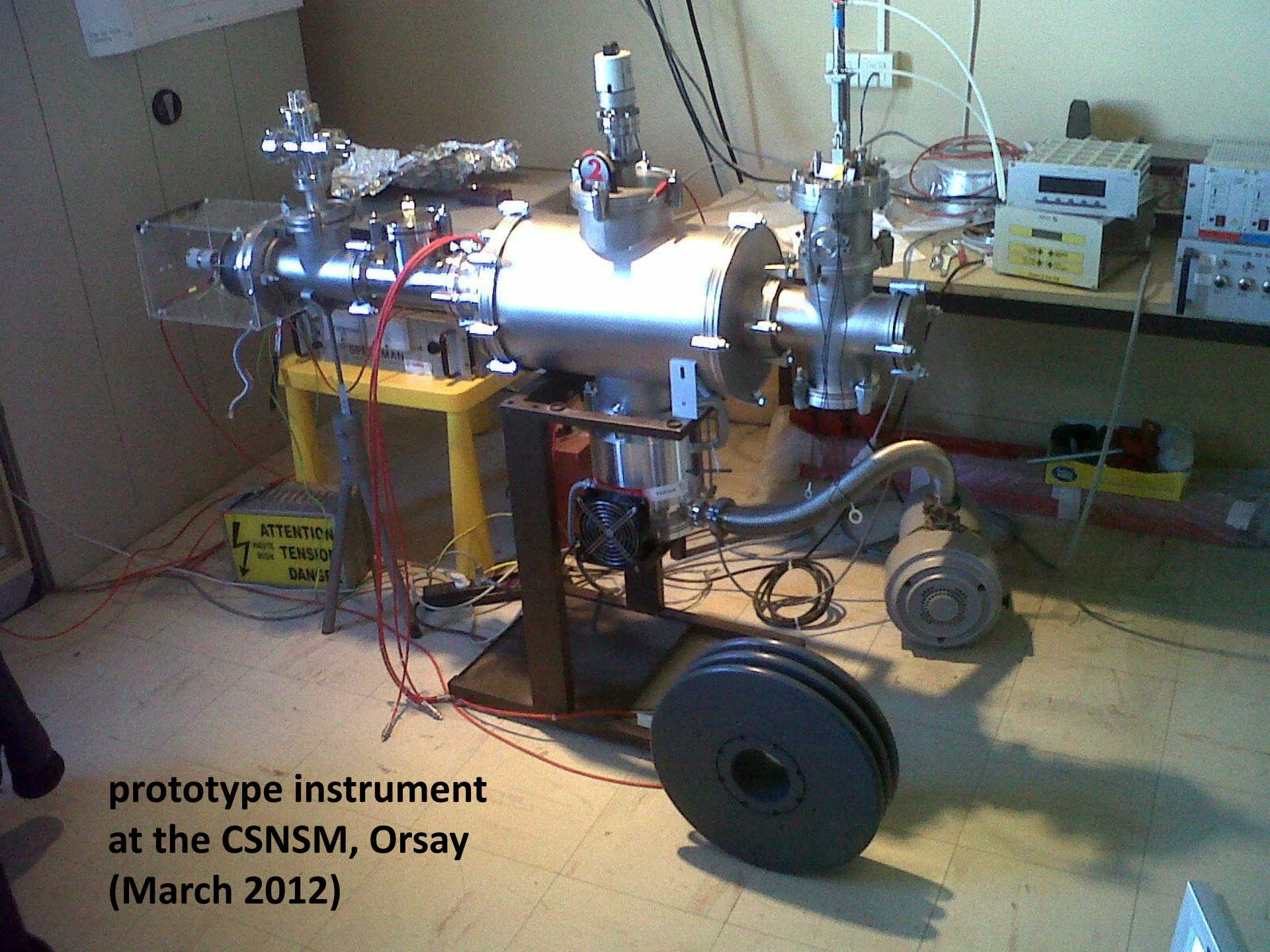
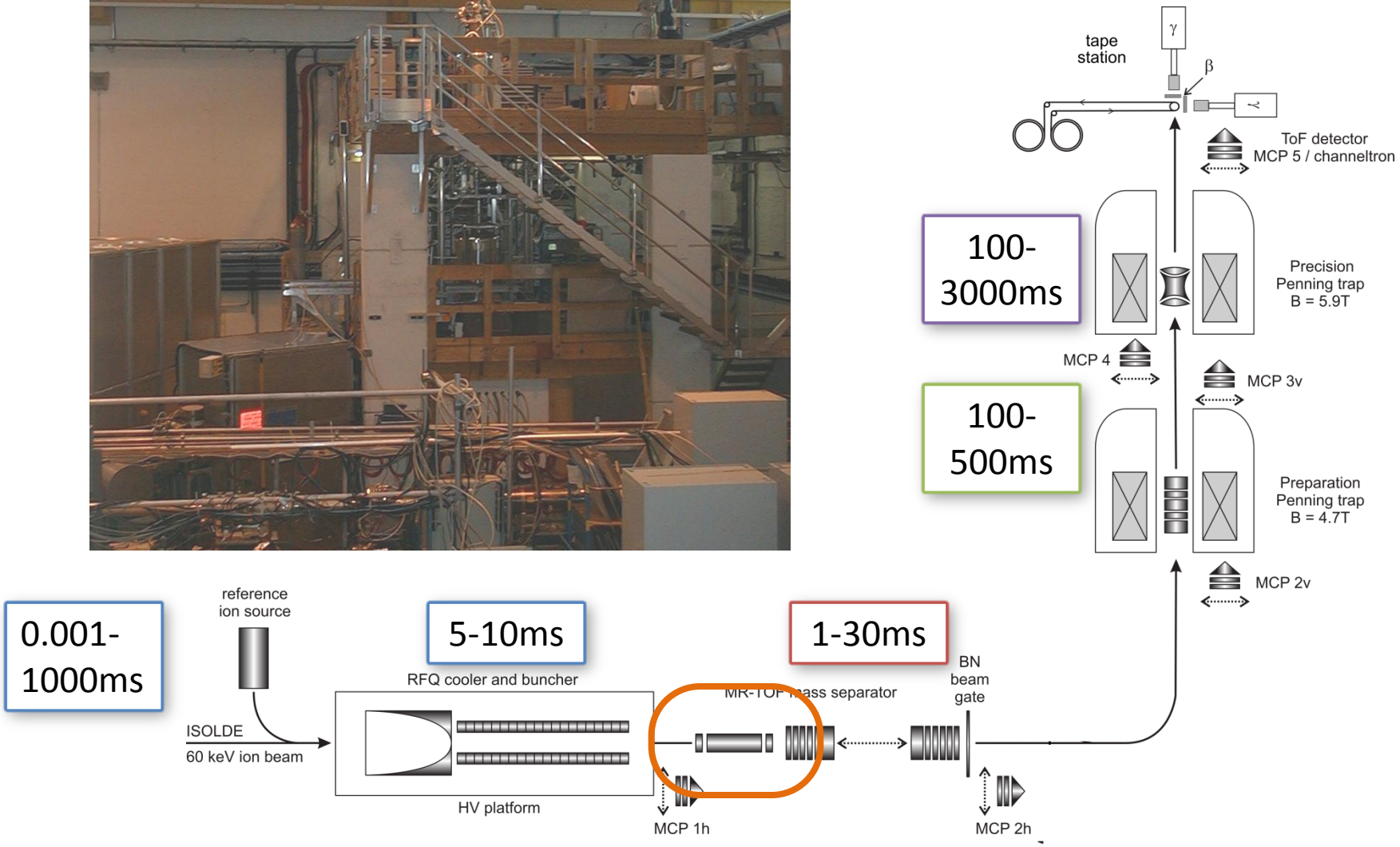


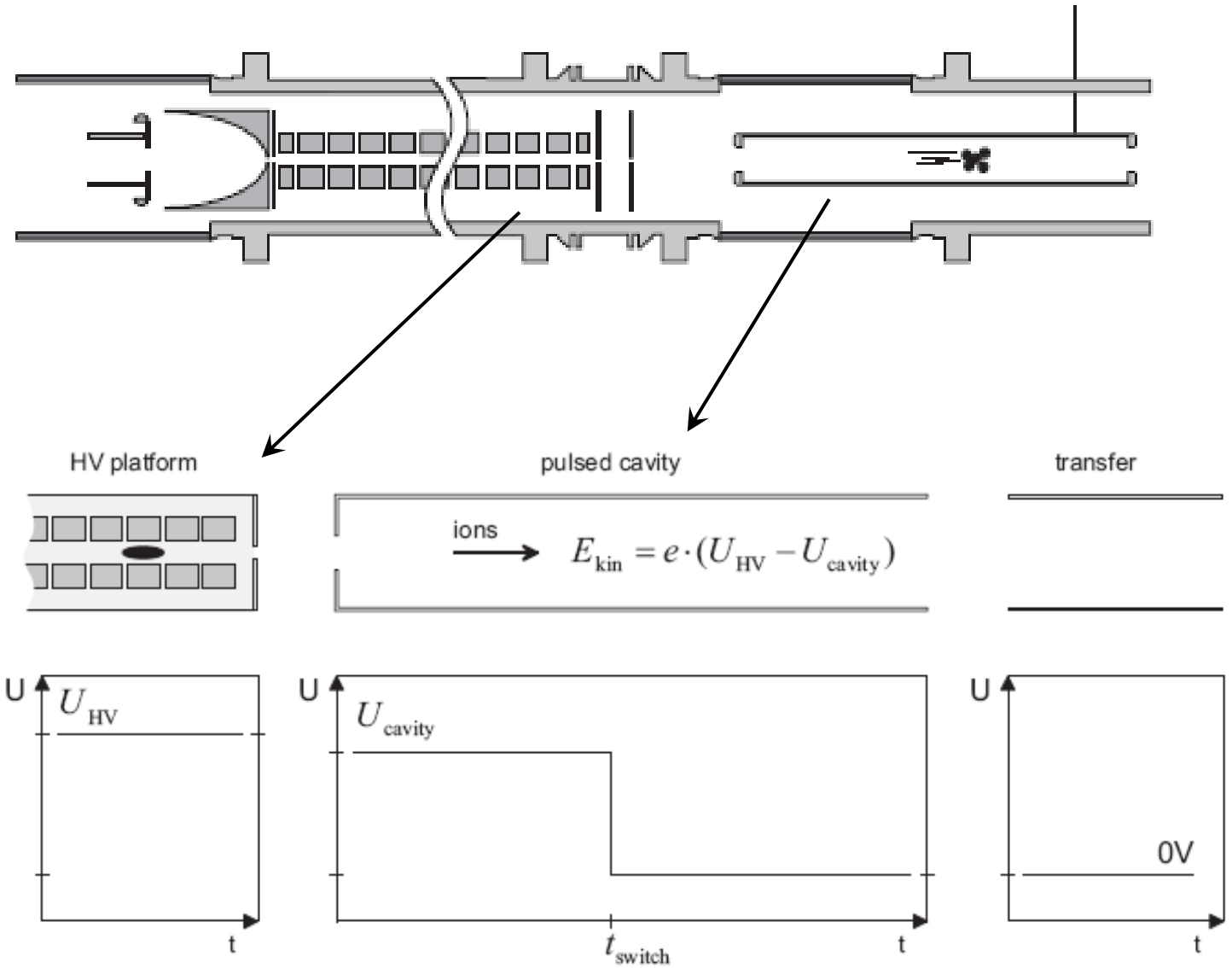
prototype instrument at the CSNSM, Orsay (March 2012)

ISOLTRAP spectrometer at ISOLDE (2 Penning, 1 Paul, 1 MR-tof trap)



60-kV, 1-kHz pulsed drift-tube switch

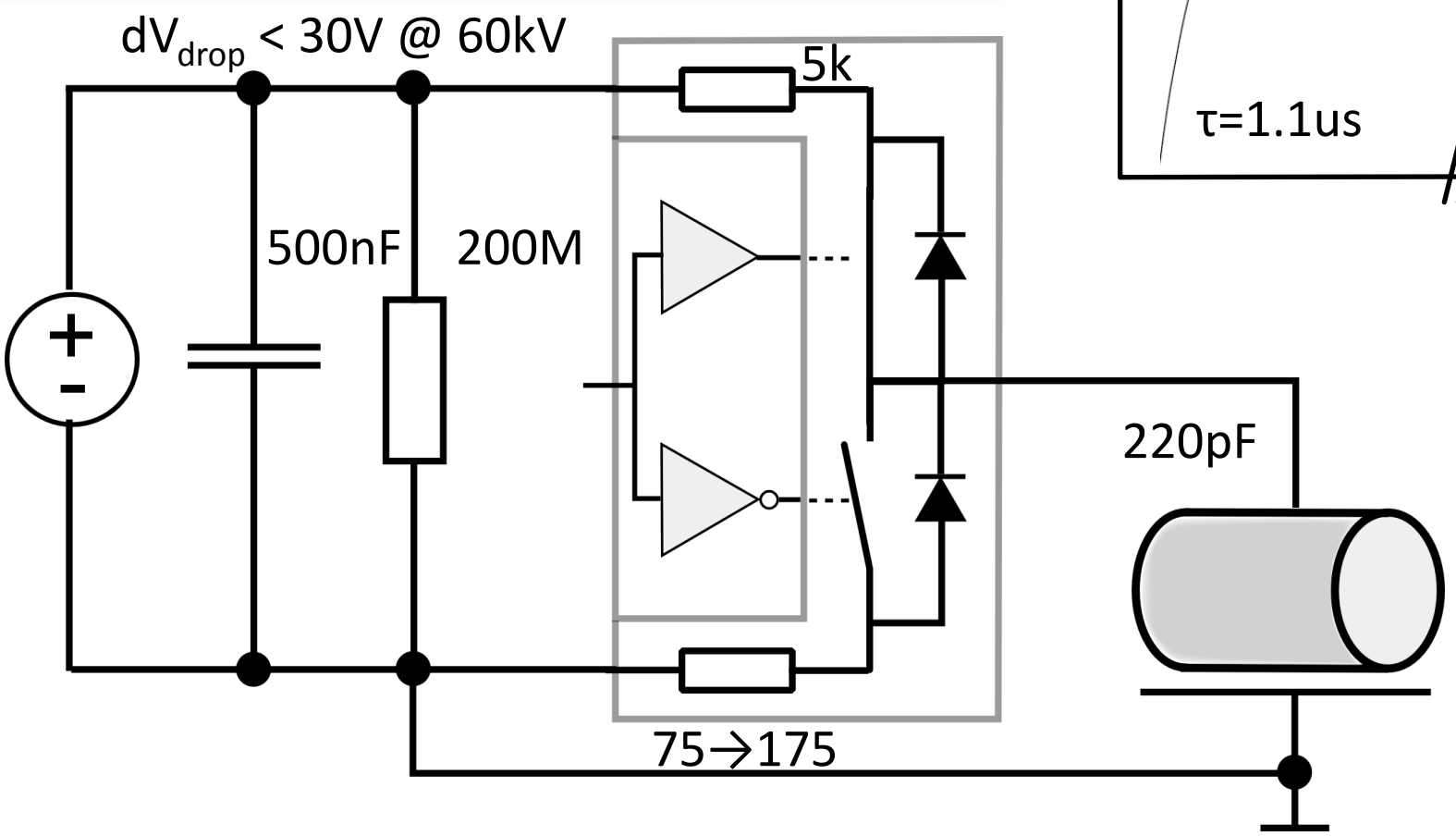
Exotic nuclides and anti-matter
major difference: buffer gas!

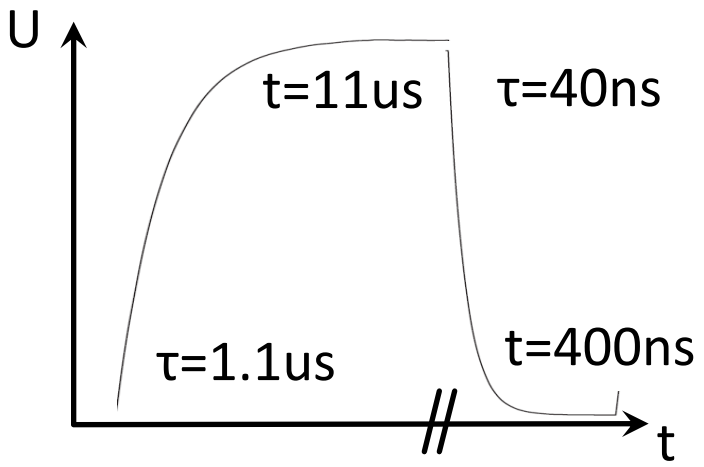


HV-switch circuit

Heinzinger PNChp ±60kV, 10mA
$dU<10^{-5}U_{nom}/8h$; $dU_{rf,pp}<10^{-5}U_{nom}$; $dU_{temp}<10^{-5}U_{nom}/K$
communication: GPIB, RS232, analog

Behlke HTS 651-10-GSM, 65kV, 100Apk

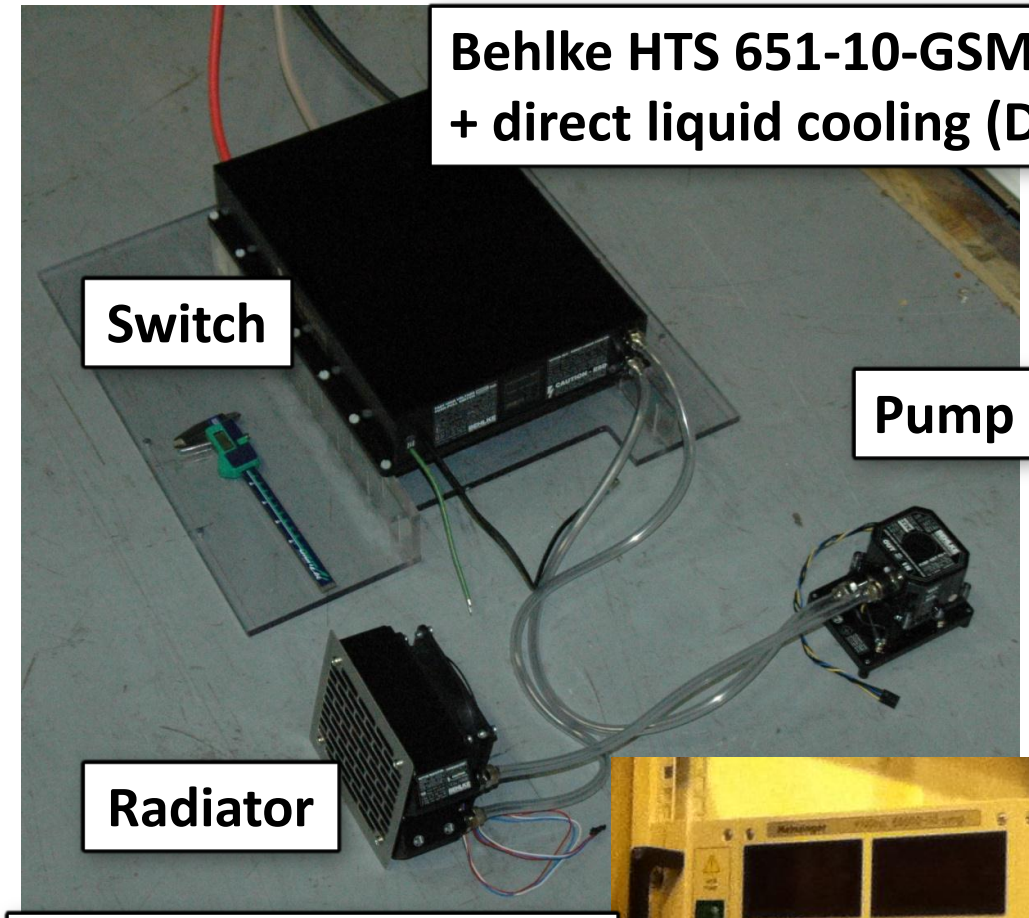




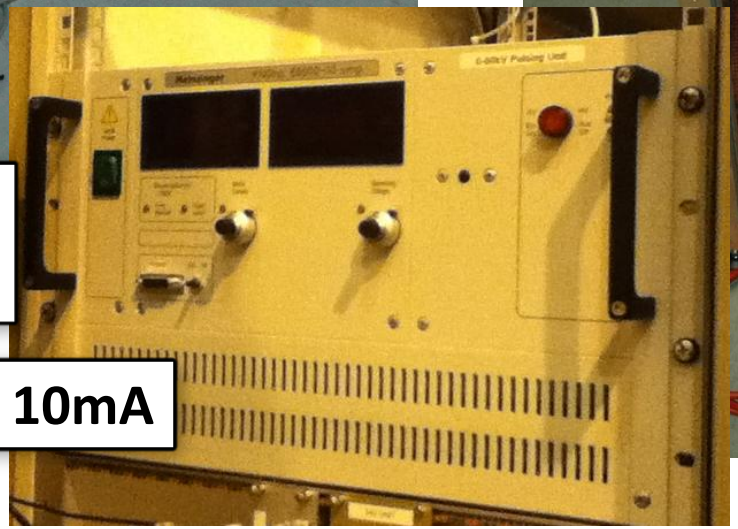
New HV-switch parts

Behlke HTS 651-10-GSM
+ direct liquid cooling (DLC)*

Buffer capacitor and
RF-sealed copper housing



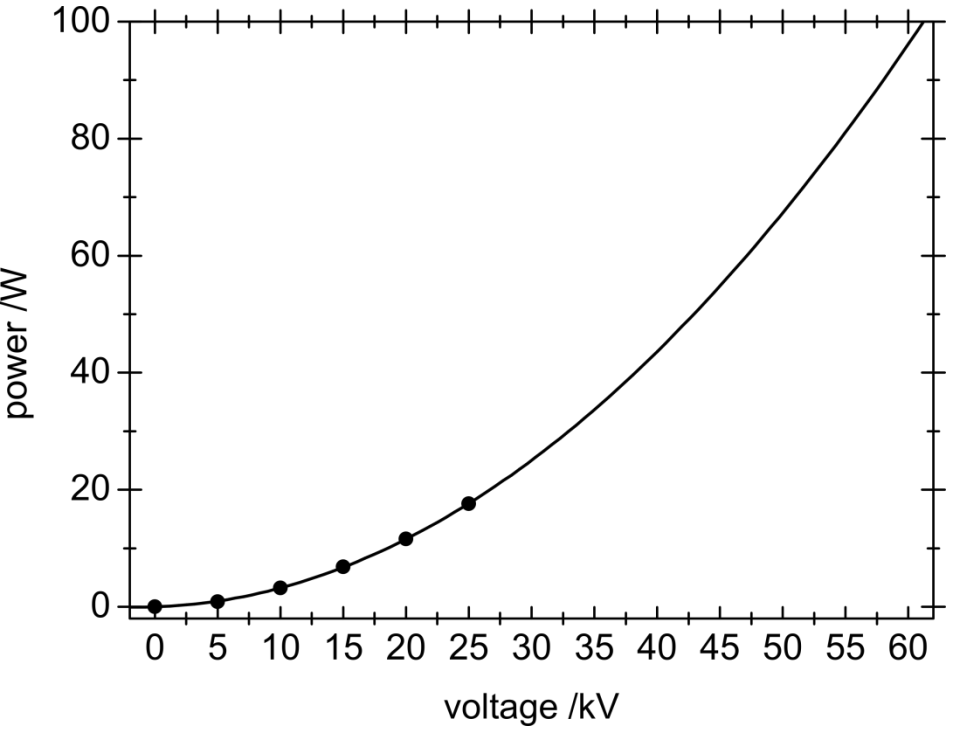

200MOhm resistor

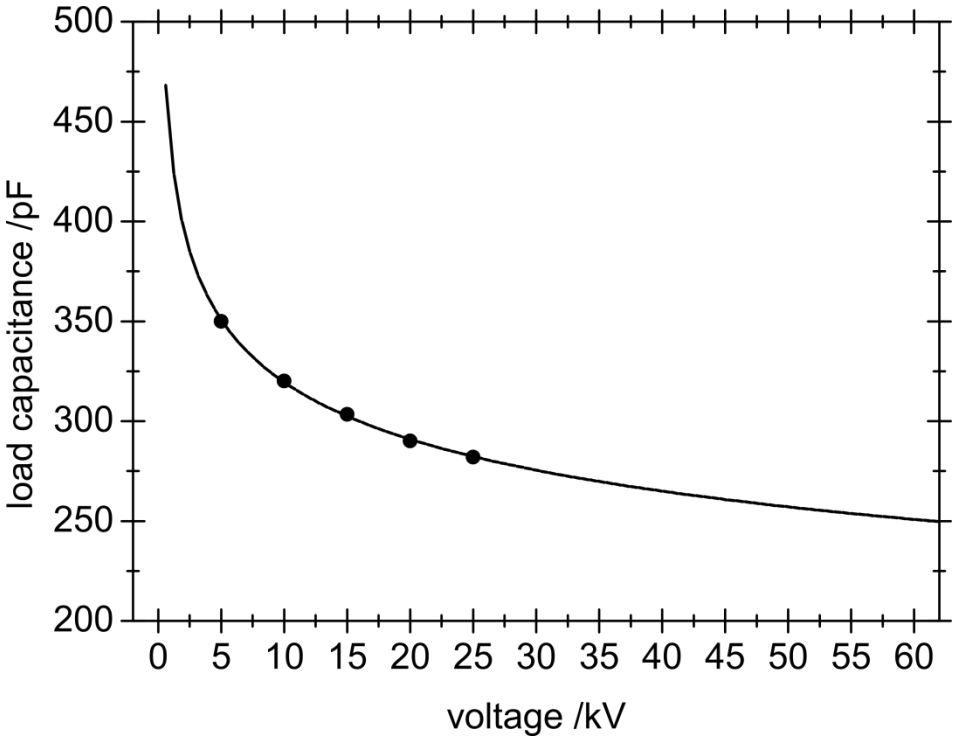

Heinzinger PNChp 60kV, 10mA

*GALDEN HT135

HV-switch present status and performance

Power dissipation and load capacitance extrapolated to 60kV @ 200Hz

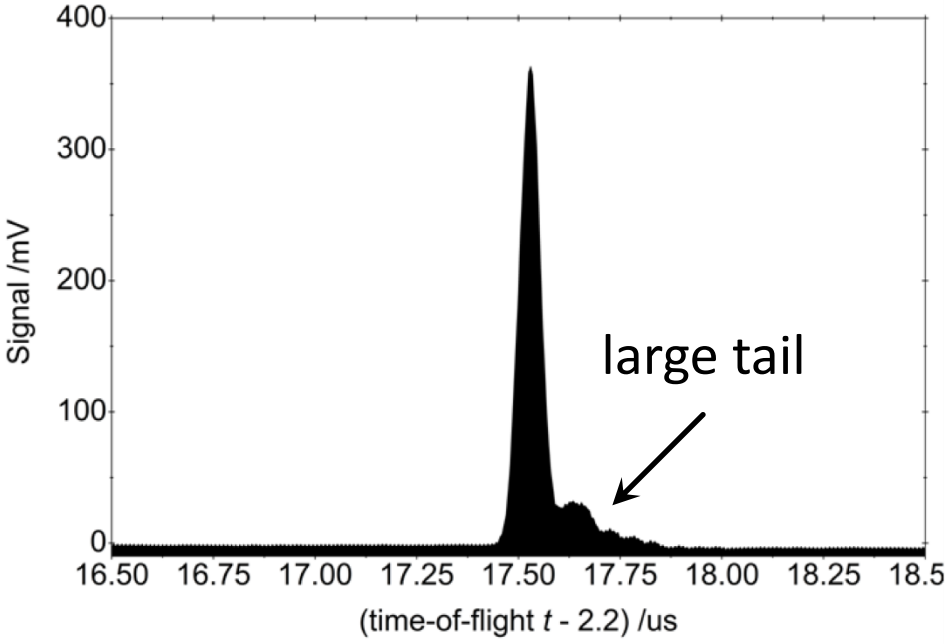




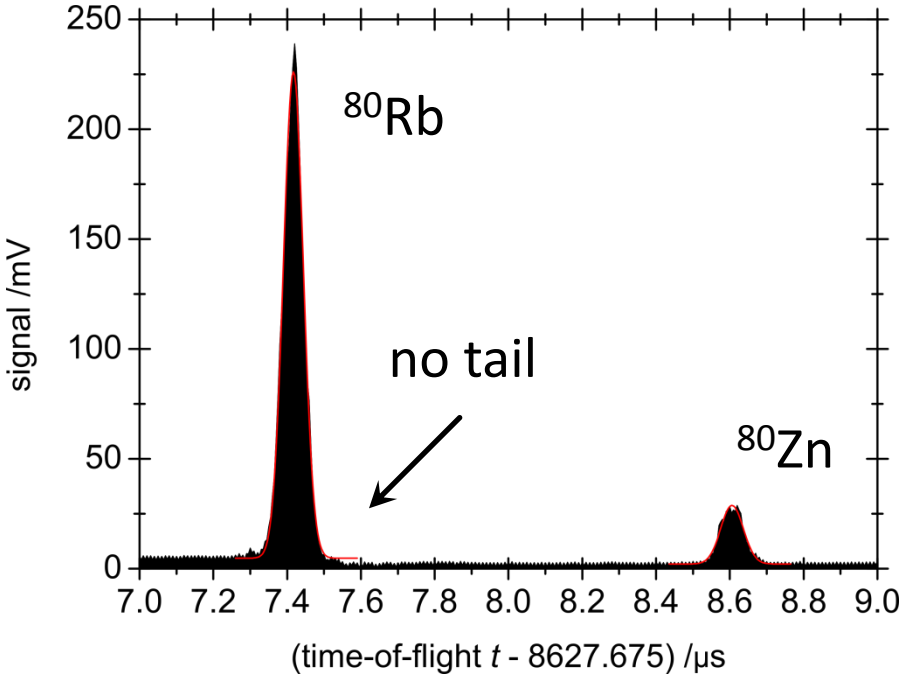
→ **Maximum power dissipation at around 1200Hz switching frequency**

HV-switch present status and performance

peak shape with old setup

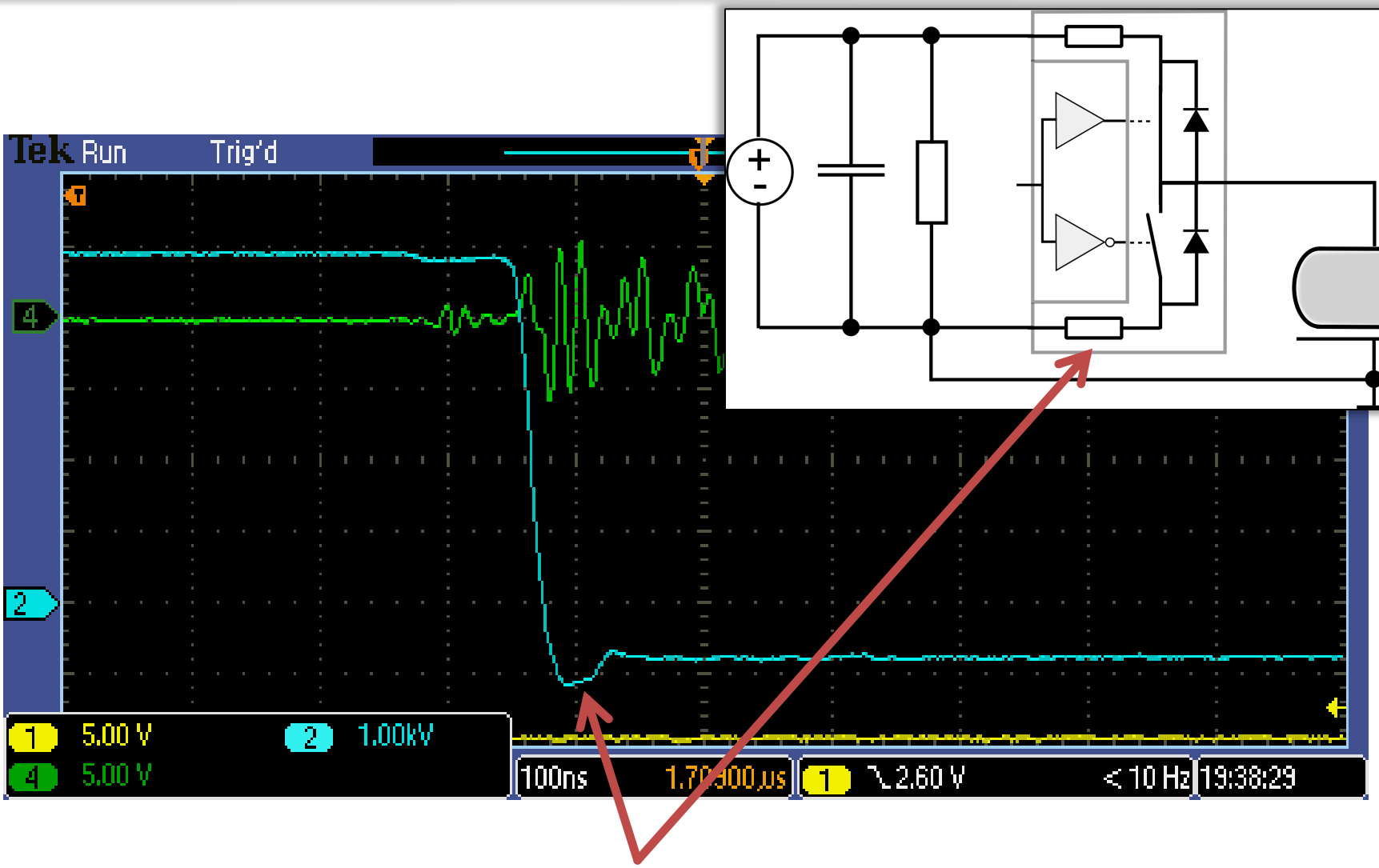


peak shape with new setup
taken from Zn run



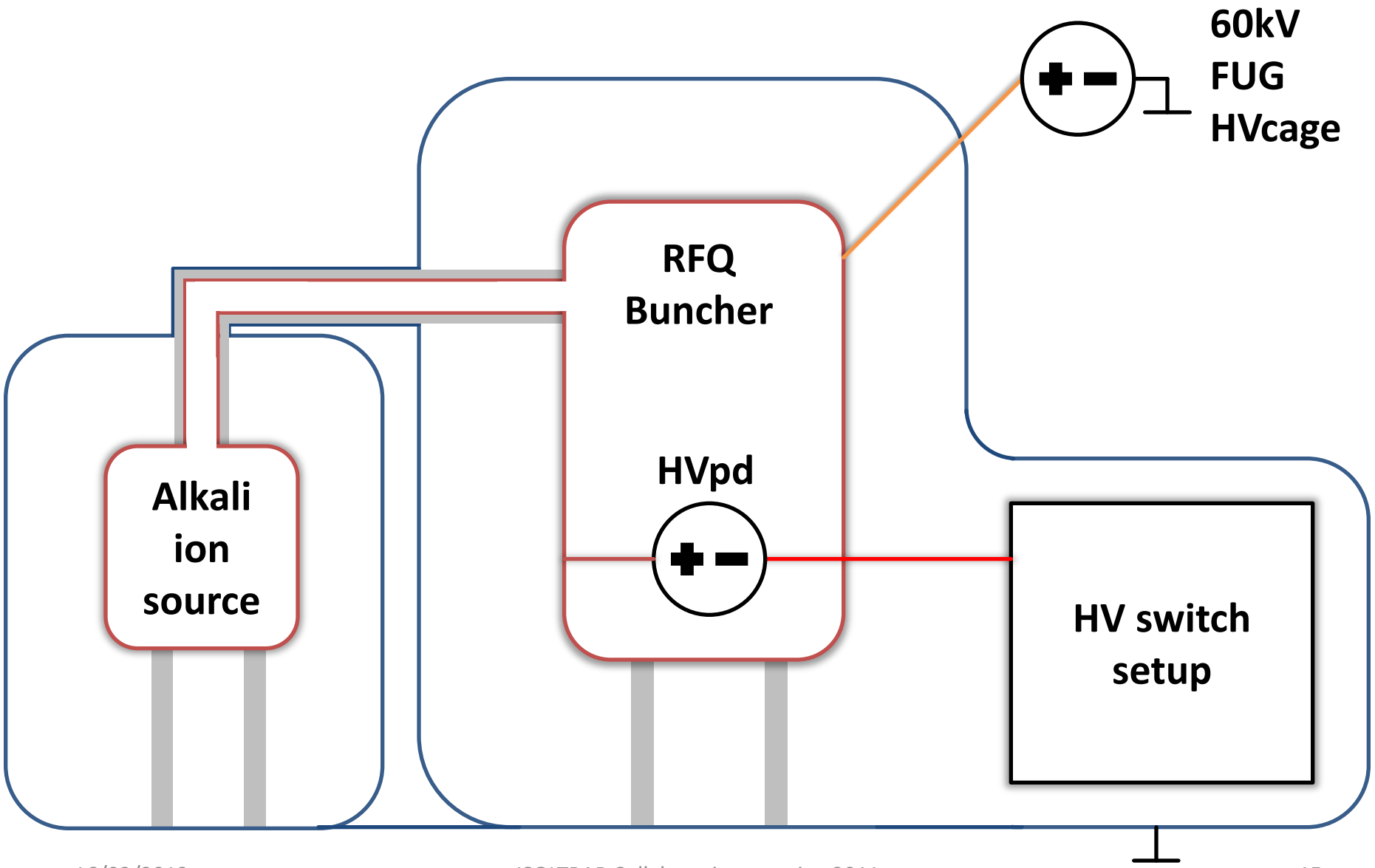
close to gaussian shape

HV-switch present status and performance

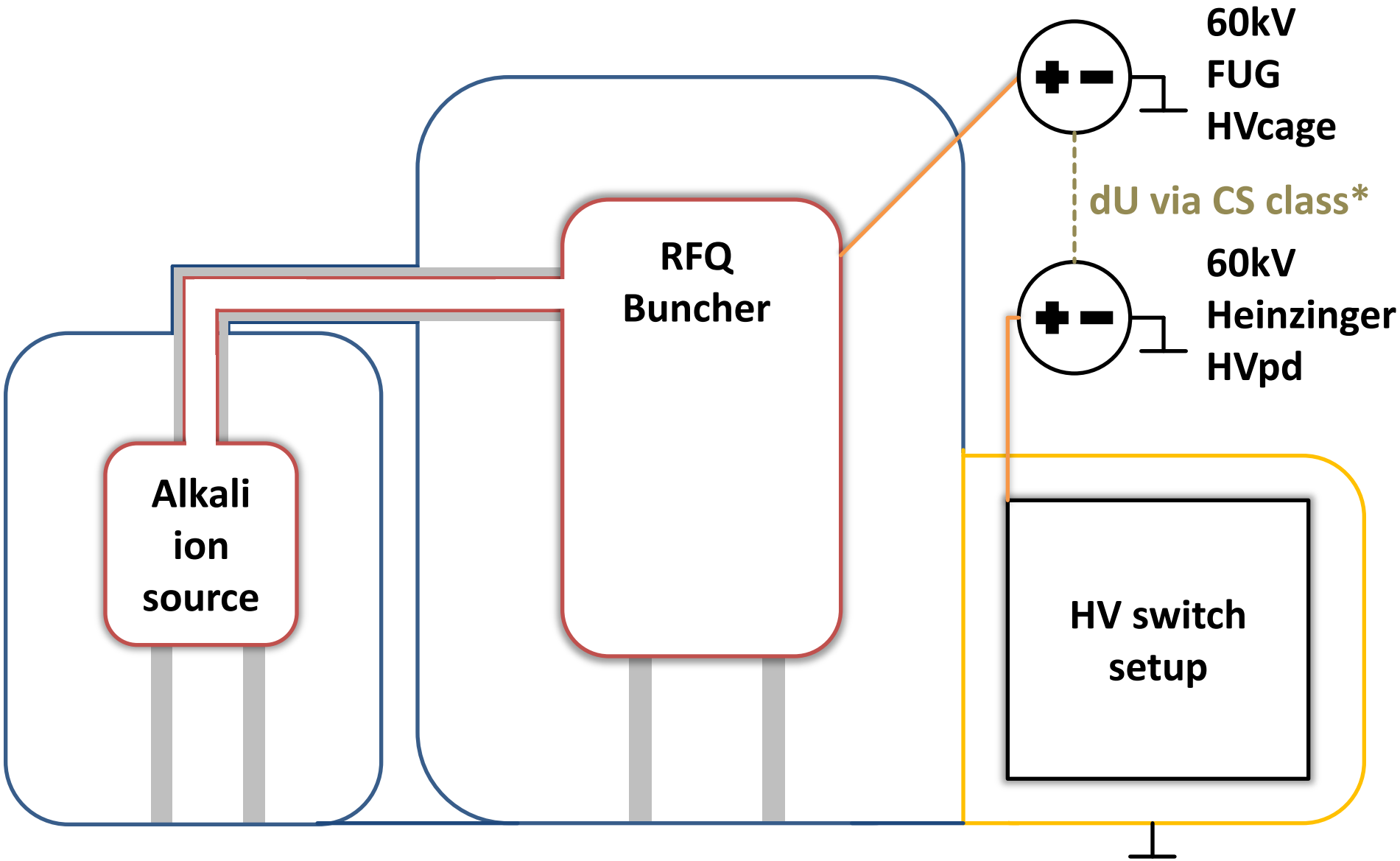


under-critical damping:
increasing resistance necessary 75 Ohm → 175 Ohm

HV cage reassembly



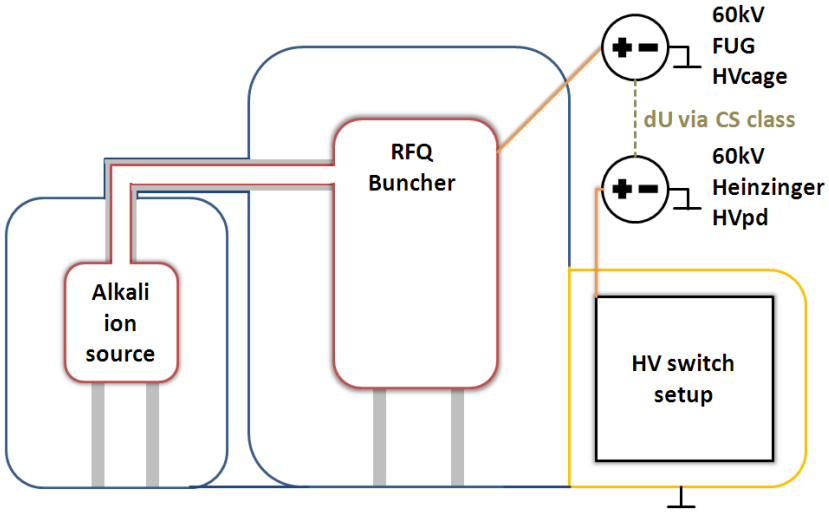
HV cage reassembly



* by Christopher

HV-switch Safety

Dividing the HV cages demands a separate safety installation for the HV-switch cage:
If VETO is set, LOW status is active -> HVpd=0V



Control System
trigger

TPG 300
pressure
p Buncher

Center 3
pressure
p drift tube

trigger IN VETO 1-4
optional:
trigger optical OUT
and trigger TTL OUT
(manual reset button)
switch status monitor
24V DC power supply
Trigger & Veto terminal

Pump and Fan status
9V DC power supply
trigger optical IN
trigger TTL IN
direct trigger
switch status optical
5V DC power supply
switch and cooling controller

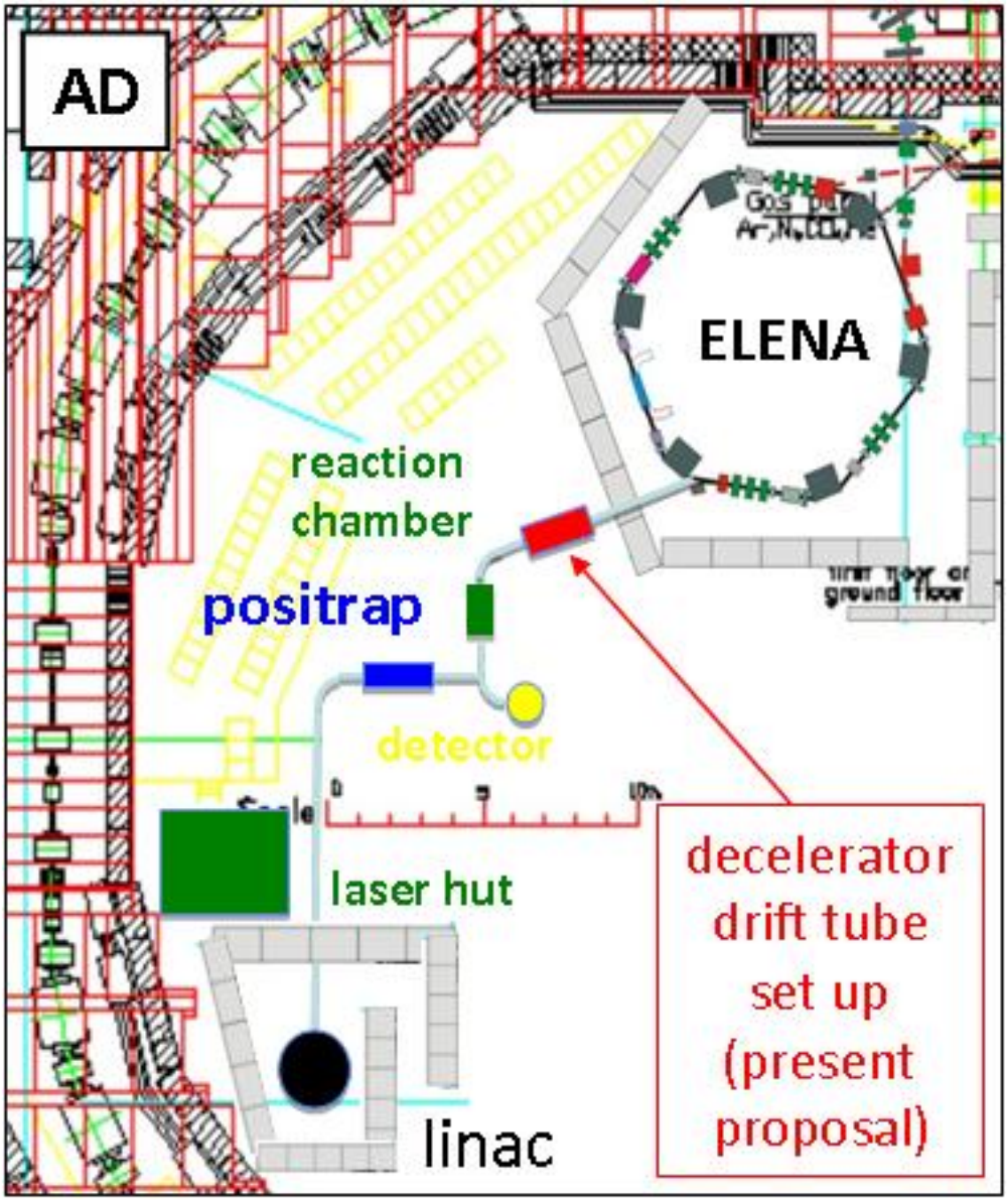
Tacho Pump and Fan speeds
Temp.: Fore, Back, Pump
Cooling system

trigger IN
status OUT: Temp, Freq., DC
5V DC IN
Behlke switch

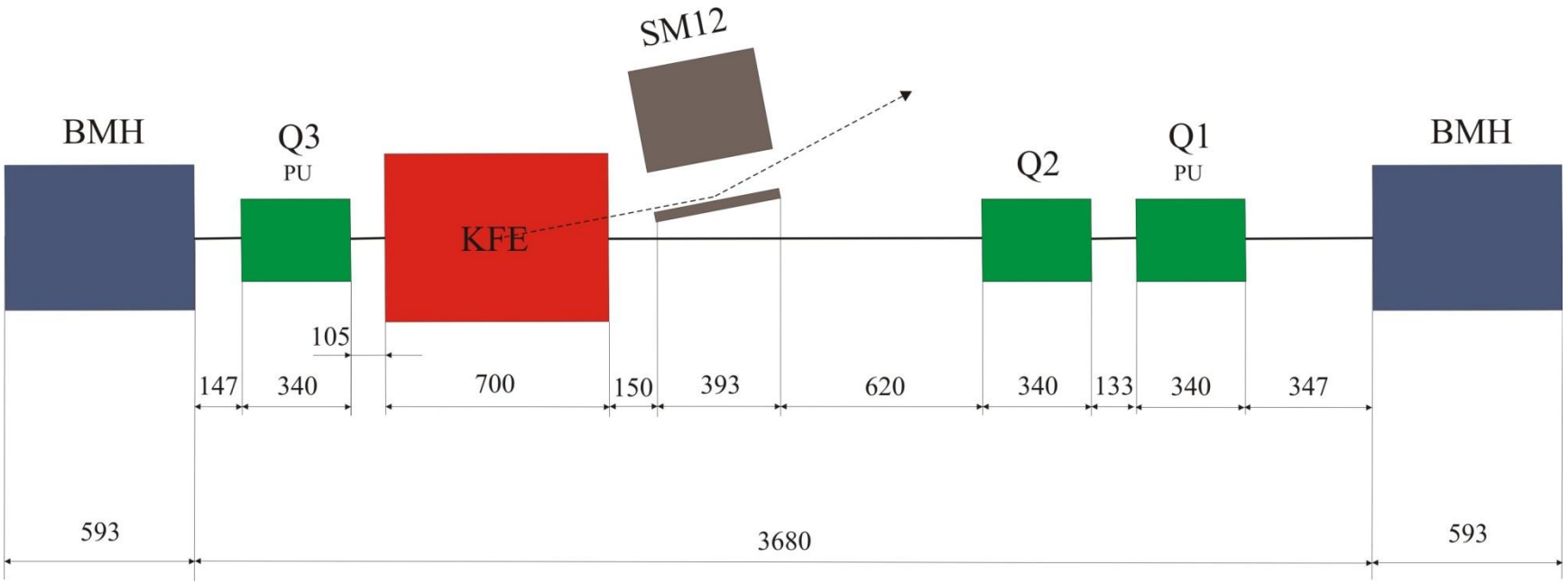
Line voltage

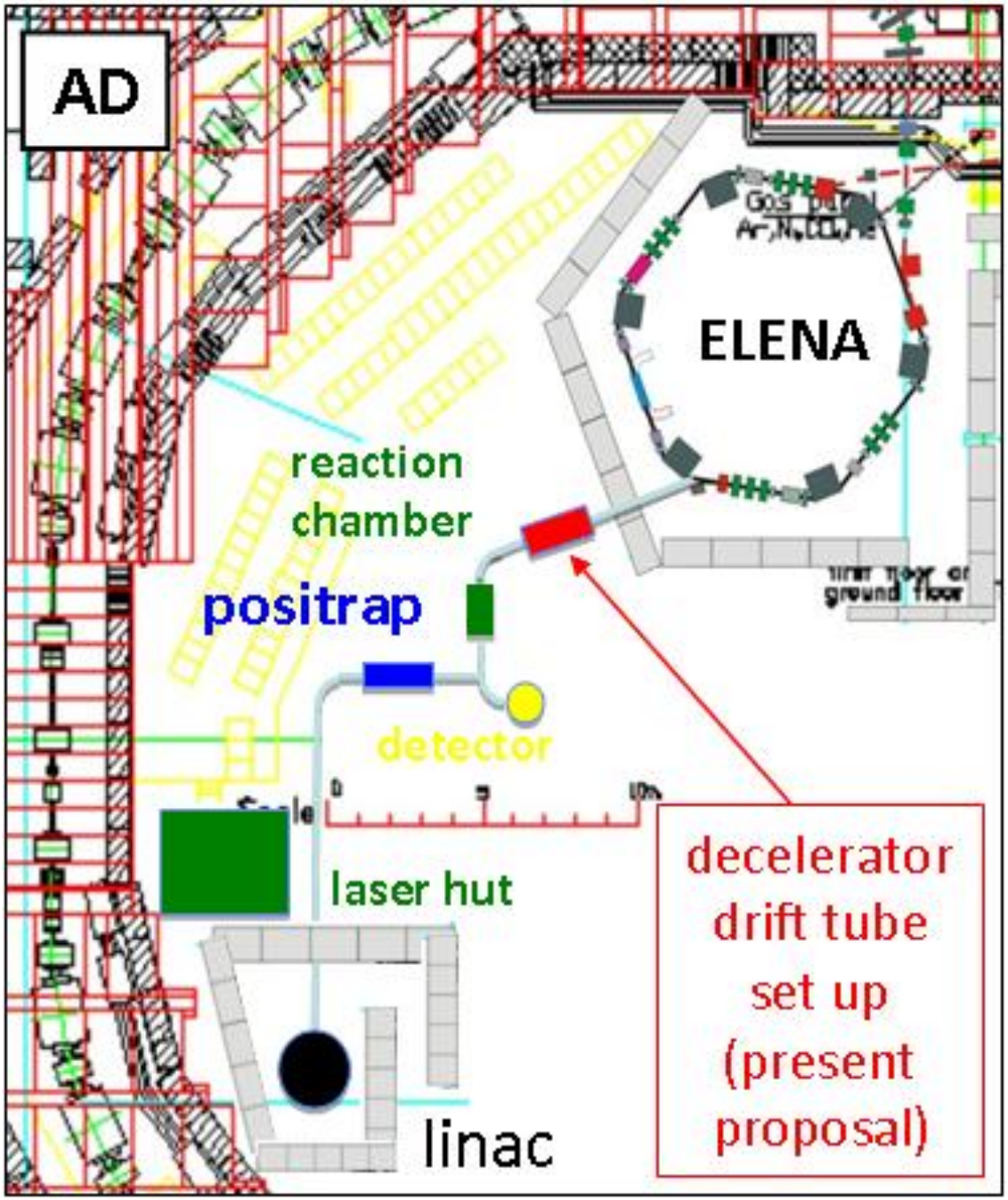
attached to cooper box grounding

GBAR layout issues


AD
ELENA
reaction
chamber
positrap
detector
laser hut
linac
deceleratordrift tubeset up(presentproposal)

Extraction from ELENA in a short straight section

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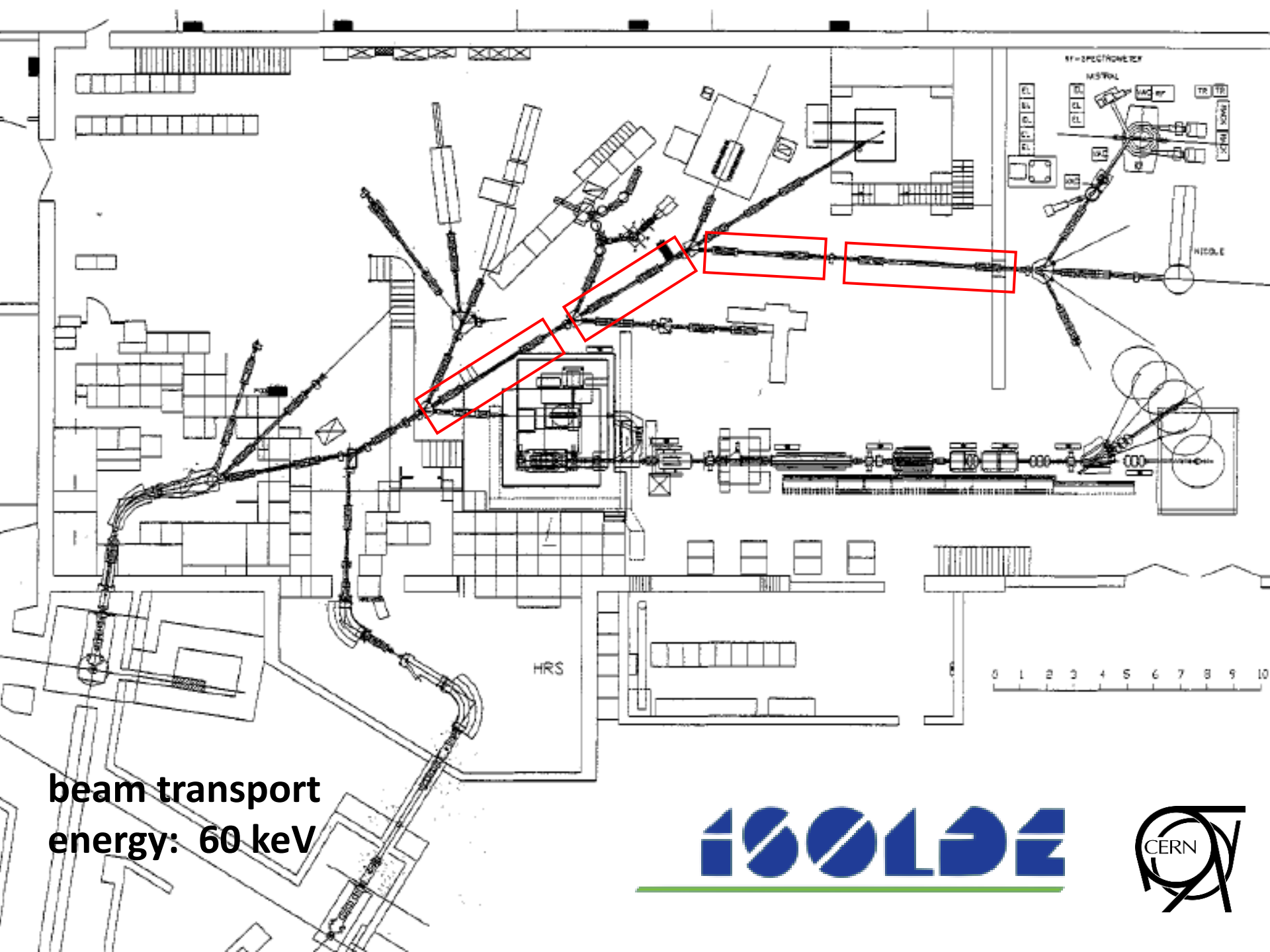
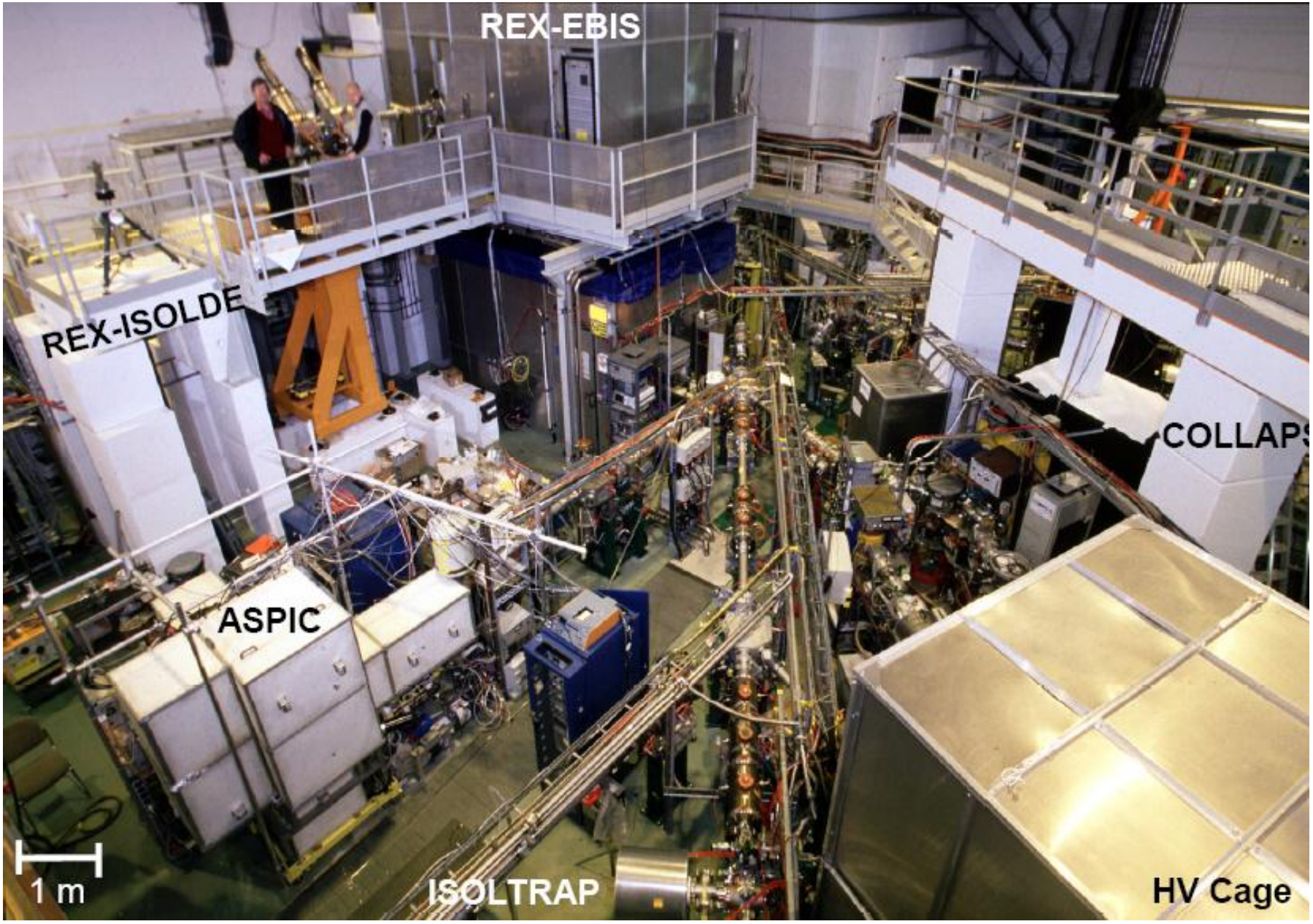
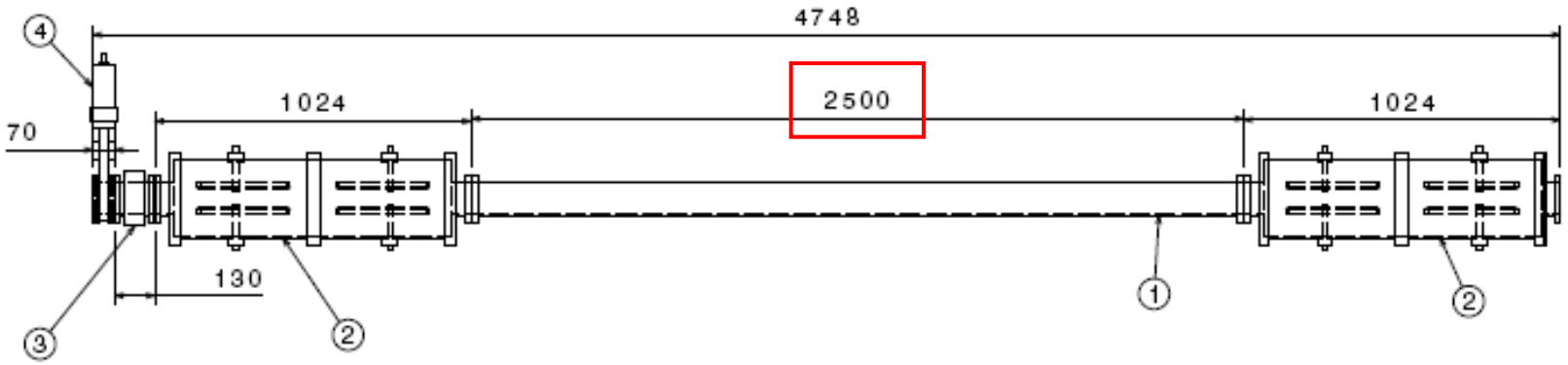


beam transport
energy: 60 keV


REX-EBIS
REX-ISOLDE
COLLAPS
ASPIC
1 m
ISOLTRAP
HV Cage



Nomenclature de sno105c1a001a

Numéro	Quantité	Référence	Nomenclature
1	1	sno106c1p002a	liaison doublet/doublet
2	2	sno106c1p001a	doublet
3	1	sno106c1p003a	soufflet
	1	Ensemble Vanne DN100 man	

Nomenclature de Ensemble Vanne DN100 man

Numéro	Quantité	Référence	Nomenclature
4	1	Vanne DN100	
5	2	CF150-100 Vanne	

Récapitulatif sur sno105c1a001a

Pièces différentes : 5

Total des pièces : 7

Quantité	Référence
1	sno106c1p002a
2	sno106c1p001a
1	sno106c1p003a
1	Vanne DN100
2	CF150-100 Vanne

module 2 doublets + tube + soufflet + vanne

Désignation : module 2 doublets + tube + soufflet + vanne

référence fichier : sno106c1a001a

Tolérances générales :
- longueur : JS10
- angles : +/- 1°
- état de surface : Ra 6.4

cotes dimensions en millimètres

Matière :

projet : Ghar

version :

traitement de surface : aucun

Poids [kg] : XXX

Taille : A3

Echelle : 5

Date de création : 10/1/2012

Date d'enregistrement : 10/1/2012

Centre de Spectrométrie Nucléaire et Spectrométrie de Masse

DESSINE PAR :
Stéphane CABARET
CSNSM
bâtiment 104
Rue Georges Clémenceau
Université Paris Sud 11
91405 ORSAY CEDEX
tél. : 00 33 (0) 1 69 15 52 21
fax : 00 33 (0) 1 69 15 61 88
stephane.cabaret@csnsm.in2p3.fr

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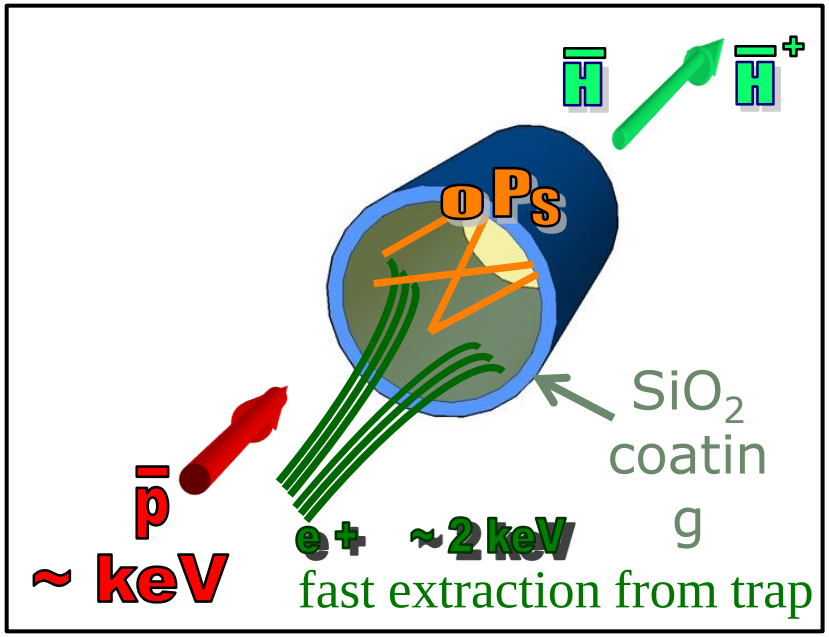
ELENA
Ep800
2000
55°
Origine
repère AD
9600
Gbar
Ep 800
1200
9500
12003
5800
6000
15700
Ø1000
(Linac)

$\bar{H}^+$ Production

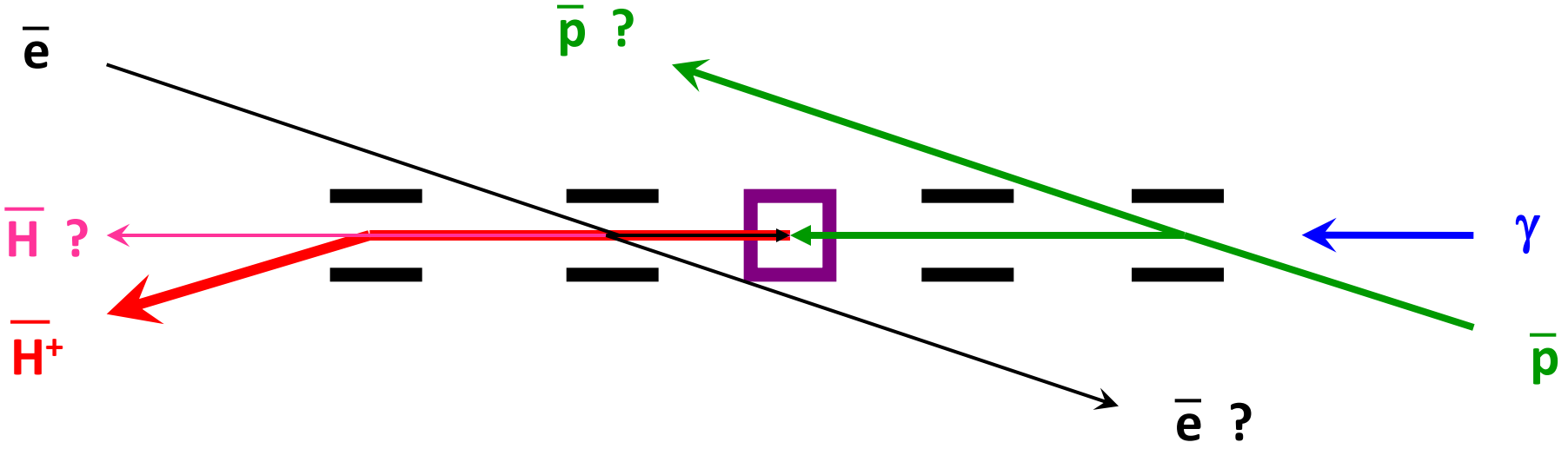


$$\bar{p} + Ps \rightarrow \bar{H} + e^-$$

$$\bar{H} + Ps \rightarrow \bar{H}^+ + e^-$$

Ortho-positronium

GBAR – reaction chamber trajectories




ELENA
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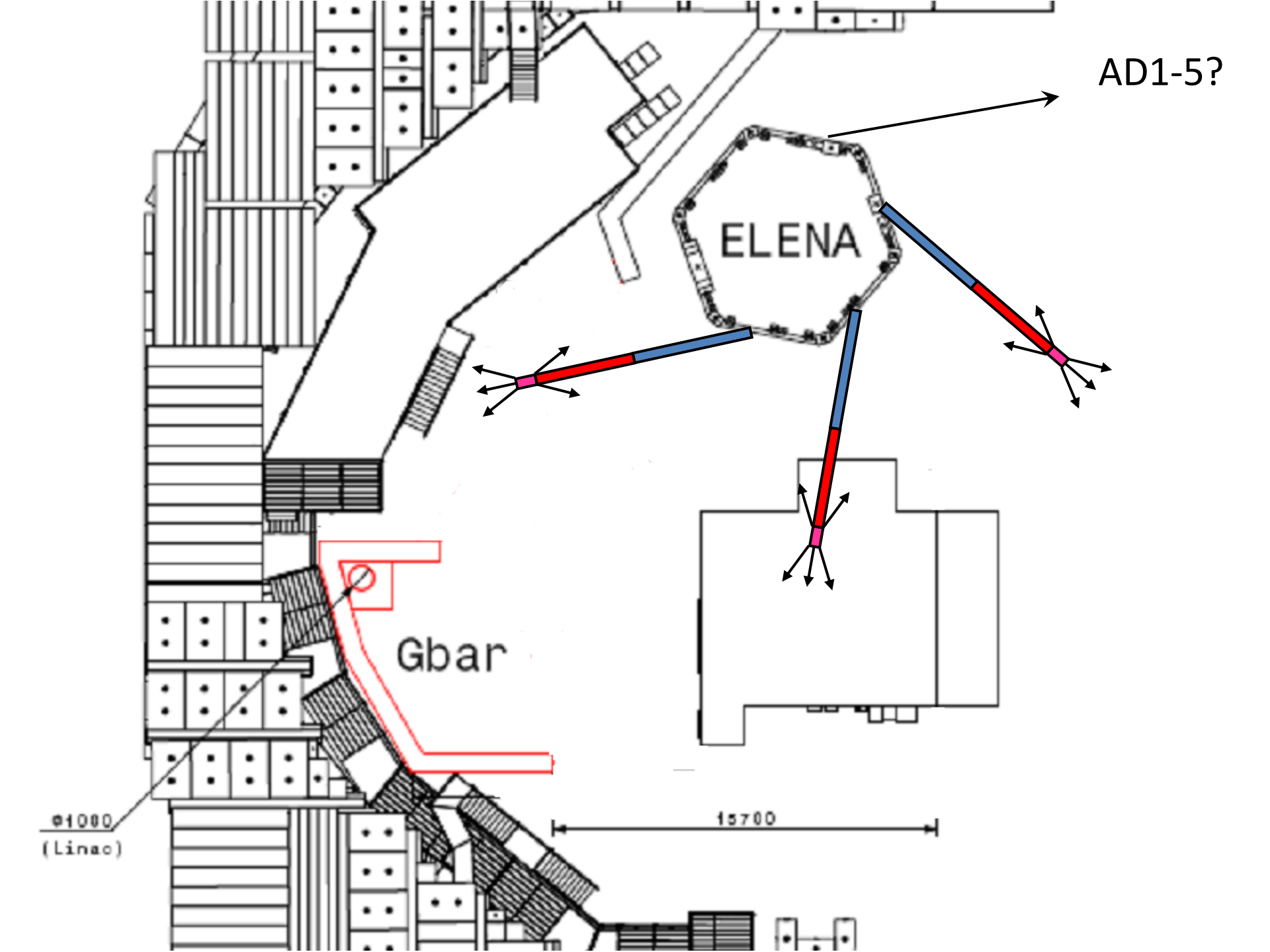
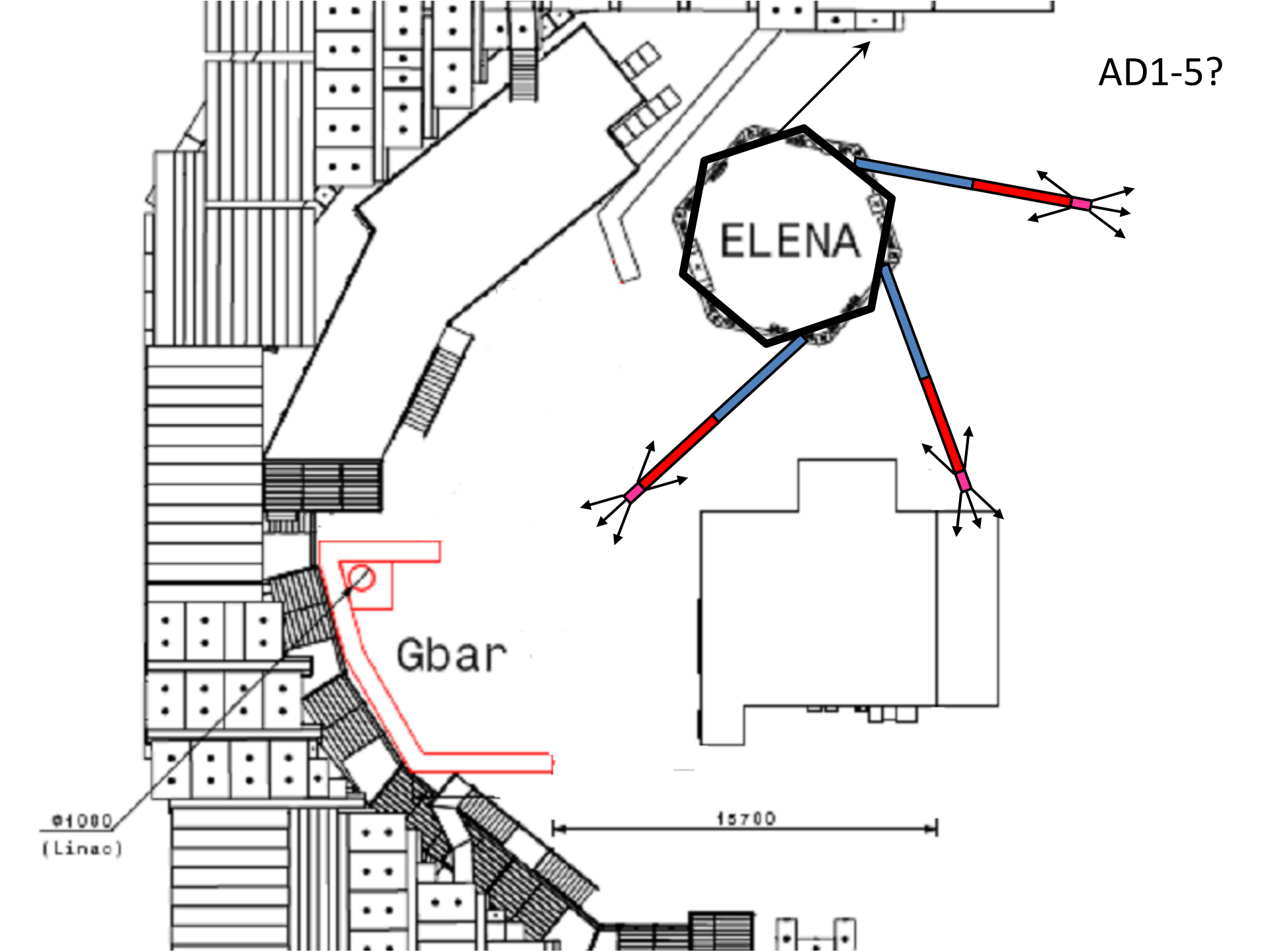
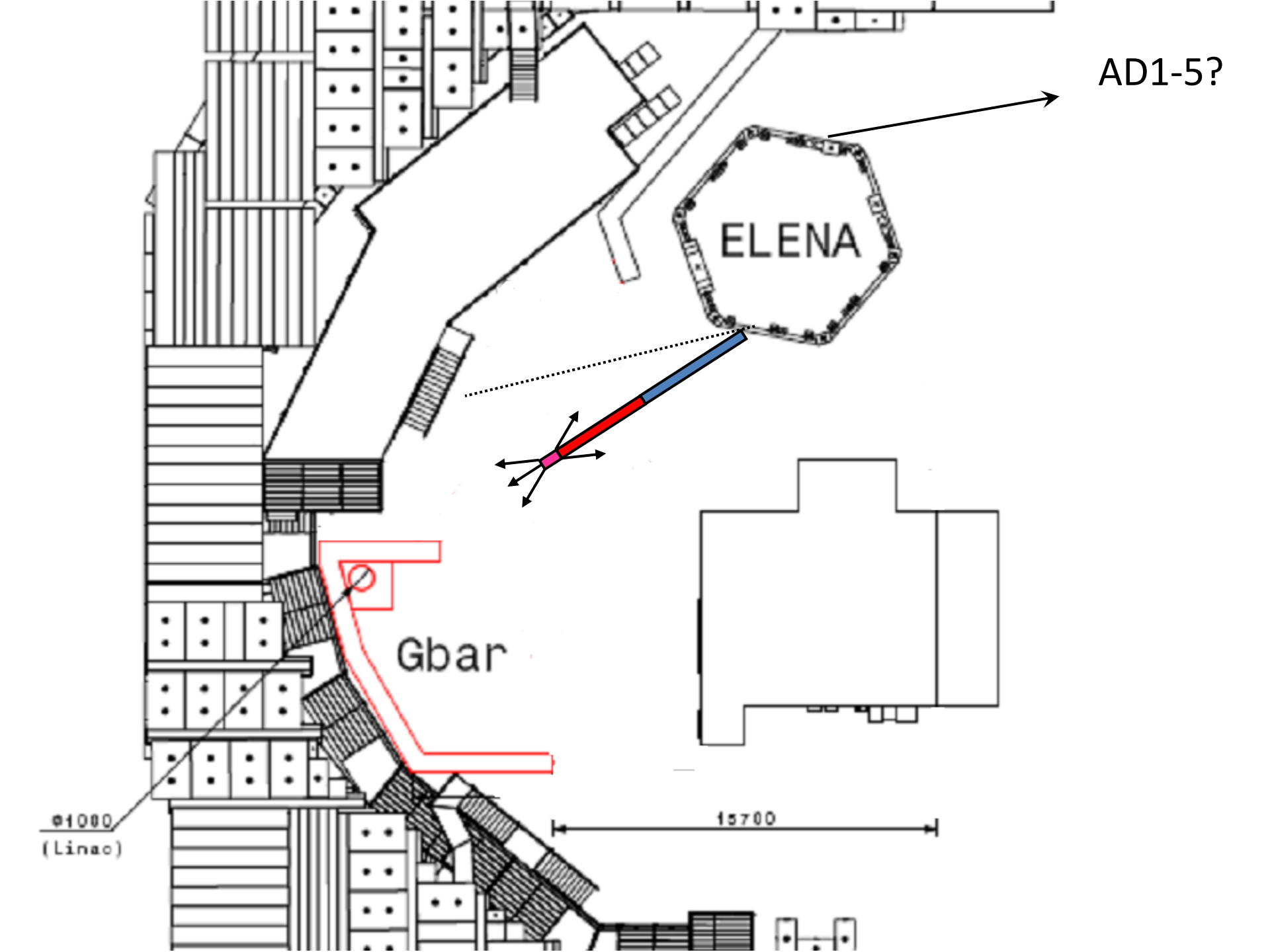

AD1-5?
ELENA
Gbar
15700
Ø1000
(Linac)


AD1-5?
ELENA
Gbar
15700
Ø1000
(Linac)


AD1-5?
ELENA
Gbar
15700
Ø1000
(Linac)

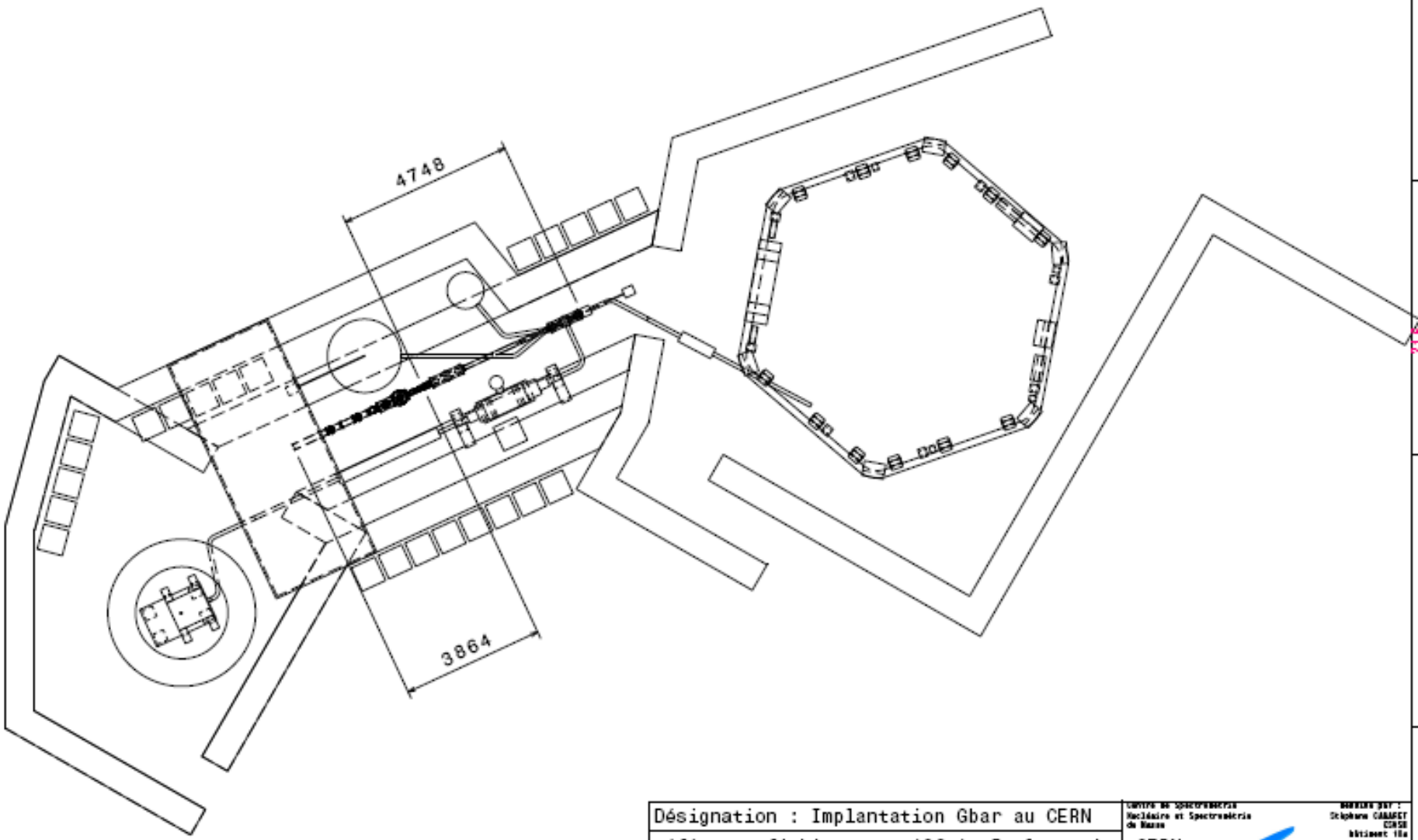
Summary

Decelerator

- Pulsed drift scheme: start from working instrument (60 kV)
- First simulations show phase space conserved
- transmission not disastrous (35%)

Layout issues

- Question: are H+, p-, e+ beams interesting for others?
- Extraction and transport part of ELENA (i.e. resp. CERN)?
- Positioning of equipment…
  - different extraction segment?
  - rotating ELENA?
  - increasing ELENA kicker-bender angle?
  - adding multipoles?



Désignation : Implantation Gbar au CERN

référence fichier : sno106c1a_Implantation-CERN

Tolérances générales :
- longueurs : .X±0
- angles : +/- 1°
- état de surface : Ra 6.4

toutes dimensions en millimètres

Matière :

projet : Gbar au CERN

version :

traitement de surface : aucun

Poids [kg] : XXX

Taille : A3

Echelle : 00

date de création : 10/10/2012

date d'enregistrement : 10/10/2012

Centre de Spectrométrie Nucléaire et Spectrométrie de Masse
CSNSM
Dessiné par :
Stéphane CABARET
CSNSM
Bâtiment 104
Rue Georges Clémenceau
Université Paris Sud 11
91405 ORSAY CEDEX
tél. : 00 33 (0) 1 69 1a a2 24
Fax : 00 33 (0) 1 69 1a a5 68
stephane.cabaret@csnsm.in2p3.fr

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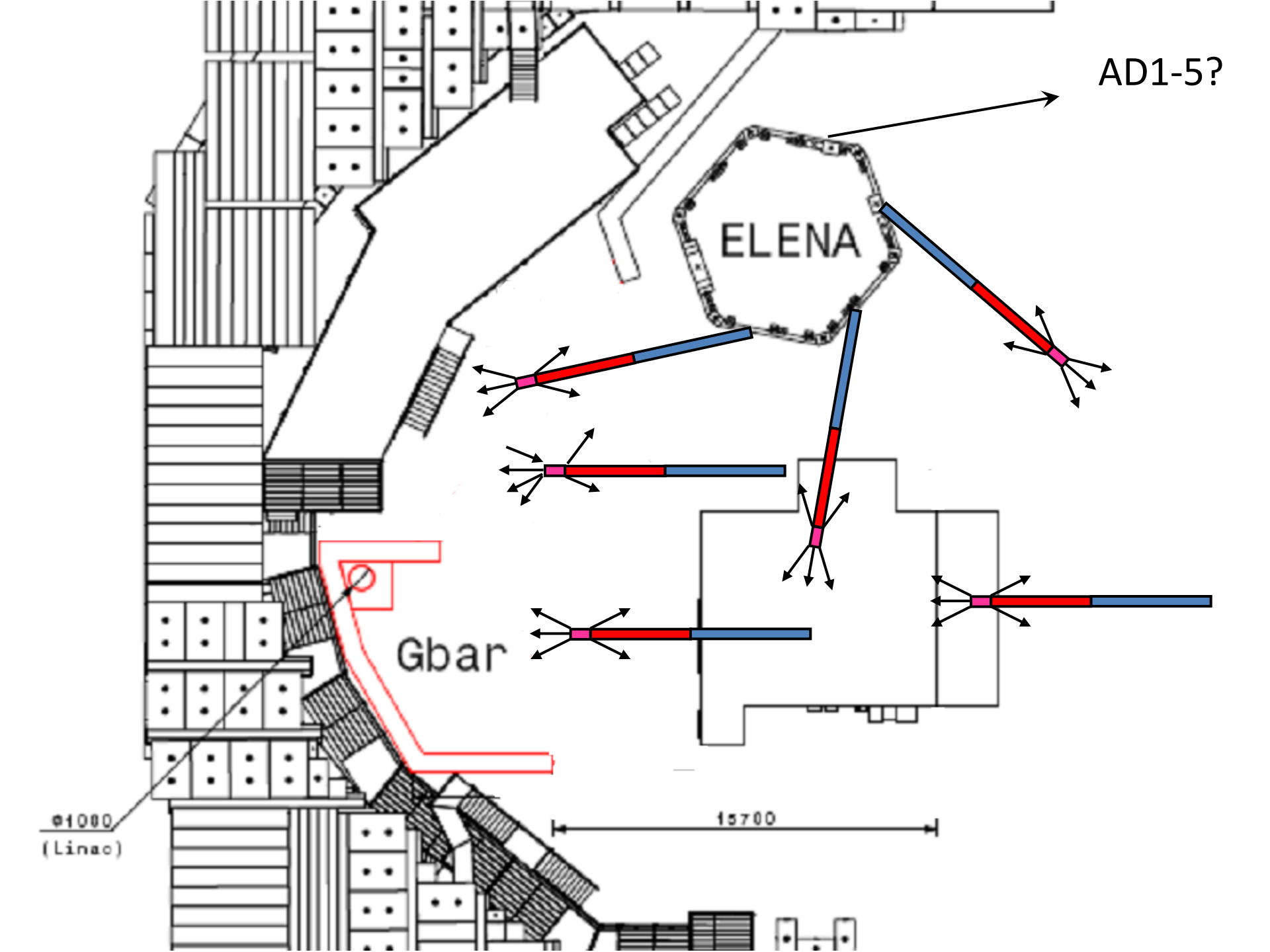
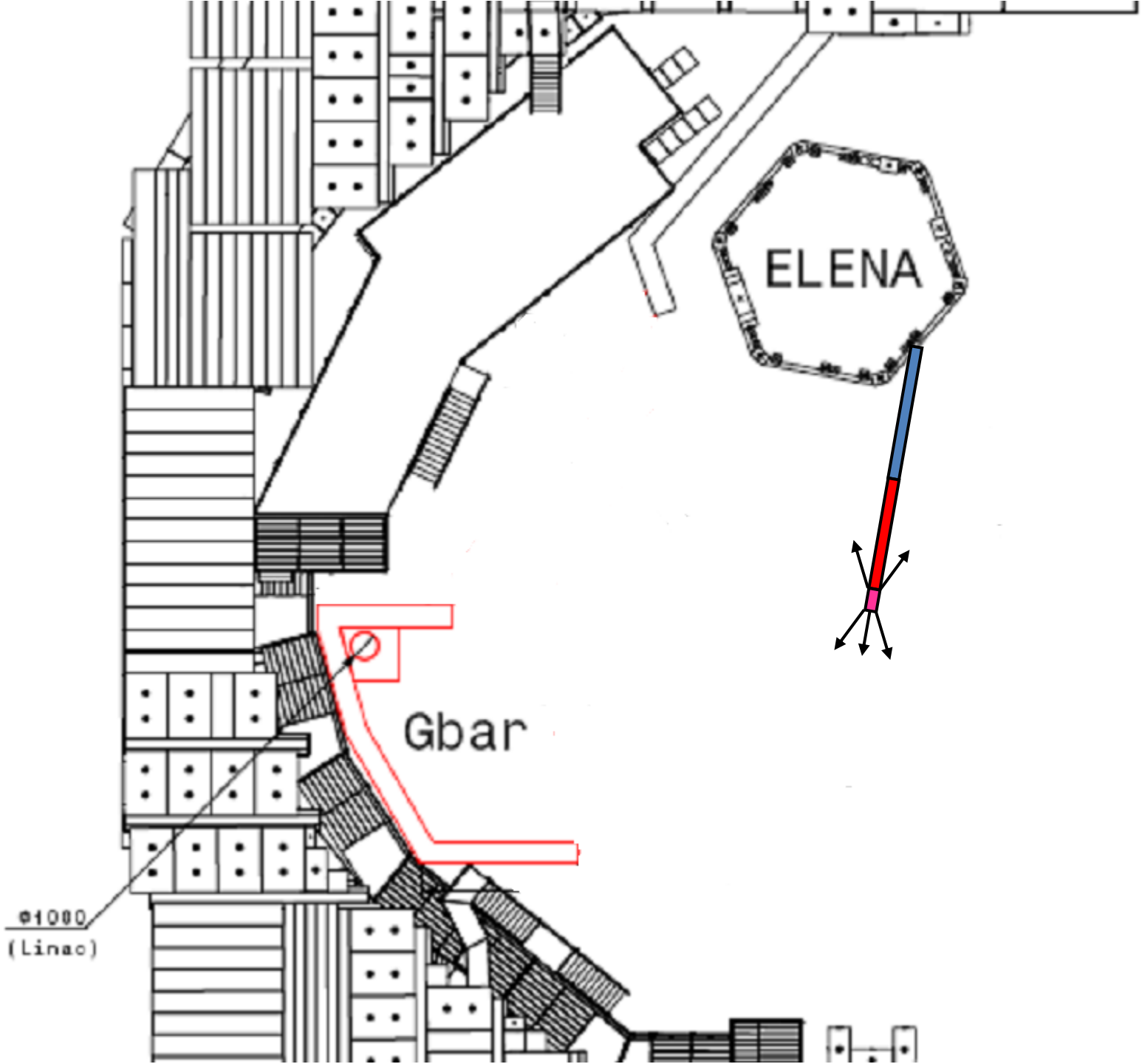
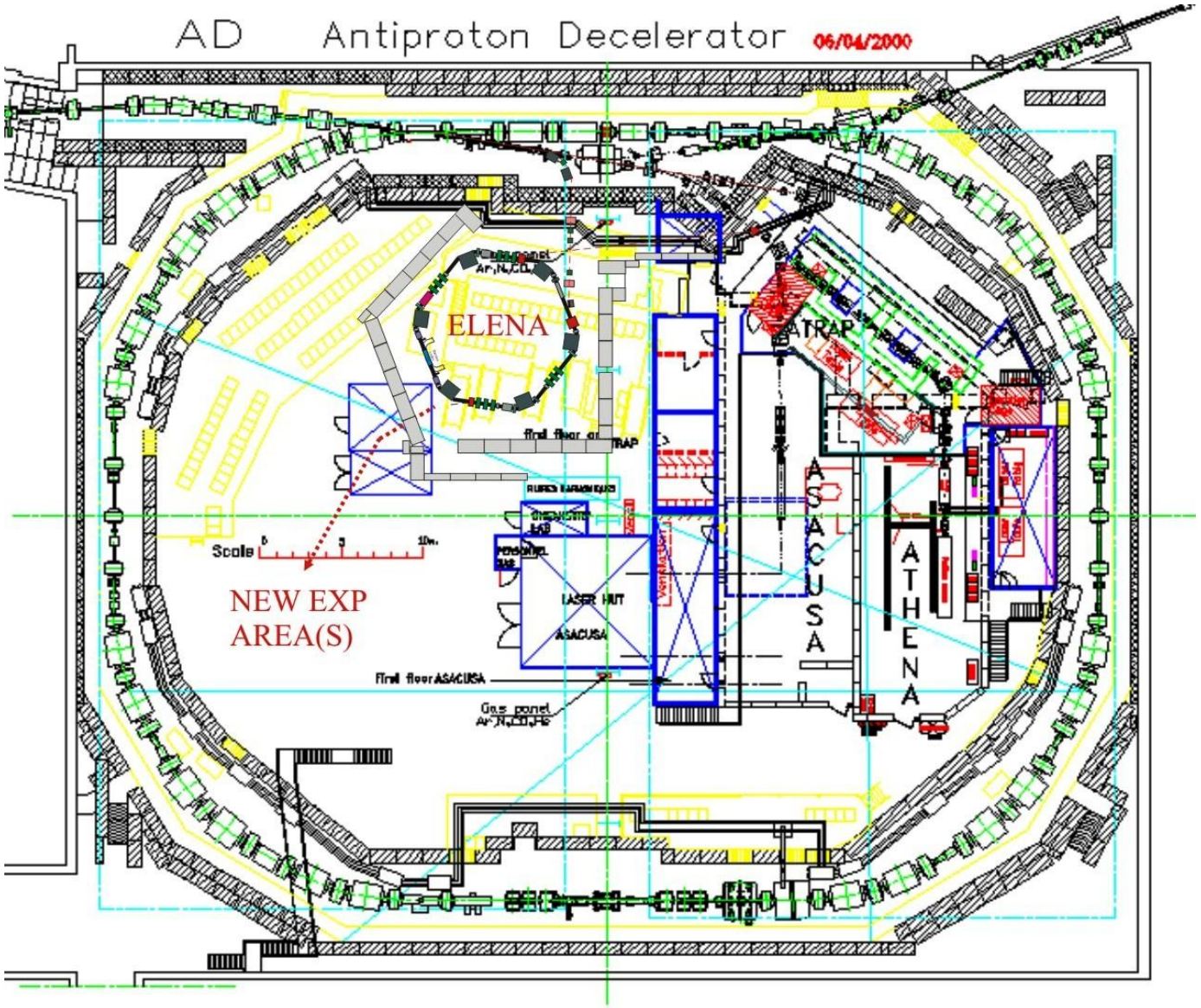
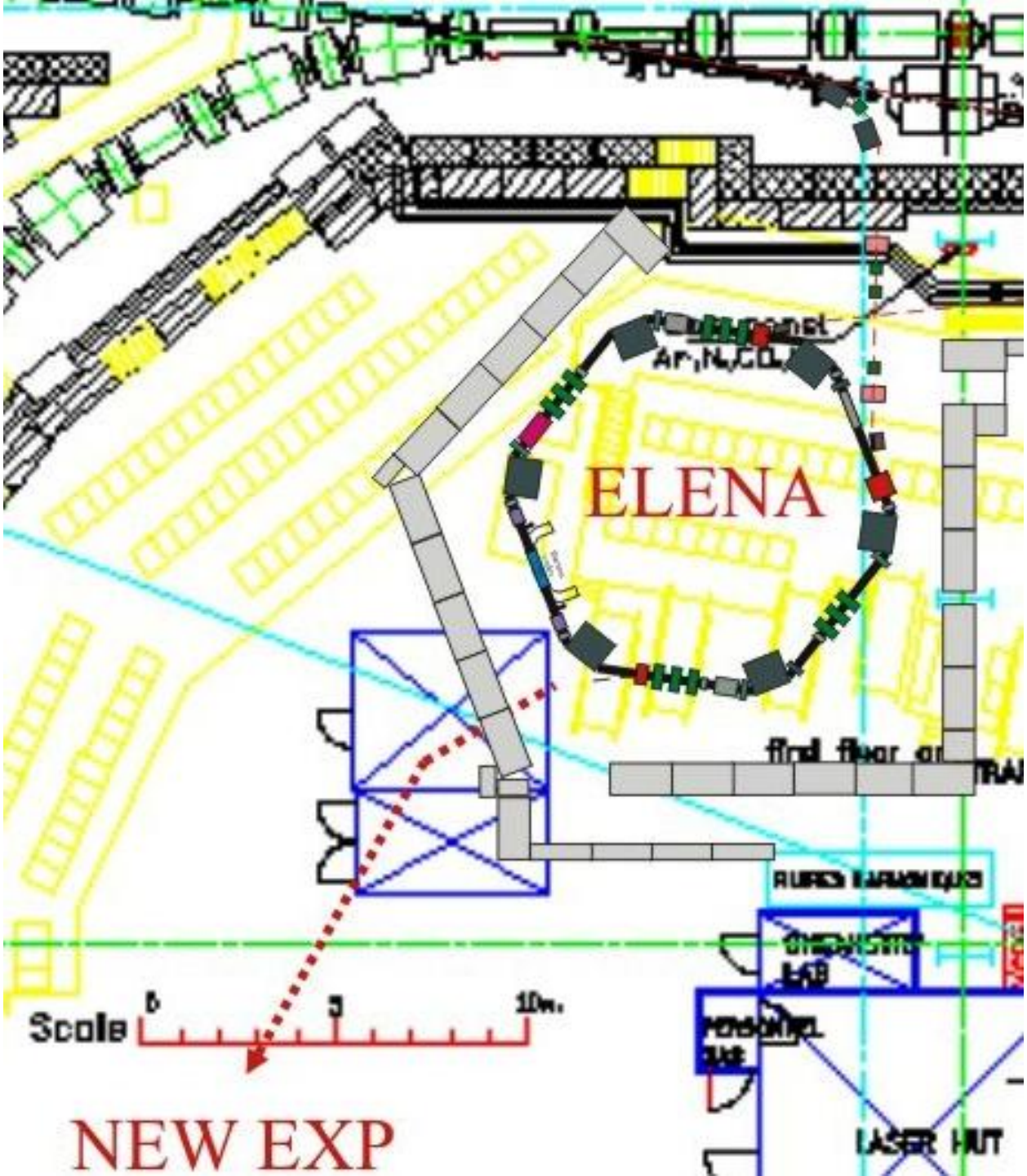
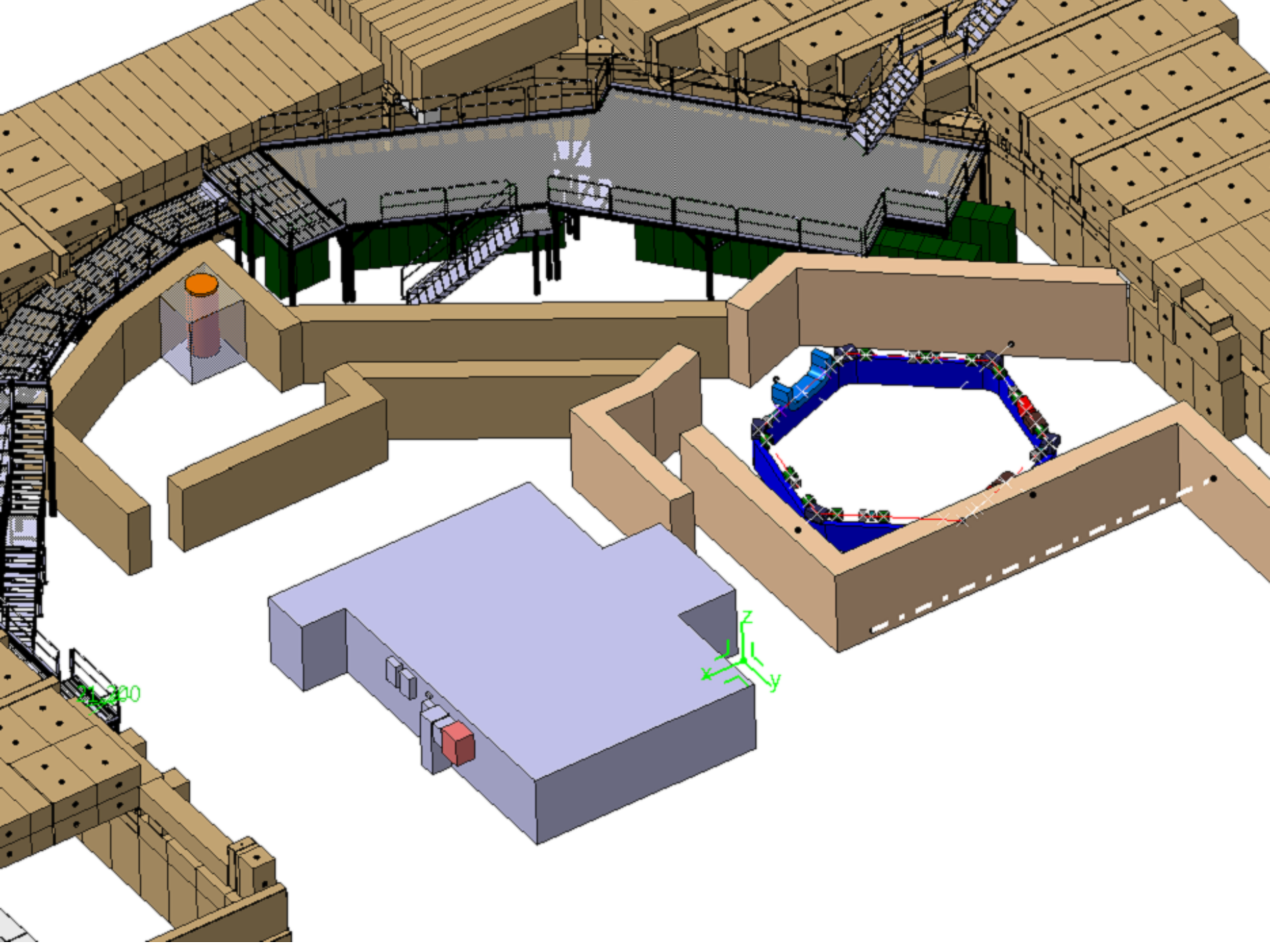

AD1-5?
ELENA
Gbar
15700
Ø1000
(Linac)


ELENA
Gbar
Ø1000
(Linac)

ELENA layout in AD Hall

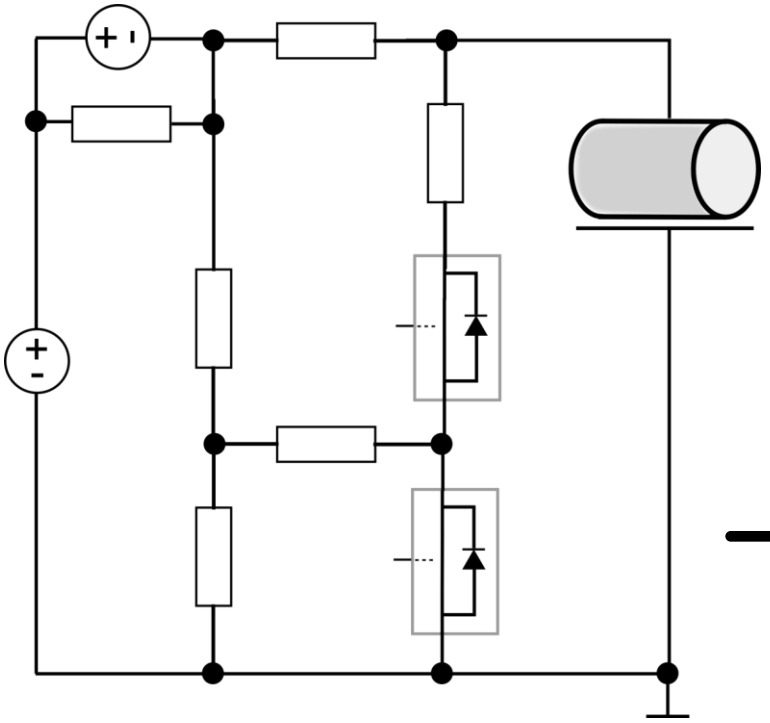



ELENA
Scale
NEW EXP
LASER HUT

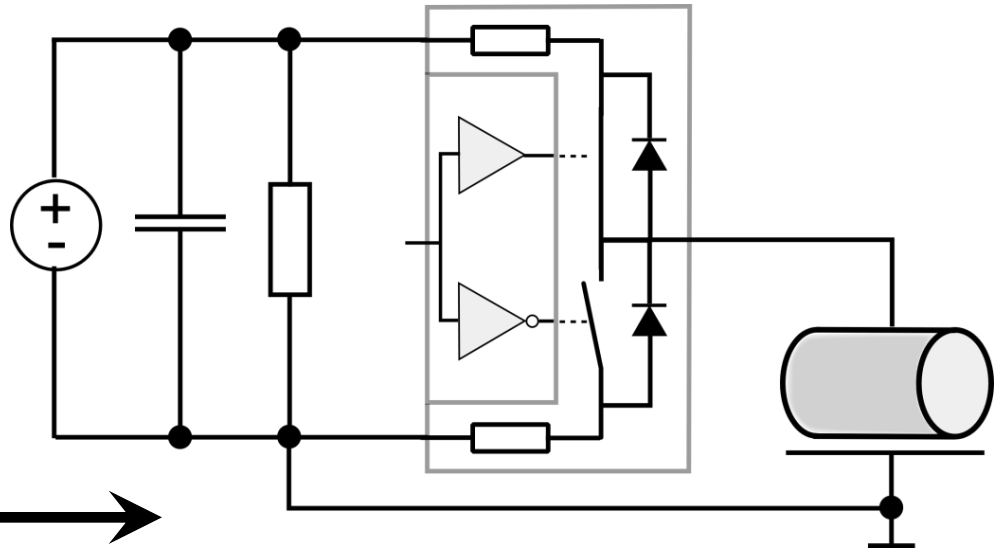

Z
y
x

HV-switch modification

old circuit:



new circuit:



Drawbacks:

– Repetition rate max. 3Hz
– dropping HVcage potential
– (Leakage current issue)

Design objectives:

– Repetition rate up to 1kHz @ 60kV
– Stable high-voltage potential
– Safety, Reliability

Challenges:

– Power dissipation: up to 600W
– RF-noise