ADAMAS 2016

GSI, 15.12.2016

Erich Griesmayer, CIVIDEC Instrumentation

“CVD DIAMOND DETECTOR DEVELOPMENT”

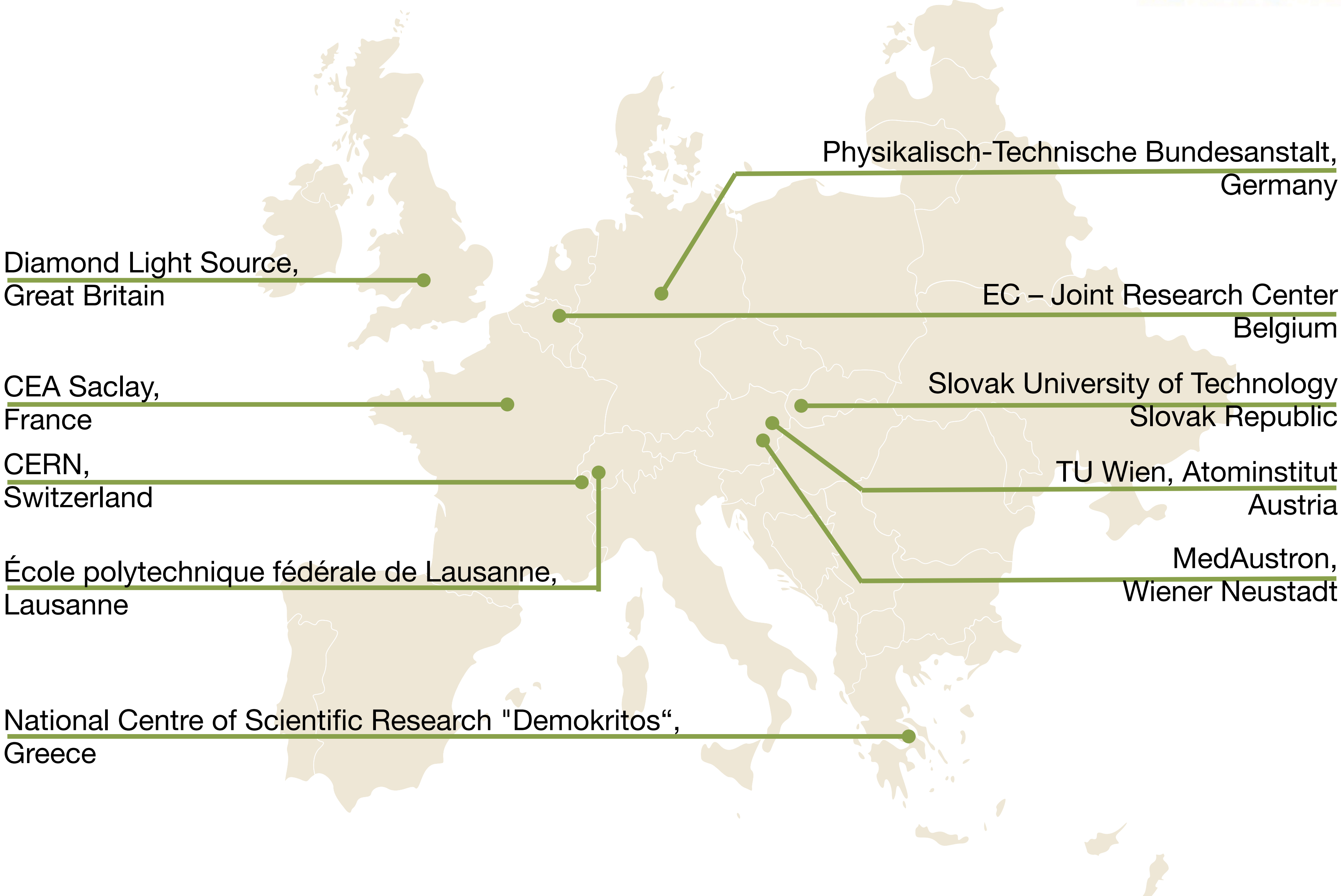
Since 2009

In the center of Vienna

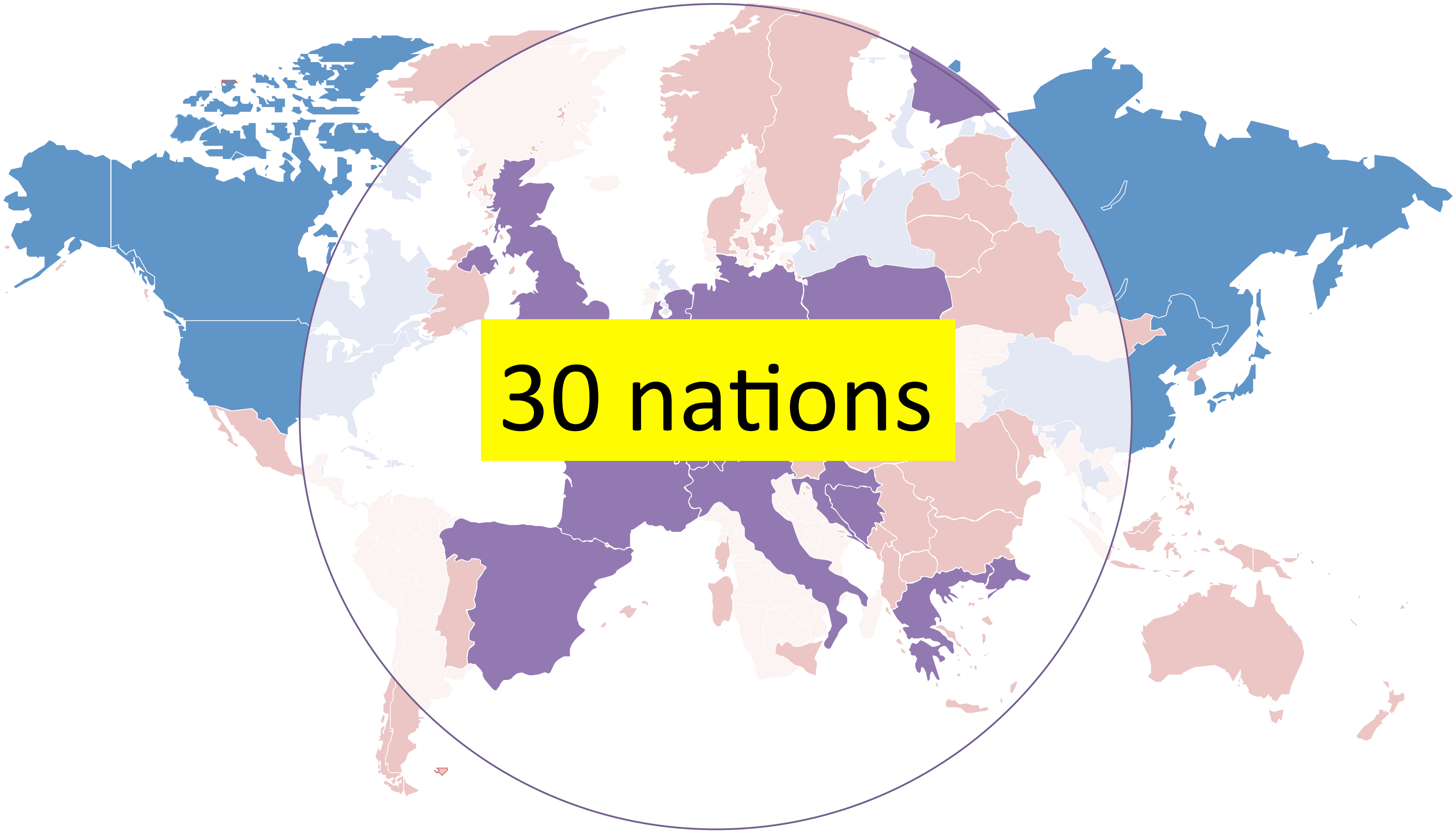
Location

Network

Science Network



Customers



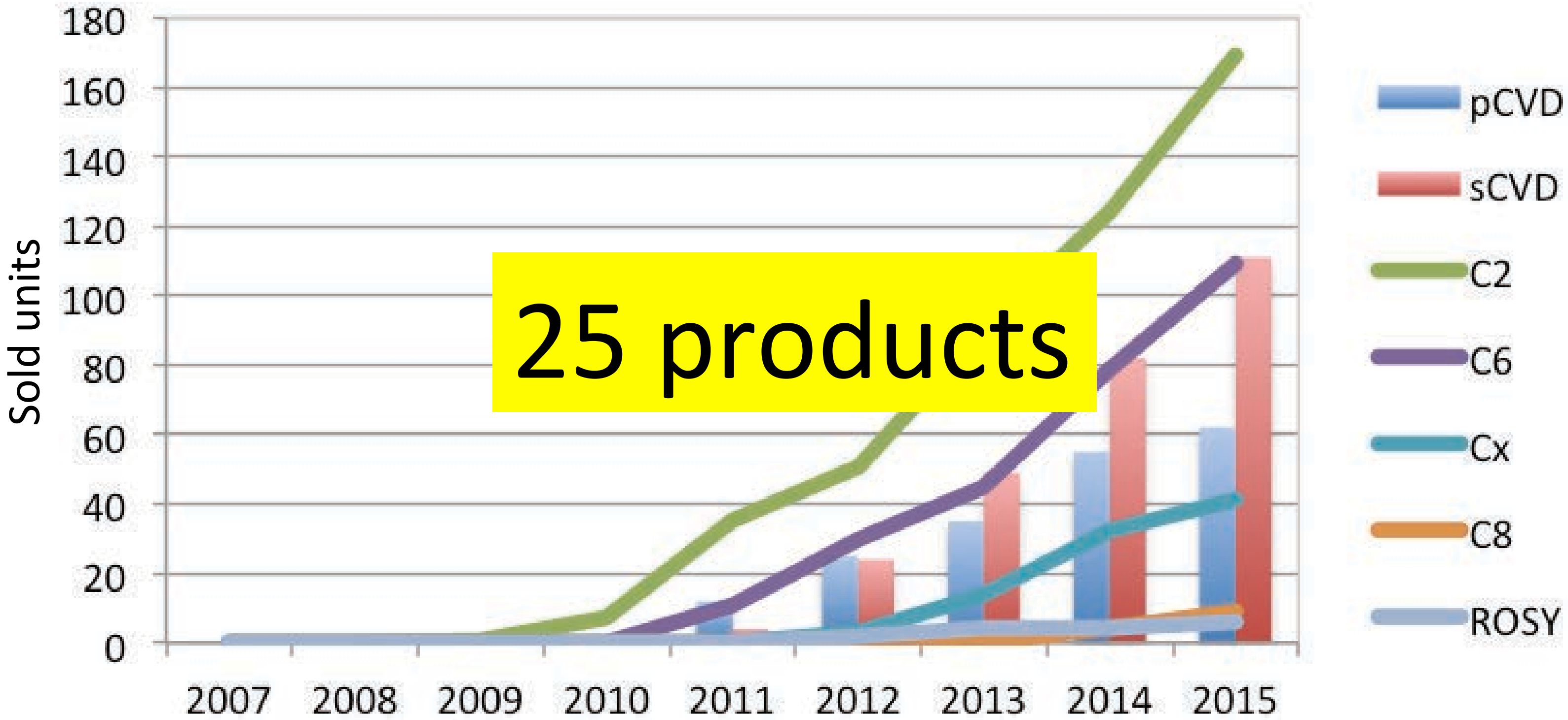
Customers

cividec Instrumentation

UK BAE SYSTEMS	UK diamond	Belgium iba	Canada UNIVERSITY OF TORONTO	USA ThermoFisher SCIENTIFIC	Spain ATI SISTEMAS	Belgium irmm
Spain FUSION FOR ENERGY	Taiwan NSRRC	India tifr	Egypt SCIENTIFIC SERVICES	PSI	Spain FUSION FOR ENERGY	France ESRF
China IMP	South Korea PAL	Germany	India	Sweden	China IMP	France LPSC Grenoble
Austria IAEA	France SOLEIL SYNCHROTRON	CERN	ETH zürich	NASA	Sweden UPPSALA UNIVERSITET	Thailand Siam Photon
UK diamond	Belgium iba	Canada UNIVERSITY OF TORONTO	USA ANIXTER	Croatia	India	Italy INFN
Russia iter	USA BROOKHAVEN NATIONAL LABORATORY	France cnrs	Germany AXILON	Sweden MAX IV	USA SLAC NATIONAL ACCELERATOR LABORATORY	Turkey METU

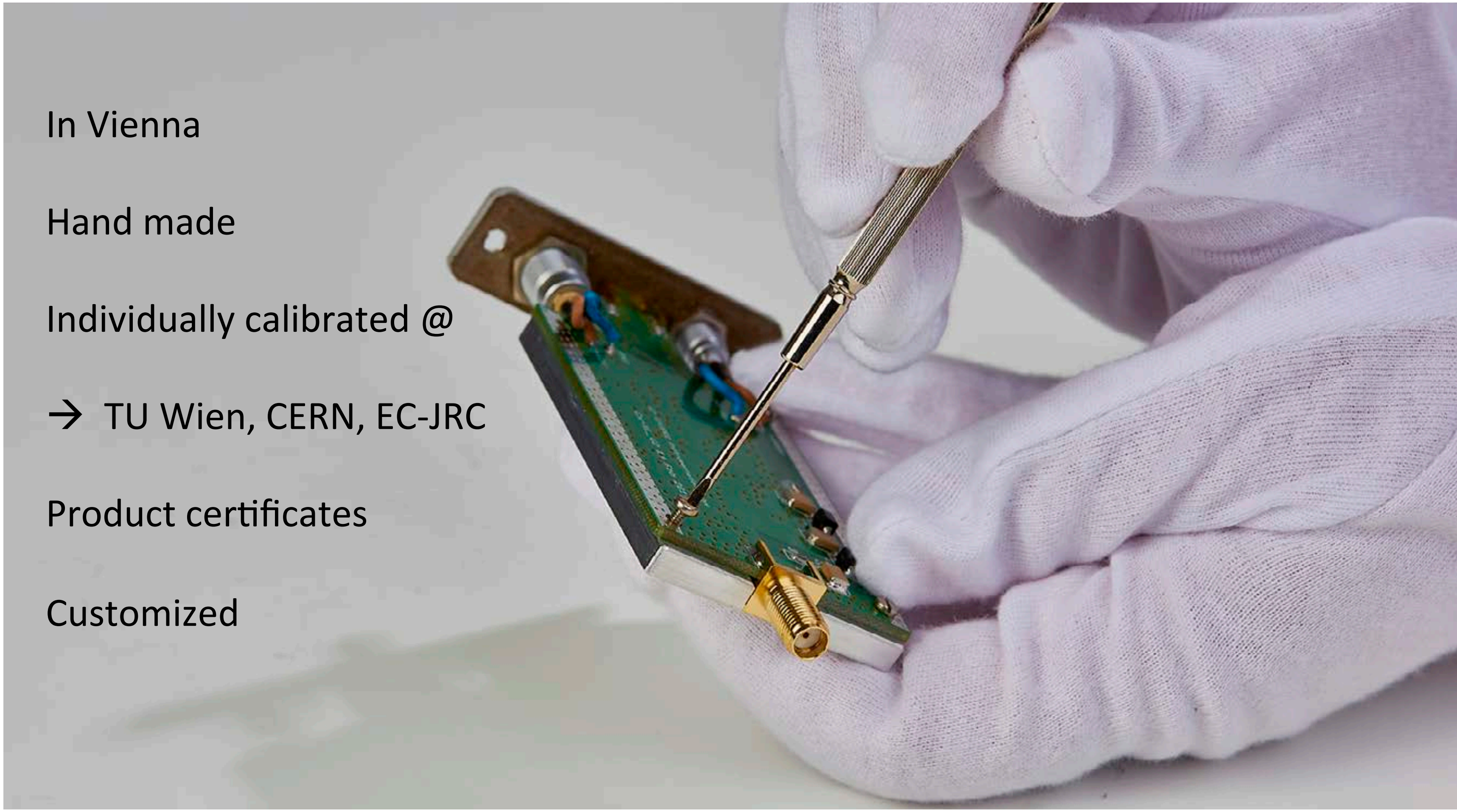
100 customers

Sold units



Sold units
180
160
140
120
100
80
60
40
20
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
pCVD
sCVD
C2
C6
Cx
C8
ROSY
25 products

Production



In Vienna

Hand made

Individually calibrated @

→ TU Wien, CERN, EC-JRC

Product certificates

Customized

1993

E. Griesmayer Draft Nov. 11, 1993

A Proposal for a Novel Ion Beam Detector

A silicon strip detector could be capable of measuring the beam parameters of the AUSTRON ion beam with a very good accuracy. Some main parameters are described here.

The main beam parameters are:

1 beam intensity
2 beam position
3 beam profile

The main questions arising are:

1 energy loss of beam
2 beam scattering
3 detector lifetime (radiation)

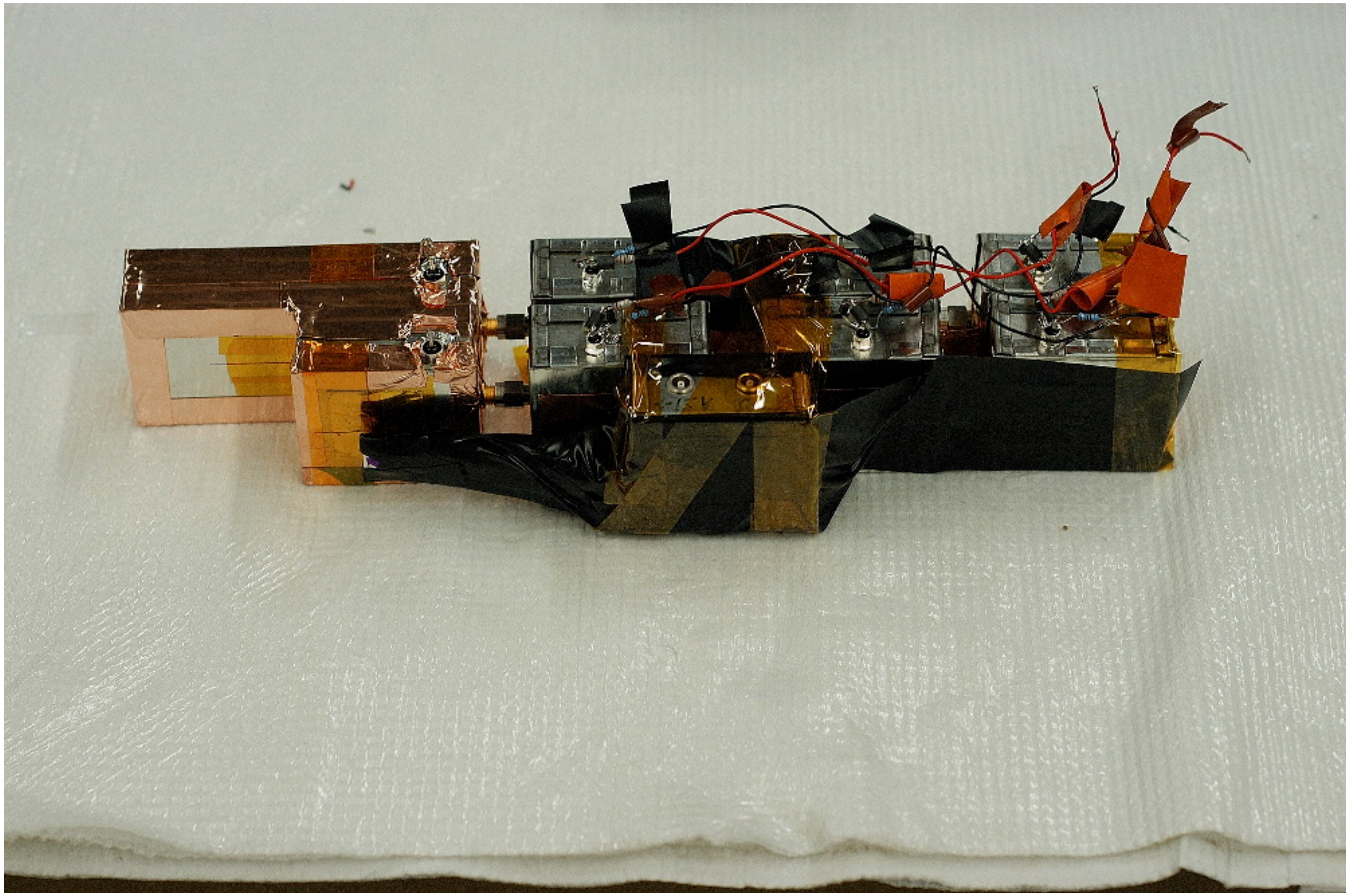
1. The detector

The idea is to use a conventional Si strip detector. The detector could be made out of a 4 inch silicon wafer, corresponding to about 10 cm in diameter. The thickness would be about 300 μm, the interstrip spacing could be about 200 μm. The detector could be manufactured double sided, one plane covering the horizontal coordinate, the other the vertical.

2. Si properties

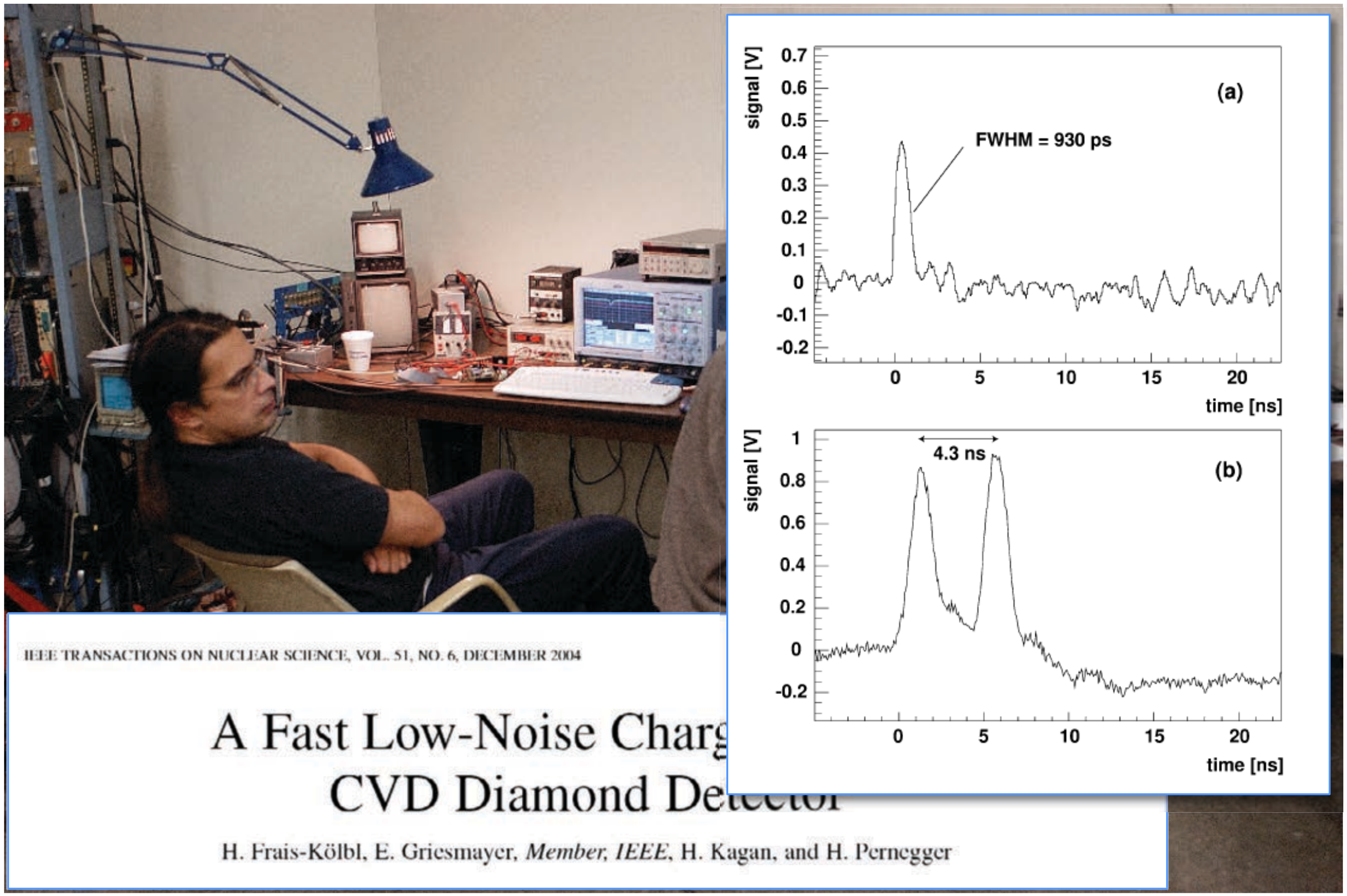
Atomic number	$Z=14$
Atomic weight	$A=28.09$
Density	$\rho=2.33$ g/cm^3
Electron mobility (300 K)	$\mu_e=1350$ cm^2/Vs
Hole mobility (300 K)	$\mu_h=480$ cm^2/Vs
Energy per pair (300 K)	3.6 eV

The Giga-Counter .....

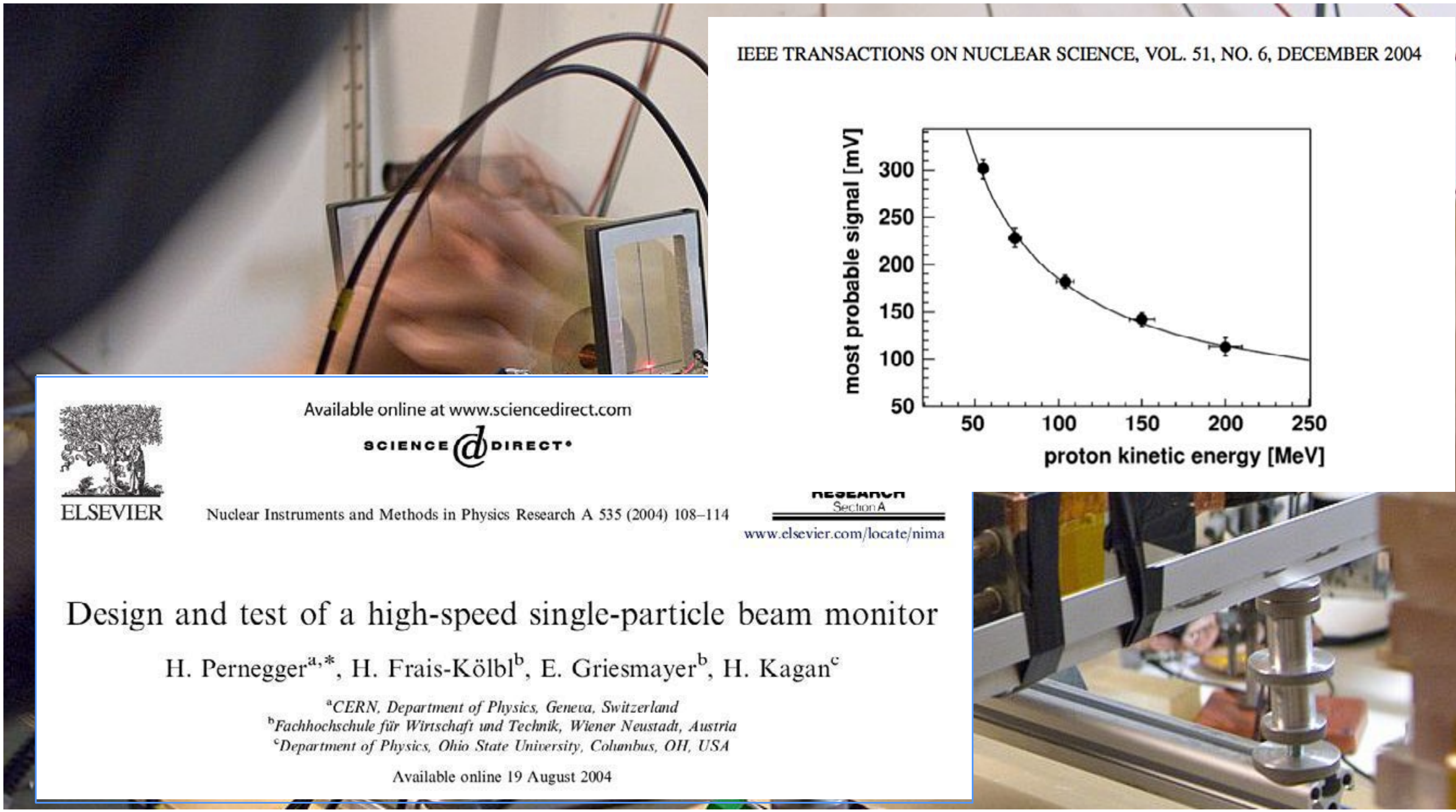


2003 Bloomington

2003 Bloomington



2004 MGH


IEEE TRANSACTIONS ON NUCLEAR SCIENCE, VOL. 51, NO. 6, DECEMBER 2004
most probable signal [mV]
50
100
150
200
250
300
50
100
150
200
250
proton kinetic energy [MeV]
Available online at www.sciencedirect.com
SCIENCE DIRECT
ELSEVIER
Nuclear Instruments and Methods in Physics Research A 535 (2004) 108–114
RESEARCH
Section A
www.elsevier.com/locate/nima
Design and test of a high-speed single-particle beam monitor
H. Pernegger[a,*], H. Frais-Kölbl[b], E. Griesmayer[b], H. Kagan[c]
[a]CERN, Department of Physics, Geneva, Switzerland
[b]Fachhochschule für Wirtschaft und Technik, Wiener Neustadt, Austria
[c]Department of Physics, Ohio State University, Columbus, OH, USA
Available online 19 August 2004

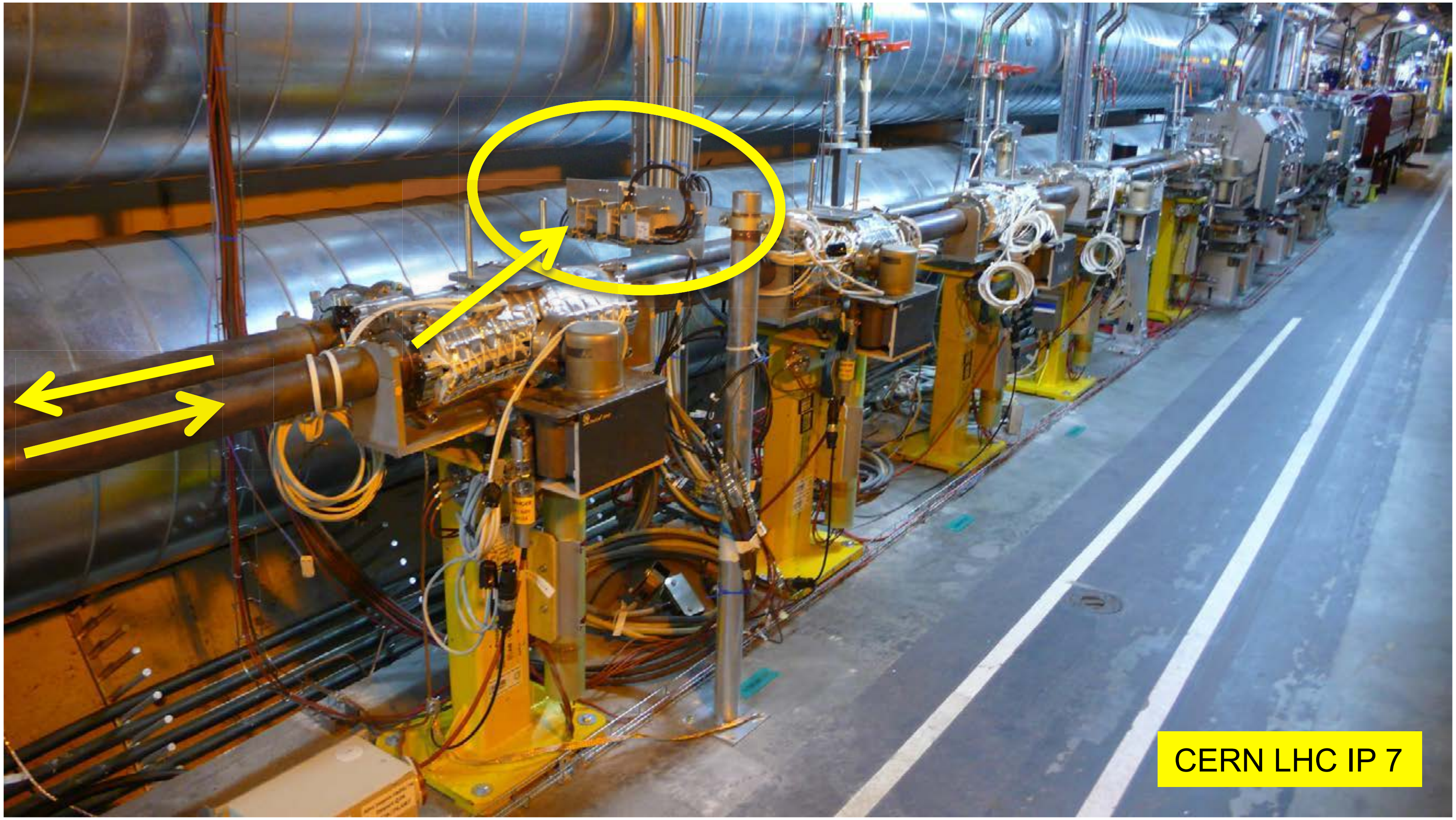
2016

Beam Loss System

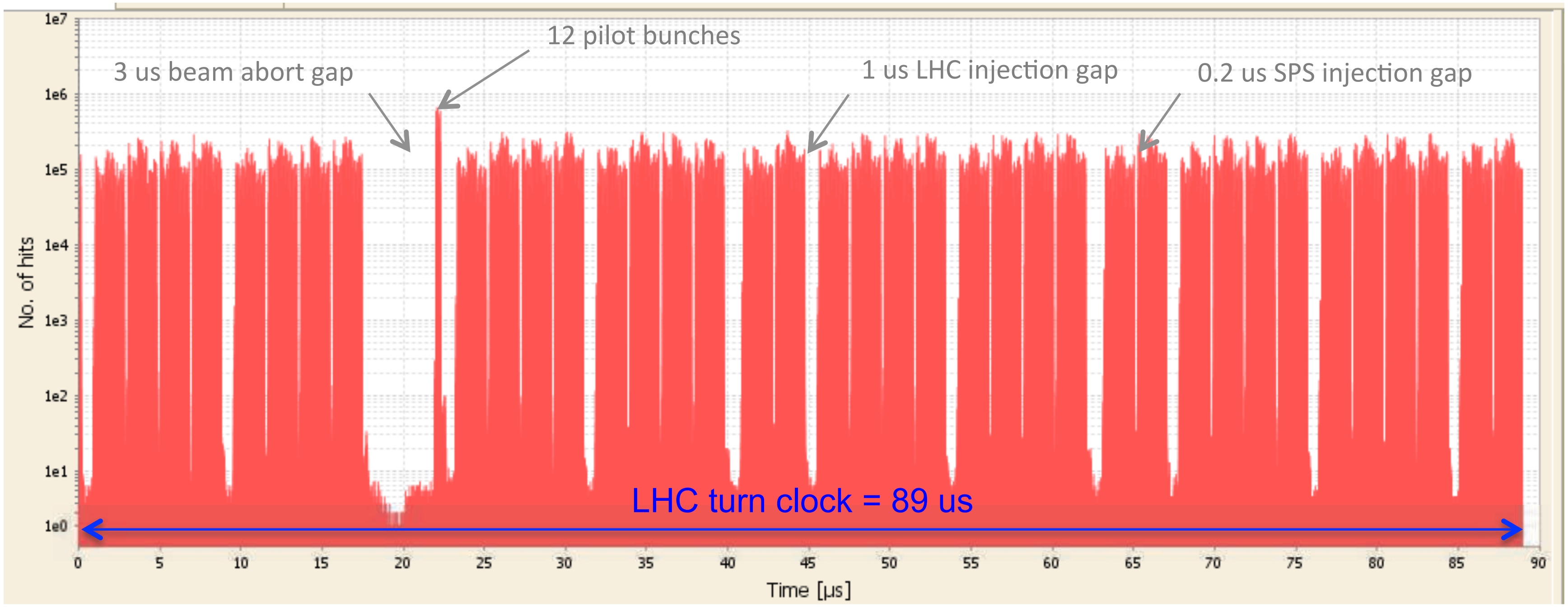
Systems

- Charged particles
  - Beam Loss Monitor
  - ToF applications
  - Spectroscopy
- Photons
  - XBPM
  - Gamma diagnostics
- Neutrons
  - Fast neutron diagnostics
  - Thermal neutron diagnostics
  - HT reactor applications

LHC DBLM

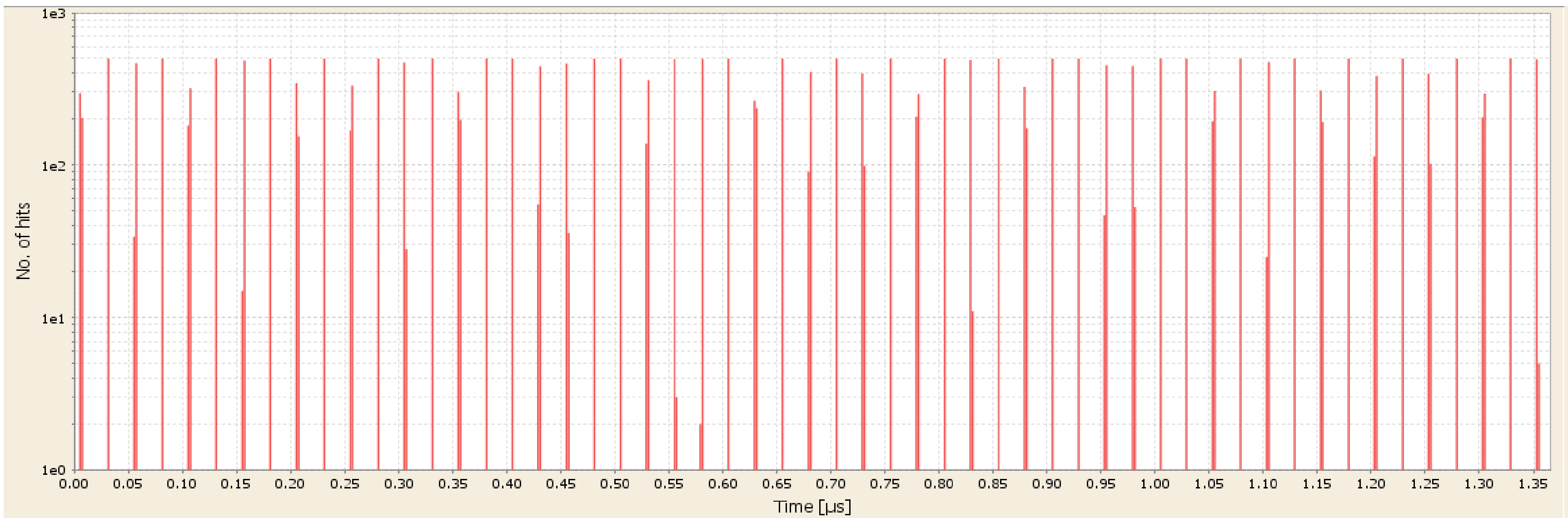


Static operation



Bunch-by-Bunch Losses

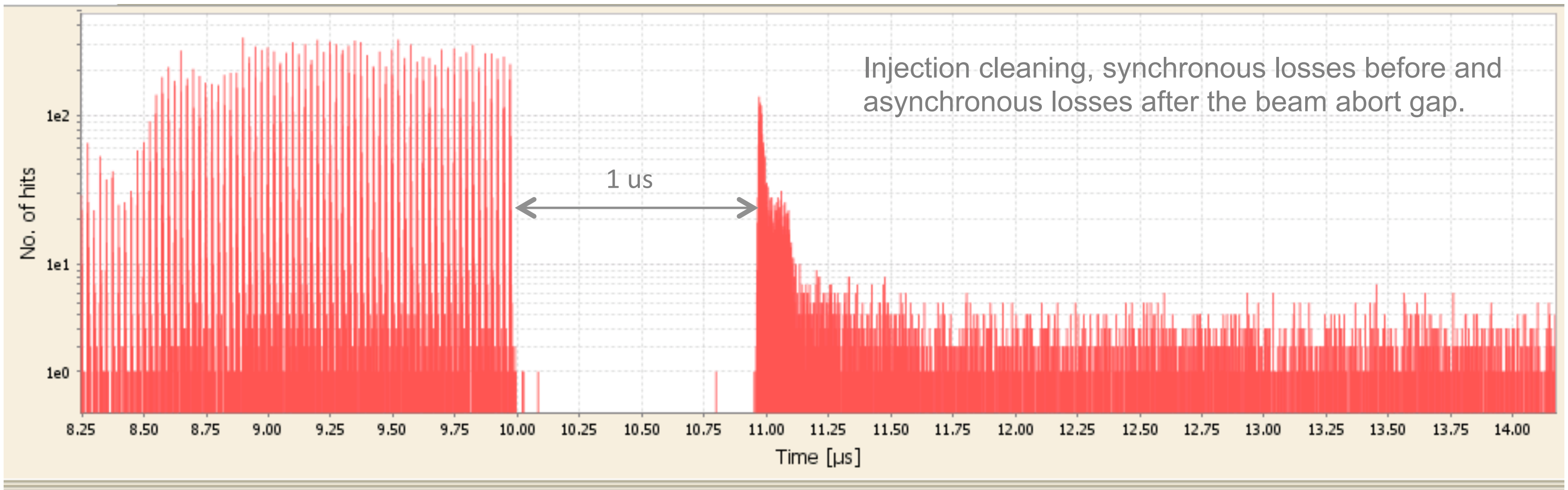
of Losses



Time = Phase

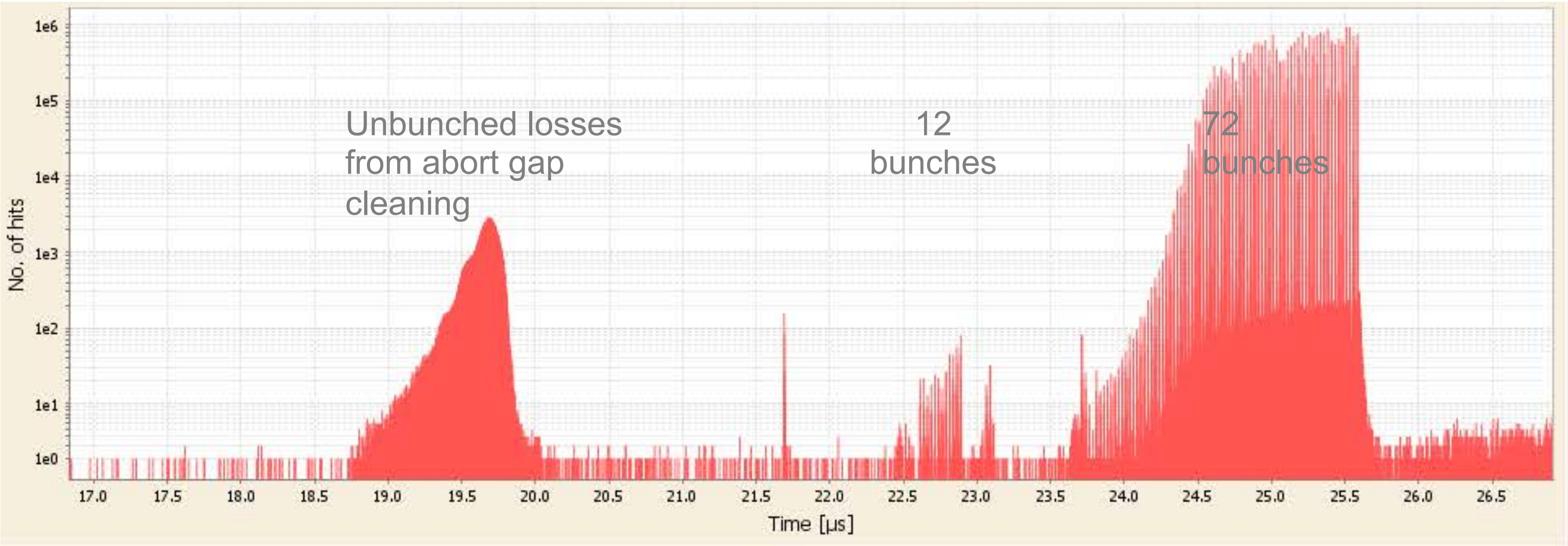
Time loss histogram as recorded with the 40 MHz bunch clock signal, 25 ns loss separation, 1.6 ns binning, 1.2 ns time resolution.

Injection cleaning



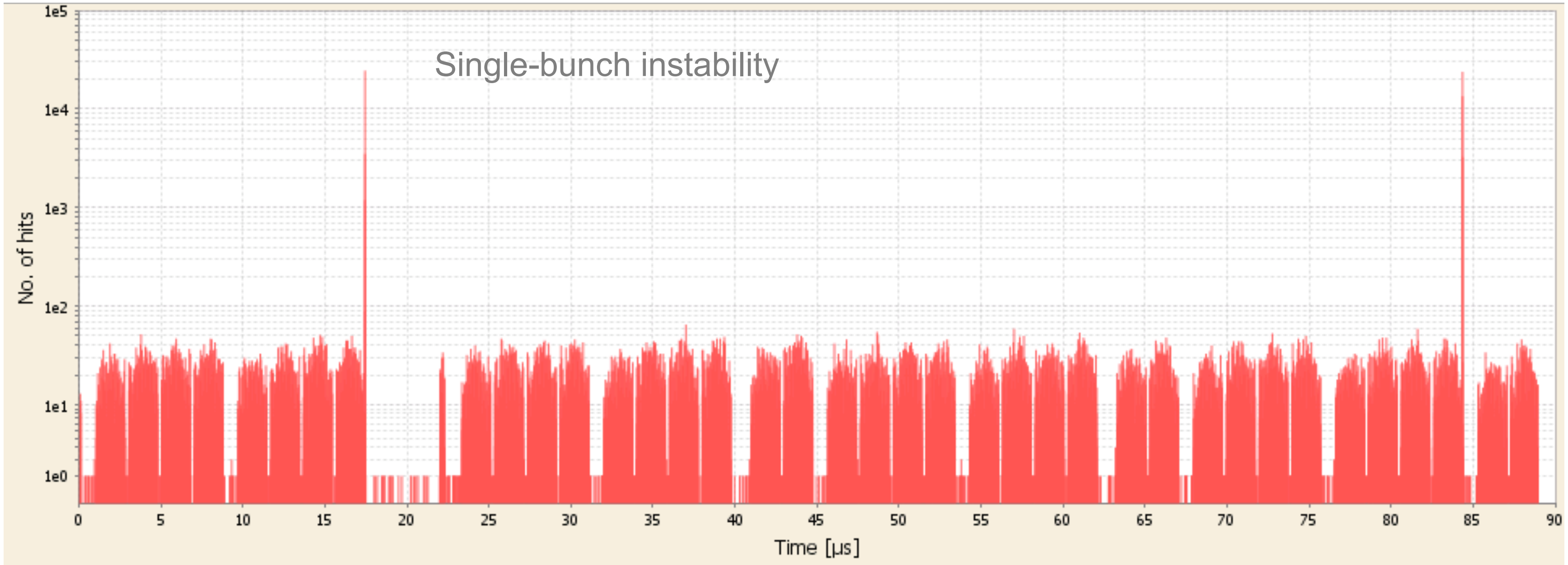
Courtesy T. Baer, CERN

Beam abort gap cleaning



Courtesy T. Baer, CERN

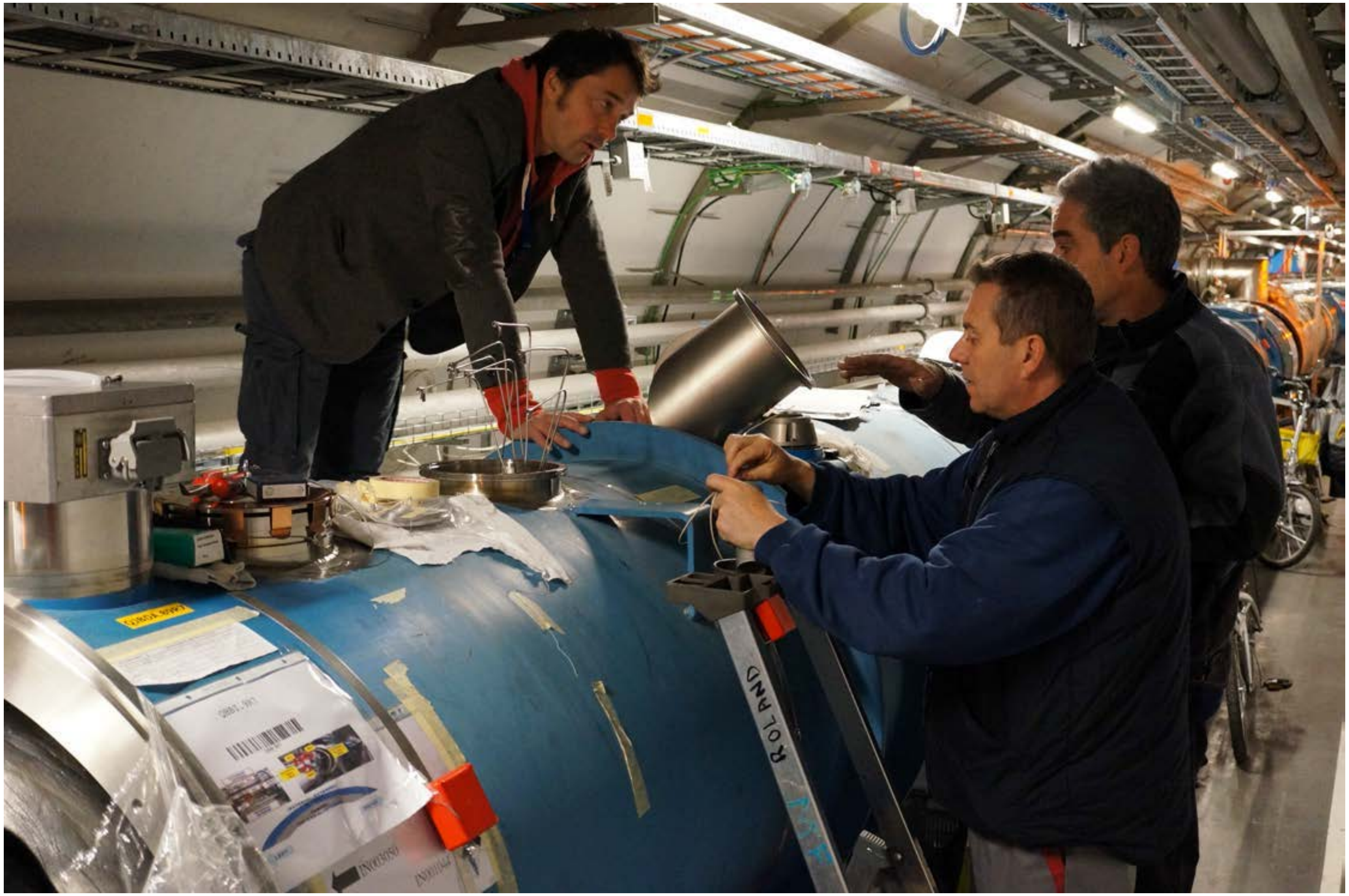
Single-Bunch Instability



Single-bunch instabilities at the end of a squeeze.

Courtesy T. Baer, CERN

LHC Cold

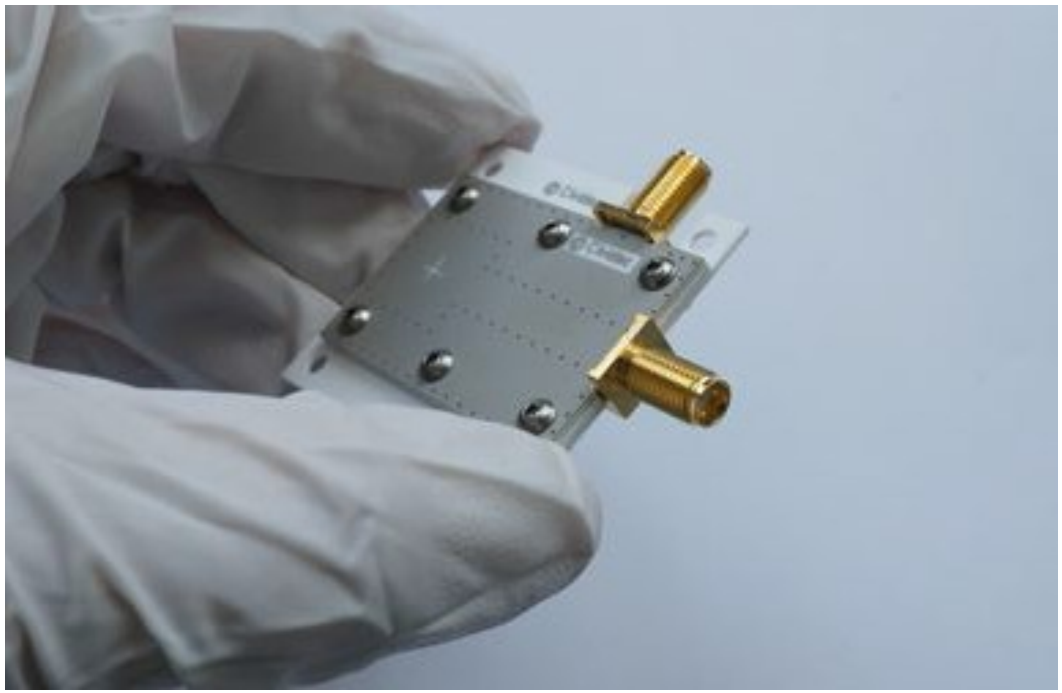


Cryogenic Application

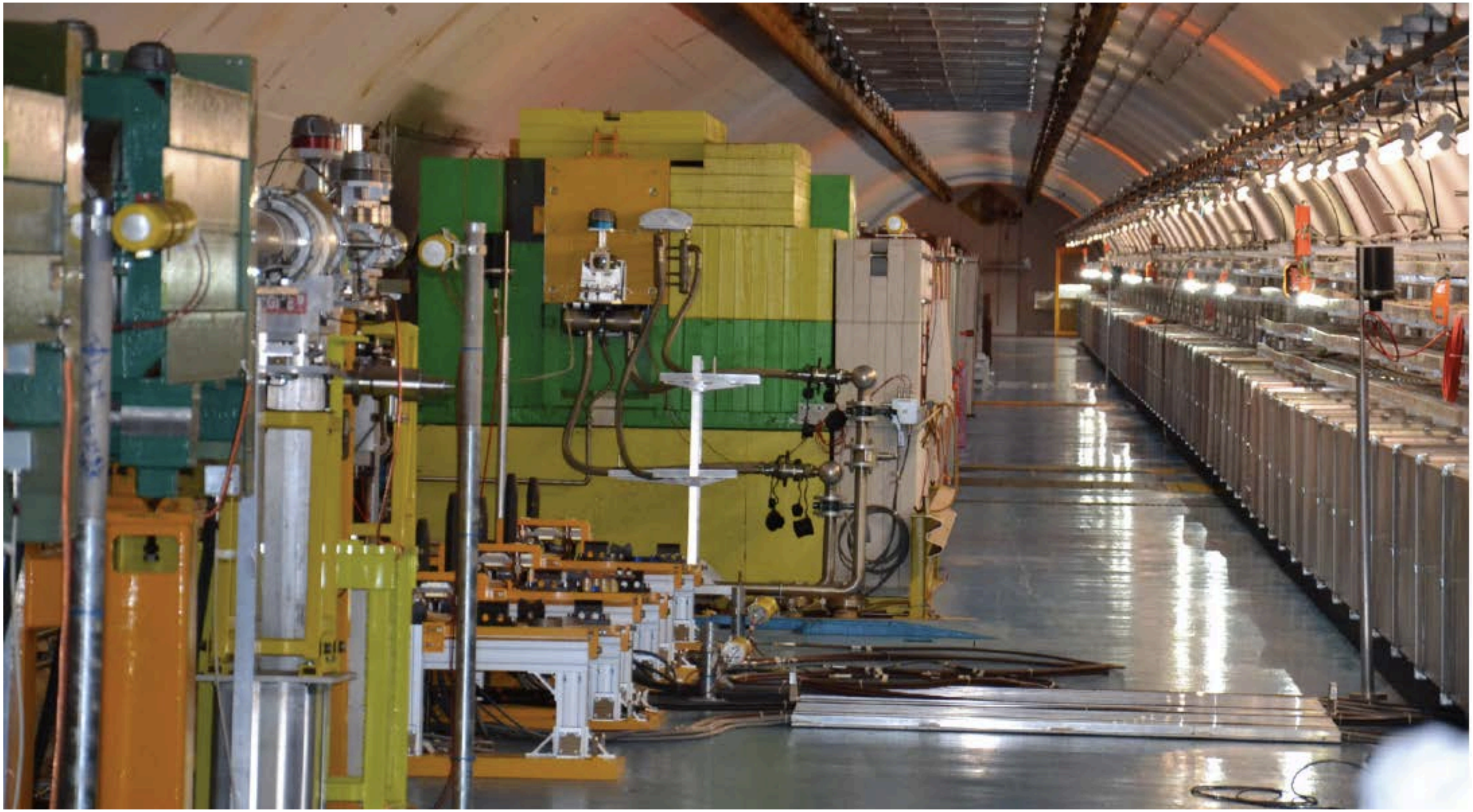
LHC Quadrupole

cividec
Instrumentation

Cryogenic Diamond Detector

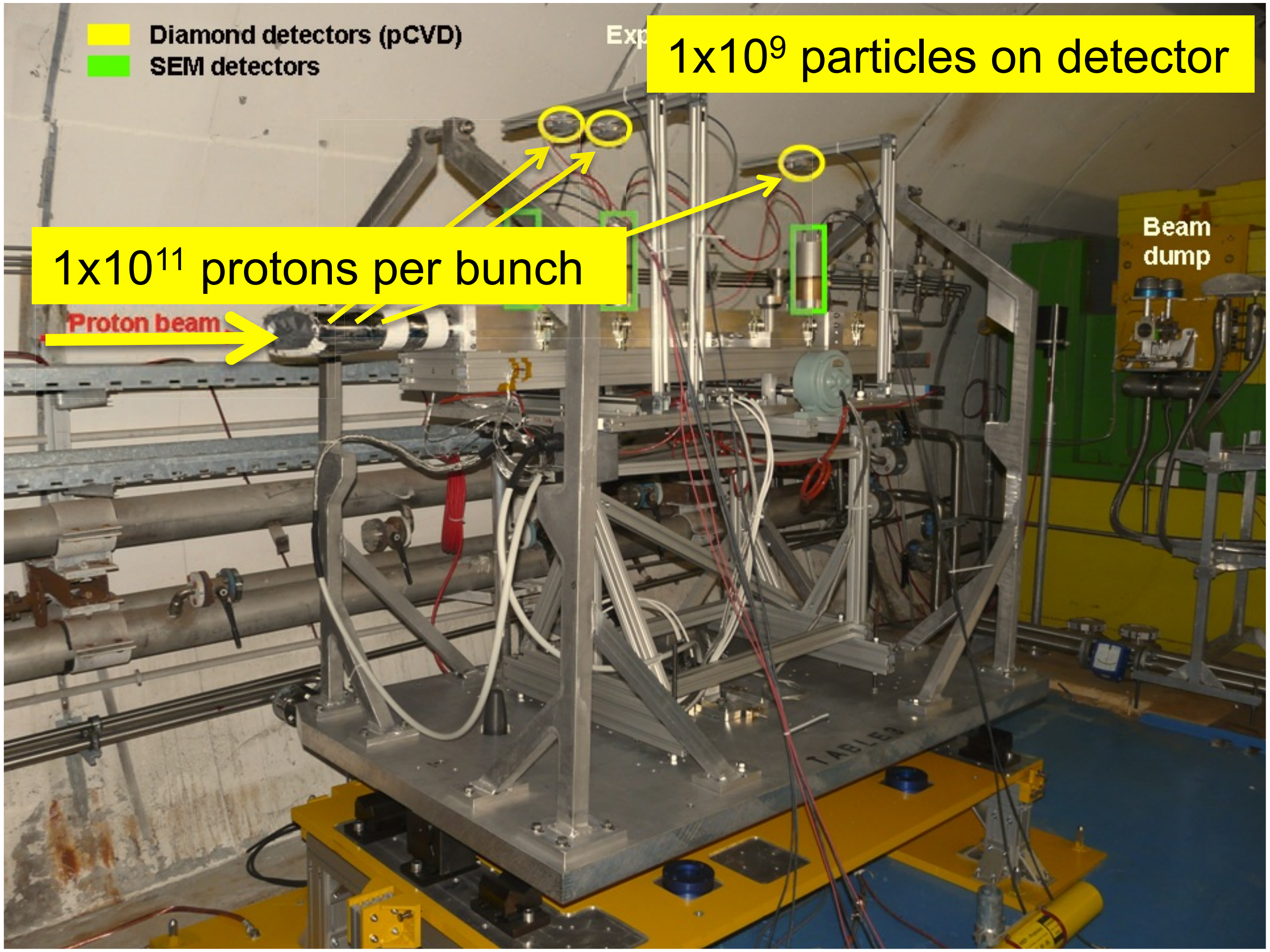


HiRadMat



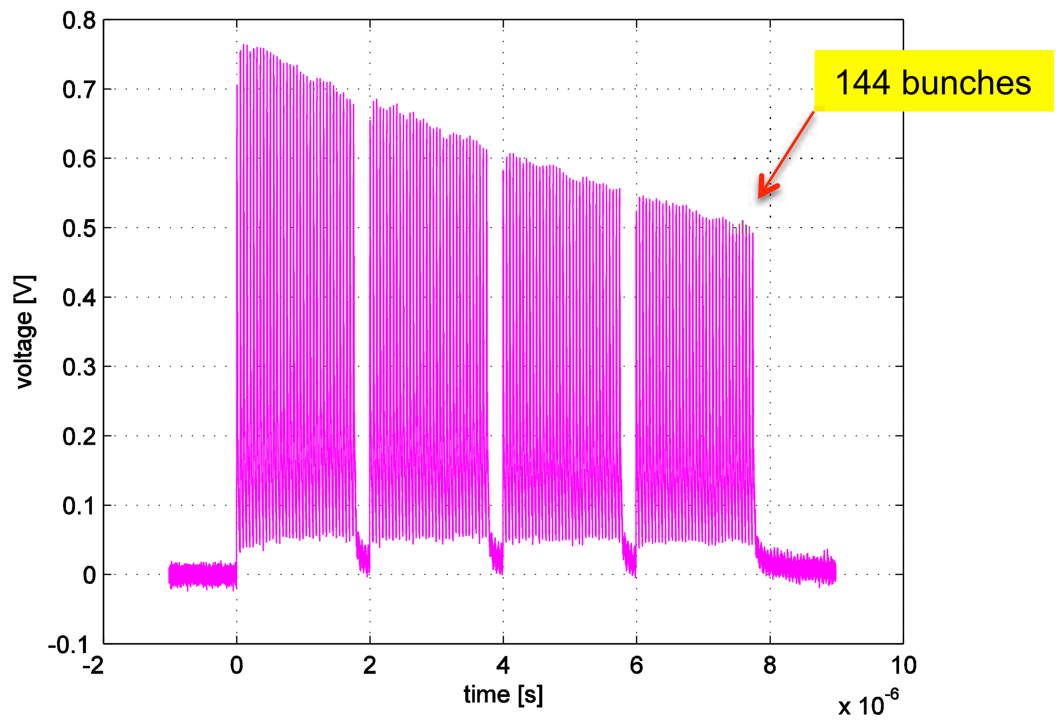
Courtesy F. Burkart, CERN

HiRadMat



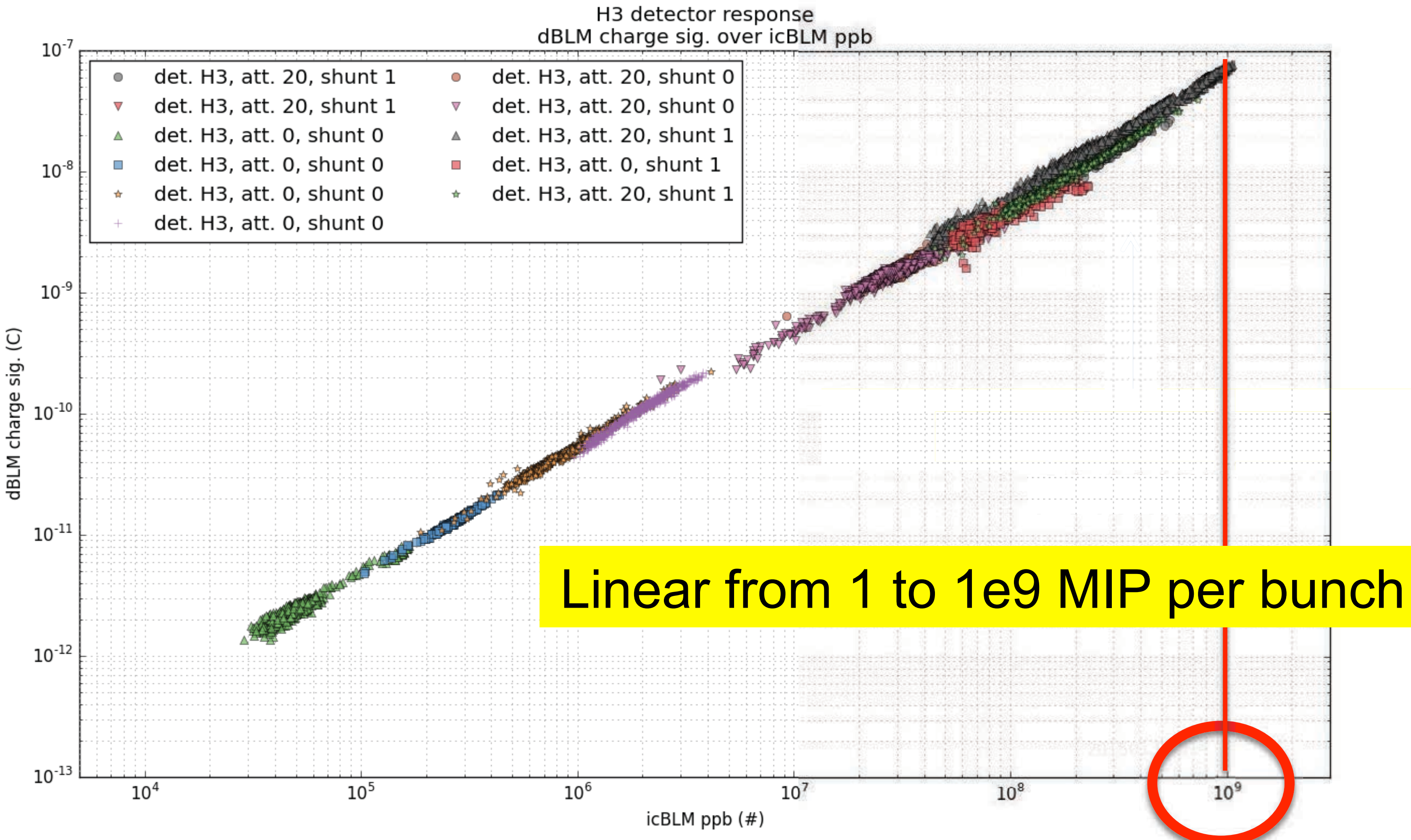
Courtesy F. Burkart, CERN

Detector Response



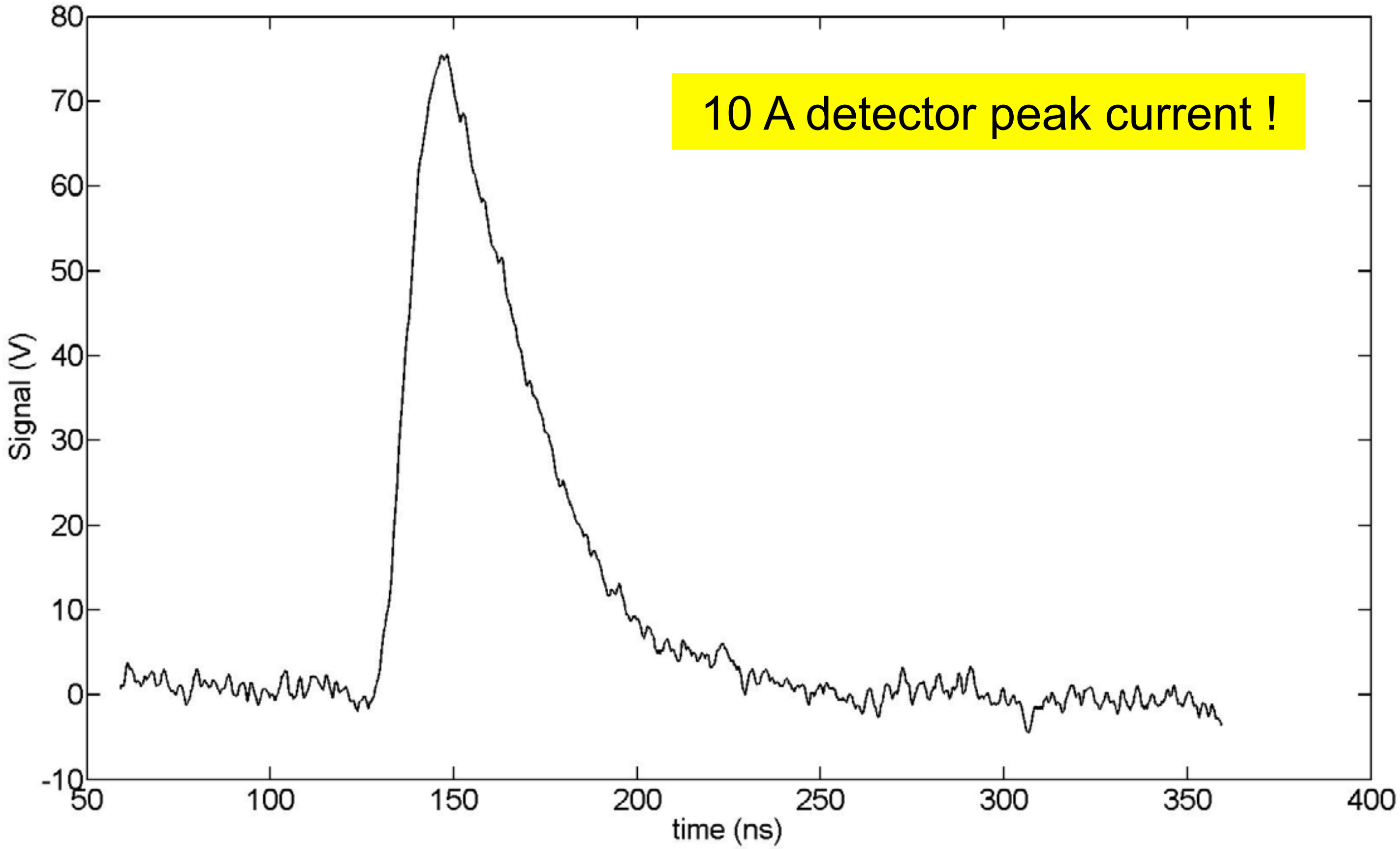
Courtesy F. Burkart, CERN

Linearity



Courtesy: BTF group Frascati - Luca Foggetta, Paolo Valente, Bruno Buonomo, Claudio di Giulio; F. Burkart, O. Stein, CERN, Shan Liu, Université Paris-Sud

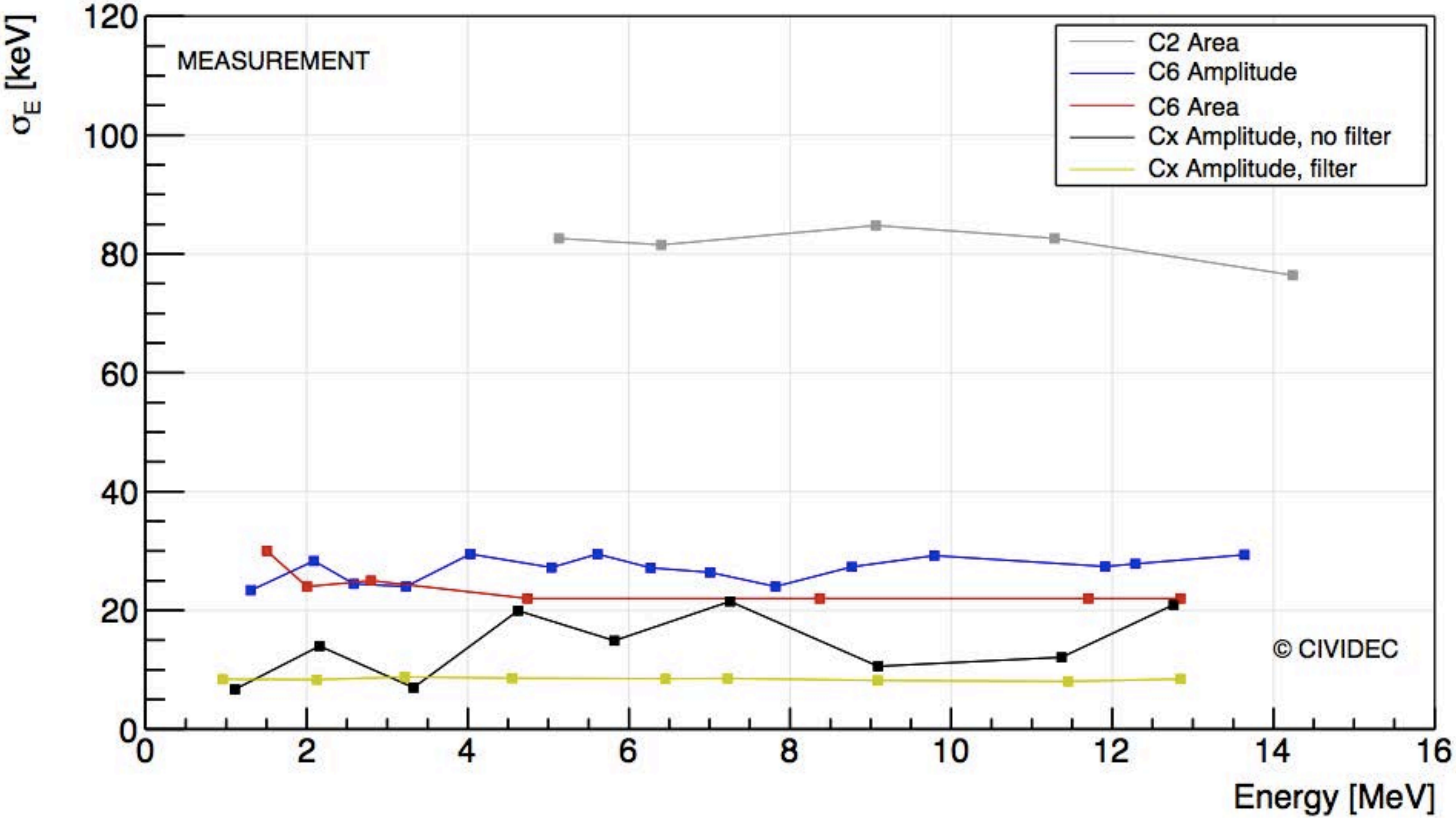
Single bunch of 1e9



Courtesy: BTF group Frascati - Luca Foggetta, Paolo Valente, Bruno Buonomo, Claudio di Giulio;
F. Burkart, O. Stein, CERN

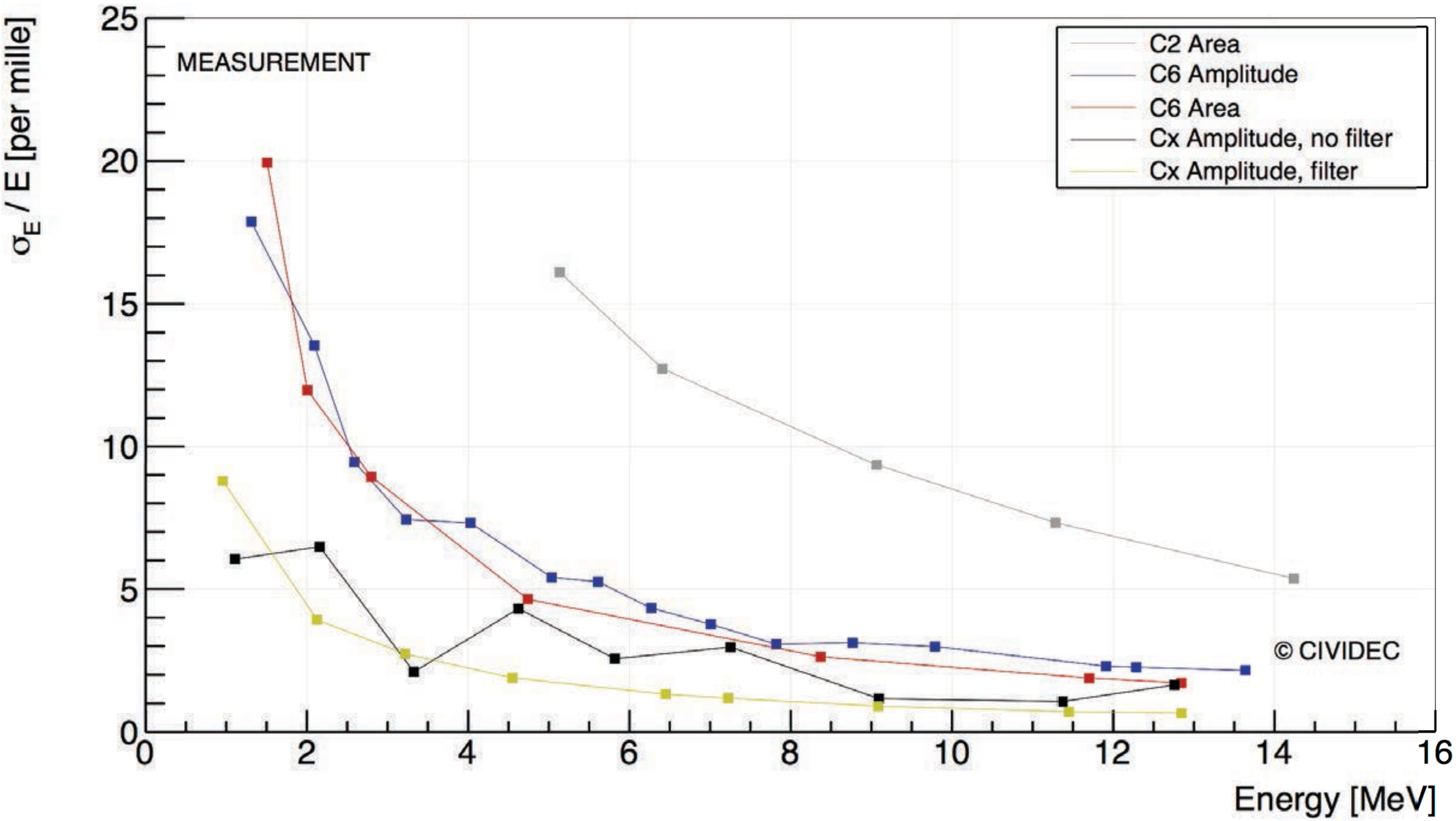
Spectroscopy

Resolution



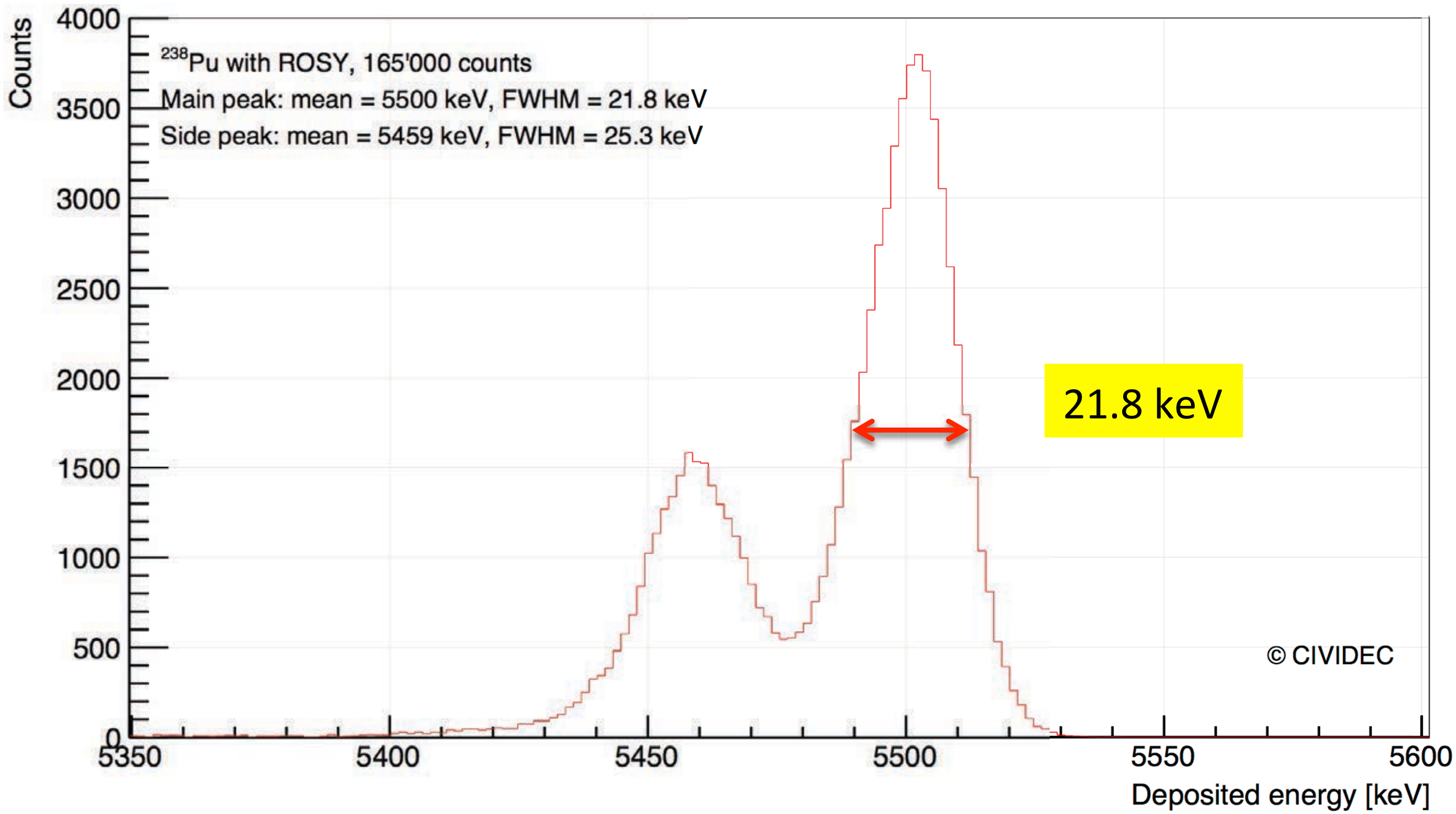
MEASUREMENT
C2 Area
C6 Amplitude
C6 Area
Cx Amplitude, no filter
Cx Amplitude, filter
© CIVIDEC
σ_E [keV]
Energy [MeV]
0
20
40
60
80
100
120
0
2
4
6
8
10
12
14
16

Resolution



MEASUREMENT
C2 Area
C6 Amplitude
C6 Area
Cx Amplitude, no filter
Cx Amplitude, filter
© CIVIDEC
σ_E / E [per mille]
Energy [MeV]
0
5
10
15
20
25
0
2
4
6
8
10
12
14
16

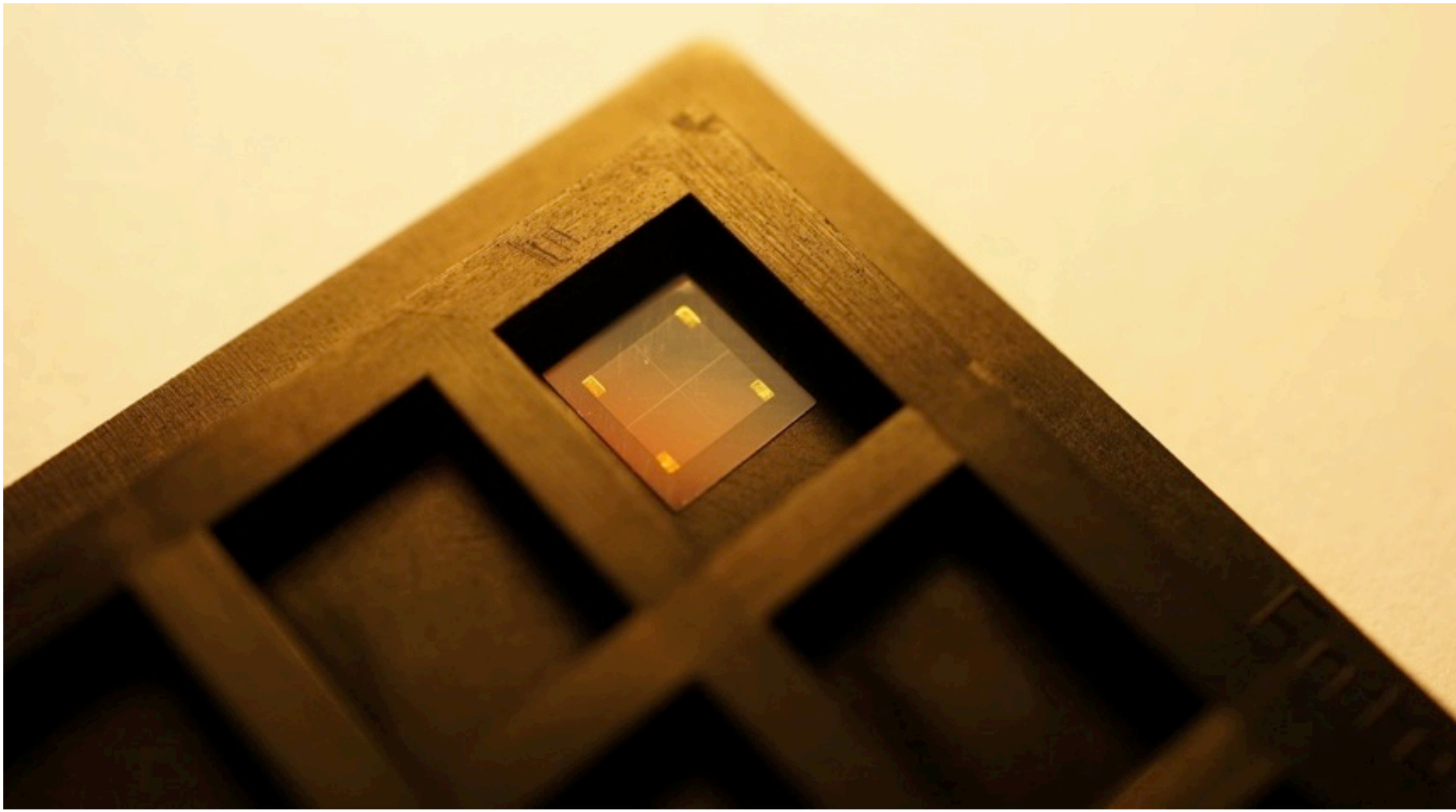
Pu-238



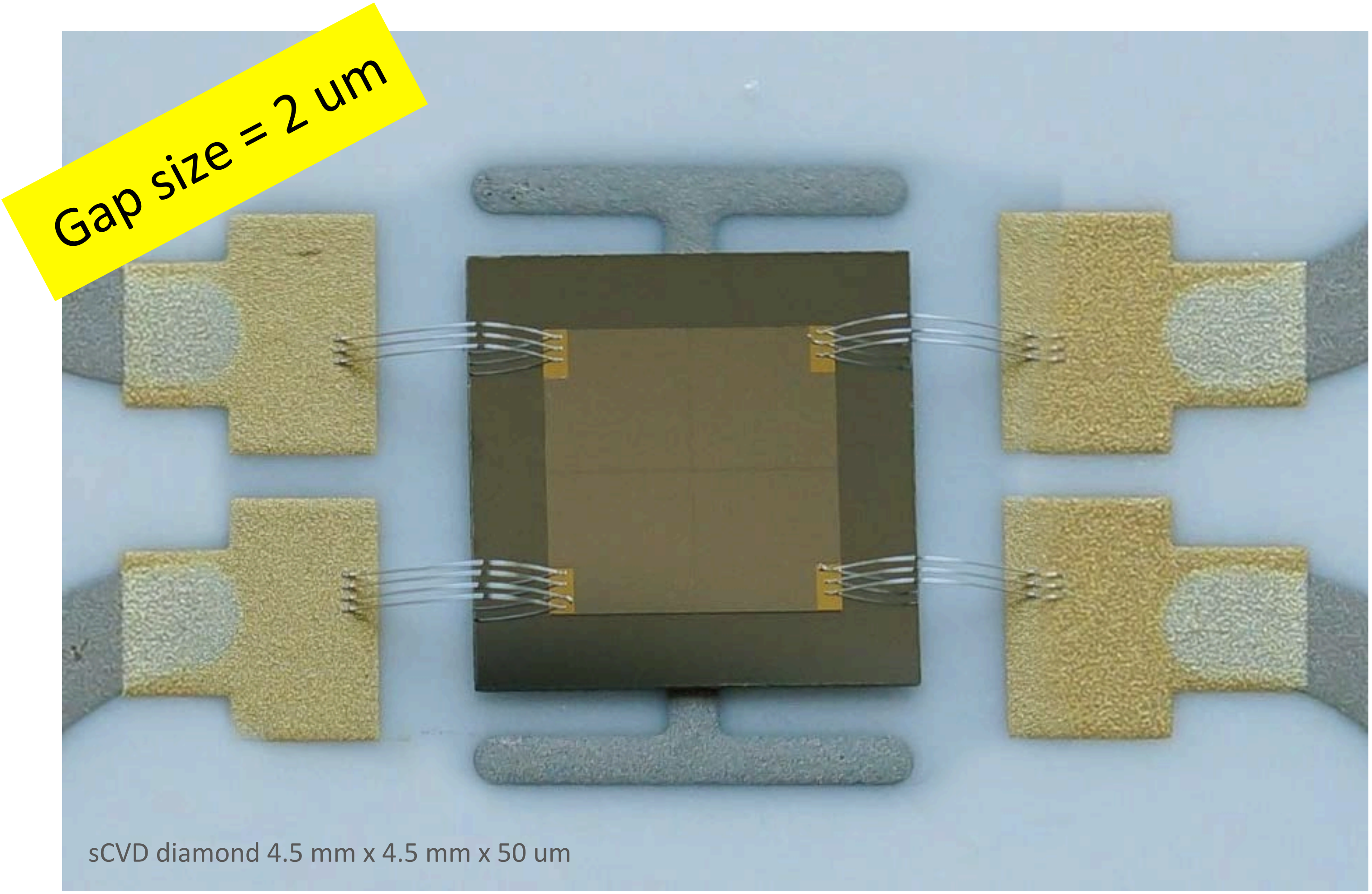
Courtesy G. Senft, TU Wien

X-Rays

The 4Q-Diode

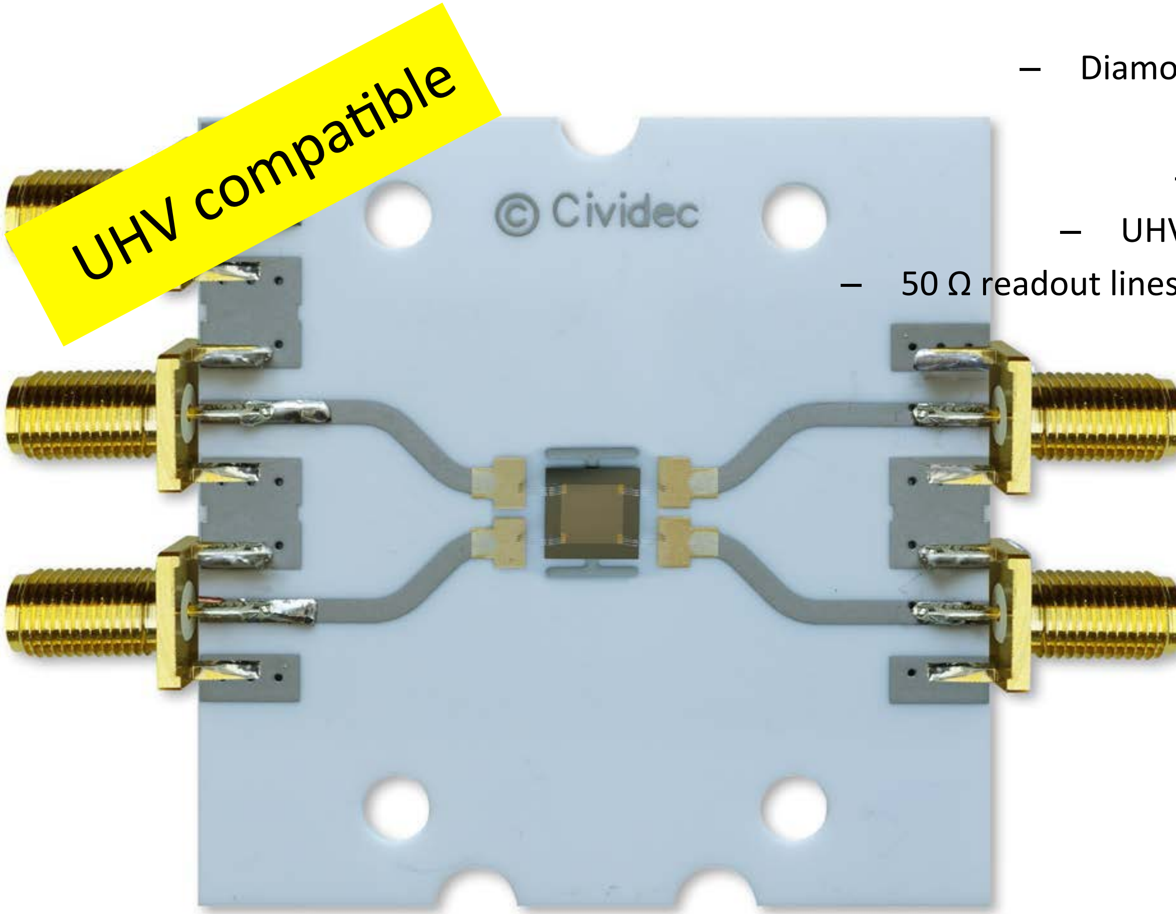


Diamond XBPM Detector



XBPM

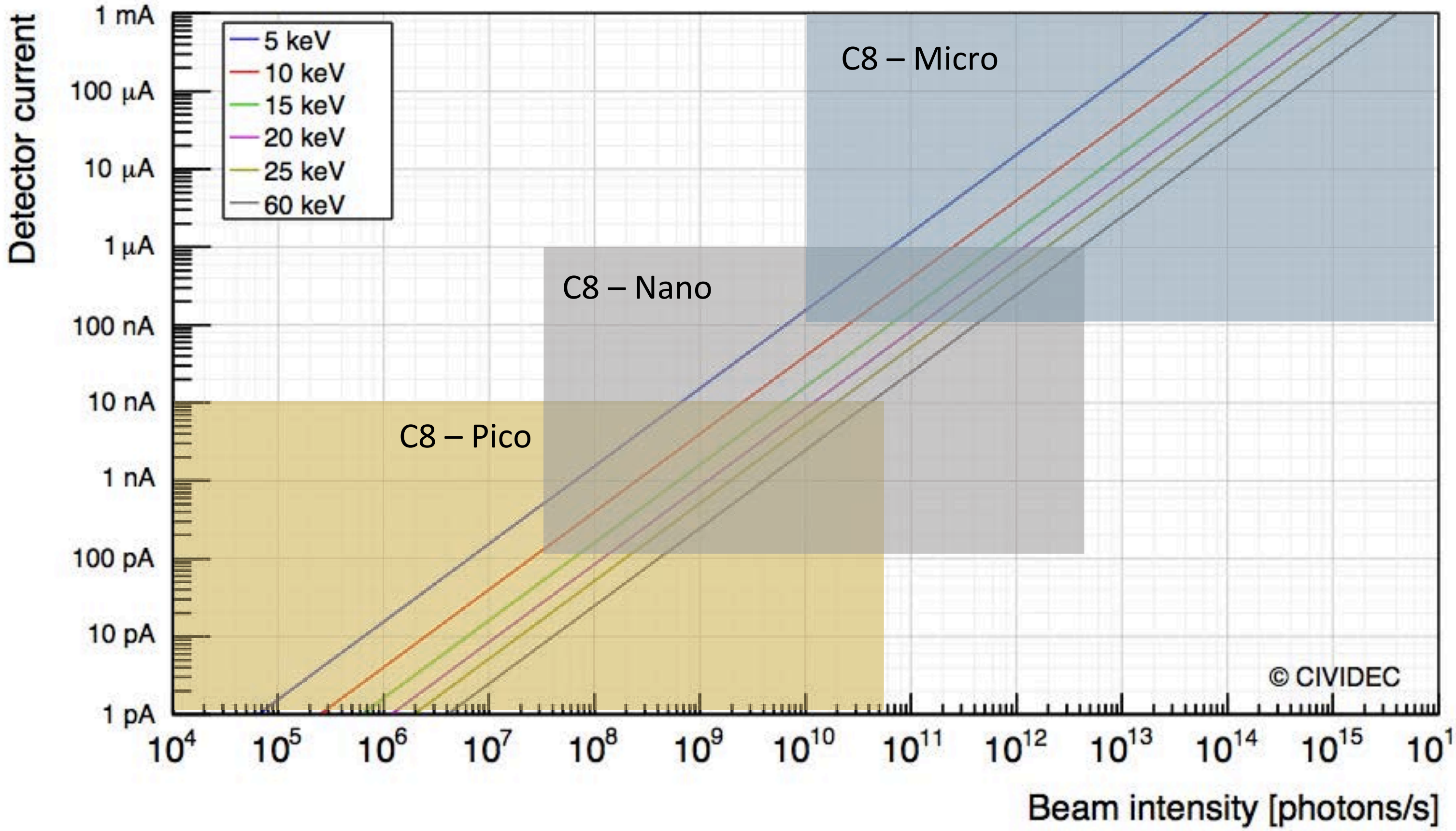
- Ceramic PCB
- Diamond is glued and bonded
- Bias voltage filter
- Charging capacitors
- UHV compatible 1e-9 mbar
- 50 Ω readout lines for fast measurements



Readout electronics

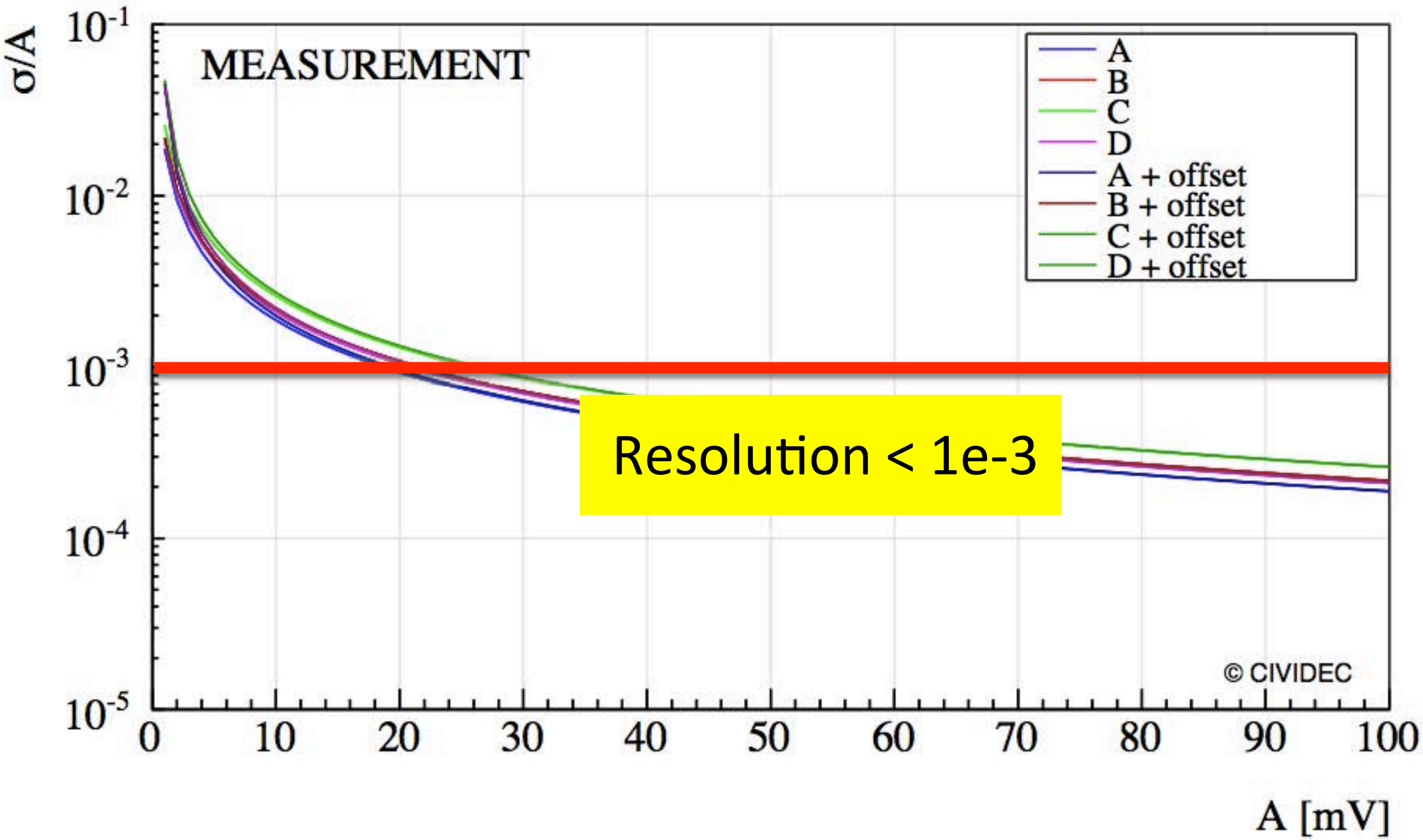
Electrometer amplifier

Ranges


Detector current
1 mA
100 µA
10 µA
1 µA
100 nA
10 nA
1 nA
100 pA
10 pA
1 pA
5 keV
10 keV
15 keV
20 keV
25 keV
60 keV
C8 – Micro
C8 – Nano
C8 – Pico
© CIVIDEC
10^4 10^5 10^6 10^7 10^8 10^9 10^{10} 10^{11} 10^{12} 10^{13} 10^{14} 10^{15} 10^{16}
Beam intensity [photons/s]

ROSY® XBPM Application

Digital noise suppression



Diffusion

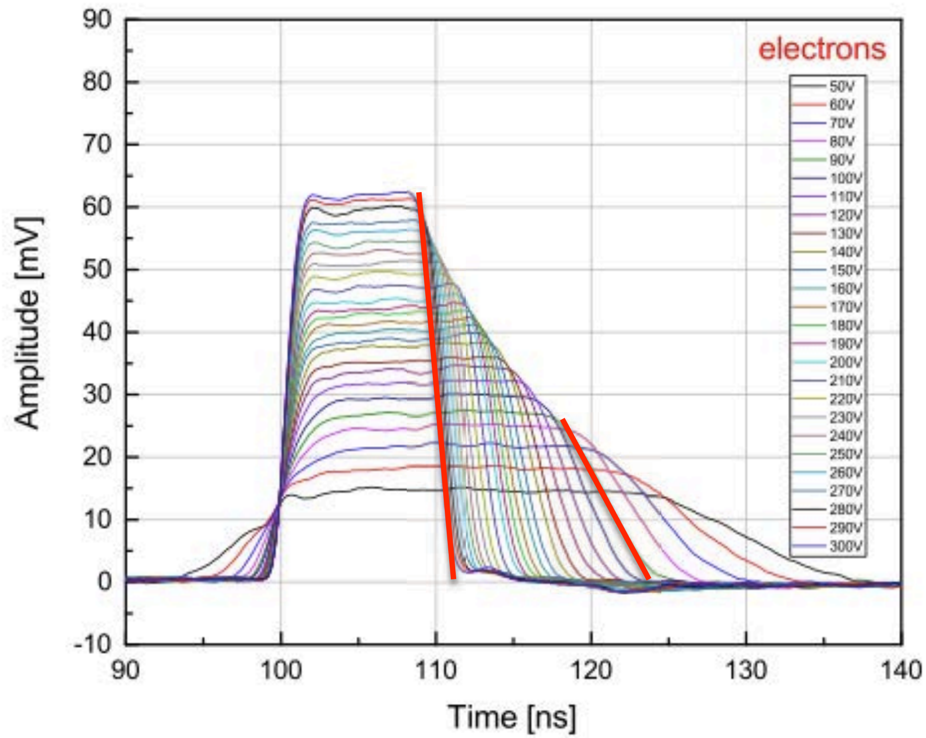
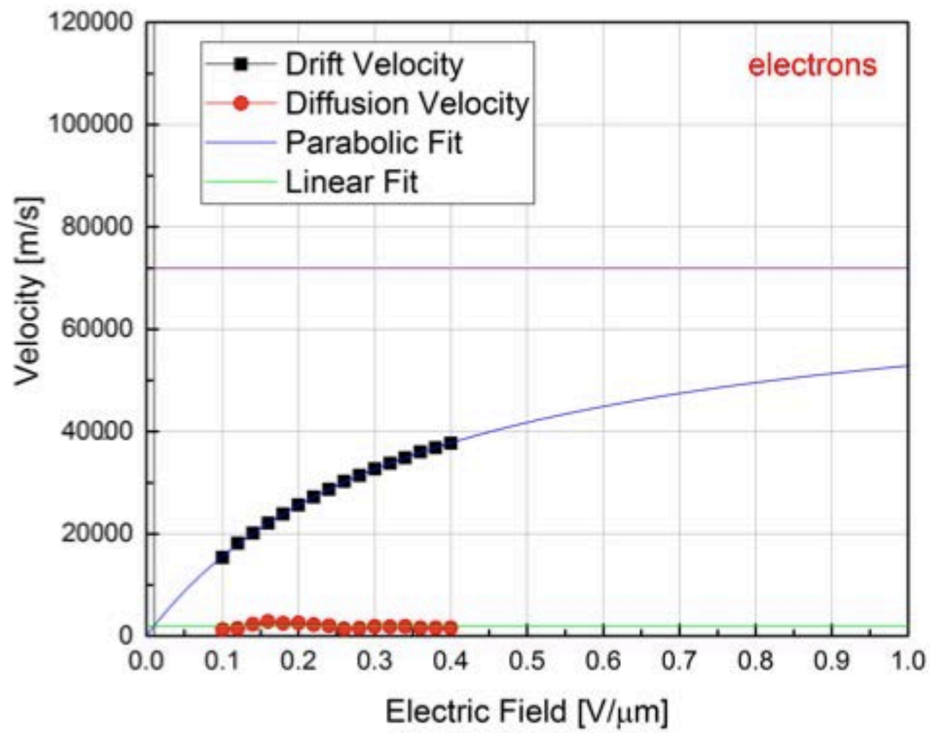


Figure 5: Electron pulse shapes for different voltages

Ref: M. Morgenbesser

Diffusion



Spread = 2%

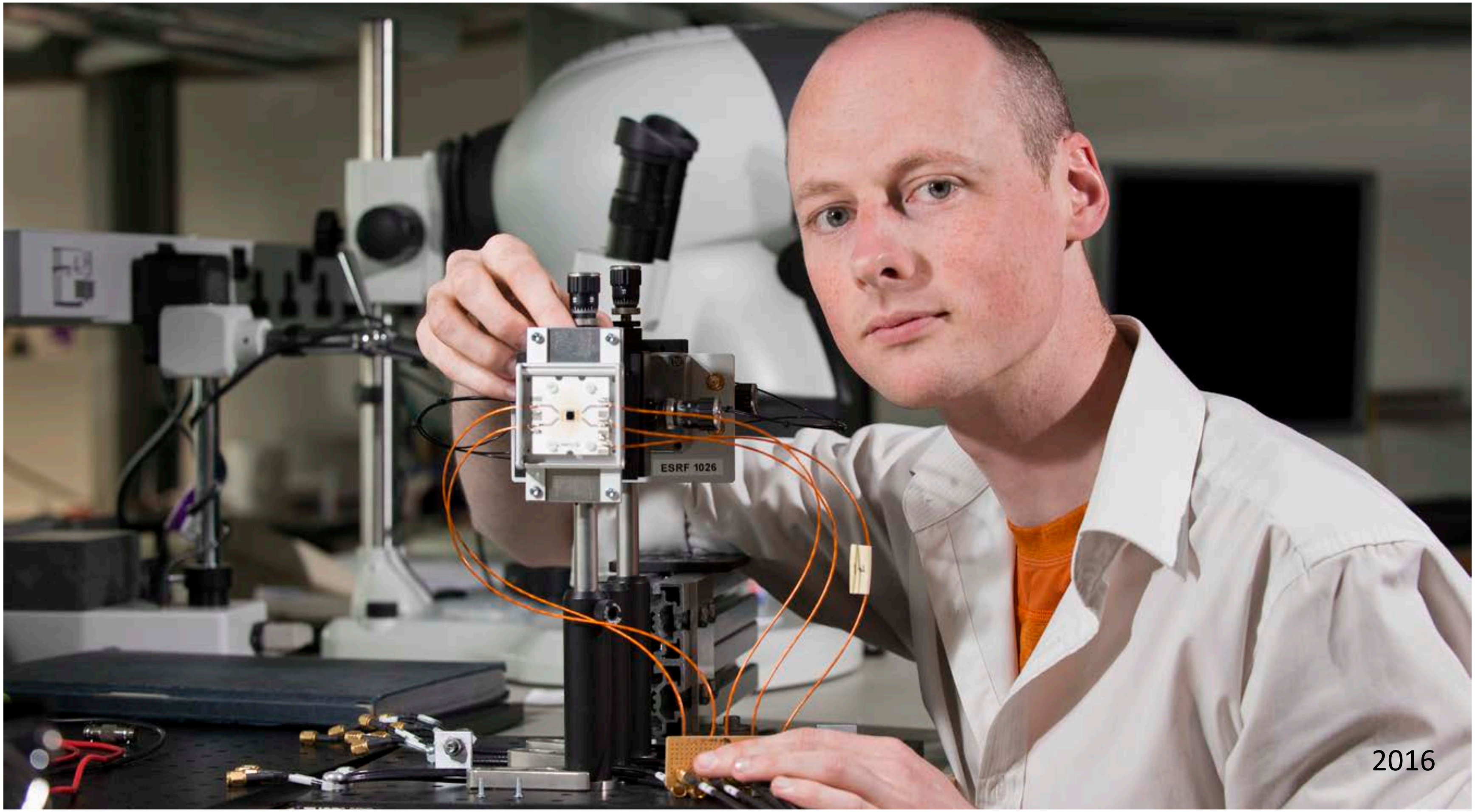
50 um → 1 um

Figure 11: Drift velocities of electrons for different electric fields

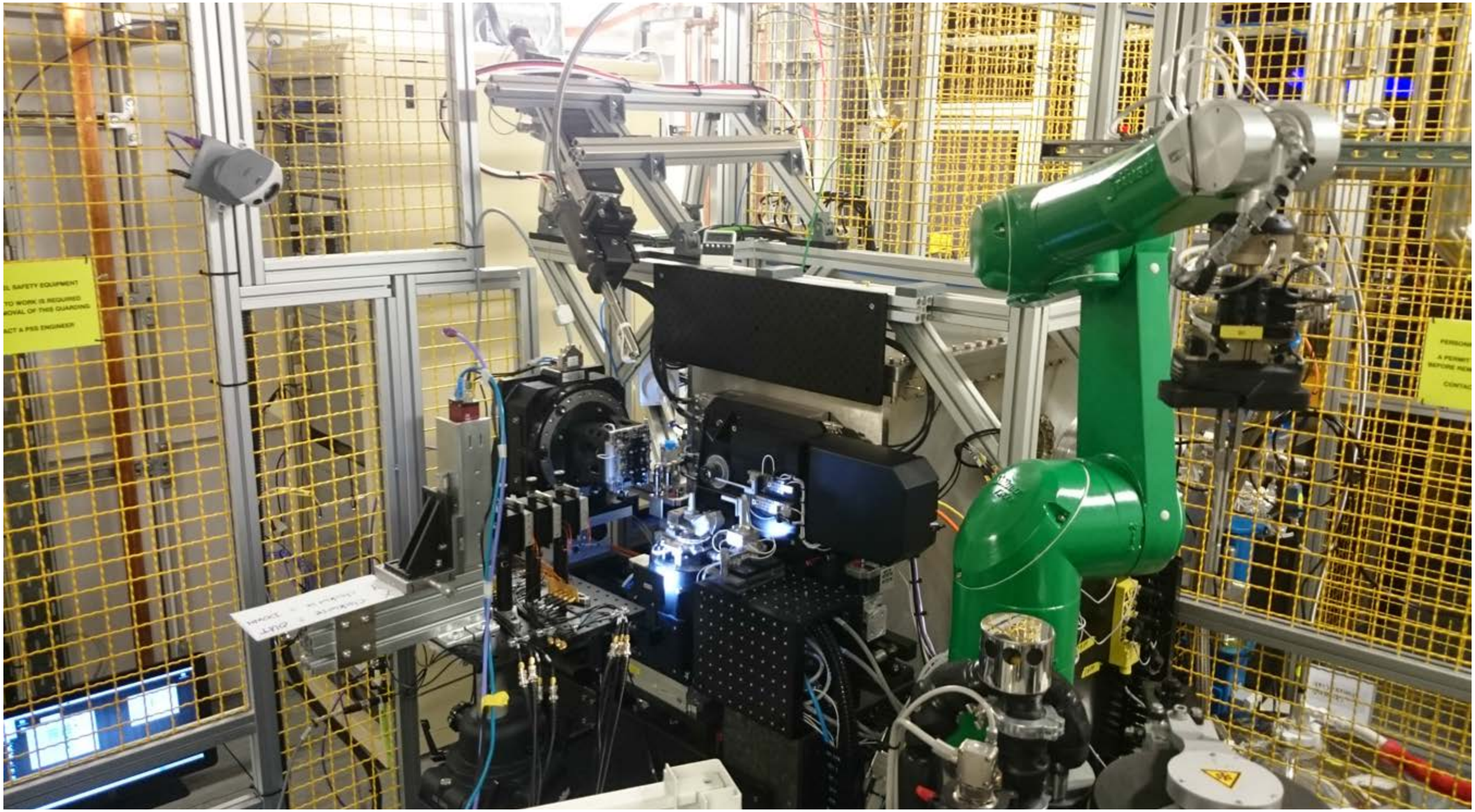
Ref: M. Morgenbesser

Beam tests at Diamond Light Source

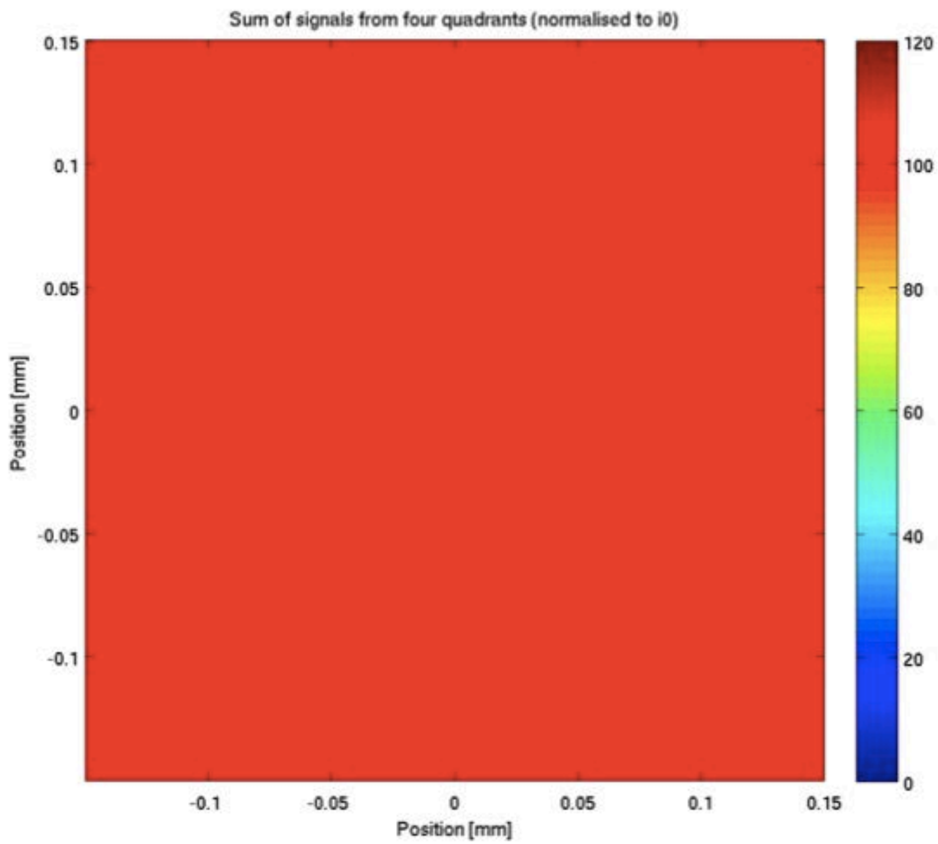
Chris Bloomer, DLS



Beamline I24

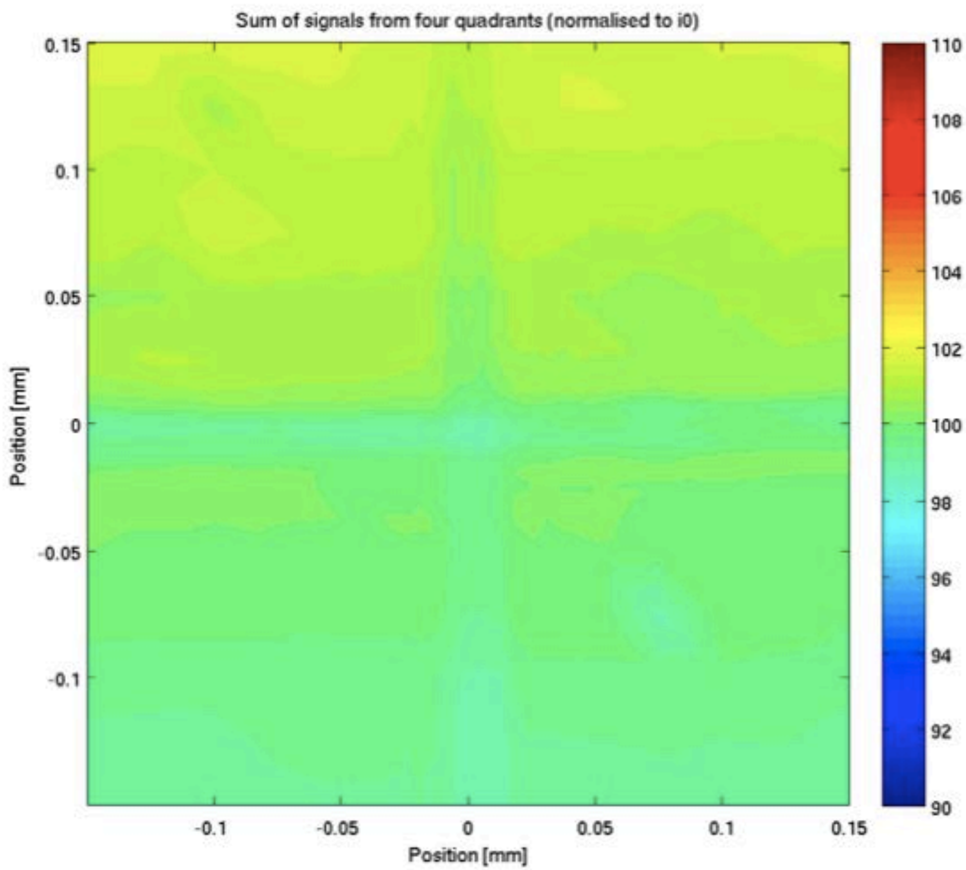


Homogeneity



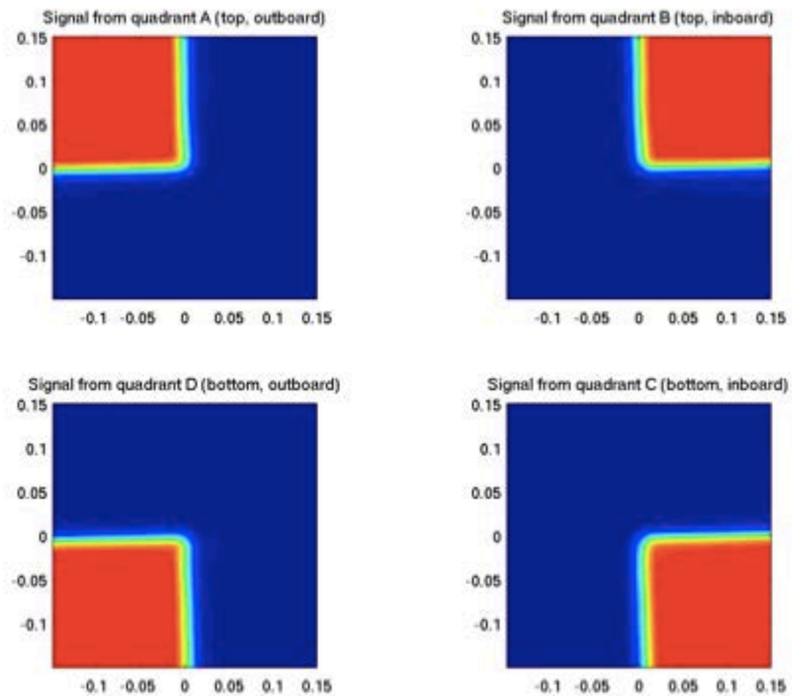
Courtesy Chris Bloomer, DLS

Homogeneity



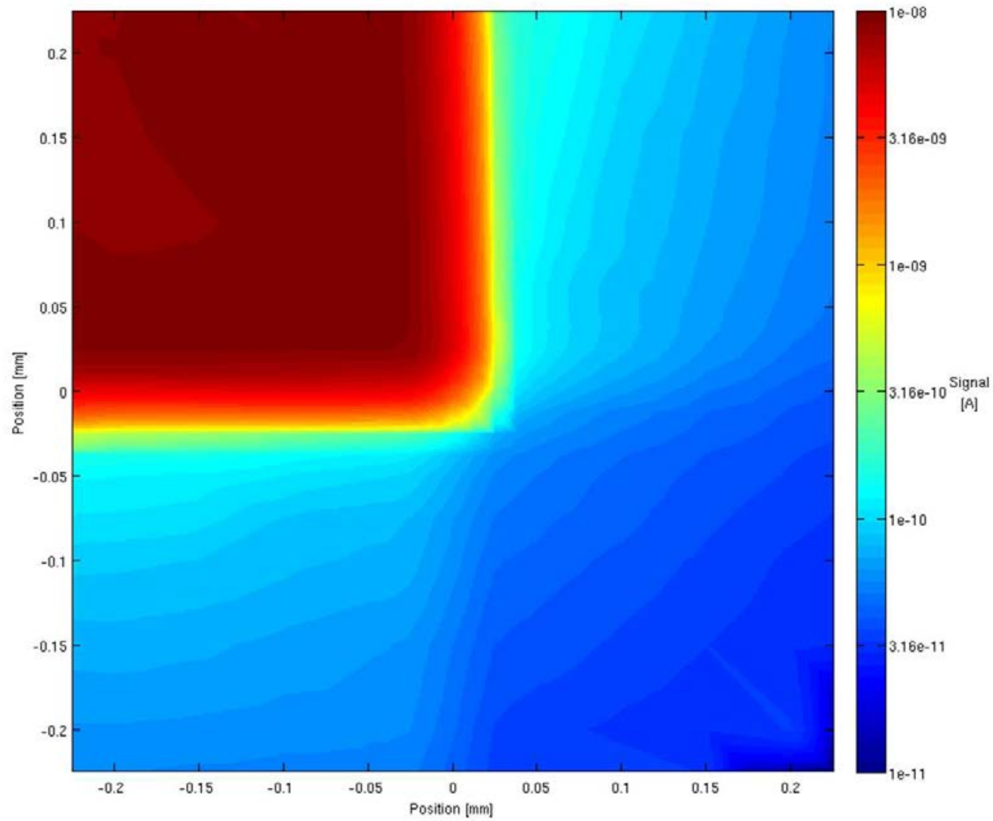
Courtesy Chris Bloomer, DLS

4Q - Homogeneity



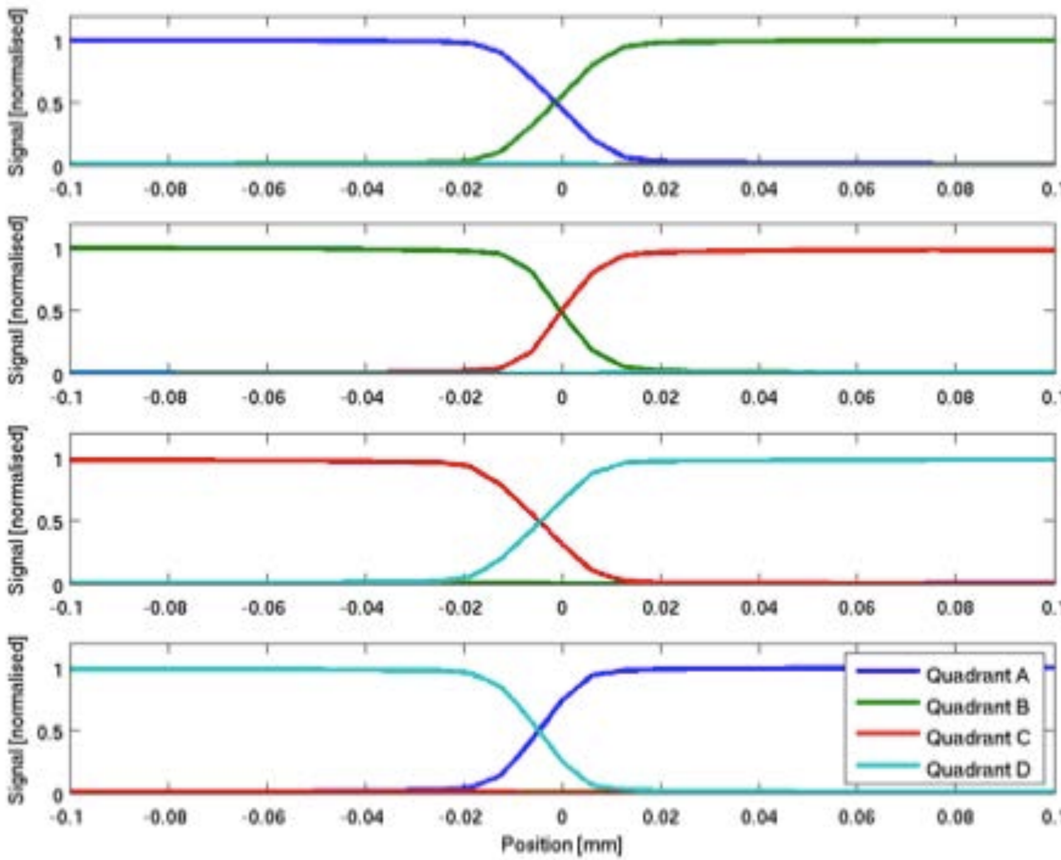
Courtesy Chris Bloomer, DLS

Edge homogeneity



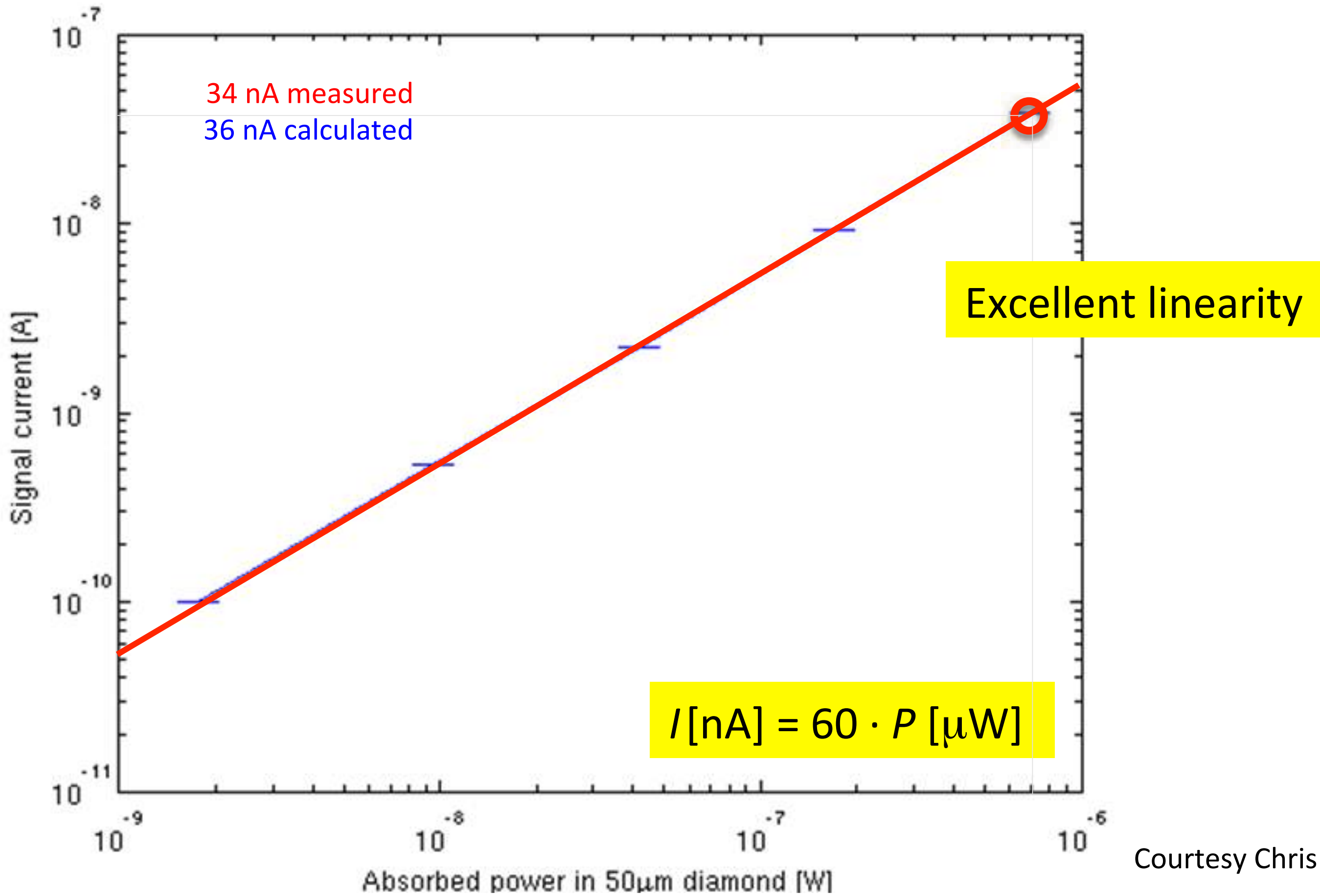
Courtesy Chris Bloomer, DLS

X-Y Scan



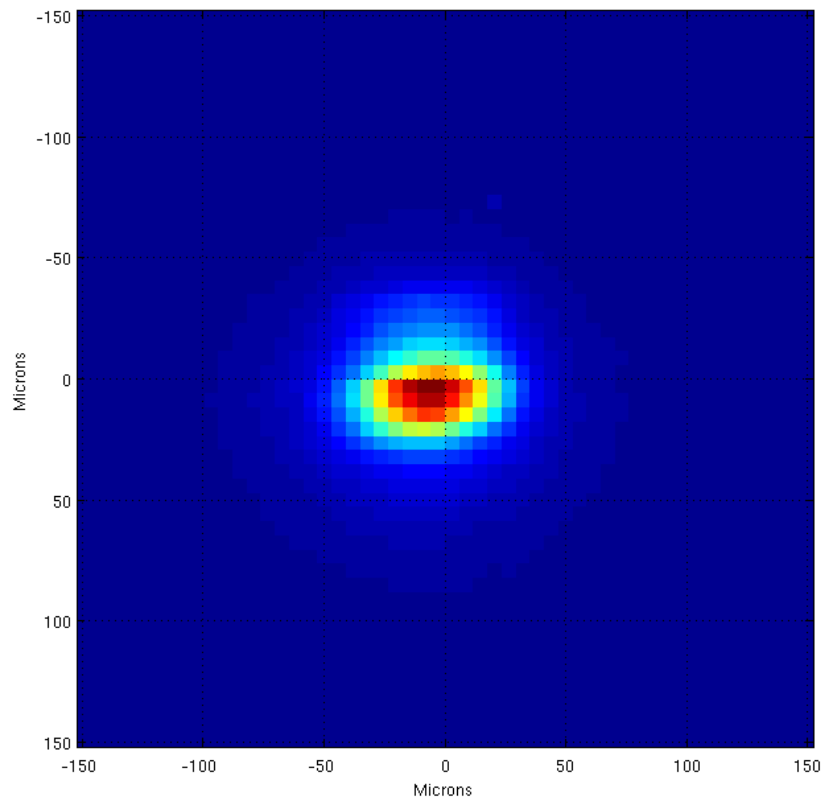
Courtesy Chris Bloomer, DLS

Linearity



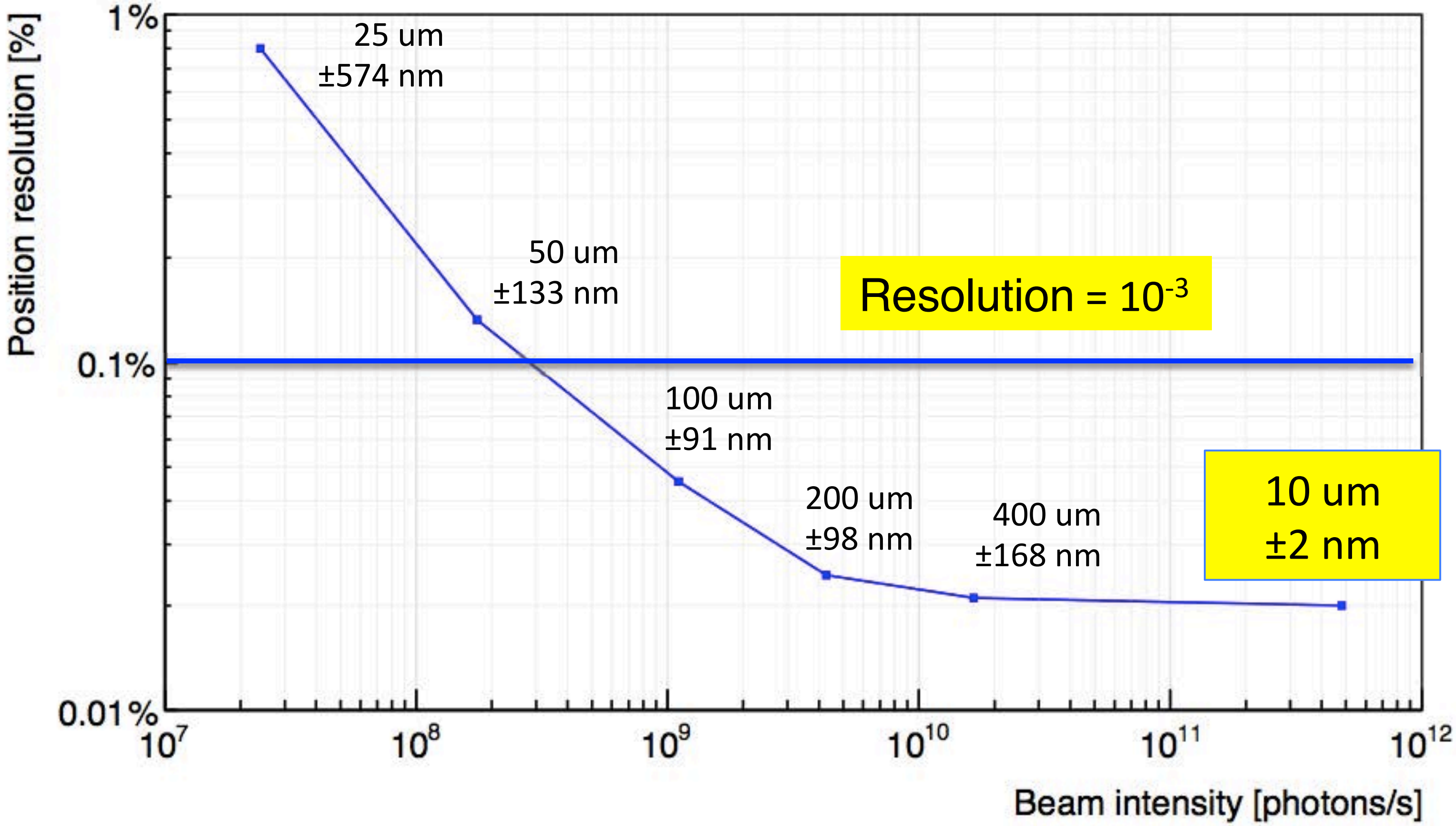
Courtesy Chris Bloomer, DLS

Beam spot



Courtesy Chris Bloomer, DLS

Position resolution



Courtesy Chris Bloomer, DLS

Gamma diagnostics

Nuclear Instruments and Methods in Physics Research A 830 (2016) 391–396

Contents lists available at ScienceDirect

Nuclear Instruments and Methods in Physics Research A

journal homepage: www.elsevier.com/locate/nima

Operation of a fast diamond γ-ray detector at the HIγS facility

T. Williams [a], C. N'Diaye [a], D. Breton [a], K. Cassou [a], K. Dupraz [a], P. Favier [a], D. Jehanno [a], V. Kubytskyi [a], X. Liu [a], J. Maalmi [a], A. Martens [a,*], Y. Peinaud [a], A. Stocchi [a], F. Zomer [a], E. Griesmayer [b], P. Kavrigin [b], M.W. Ahmed [c,d,e], M. Sikora [c,d], H.R. Weller [c,d]

[a] LAL, Univ Paris-Sud, CNRS/IN2P3, Université Paris-Saclay, Orsay, France
[b] Vienna University of Technology, Austria
[c] Triangle Universities Nuclear Laboratory, Durham, NC 27708, USA
[d] Physics Department, Duke University, Durham, NC 27708, USA
[e] Department of Mathematics and Physics, North Carolina Central University, Durham, NC 27707, USA

ARTICLE INFO

Article history:

ABSTRACT

Operations of a diamond sensor placed in a high average-intensity beam of photons with energies of a

Courtesy Aurélien Martens, LAL

7 MeV gammas

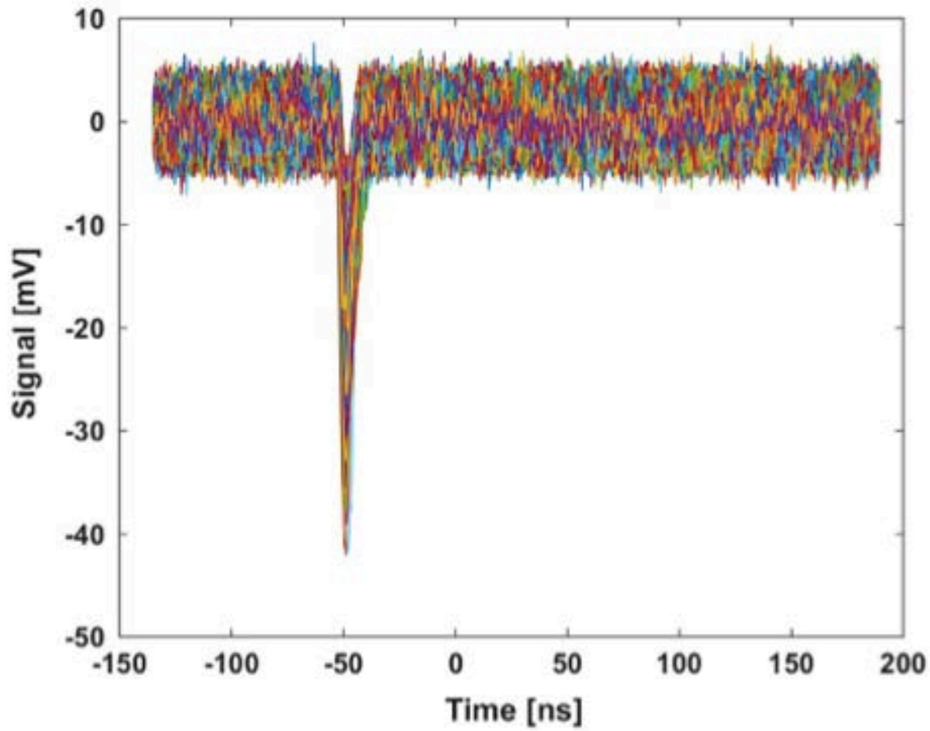


Fig. 1. Observed signal of a run of 10,000 events collected at a photon beam energy of 3 MeV. The events are corrected for trigger jitters, cross-talk and pedestals. The typical pulse duration is on the order of a few nanoseconds and all the events are well synchronised.

Courtesy Aurélien Martens, LAL

Detector response

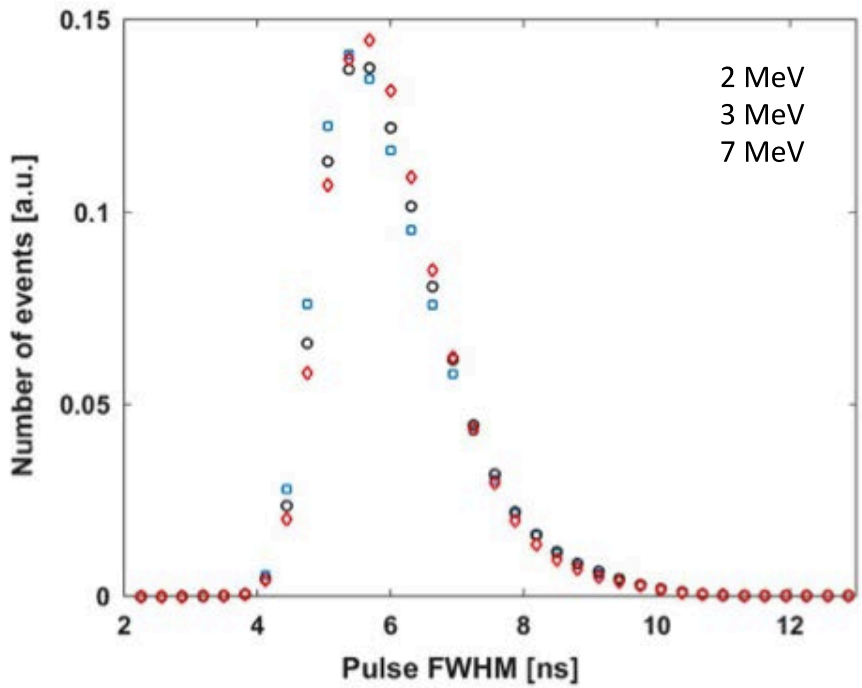


Fig. 2. Distribution of the FWHM of the signal candidates for photon beam energies of 2, 3 and 7 MeV in blue squares, black circles and red rhombi, respectively. Only events with single candidates are considered in this figure. The error bars are not shown as they are smaller than the size of the points. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

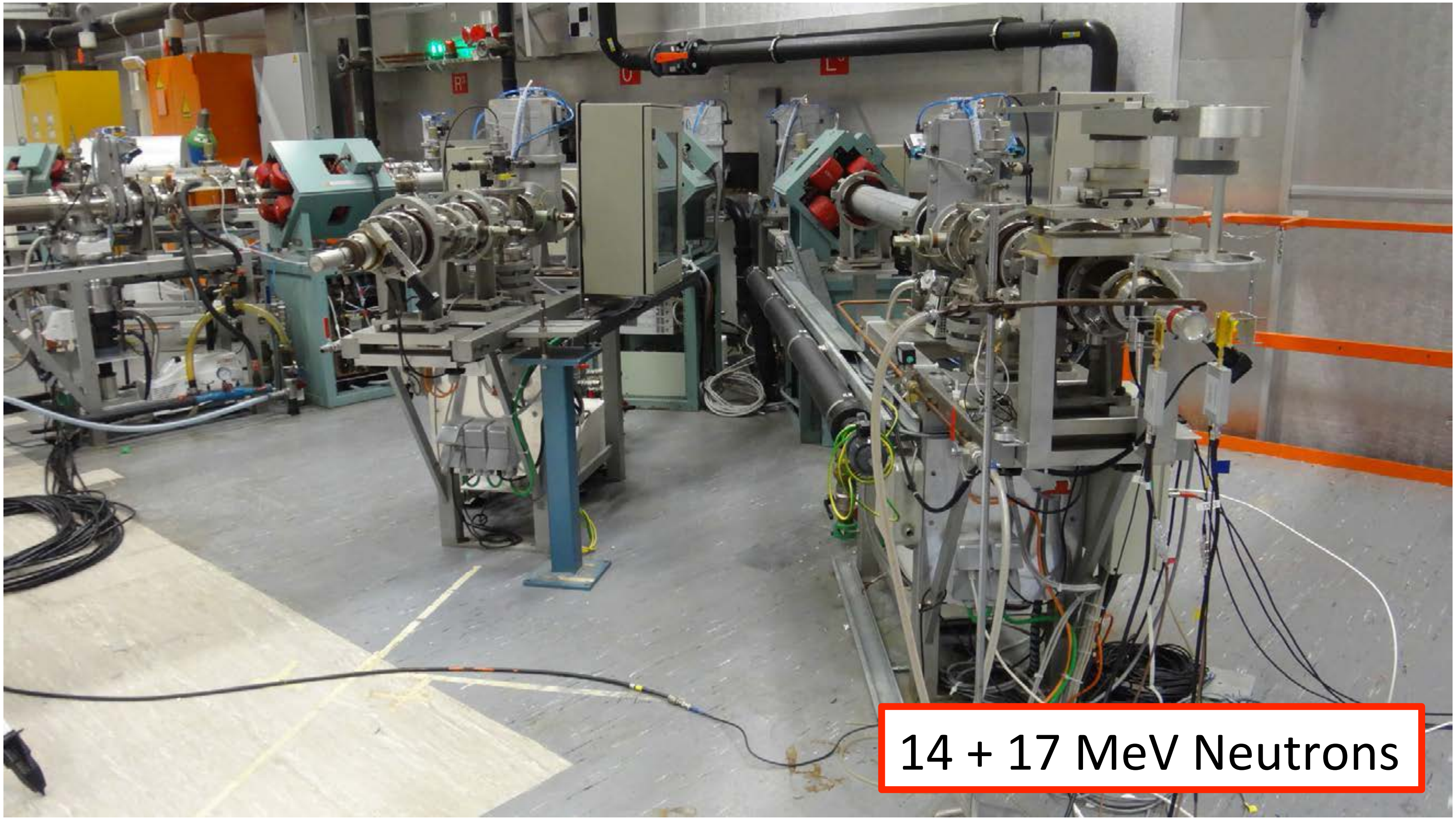
Courtesy Aurélien Martens, LAL

Neutrons

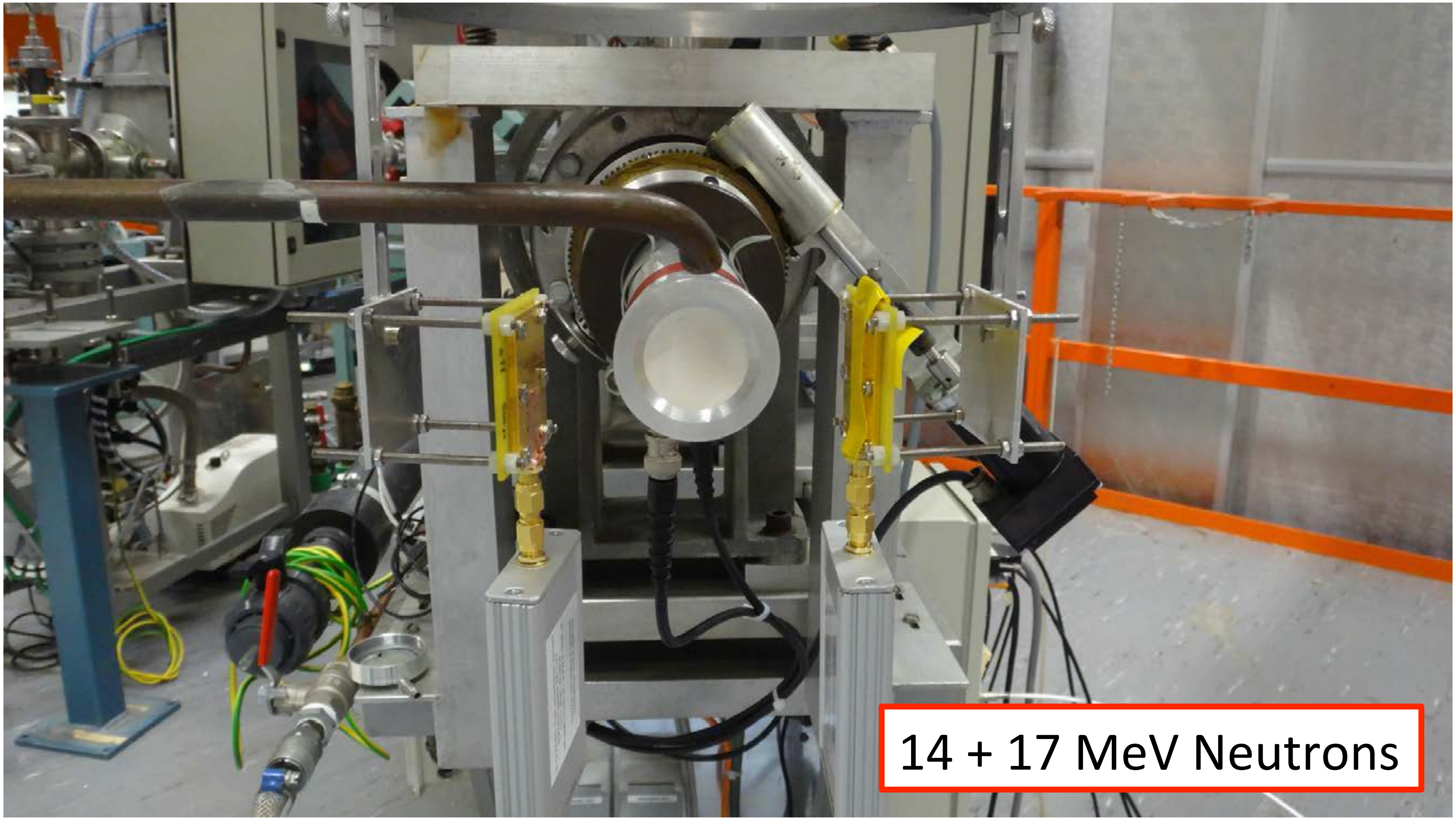
PTB Neutron Generator

B1 sCVD & B2 pCVD

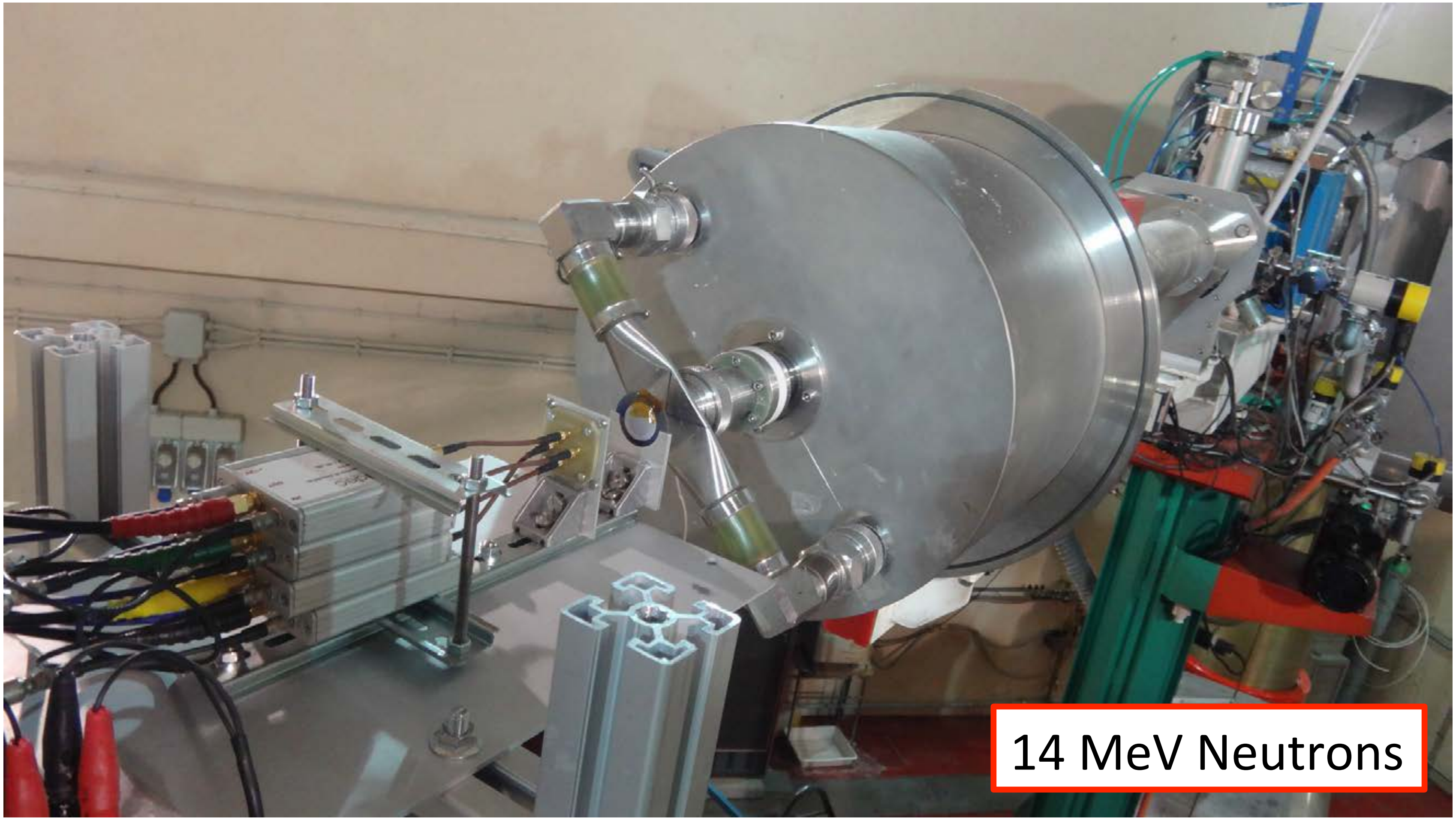
IRMM Van de Graaf



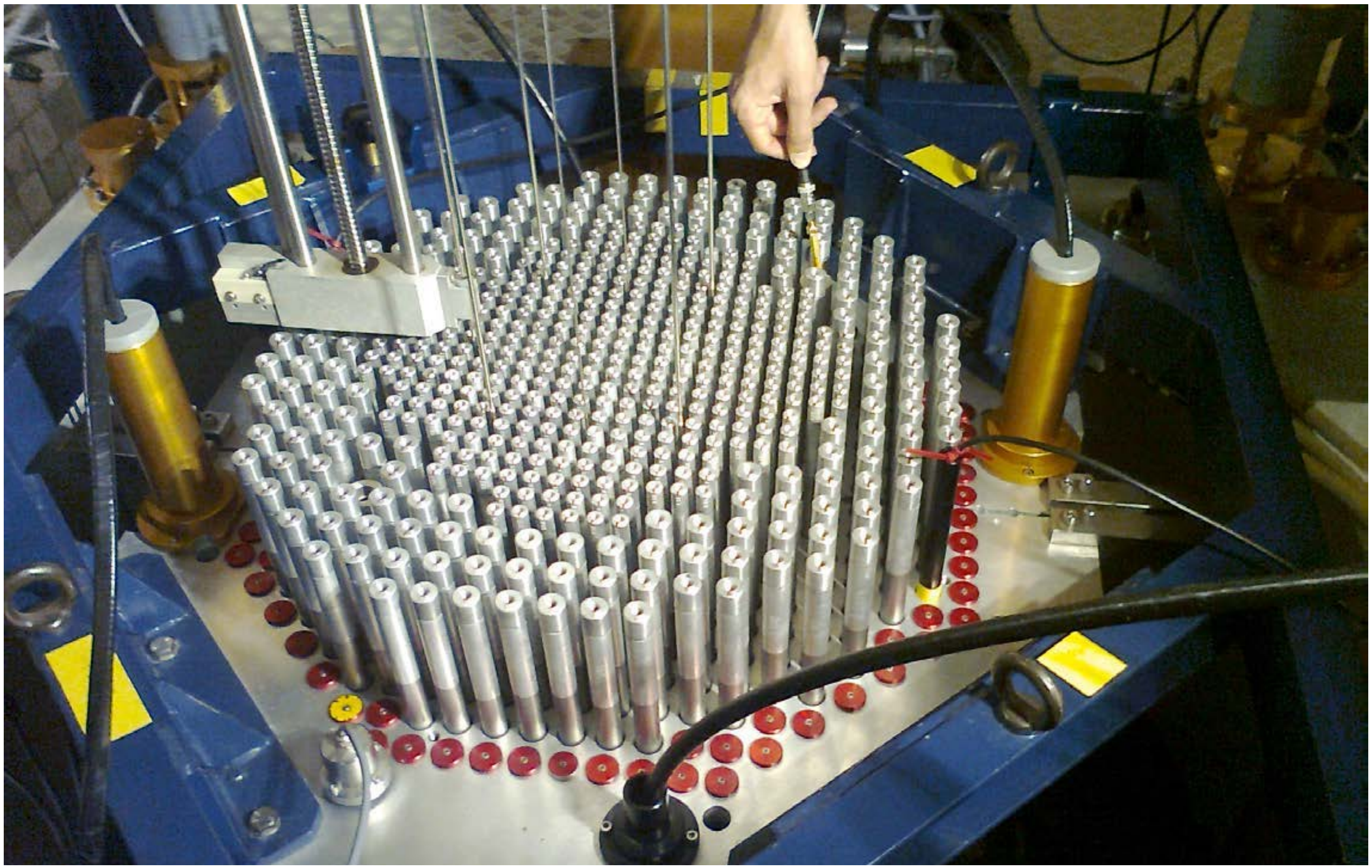
B7 Fast-Neutron Diamond Detector



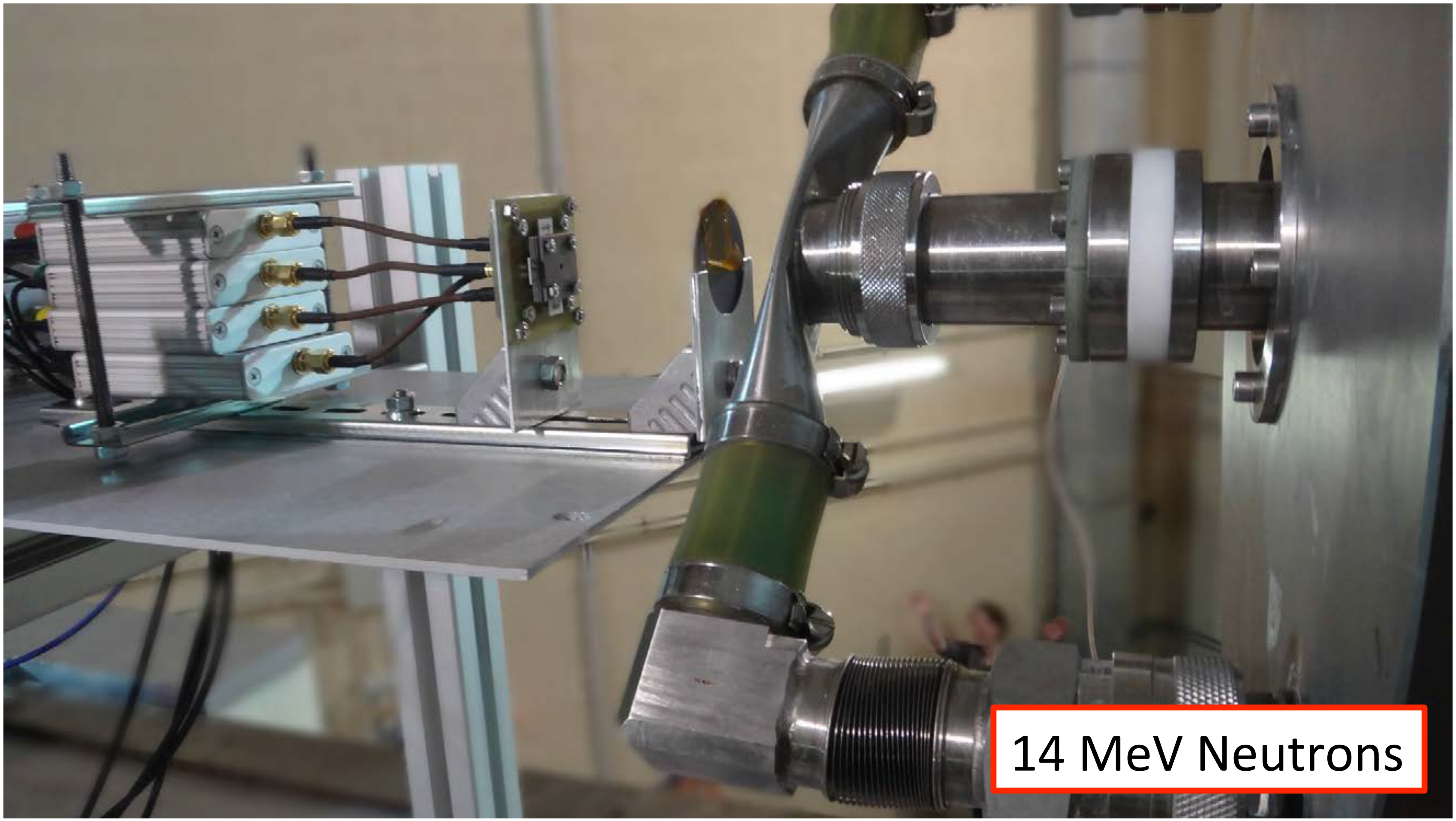
Frascati Neutron Generator



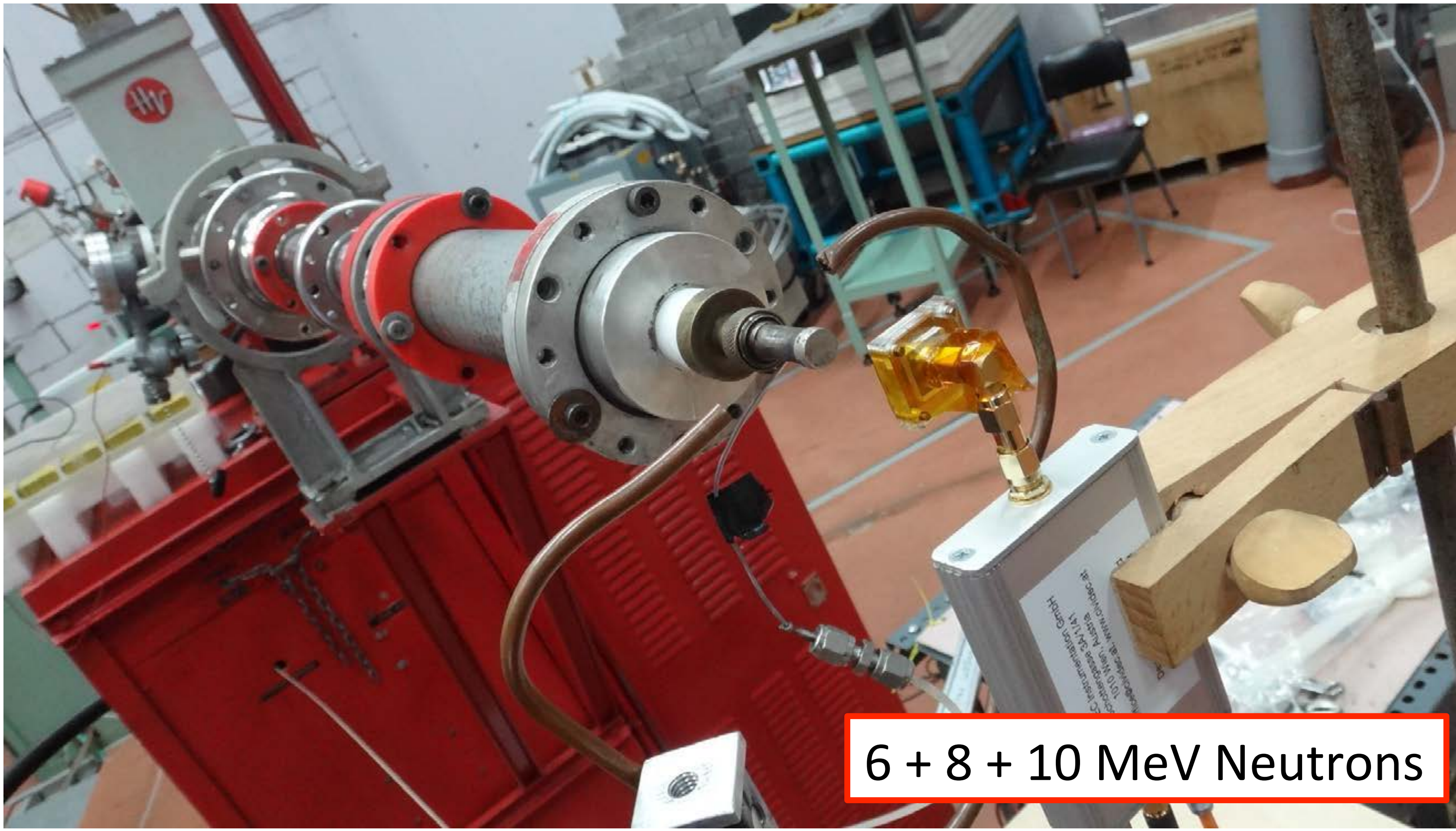
EPFL – Nuclear Detector



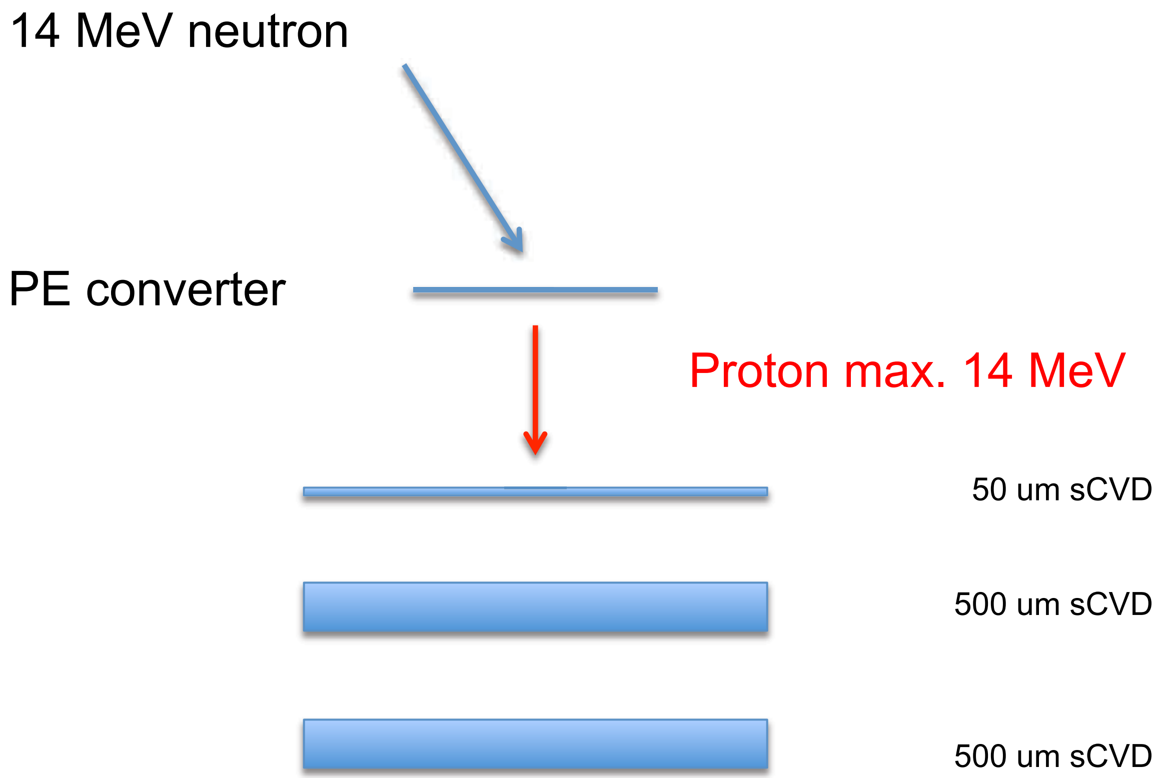
B14 Diamond Telescope Detector



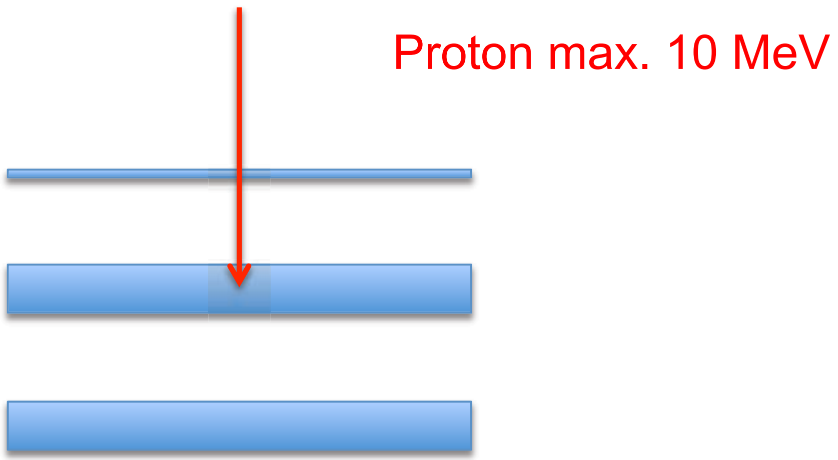
Demokritos Neutron Generator



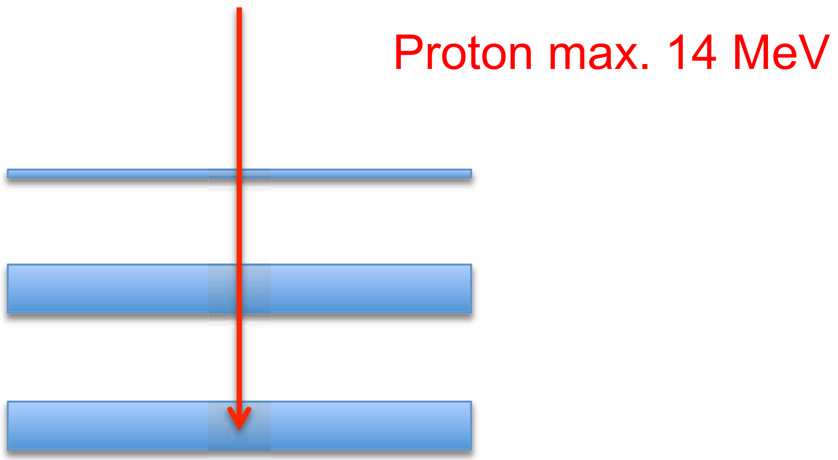
Proton Recoil Spectrometer



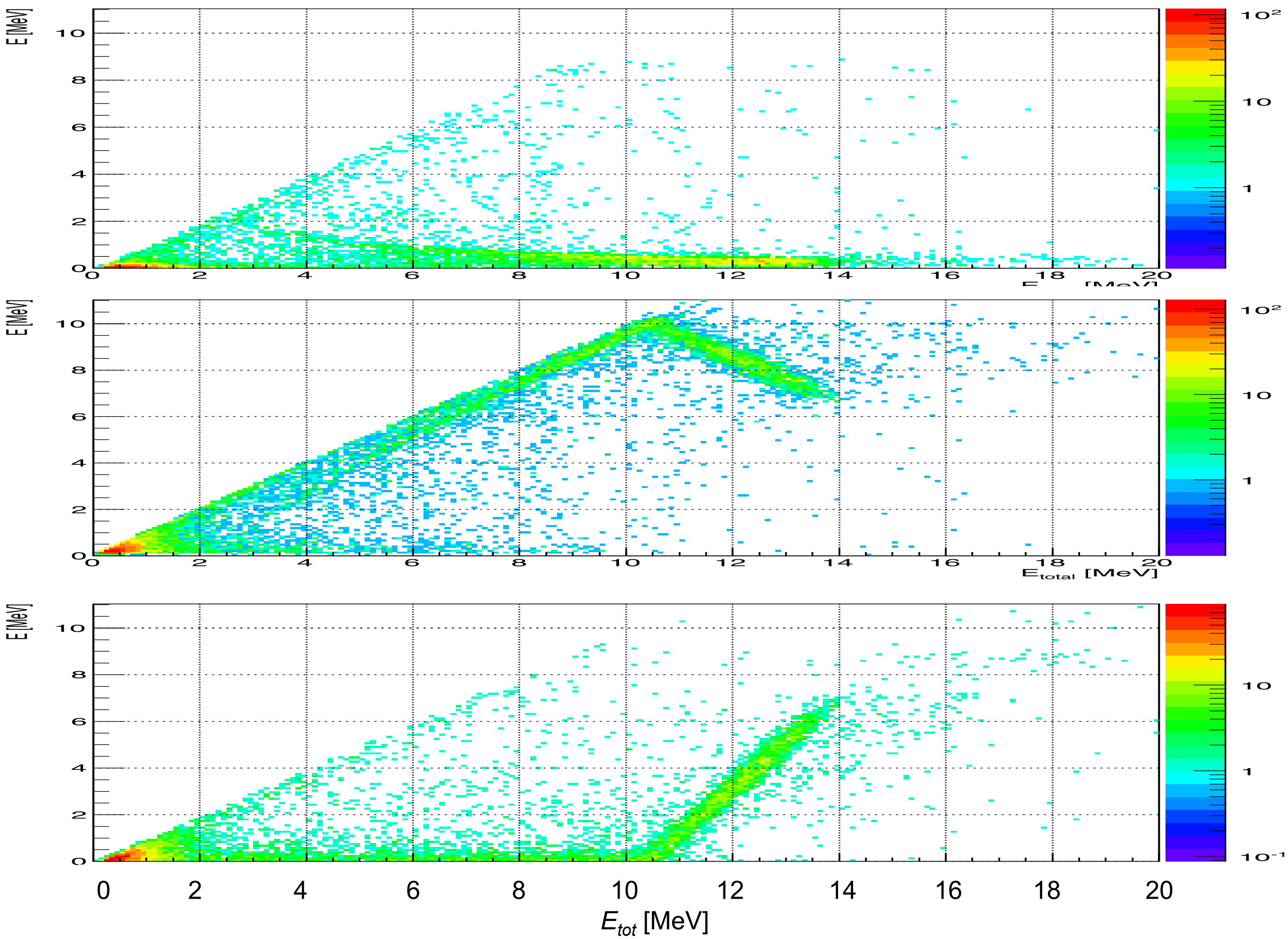
Proton Recoil Spectrometer



Proton Recoil Spectrometer



Bethe Bloch



E [MeV]
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
20
10^2
10
1
E_{total} [MeV]
10^{-1}
E_{tot} [MeV]

Neutron applications

Christina …..