正电子概况VI

正电子技术及其发展

叶邦角

核固体物理研究室

Laboratory of Nuclear Solid State Physics, USTC

三、正电子技术的发展

- 数字化
- 大型综合化
- 平台化

1.探测技术数字化

- 数字示波器
- 数据采集卡

用数字示波器做采集卡

Digital measurement of positron lifetime

K. Rytsölä*, J. Nissilä, J. Kokkonen, A. Laakso, R. Aavikko, K. Saarinen

Laboratory of Physics, Helsinki University of Technology, P.O. Box 1100, FIN-02015 HUT, Espoo, Finland

Applied Surface Science 194 (2002) 260–263

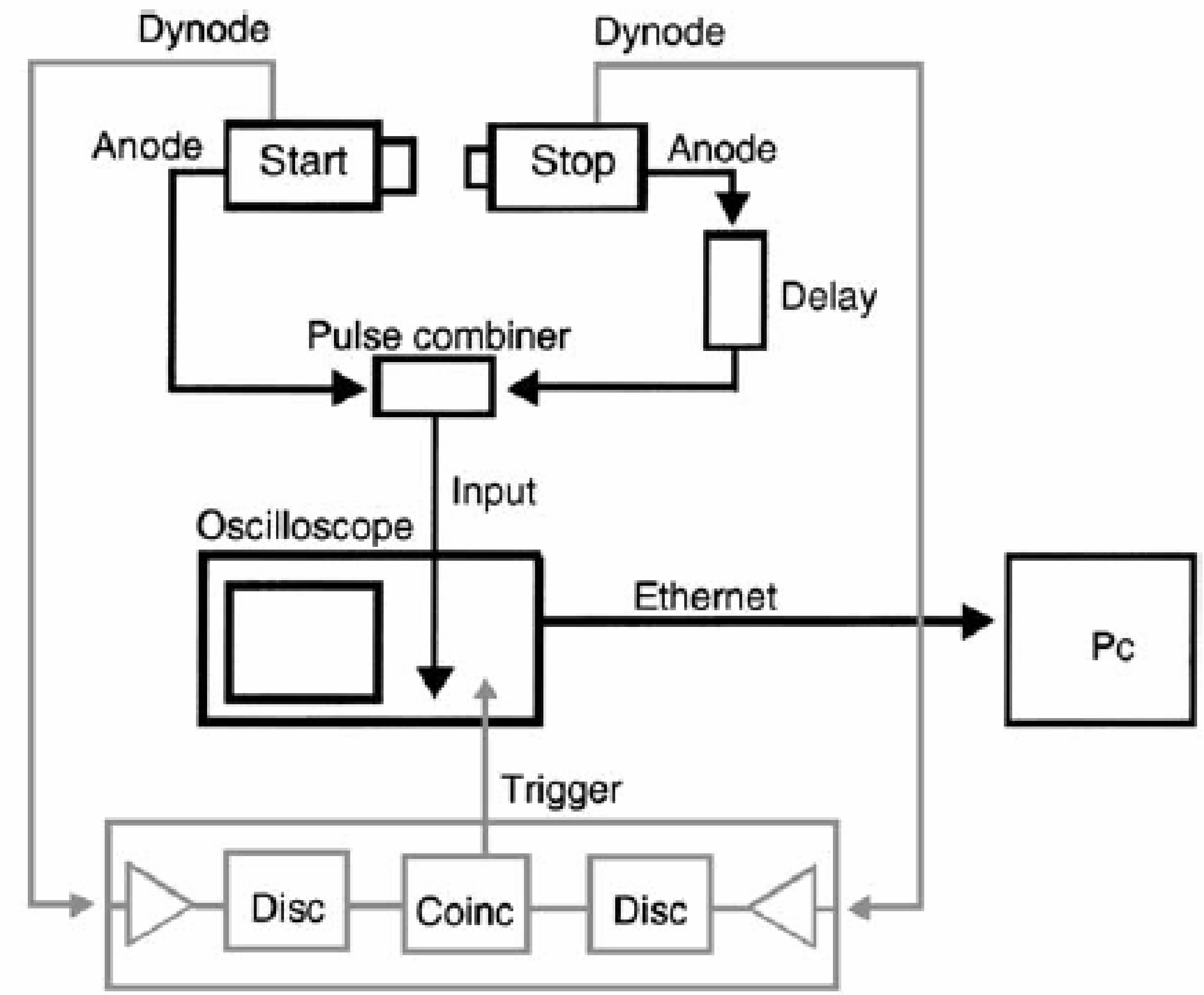


Fig. 1. Schematic diagram of a 'first generation' digital positron lifetime spectrometer.

- **Detector:**

  Plastic $\phi 30\times 20mm^3$ cylindrial scintillators

  Philips XP2020 PMT

Digital oscilloscope

  Tektronix TDS 3052, 5GS/s, 500MHz)

Pulses at 200 ps intervals, leading into about 100 samples per pulse.

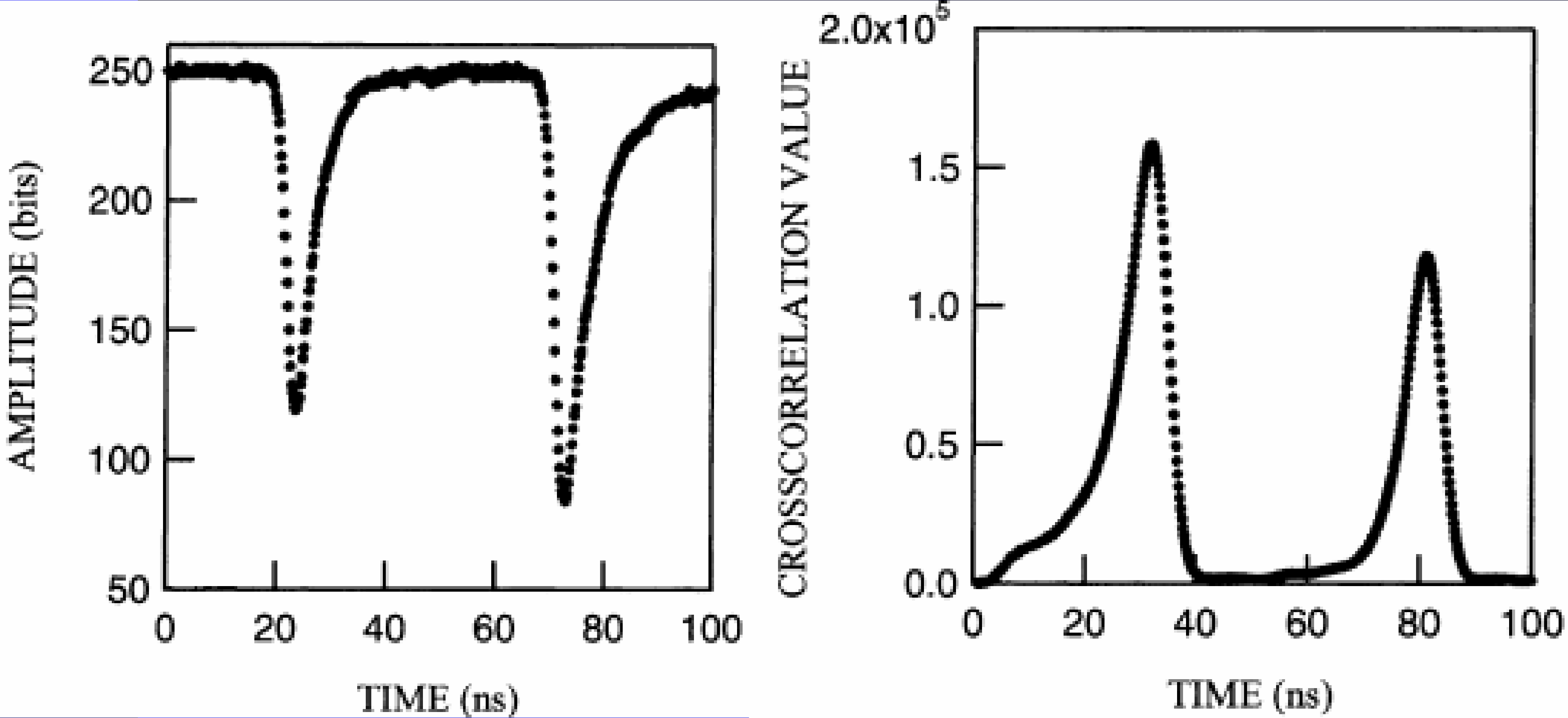


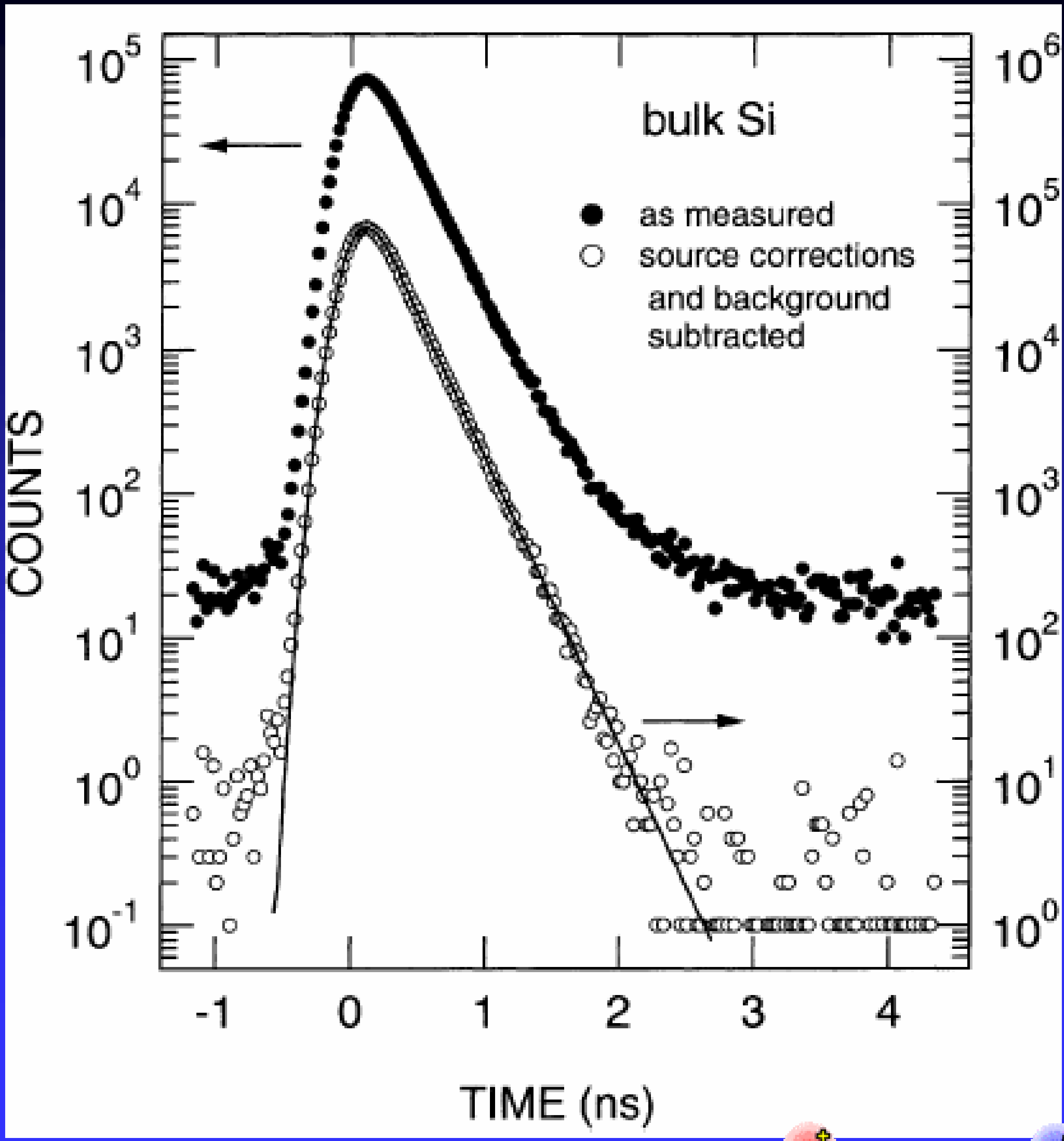
Fig. 2. (a) A typical digitized lifetime event captured by the oscilloscope. About 15 samples are collected within the rise time of the pulse. The timing information is extracted from the digitized pulses by crosscorrelation with a model pulse, the result of which is given in (b). The positron lifetime is then calculated as a time difference between the peak positions.

Time resolution

- Electronics time resolution:33ps
- Total time resolution: 203ps, for 50%Co windows
- Counts: 15/s

Bulk Si

218ps



A new positron lifetime spectrometer using a fast digital oscilloscope and BaF_2 scintillators

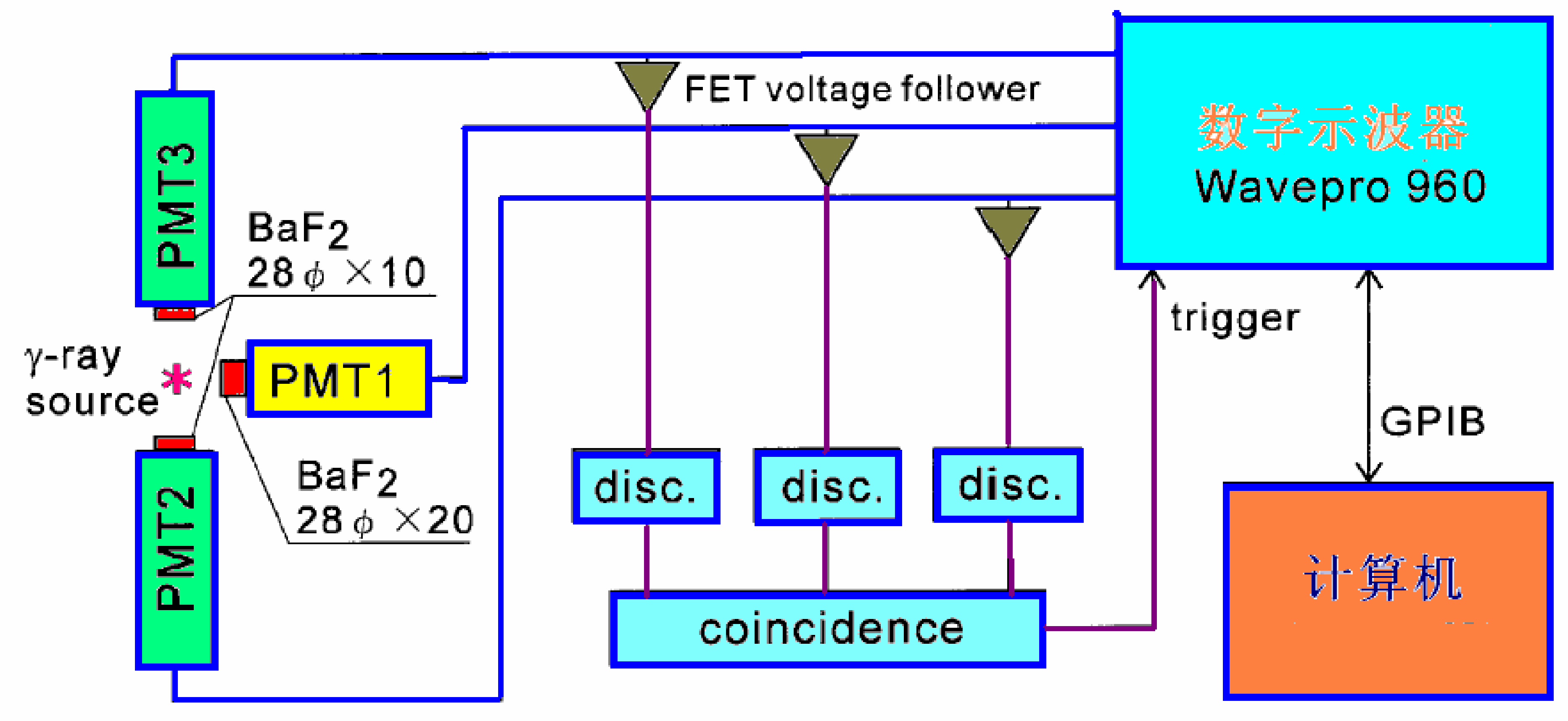
H. Saito[a,*], Y. Nagashima[a], T. Kurihara[b], T. Hyodo[a]

[a] *Institute of Physics, Graduate School of Arts and Sciences, University of Tokyo, 3-8-1 Komaba Meguro-ku, Tokyo, 153-8902 Japan*
[b] *Institute of Materials Structure Science, High Energy Accelerator Research Organization (KEK), 1-1, O-ho, Tsukuba-shi, Ibaragi, 305-0801 Japan*

Nuclear Instruments and Methods in Physics Research A 487 (2002) 612–617

Detector system

- Hamamatsu H3378(R2083Q)+BaF_2,
  one $\phi 28 \times 20$, two $\phi 28 \times 10$
- Digital oscillocsope: LeCroy Wavepro 960 4GS/s, 2GHz, 4channels in.



The time range of the oscilloscope is set to 100 ns. Data are transferred to a personal computer through a GPIB. The maximum transfer rate is about 300 kByte/s.

2-gamma system

$$\Delta t = T_{\text{stop}} - T_{\text{start}} = T_{\text{CF}}(\text{PMT2}, 0.511\ \text{MeV}) - T_{\text{CF}}(\text{PMT1}, 1.27\ \text{MeV})$$

where TCF is the time at which the pulse crosses the constant fraction of 25% of the amplitude.

3-gamma system

$$\Delta t = T_{\text{stop}} - T_{\text{start}}$$

where

$$T_{\text{stop}} = [T_{\text{CF}}(\text{PMT2}, 0.511\ \text{MeV}) + T_{\text{CF}}(\text{PMT3}, 0.511\ \text{MeV})]/2$$

$$T_{\text{start}} = T_{\text{CF}}(\text{PMT1}, 1.27\ \text{MeV}).$$

In addition only those events that satisfy

$$|T_{\mathrm{CF}}(\mathrm{PMT2}, 0.511\ \mathrm{MeV}) - T_{\mathrm{CF}}(\mathrm{PMT3}, 0.511\ \mathrm{MeV})| < 400\ \mathrm{ps}$$

are accepted.

Time response

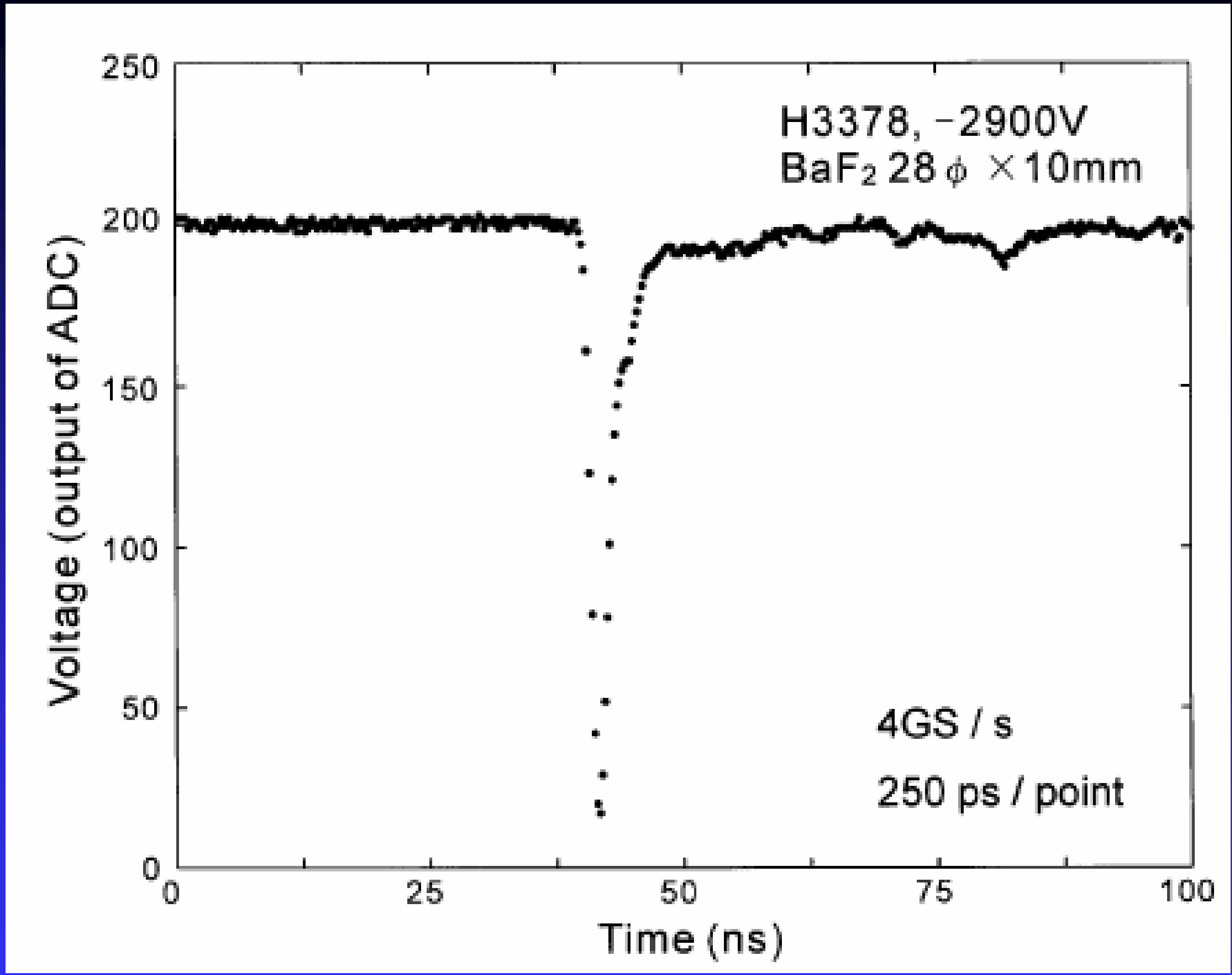
标定源:

^{60}Co (1.33 MeV, 1.17 MeV),

^{207}Bi (1.064 MeV, 0.570 MeV),

^{22}Na(0.511MeV, 0.511 MeV).

$$\Delta t = T_{\mathrm{CF}}(\text{pulse 2}) - T_{\mathrm{CF}}(\text{pulse 1}).$$



An anode output signal of the H3378 PMT recorded by Wavepro 960. The sampling rate is set to 4 GS/s. The rise time (10–90%) is about 1 ns, which is comparable to the specification (0.7 ns) of the PMT.

The PAL spectra obtained were fitted to a sum of two exponential components convoluted with a single Gaussian resolution function as

$$f(t) = \int R(t')\Theta(t - t')\left(\frac{I_1}{\tau_1}\exp(-(t - t')/\tau_1) + \frac{I_2}{\tau_2}\exp(-(t - t')/\tau_2)\right) \mathrm{d}t' \quad (8)$$

where

$$R(t') = \exp\left(-\frac{t'^2}{\tau_{\mathrm{res}}^2} 4 \log 2\right) \quad (9)$$

is the time resolution function and $\Theta(t)$ is the Heaviside step function. The first exponential component corresponds to the free positrons in the sample, the second to the positrons annihilating in the deposited ^{22}NaCl positron source.

Single-stop setup :

t_{res} =144±0.4 ps;

T_1=115 ± 0.5 ps; I_1 =95:4%;

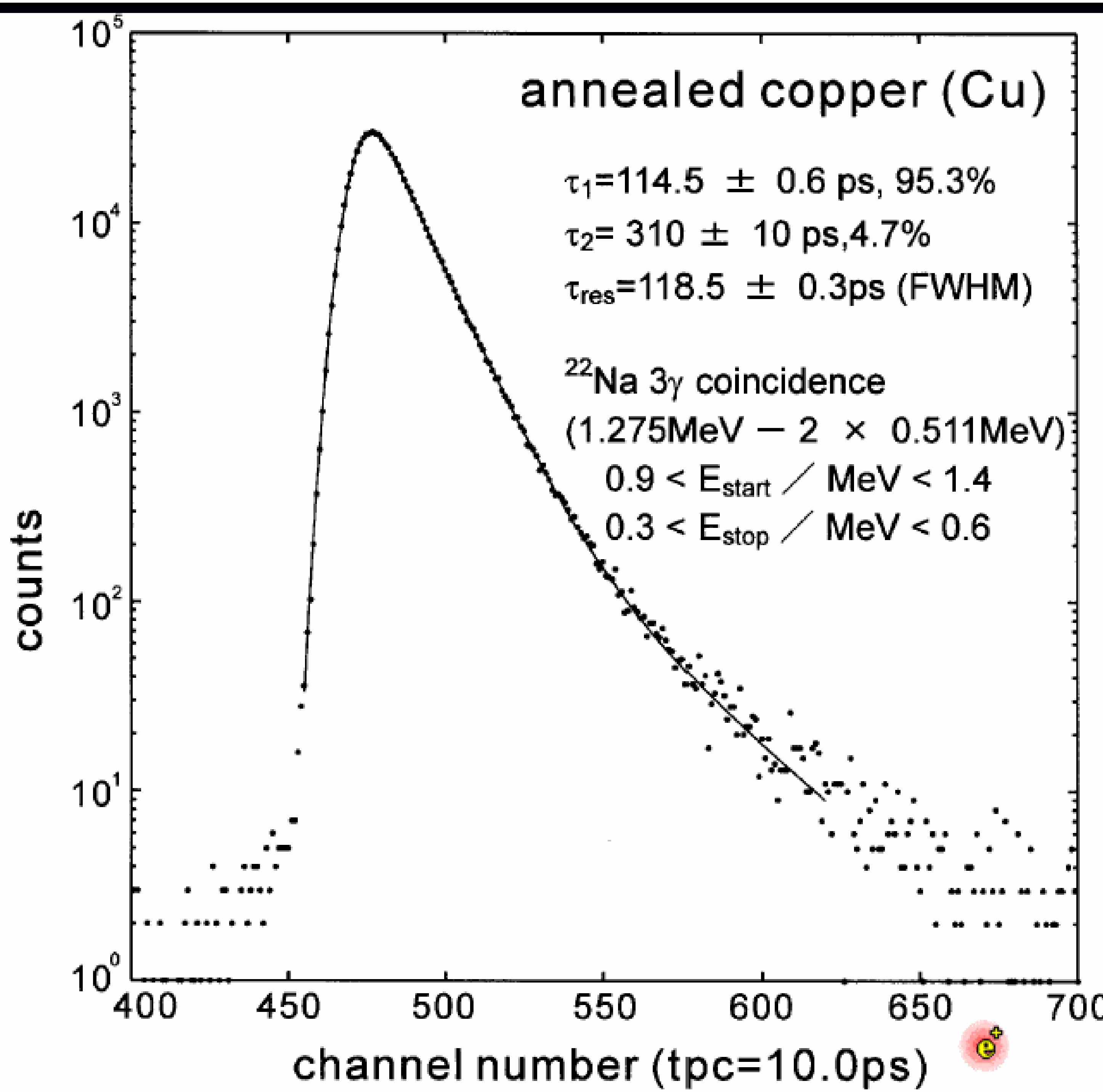
T_2 =319 ± 10 ps; I_2 =4.6%.

Doublestop setup :

t_{res} =118.5±0.4 ps;

T_1=114 ± 0.6 ps; I_1=95.3%;

T_2=310 ± 10 ps; I_2=4.7%:



annealed copper (Cu)
τ1=114.5 ± 0.6 ps, 95.3%
τ2= 310 ± 10 ps,4.7%
τres=118.5 ± 0.3ps (FWHM)
22Na 3γ coincidence
(1.275MeV − 2 × 0.511MeV)
0.9 < Estart / MeV < 1.4
0.3 < Estop / MeV < 0.6
counts
channel number (tpc=10.0ps)
400
450
500
550
600
650
700
10^0
10^1
10^2
10^3
10^4
10^5

This improvement is explained as a result of the reduction in the fluctuations in the T_{CF}(PMT2; 0.511 MeV) and T_{CF}(PMT3; 0.511 MeV) by averaging. This amazingly high resolution is obtained easily by the double-stop setup at the expense of the reduction of the count rate to 1/5 of that of the single-stop setup. The count rate is still of practical use; it took B1day to accumulate one million counts with a source of~90 kBq (~2.4 mCi).

时间分辨测试结果

Timing resolutions of the present system for several gamma-ray sources and setups

γ-ray source	γ-ray energy (MeV)	Sizes of BaF_2 scintillator (mm)	Energy window (MeV)	FWHM of time resolution (ps)	Lifetime
^{22}Na double-stop PAL	1.275 2×0.511	$28\phi \times 20$ $28\phi \times 10$ $28\phi \times 10$	$0.9 < E < 1.4$ $0.3 < E < 0.6$	119	$\tau_1(\mathrm{Cu}) = 115\,\mathrm{ps}$
^{22}Na single-stop PAL	1.275 0.511	$28\phi \times 20$ $28\phi \times 10$	$0.9 < E < 1.4$ $0.3 < E < 0.6$	144	$\tau_1(\mathrm{Cu}) = 116\,\mathrm{ps}$
^{60}Co	1.33, 1.17	$28\phi \times 10$ $28\phi \times 20$	$0.7 < E < 1.4$	118	
^{22}Na annihilation γ-ray pair	0.511 0.511	$28\phi \times 10$ $28\phi \times 10$	$0.3 < E < 0.6$ $0.3 < E < 0.6$	155	
^{207}Bi	1.064 0.570	$28\phi \times 20$ $28\phi \times 10$	$0.8 < E < 1.2$ $0.4 < E < 0.7$	140	Half-life = 125 ps

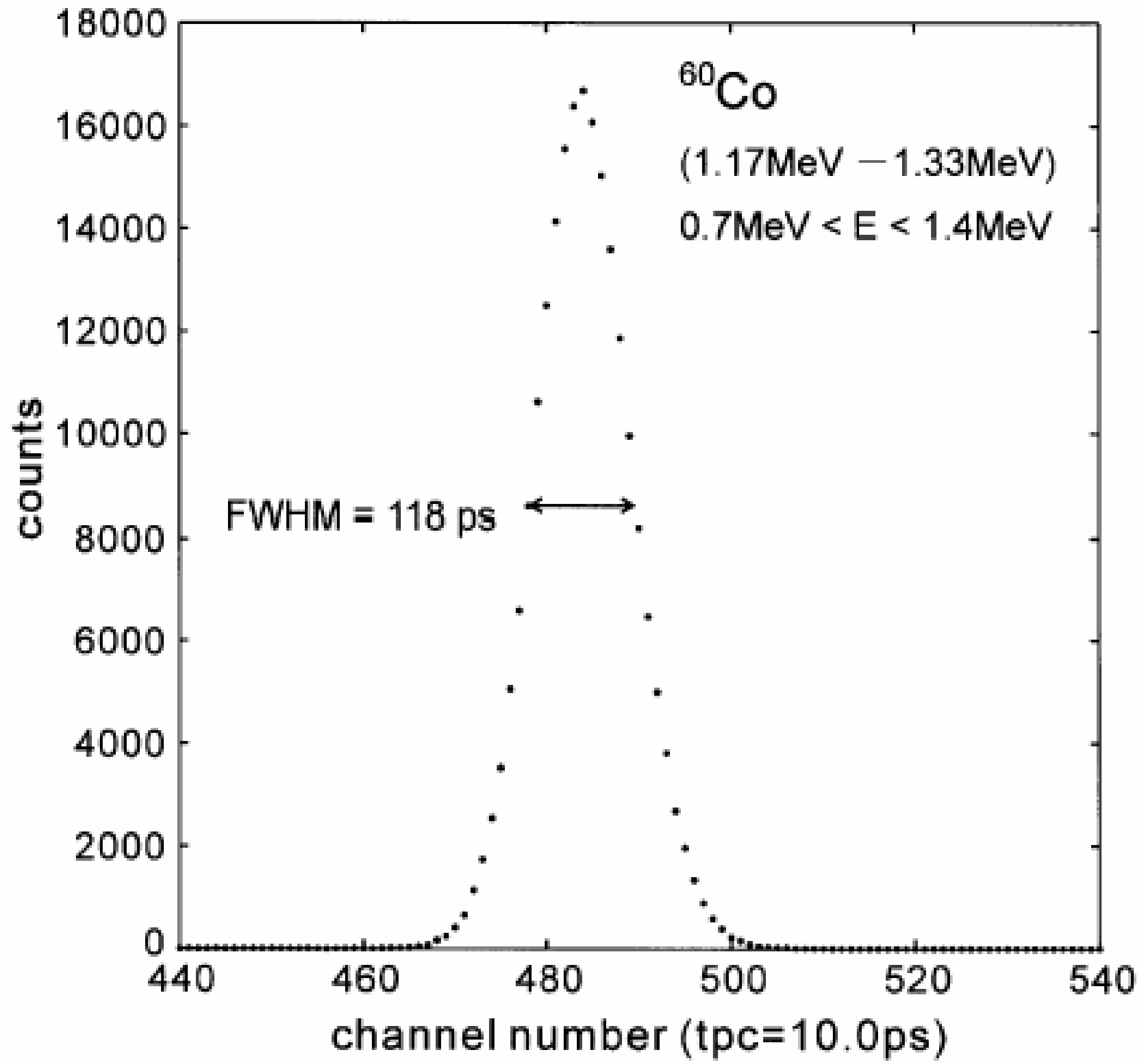
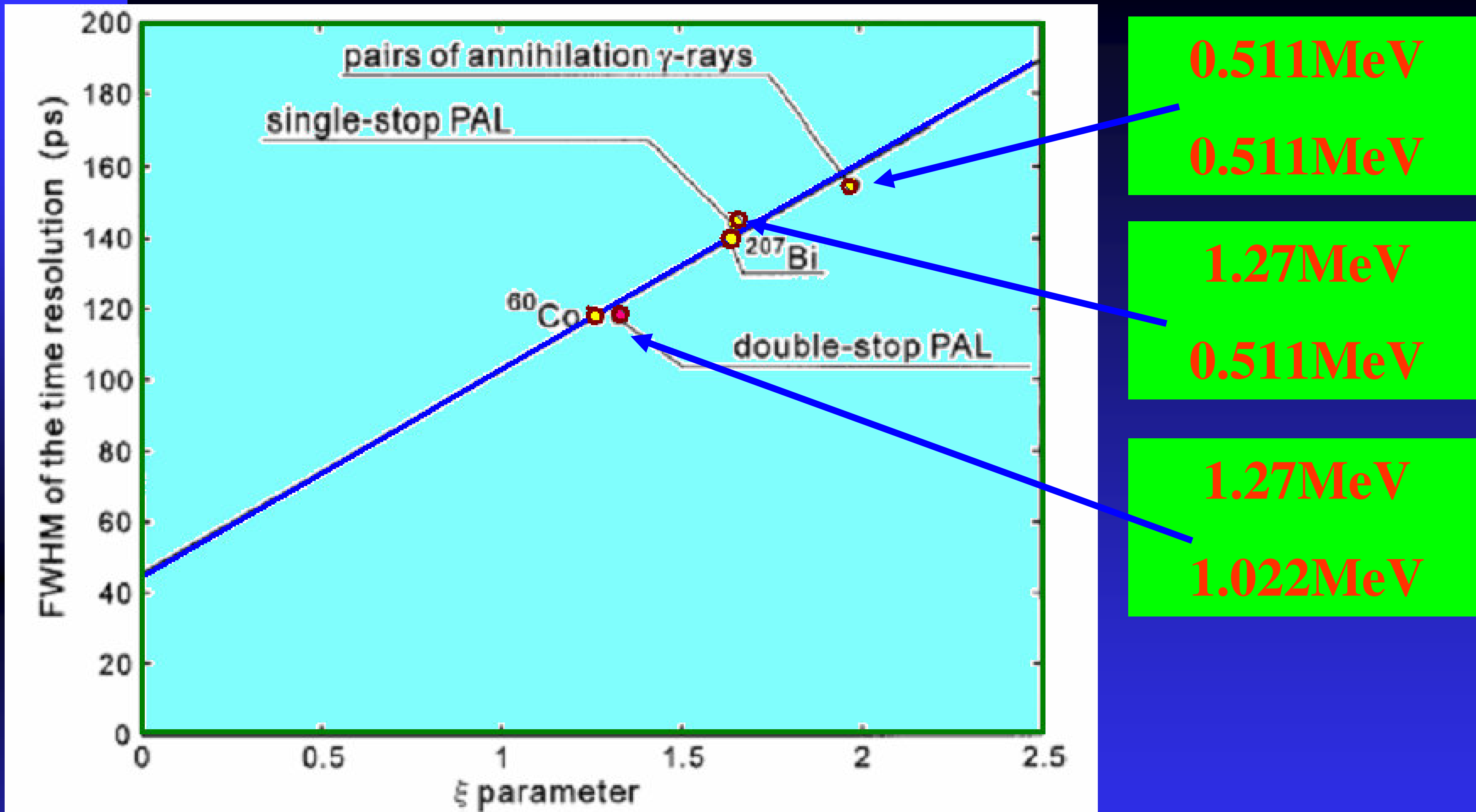


Fig. 4. Time spectrum for the ^{60}Co cascade radiations (1.17–1.33 MeV). The time resolution is 118 ps FWHM.



$$\xi = \sqrt{\frac{1}{E_{\mathrm{start}}(\mathrm{MeV})} + \frac{1}{E_{\mathrm{stop}}(\mathrm{MeV})}}$$

数字采集卡

基于数字采集卡的PAS

FEATURES

- 2 GS/s A/D sampling
- 8 bit resolution
- Up to 16 MegaSamples acquisition memory
- Up to 1.2 GHz bandwidth
- Multi-card systems of up to 2 channels at 2 GS/s (4 channels at 1 GS/s)
- Pre-Trigger Multiple Record mode
- Fast data transfer rate to system RAM
- SDKs for C/C++, MATLAB, LabVIEW & LabWindows/CVI under Win 95/98/ ME and Win NT/2000/XP

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Nuclear Instruments and Methods in Physics Research A 538 (2005) 778–789

NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH Section A

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Performance analysis of a digital positron lifetime spectrometer

J. Nissilä[1], K. Rytsölä, R. Aavikko*, A. Laakso, K. Saarinen, P. Hautojärvi

Laboratory of Physics, Helsinki University of Technology, P.O. Box 1100, FIN-02015 HUT, Espoo, Finland

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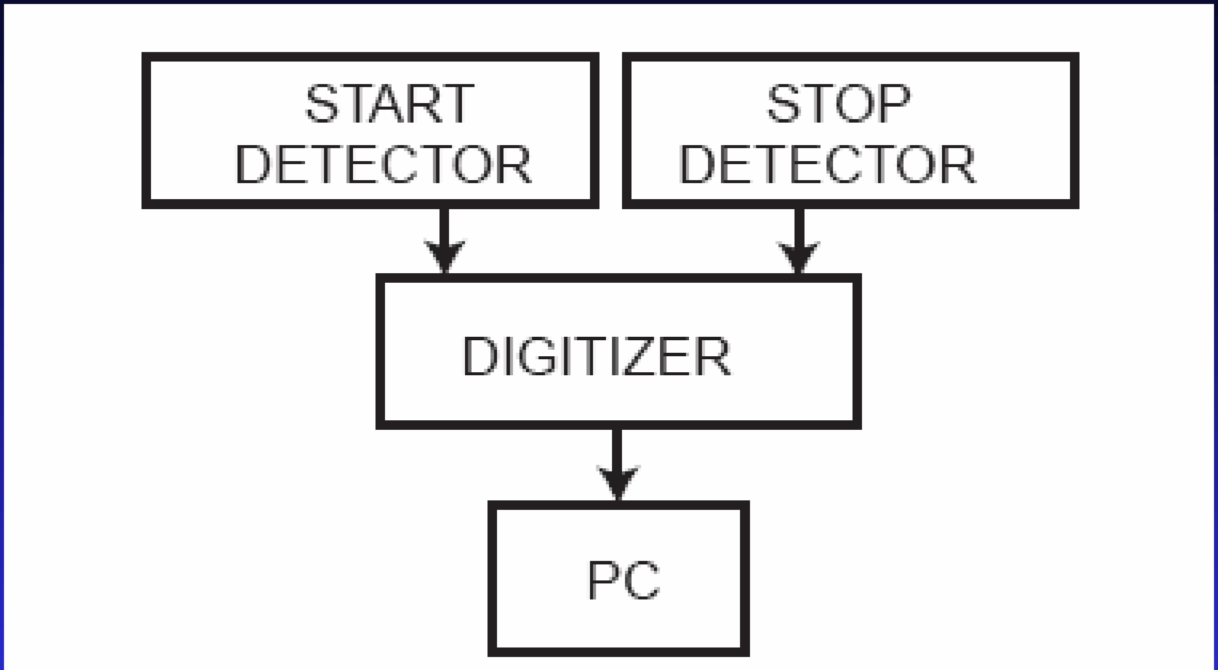
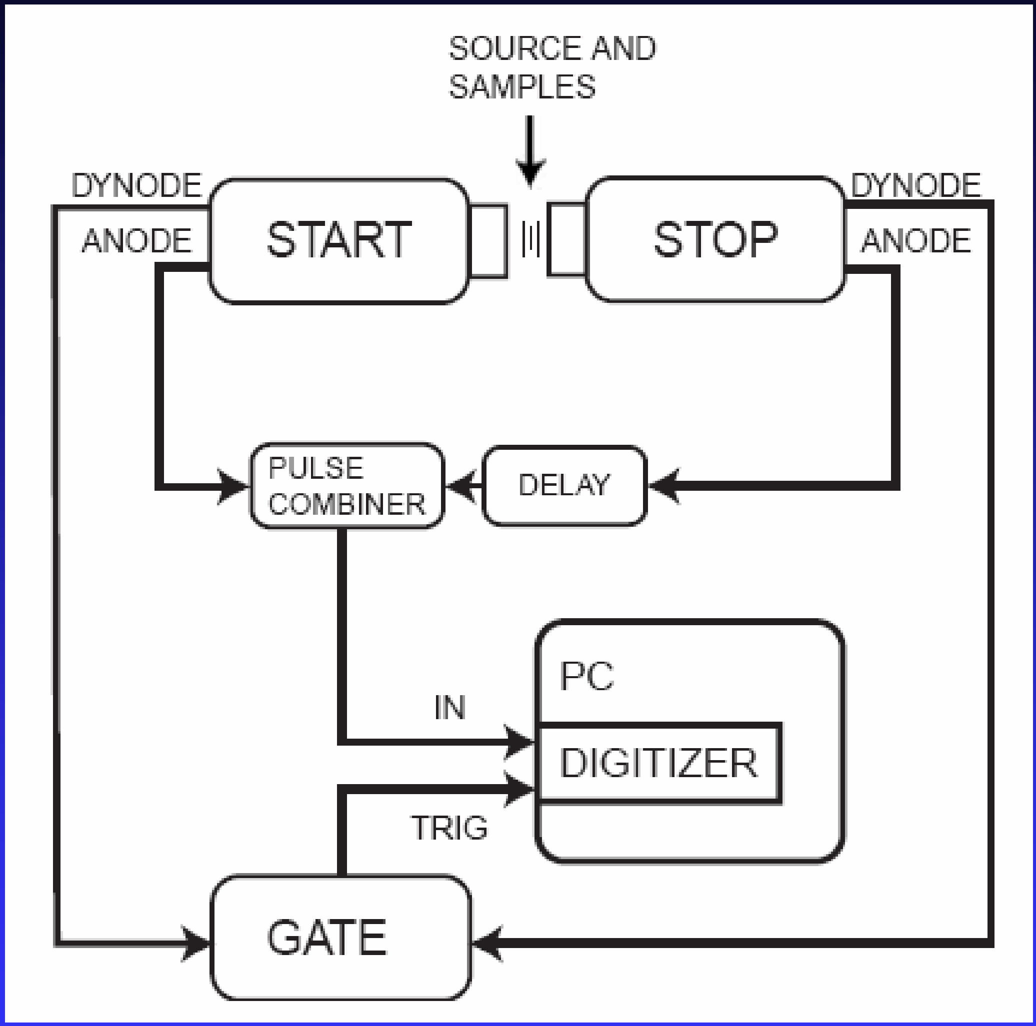


- An 8-bit digitizer card DP210 by Acqiris connected to the PCI-bus of the measurement computer.
- The sampling rate of 2 GS/s, an analog bandwidth of 500 MHz turns out to be a good recording apparatus for the positron lifetime spectrometer.


SOURCE AND
SAMPLES
DYNODE
ANODE
START
STOP
DYNODE
ANODE
PULSE
COMBINER
DELAY
PC
IN
DIGITIZER
TRIG
GATE

Time resolution

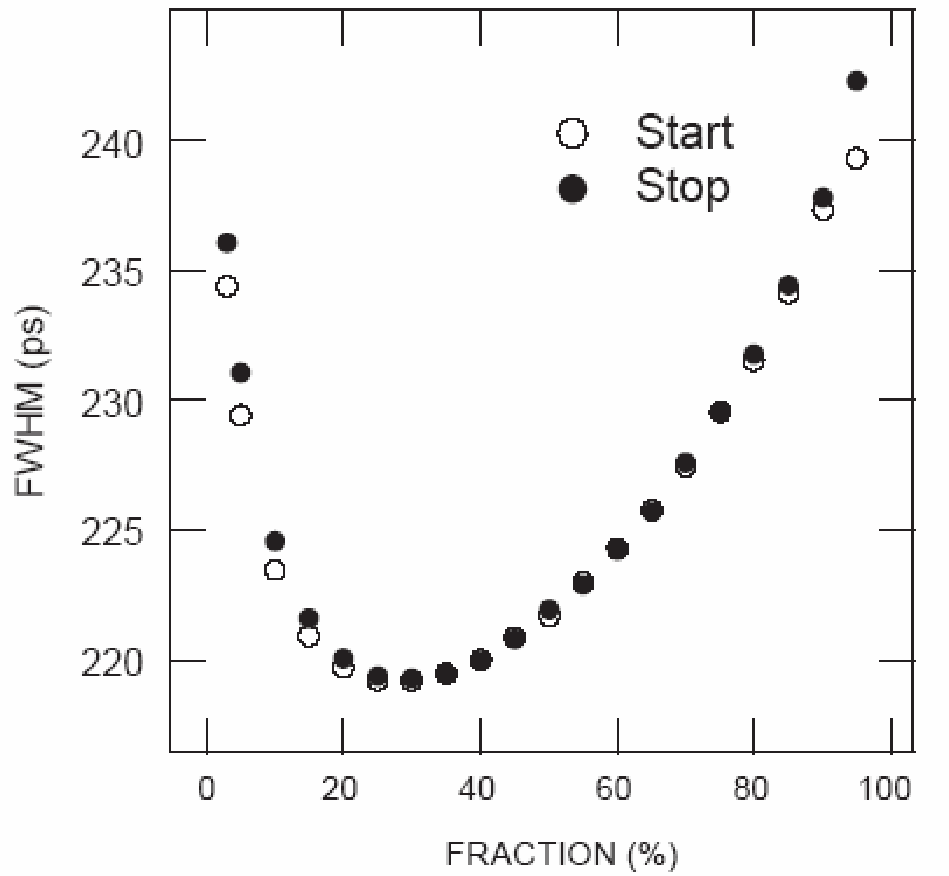
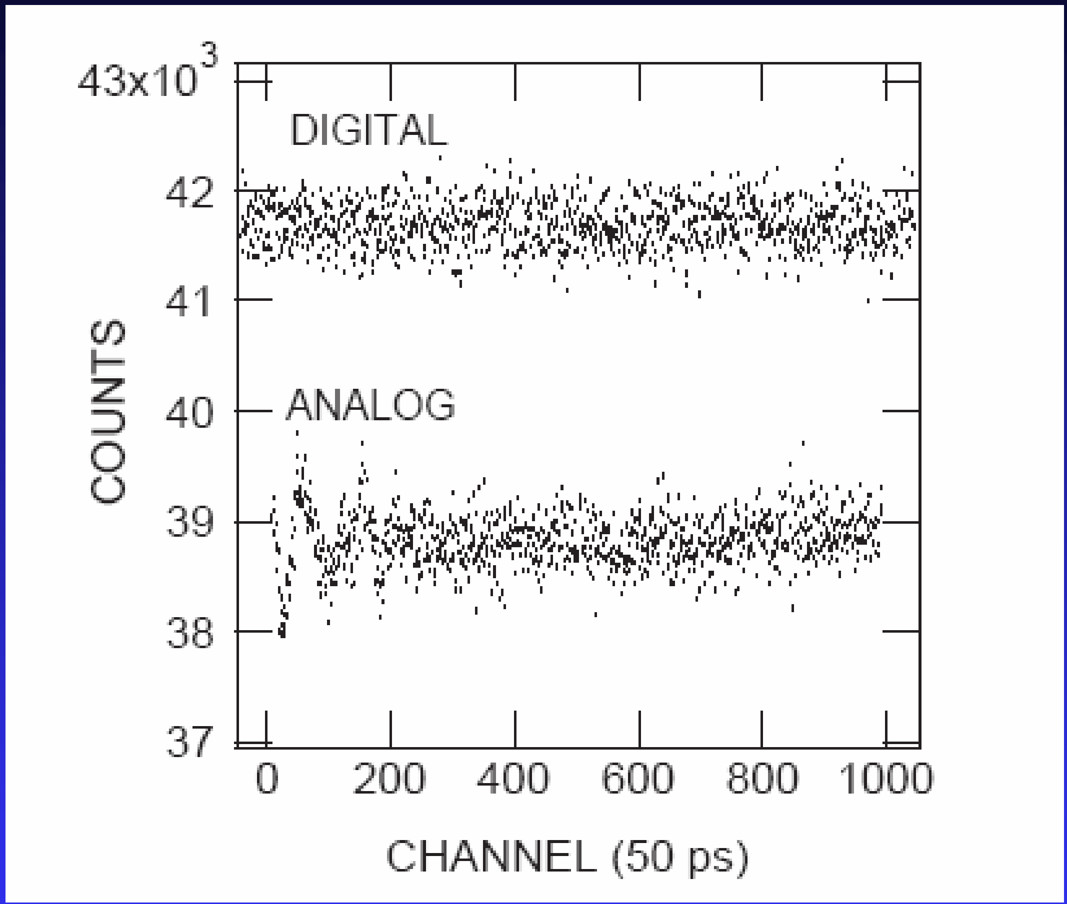
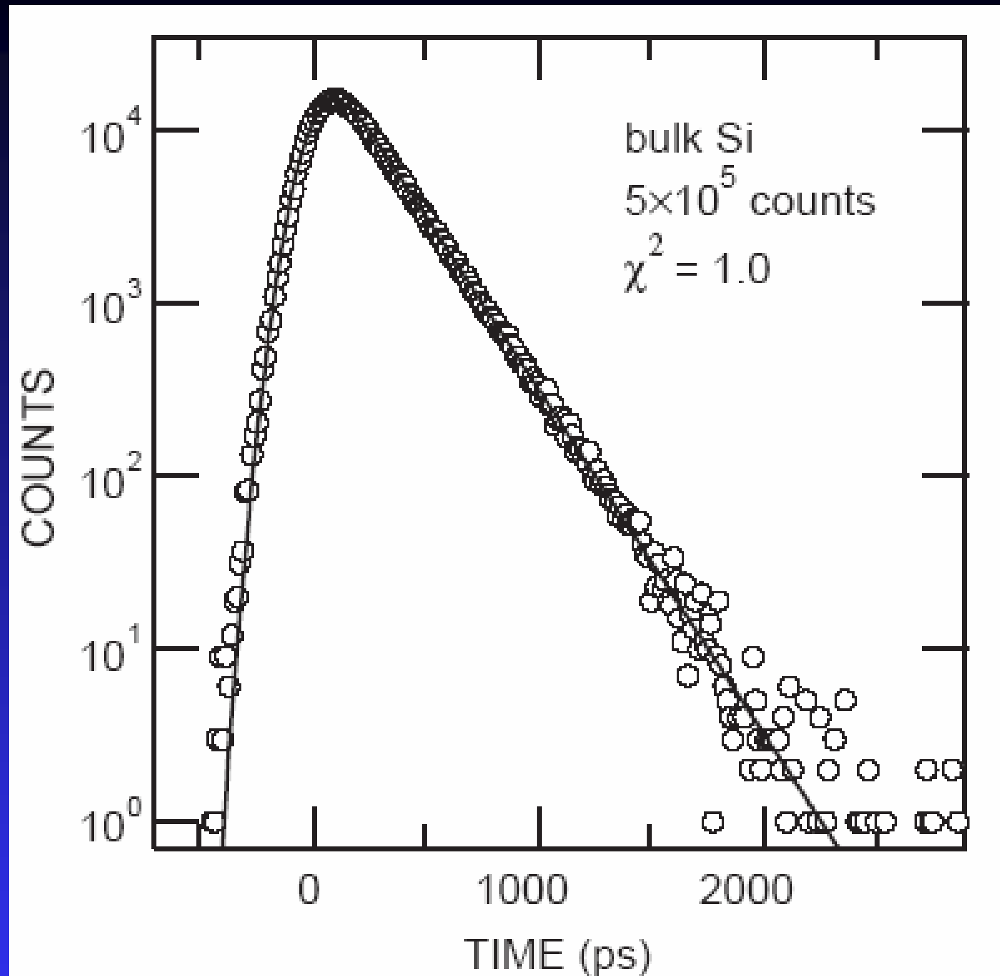


Fig. 6. The time resolution of a test spectrometer as a function of the fraction f_{CF} used in the CF timing.

DP210 : 204 ps at 1 GS/s
201 ps at 2 GS/s.
TDS 3052: 208 ps at both .



The linearity measurement of the digital apparatus has been performed without the gate module. The oscillations observable in the beginning ofthe analog spectrum are a normal artifact and pose no problem in positron lifetime measurements.



Positron lifetime spectrum measured in bulk Si. The spectrum is source and background corrected. The average positron lifetime from the fit is t =219 ps and the time resolution FWHM ~220 ps.

数字化双多谱勒谱仪

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Nuclear Instruments and Methods in Physics Research B 225 (2004) 623–627

NIM B
Beam Interactions with Materials & Atoms

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A digital measurement system of 2-detector Doppler broadening

W. Kong *, C.Y. Xi, B.J. Ye, H.M. Weng, X.Y. Zhou, R.D. Han

Department of Modern Physics, University of Science and Technology of China, Room 8-234, W. Compus, P.O. Box 4, Hefei, Anhui 230027, PR China

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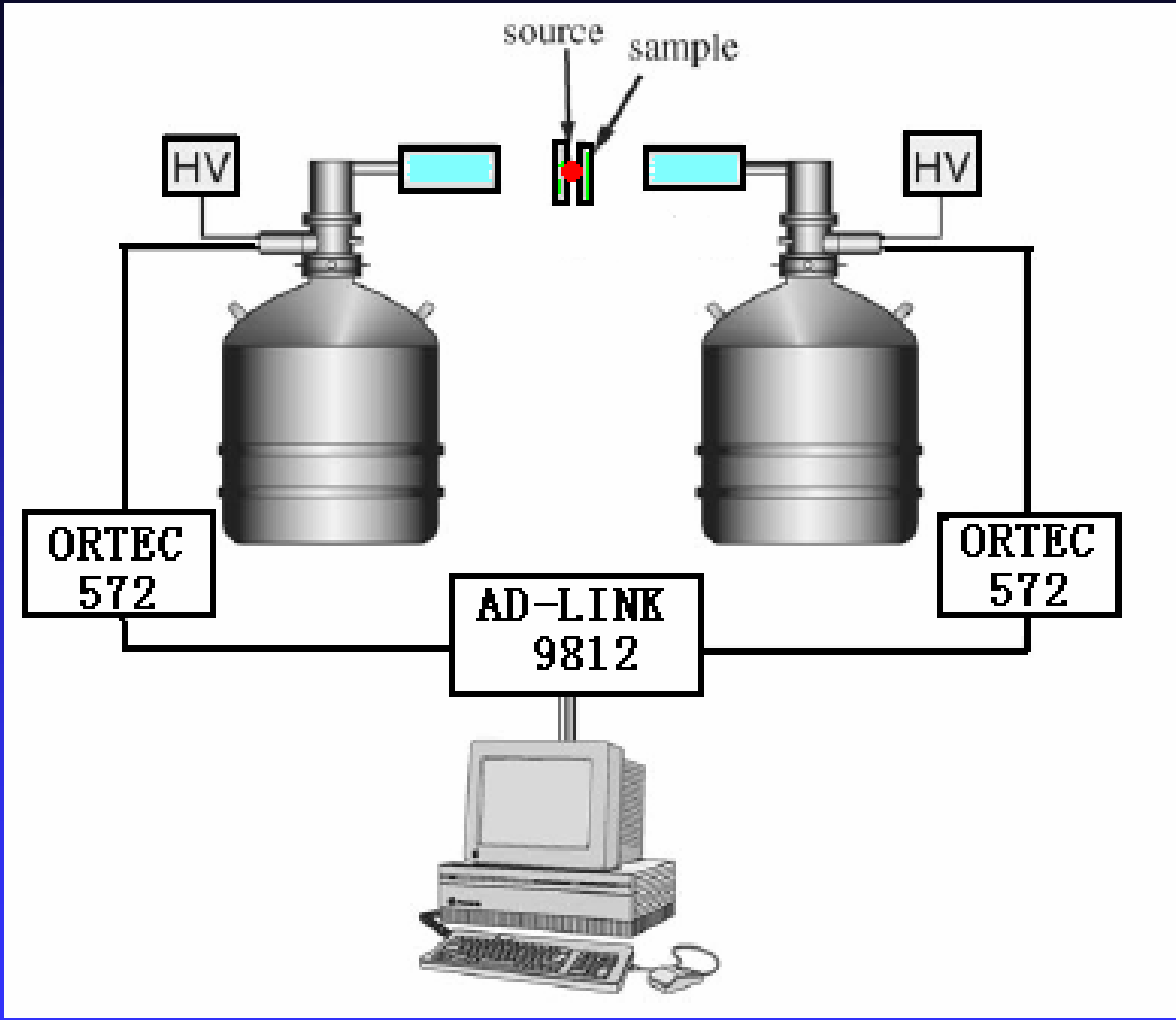
source
sample
HV
HV
ORTEC 572
ORTEC 572
AD-LINK 9812

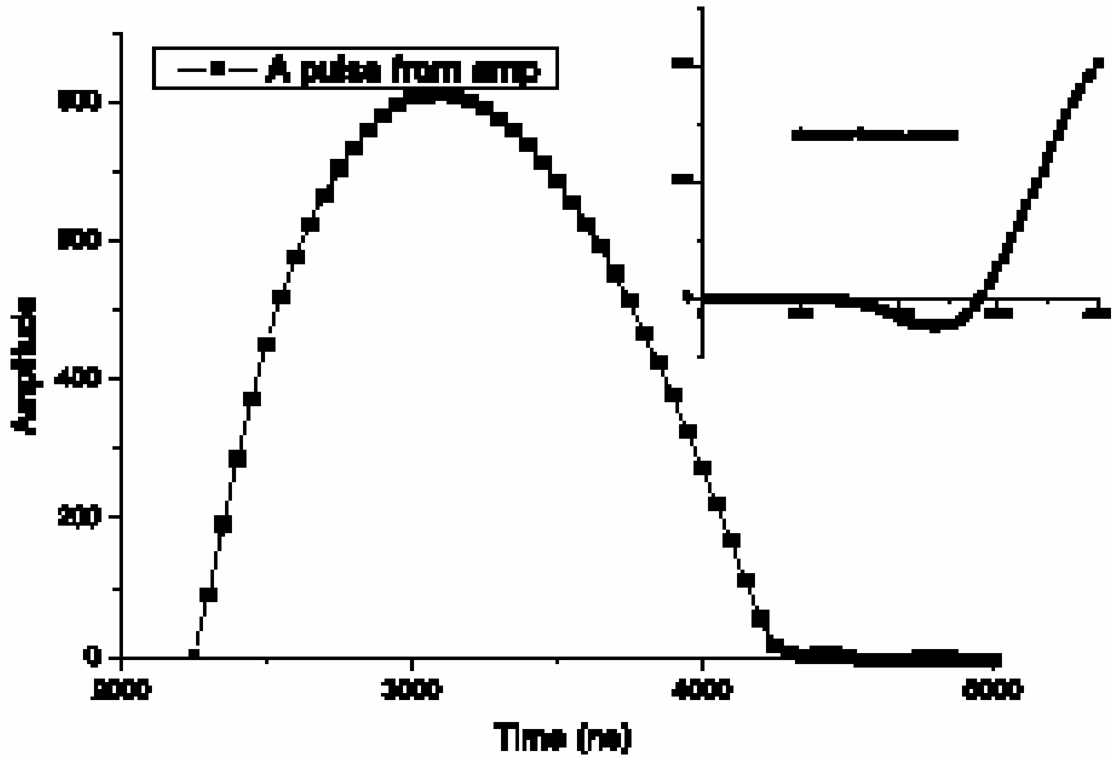

Fig. 2. One signal collected by the DAQ card (UNI), the inlet indicates the constant fraction method.

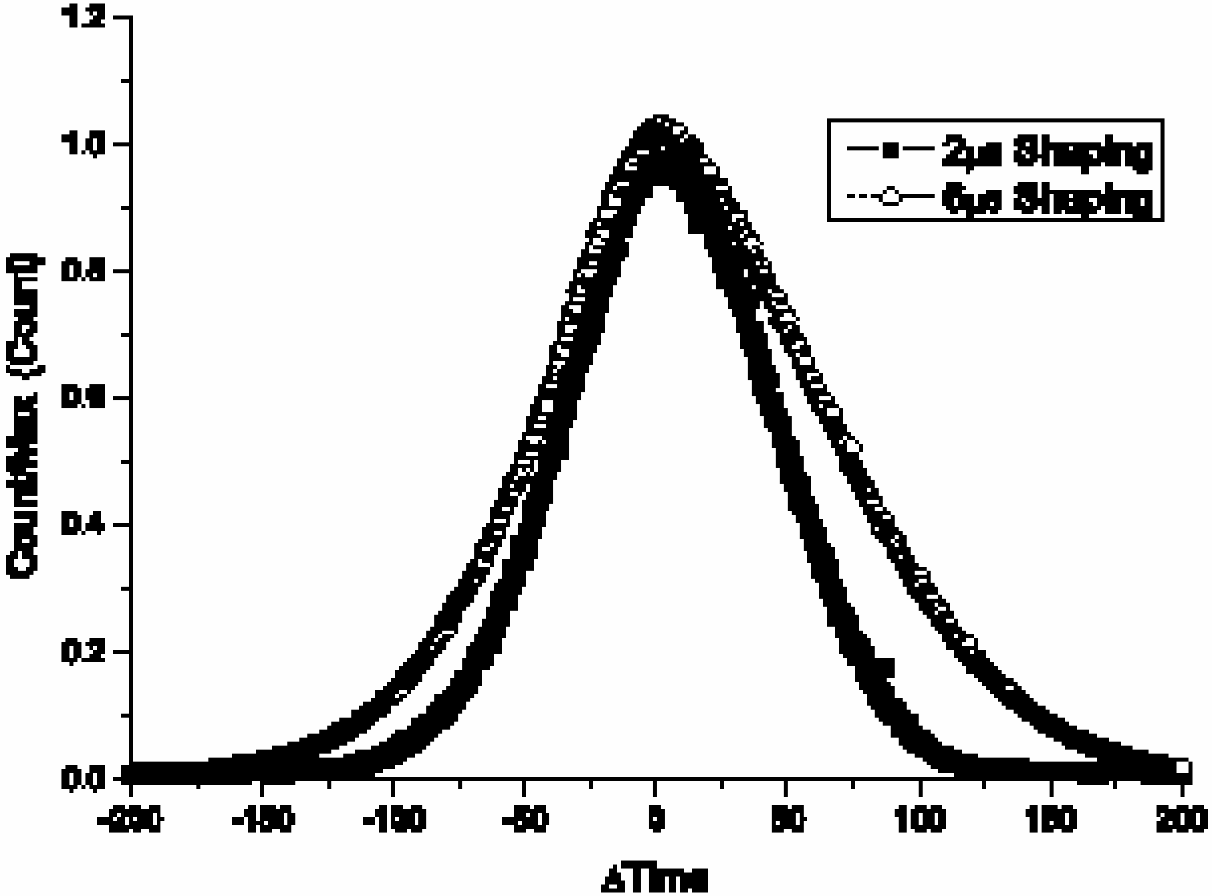

Fig. 3. Timing resolution: the shaping time of two linear amplifiers is 2000 and 6000 ns, respectively. The radioactive source is ^{22}Na, and the counting rate is about 2000 cps in each signal channel.

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Nuclear Instruments and Methods in Physics Research A 513 (2003) 622–630

NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH
Section A

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A high-performance, high-resolution positron annihilation coincidence Doppler broadening spectrometer

S. Van Petegem, B. Van Waeyenberge, D. Segers*, C. Dauwe

NUMAT, Department of Subatomic and Radiation Physics, Ghent University, Proeftuinstraat 86, B-9000 Ghent, Belgium

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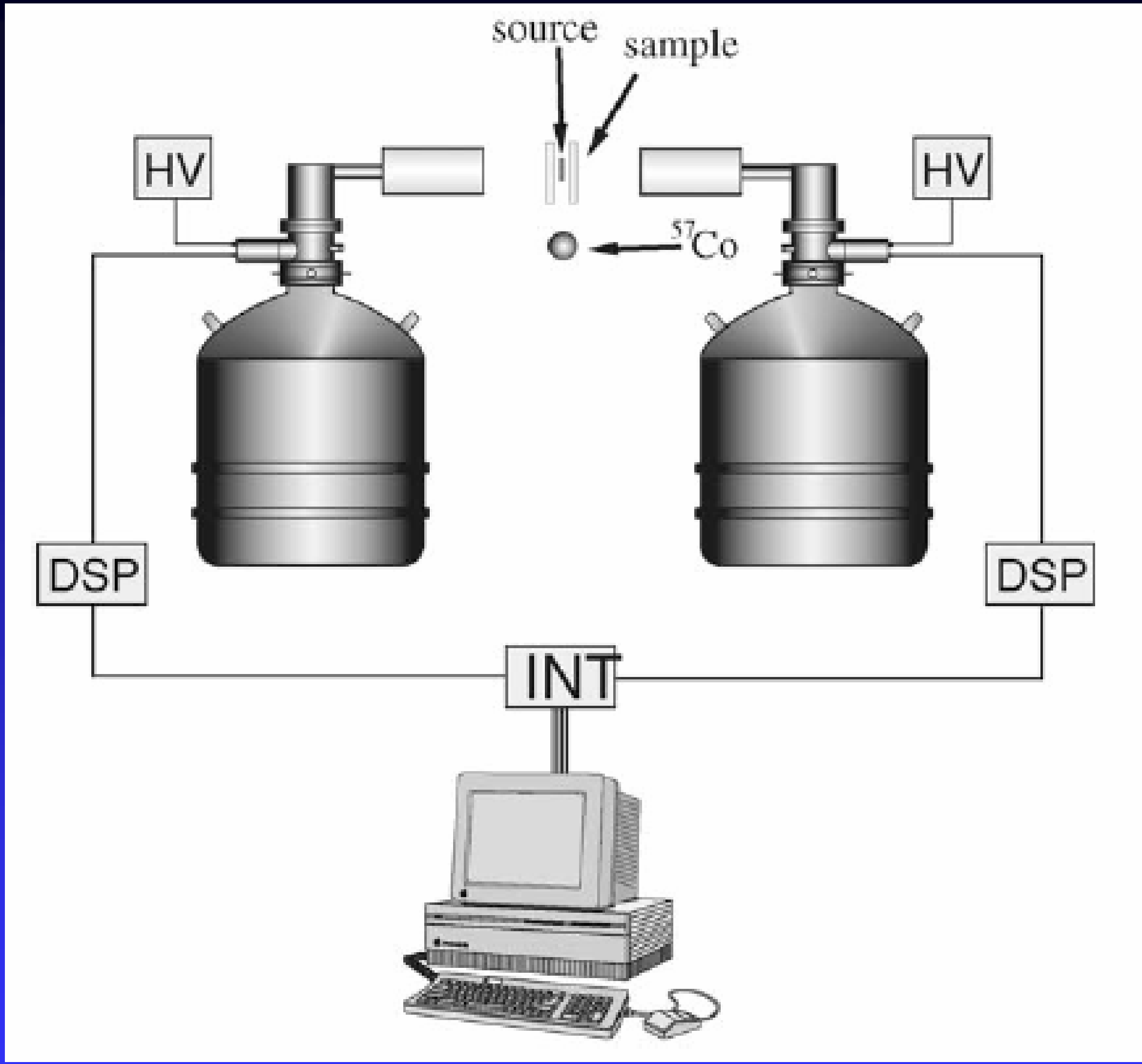
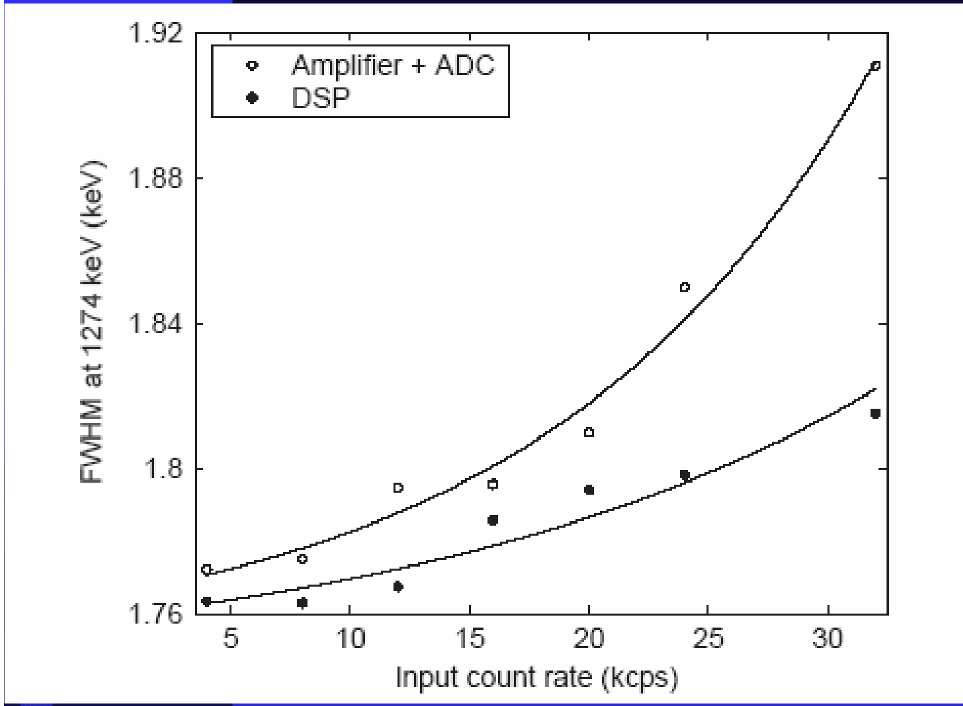


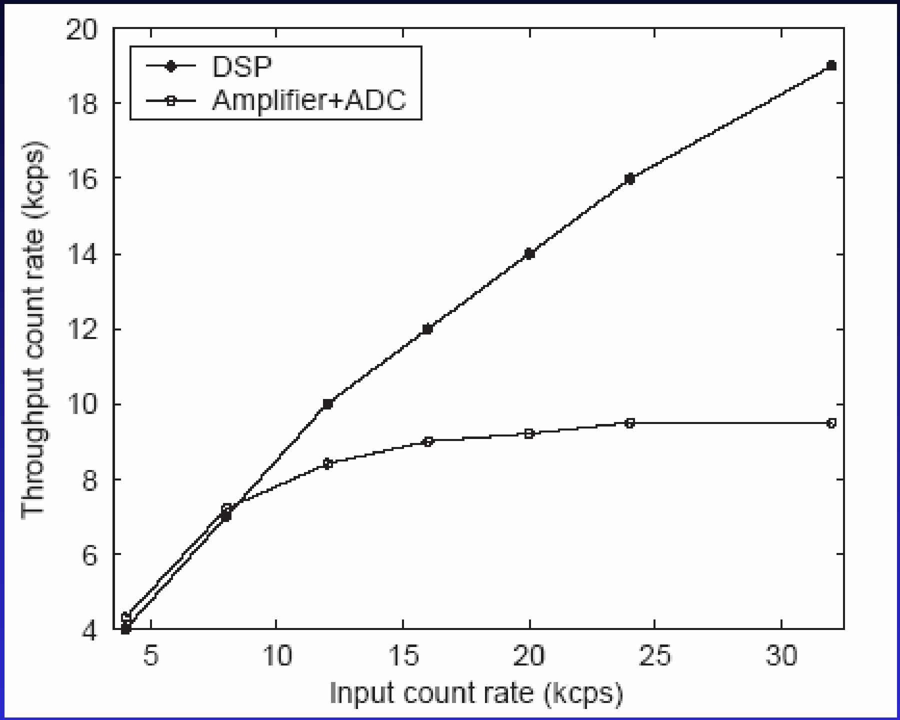
Two Digital Signal Processor (DSP) units were used.

(Canberra, model2060)

- The internal card is a digital data acquisition card from National Instruments (type PCI-6503). This card is based on PCI technology and allows a fast transfer of data to the computer (up to 10 million events per second). The other card serves as an interface between the DSP units and the data acquisition card. On this card the 14 data bits of both DSP units are connected to the upper and lower 16 bit data paths (words) of the 32 bit acquisition card.

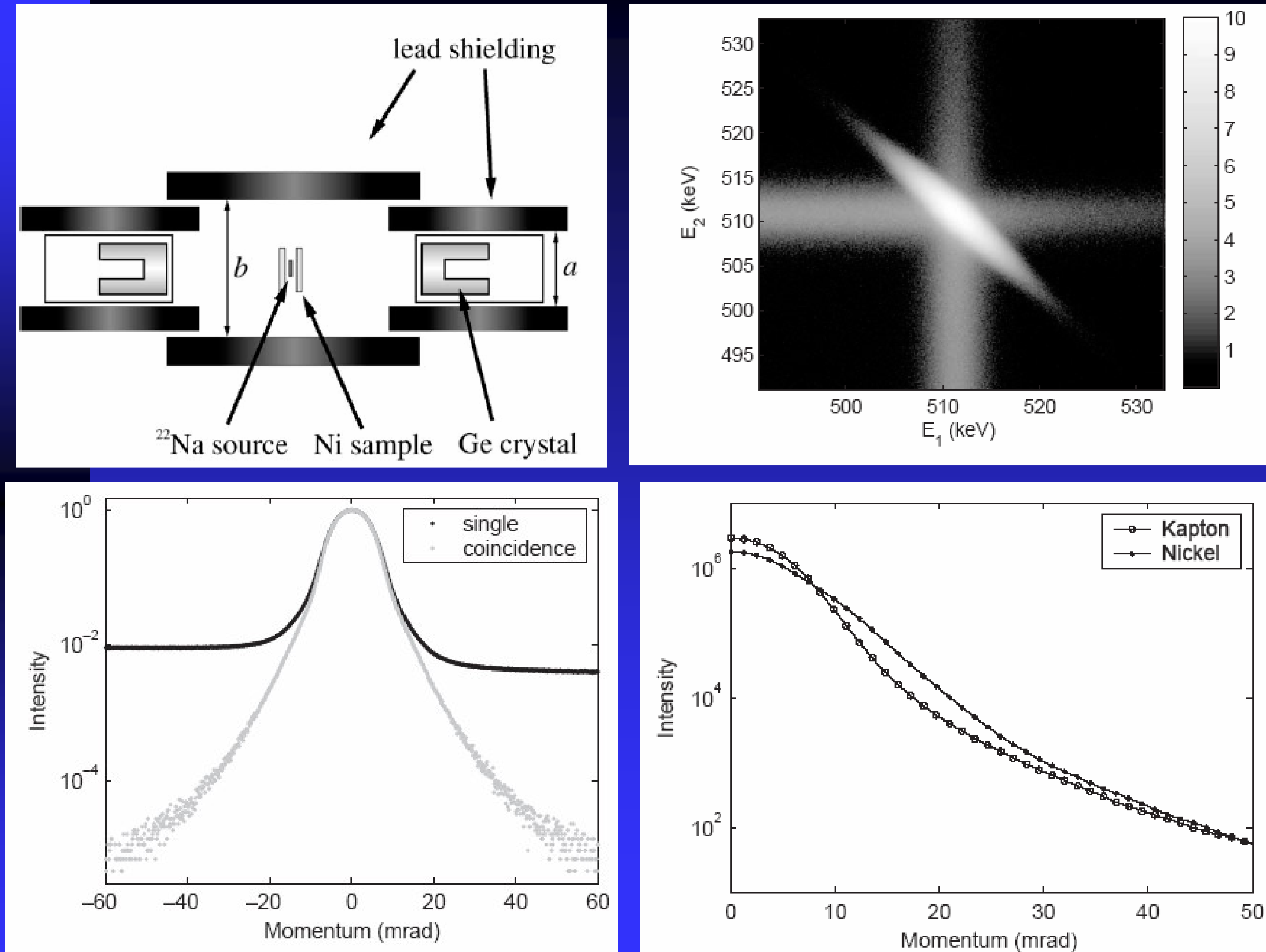
- The analysis software was written using LabView (National Instruments).
- The coincidence count rate varies between 300 and 500 CPS, depending on the thickness of the sample
- The overall cost of this setup is estimated at about 60,000 euro which is on average about 10–15% lower than a setup with a conventional multi-parameter system.





FWHM at the 1274 keV line as function of the input count rate for the setup with an ADC+amplifier combination compared to the setup with the DSP. The solid lines are guides for the eye.

Comparison of the throughput of a DSP and an ADC+amplifier combination as function of the input count rate.

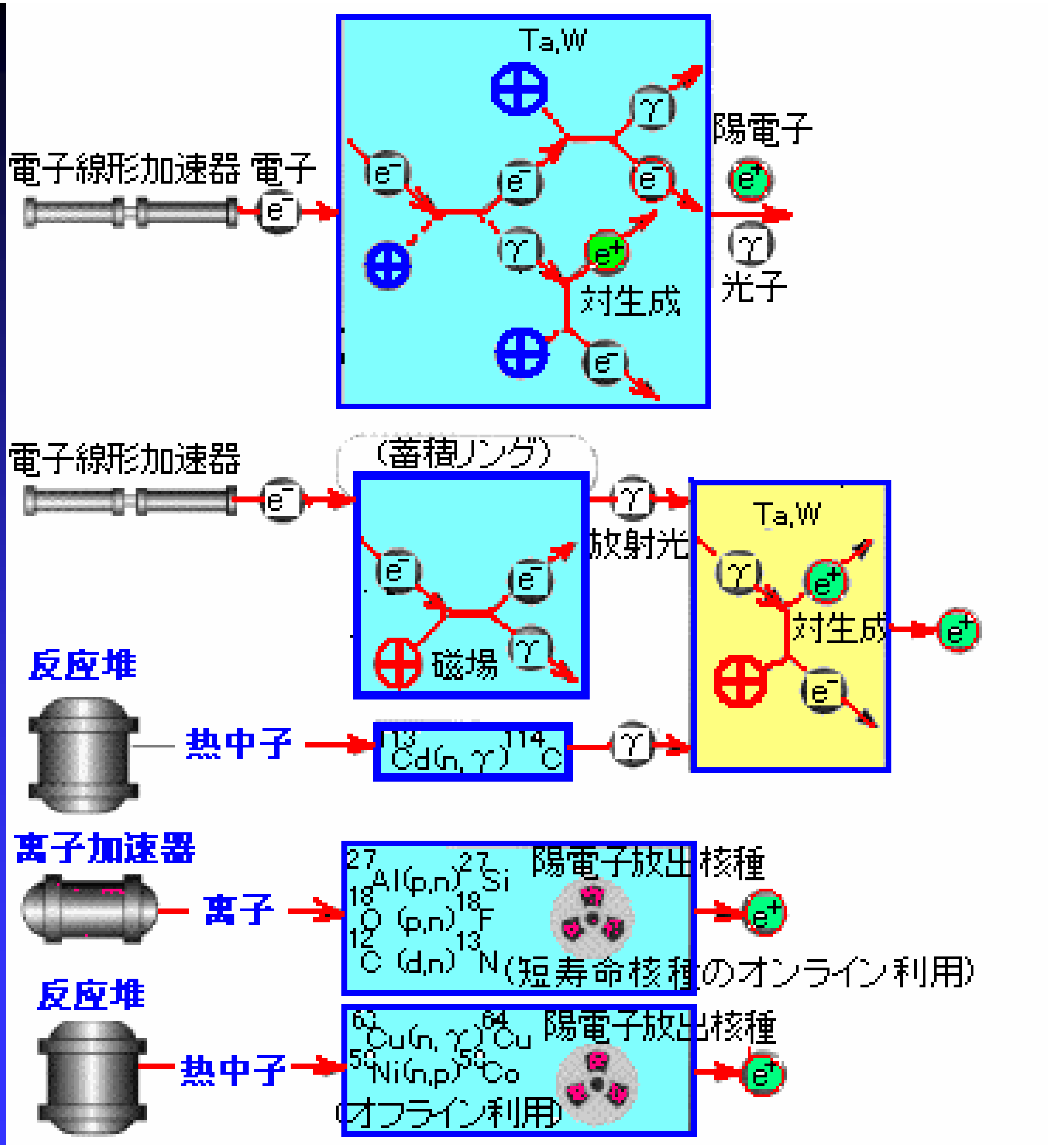

lead shielding
b
a
22Na source
Ni sample
Ge crystal
E2 (keV)
E1 (keV)
530
525
520
515
510
505
500
495
500
510
520
530
10
9
8
7
6
5
4
3
2
1
Intensity
Momentum (mrad)
single
coincidence
10^0
10^-2
10^-4
−60
−40
−20
0
20
40
60
Kapton
Nickel
10^6
10^4
10^2
0
10
20
30
40
50

2. 探测系统大型化和平台化

- EPOS (Germany)
- FRM-II (Germany)
- LLNL (USA)
- KEK (Japan)
- AISP (Japan)
- JLC(Japan-US)

世界高強度単色正电子束(10^{10}個/秒以上)規划

单位	产生方式	特征
日本原子力研究所高崎研究所（日本）	専用電子 Linac(100-150 MeV, 100 kW)→电子→Ta	◎専用施設
CEBAF（美国）	CEBAF(0.5-4 or 6 GeV, 200 μA, CW)→FEL 用分岐：電子(400 MeV, 1.0mA, 7.5MHz)	◎連続ビーム
ILL (Institut Laue-Langevin) （法国）	反应堆→热中子→Cd ボトル →^{113}Cd (n, γ)^{114}Cd→ γ	◎連続ビーム
INEL (Idaho National Engineering Lab.) （美国）	EBR II (高速中性子源炉)→ 10^{15}n/cm^2·s→^{58}Ni(n, p)^{58}Co → 2 か月で 10^{16}Bq の ^{58}Co(15 %β$^+$, 半減期 70.8d)→濃縮	◎偏極ビーム可、連続ビーム
ORNL (Oak Ridge National Lab.) （美国）	HFIR(高中性子束炉)→熱中性子 4×10^{14}n/cm^2·s→^{78}Kr+n(5 barn)→^{79}Kr(6.8%β$^+$, 半減期 35h)→コールドトラップ→β$^+$→固体氖→	◎偏極ビーム可、連続ビーム △断続的利用(4日間照射後4日間利
PSI (Paul Scherrer Institut) （瑞士）	回旋加速器(p: 20 MeV, 20 μA)→H$_2^{18}$O ターゲット (^{18}O (p, n)^{18}F)→^{18}F(100%β$^+$, 半減期 110min)→LiF を C 箔に蒸着→Taqqu コンバータ→低速陽電子(他に ^{79}Br(p, n)^{79}Kr)	◎偏極ビーム可、連続ビーム



Ta,W
電子線形加速器 電子
e⁻
陽電子
e⁺
γ
光子
対生成
電子線形加速器
(蓄積リング)
放射光
磁場
Ta,W
対生成
反应堆
热中子
$^{113}Cd(n,\gamma)^{114}Cd$
离子加速器
离子
$^{27}Al(p,n)^{27}Si$
$^{18}O\ (p,n)^{18}F$
$^{12}C\ (d,n)^{13}N$
陽電子放出核種
(短寿命核種のオンライン利用)
反应堆
热中子
$^{63}Cu(n,\gamma)^{64}Cu$
$^{58}Ni(n,p)^{58}Co$
陽電子放出核種
(オフライン利用)

EPOS

德国Halle大学

- means "**ELBE POsitron Source**" or "European Positron Source"
- ELBE = "**Electron Linac of high Brilliance and low Emittance**"
- will be an external facility of CMAT
- is especially dedicated to materials science
- will be a user-dedicated facility
- will be open for user groups

Main Features of EPOS

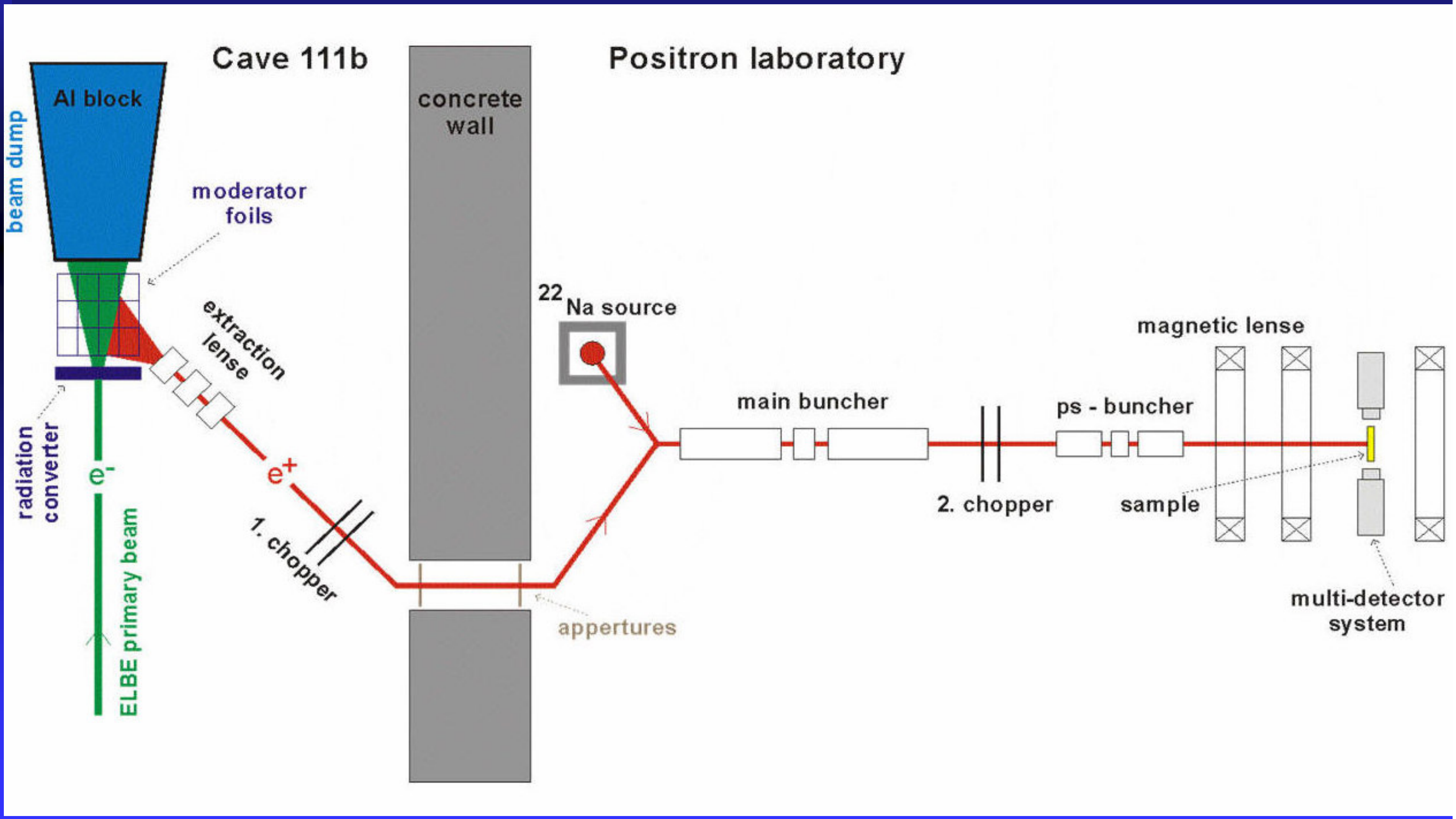
- EPOS will be the combination of a positron lifetime spectrometer, Doppler coincidence, and AMOC
- high quality data for optimum defect characterization
- Main features:
  - high-intensity bunched positron beam (E_+=1…30 keV)
  - repetition time 77ns (13 MHz), but also longer for positronium studies (lifetime > 100ns)
  - small beam diameter (25…50 μm), suitable for depth scans at beveled samples (wedge about 1°)
  - high quality spectra by using lifetime and Doppler coincidence spectroscopy
  - fast lifetime mode (single detector mode)
  - high count rate (> 3×10^5 s^{-1}) by multi-detector array (16 + 1 BaF_2 probes)
  - conventional source included for Doppler measurements (between periods of primary beam time; in continuous mode)
  - fully remote controlled via Internet by user (apart from sample change procedure etc.)

Potential Applications of EPOS

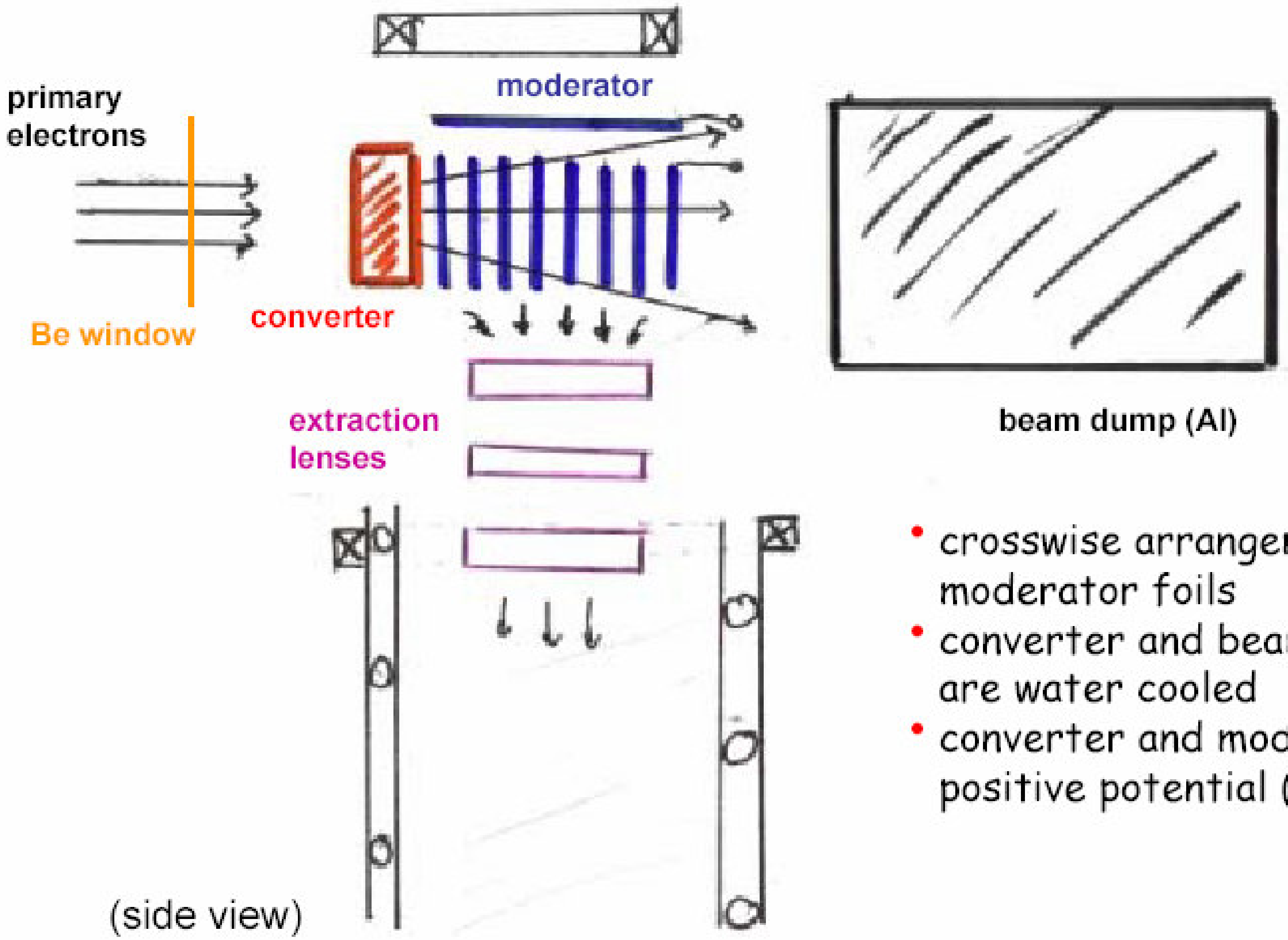
Variety of applications in field of materials science:

- defect-depth profiles due to surface modifications and ion implantation
- tribology (defects after mechanical damage of surfaces)
- polymer physics (pores; interdiffusion; ...)
- low-k materials (thin high porous layers for electronic devices)
- bulk defects in semiconductors, ceramics and metals
- epitaxial layers (growth defects, misfit defects at interface, ...)
- fast kinetics (e.g. precipitation processes in Al alloys; defect annealing; diffusion; ...)
- radiation resistance (e.g. space materials)
- many more ...

Cross Section of EPOS



Converter chamber

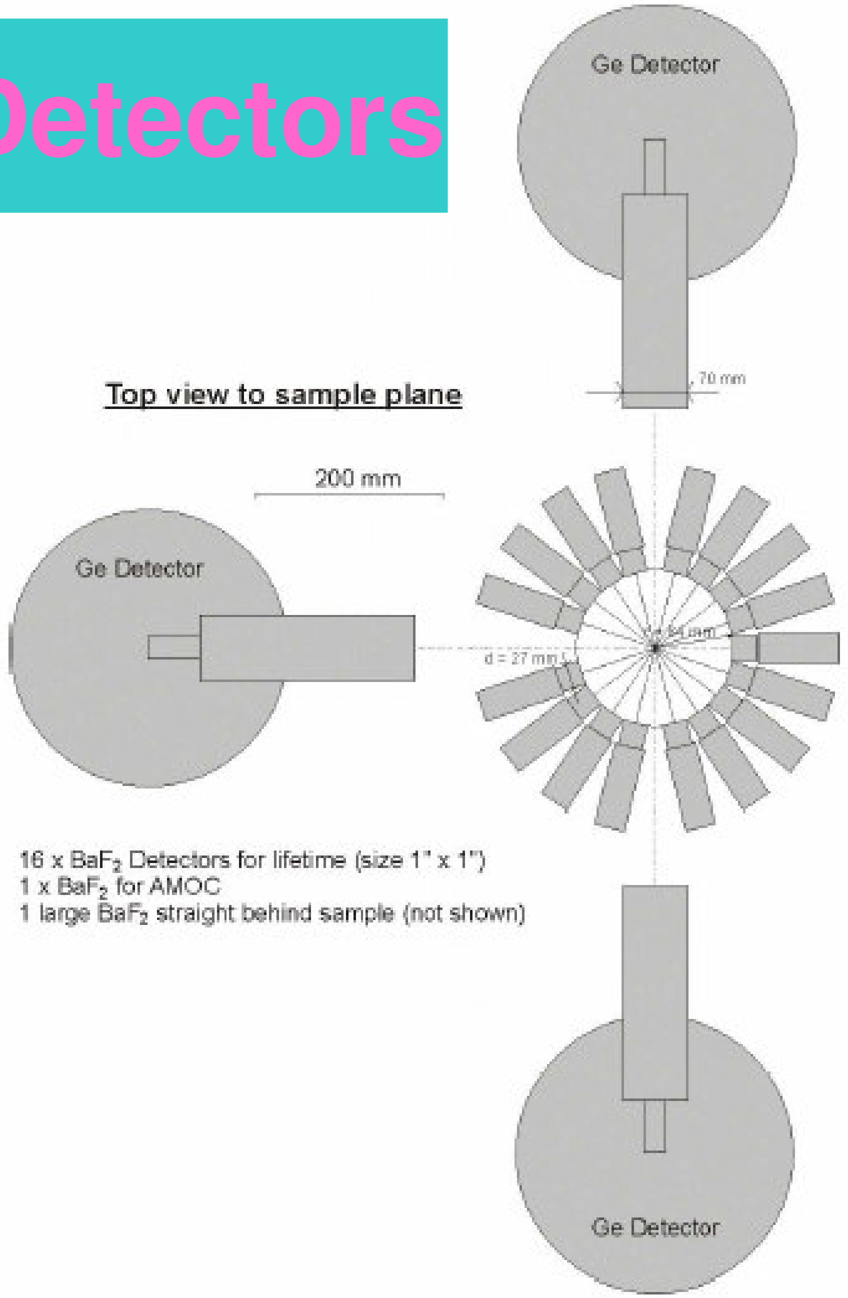


- crosswise arrangement of moderator foils
- converter and beam dump are water cooled
- converter and moderator at positive potential (2...5 kV)

Positron Lab.

Detectors

- **3 experiments**: lifetime spectroscopy (16 BaF_2 detectors); Doppler coincidence (2 *Ge* detectors), and *AMOC* (1 *Ge* and 1 BaF_2 detector)
- arrangement of all detectors in a plane
- for 1" x 1" BaF_2: minimum radius about 100 mm (magnetic shielding for tubes required)
- one **large extra BaF_2** behind the sample for detection with high counting rate (no coincidence possible)
- advantages of **digital detection system**:
  - lifetime: almost nothing to adjust; time scale exactly the same for all detectors; easy realization of coincidence
  - Doppler: better energy resolution and pile-up rejection expected
- disadvantage: large number of data; speed ?



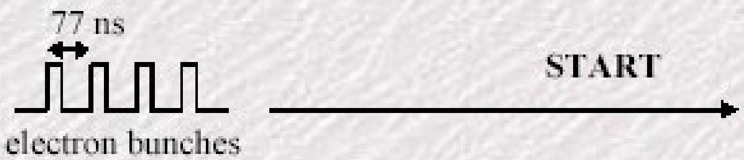
16 x BaF_2 Detectors for lifetime (size 1" x 1")
1 x BaF_2 for AMOC
1 large BaF_2 straight behind sample (not shown)

Experimental techniques

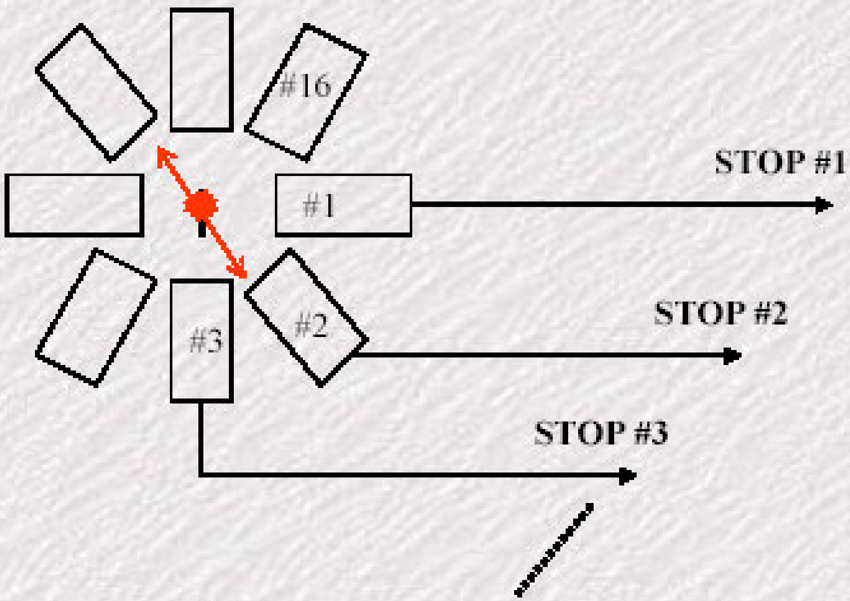
- ▶ positron lifetime spectroscopy
  - type and density of defects
- ▶ 2D Doppler broadening spectroscopy
  - chemical surrounding of defects
- ▶ age momentum correlation
  - correlation between electron momentum and open volume

→ as a function of depth

Positron Lifetime Spectroscopy



16 detectors (fast scintillator + PMT)



Selection of scintillator

1. BaF_2 scintillator $Z_{eff} = 24.7$

Fast component: $\lambda_1 = 220$ nm, $\tau = 0.6$ ns
Slow component: $\lambda_2 = 310$ nm, $\tau = 630$ ns → high count rates: "almost continuous" current, pile ups of slow pulses

? possible solution ?
↓
thin foil filter for λ_2 on BaF_2 scintillator

Relative light output (NaI(Tl) = 100%): 10% (fast)
37% (slow)

2. plastic scintillators $Z_{eff} = 3.4$

	λ max. emiss. (nm)	decay const. (ns)	relative light output (NaI(Tl) = 100%)
Pilot U:	391	1.36	29
NE111A:	370	1.6	24

γ-rays interactions: photoelectric effect ~ Z^5 → for BaF_2 higher by factor 2×10^4
Compton effect ~ Z → comparable

Selection of PMT

	Philips	HAMAMATSU		
Type	XP2020 Head-on	H3378-50 Head-on	R7400U-09 Metal package	R3809U-57 MCP-PMT
photocath. diameter (mm)	BA 51.0	BA 51.0	Cs-Te 11.0	Cs-Te 11.0
window range (nm) peak λ (nm) quant. eff.	fused silica 160-650 420 0.25	fused silica 160-650 420 0.24	fused silica 160-320 240 0.11	MgF_2 115-320 230 0.11
voltage (V) gain	3000 3×10^7	3000 2.5×10^6	800 5×10^4	-3000 2×10^5
rise time (ns) transit time (ns) TTS (ps)	1.4 28 ~200	0.7 16 370	0.78 5.4 ~100	0.15 0.55 25
cost (EUR)	1000	3650	700	15000

Estimation of anode current

luminous sensitivity ~ 10 μA/lmCB ⇔ 0.3 pe^-/keV → N_{pe} = 150 pe^- for 512 keV (*fast component:*)

1 pe^-/keV → N_{pe} = 500 pe^- for 512 keV (*slow component:*)

count rate: $c = 3 \times 10^5\ s^{-1}$

cathode current : $I_{cath} = e\, N_{pe} c \approx 30$ pA

anode current : $I_{anode} = I_{cath}\, g$ ← gain

Hamamatsu H3378-50: $g = 2.5 \times 10^6 \Rightarrow I_{anode} \approx 0.08$ mA

Maximum ratings: $I_{anode}^{max} = 0.2$ mA

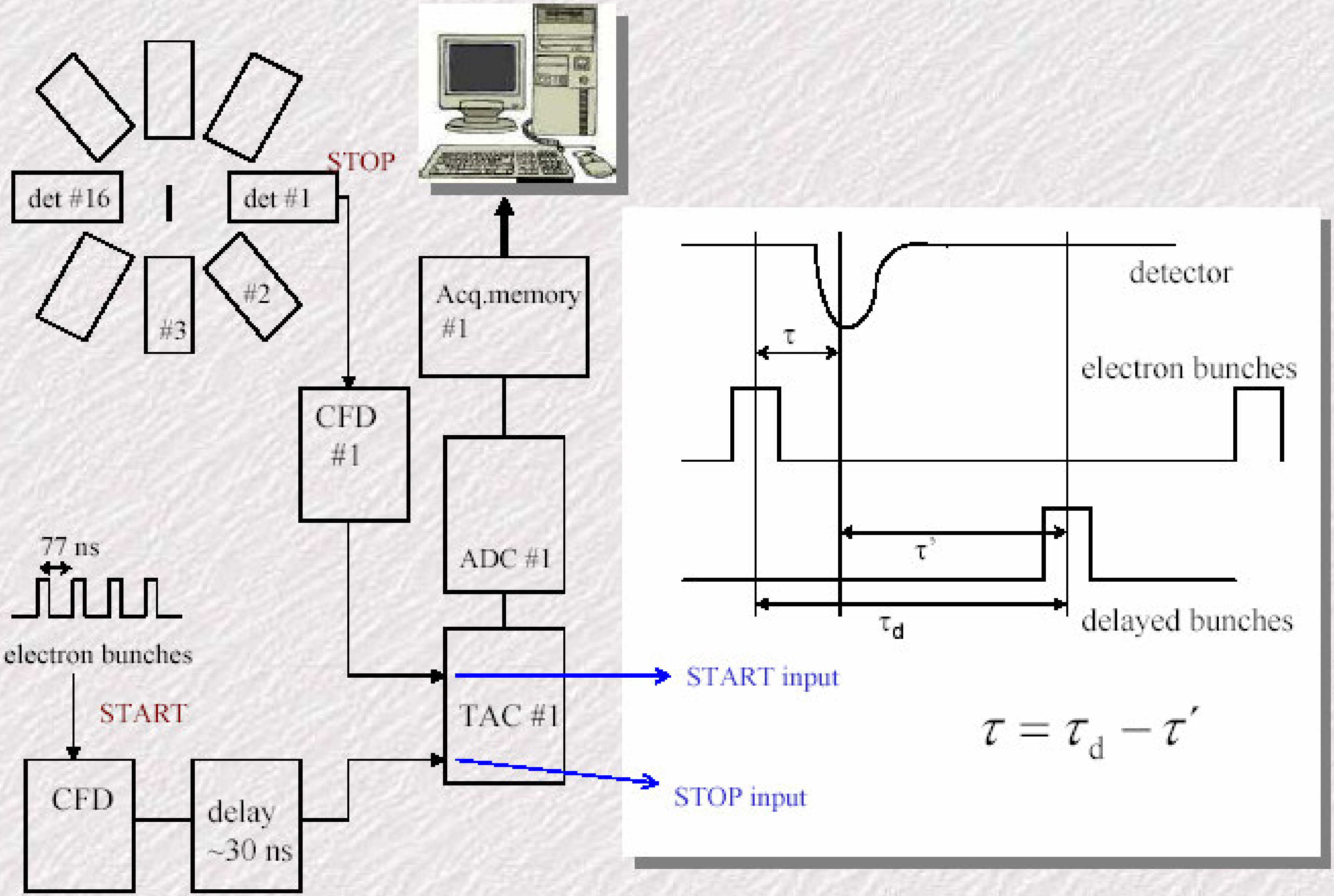
Hamamatsu R7400U-09: $g = 5 \times 10^4 \Rightarrow I_{anode} \approx 1.5\ \mu A$

Maximum ratings: $I_{anode}^{max} = 10\ \mu A$

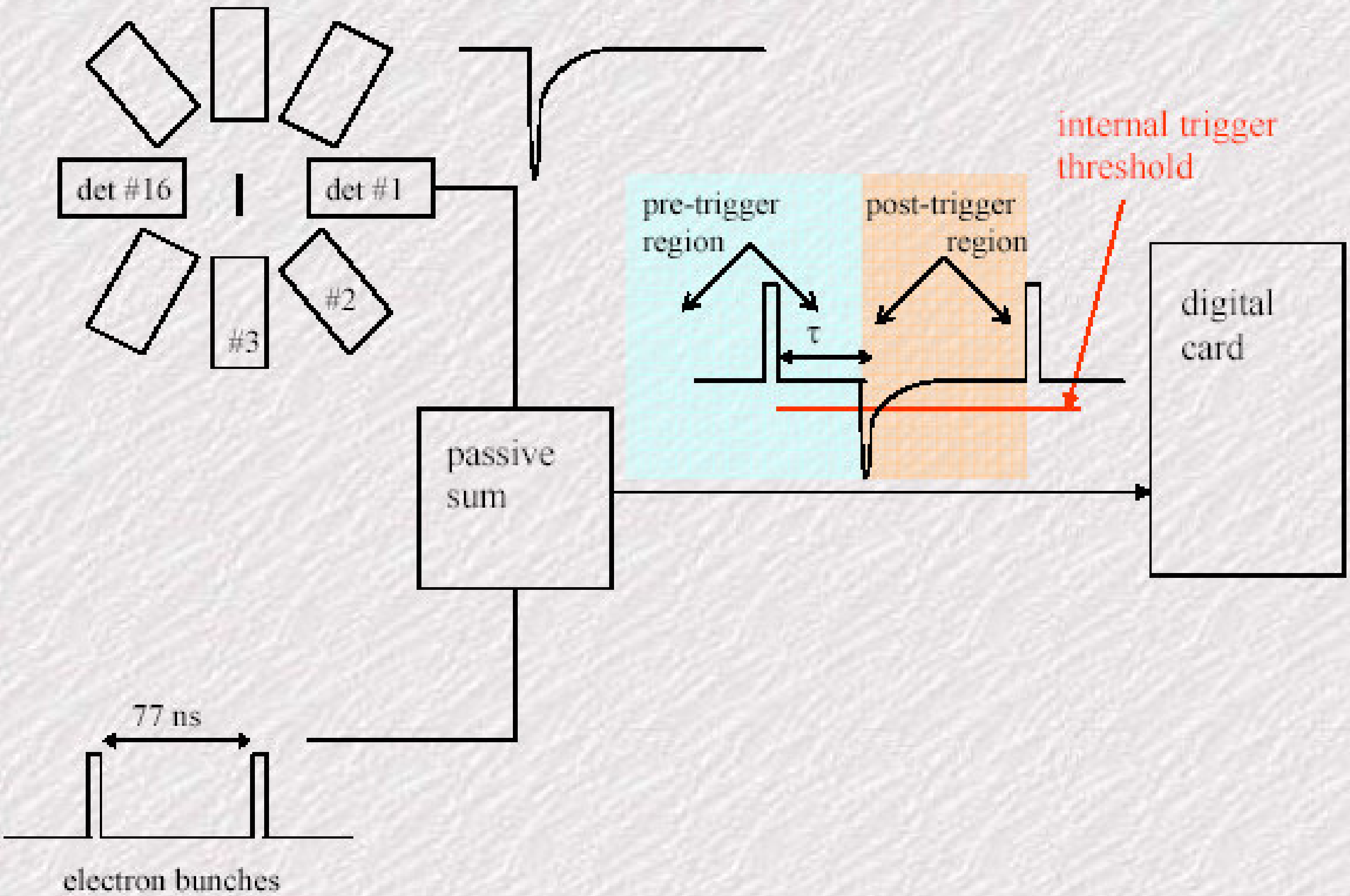
Philips XP2020/Q: $g = 3 \times 10^7 \Rightarrow I_{anode} \approx 0.9$ mA

Maximum ratings: $I_{anode}^{max} = 0.2$ mA

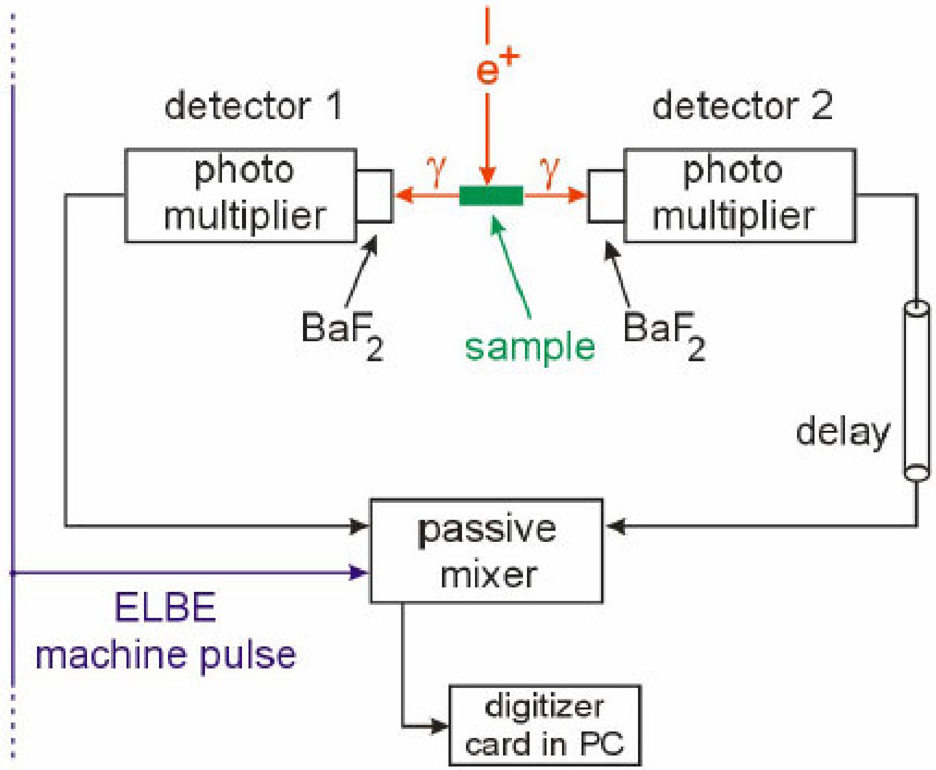
Timing electronics   1. Analog NIM devices

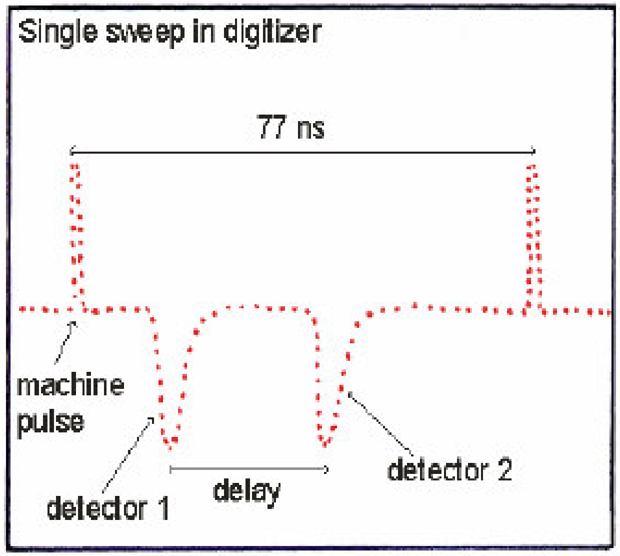


Positron lifetime measurement with digital cards



Digital Lifetime Spectroscopy

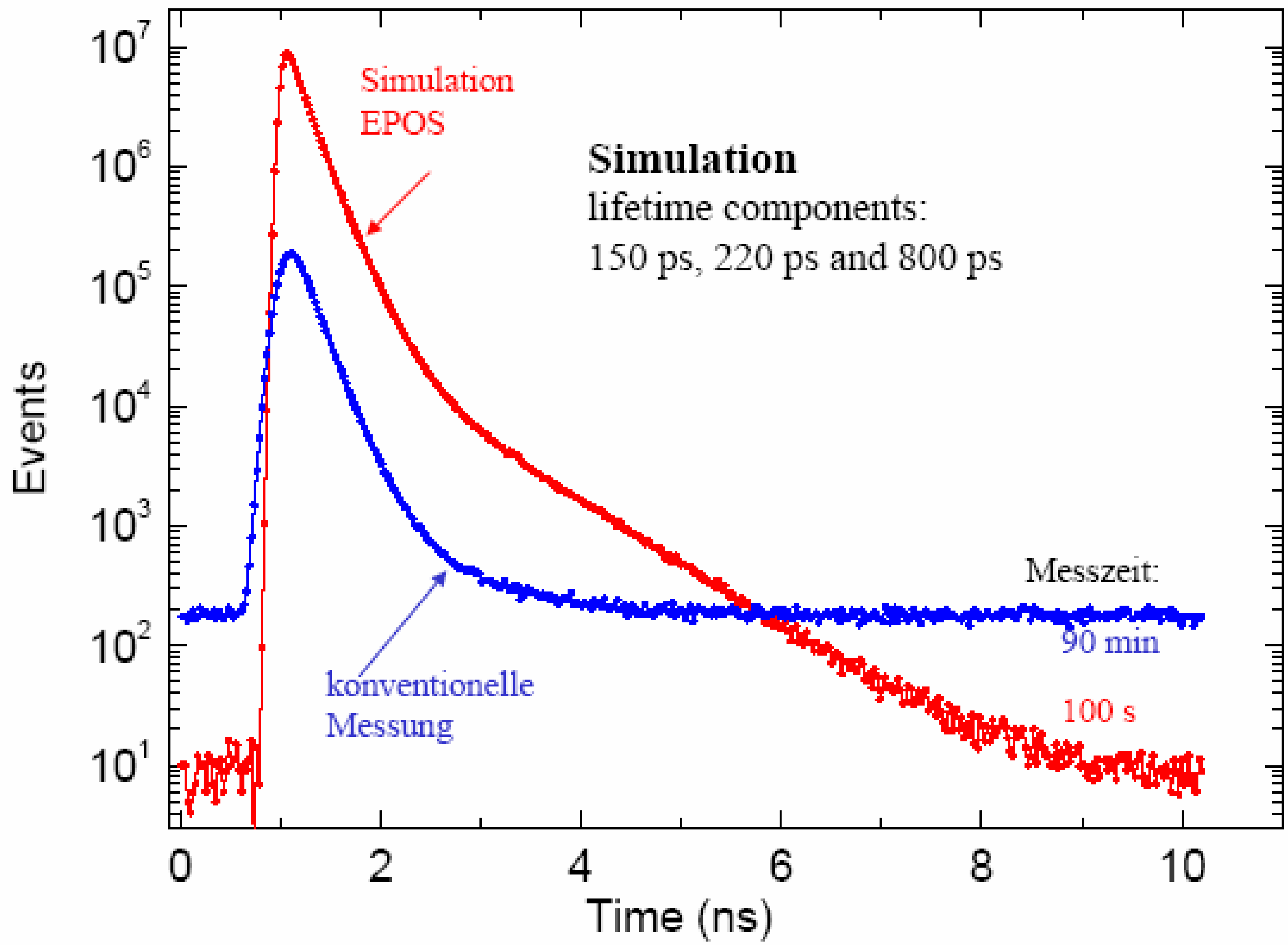


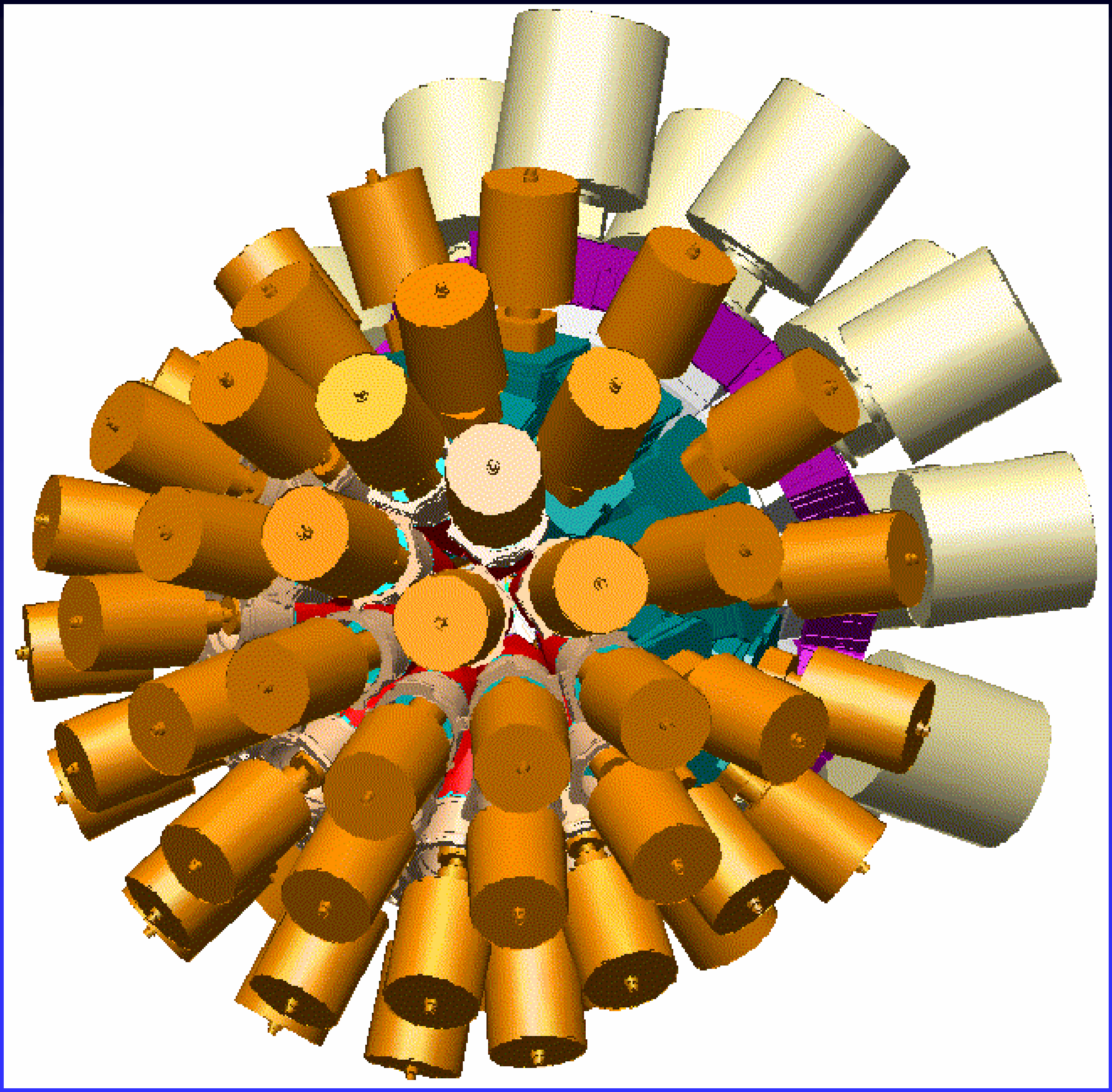


Digitizer:

- > 1 GHz analog band width
- Sample-Rate 2...5 GS/s

- due to coincident lifetime measurement: quality of spectra will be improved

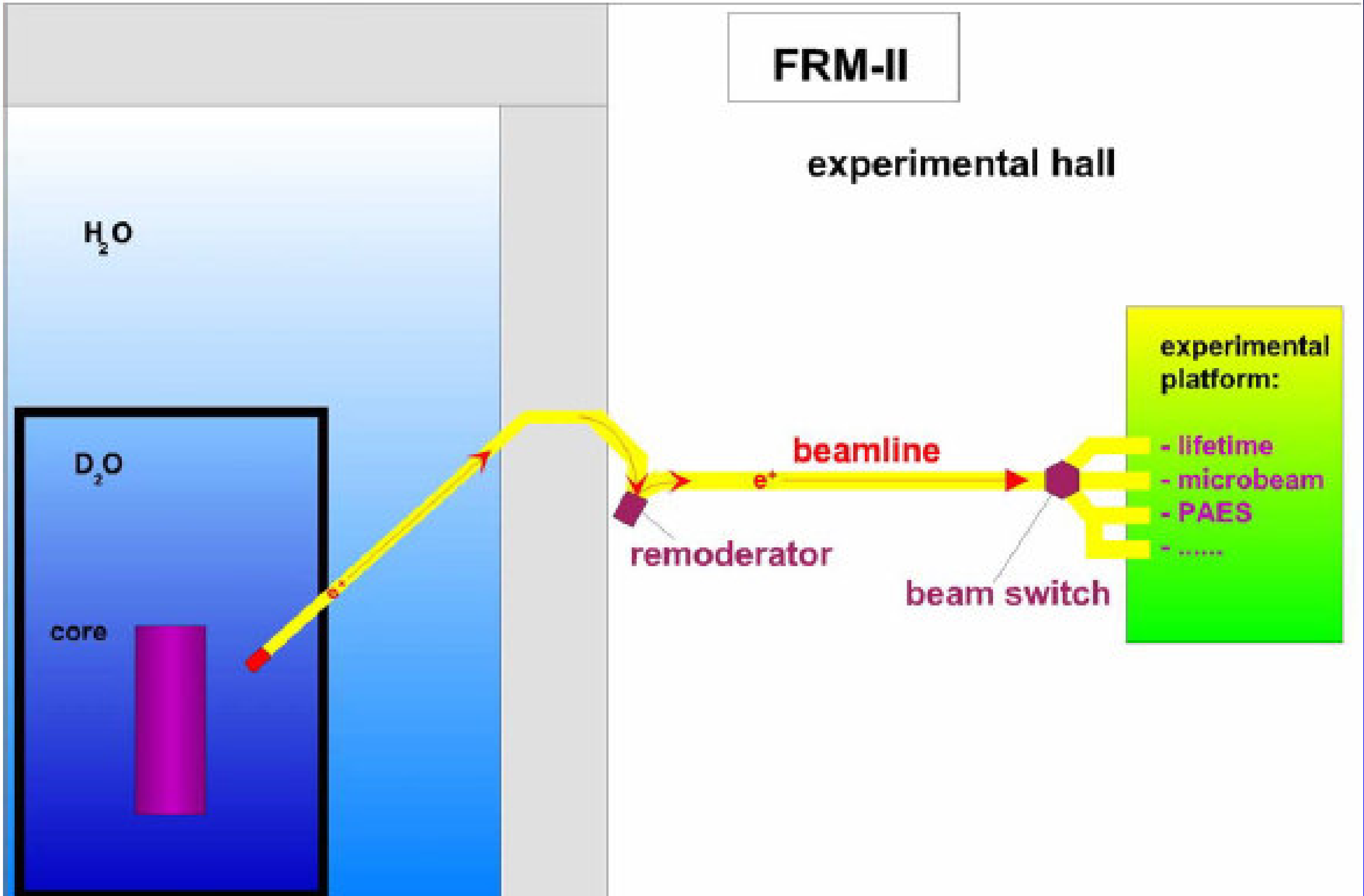




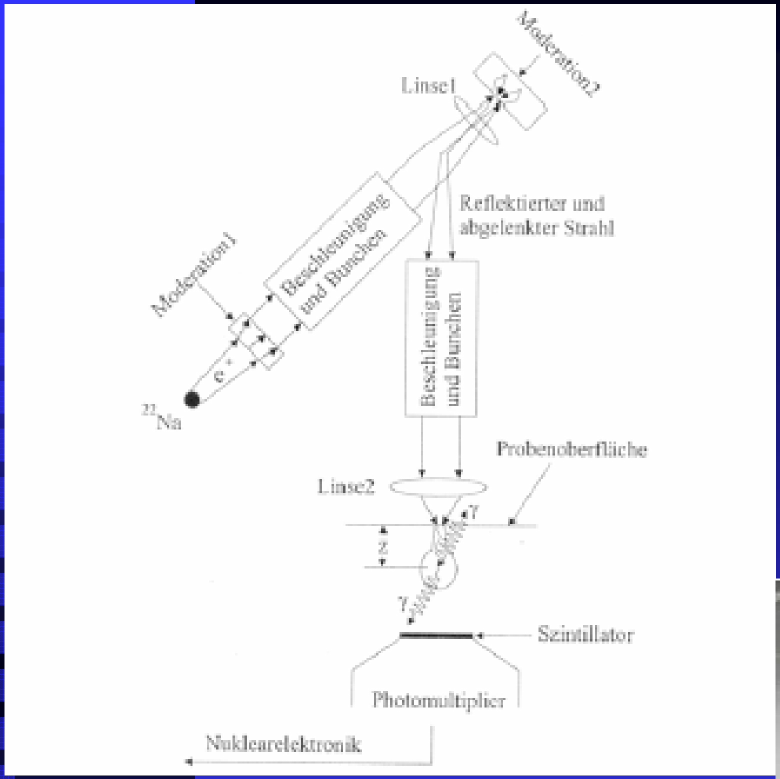
德国Technische Universität München

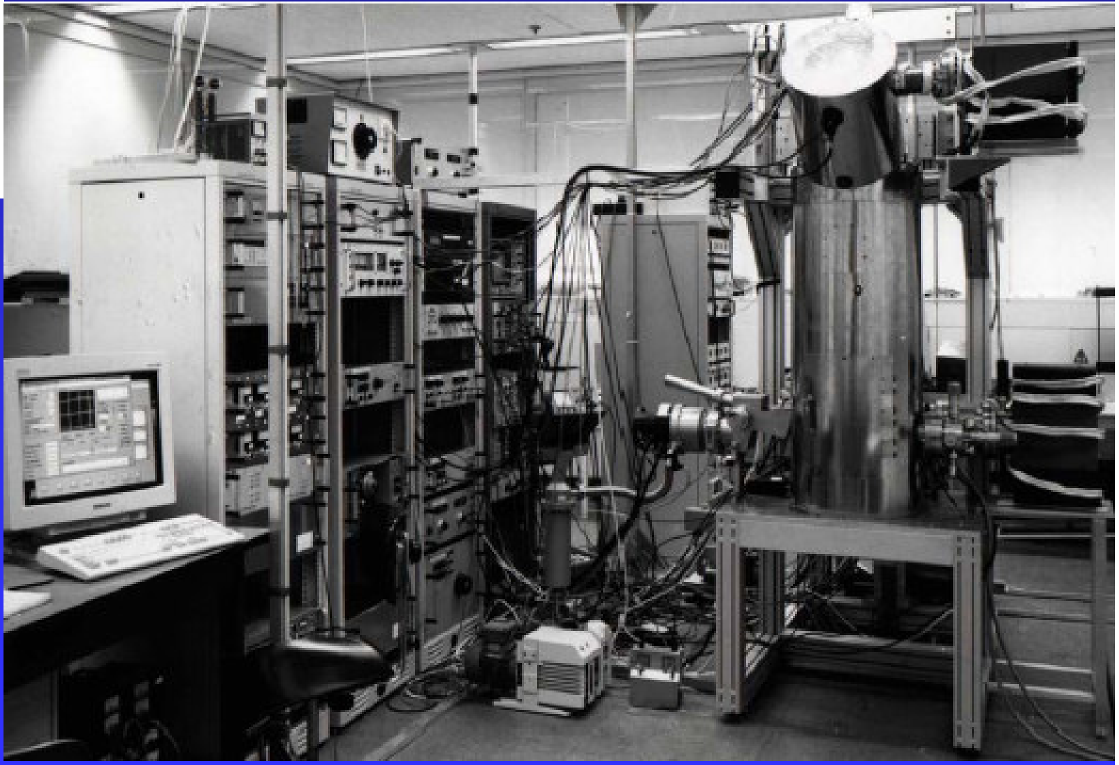
- Scanning microbeam
- PAES
- ACAR
- 2D-Doppler
- PAS
- AMOC

Positron Beam Facility at FRM-II

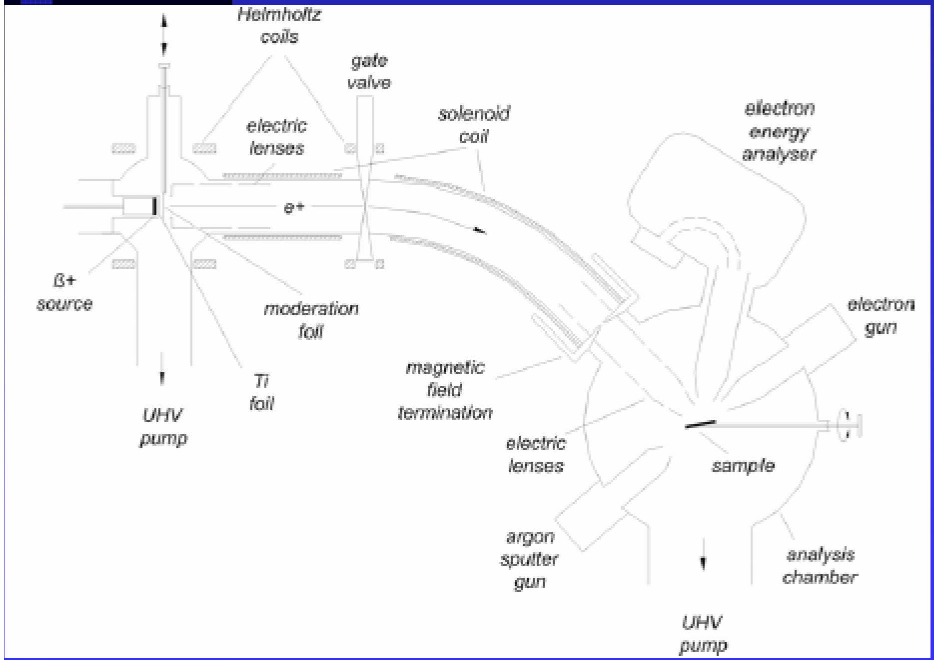


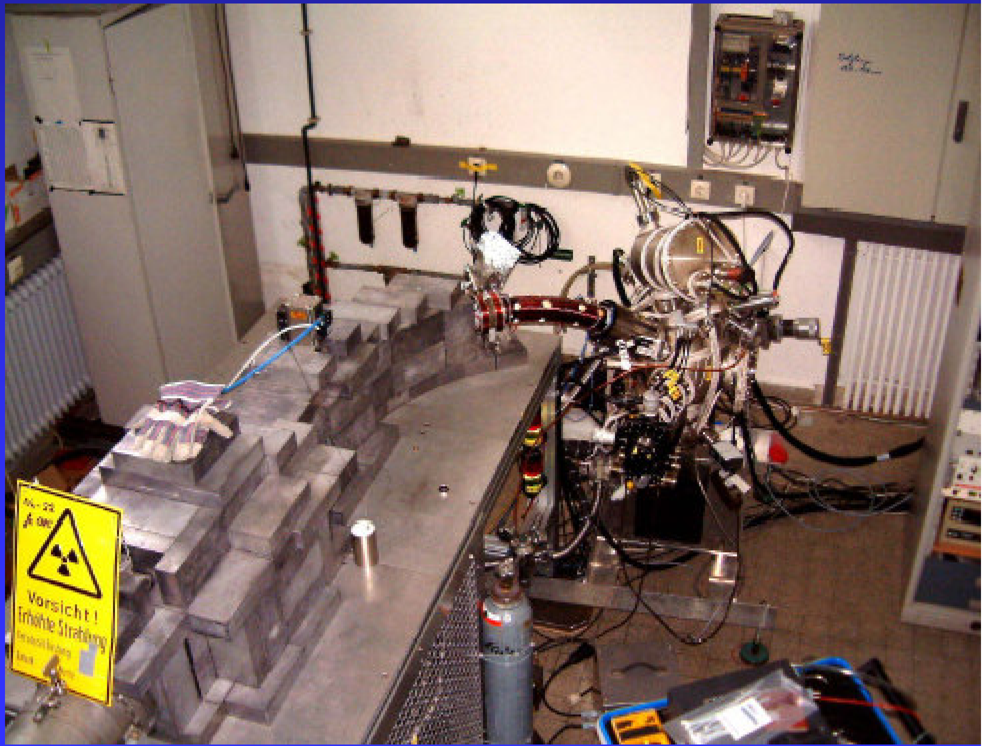
Scan Positron Microbeam





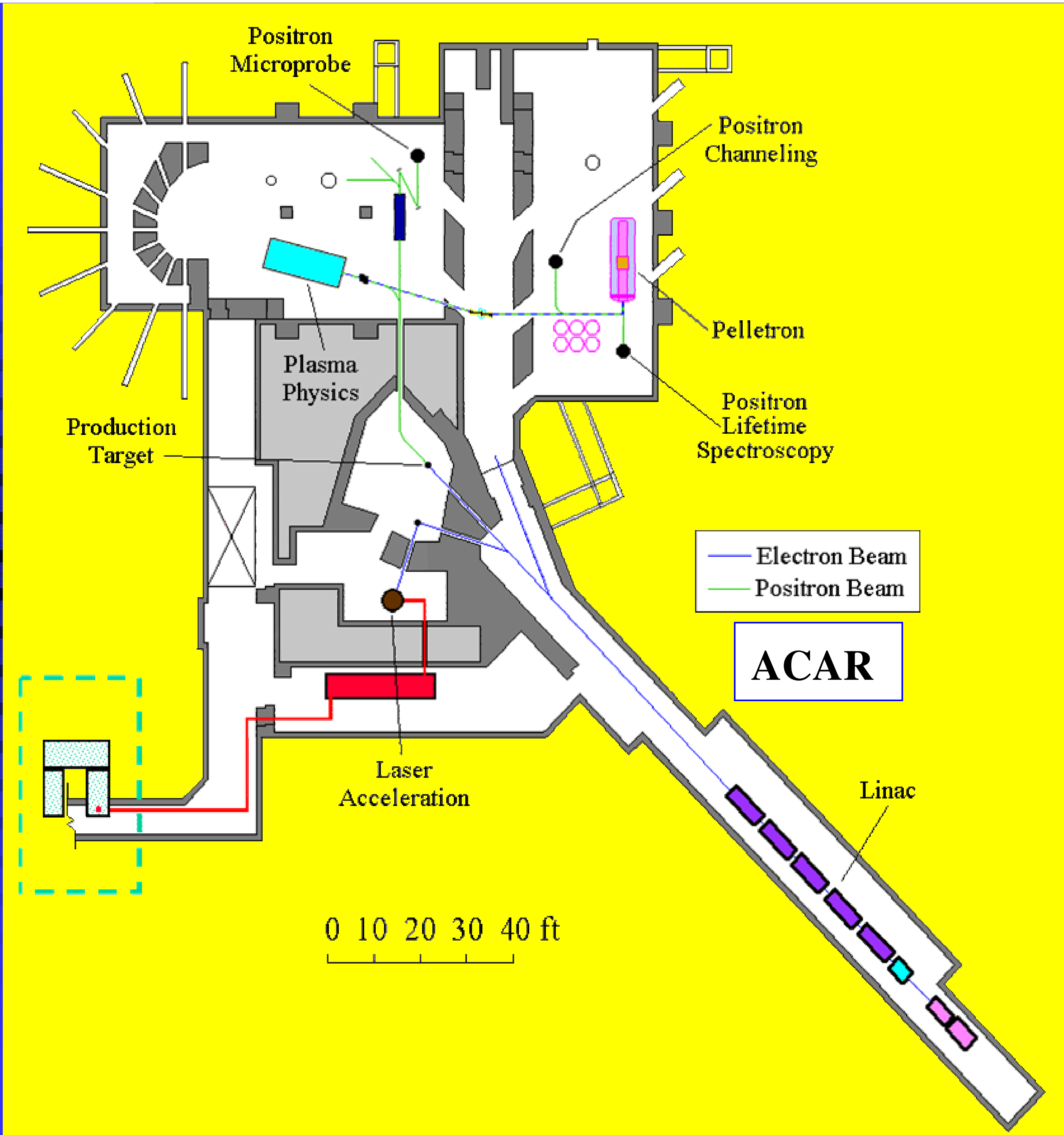
PEAS


Helmholtz coils
gate valve
solenoid coil
electric lenses
electron energy analyser
e+
ß+ source
moderation foil
electron gun
magnetic field termination
Ti foil
UHV pump
electric lenses
sample
argon sputter gun
analysis chamber
UHV pump


Vorsicht!
Erhöhte Strahlung

Positron in UAS

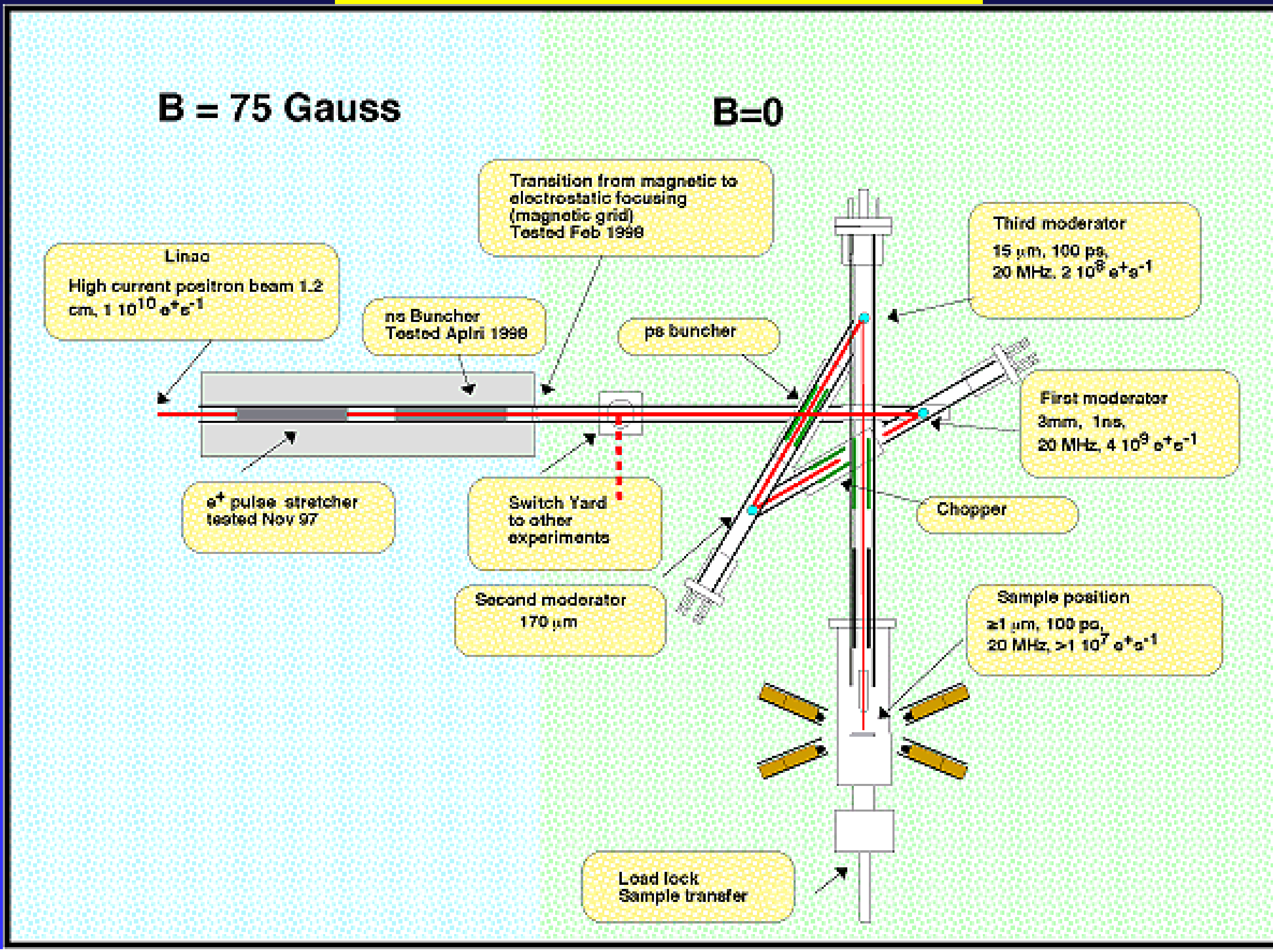
- LLNL
- Univ. of Michigen
- Brandeis Univ.
- University of Missouri - Kansas City



LLNL

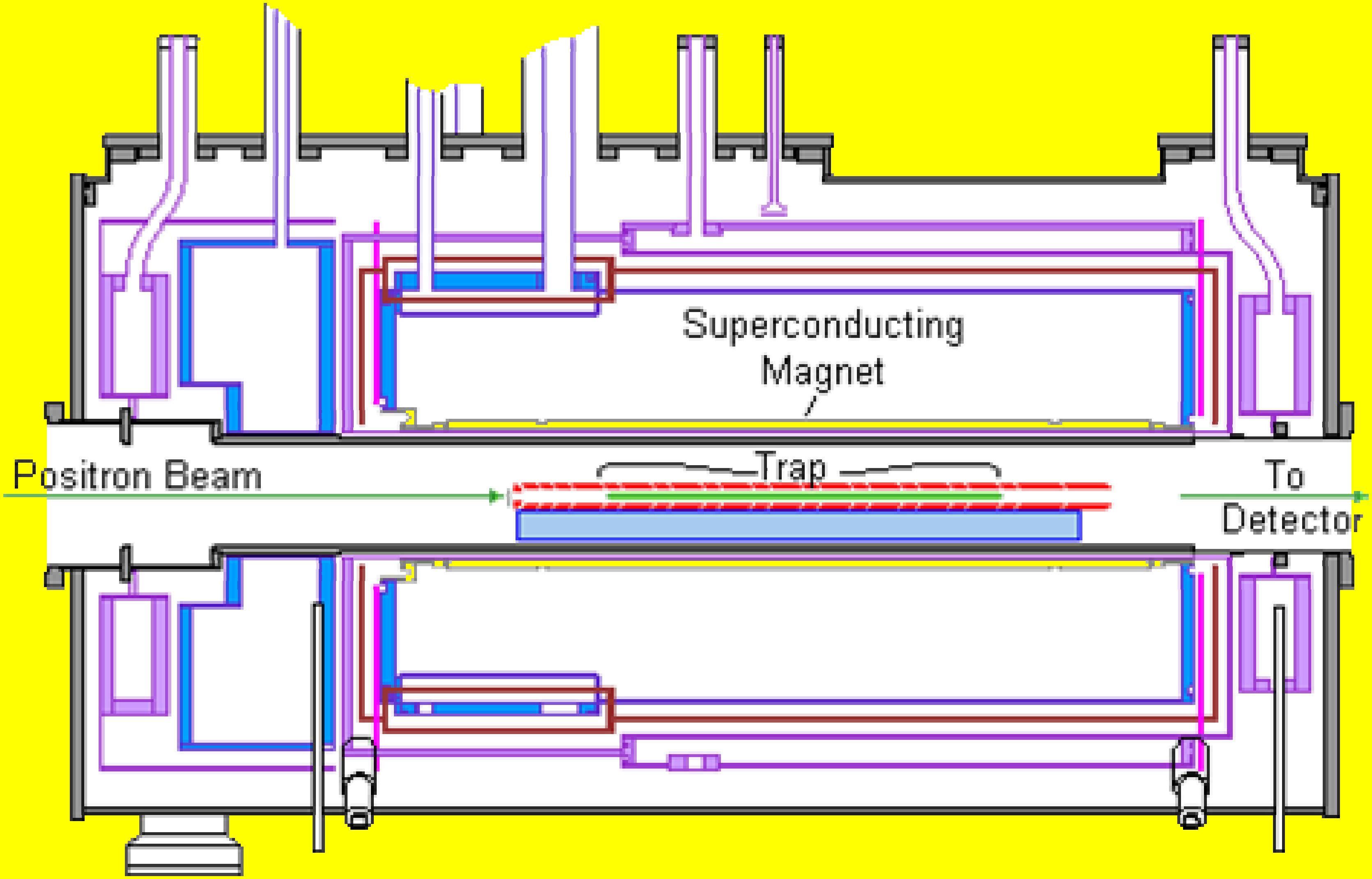
PAS
ACAR
Microprobe
Trap

Microbeam



B = 75 Gauss
B=0
Transition from magnetic to electrostatic focusing (magnetic grid) Tested Feb 1998
Linac
High current positron beam 1.2 cm, 1 10^10 e+s-1
ns Buncher Tested Aplri 1998
ps buncher
Third moderator
15 μm, 100 ps, 20 MHz, 2 10^8 e+s-1
First moderator
3mm, 1ns, 20 MHz, 4 10^9 e+s-1
Chopper
e+ pulse stretcher tested Nov 97
Switch Yard to other experiments
Second moderator 170 μm
Sample position
≥1 μm, 100 ps, 20 MHz, >1 10^7 e+s-1
Load lock Sample transfer

Positron Trap



Positron in Japan

- AIST
- KEK
- JAERI
- University of Tokyo
- Spring 8

Positron research in AIST

National Institute of Advanced Industrial Science and Technology
AIST

RI of Instrumentation Frontier

Electron Linac

Development of Next Generation e+ beam

Pulsed e+ Beam

PALS, • Ð-PALS, DBAR, AMOC, TOF-PAES, TOF-Ps, LCS-PAS

AIST

Industries

Development of ^{22}Na-based Pulsed e+ beam for PALS

Standard Samples

Universities

^{22}Na based e+ beam DBAR

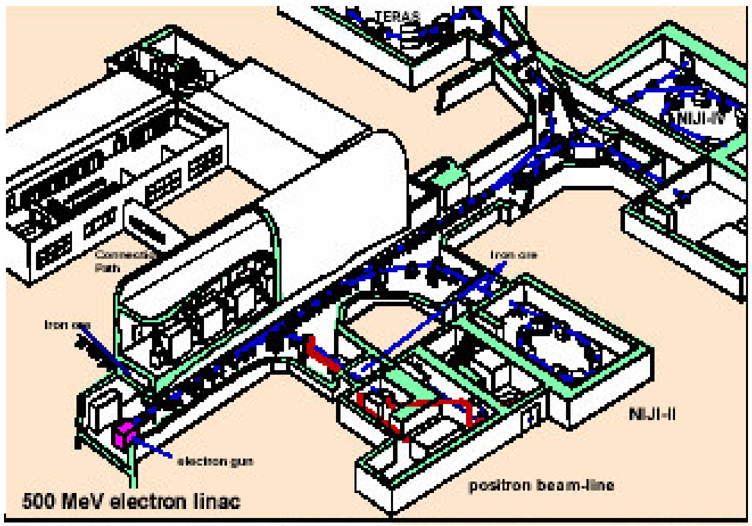
Conventional Techniques

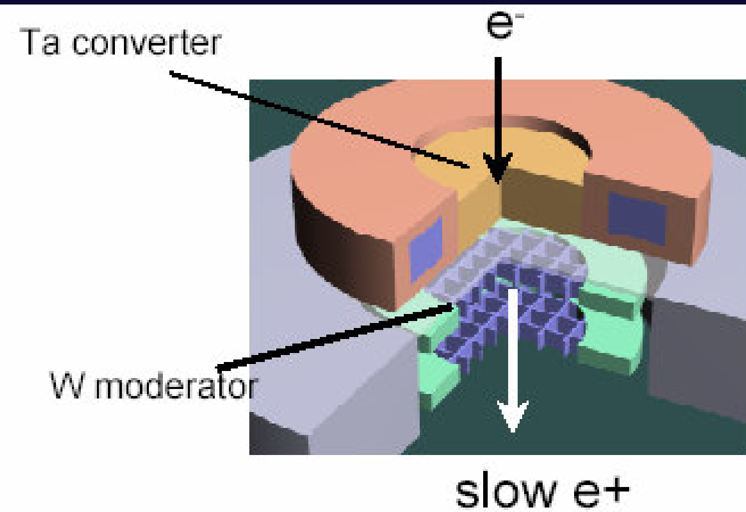
Theoretical Calculation

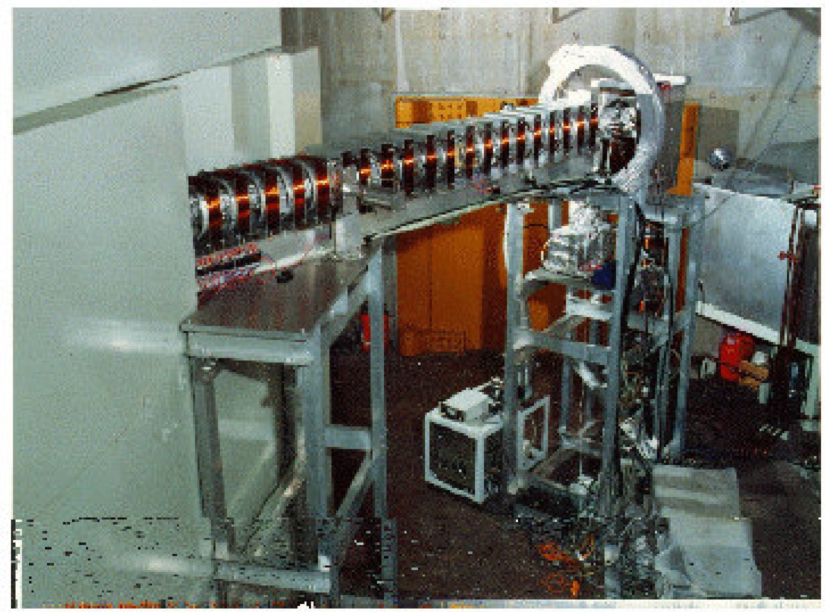
Other RI's

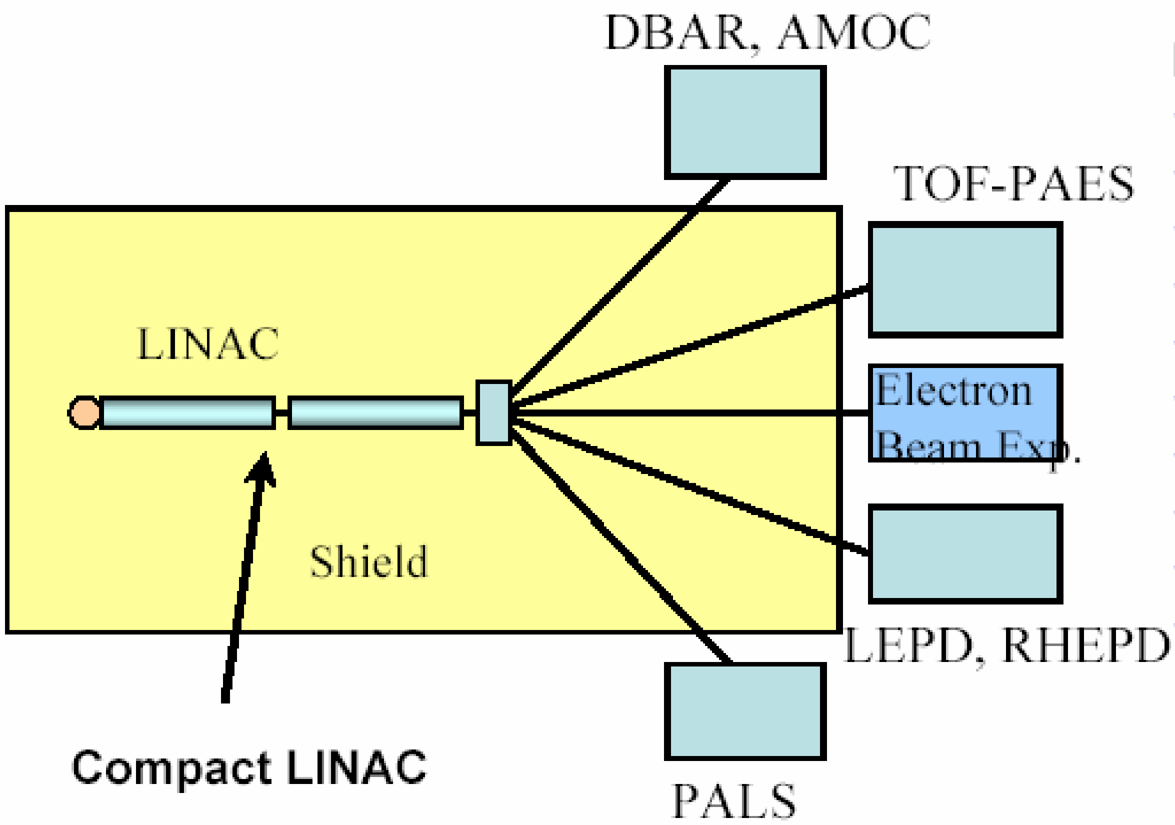
RI of National Standards

RI of Comp. Science


TERAS
NIJI-IV
electron gun
500 MeV electron linac
positron beam-line
NIJI-II


Ta converter
e-
W moderator
slow e+





Measurement Techniques

- PALS
- DBAR
- AMOC
- ACAR
- TOF-PAES
- LEPD
- RHEPD
- Ps· TOF
- Positron induced Desorption
- Positron Microprobe

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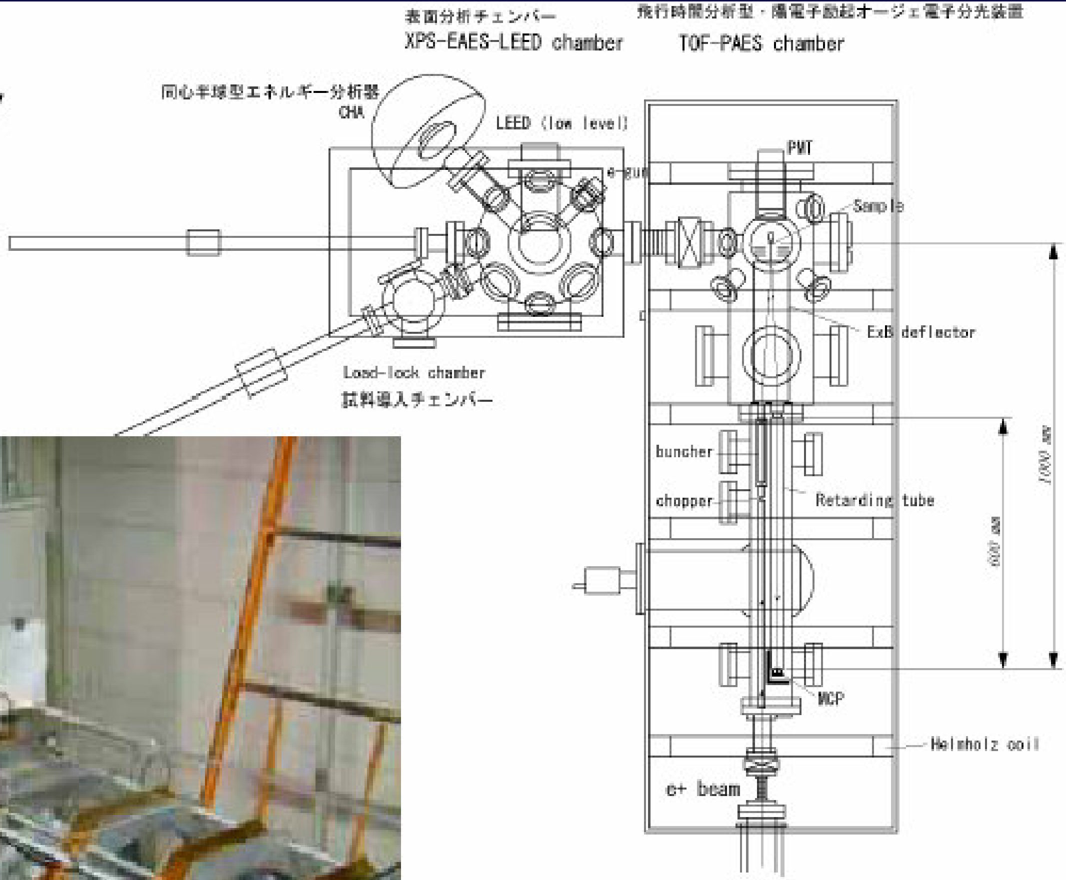
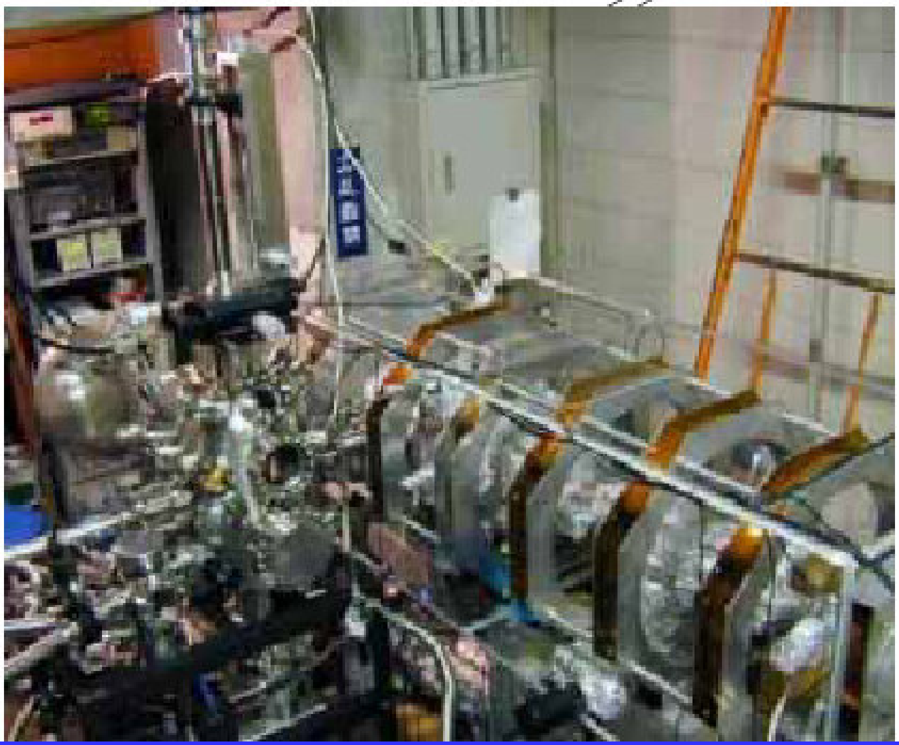
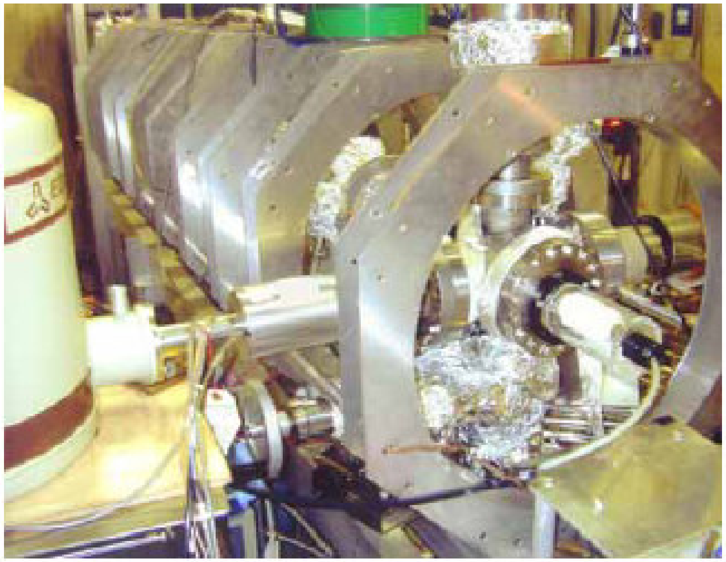
PEAS

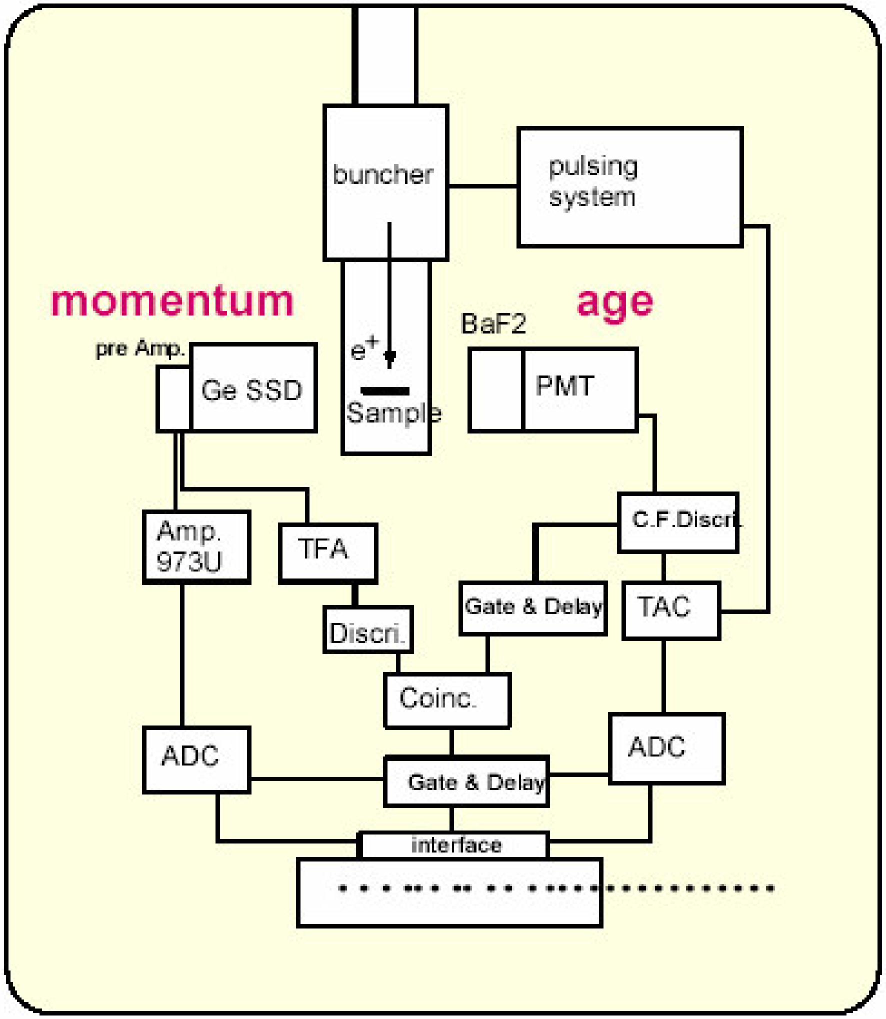
Energy spectra of Auger electrons are measured by Time-of-Flight with pulsed positrons





AMOC measurement system



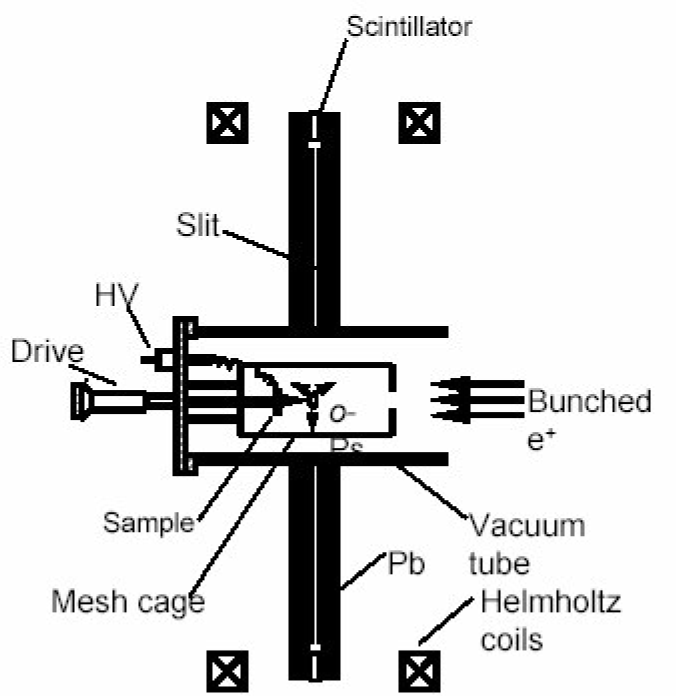


detector: SSD efficiency 60%
• • • • •BaF_2 50 mm X 50 mm• (truncated)

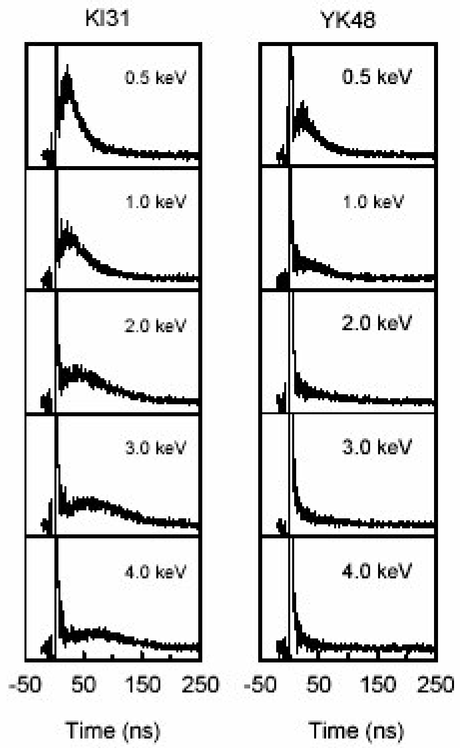
detector-sample distance: ~8 cm

resolution: • 250 ps , 1.3• 1.5 keV
e^+ energy: 0.5 keV – 25 keV
coincidence count rate (511 peak): 1,200 cps
@130 ns pulse interval

Ps-TOF

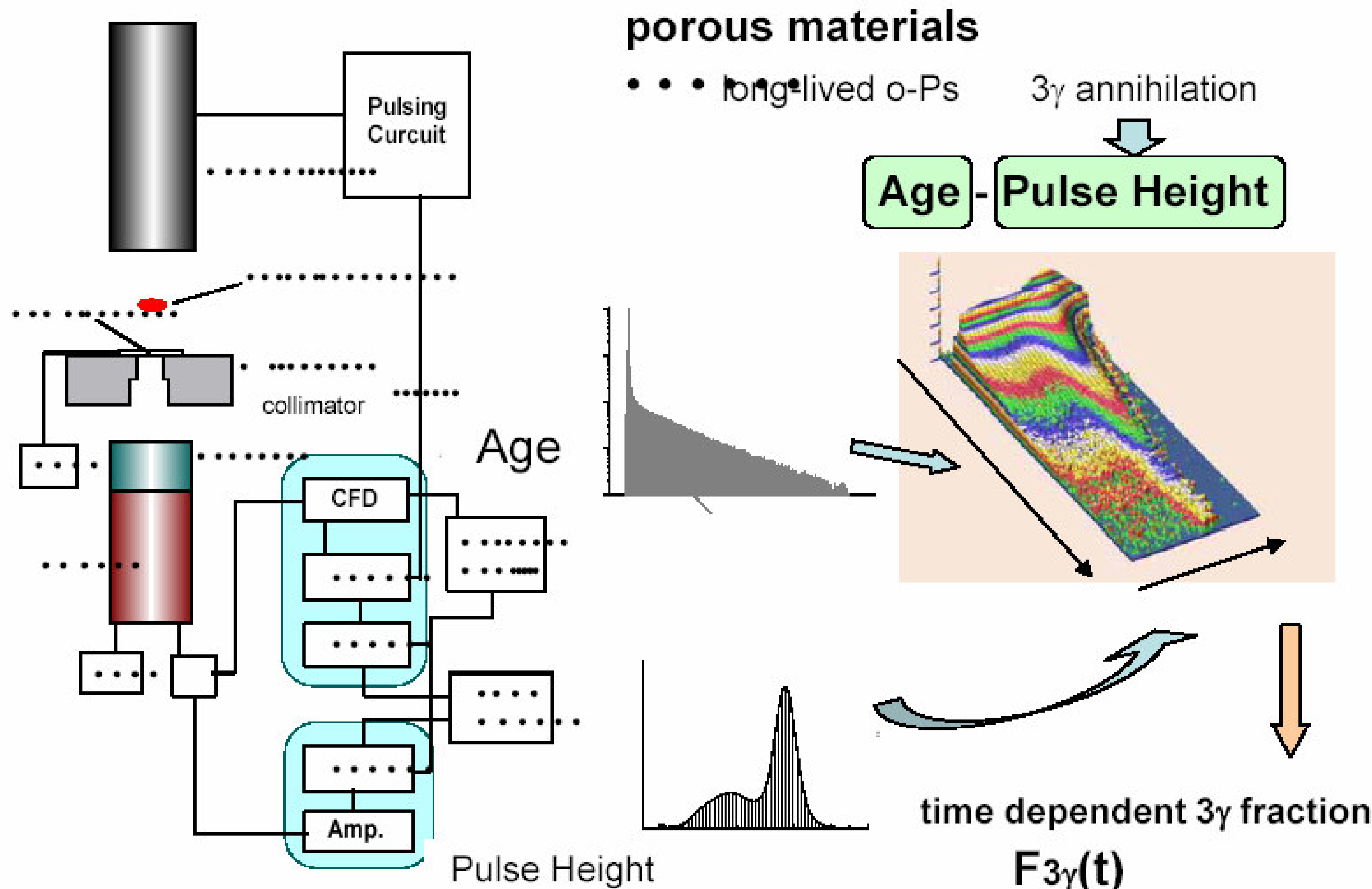


Positronium time-of-flight measurement system



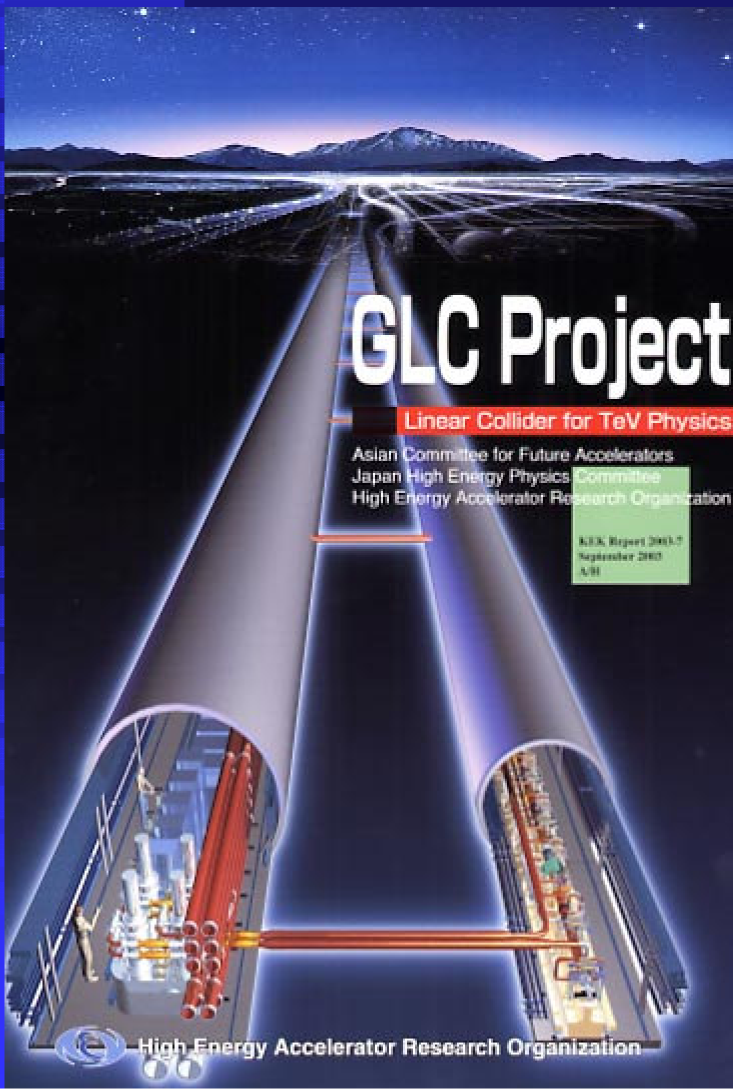
TOF spectra for KI31 and YK48 measured at a fixed o-Ps flight length z = 10 mm after corrections for the effects of background and o-Ps intrinsic decay as well as time spent by o-Ps in the view of the detectors. The incident positron energy was varied from 0.5 to 4.0 keV.

2D(Age - Pulse Height)-PALS



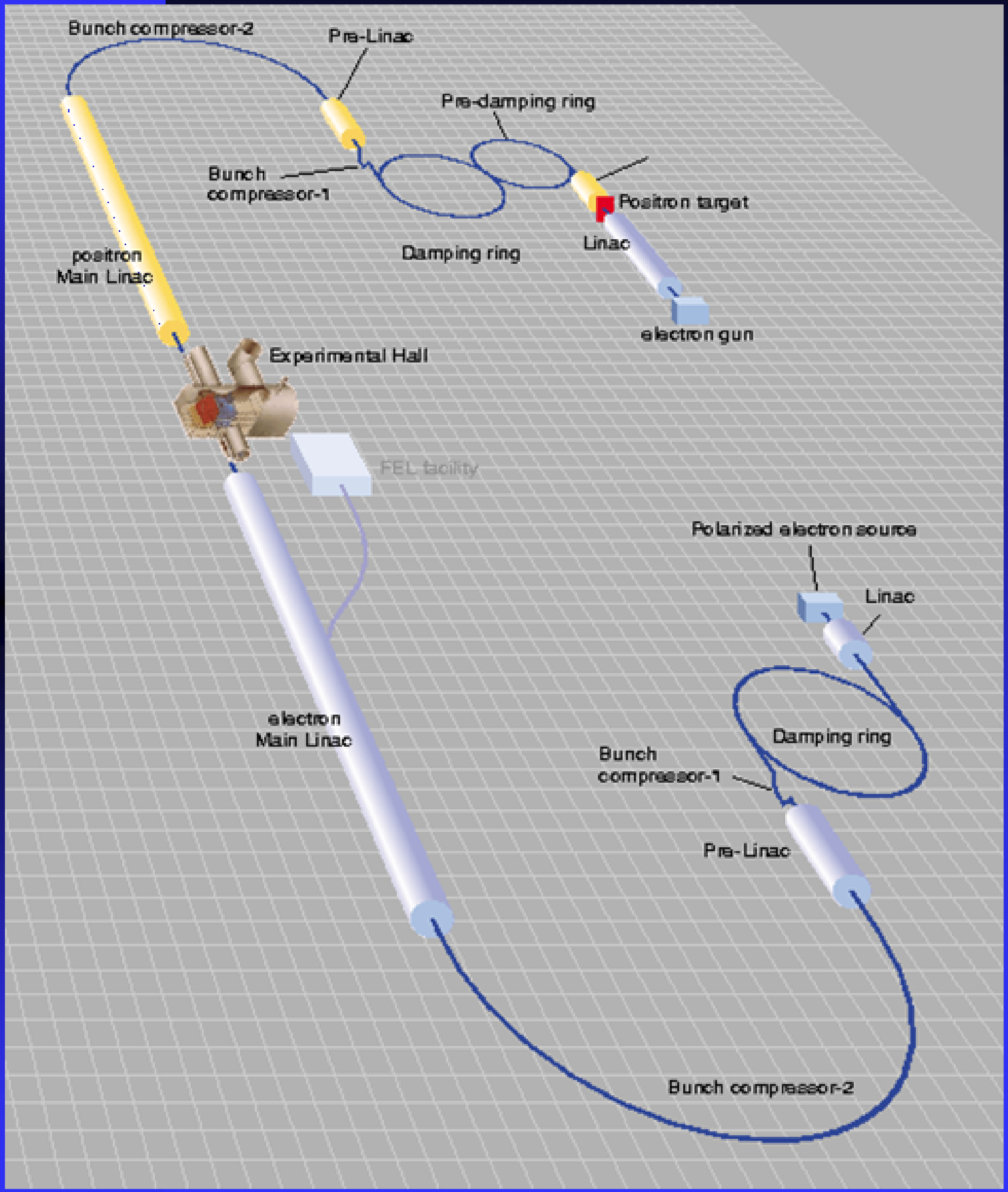
US-Japan Cooperation in the Field of High Energy Physics

Goal of the Cooperative Research



Development of polarized positron source for the future linear collider.

The linear collider project in Japan, formerly known as JLC (Japan Linear Collider), has received a new name GLC (Global Linear Collider).



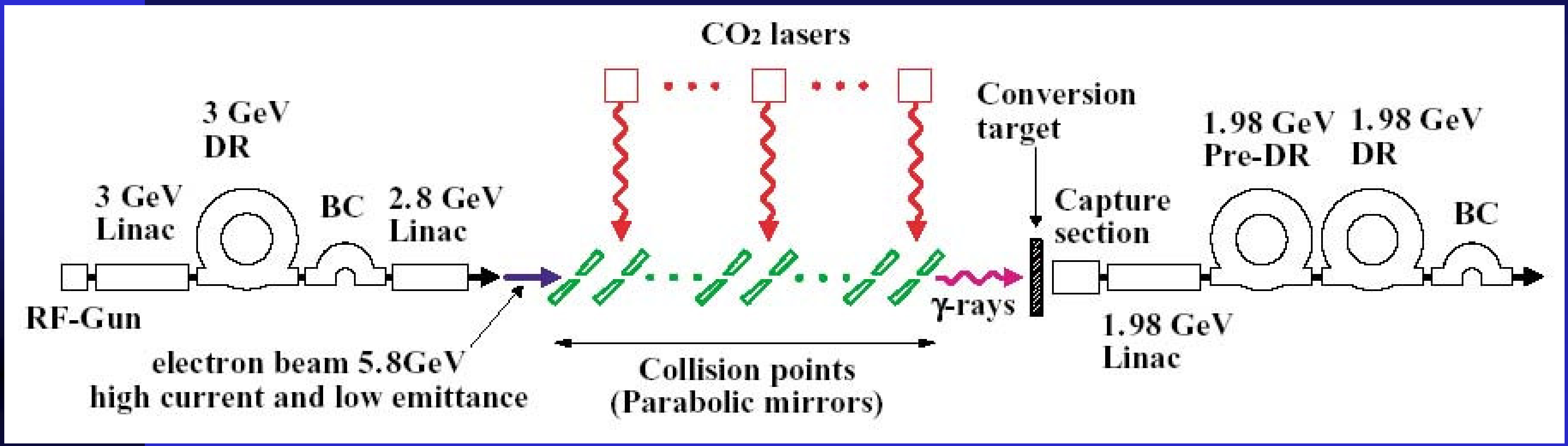
GLC is a 30-km, E_{CM}=1TeV electron positron linear collider.

Construction starts: 2007

Commissioning: 2013

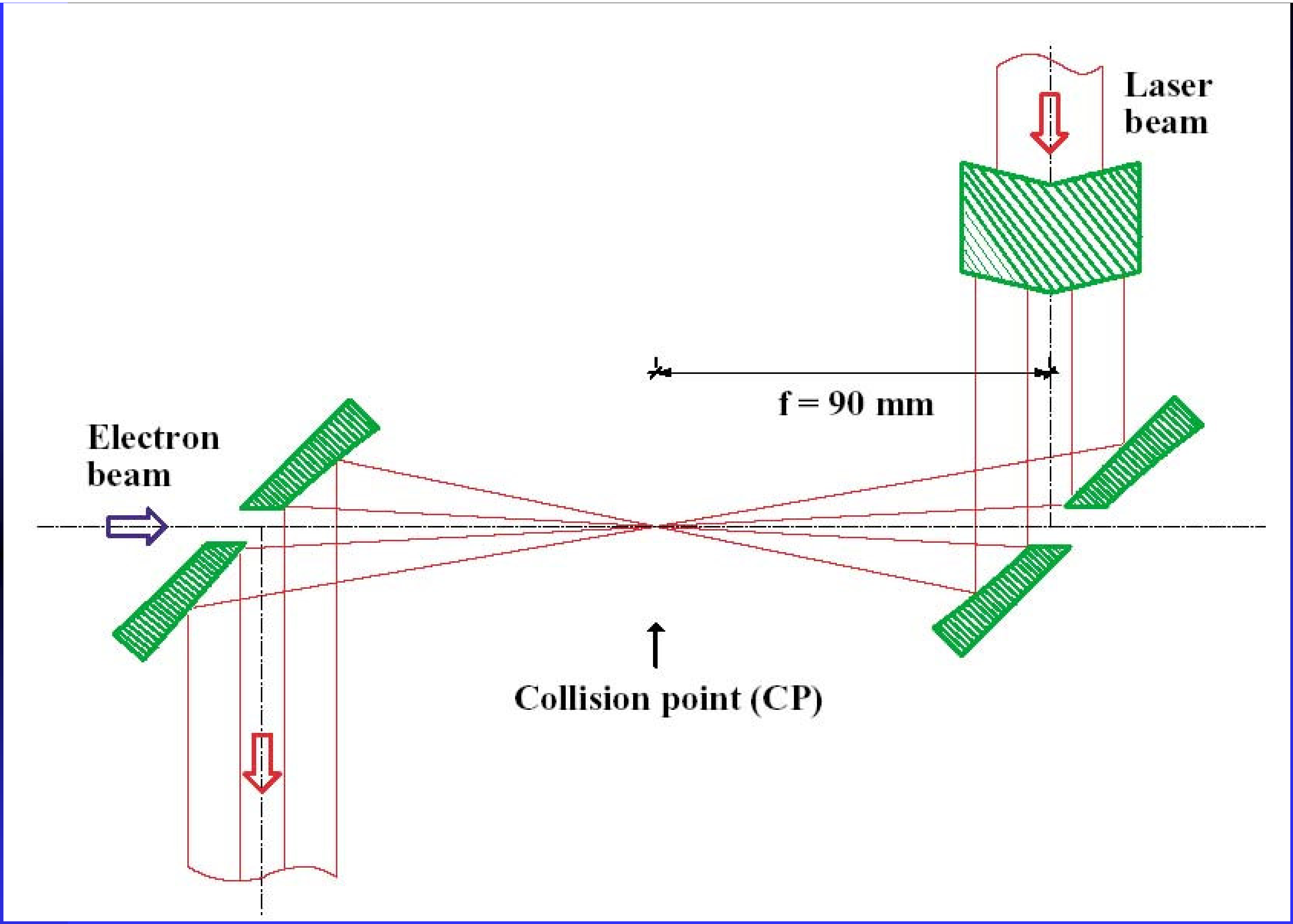
Spin polarization of both electron and positron beams allows us to make precise observation of exotic processes, such as SUSY particles.

“Original” design of the pol. e^+ source utilizing CO_2 lasers



Circularly polarized CO_2 laser beams are scattered by a 5.8GeV electron beam.

10 CO_2 laser modules supply laser beams to 200 collision points.



A pair of parabolic mirrors and an axicon expander are placed at each collision point.

合肥e+−物质微结构研究中心

- 多手段的探测方法：

  多种探针：正电子、电子和光子

  空间探测：表面、近表面和体内

  时间探测：随时间演化

  关联探测：时间、角度、动量间的关联

  为固体物理和材料科学提供新的研究平台

  和无损探测手段。

- 拥有配套完整的以正电子为探针的凝聚态物理和材料科学的研究装置以及以射线为探针的核分析技术，

- 建立基于**200MeV Linac**的强流慢正电子束装置

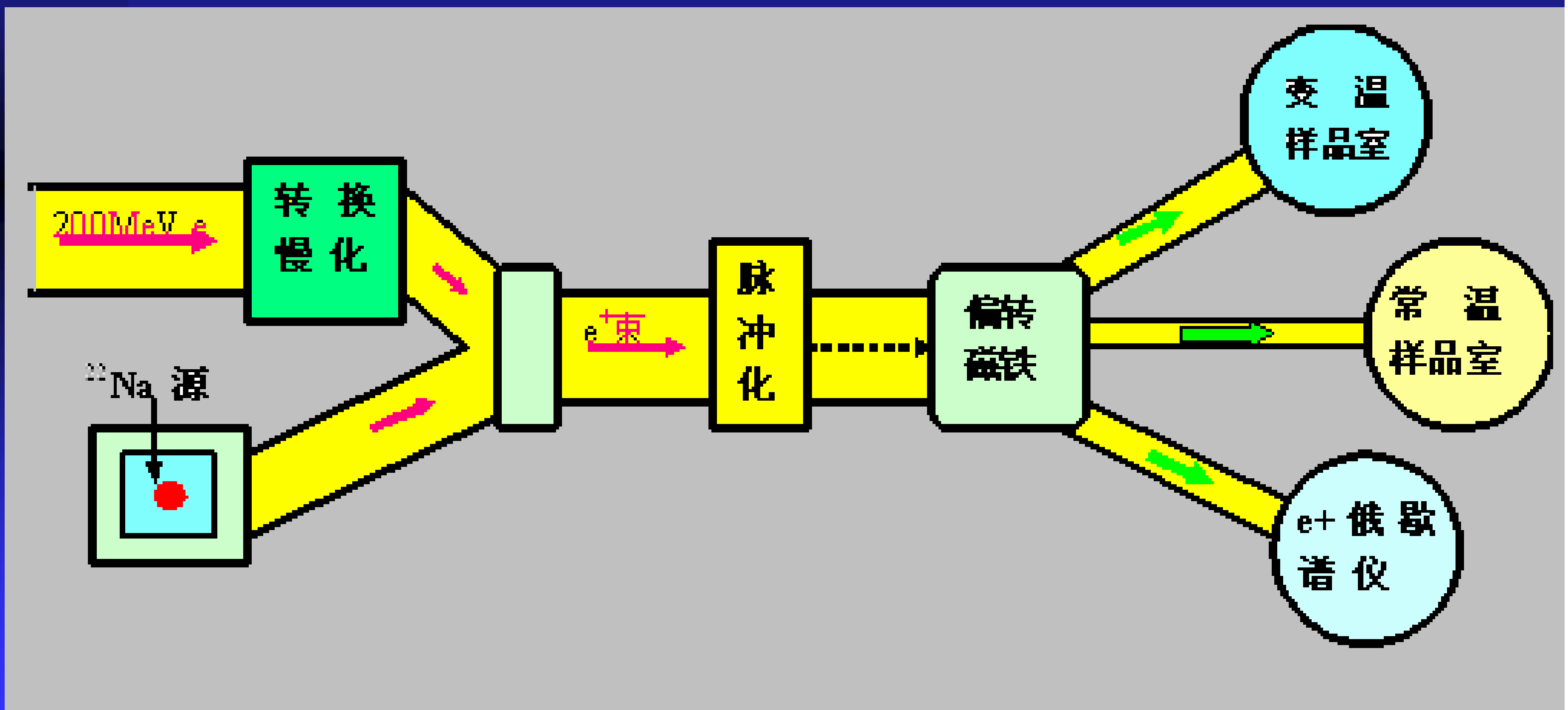
  为我国的新型材料研究提供新的研究平台。

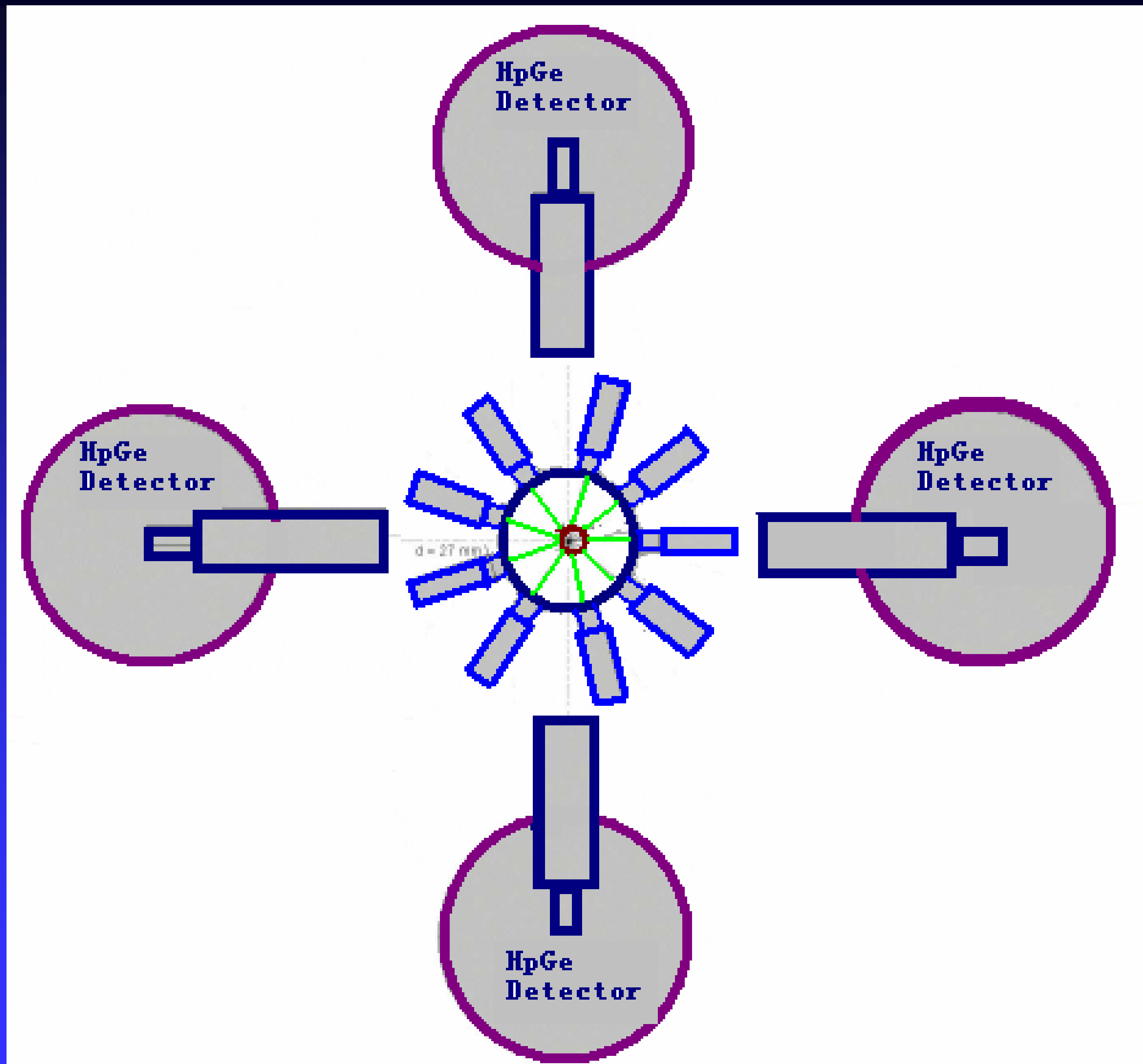
- 研究各种新型材料的原子和电子结构及其动力学特性；各能区微观粒子与材料表面、近表面及界的相互作用机制，探索表征复杂材料的结构和性能的新方法。

利用正电子湮没技术研究物质微观结构问题及微观局域相变、缺陷类型及分布、微观电子动量密度及分布、物质表面及界面性质、薄膜材料物性等基本问题。

合肥e+–物质微结构研究中心

（Hefei Positron and Matter Micro-structure Research Center）




HpGe
Detector
HpGe
Detector
HpGe
Detector
HpGe
Detector

全数字化的多探测系统

- 正电子寿命（ PAL）
  8 个BaF2 探测器阵列
- 双多勒展宽(2D- DBAR)
  4个HpGe 探测器
- 寿命-动量关联(AMOC)
  1个HpGe探测器和1个BaF_2 探测器
- 正电子俄歇谱仪（PAES）
  TOF-PAES 探测系统.

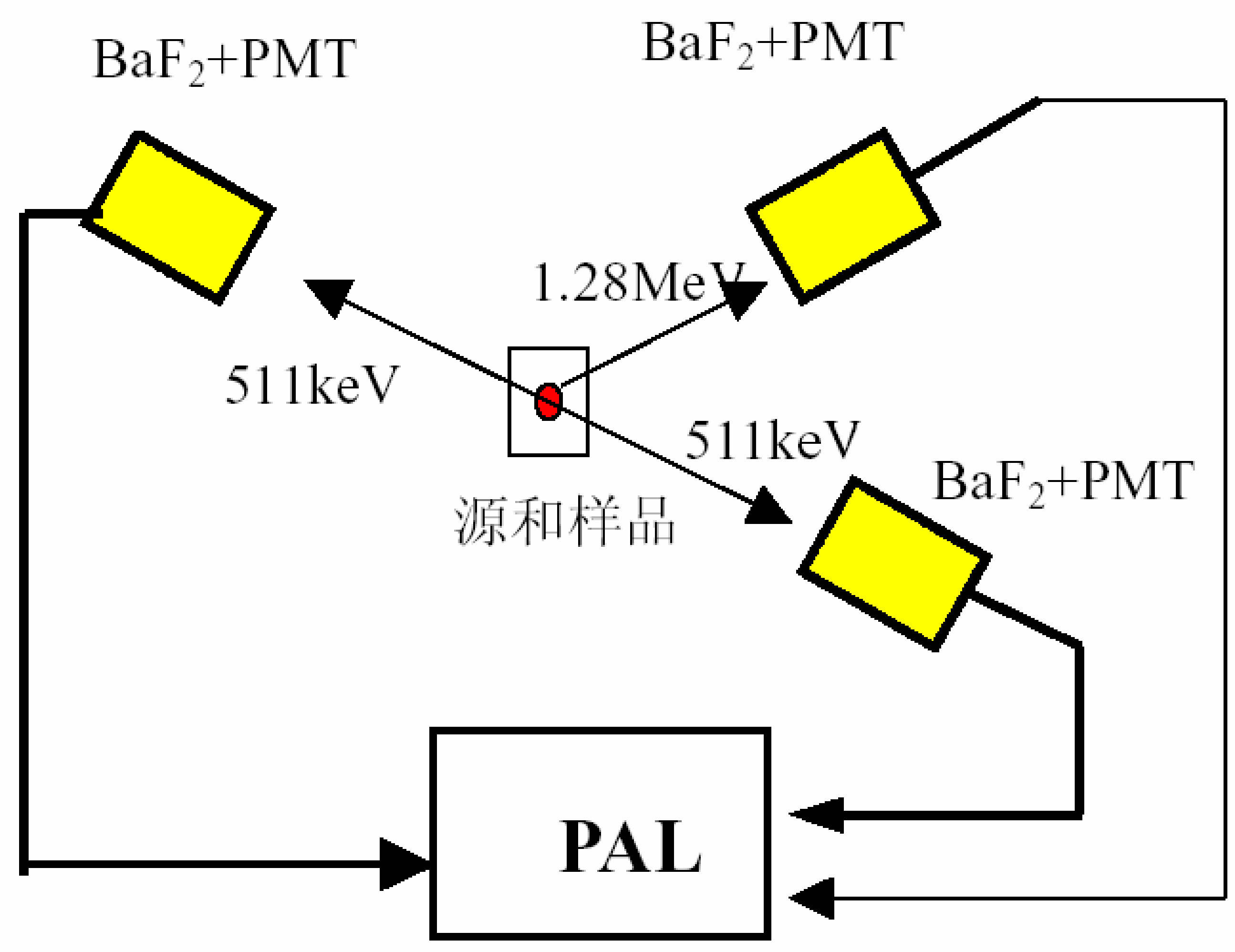


图 1　3 个探测器 **PAL** 探测系统

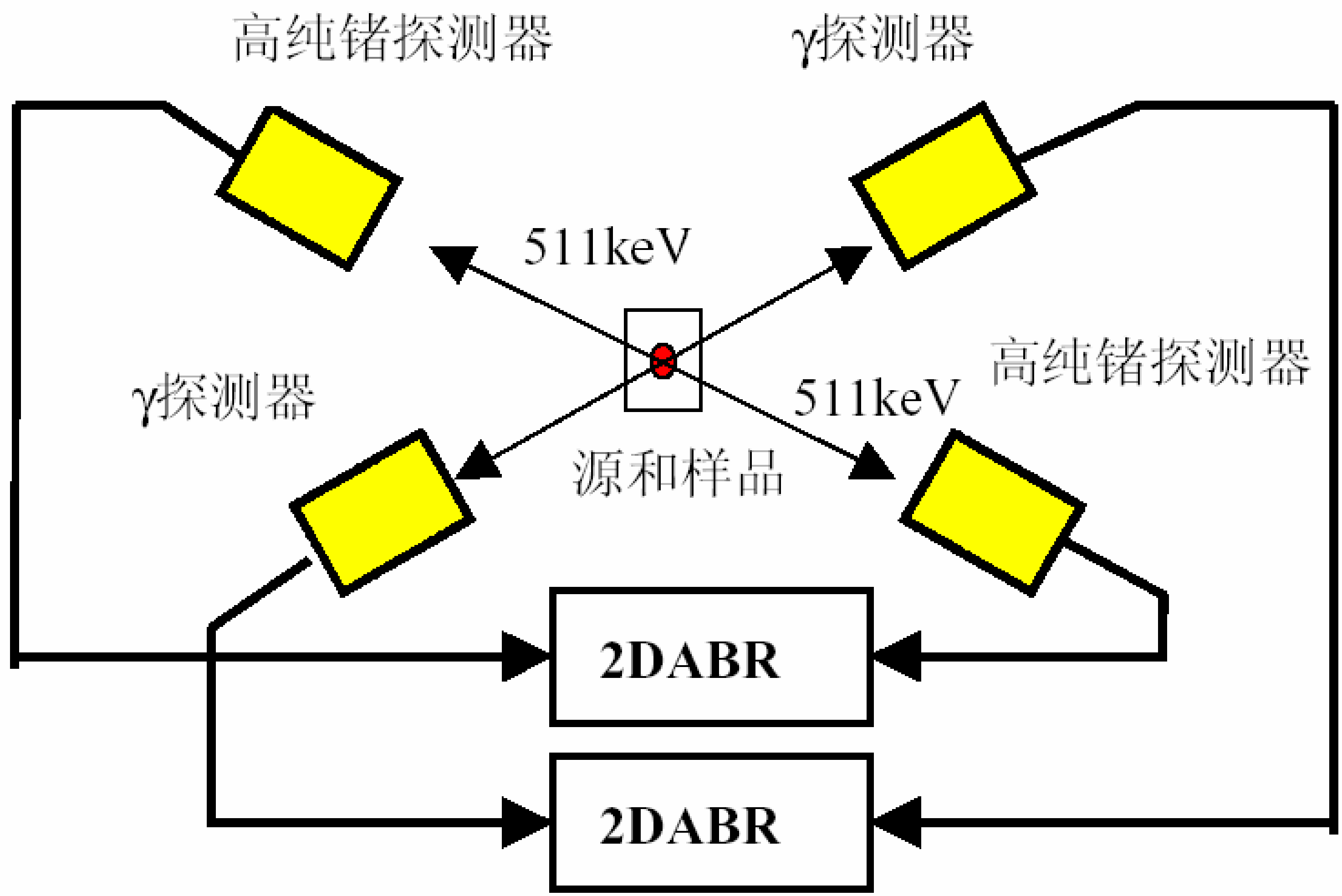
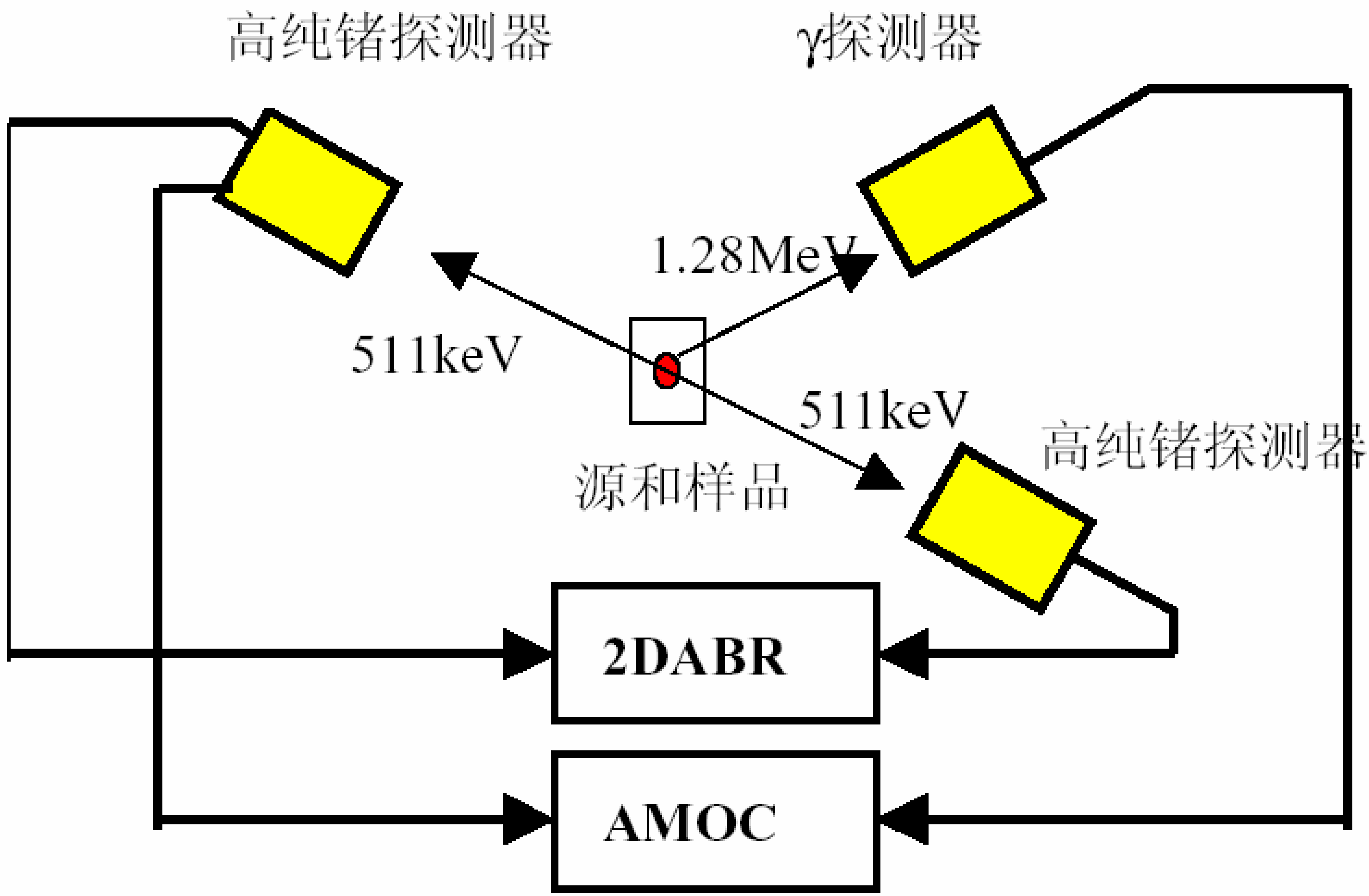
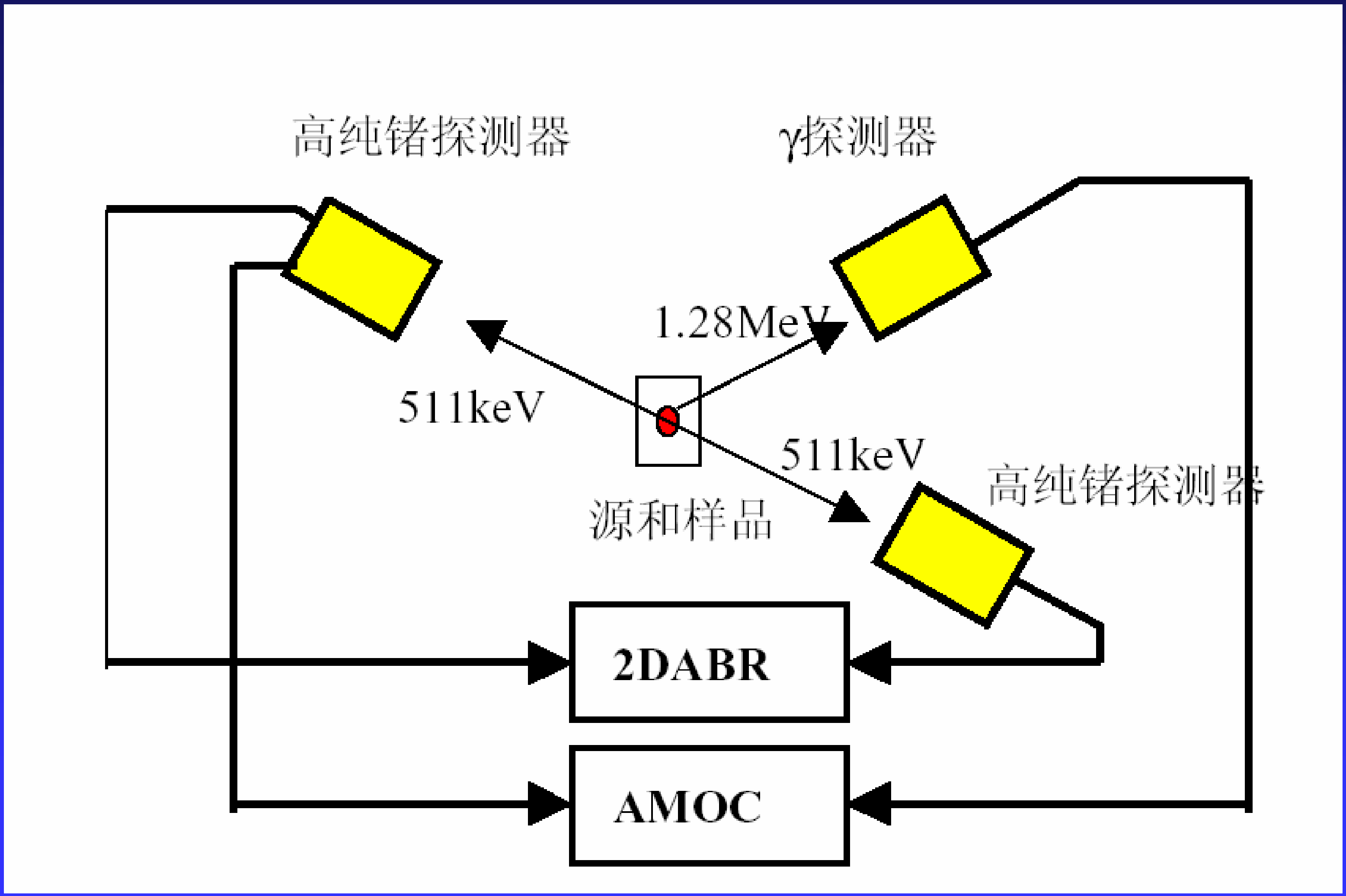


图 2　　4 个探测器构成 2 组 **2DABR** 探测系统



高纯锗探测器
γ探测器
1.28MeV
511keV
511keV
高纯锗探测器
源和样品
2DABR
AMOC

AMOC-2DBAR



Thank you!