Detection and Experimental Study of Dark Electric Matter Objects

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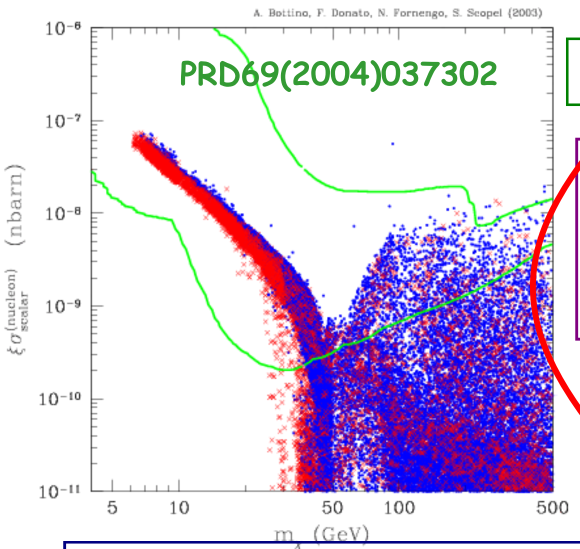
The model-independent evidence by DAMA/NaI well compatible with several candidates in several of the many astrophysical, nuclear and particle physics scenarios; other ones are open



Neutralino as LSP in SUSY theories

Various kinds of WIMP candidates with several different kind of interactions
Pure SI, pure SD, mixed + Migdal effect +channeling,… (from low to high mass)

a heavy ν of the 4-th family

Pseudoscalar, scalar or mixed light bosons with axion-like interactions

WIMP with preferred inelastic scattering

Mirror Dark Matter

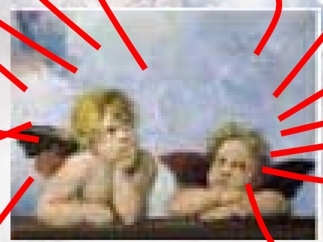
Light Dark Matter

Self interacting Dark Matter

Dark Matter (including some scenarios for WIMP) electron-interacting

Sterile neutrino

heavy exotic canditates, as "4th family atoms", ...



Elementary Black holes such as the Daemons

Kaluza Klein particles

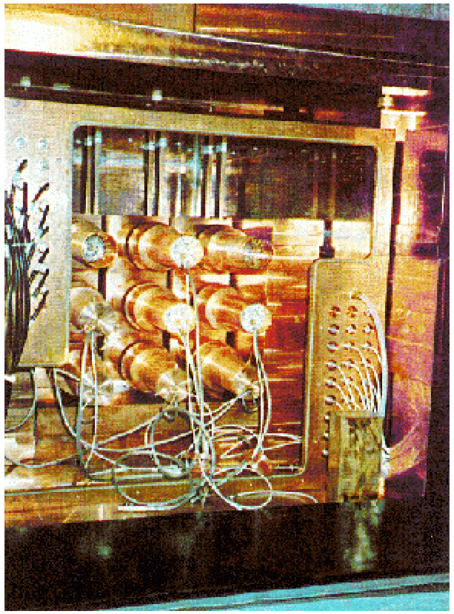
… and more

Possible model dependent positive hints from indirect searches not in conflict with DAMA/NaI result
(but interpretation, evidence itself, derived mass and cross sections depend e.g. on bckg modelling, on DM spatial velocity distribution in the galactic halo, etc.)

Available results from direct searches using different target materials and approaches and from searches for up-going muons do not give any robust conflict

The ≈100 kg NaI(Tl) set-up (DAMA/NaI)

- 9 highly radiopure NaI(Tl) of 9,7 kg coupled throught 10 cm long Tetrasil-B light guides to 2 low background PMTs (specially developed).
- Detectors enclosed in a sealed copper box, continuously maintained in HP Nitrogen atmosphere, in slightly overpressure with respect to the external environment.
- A suitable low background hard shield against e.m. and neutron background was realized using very high radiopure Cu and Pb bricks, Cd foils and 10/40 cm polyethylene/paraffin; the hard shield is also sealed in a plexiglas box and maintained in the high purity HP Nitrogen atmosphere.
- Etc.



Performances: **N.Cim.A112(1999)545-575, EPJC18(2000)283, Riv.N.Cim.26 n. 1(2003)1-73, IJMPD13(2004)2127**

Results on rare processes:

• **Possible Pauli exclusion principle violation**	**PLB408(1997)439**
• **CNC processes**	**PRC60(1999)065501**
• **Electron stability and non-paulian transitions in Iodine atoms (by L-shell)**	**PLB460(1999)235**
• **Search for solar axions**	**PLB515(2001)6**
• **Exotic Matter search**	**EPJdirect C14(2002)1**
• **Search for superdense nuclear matter**	**EPJA23(2005)7**
• **Search for heavy clusters decays**	**EPJA24(2005)51**

Results on DM particles:

• PSD	**PLB389(1996)757**
• Investigation on diurnal effect	**N.Cim.A112(1999)1541**
• Exotic Dark Matter search	**PRL83(1999)4918**
• Annual Modulation Signature	

PLB424(1998)195, PLB450(1999)448, PRD61(1999)023512, PLB480(2000)23, EPJC18(2000)283, PLB509(2001)197, EPJC23(2002)61, PRD66(2002)043503, Riv.N.Cim.26 n.1 (2003)1, IJMPD13(2004)2127, IJMPA21(2006)1445, EPJC47(2006)263, IJMPA22(2007)3155, EPJC53(2008)205, PRD77(2008)023506 + arXiv:0802.4336, other works in progress ...

Model independent evidence for the presence of DM particles in the galactic halo

data taking completed on July 2002, last data release 2003; still producing results on corollary quests for the candidate particle and the possible astrophysical, nuclear and particle physics scenarios

total exposure (7 annual cycles) 0.29 ton x yr

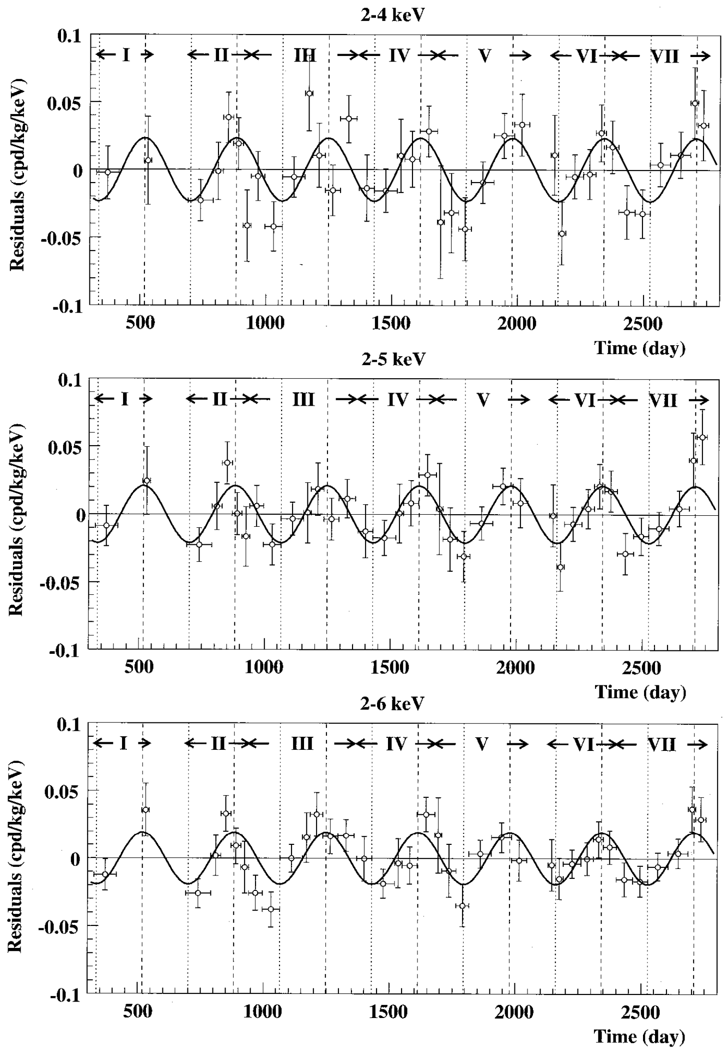


Fig. 10. – Model-independent residual rate for single-hit events, in the (2–4), (2–5) and (2–6) keV energy intervals as a function of the time elapsed since January 1st of the first year of data taking. The experimental points present the errors as vertical bars and the associated time bin width as horizontal bars. The superimposed curves represent the cosinusoidal functions behaviours expected for a WIMP signal with a period equal to 1 year and phase on the 2nd of June; the modulation amplitudes have been obtained by best fit. See text. The total exposure is 107731 kg · day.

I. What is DAEMON?

Our Universe began with Planckian scales.

The Planckin scales are determined by parameters of mini black hole whose gravitational radius $r_{g0} = \frac{2GM_0}{c^2}$ is equal to quarter of its Compton wave length $\lambda_c / 4 = 2\pi\hbar / 4M_0 c$:

$$M_0 = (\pi\hbar c / 4G)^{1/2} \approx 2 \cdot 10^{-5} g;$$

$$r_{g0} \approx 3 \cdot 10^{-33} cm.$$

In multidimensional (n > 4) scenarios they could have a stable electric charge:

$$Ze \leq G^{1/2} M_0 \approx 10e.$$

So it is reasonable to suggest the DM consist of such DArk Electric Matter Objects - daemons

"παντα δαιμονων πληρη"

(Thales of Miletus, 624-545 BC)

The main modes of the daemon ($Z_d e \approx -10e$) interaction with matter

(at A $\geq$ 2 daemon is inside a nucleus,
at $Z_n \geq 24/Z_d$ it is inside a nucleon)

(1) Slowly moving (V ~ 10 km/s) daemon does not excite or ionize atoms by impact
$\rightarrow$ it does not cause a scintillation (Markov 1966).

(2) When passing ~1-10 μm through matter, daemon is capable of capturing an atomic nucleus with:

(a) emission of highly energetic (~0.1-1 MeV) Auger electrons in $\tau_{Aug} \approx 10^{-10}$ s;

(b) emission of nucleons, their clusters, and γ-radiation in $\tau_{ev} \sim 10^{-9}$ s due to high daemon-nucleus binding energy $W \approx 1.8 Z_d Z_n A^{-1/3}$ MeV ($\sim 10^2$ MeV).

(3) Proton-by-proton decay in the residual captured nucleus due to the daemon-containing nucleon decay in $\Delta\tau_{ex} \approx 10^{-6}$ s (analogue of the monopole-stimulated proton decay?).

(4) When Z_n drops below Z_d ($\approx$10), a new nucleus can be captured, etc.

(5) Besides, daemon is capable of catalyzing fusion of light nuclei, etc.

An analogue of the muon-catalyzed fusion of deuterons

{but muon (with its $m_m = 208 m_e$) lives 2.2 μs and has $Z_m = -1$, while daemon (with $M \approx 10^{19} m_p$) is eternal and its $Z_d \approx -10$ → possibility of, e.g., $^{12}C + ^{12}C$ fusion}.

Daemons and Their Near-Earth Flux

Dark matter density in the Galaxy disc is ~ $0.07-0.16 M_\odot/pc^3$ (Bahcall et al 1992) → up to $n_d \approx 0.56\cdot 10^{-18}$ cm^{-3} at the velocity dispersion 4-30 km/s; the Sun's velocity is $V_\infty = 19.7$ km/s.

The Galactic flux of daemons at the Earth orbit

$$f_{orb} \approx n_d V_\infty (2GM_\odot / V_\infty^2 R) = 5\cdot 10^{-12}\, cm^{-2} s^{-1} \qquad (1)$$

On passing through the Sun, daemon loses $\Delta E_\odot \approx 3.9\cdot 10^7$ erg corresponding to the velocity decrease $\Delta V \approx V_\infty \approx 20$ km/s. So the Sun captures daemons in elongated orbits.

Around the Sun they create an "atmosphere" of density:

$$n_a \approx (F_\odot / 4\pi R^2) N(R) / V \qquad (2)$$

Here $F_\odot = \pi R_\odot^2 n_d V_\infty (V_0/V_\infty)^2 = 1.6\cdot 10^{13}$ s^{-1} is the primary daemon Galactic flow through the Sun;

$N(R) = 1 + 2(R_\odot/R)(V_0/\Delta V)^2$ **is the number of arms of closed contracting orbits intersecting surface of** R**;** $V \approx (2GM_\odot/R)^{1/2}$ **is nearly radial velocity along these arms;** $V_\odot = V(R_\odot) = 617.4$ **km/s.**

The Earth sphere of action radius is $\Delta R_\oplus \approx 0.01$ **AU. When passing it, the "atmospheric" daemons are deflected and no more pass through the Sun, being accumulated on orbits with** $P \sim 1$ **yr at a rate of**

$$\Delta N_a/\Delta t \approx \pi \Delta R_\oplus^2 n_a V \qquad (3)$$

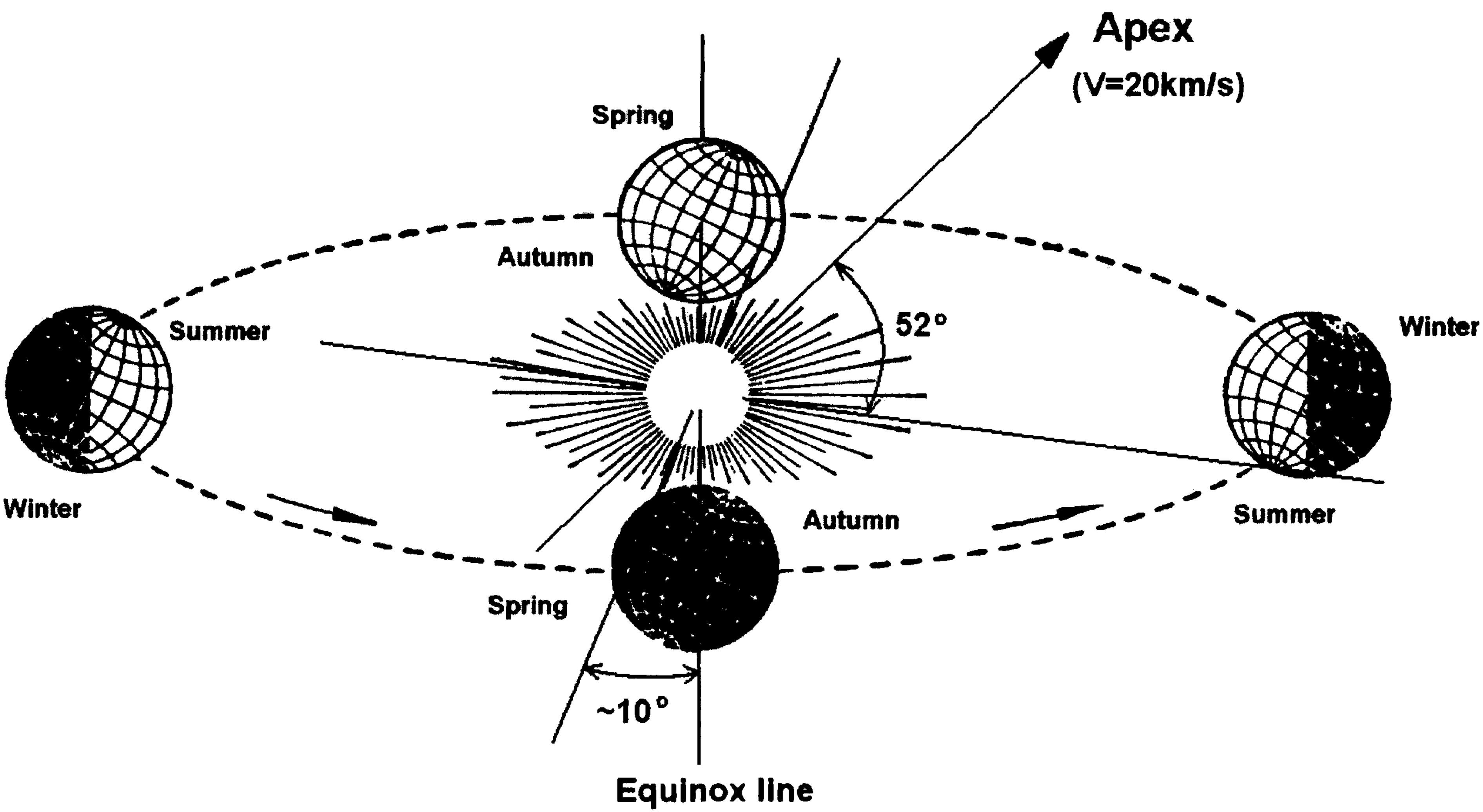
Once a year these particles traverse a torus with $R \approx 1$ **AU and** $r = \Delta R_\oplus$**. Their concentration here will be** $n_{tor} \approx \Delta N_a / 2\pi^3 R^2 \Delta R_\oplus$**, and they collide the Earth at** $V_r \approx 51.6$ **km/s.**

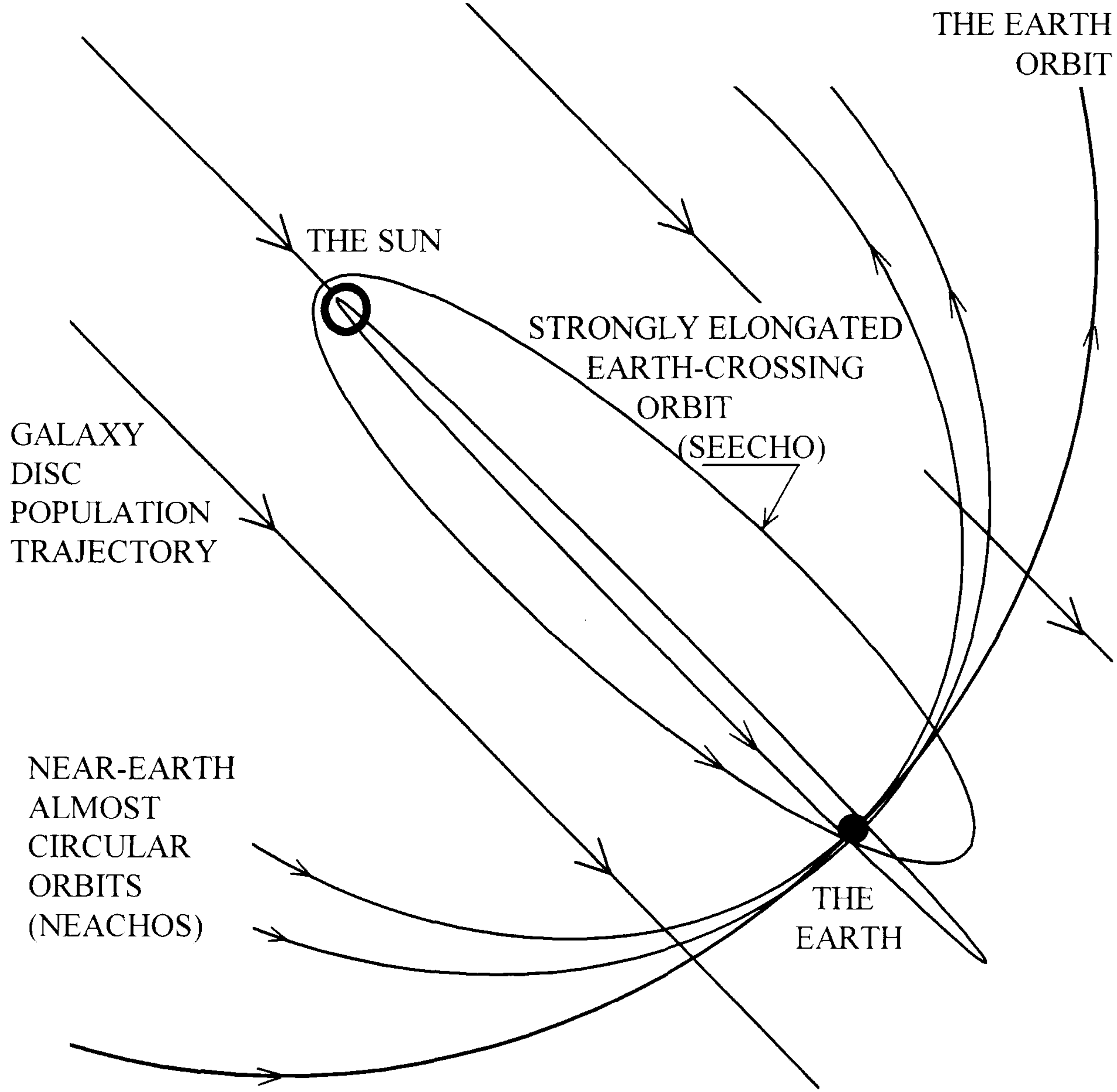
So the near-Earth flux is

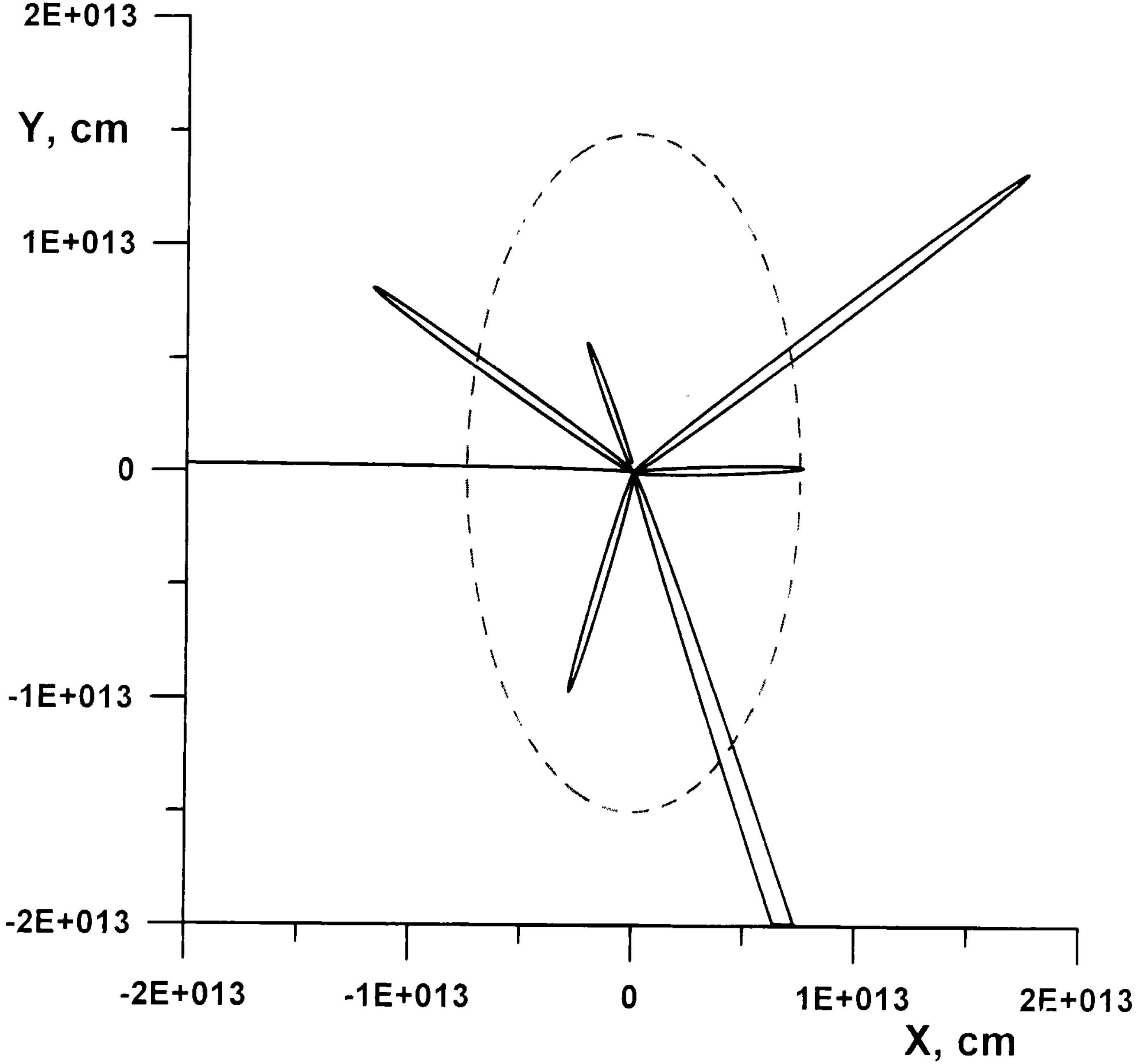
$$f_\oplus = V_r n_{tor} \approx 10^{-23}\,\Delta t \;\; cm^2 s^{-1} \qquad (4)$$

When taking into account the daemon braking by the Earth, $\Delta t_{\max} \approx 1.1$ **Byr, whence** $\Delta N_a = 1.3 \cdot 10^{26}$ **and**

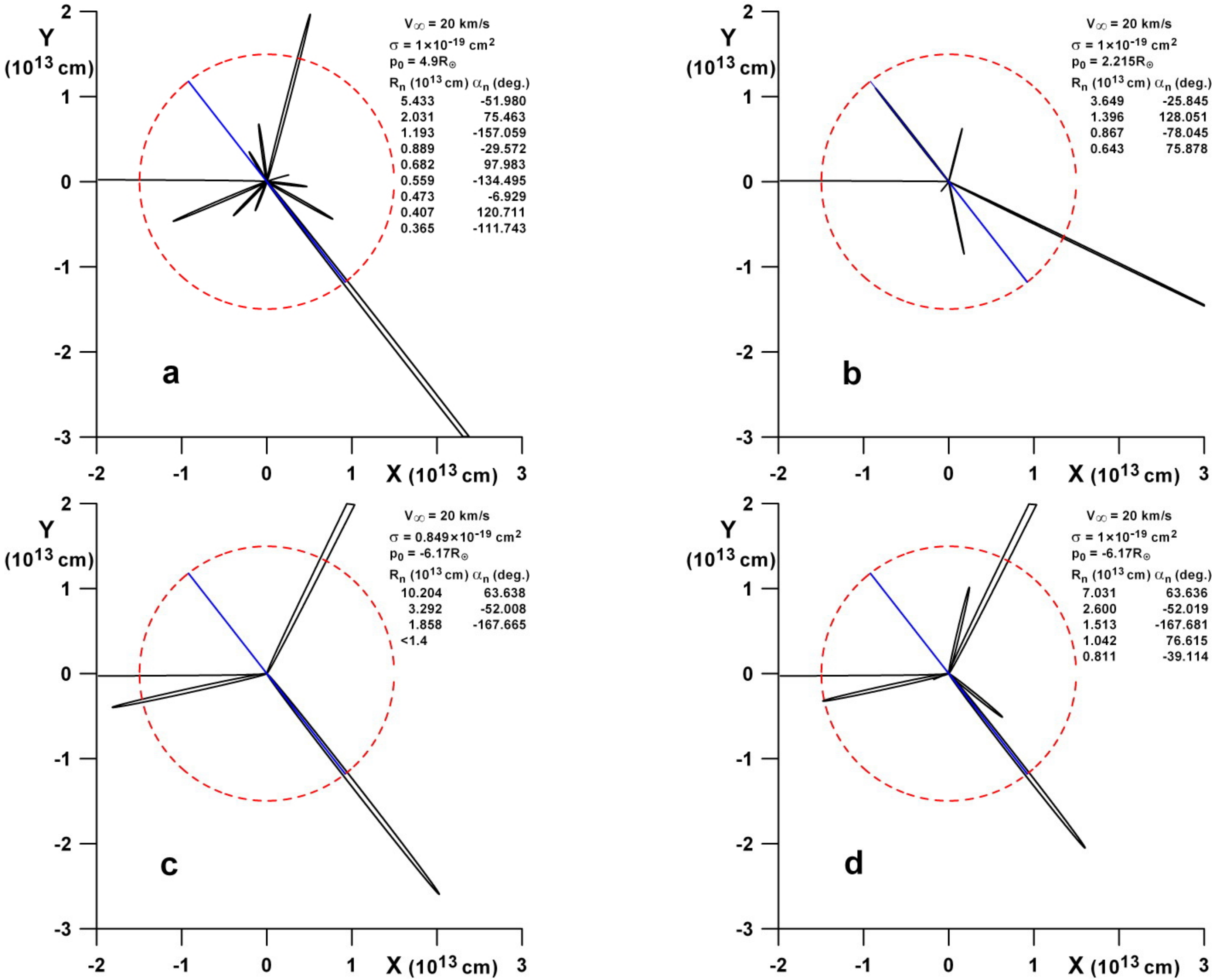
$$f_\oplus = 3.4 \cdot 10^{-7}\,\mathrm{cm}^{-2}\mathrm{s}^{-1} >> f_{orb} \;\; !!! \qquad (5)$$


Apex
(V=20km/s)
Spring
Autumn
Summer
Winter
52°
Winter
Summer
Autumn
Spring
~10°
Equinox line

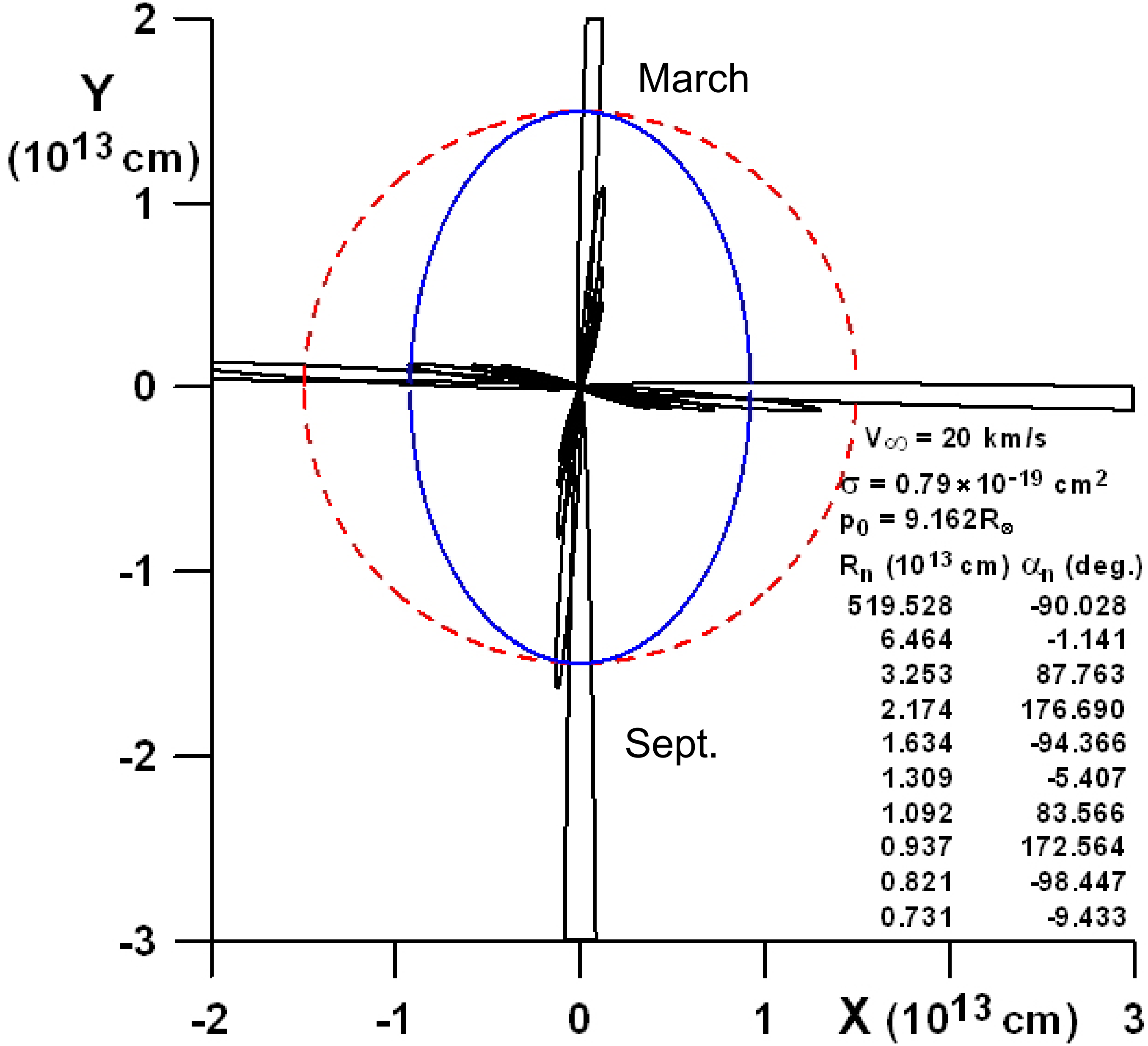

THE EARTH
ORBIT
THE SUN
STRONGLY ELONGATED
EARTH-CROSSING
ORBIT
(SEECHO)
GALAXY
DISC
POPULATION
TRAJECTORY
NEAR-EARTH
ALMOST
CIRCULAR
ORBITS
(NEACHOS)
THE
EARTH



2E+013
Y, cm
1E+013
0
-1E+013
-2E+013
-2E+013
-1E+013
0
1E+013
2E+013
X, cm

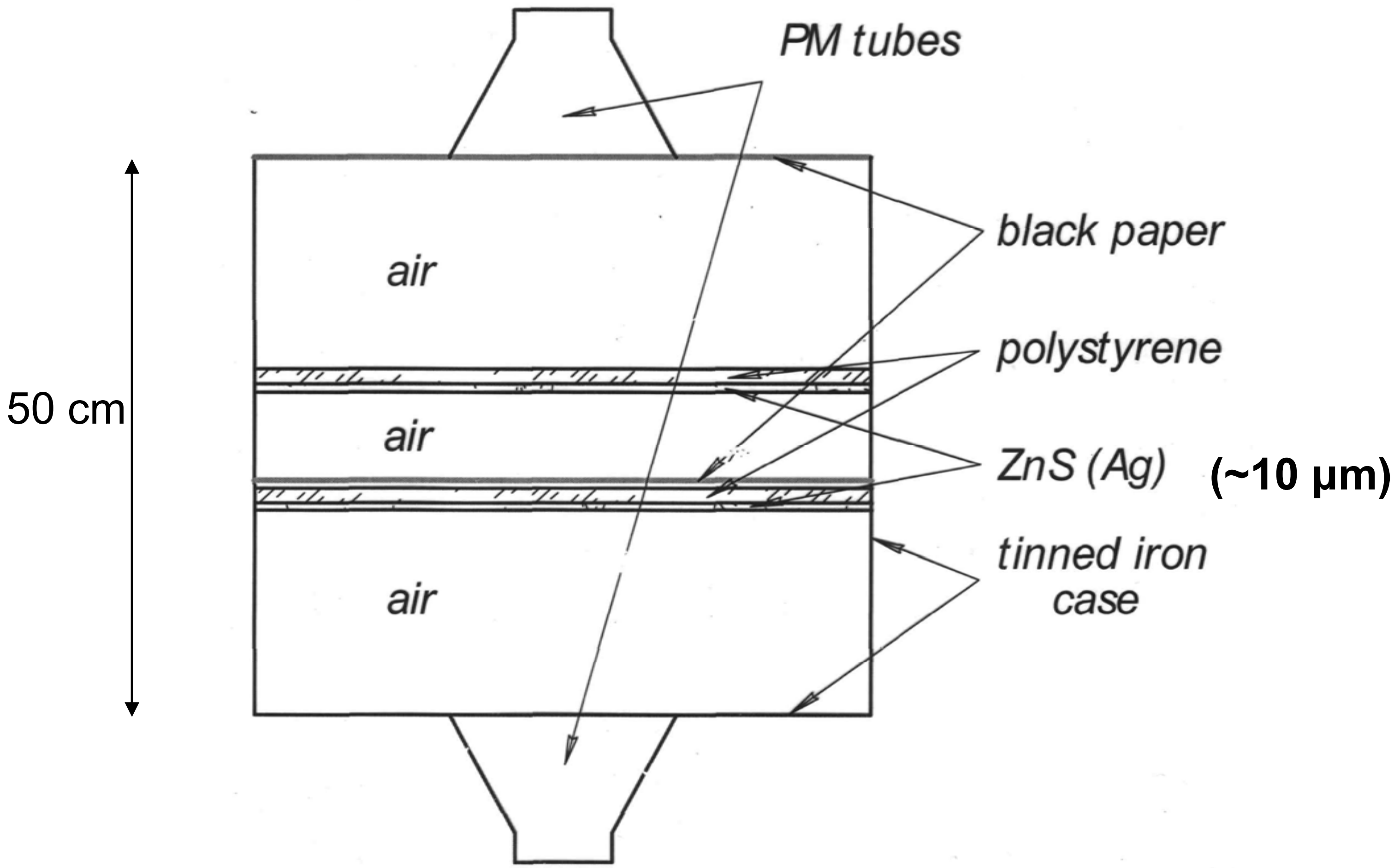


SEECHOs are concentrating behind the Sun (origin of P = 1 yr modulation)



Daemons are accumulated in the outer NEACHOs touching the Earth's orbit near equinoxes mainly (origin of P = 0.5 yr modulation)

Daemon detection facility exploiting the daemon-containing proton decay



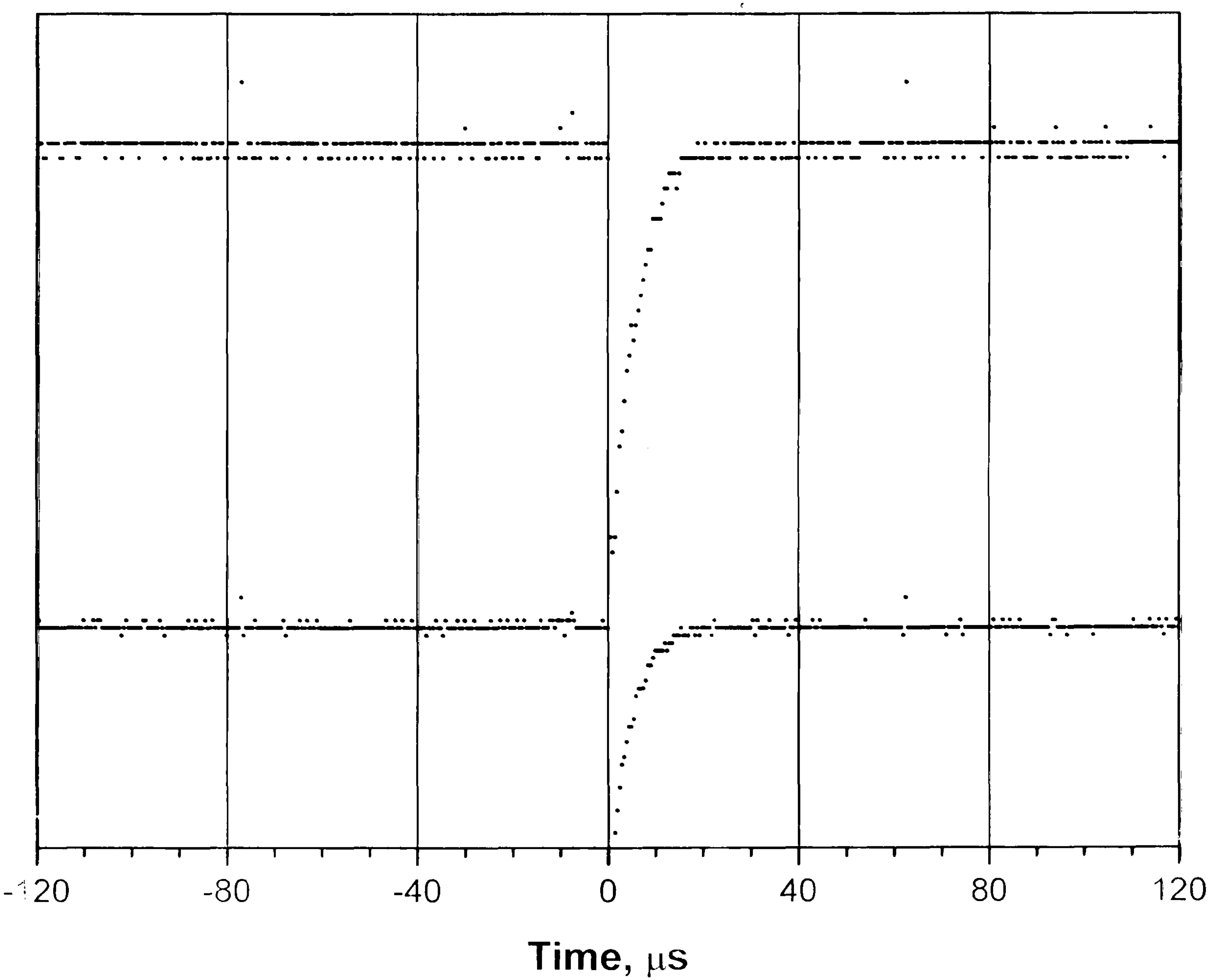
The ‘touch’ cross section for a nucleus with charge Z_n and mass Am_p, taking into account its displacement by a massive negative Z_{eff} projectile, is determined according to Cahn & Glashow (1981) as

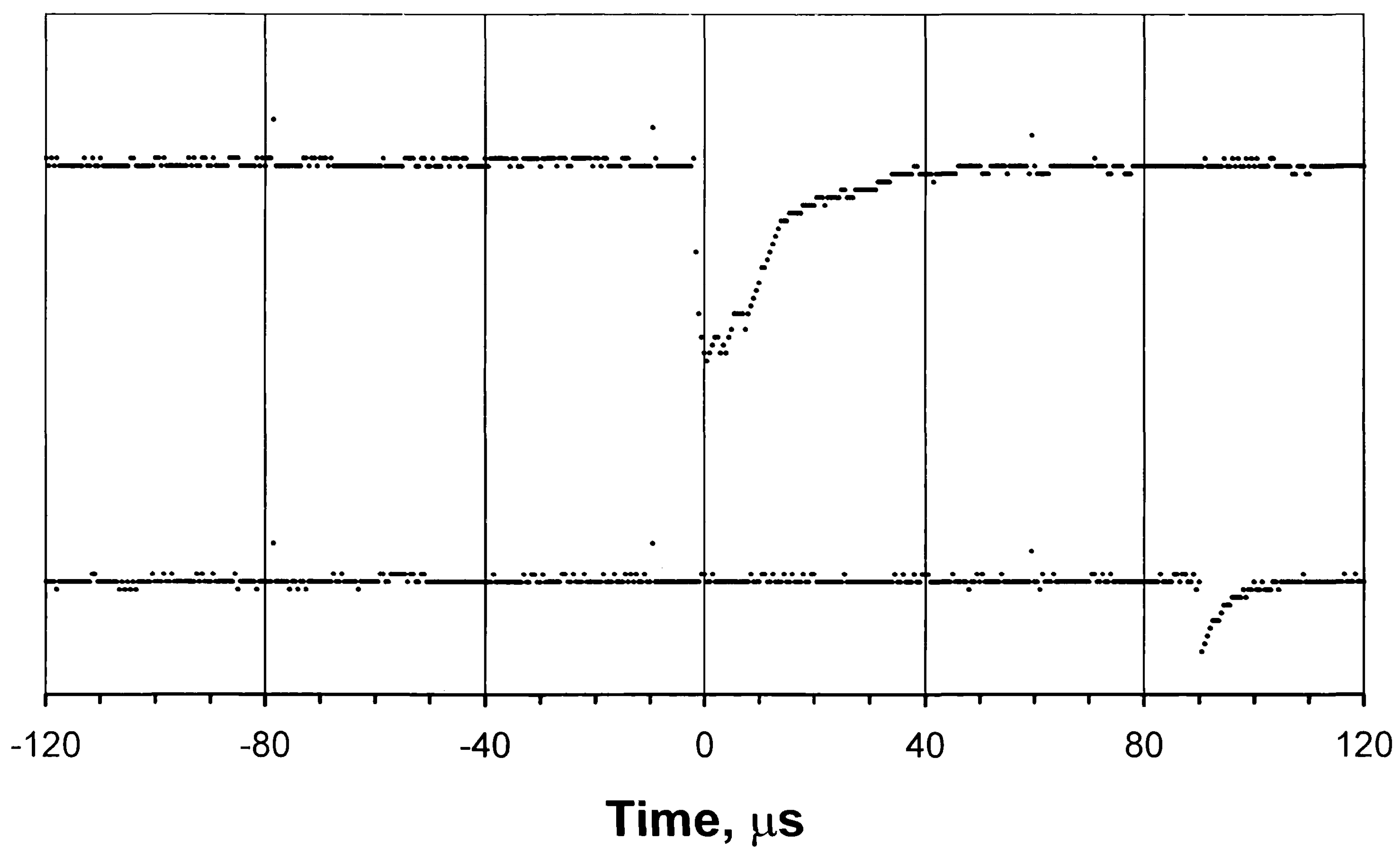
$$\sigma = \sigma_0 \frac{2Z_n e^2}{m_p R_0 A^{4/3}} \cdot \frac{Z_{eff}}{V^2}$$

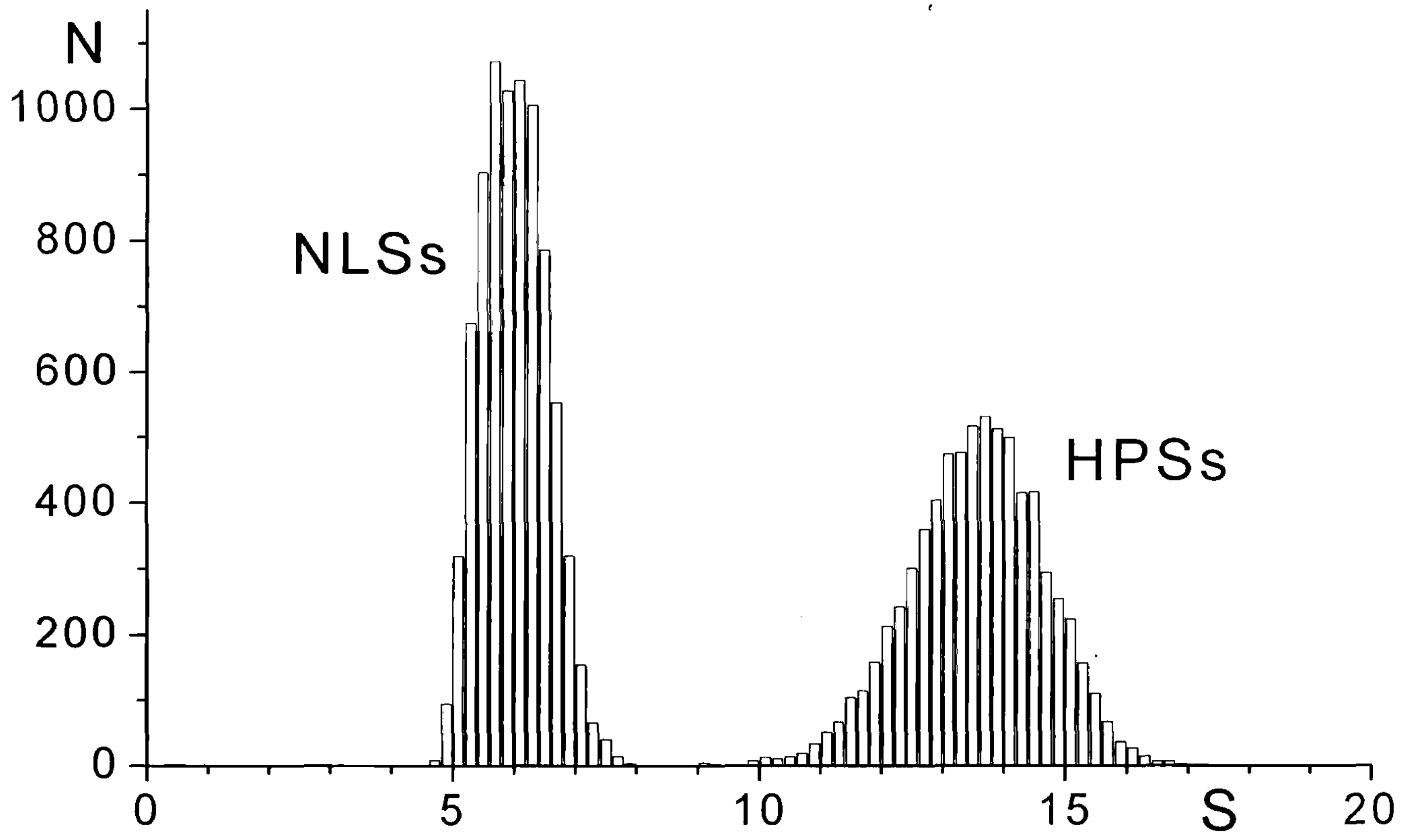
where $\sigma_0 = \pi R_0^2 A^{2/3}$ and $R_0 = 1.2 \cdot 10^{-13}$ cm.

Table 1. Parameters of the detector components and quantities characterizing their interactions with daemons at three typical velocities (V = 5, 15, and 45 km/s). l is the component size and t_l is time of its traversing by daemon; λ is the mean free path needed for a daemon with $Z_{eff} = 1$ (the most probable case) to capture a nucleus, τ_λ is the corresponding time (to calculate λ and τ_λ, the cross-section defined by Eq.1 is used).

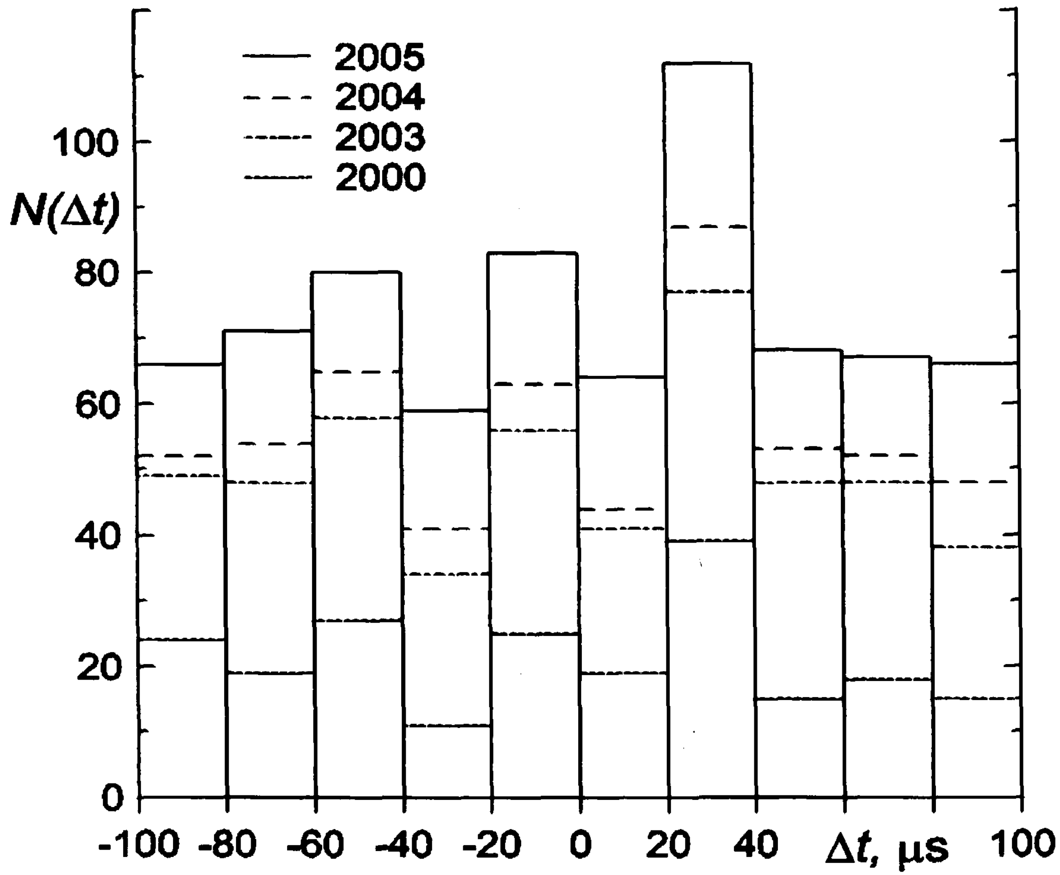
	Z_n	A	ρ [g/cm^3]	l [cm]	t_l [μs]			$\lambda \cdot Z_{eff}$ [cm]			$\tau_\lambda \cdot Z_{eff}$ [ns]		
V [km/s]					5	15	45	5	15	45	5	15	45
H	1	1	(0.082)					$4.9 \cdot 10^{-5}$	$4.4 \cdot 10^{-4}$	$4.0 \cdot 10^{-3}$	0.1	0.29	0.89
C	6	12	(0.978)					$5.2 \cdot 10^{-5}$	$4.7 \cdot 10^{-4}$	$4.2 \cdot 10^{-3}$	0.1	0.31	0.93
poly-styrene	CH		1.06	0.4	0.8	0.27	0.09	$2.5 \cdot 10^{-5}$	$2.3 \cdot 10^{-4}$	$2.0 \cdot 10^{-3}$	0.05	0.15	0.44
N	7	14	(0.00091)					$5.1 \cdot 10^{-2}$	$4.6 \cdot 10^{-1}$	4.1	102	307	910
O	8	16	(0.00028)					0.18	1.6	14.5	360	1070	3200
air			0.0012	7 22	14 44	4.7 14.7	1.6 4.9	0.04	0.36	3.2	80	240	710
S	16	32	(1.35)					$5.8 \cdot 10^{-5}$	$5.2 \cdot 10^{-4}$	$4.7 \cdot 10^{-3}$	0.12	0.35	1.04
Zn	30	65	(2.74)					$5.1 \cdot 10^{-5}$	$4.5 \cdot 10^{-4}$	$4.1 \cdot 10^{-3}$	0.10	0.30	0.91
ZnS(Ag)			4.09	10^{-3}	$2 \cdot 10^{-3}$	$0.7 \cdot 10^{-3}$	$2.2 \cdot 10^{-4}$	$2.7 \cdot 10^{-5}$	$2.4 \cdot 10^{-4}$	$2.2 \cdot 10^{-3}$	0.054	0.16	0.49
Fe	26	56	7.9	0.03	0.6	0.02	0.007	$1.6 \cdot 10^{-5}$	$1.4 \cdot 10^{-4}$	$1.3 \cdot 10^{-3}$	0.032	0.093	0.29
Sn	50	119	7.3	$2 \cdot 10^{-4}$	$4 \cdot 10^{-4}$	$1.3 \cdot 10^{-4}$	$4.4 \cdot 10^{-5}$	$3.1 \cdot 10^{-5}$	$2.8 \cdot 10^{-4}$	$2.5 \cdot 10^{-3}$	0.062	0.19	0.56


-120
-80
-40
0
40
80
120
Time, μs


-120
-80
-40
0
40
80
120
Time, μs

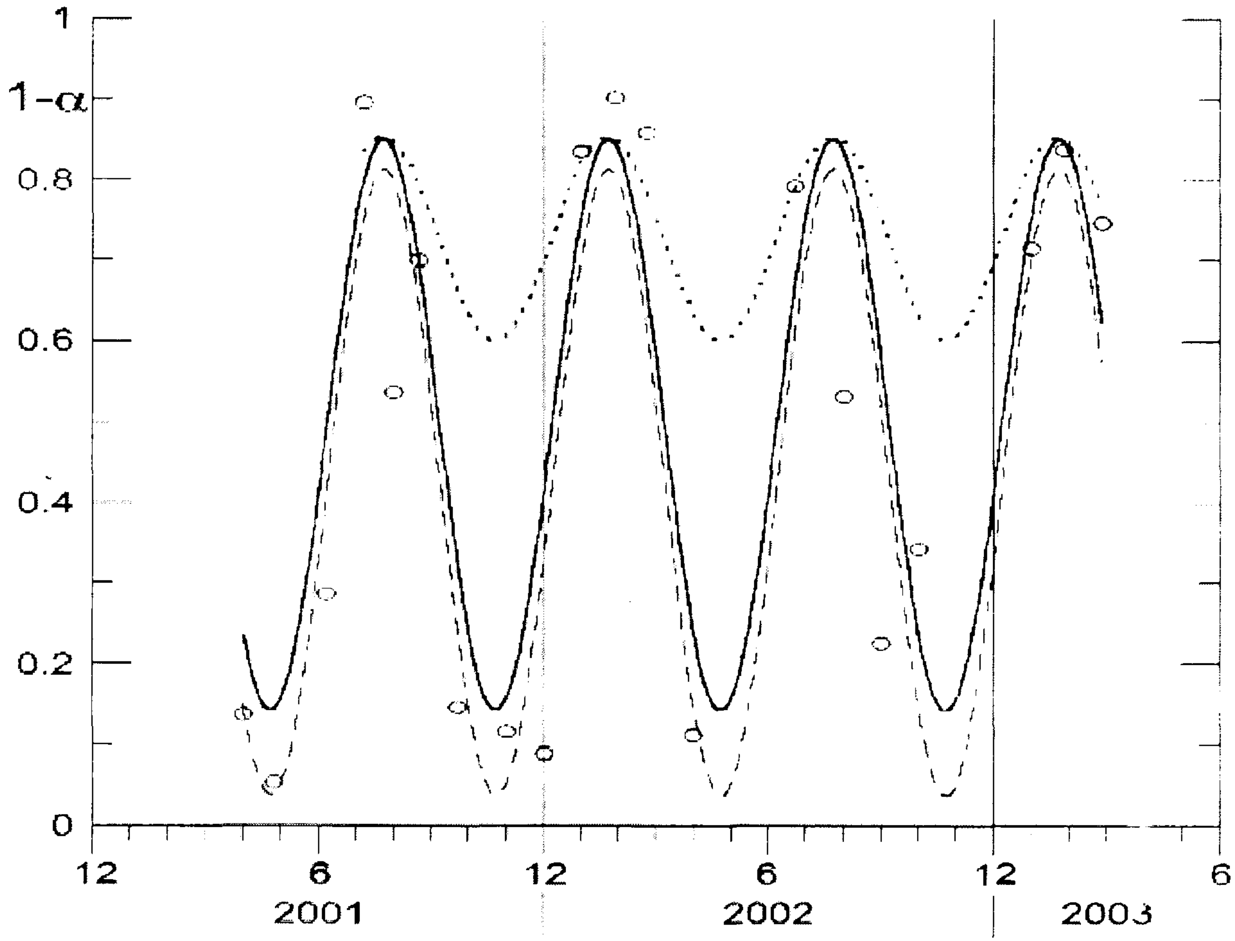


Typical distribution of the noise-like (light-particle) scintillations (NLSs) and heavy-particle scintillations (HPSs) vs. S – the signal-amplitude normalized area swept by the oscilloscopic trace of the scintillation. The LPS and HPS distributions are well distinctive by their S's. The "narrow" HPSs and "wide" HPSs lie at left and right parts of the HPS Gaussian, correspondingly.



The sum of $N(\Delta t)$ distributions for the system of modules 1, 2, 3 and 4 collected during 24 February-27 March, 2000 ($N(\Delta t)$ for the interval $-100 < \Delta t < 100$ μs is 24, 19, 27, 11, 25, 19, 39, 15, 18, 15), 24 February 27 March, 2003 (25, 29, 31, 23, 31, 22, 38, 33, 30, 23), 8-20 March, 2004 (3, 6, 7, 7, 7, 3, 10, 5, 4, 10), and 5-25 March, 2005 (three modules 1, 2 and 24; 14, 17, 15, 18, 20, 20, 25, 15, 15, 18).

The 30 μs maximum in the total distribution exceeds the mean level by 33 events and has a significance of 3.63σ (confidence level, greater than 99.97%).

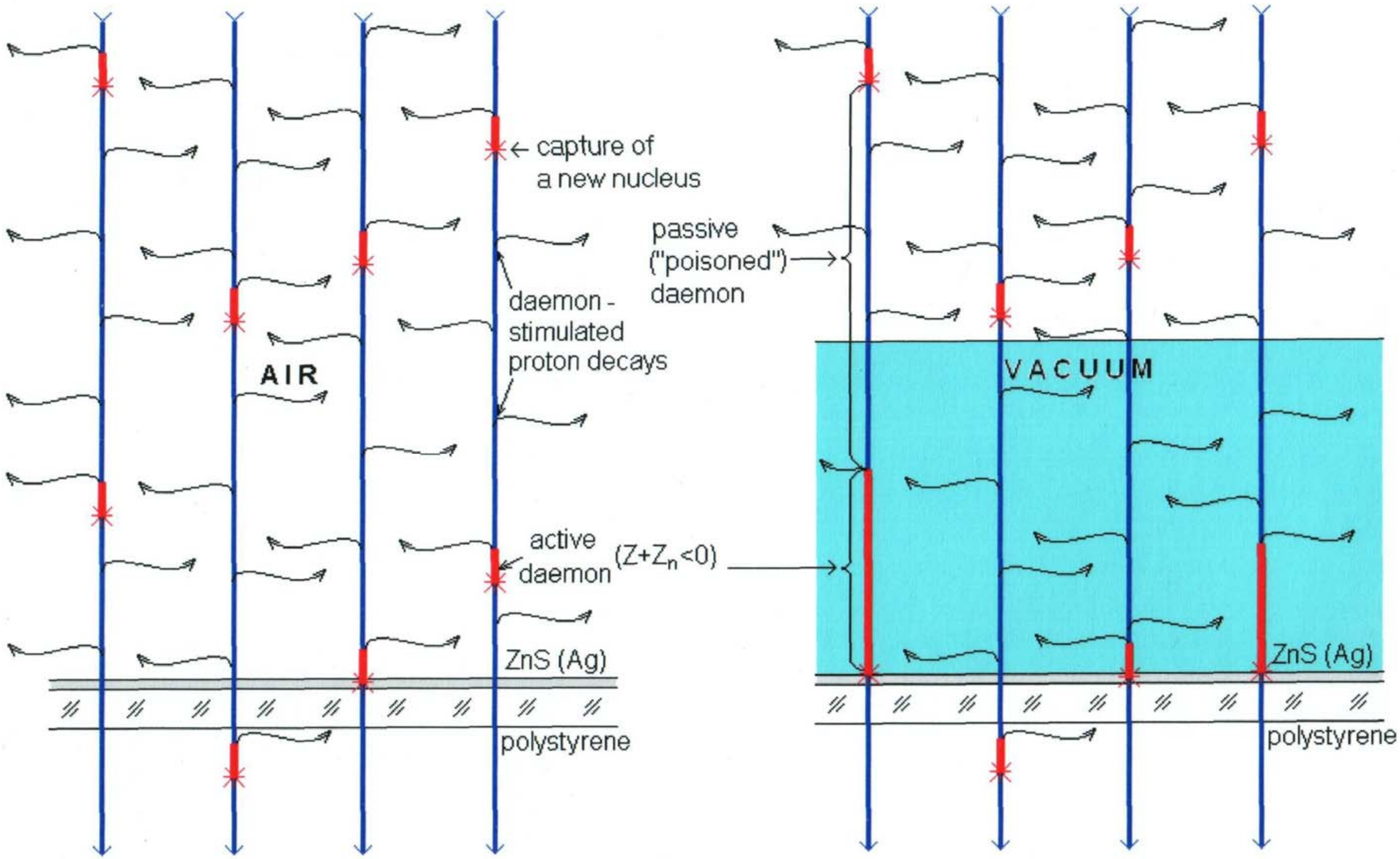


Seasonal variation of 1 - α , the extent to which the $N(\Delta t)$ distribution (at $-100 < \Delta t < 100$ μs) deviates from the constant level produced by background events.

(- - - -) Weights of all the points are equal, the correlation coefficient of the sine curve ($P = 0.5$ yr) with the points is $r = 0.86$, its C.L. > 99.9%.

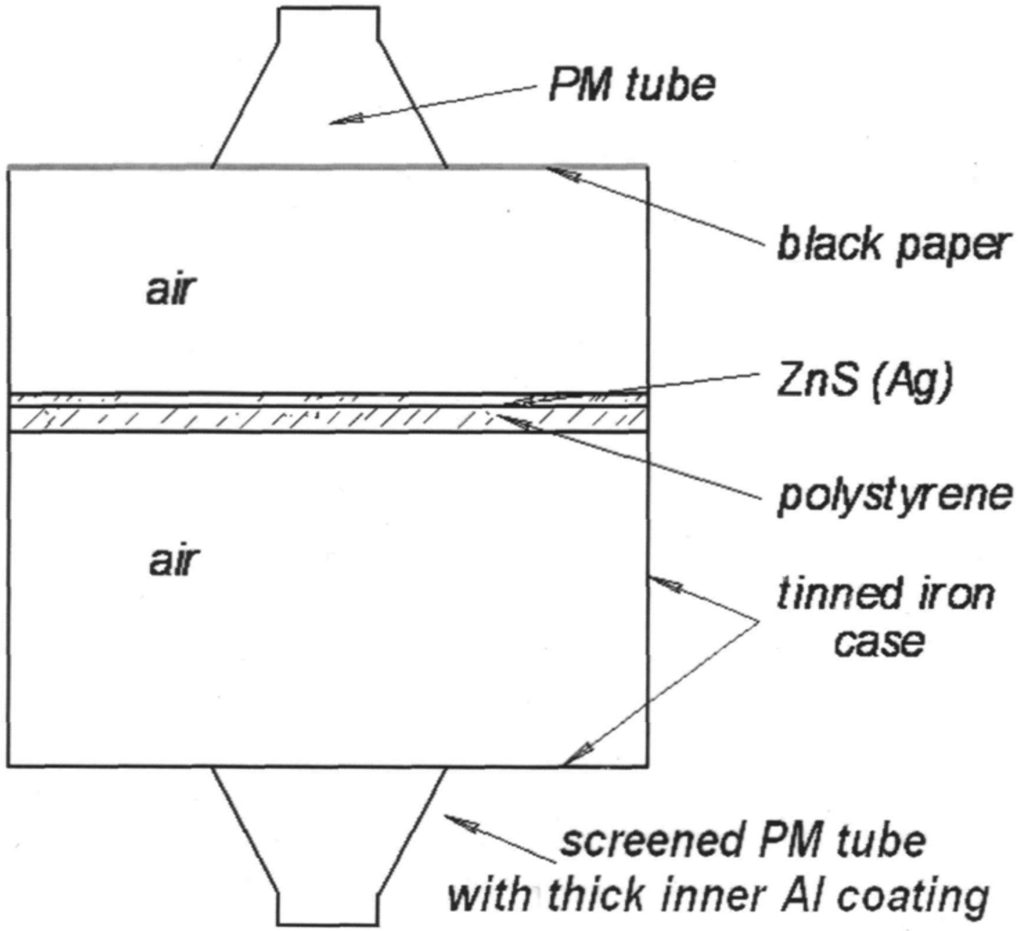
(——) Weights of the points are proportional to 1 - α; $r = 0.75$, its C.L. = 98.7%.

(........) Points with 1 - α > 0.5 are considered only; their weights are equal to 1 - 2α; $r = 0.36$, its C.L. ≈ 50%.



capture of
a new nucleus
passive
("poisoned")
daemon
daemon -
stimulated
proton decays
AIR
VACUUM
active
daemon
$(Z+Z_n<0)$
ZnS (Ag)
polystyrene
ZnS (Ag)
polystyrene

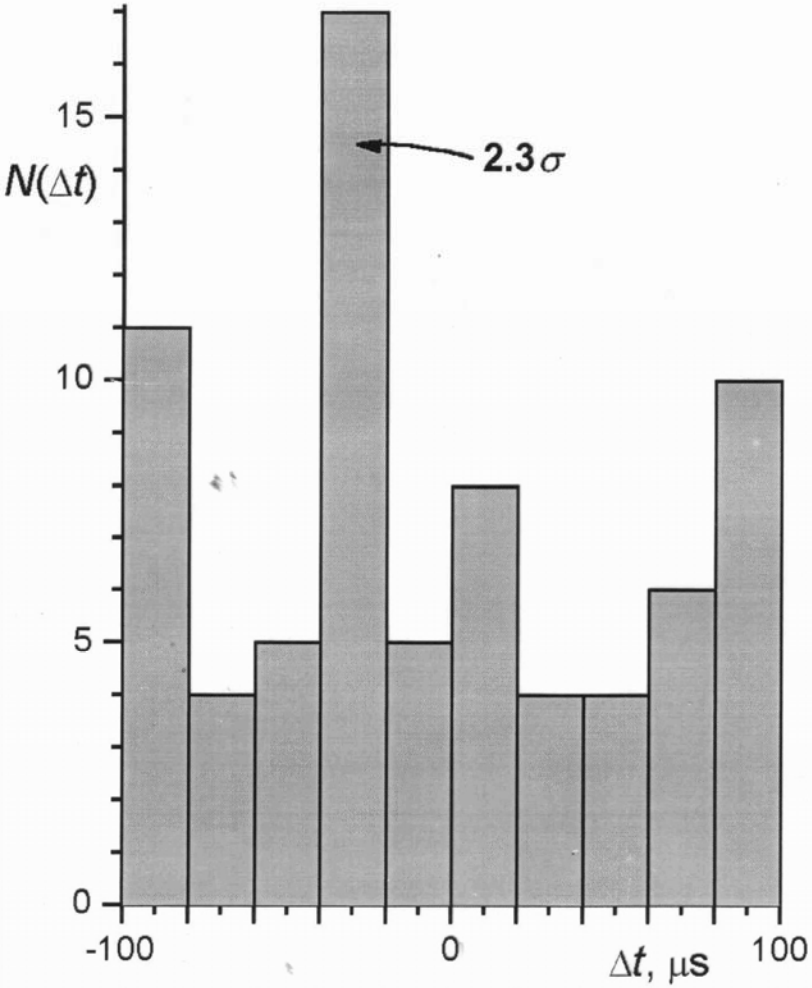
Daemon detection facility with one ZnS(Ag) scintillator plate and the screened lower PM tube

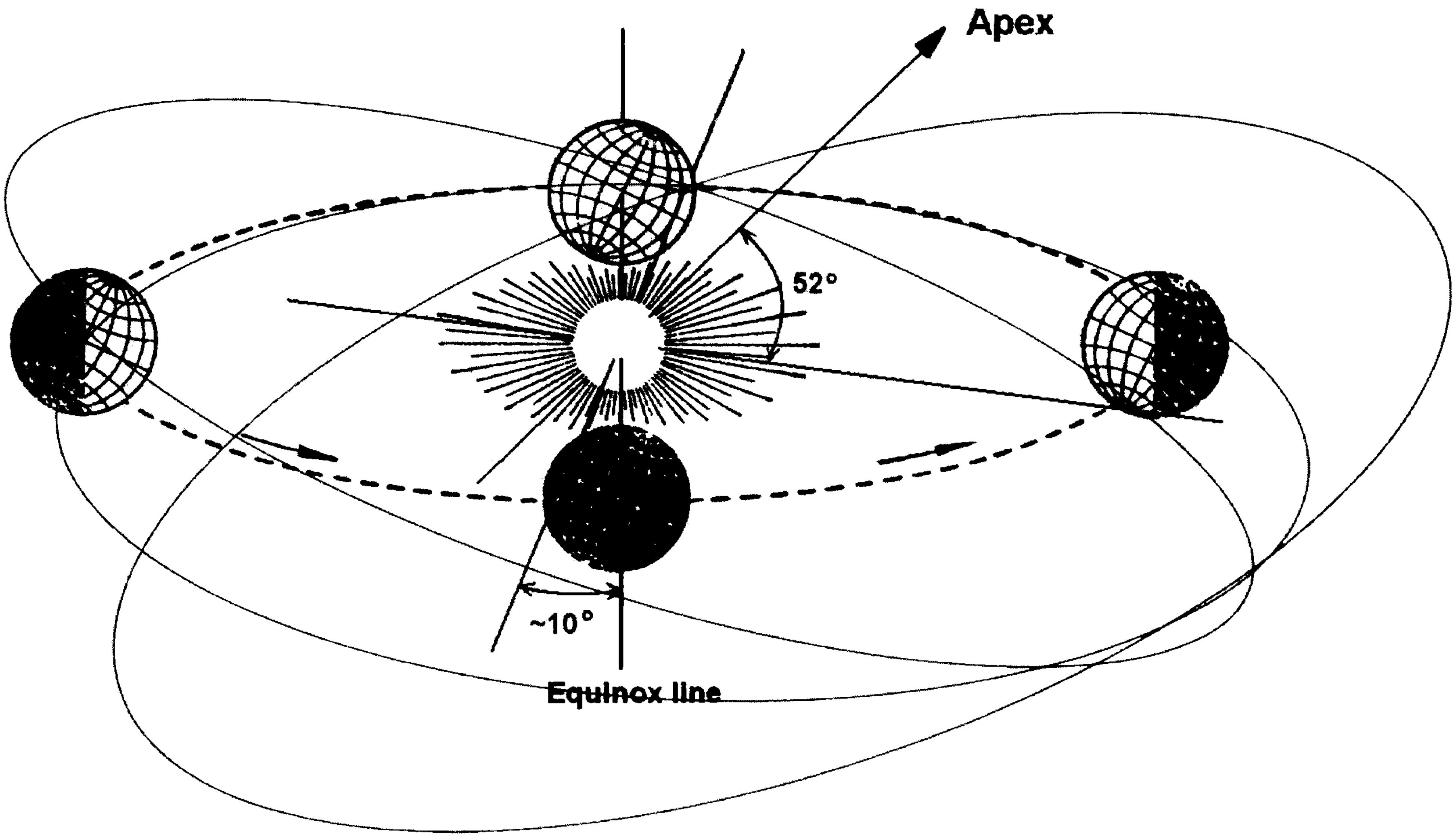


Baksan–PhTI low-background experiment

(with an Al foil-shielded lower PMT and
the ZnS(Ag) layer on the top side of the polystyrene plate)

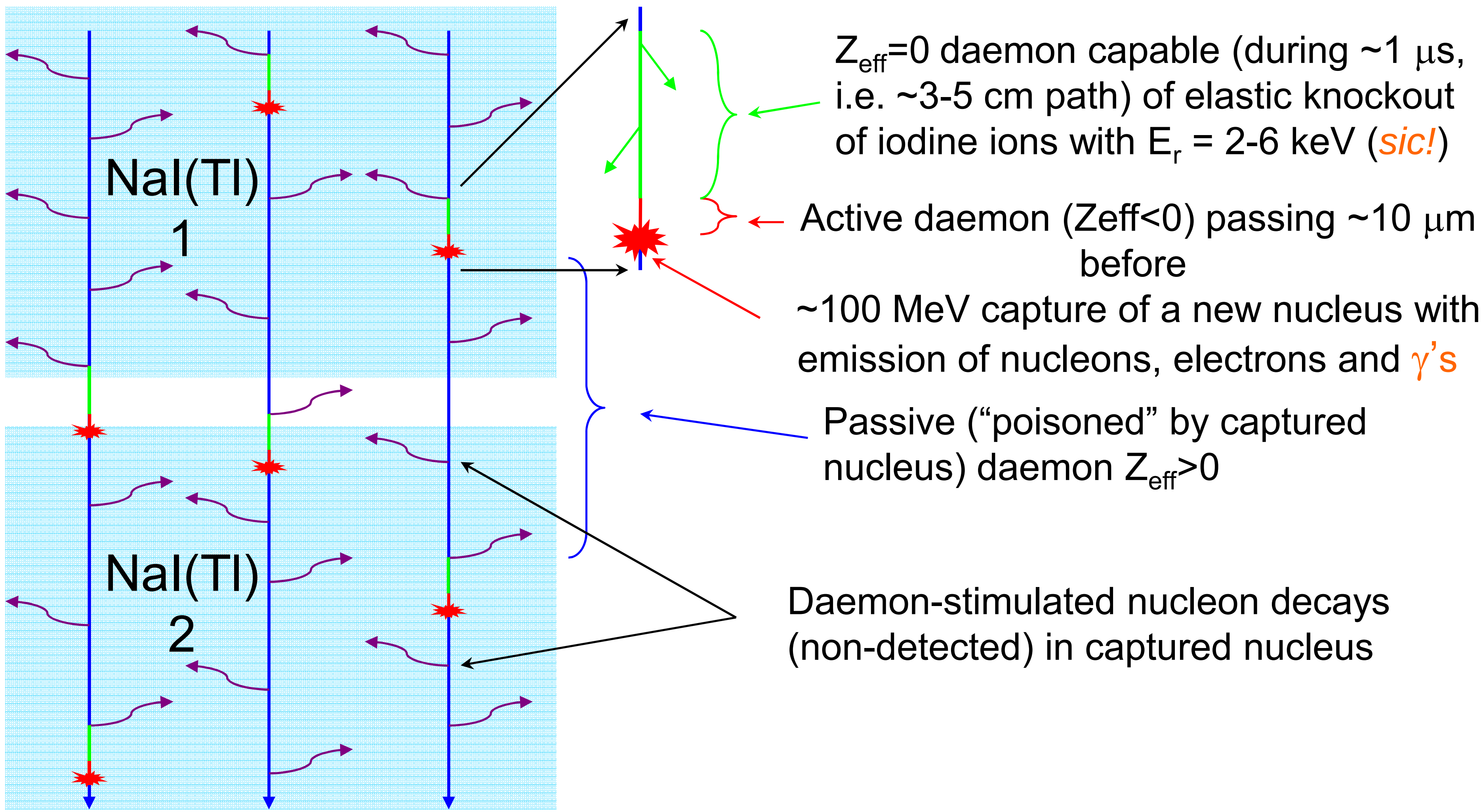
74 events from 12^h 03.09.2005 to 9^h 11.09.2005
At PMT dia. 12 cm, the mean flux of objects
in $-40<\Delta t<-20$ μs bin (velocities $V \approx 10\text{-}20\ \mathrm{kms^{-1}}$)
is $\boldsymbol{f \approx 10^{-7}\ cm^{-2}s^{-1}}$





Apex
52°
~10°
Equinox line

SEECHO daemons in NaI(Tl) crystals (V = 30-50 km/s)



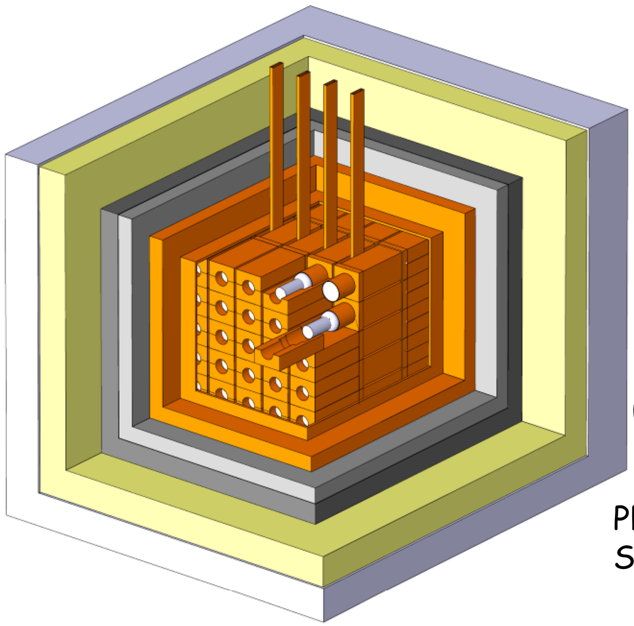
DAMA observes not WIMPs, but SEECHO daemons!

What favors this statement?

1. Non-reproducibility of DAMA results by other WIMP-aimed experiments.
2. 1 y seasonal variation and its phase are typical of the SEECHO daemon flux.
3. A rather narrow 2-6 keV scintillation energy range, where the meaningful data are observed, is equal just to energy of an iodine ion elastically recoiled by a supermassive SEECHO object (V=30-50 km/s). (2 keV is the threshold value.)

4. The previous point has a sense if intensities of scintillations caused by iodine ion and electron of equal energy are the same (i.e. the quenching factor =1). In NaI(Tl) this has to have place for about η = 20% of iodine ions with E_r = 2-6 keV due to their channeling in the crystal (the channeled ions transfer their energy to electrons mainly) (arXiv:0706.3095).
5. At the seasonal modulation depth of number of single-hit events 0.04 cpd/kg/keV for 96 kg NaI(Tl) crystals and their total projected area ~1500 cm^2, one obtains at η = 0.2 the mean flux of objects through the detector in June to be about $6\times10^{-7}\ cm^{-2}s^{-1}$. This value well corresponds to all other our estimates and measurements of the daemon flux.
6. *Prediction* of smaller flux registered by LIBRA.

DAMA/LIBRA shield from environmental radioactivity

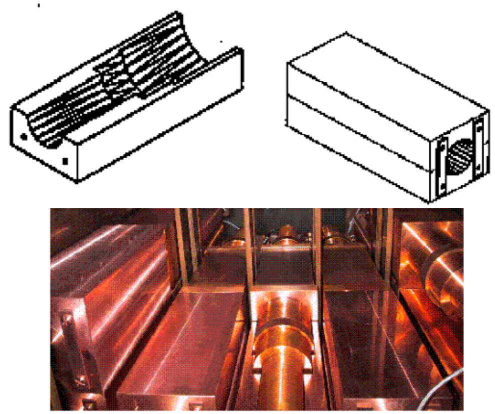


Heavy shield:

>10 cm of Cu, 15 cm of Pb + Cd foils, 10/40 cm Polyethylene/paraffin, about 1 m concrete **(mostly outside the installation)**

High radiopure materials, most underground since at least about 15 year

Pb and Cu etching and handling in clean room.
Storage underground in packed HP N_2 atmosphere



New shaped Cu shield surrounding light guides and PMTs

Three-level system to exclude Radon from the detectors:

- Walls and floor of the inner installation sealed in Supronyl (2×10^{-11} cm^2/s permeability).
- Whole shield in plexiglas box maintained in HP Nitrogen atmosphere in slight overpressure with respect to environment
- Detectors in the inner Cu box in HP Nitrogen atmosphere in slight overpressure with respect to environment

Residual radioactivity in some components of the Cu box (95% C.L.)

Materials	^{238}U (ppb)	^{232}Th (ppb)	^{nat}K (ppm)
Cu	< 0.5	< 1	< 0.6
feedthroughs	—	< 1.6	< 1.8
Neoprene	—	< 54	< 89

Sensitivity limited by the method

Residual contaminants in some components of the passive shield (95% C.L.)

Materials	^{238}U (ppb)	^{232}Th (ppb)	^{nat}K (ppm)
Cu	< 0.5	< 1	< 0.6
boliden Pb	< 8	< 0.03	< 0.06
boliden2 Pb	< 3.6	< 0.027	< 0.06
polish Pb	< 7.4	< 0.042	< 0.03
polyethylene	< 0.3	< 0.7	< 2
plexiglass	< 0.64	< 27.2	< 3.3

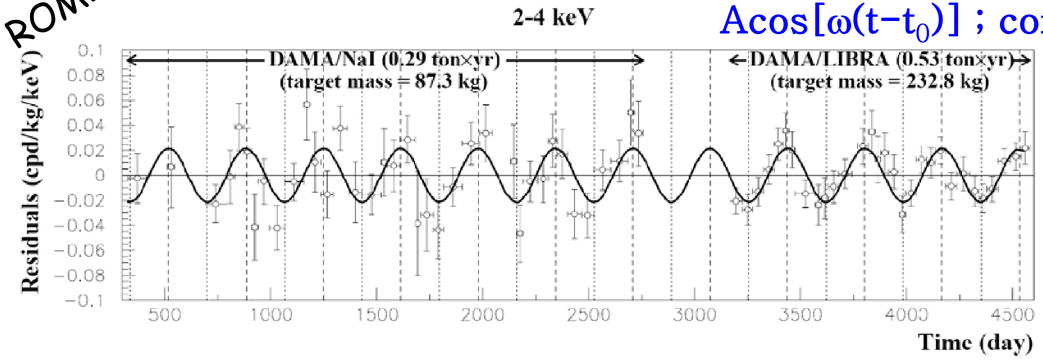
Model Independent Annual Modulation Result

ROM2F/2008/07

DAMA/NaI (7 years) + DAMA/LIBRA (4 years) Total exposure: 300555 kg×day

experimental **single-hit** residuals rate vs time and energy

$A\cos[\omega(t-t_0)]$; continuous lines: t_0 = 152.5 d, T = 1.00 y



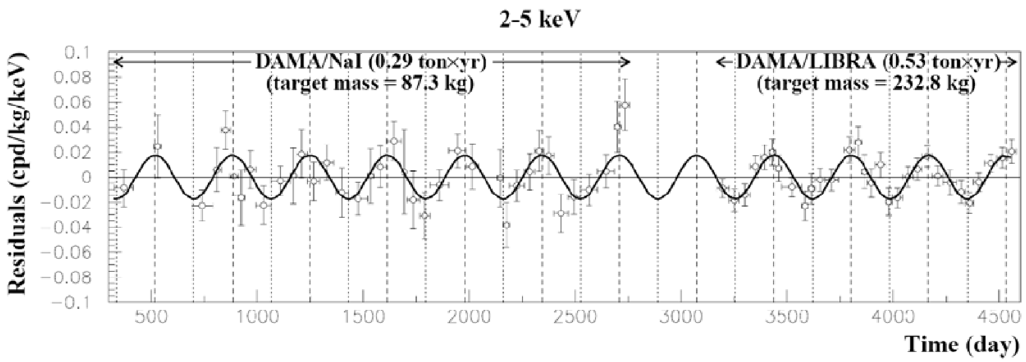
2−4 keV

A=(0.0215±0.0026) cpd/kg/keV

χ^2/dof = 51.9/66 **8.3 σ C.L.**

Absence of modulation? No

χ^2/dof=117.7/67 ⇒ P(A=0) = 1.3×10^{-4}



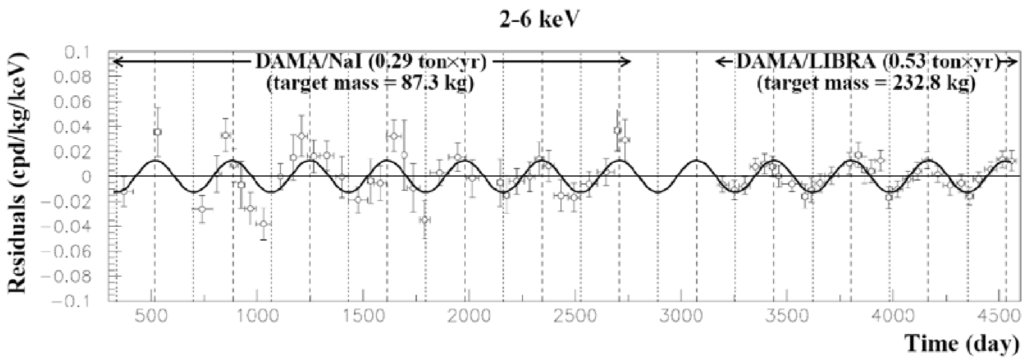
2−5 keV

A=(0.0176±0.0020) cpd/kg/keV

χ^2/dof = 39.6/66 **8.8 σ C.L.**

Absence of modulation? No

χ^2/dof=116.1/67 ⇒ P(A=0) = 1.9×10^{-4}



2−6 keV

A=(0.0129±0.0016) cpd/kg/keV

χ^2/dof = 54.3/66 **8.2 σ C.L.**

Absence of modulation? No

χ^2/dof=116.4/67 ⇒ P(A=0) = 1.8×10^{-4}

The data favor the presence of a modulated behavior with proper features at 8.2σ C.L.

Model-independent residual rate for *single-hit* events

DAMA/NaI (7 years) + DAMA/LIBRA (4 years) total exposure: 300555 kg×day;

Single-hit criterion does not work – particles are not WIMPs!

They are DAEMONS!

Results of the fits keeping the parameters free:

	A (cpd/kg/keV)	T= 2π/ω (yr)	t_0 (day)	C.L.
DAMA/NaI (7 years)				
(2÷4) keV	0.0252 ± 0.0050	1.01 ± 0.02	125 ± 30	5.0σ
(2÷5) keV	0.0215 ± 0.0039	1.01 ± 0.02	140 ± 30	5.5σ
(2÷6) keV	*0.0200 ± 0.0032*	1.00 ± 0.01	140 ± 22	6.3σ
DAMA/LIBRA (4 years)				
(2÷4) keV ?? ?!	0.0213 ± 0.0032	0.997 ± 0.002	139 ± 10	6.7σ
(2÷5) keV	0.0165 ± 0.0024	0.998 ± 0.002	143 ± 9	6.9σ
(2÷6) keV	*0.0107 ± 0.0019*	0.998 ± 0.003	144 ± 11	5.6σ
DAMA/NaI + DAMA/LIBRA				
(2÷4) keV	0.0223 ± 0.0027	0.996 ± 0.002	138 ± 7	8.3σ
(2÷5) keV	0.0178 ± 0.0020	0.998 ± 0.002	145 ± 7	8.9σ
(2÷6) keV	0.0131 ± 0.0016	0.998 ± 0.003	144 ± 8	8.2σ

(Slide by R. Bernabei *et al.* with comments by E. Drobyshevski)

Results of DAMA/LIBRA

1. Prediction of a smaller number of 2-6 keV number of the 1-yr modulated events was confirmed (great deficiency of events in 5-6 keV range due to applying the single-hit criterion in 600 ns window; daemons are not WIMPs!).
2. Further *prediction*: the 2-6 keV events caused by neutral c-daemons are ~1 μs precursors of MeV events due to capture of nuclei by c-daemons obtaining in ~1 μs a negative charge owing to daemon-stimulated proton decay in the remnant of previously captured nucleus.

Why, say, the CDMS experiments do not detect SEECHO daemons?

- Towers at T = 50 mK of Si (A = 28) & Ge (A = 72.6) disc elements 7.6 cm dia. (S = 45.4 cm^2) of 1 cm thick.
- At maximal SEECHO velocity $V_d = 51.6$ km/s, $V_{r\ max} = 2V_d = 103.2$ km/s.
- Even for Ge: $E_{r\ max} = 4.04$ keV < $E_{thresh} = 7$ keV (see Fig.2 in CDMS Collab., DARK-2007, p.66)

Attempts to reveal the daemon-stimulated decay of proton

- Besides the existence of daemons by themselves, another basic assumption underlying our experiment is a gradual decomposition of nucleus captured by the daemon. The decomposition is caused by the daemon-stimulated proton decay. Time of the daemon-containing Zn nucleus transition through our detector defines the mean proton decay time as ~1 μs (astro-ph/0108231).
- To reveal such successive events, we assembled a detector of 4.3 cm-thick CsI(Tl) scintillators of 560 cm^2 total area. The idea was that, at the daemon flux ~10^{-7} $cm^{-2}s^{-1}$, in about every 5 hours, we'll observe a trail of 3-4 scintillations separated by a mean ~1 μs interval.

- At the proton decay, 938 MeV energy is liberated. If proton decays into positive π+ and uncharged π^0 mesons, they leave in a 4.3 cm thick CsI(tl) crystal about 100 MeV only.
- At the threshold level of about 50 MeV, we did not observe triple events during weeks!
- So our tentative conclusion is that a daemon – being a Planckian black hole – decomposes the captured nucleus in a somewhat different way. How?…

Conclusions

1. The daemon paradigm occurred to be self-consistent and rather fruitful (arXiv:0711.4779, etc).
2. Our two-screen surface-based (in SPb) and one-screen + daemon-sensitive PMT (in Baksan) detectors registered NEACHO daemons with C.L. = 99.99%. Their flux exceeds 10^{-7} $cm^{-2}s^{-1}$ and changes with 0.5 y period.

3. The daemon paradigm explains quantitatively the DAMA/NaI results and their non-reproducibility in other WIMP-focused experiments as well. It had predicted (now confirmed!) deficiency of DAMA/LIBRA events. The SEECHO daemon flux measured by DAMA/NaI achieves about the same value of $>10^{-7}$ $cm^{-2}s^{-1}$.

4. If combining both our SPb and DAMA results, the celestial-mechanics calculations of the daemons' capture from their Galaxy disk population by the Sun and the Earth define the daemon cross-section relative the Solar matter as 10^{-19} cm^2.

5. Great significance presents a coincidence of the daemon fluxes (in a rather narrow range of 10^{-7}-10^{-6} $cm^{-2}s^{-1}$) defined by different methods: estimate of capture into SEECHOs (1996), explanation of "Troitsk anomaly" in ^3T beta-spectrum tail (2005), measurements in PhTI-Baksan (2005), DAMA/NaI (2007), and DAMA/LIBRA data (2008).
6. Of special interest would be synchronous detection of the NEACHO daemon primary flux direction in Northern and Southern hemispheres during March and September maxima (the directions must be opposite!).

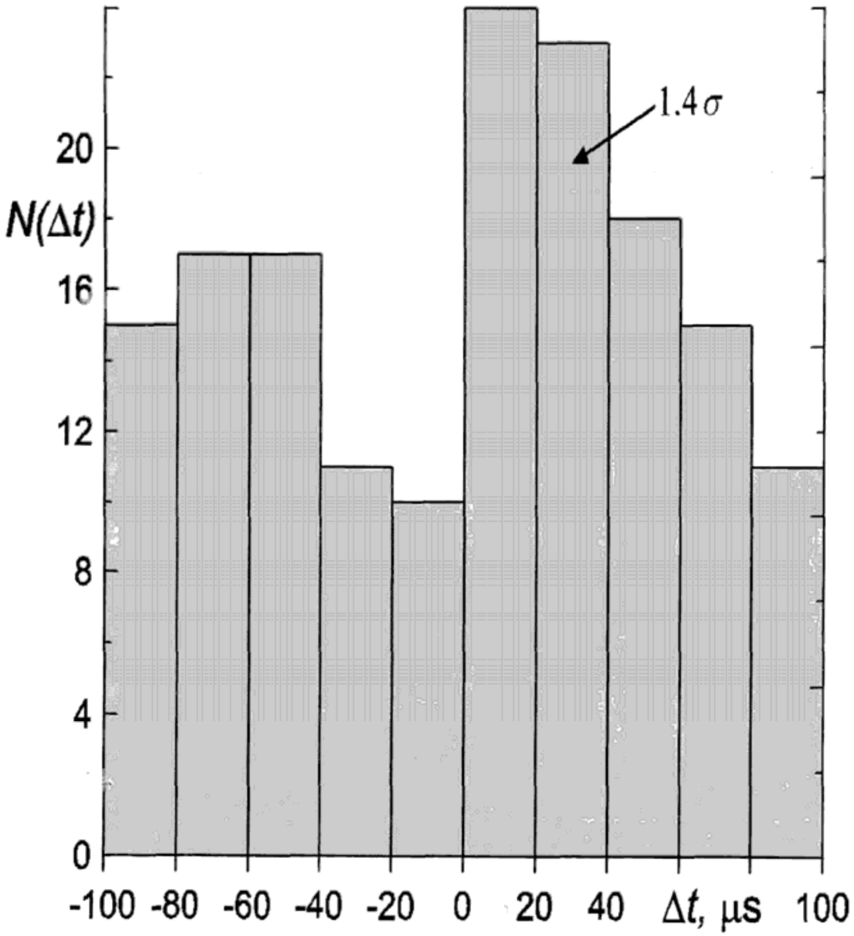
7. The daemon paradigm proved to be successful in (sometimes quantitative!) *explanation* (DAMA/NaI & DAMA/LIBRA data, excessive heat, seismic anisotropy and ^{3}He fluxes from the Earth core, 511 keV – excess positrons' annihilation in the Galaxy center, "Troitsk anomaly" – 5 eV value and 0.5 year drift of a step in the ^{3}T beta-spectrum tail, etc.),

8. and *prediction* of numerous phenomena {daemon kernels in stars and planets, ~10-fold increasing the iodine ion quenching factor in NaI(Tl) due to channeling (confirmed!), DAMA/LIBRA event deficiency (confirmed!), appearance of "Troitsk anomaly" in future - 2009-et seq. - KATRIN experiments, etc.}.

Baksan-PhTI low-background experiment

(with an Al foil-shielded lower PMT and the ZnS(Ag) layer on the top side of the polystyrene plate)

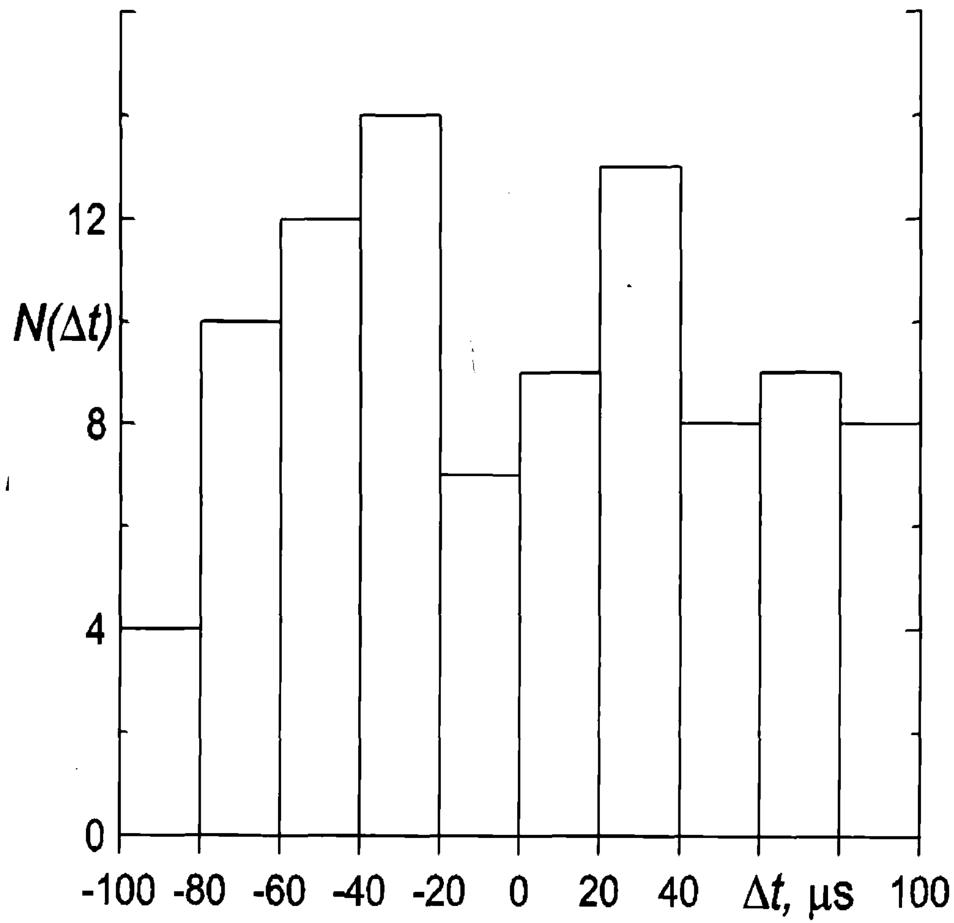
161 events from 16^h 03.03.2006 to 04^h 18.03.2006



Baksan-PhTI low-background experiment

(with an Al foil-shielded lower PMT and
the ZnS(Ag) layer on the top side of the polystyrene plate)

94 events from 04^h 18.03.2006 to 24^h 24.03.2006



“Troitsk anomaly”

– occurrence of a 5 eV step in the ^{3}T beta spectrum tail and its 0.5 y variation **–**

favors NEACHO daemon existence

Transit of daemons through the $NbTi_2$ and Nb_3Sn superconducting magnet windings of the tritium gas source leads to capture of the Nb (and Sn) atom-containing clusters. Their transport into the gas channel and excitation there result in emission of five (18566, 18568, 18569, 18570 and 18572 eV) Nb Auger electron lines, just close to the region of the β-spectrum end-point (E_0=18574-18590 eV).

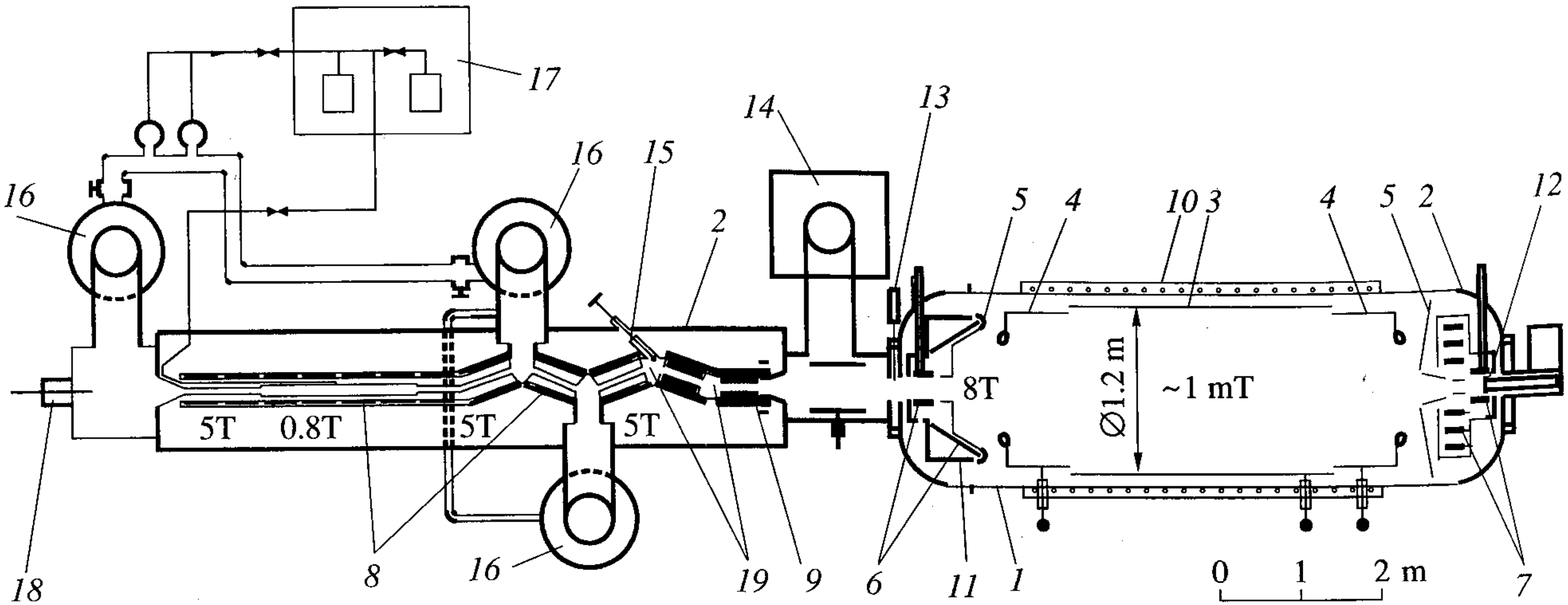


Fig. 2. Experimental set-up. (*1*, *2*) vacuum tanks; (*3*, *4*) electrostatic analyzers; (*5*) grounded electrodes; (*6–9*) superconducting coils (LHe-system, 4.7 K); (*10*) warm coil; (*11*) LN_2 jacket; (*12*) Si(Li) detector; (*13*) fast shutter; (*14*) Ti pump; (*15*) cold valve; (*16*) Hg diffusion pump; (*17*) T_2 purification system (27 K); (*18*) electron gun; (*19*) argon pump.

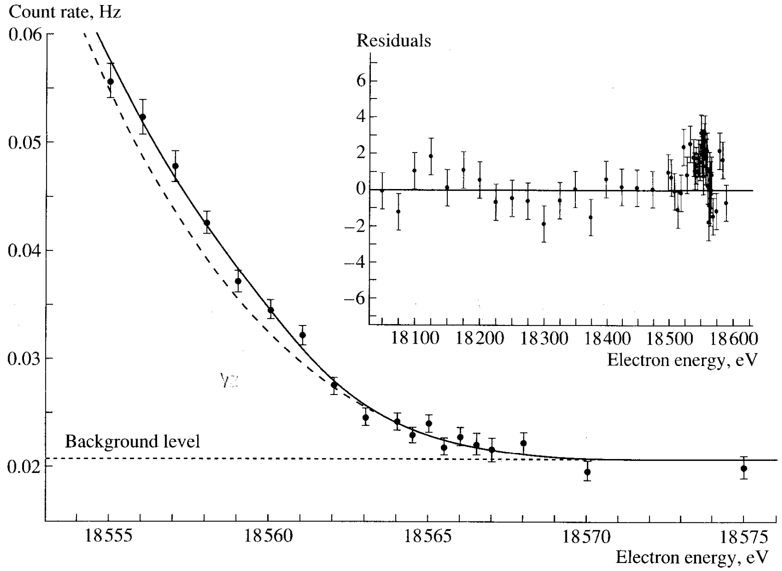


Fig. 3. Part of the experimental spectrum near the end-point. The solid line is the fitted theoretical spectrum with a step function. The dotted line is the theoretical spectrum with a subtracted step function. Upper right corner: the spectrum of residuals for entire measured part of the spectrum. Residuals are $(N_{exp} - N_{theor})/\sigma$, where N_{exp} is the same as the dotted line in the previous plot, σ is the standard deviation at each point.

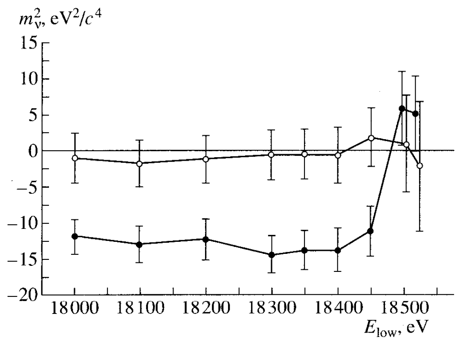


Fig. 4. Dependence of m_ν^2 on E_{low} for the sum of the runs 94, 96, 97.2, 98 data. Closed circles are the fit without the step function (4-parameter fit). Open circles are the fit with the step function (6-parameter fit).

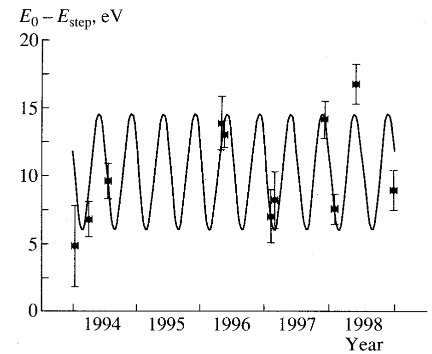


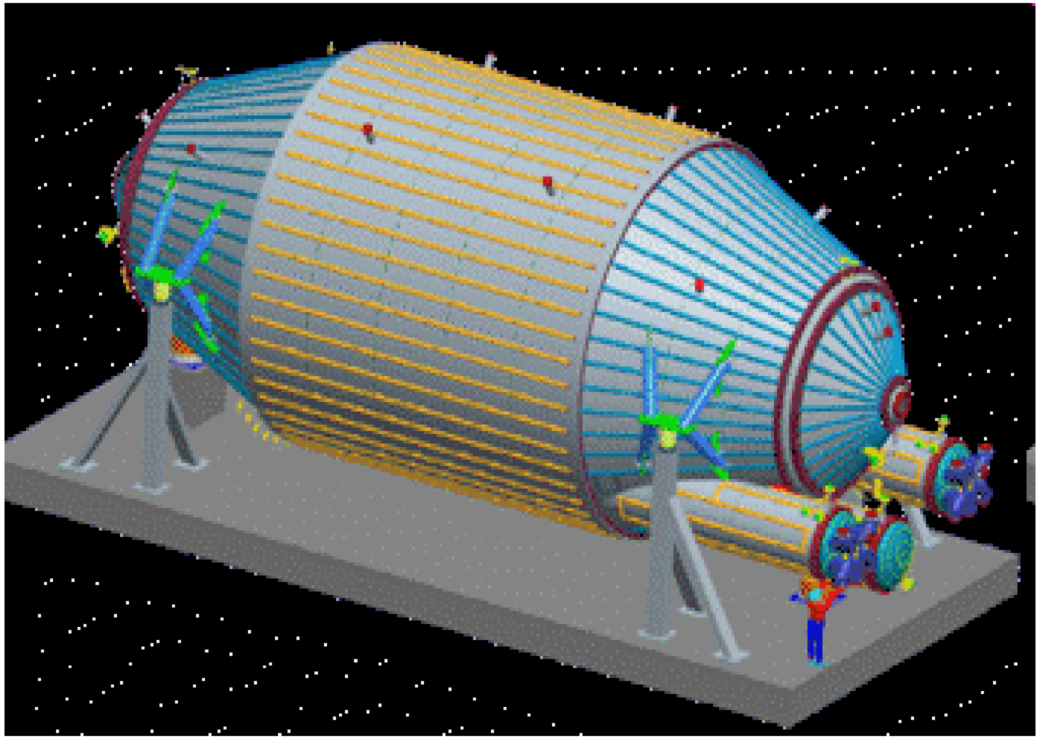
Fig. 5. Dependence of the step position on the calendar time of measurements. Parameters of the fitted sinusoid: period 0.499 ± 0.003 yr, mean value 10.4 ± 0.4 eV, amplitude 4.3 ± ± 0.55 eV, phase 2.6 ± 0.23 rad.

Data of all the years including points of the Mainz group reported in this conference are combined in one year plot (Fig. 7). It confirms that the variation of the step position has biseasonal character.

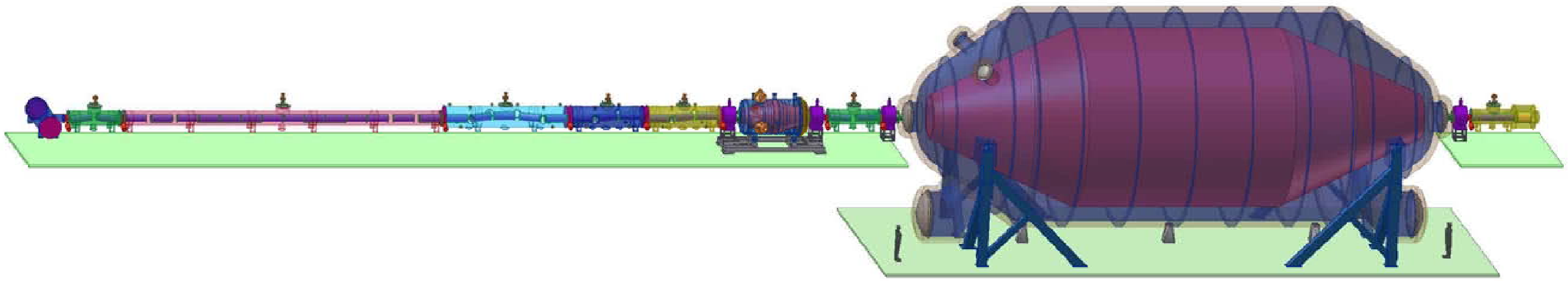
The plot of step size values given in Fig. 8 proved to be more peculiar. The data obtained before 98.3 roughly agreed, at least for the first maximum, with the half-year period so that a larger step size corresponds to a

The observed emission intensity (the step size) defines the value of the daemon flux (just 10^{-6}-10^{-7} $cm^{-2}s^{-1}$), while the step position on the energy axis is determined by seasonal variation of the daemon velocity (addition of 10-15 km/s to Auger electrons corresponds to just ΔE ≈ 5 eV their energy dispersion).

The phase of the effect corresponds to our measurements but again (hep-ph/0502056).



One can *predict*: the KATRIN-2009 version with gaseous ^3T source (and Nb-Sn containing windings) shall demonstrate a still larger magnitude of the "Troitsk effect".



KATRIN from Tritium Source to Detector