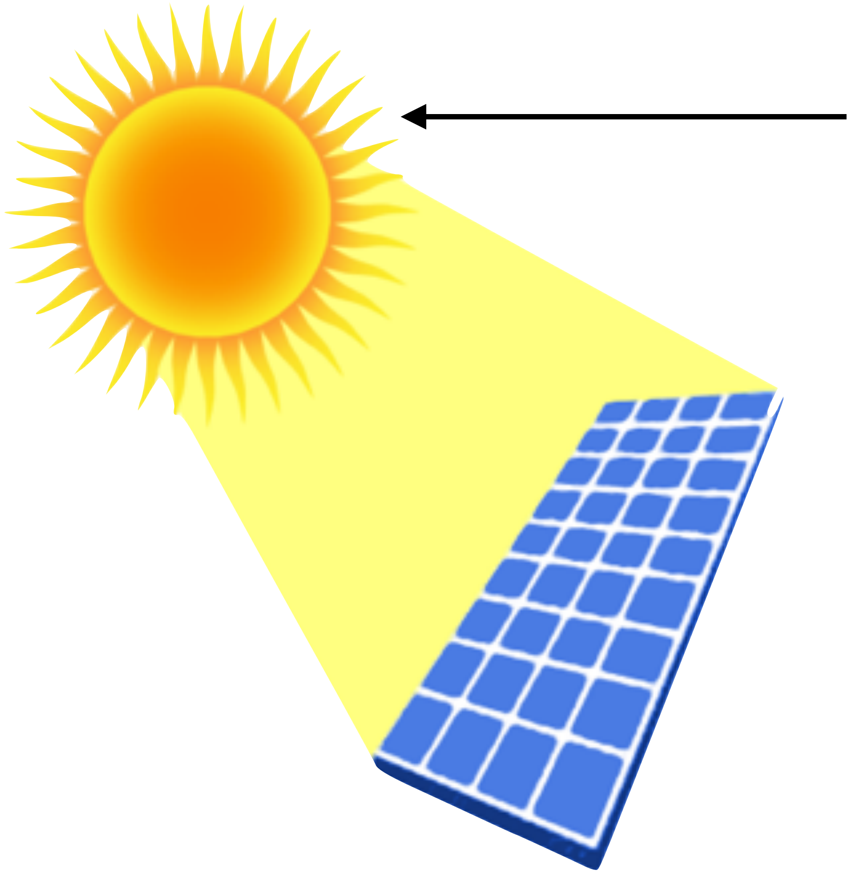
Ultra-dense Hydrogen and Low Energy Nuclear Reactions

Presenter Sveinn Ólafsson Research professor Science Institute University of Iceland

AVS62 Photocatalysis session

Overview of talk



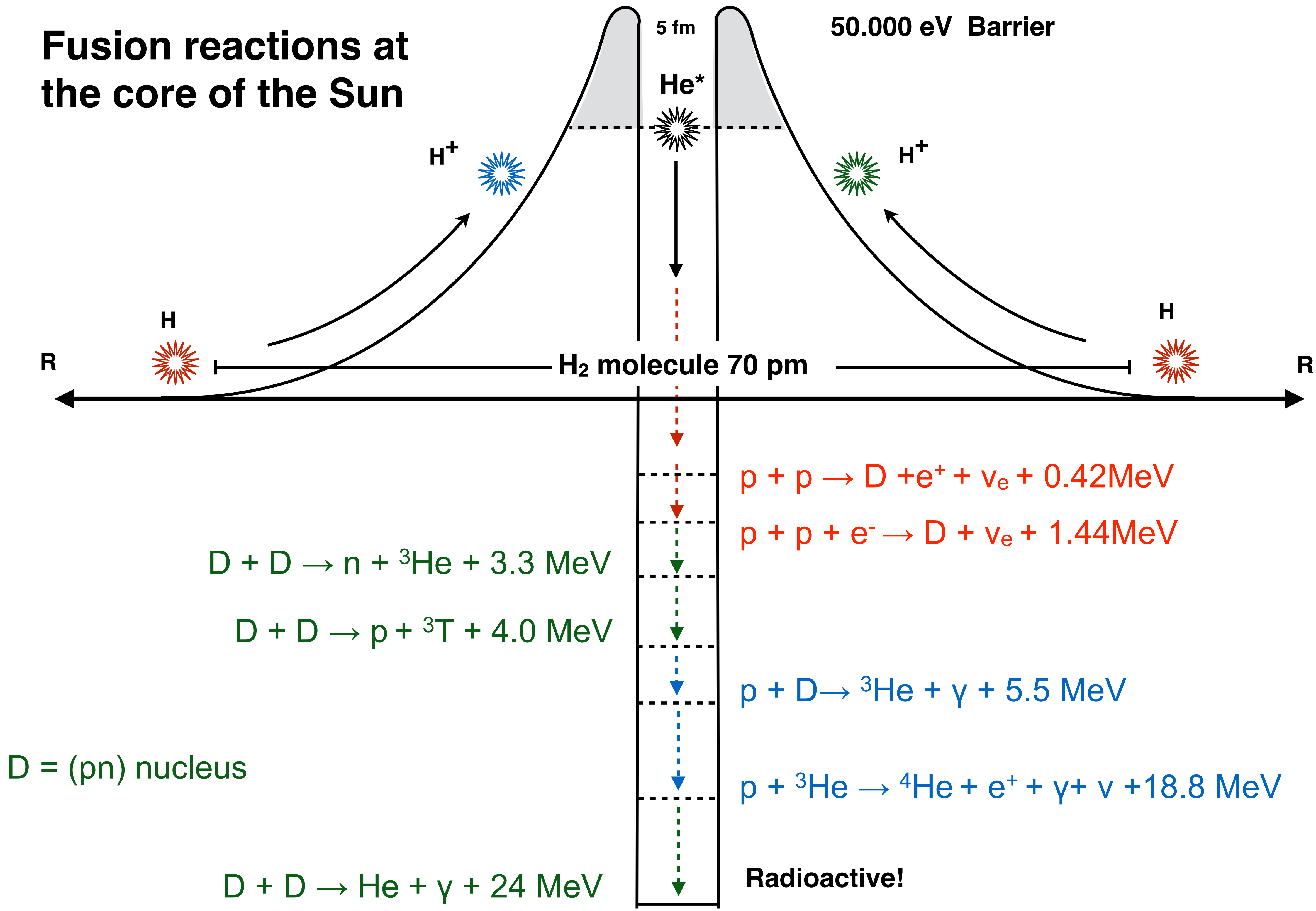
1. Fusion reactions short overview
2. Palladium Deuterium
3. Nickel - Hydrogen
4. The Ultra-dense hydrogen
5. Theoretical discussion
6. Summary

1. Fusion reactions short overview

University of Iceland School of Natural Science and engineering

Sveinn Ólafsson and Leif Holmlid

Fusion reactions at the core of the Sun



Molecular muonium fusion, *μ*-catalysed fusion known since 1947

Couloumb barrier is thin,

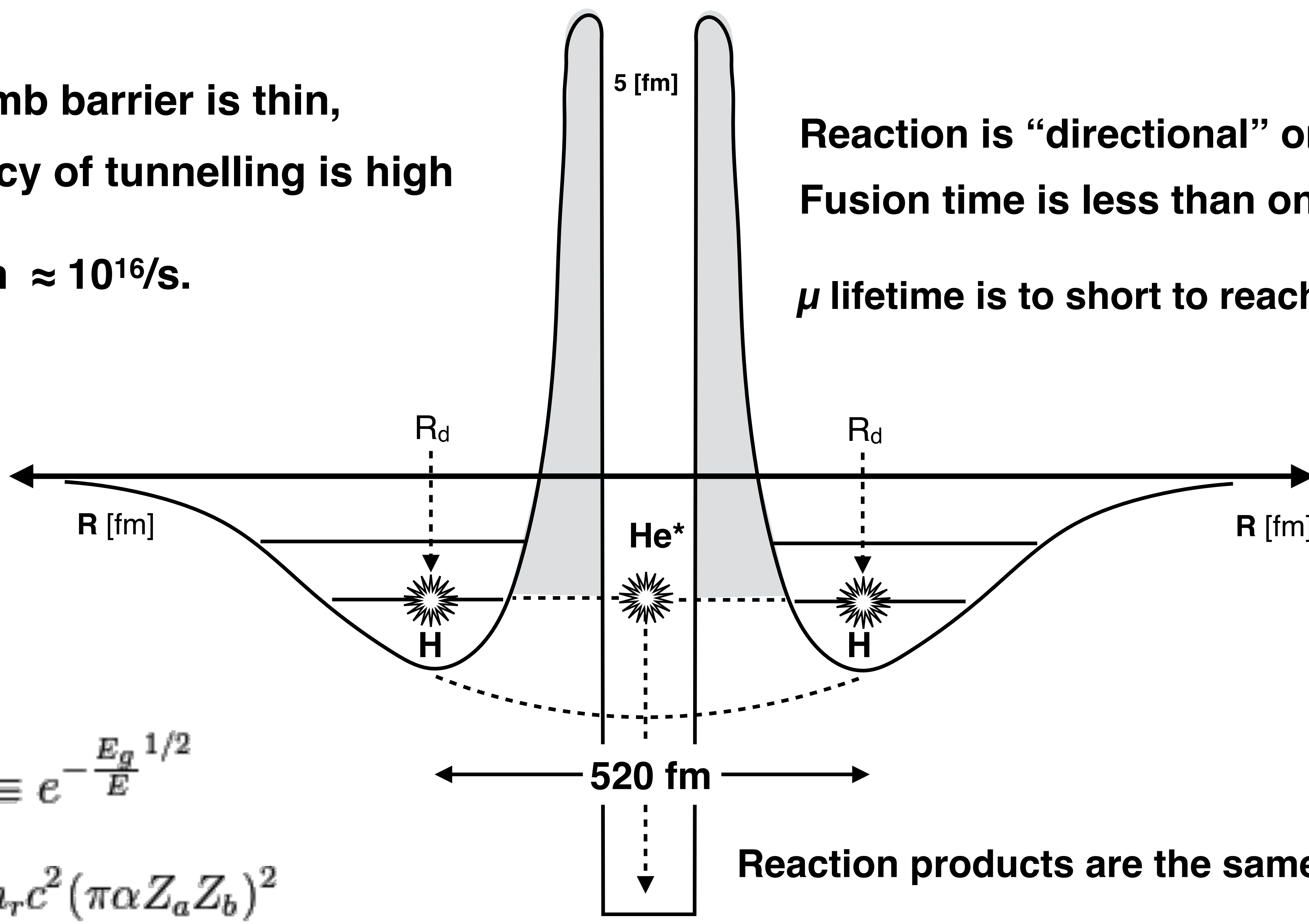
frequency of tunnelling is high

$f = E_{vib}/h \approx 10^{16}$/s.

Reaction is “directional” or “lined up”

Fusion time is less than one nanosecond

***μ* lifetime is to short to reach beak even**



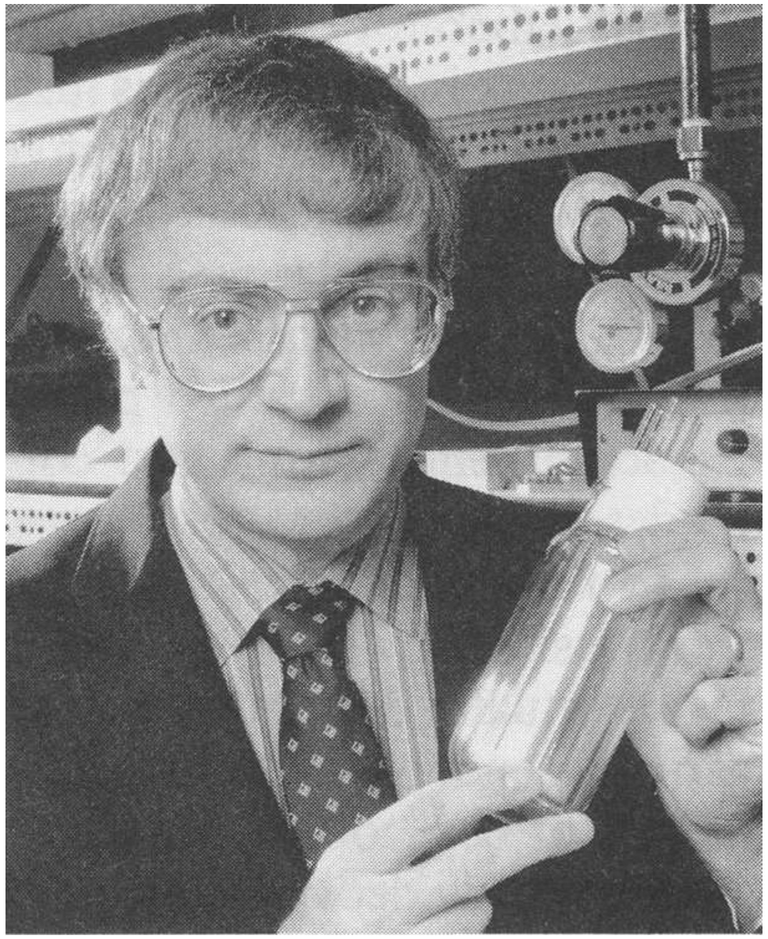
$$P_g(E) \equiv e^{-\frac{E_g}{E}^{1/2}}$$

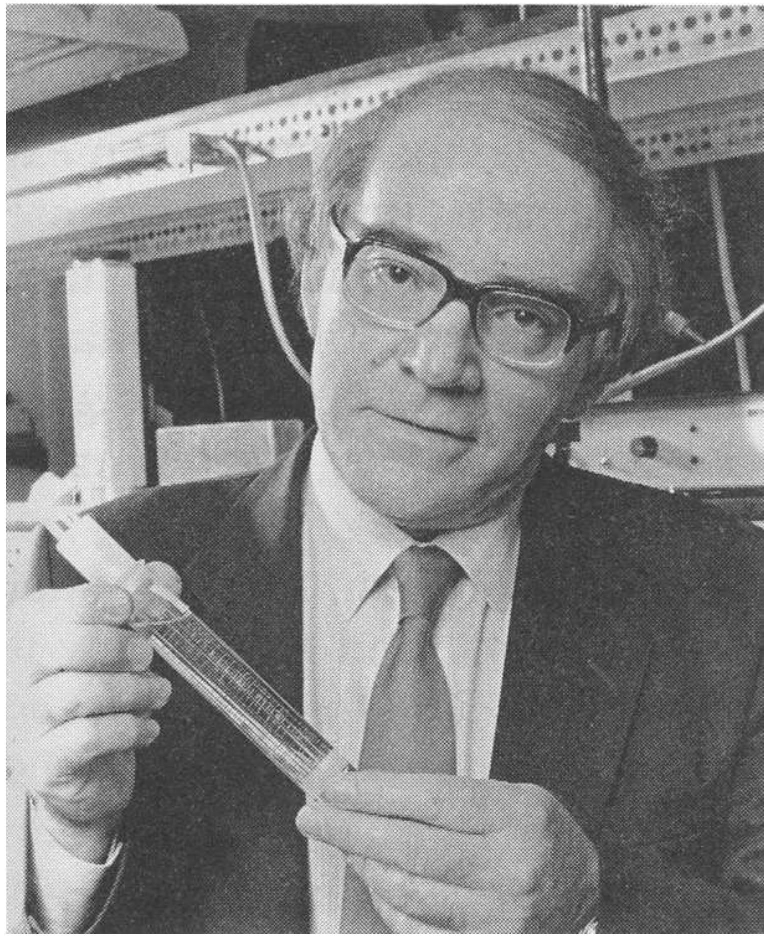
$$E_g \equiv 2m_r c^2 (\pi\alpha Z_a Z_b)^2$$

Reaction products are the same as in the Sun !

Not drawn to scale

2. Palladium-Deuterium



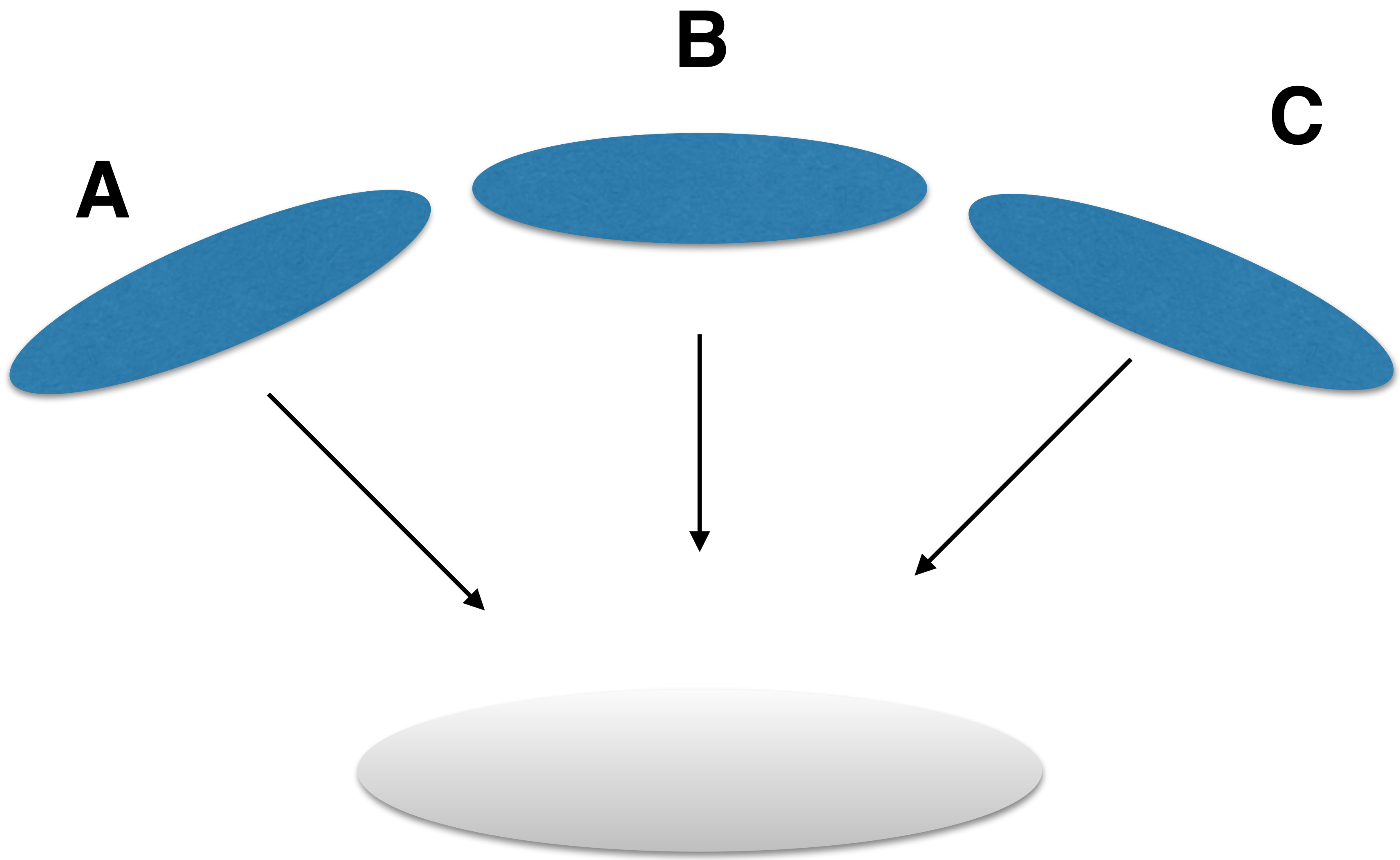


1989

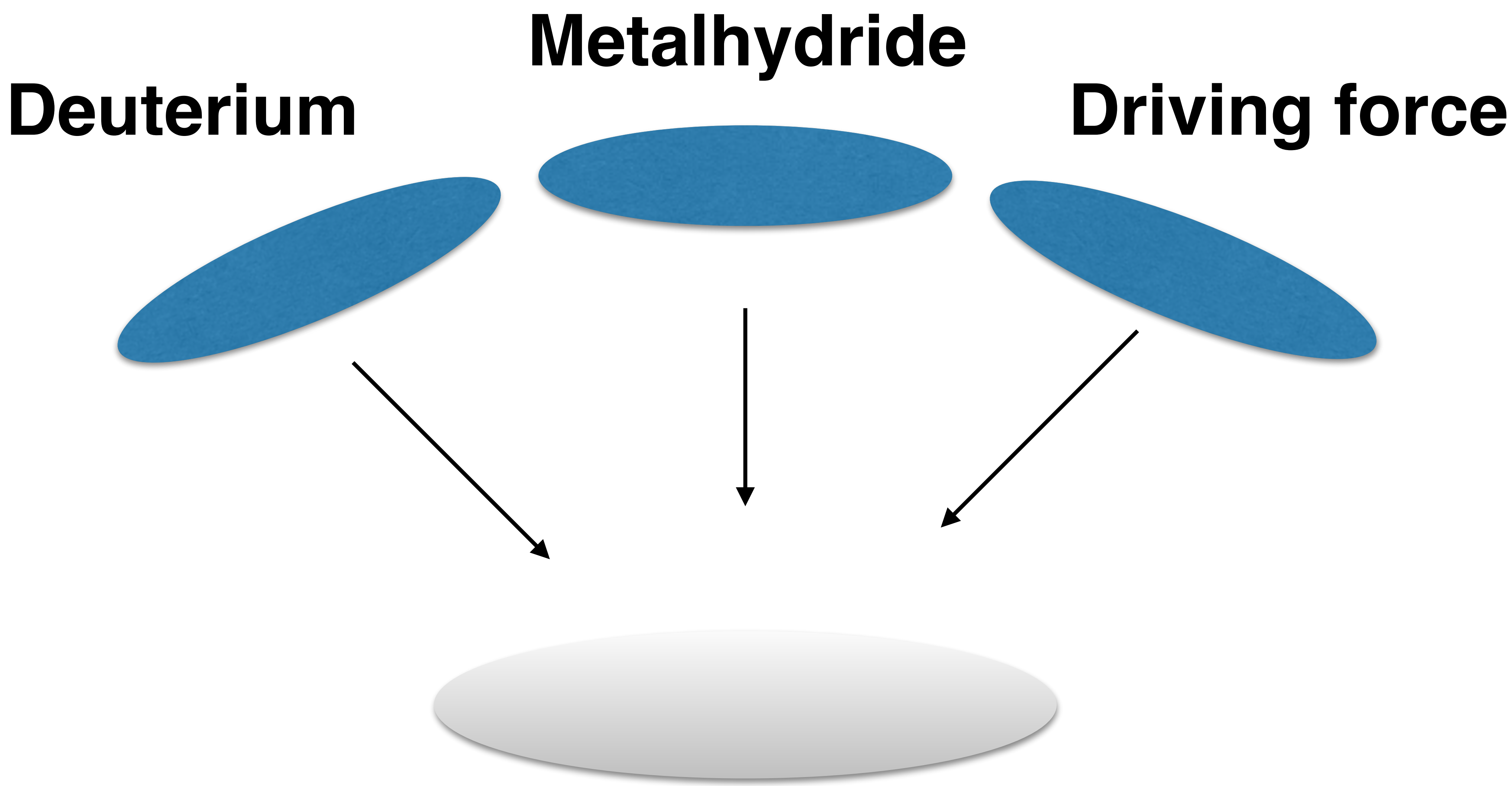
Pons and Fleischmann

How would scientist start a research on the possibility of cold fusion in year 2015?

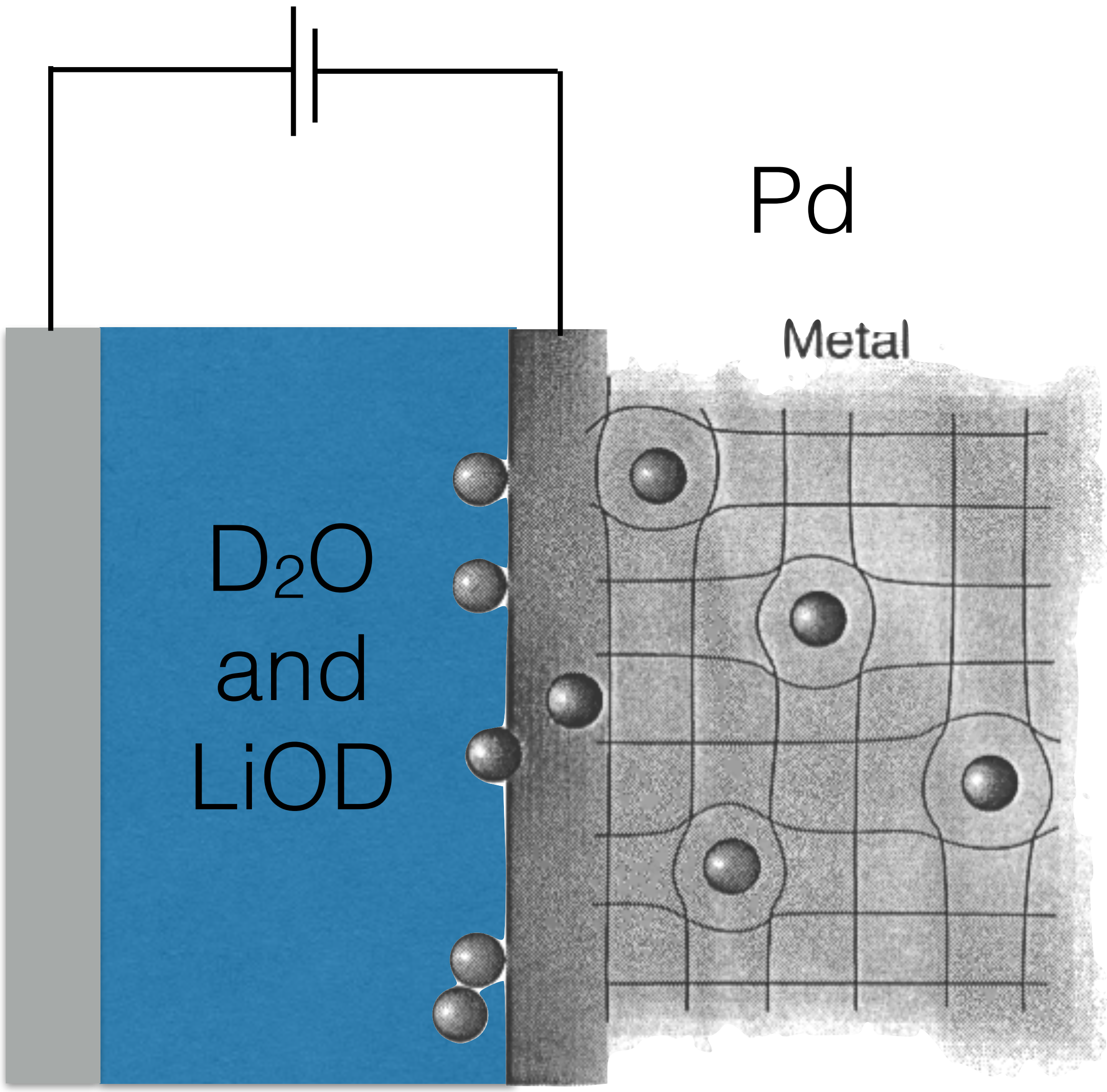
Combinatorical Research!



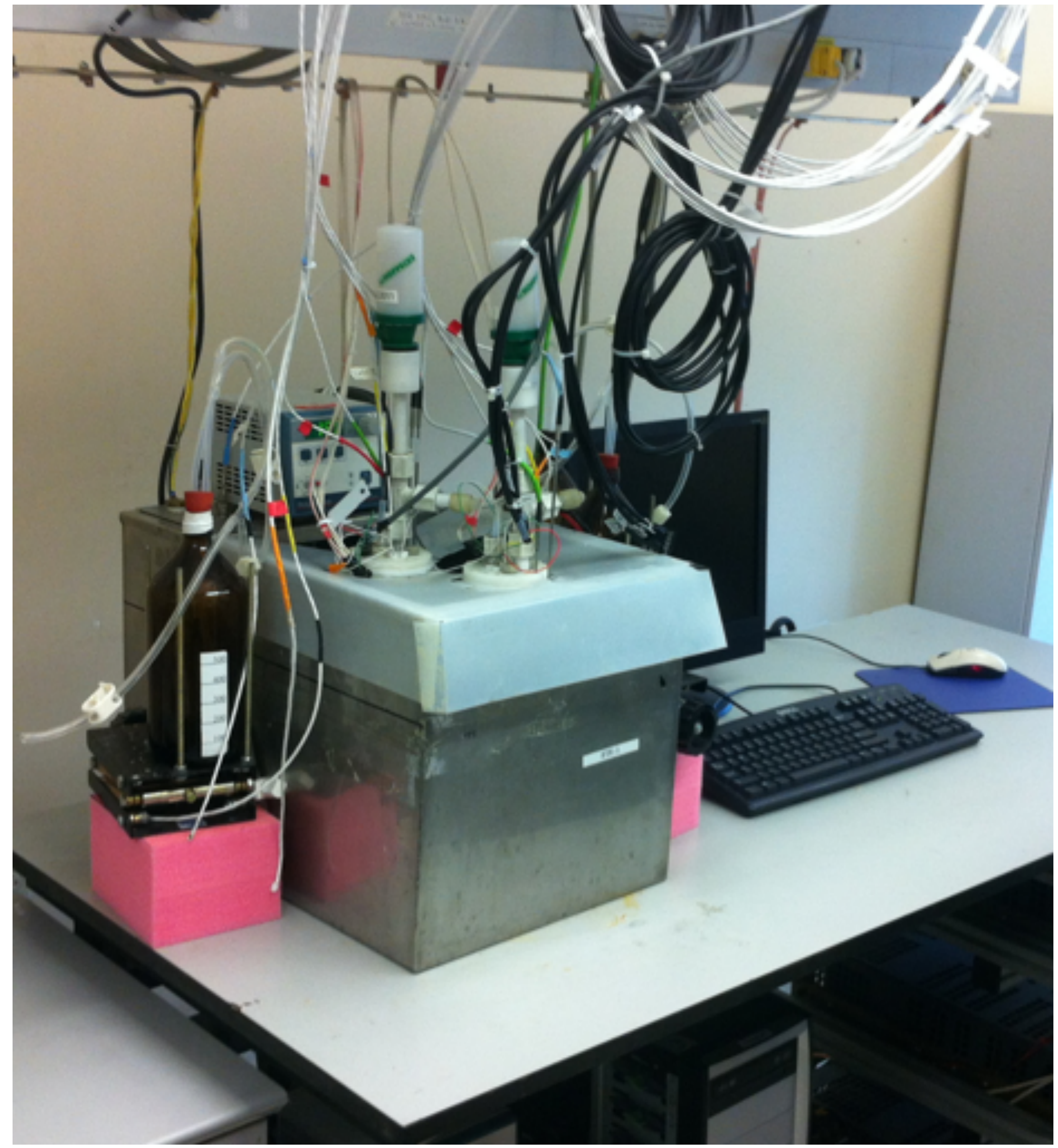
Combinatorical Research!



Deuterium in Palladium



Electrochemical cell



University of Missouri

No need to perform the experiment, the results are in

Modest Excess heat 1 - 50W for varying time span

19 conferences since 1989

Helium is detected, transmutations are detected

Small reproducibility possible with protocols.

Not limited to Pd or Ni

JOURNAL OF CONDENSED MATTER NUCLEAR SCIENCE
www.iscmns.org

Radioactivity is quenched! tiny amount of Tritium, neutrons and protons are detected

LENR-CANR.ORG

The library includes more than 1,000 original scientific papers reprinted with permission from the authors and publishers. Bibliography of over 3,500 journal papers, news articles and books about LENR.

www.iccf19.com

"Nanocracks in Palladium are the active sites in Pd"

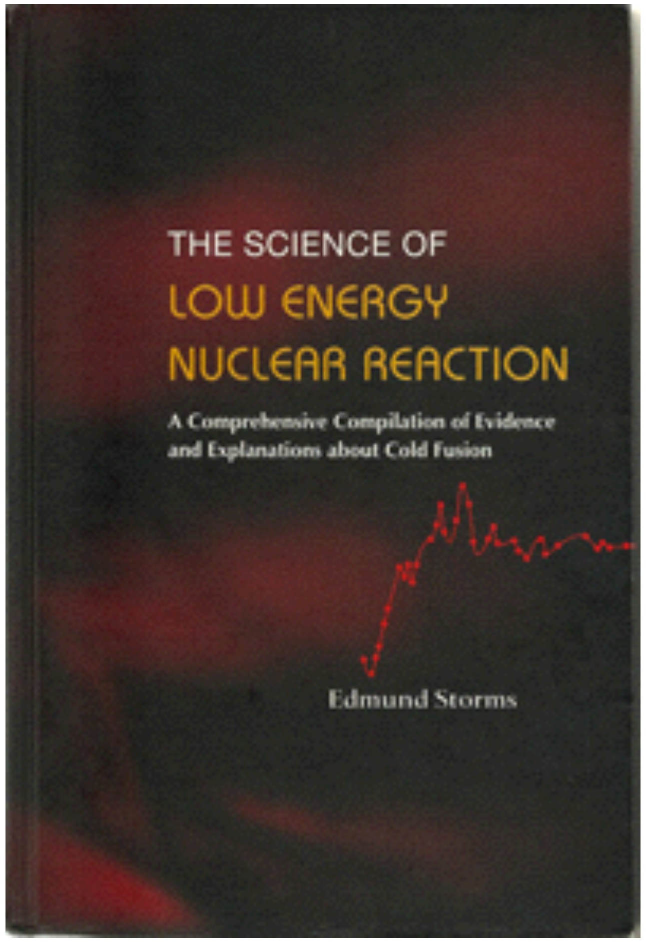
Conducts online PdD experiments with 0.4W excess heat or ~10^{12} fusion events /sec

Progress report #1- #6

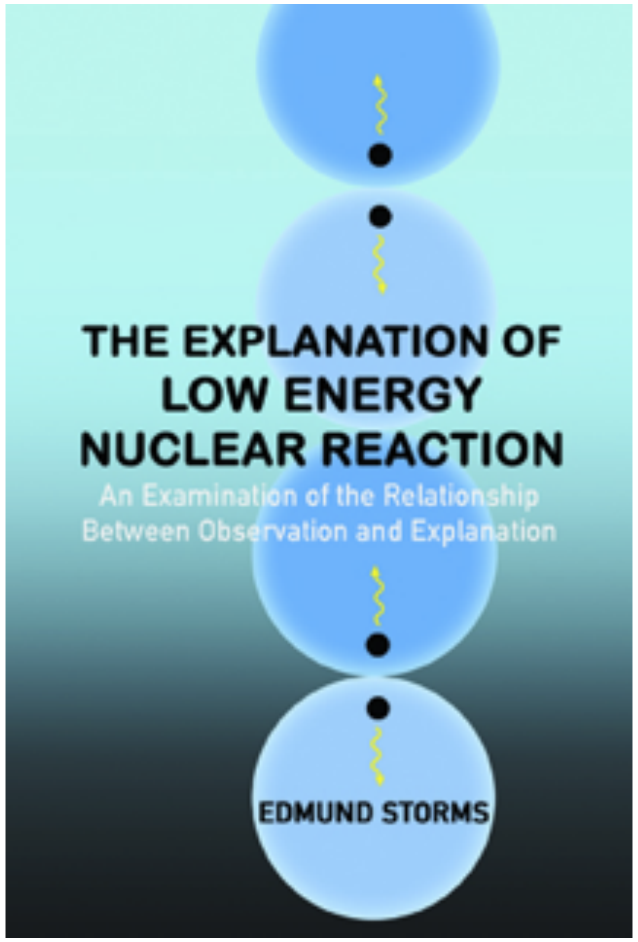
Review books

lenrexplained.com

Edmund Storms



Review book 2007

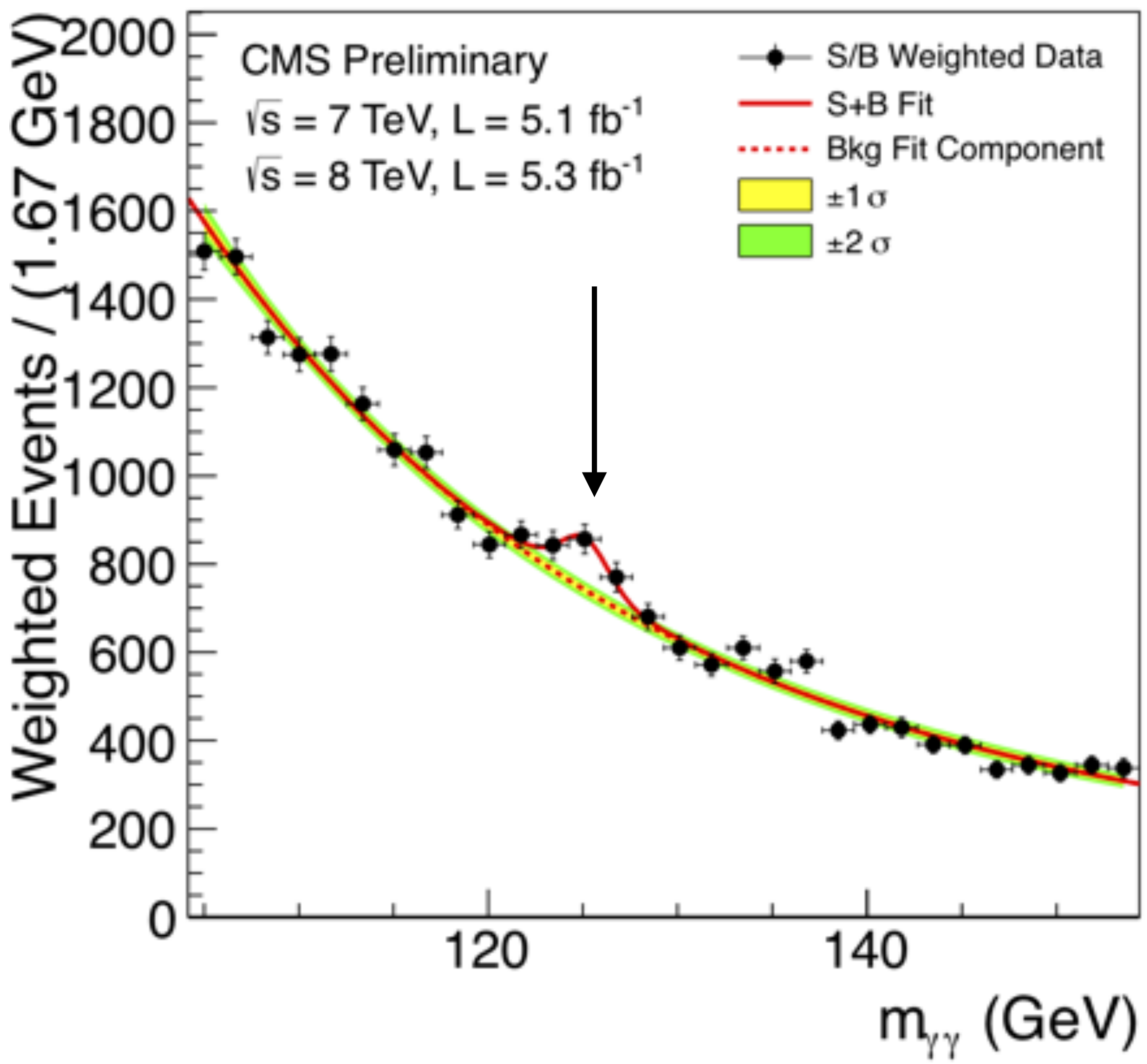


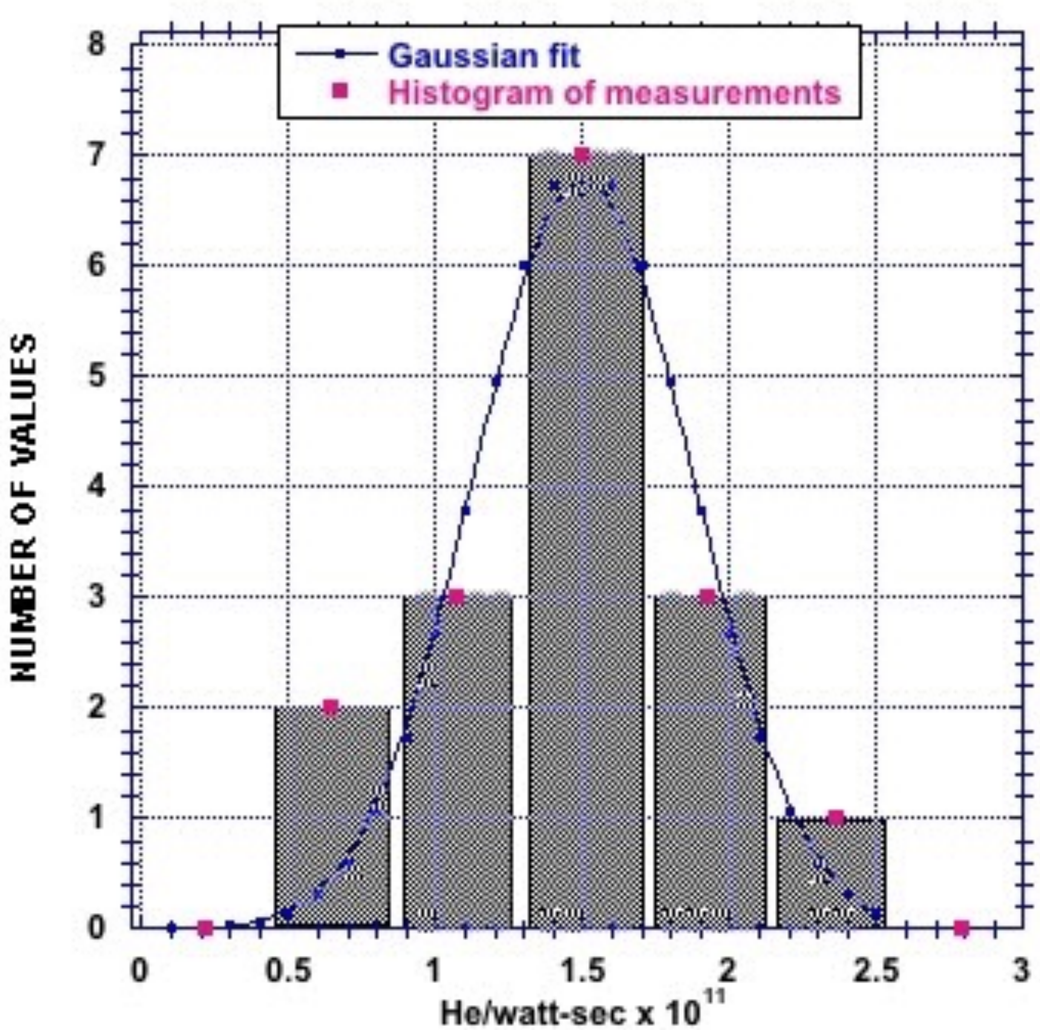
Review book 2014

Strengths of proofs compared

Higgs discovery bump 2012
200 events/month?
5σ

Storms Helium bump
0.4W ~ 10^{12} events/sec
10-40 σ ?





The scientific conclusion of the Combinatorical Research

Something is accidentally created, that causes "impossible" nuclear reactions

This has been be known for 25 years!

With this simple conclusion it is very strange that it has mostly not be possible to perfom funded basic research in this field only ineffective recreational basic reseach has been possible

Basic research has proven over and over to be the lifeline of practical advances in "science". Without "funded basic research", "science" regresses and reverts to witchcraft.

3. Nickel - Hydrogen Nickel - Deuterium ?

Rossi radioactivity free 1.0 MW Nickel-Hydrogen LENR powerplant is in one year engineering trial in Florida, Patent obtained in USA 2015, report in March 2016?

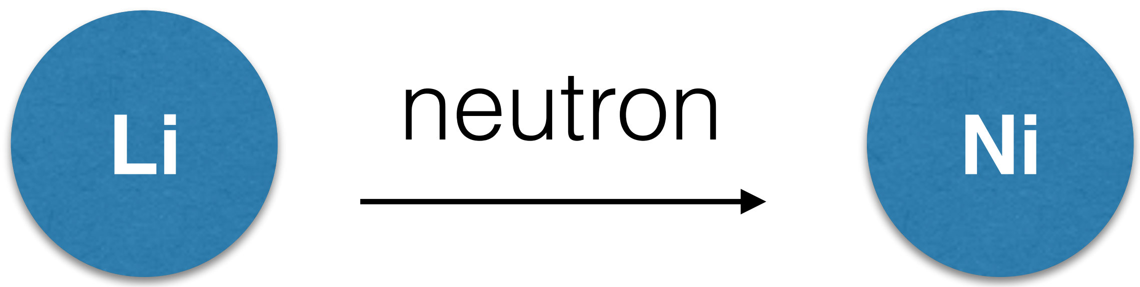
This investor is chasing a new kind of fusion

Fortune.com SEPTEMBER 27, 2015, 12:00 PM EDT

A prominent North Carolina investor is backing a new kind of fusion that operates at much lower temperatures than thought possible, which would make it easier to commercialize. So far the early results show promise.

Tom Darden 10M dollar investment

Rossi formula Nickel,$LiAlH_4$, Li and Hydrogen isotope



Rossi explanation, Neutrons in Li,D? are transmuted by unknown process over to Nickel at 1400°C

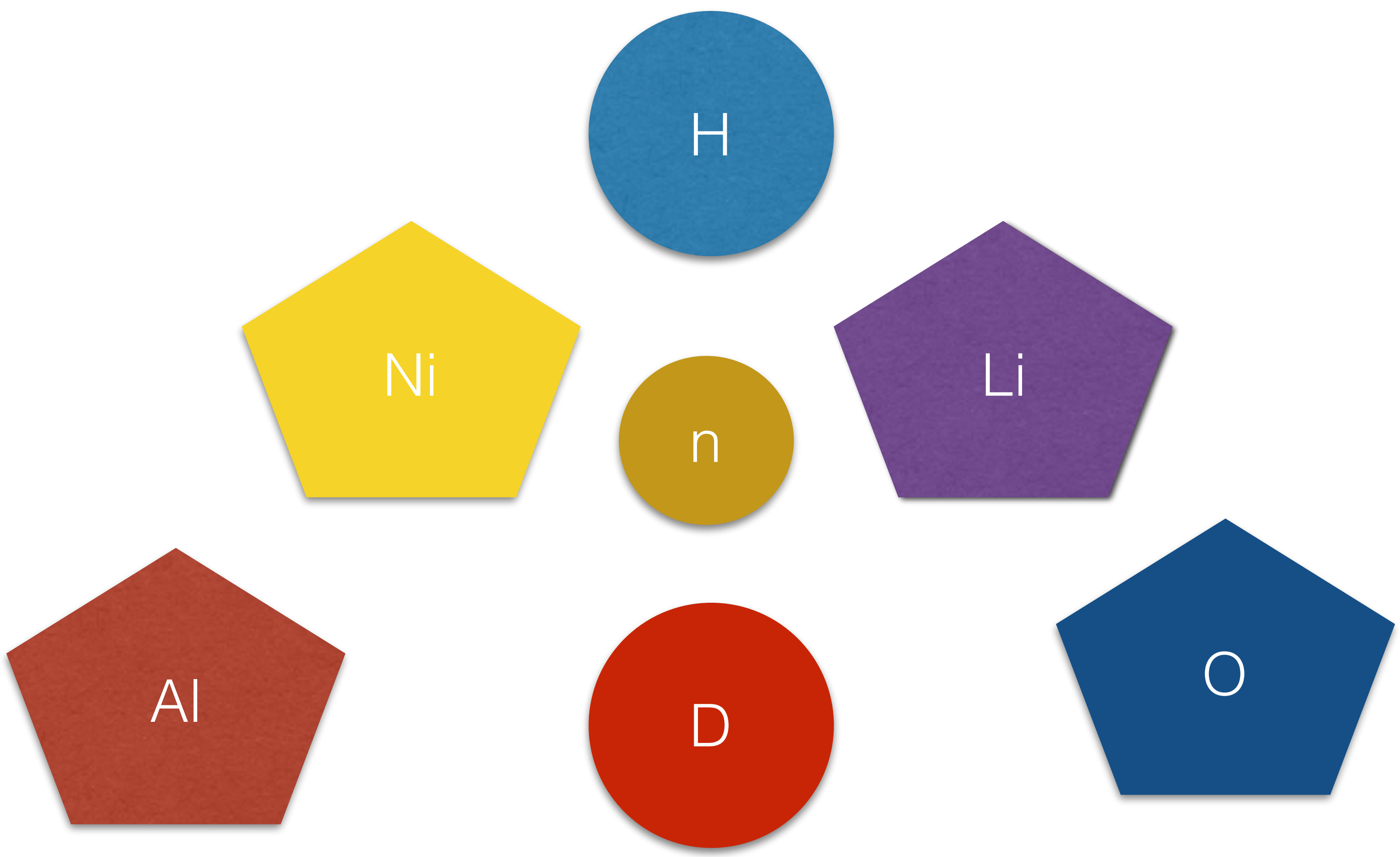
One very recent candidate theory

Nuclear Spallation and Neutron Capture Induced by Ponderomotive Wave Forcing

Rickard Lundin and Hans Lidgren
[1]Swedish Institute of Space Physics, BKiruna, Sweden [2]Le Mirabeau, 2 ave des Citronniers, MC 98000, Monaco

But Radioactivity in not suppressed in such theory

Neutrons or Ultra dense hydrogen?



4. The Ultra-dense hydrogen **Leif Holmlid 30+ papers 2008-2015**

Publications Leif Holmlid 2015 - 2013

Heat generation above break-even from laser-induced fusion in ultra-dense deuterium
Leif Holmlid
AIP Advances, Volume 5, Issue 8, Pages artikel nr 087129 2015

Charged particle energy spectra from laser-induced processes: nuclear fusion in ultra-dense deuterium D(0)
Leif Holmlid and Sveinn Ólafsson
International Journal of Hydrogen Energy, accepted 19 Okt 2015

Muon detection studied by pulse-height energy analysis: Novel converter arrangements
Leif Holmlid, Sveinn Olafsson
Review of Scientific Instruments, Volume 86, Issue 8, Pages artikel nr 083306 2015

Spontaneous ejection of high-energy particles from ultra-dense deuterium D(0)
Leif Holmlid, Sveinn Olafsson
International journal of hydrogen energy, Volume 40, Issue 33, Pages 10559-10567 2015

Meissner Effect in Ultra-Dense Protium p(l=0, s=2) at Room Temperature: Superconductivity in Large Clusters of Spin-Based Matter
Leif Holmlid, S. Fuelling
Journal of Cluster Science, Volume 26, Issue 4, Pages 1153-1170 2015

MeV particles in a decay chain process from laser-induced processes in ultra-dense deuterium D(0)
Leif Holmlid
International Journal of Modern Physics E-Nuclear Physics, Volume 24, Issue 4, Pages artikel 1550026 2015

Leif Holmlid publications continued

Heat generation above break-even from laser-induced fusion in ultra-dense deuterium
Intense ionizing radiation from laser-induced processes in ultra-dense deuterium D(-1)
Frans Olofson, Leif Holmlid
International Journal of Modern Physics E-Nuclear Physics, Volume 23, Issue 9, Pages 1450050 2014

Ultra-Dense Hydrogen H(-1) as the Cause of Instabilities in Laser Compression-Based Nuclear Fusion
Leif Holmlid
Journal of Fusion Energy, Volume 33, Issue 4, Pages 348-350 2014

TWO-COLLECTOR TIMING OF 3 14 MeV/u PARTICLES FROM LASER-INDUCED PROCESSES IN ULTRA-DENSE DEUTERIUM
Leif Holmlid
International Journal of Modern Physics E, Volume 22, Issue 12, Pages artikel nr 1350089 2013
Journal Article, peer-reviewed

Direct observation of particles with energy >10 MeV/u from laser-induced processes with energy gain in ultra-dense deuterium
Leif Holmlid
Laser and particle beams, Volume 31, Issue 4, Pages 715-722 2013

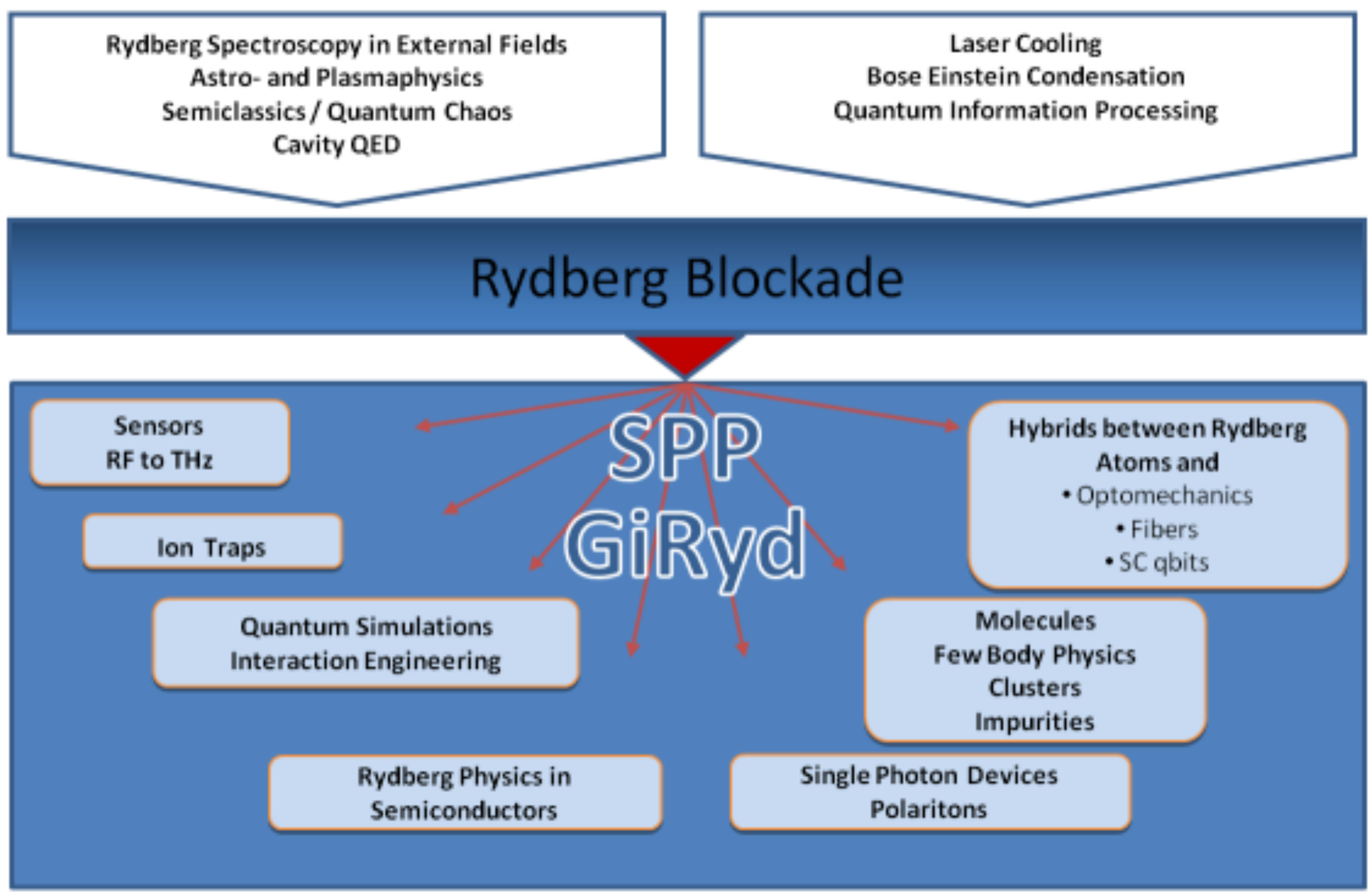
Excitation levels in ultra-dense hydrogen p(-1) and d(-1) clusters: Structure of spin-based Rydberg Matter
Leif Holmlid
International Journal of Mass Spectrometry, Volume 352, Pages 1-8 2013

Laser-mass spectrometry study of ultra-dense protium p(-1) with variable time-of-flight energy and flight length
Leif Holmlid
International Journal of Mass Spectrometry, Volume 351, Pages 61-68 2013

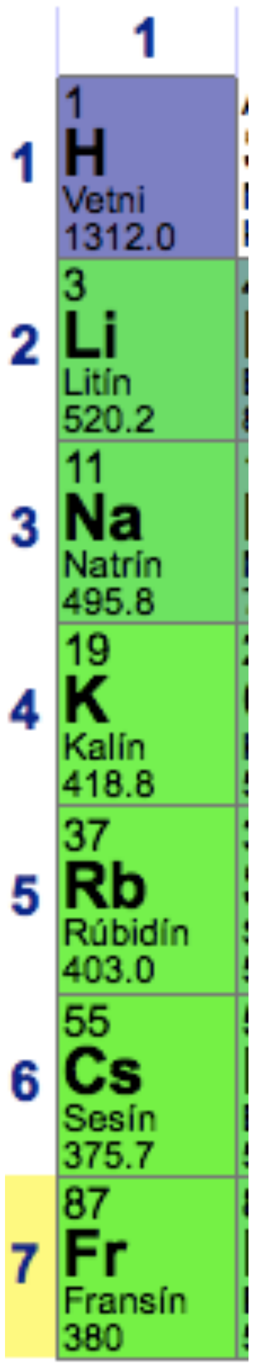
What is Rydberg atom?

and how do they condense?

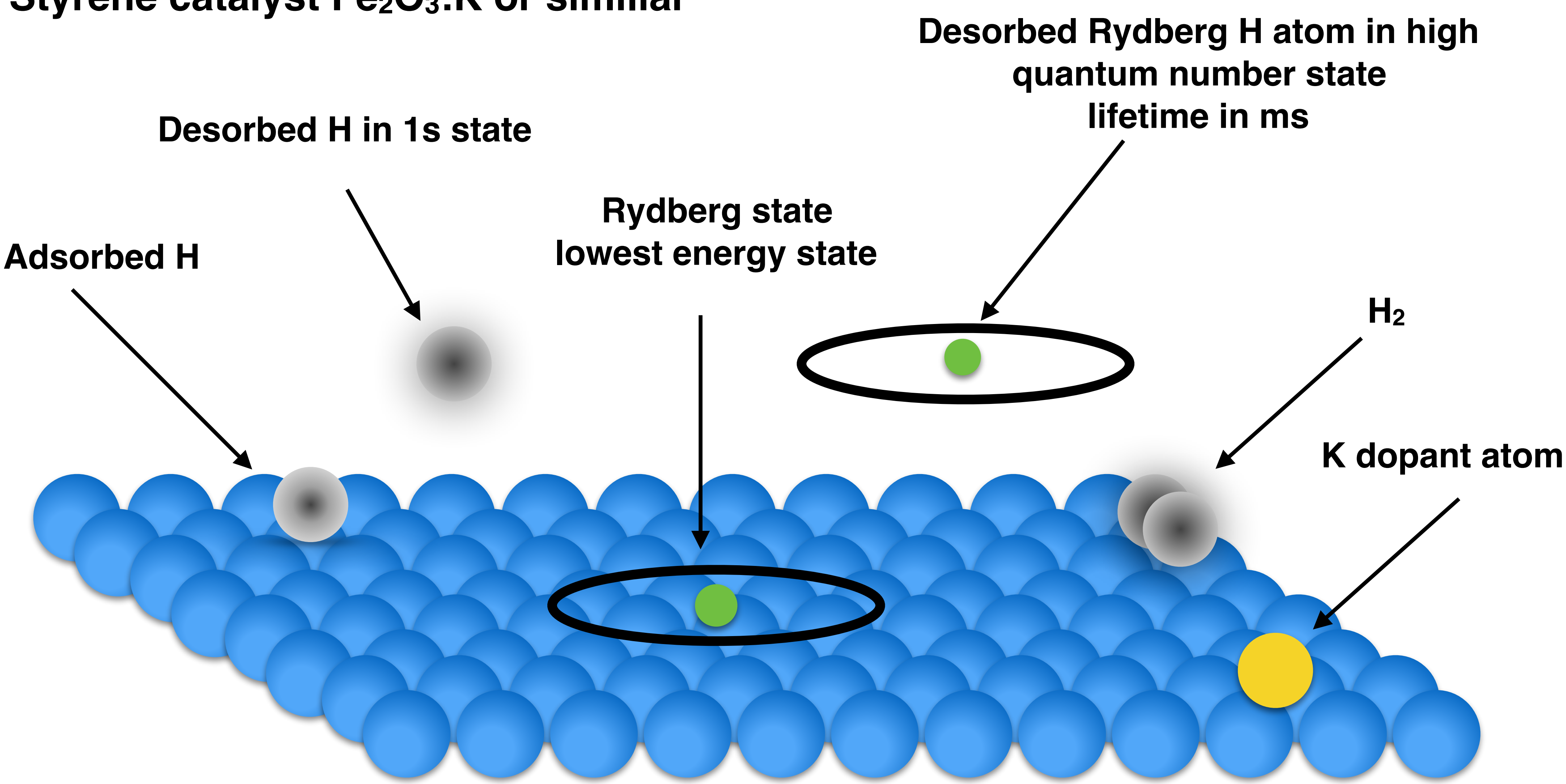
DFG Schwerpunktsprogramm Giant interactions in Rydberg Systems (GiRyd)



Rydberg atom generation



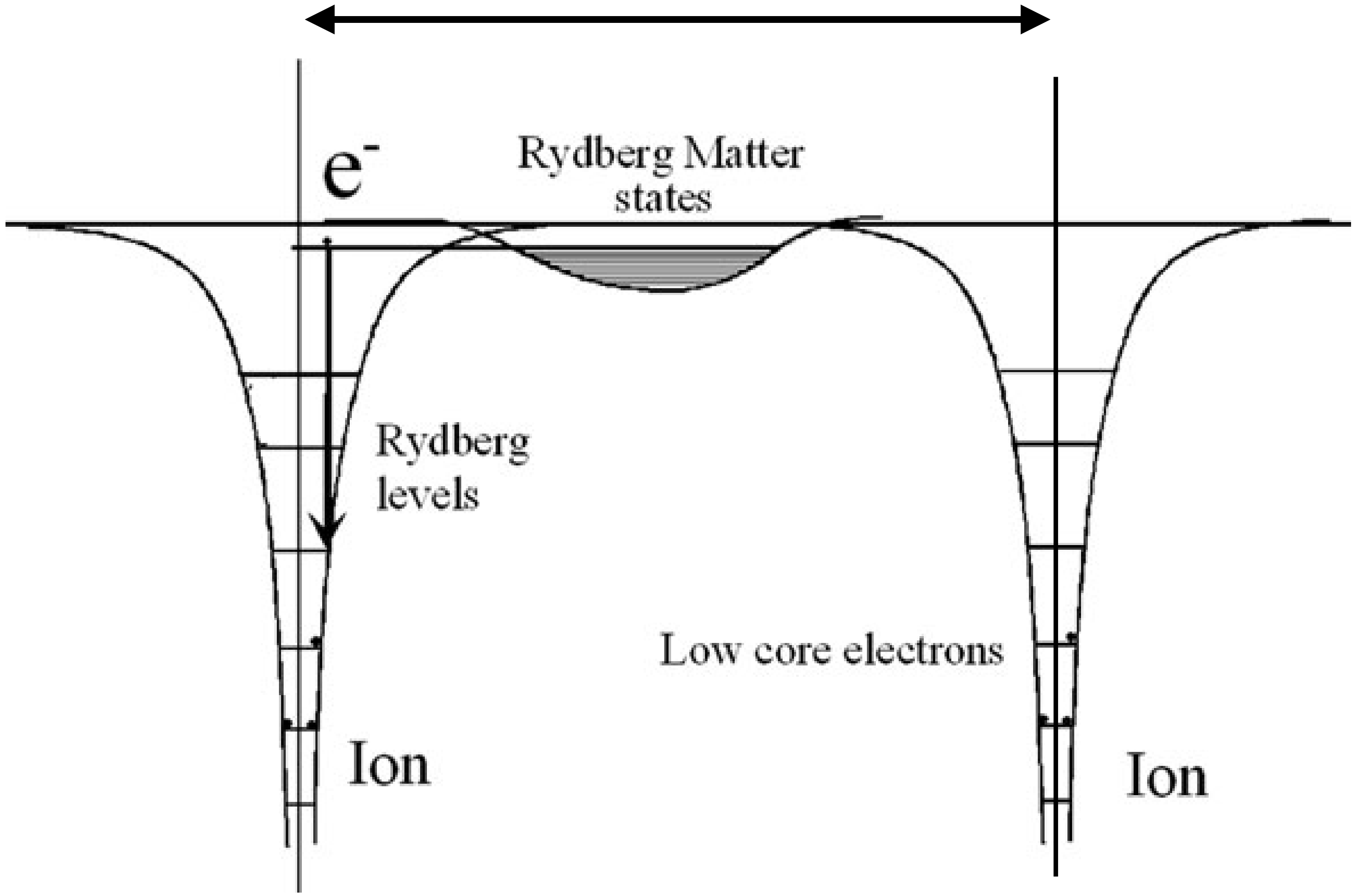
Styrene catalyst Fe_2O_3:K or similiar

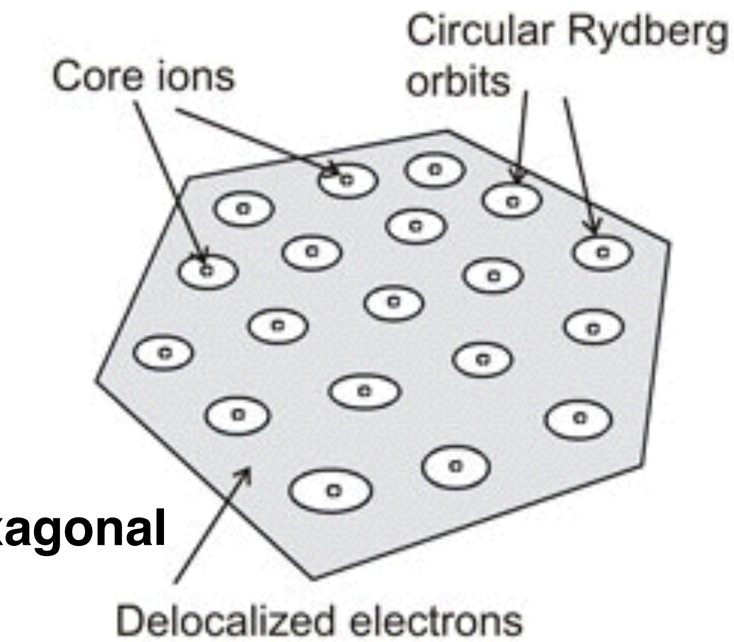


Rydberg Matter Clusters: Theory of Interaction and Sorption Properties
Michael I. Ojovan J Clust Sci (2012) 23:35–46 DOI 10.1007/s10876-011-0410-6

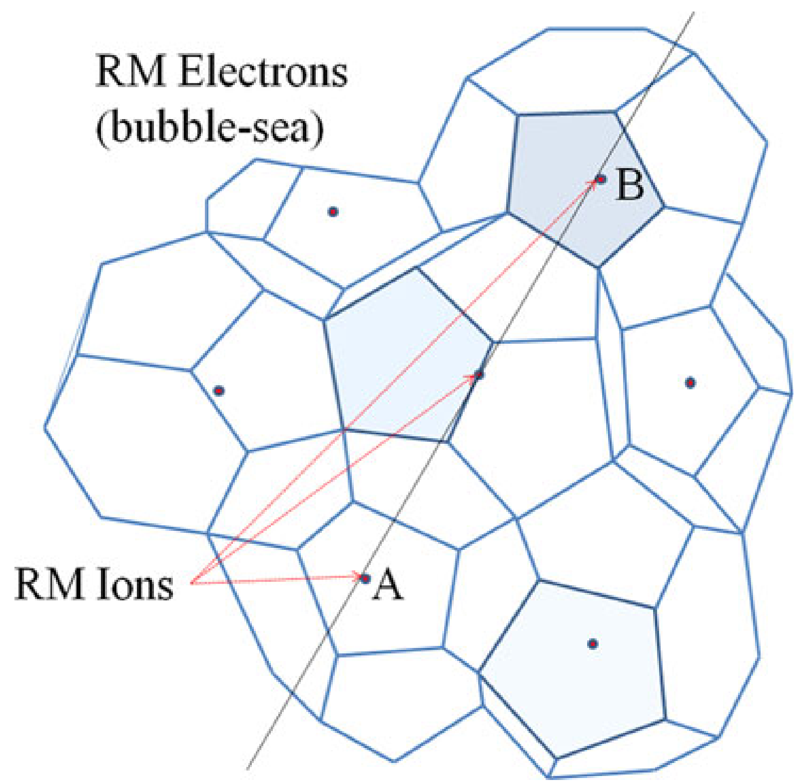
Rydberg matter Frozen plasma?

$$d = 2.9\, n_B^2\, a_0,$$





2D hexagonal



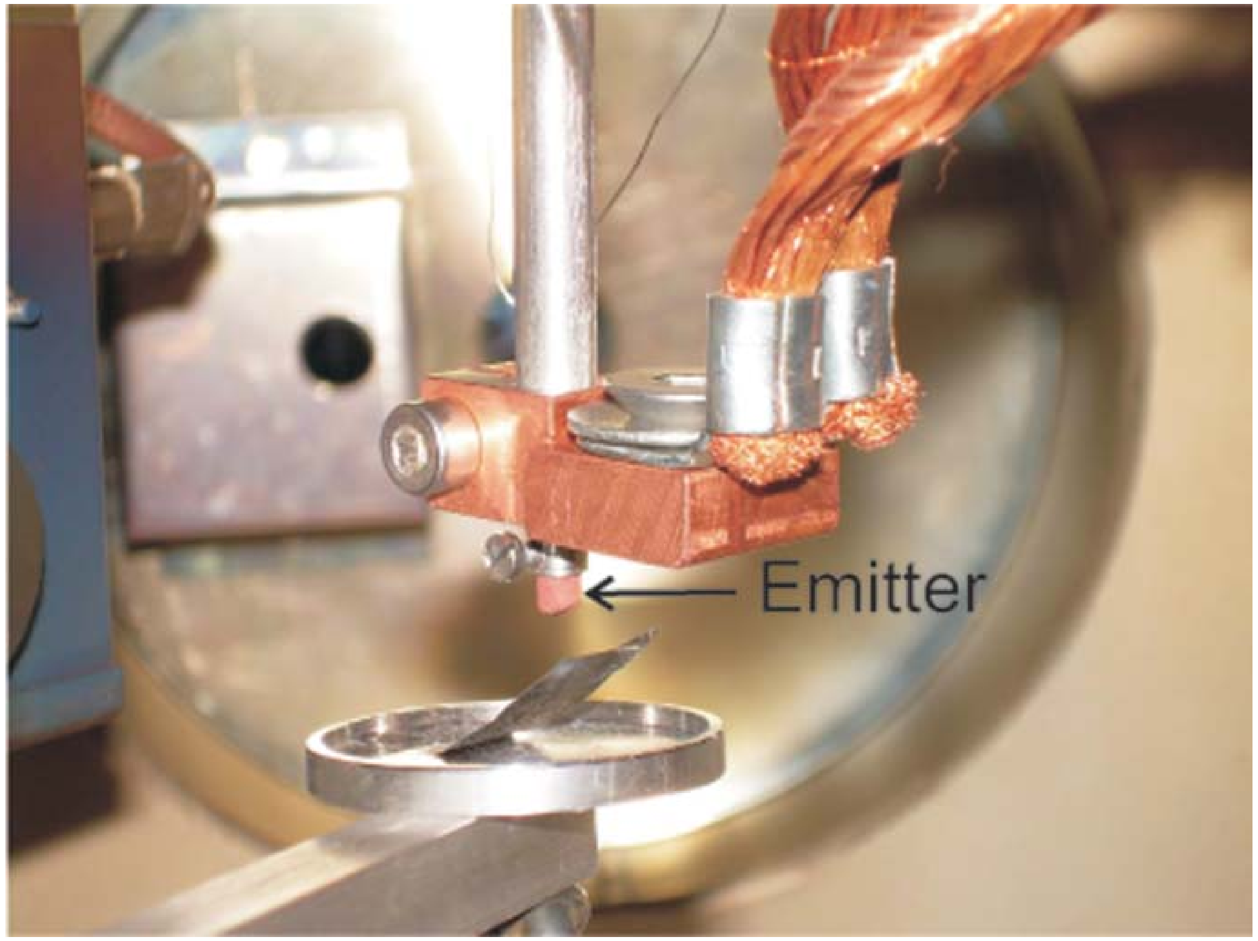
Any cluster structure is possible

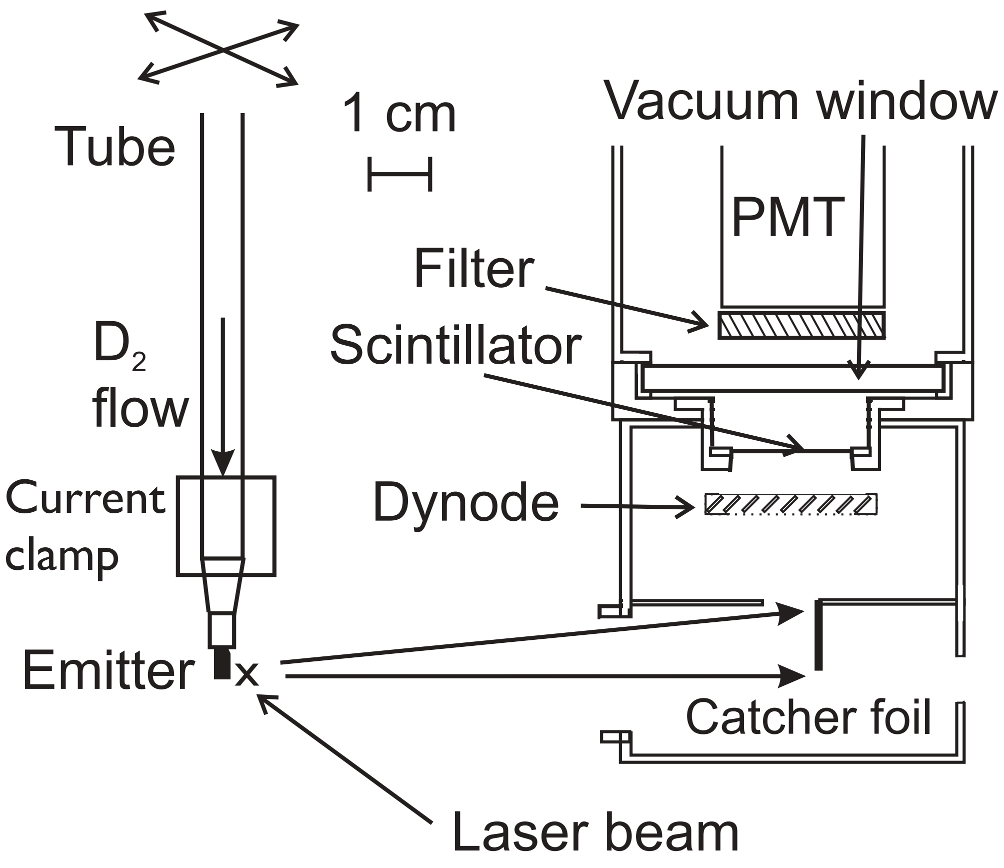
Amorphous

Efficient source for the production of ultradense deuterium D(-1) for laser-induced fusion (ICF)

REVIEW OF SCIENTIFIC INSTRUMENTS 2011

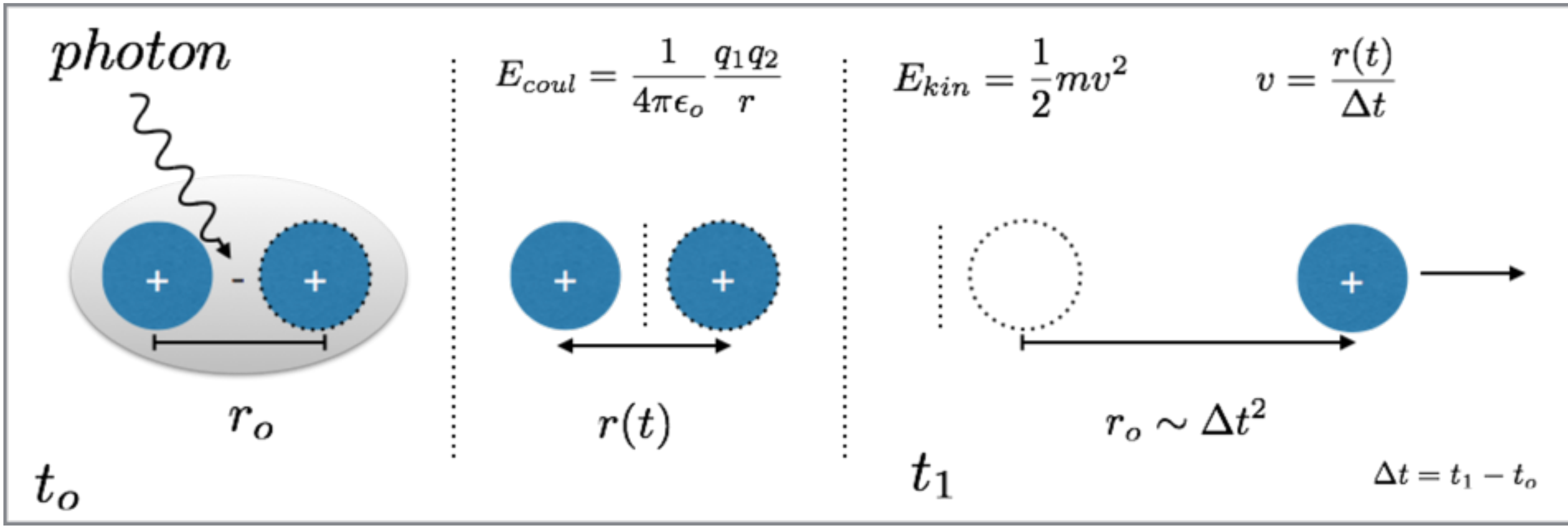
Patrik U. Andersson, Benny Lönn, and Leif Holmlid[a)]
Atmospheric Science, Department of Chemistry, University of Gothenburg, SE-412 96, Göteborg, Sweden



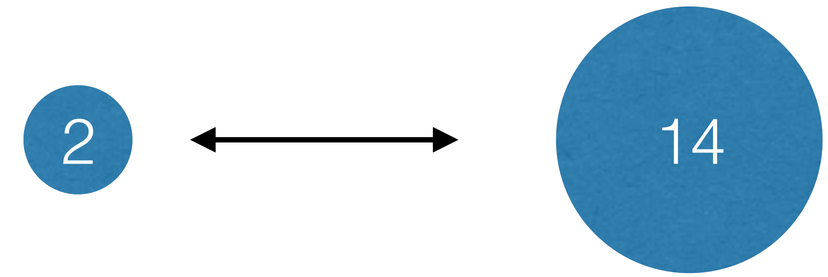


Styrene catalyst Fe_2O_3:K

Time of flight analysis



Cluster breakup



Total charge	Total cluster mass	Name	t_1 (ns)	t_2 (ns)	t_3 (ns)	Figures
Asymmetric						
2	16	2↔14	440	3080		3,4,9
	14	2↔12	445	2667		3,4,6,7
	12	2↔10	451	2254		7,8,9,10
	10	2↔8	460	1841		3,7,9
	8	2↔6	475	1486		3,6,7,8,9,10
	6	2↔4	504	1008		8
3	16	2↔14 (2+)	311	2178		
	14	2↔12 (2+)	314	1886		
	12	2↔10 (2+)	319	1594		
	10	2↔8 (2+)	325	1302		
	8	2↔6 (2+)	336	1008		
Symmetric						
2	40	20↔20	1841	1841		6
	36	18↔18	1746	1746		
	32	16↔16	1646	1646		3,7,8
	28	14↔14	1540	1540		4,6,9,10
	24	12↔12	1426	1426		
	20	10↔10	1302	1302		8
	16	8↔8	1164	1164		6,8
	12	6↔6	1008	1008		
	8	4↔4	823	823		3,4,7,9,10
	4	2↔ 2	582	582		10
3	6	6(3+)	≈ 412	≈ 412	≈ 412	3,4,6,7,8,9,10

Sveinn Ólafsson and Leif Holmlid

Ultra dense Hydrogen

$$W = \frac{e^2}{4\pi \varepsilon_0 d},$$

The CE fragmentation processes in the material D(-1) indicate a common KER of 630 eV. This means an interatomic distance of 2.3 ± 0.1 pm,

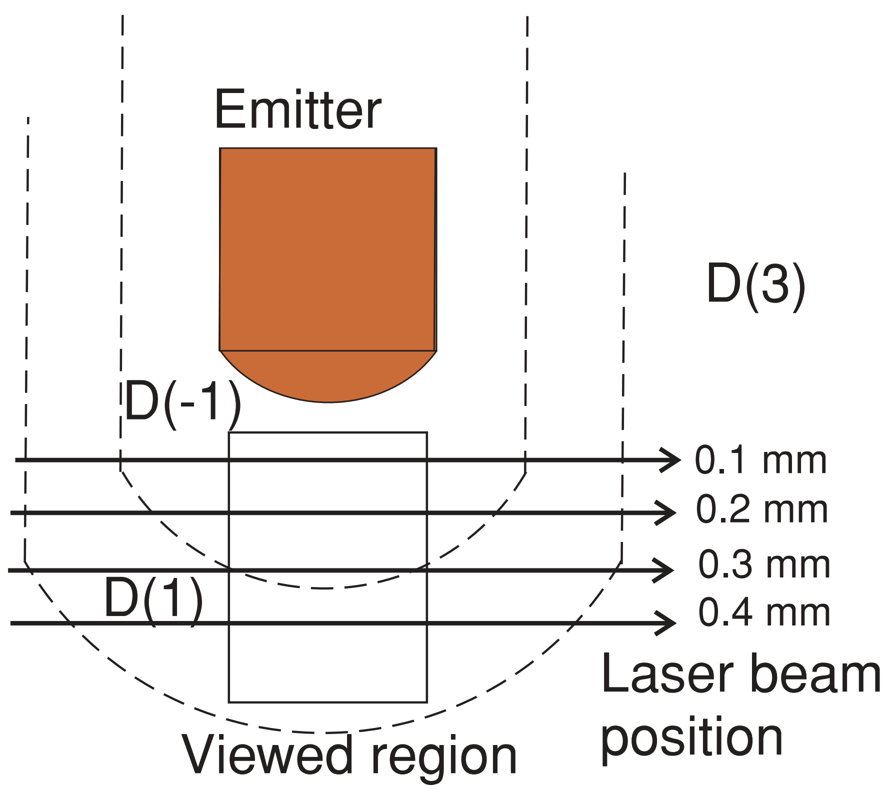
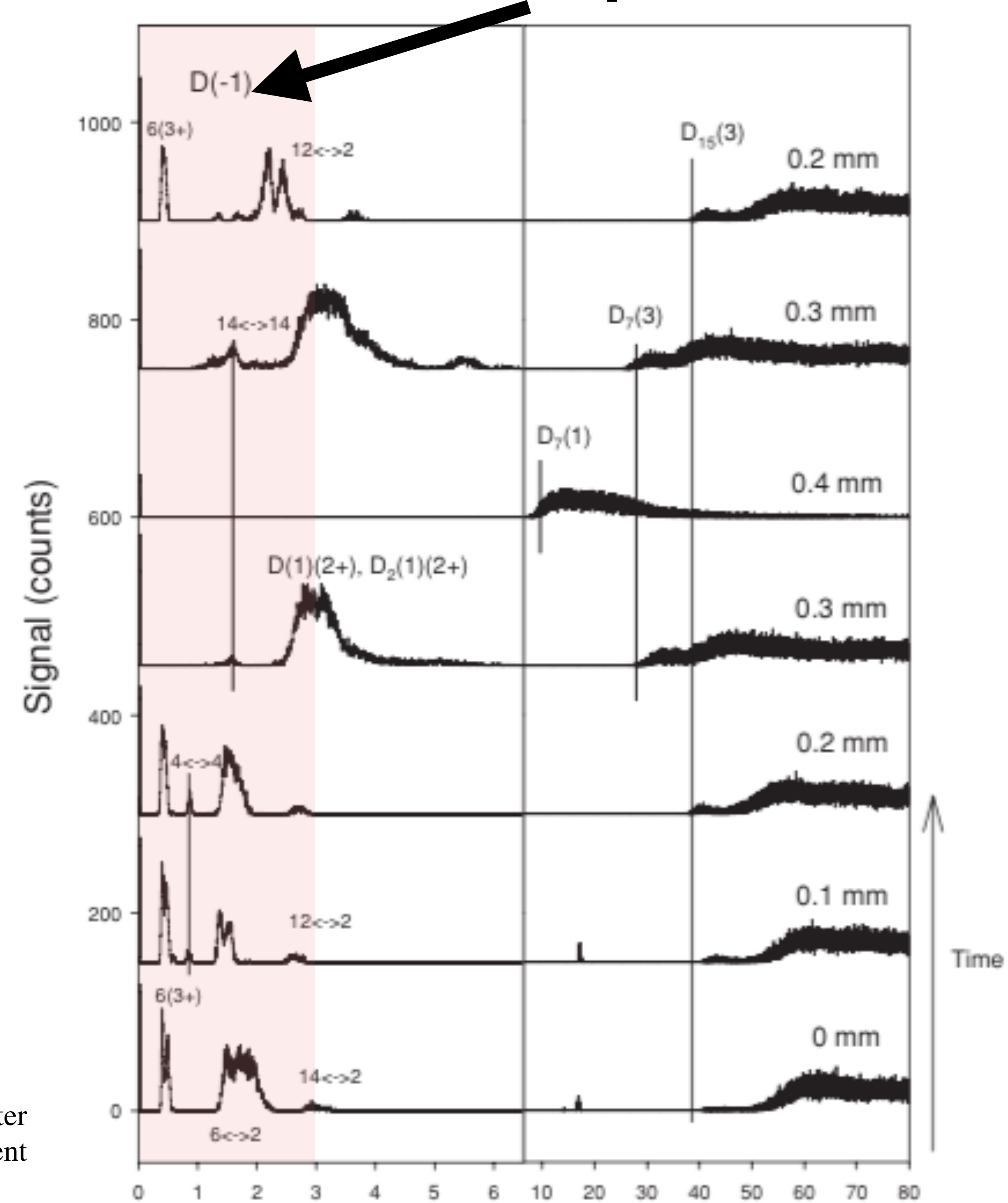


FIG. 5. (Color online) The laser beam position in the cloud below the emitter is shown for the data in Fig. 4. The approximate regions in space for different forms of condensed deuterium are indicated.

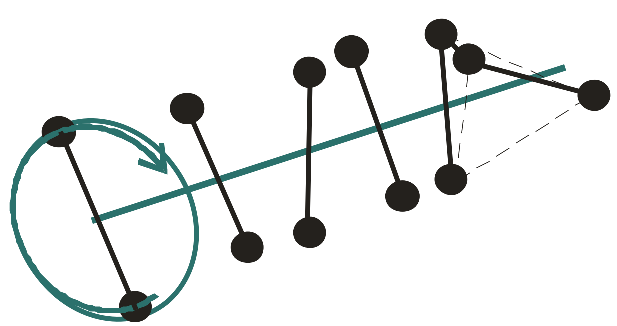
There should be no peaks here!

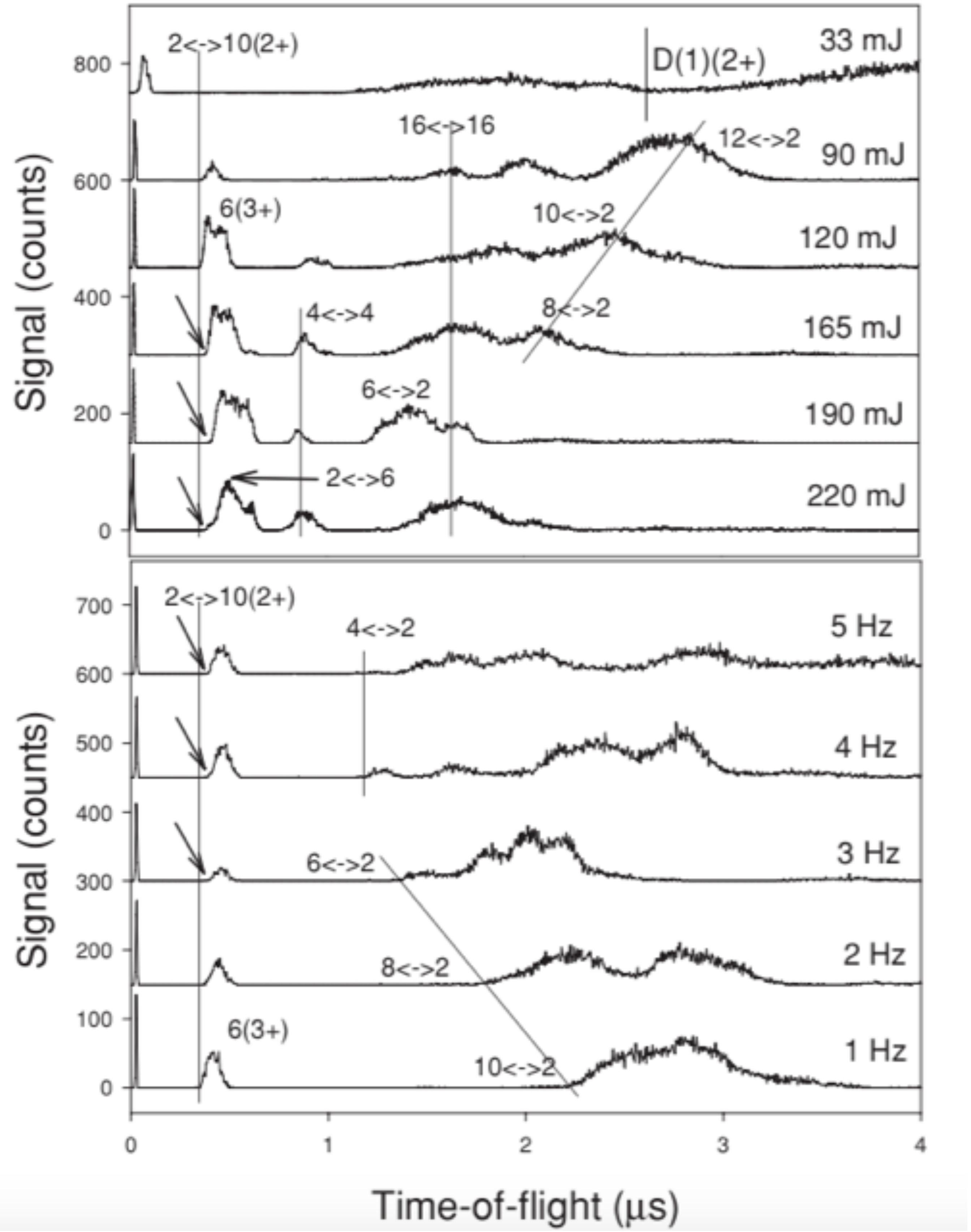


2.3 ± 0.1 pm!

Laser Intensity dependency

Frequency dependency





Leifs Holmlid length scales

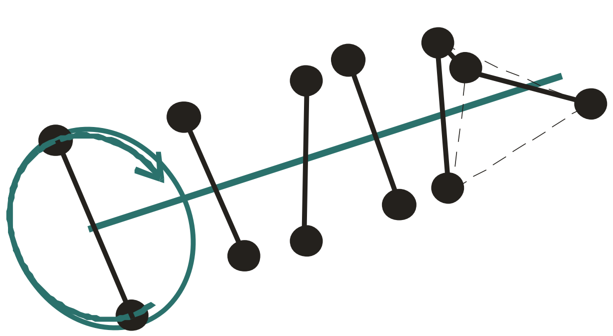
H(l) = H(1) $d = 2.9a_0 l^2$ **l=1, d=153 pm l=2, d=613 pm,**

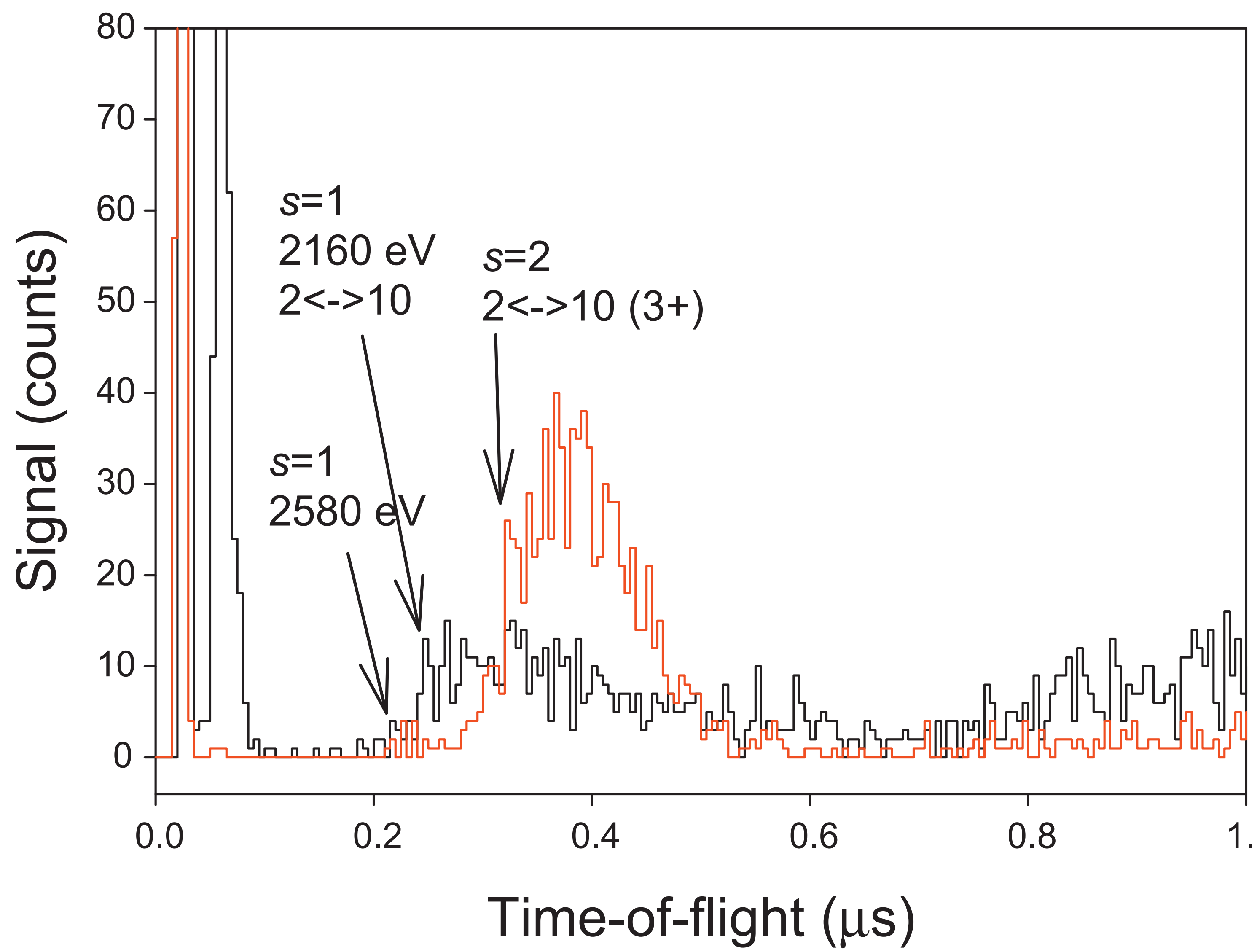
H(0) $d = 2.9 r_q s^2$ **s=1, d=0.56 pm s=2, d=2.23 pm s=3, d=5.01 pm,**

$r_q = 0.192$ pm

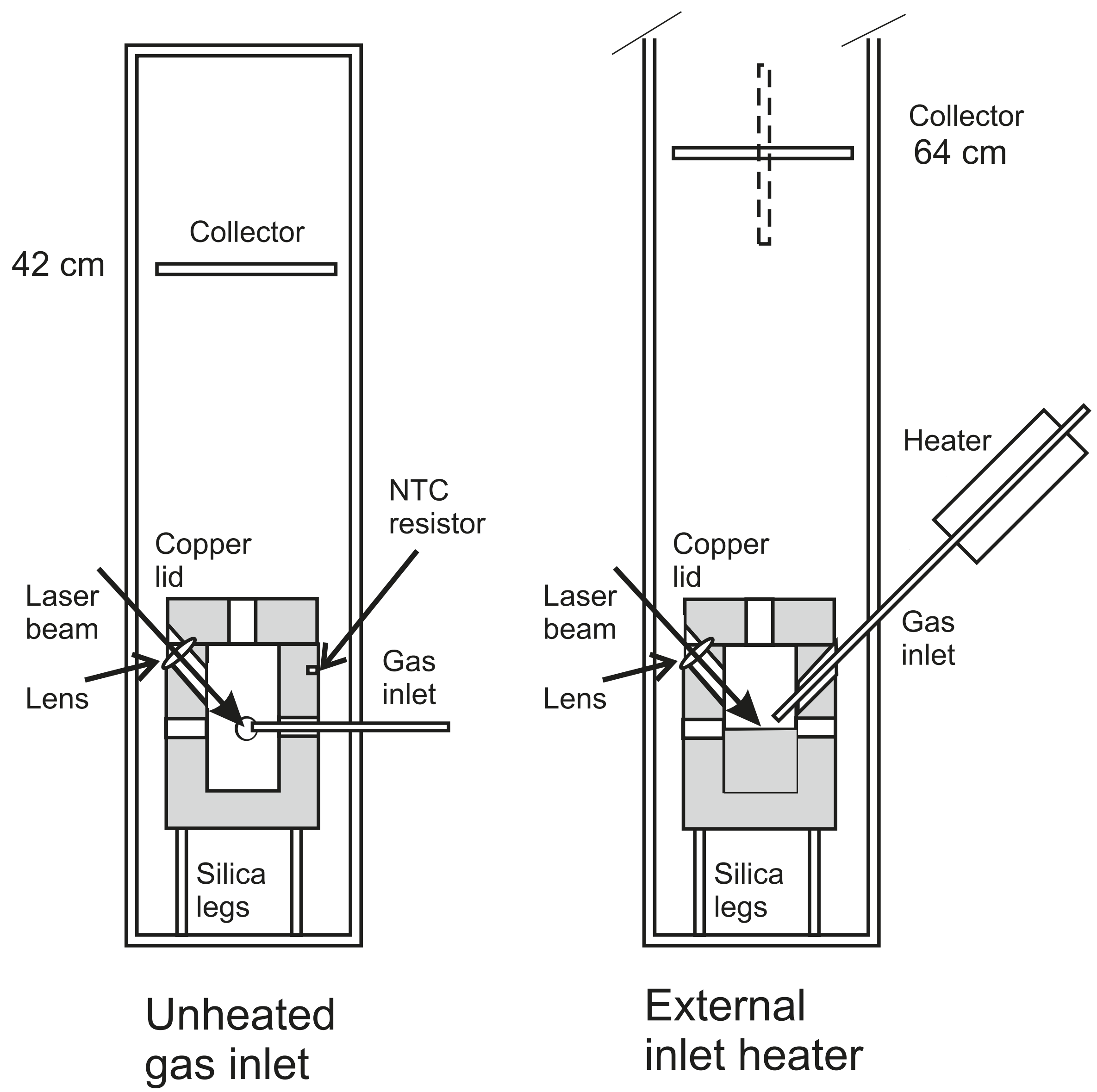
$a_0 = 52.9$ pm

2.3 ± 0.1 pm!





Heat generation above break-even from laser-induced fusion in ultra-dense deuterium
Leif Holmlid AIP Advances, Volume 5, Issue 8, Pages artikel nr 087129 2015



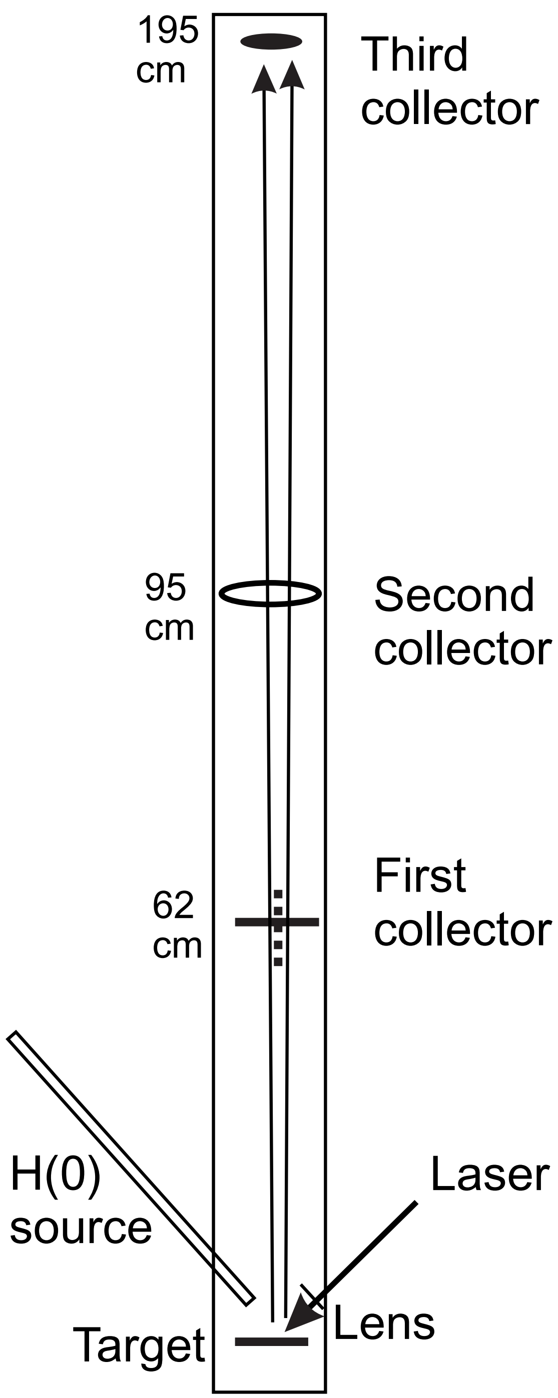
Calorimetry confirms break even fusion

But is this only fusion ?

There is more to this

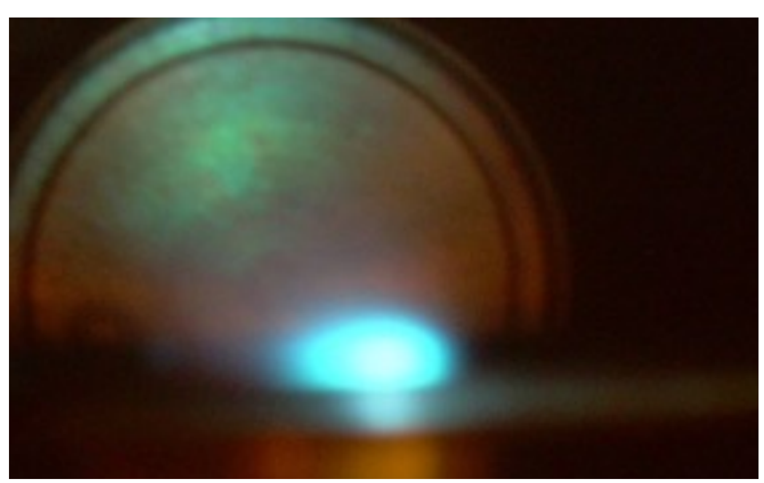
Sveinn Ólafsson and Leif Holmlid

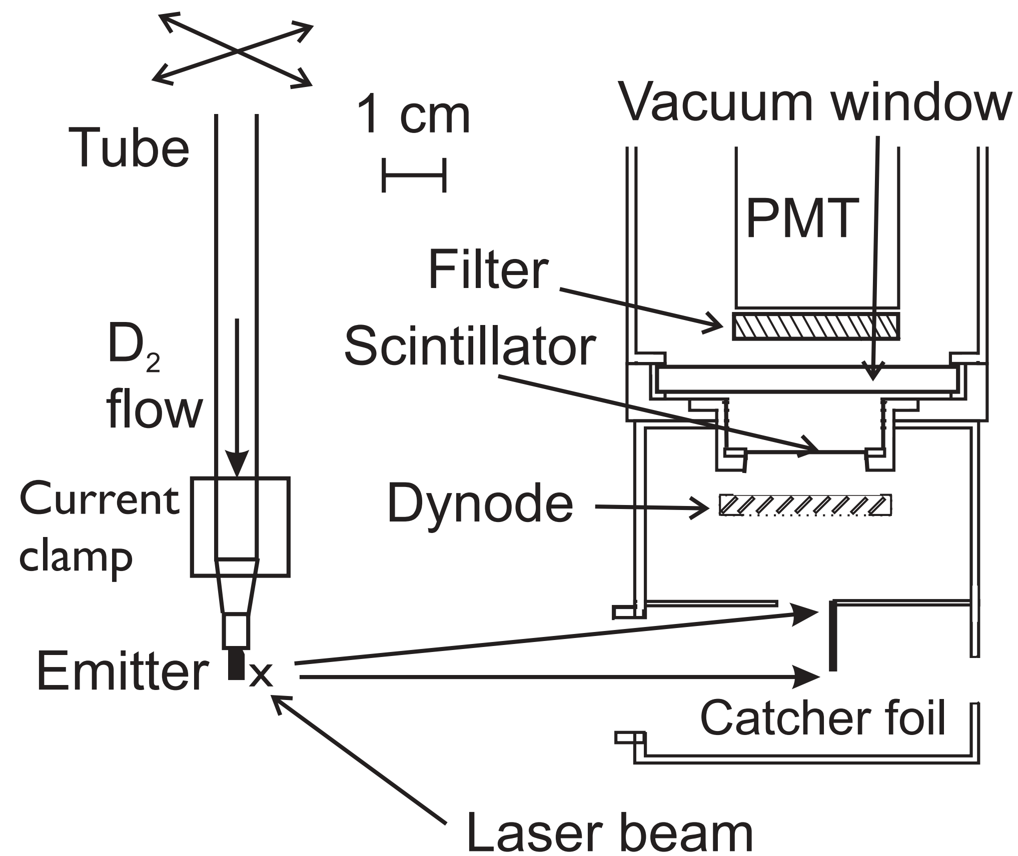
Laser induced results



Mesons,electrons positron, helium and neutrons observed

Particle Decay



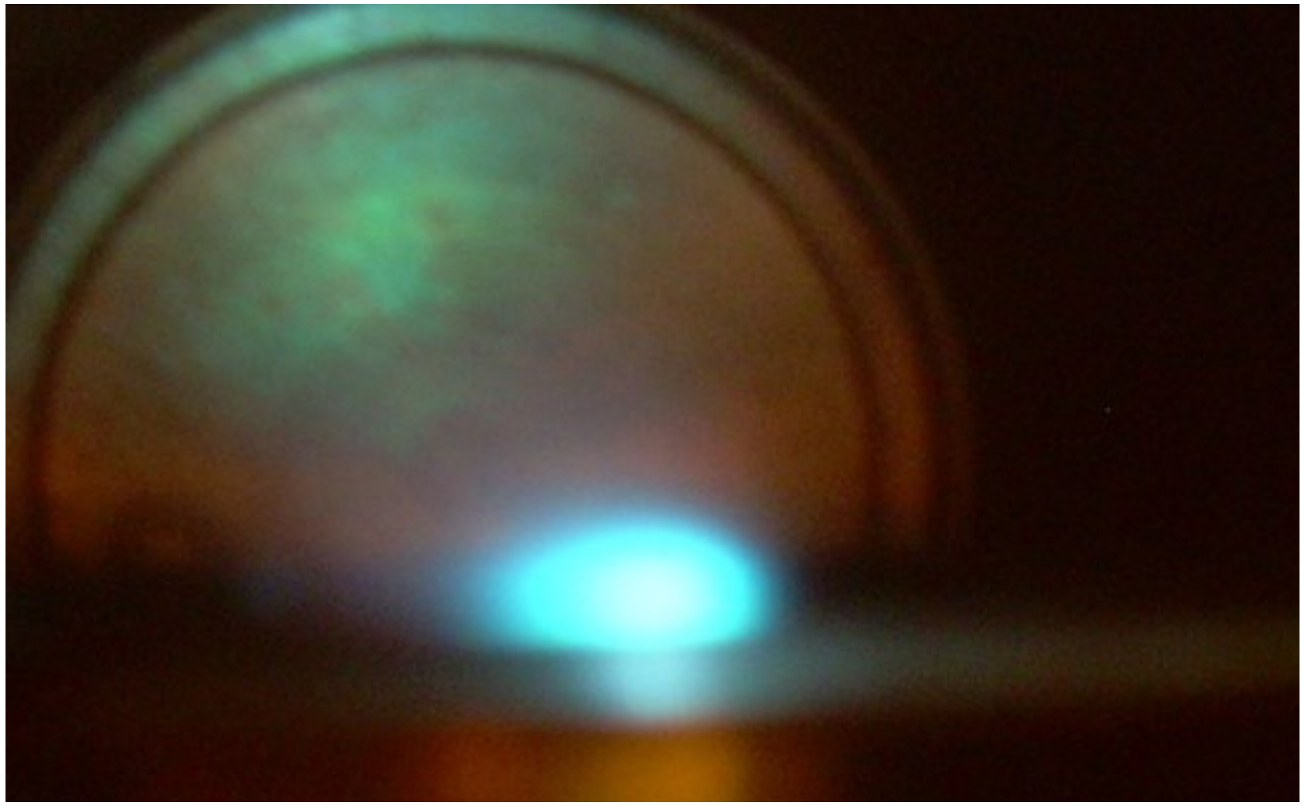


Target contains catalyst that increases and maintains the D(0), p(0) phase

Nuclear particle decay in a multi-MeV beam ejected by pulsed-laser impact on ultra-dense hydrogen H(0)

Leif Holmlid International Journal of Modern Physics E Vol. 24, No. 11 (2015) 1550080

Meson chain and conservation of energy



Just published by Leif Holmlid

Total rate estimation

10^{7}-10^{10} s^{-1}

$$D_N(0) \rightarrow \cdots \rightarrow \cdots \rightarrow K^{\pm} \rightarrow \pi^{\pm} \rightarrow \mu^{\pm} \rightarrow e^{\pm}$$

$$N \times 4 \times 938\,\text{MeV} \rightarrow \cdots \rightarrow \cdots \rightarrow 493\,\text{MeV} \rightarrow 139\,\text{MeV} \rightarrow 105\,\text{MeV} \rightarrow 0.511\,\text{MeV}$$

Ultra-dense Hydrogen and Low Energy Nuclear Reactions

University of Iceland School of Natural Science and engineering

Sveinn Ólafsson and Leif Holmlid

These results show directly that the signal at long distance is mainly due to a mixture of intermediate particles formed by decay in the beam. The decaying signals have time constants of approximately 12 and 26 ns for ultra-dense deuterium D(0) and 52 ns for ultra-dense protium p(0). These decay time constants agree well with those for decay of light mesons.

These particles with narrow MeV energy distributions are formed by stepwise decay from particles like $H_N(0)$. The main result is that a decaying particle flux is formed by the laser-induced processes. The final muons produced may be useful for muon catalyzed fusion.

The difference observed between the signals for D(0) and p(0) is intriguing. The kaon K_L^0 may be formed in this case of p(0) instead of $K^\pm$ in the case of D(0). This could mean that a down quark replaces an up quark in the laser-induced processes in p(0) relative to D(0).

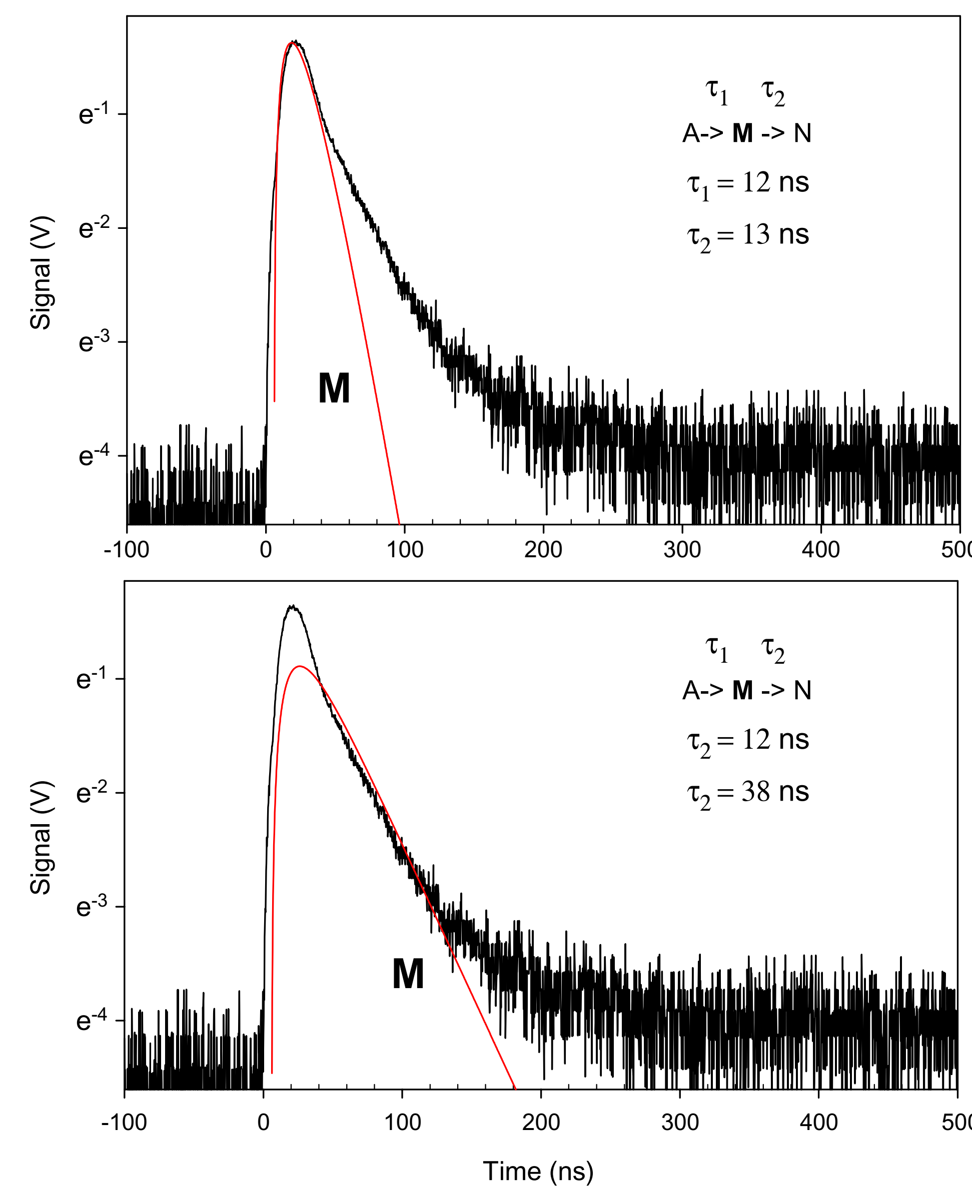


Fig. 7. Matching of an intermediate particle from D(0) with Eq. (3) to the signal decay in Fig. 6(c), second collector signal, bias −50 V, first collector open.

$$D_N(0) \rightarrow \cdots \rightarrow \cdots \rightarrow K^{\pm} \rightarrow \pi^{\pm} \rightarrow \mu^{\pm} \rightarrow e^{\pm}$$

$$N\text{x}4\text{x}938\text{MeV} \rightarrow \cdots \rightarrow \cdots \rightarrow 493\text{MeV} \rightarrow 139\text{MeV} \rightarrow 105\text{MeV} \rightarrow 0.511\text{MeV}$$

Meson chain and conservation of energy

Only two possibilities

Coherent multibody fusion

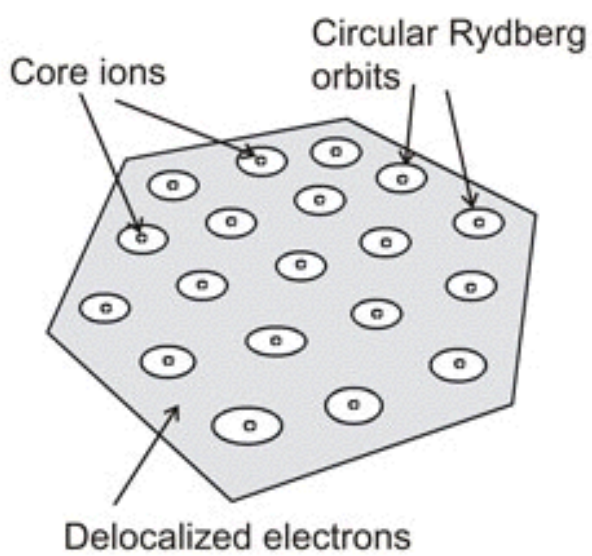
Proton/deuteron to Meson spallation

Quantum entanglement needed

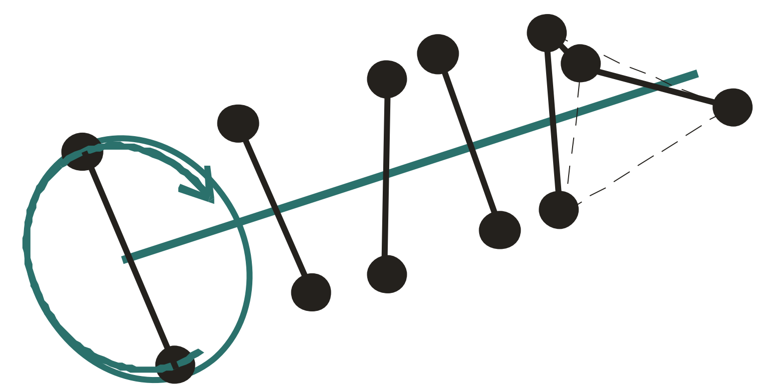
$$D_N(0) \rightarrow \cdots \rightarrow \cdots \rightarrow K^{\pm} \rightarrow \pi^{\pm} \rightarrow \mu^{\pm} \rightarrow e^{\pm}$$

$$N \mathrm{x} 4 \mathrm{x} 938\,\mathrm{MeV} \rightarrow \cdots \rightarrow \cdots \rightarrow 493\,\mathrm{MeV} \rightarrow 139\,\mathrm{MeV} \rightarrow 105\,\mathrm{MeV} \rightarrow 0.511\,\mathrm{MeV}$$

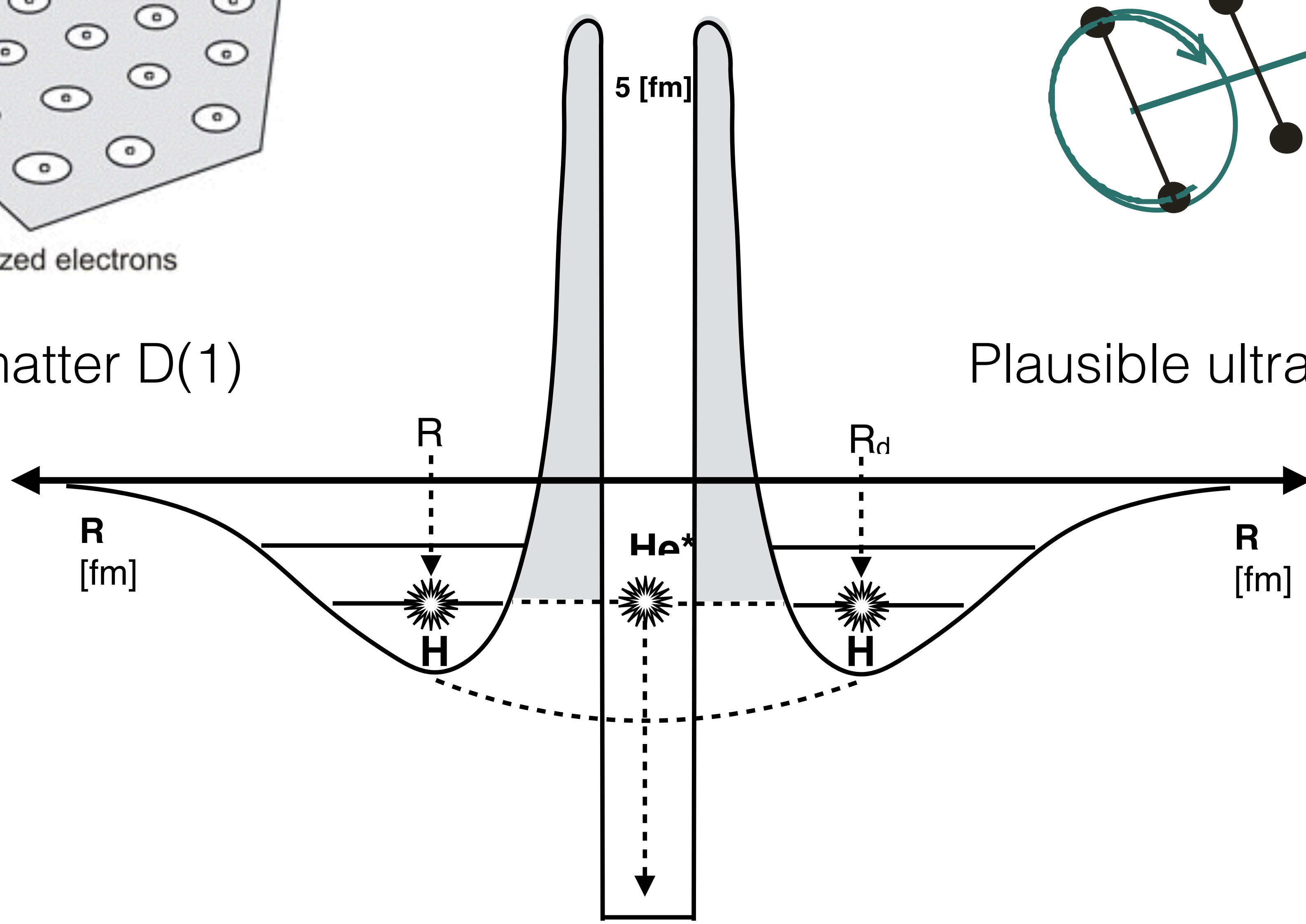
5. Theoretical discussion



Rydberg matter D(1)



Plausible ultra-dense matter D(0)



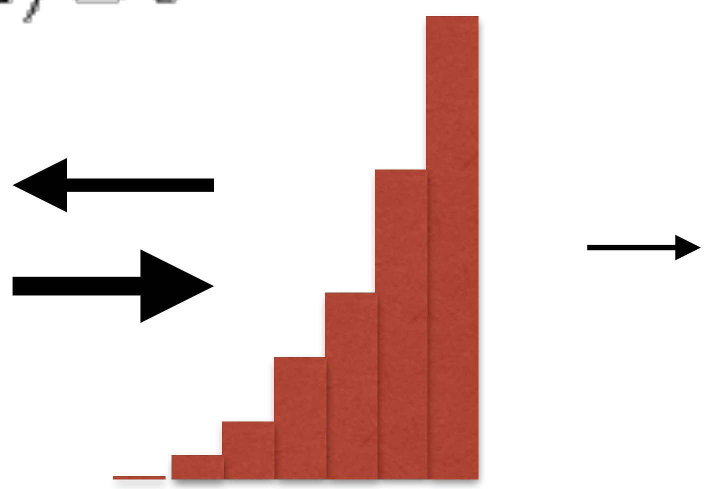
Not drawn to scale

Simple Tunnelling fusion rate model for Coulomb potential

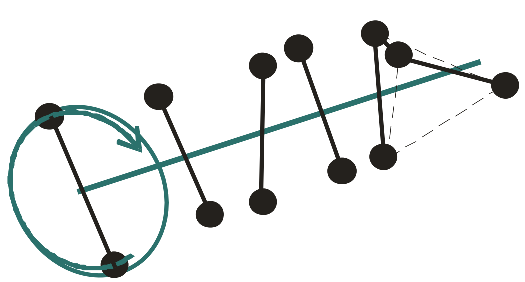
Rate = Gamov probability of crossing the barrier x attempt frequency

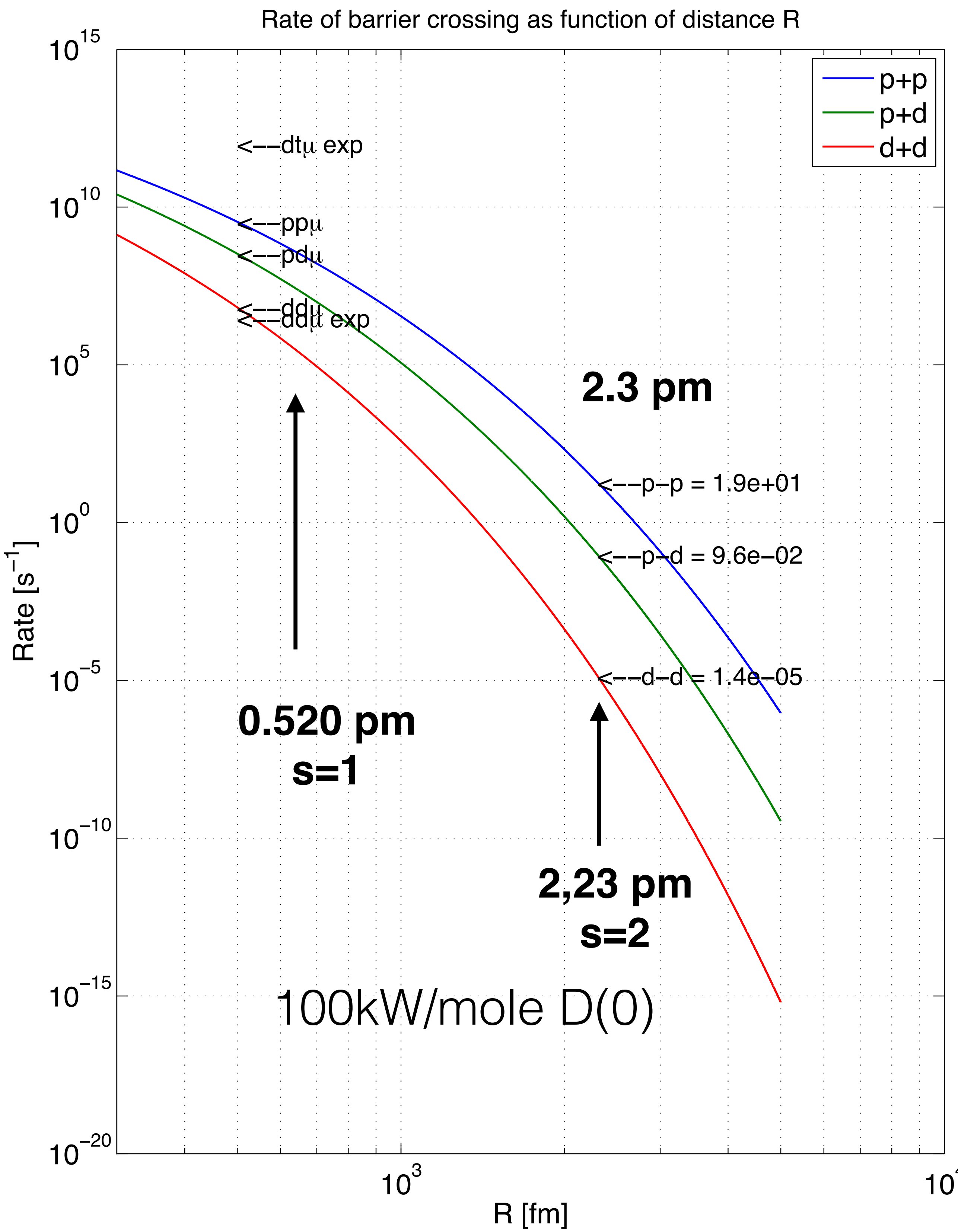
Reaction crossections are not included
Calculation are shown for f = 10^{16}/s.

$$P_g(E) \equiv e^{-\frac{E_g}{E}^{1/2}}$$



2.3 ± 0.1 pm!





6. Summary

1. Ultra dense hydrogen can be the source of all or part of Cold fusion LENR related phenomena.
2. Laser induced fusion in Ultra dense hydrogen seemingly produces mesons, possibly in a proton or neutron meson spallation process. (Full 4π calorimetric high energy particle detection exp. needed)
3. If confirmed, such process releases similar or higher energy than fission of Uranium 200MeV.
4. Rossi Ni-H product commercialized 2016?
5. Limited energy system disruption starts 2016 and takes 5-20 years?
6. Funded basic research in cold fusion starting 2016-2017?
7. Full scale energy system disruption possible 2020-2030?
8. Theory possible 2017-2019?

Not drawn to scale

University of Iceland School of Natural Science and engineering
Sveinn Ólafsson and Leif Holmlid

Spontaneous

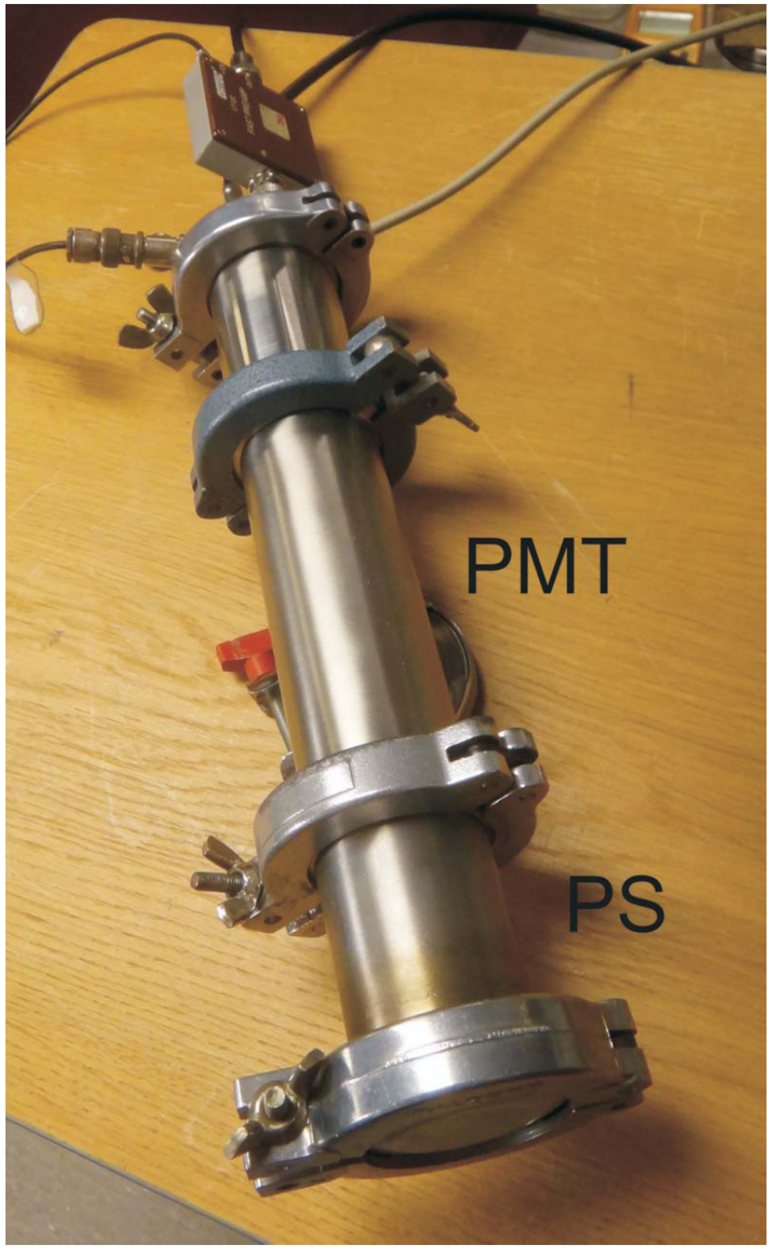


FIG. 1. Detector part from vacuum components. The PMT part and the PS part are indicated. Without the PS part, a metal blind flange is used to close the tube.

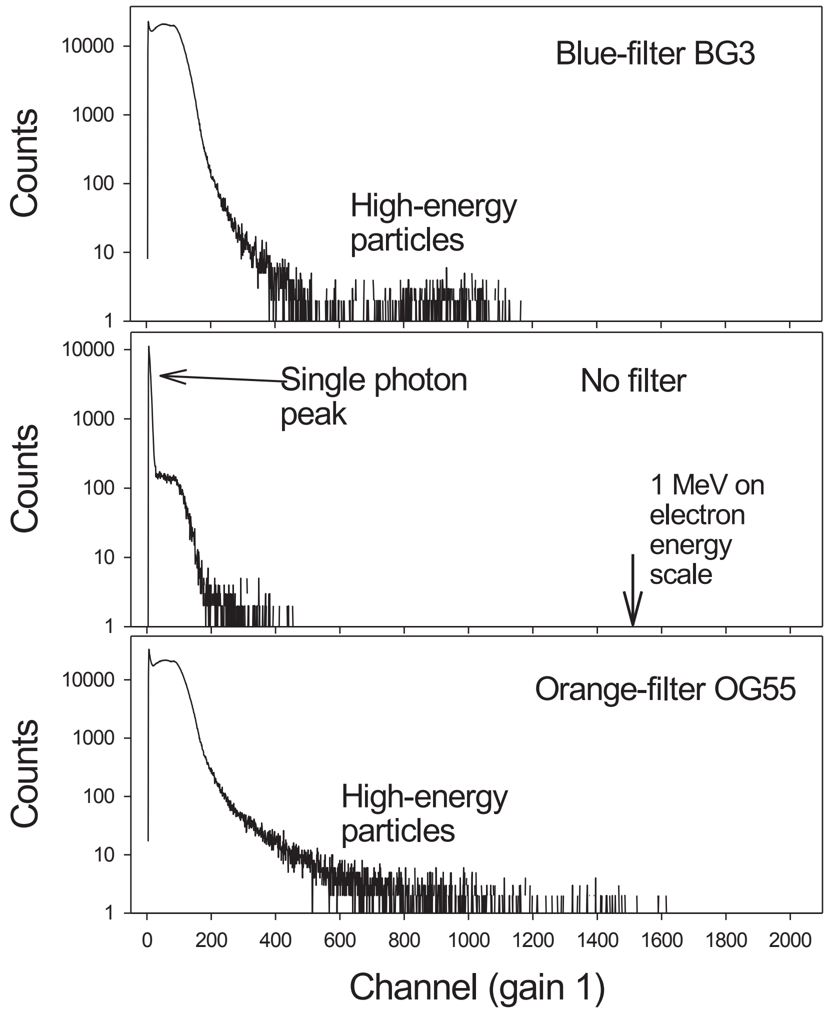


Fig. 9 – Spontaneous signal with detector 3 m from chamber. The three spectra are taken in sequence from top spectrum, changing converter took 60 s.

Spontaneous

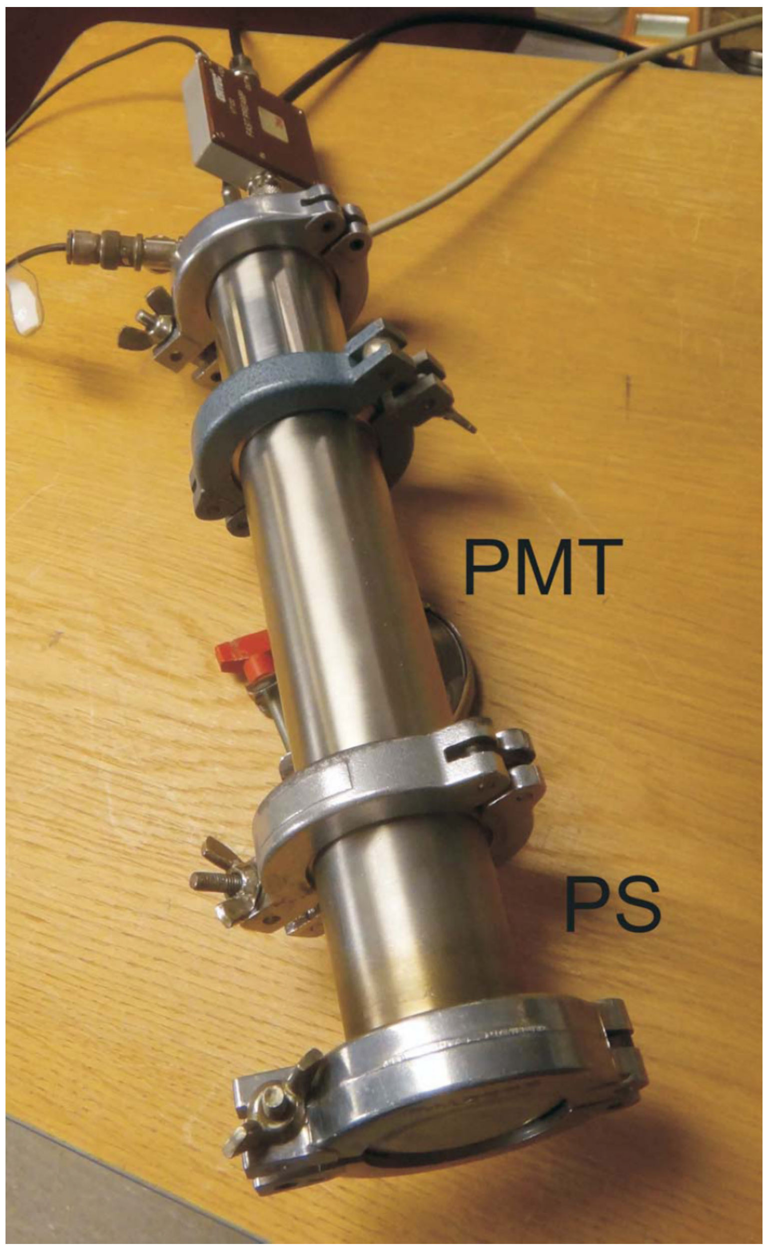


FIG. 1. Detector part from vacuum components. The PMT part and the PS part are indicated. Without the PS part, a metal blind flange is used to close the tube.

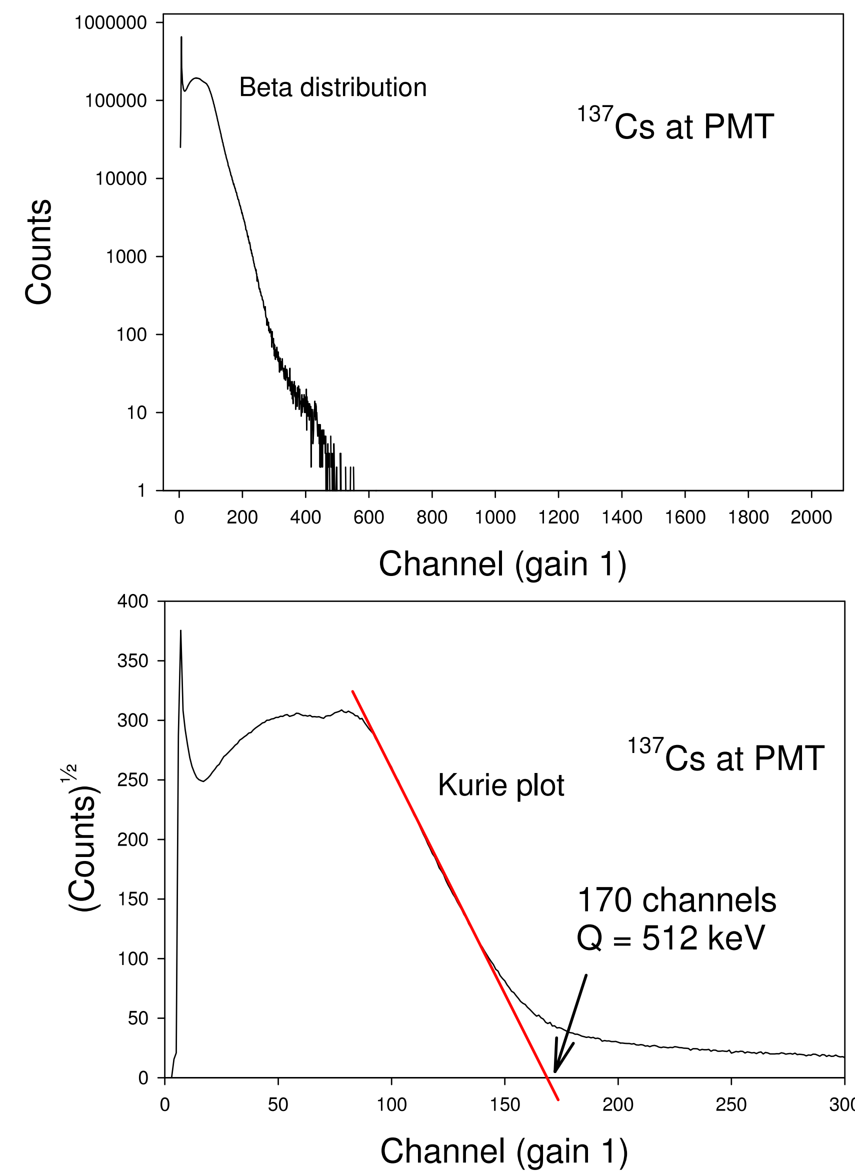


FIG. 2. A ^{137}Cs probe at the PMT with no metal flange. The approximate Kurie plot shows the zero signal intercept at 170 channels corresponding to Q = 512 keV.

Thank you for listening