



Wiki Lampao, Thailand

FolderFolders/ RecentChanges Preferences Edit

Main Topics

ProjectIssues
ProjectDocumentation
PartnersAndSponsors
PhotoGallery
ContactUs

Navigation

Home / FrontPage
Folders
Search
All Pages

Wiki How-To

Help
SandBox

Administration

Login / Logout
EditorialWork
ToDoList for the wiki
Edit Sidebar
Configuration

Folder Folders / Nano Solex



Welcome to the Research, Development, Demonstration
and Education site of the Solar Experiment pump:

The solar powered water pump with no moving parts –
developed out of an inverse water rocket as an example
for affordable sustainability by technological innovation

Program [Homepage](#)Presentation homepage <http://www.sustainicum.at/de/home>For the NatLab (in German) see here [Natural Laboratory](#)

Solex Project tool is under the research focus Sustainicum

Dr. UweChristianPlachetka DI. Emmerich Seidelberger

Thanks to:

- Prof. Liliana Munoz Huancayo Peru,
- Dec. Juan Carlos Condor Ames, Huancayo - Peru
- Prof. Suphan Soodsoon, Thailand
- Sepp Lumper, Austria for the modification of the portable Solex pump

The pump was originally constructed by Dr. Plachetka in Huancayo, Peru in 2009 and, after a demonstration tool in Kirchbach-Steiermark finished at the Ramayagala Technical University Isaan Campus Thailand in 2011.

Para I@s companer@s en Sudamerica - favor que se consulta a Liliana Munoz [aquí](#)For German teachers: [NanosolexLehrerhandbuch](#)

Final version of this tool is under permanent construction to allow the integration of practical experiences by using it



[1] [2]

Navigation

Final version of this tool is under permanent construction to allow the integration of practical experiences by using it
Navigation

How to teach Energy in a sensitive, impressing and imaginable form that students can remember it?

DidacticalPotential and teaching advices for the Solex Pump

Show sheet how to teach energy by the Nano-Solex-Pump

Didactical Potential

Milestone #1: Bangling theory

Visualization of how heat is transformed into work

Step 2: Heated gas or evaporized water in a closed vessel means pressure:

How work is transformed into potential energy by pressure: The water rocket film

Comments by the teacher when showing the film

Turning the water rocket into a (refillable) water pump

Solex Film documents on the test run in Thailand

The Nano-Solex

Nanosolex - Description**First start of the pump brought to Vienna - Proof of concept video 1****Explanation****Content of proof of concept videos****Bottleneck by February - March 2012****Proof of concept video 2****For advanced Students: Exergy and related issues****Solar Energy provision****For small pumps we have to increase the energy density****Now the students should learn how to use environmental energy in a correct way****Milestone # 2 The Construction step by step****Step 1 Using lenses****Do-it-yourself Fresnell lense device****LenseRepository****Step 2: Developing a feedback heater****Conventional solar cookers****The construction of a heat trap****the construction of an evaporizer that means water boiler****The steps for constructing the small pump****The experiments in Mr SeppLumper's lab in Purgstall****Exercises and fun for students to practice those lessons**

How to teach Energy in a sensitive, impressing and imaginable form that students can remember it?

by Uwe Christian Plachetka (CopyRight)

AdvisesforTeachers

DidacticalPotential and teaching advices for the Solex Pump

Teacher's manual

Show sheet how to teach energy by the Nano-Solex-Pump

The target is to make abstract units such as Kilojoules comprehensible. This sounds as an impossible task



"Yes I know - the impossible you do now - miracles take a little longer" says Daktari's Judy.

Okay, Judy, let's start with the miracle - and stop laughing!

Didactical Potential

Demystification of Technology and fostering phenomenological empathy. Education of frontier researchers.

- See this link [DidacticalPotential](#) for detail

Milestone #1: Bangling theory

The textbook says: The potential energy achieved by thermal input is Greek γ multiplied by G (the gravitation constant $9.81 \text{ m per square second}^*$ height).

This is the basic relation for thermal energetic engines.

Is that true?



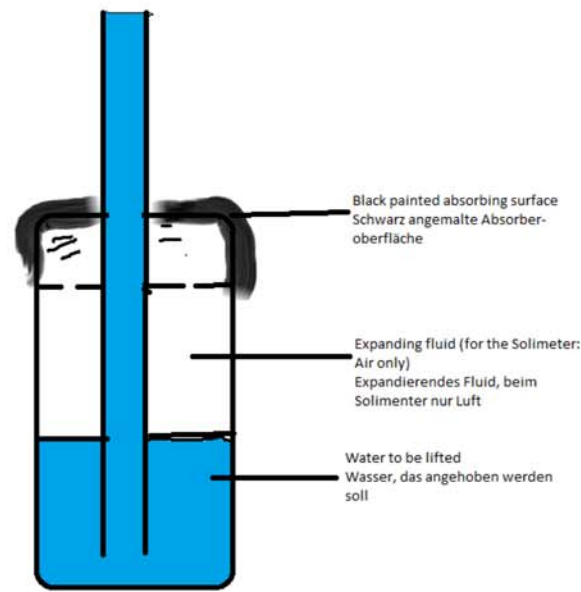
This is a more beautiful Judy with a Solimeter.

(Prof. Liliana Munoz in Huancayo - Peru)

The sun rays are absorbed on the area painted black, so the water rises in the lift tube - to be measured (yes you can come close to the lady).

Visualization of how heat is transformed into work

This is the Principle of the Solimeter and the Solex pump



The basic pattern: The Heron's ball. The maximum water table in the lift tube indicates the maximum realizable thermal energy (the Exergy).

The Solimeter indicates the available exergy of solar heat. Exergy is the part of energy that can be transformed into technical work.



This is the potential energy provided by thermal energy: potential energy = $G \cdot r \cdot h$. $G = 9.81 \text{ m/square second}$, $r = \text{density of water}$, $h = \text{to be measured}$. This is potential energy but as a result of solar thermal work (watts per centimeter or in a vintage unit system kilocalories per minute per square centimeter). This means the Solimeter needs some time to reach the maximum height of the water column in its lift tube.

Now let's turn the potential energy provided by heat into work: Here:



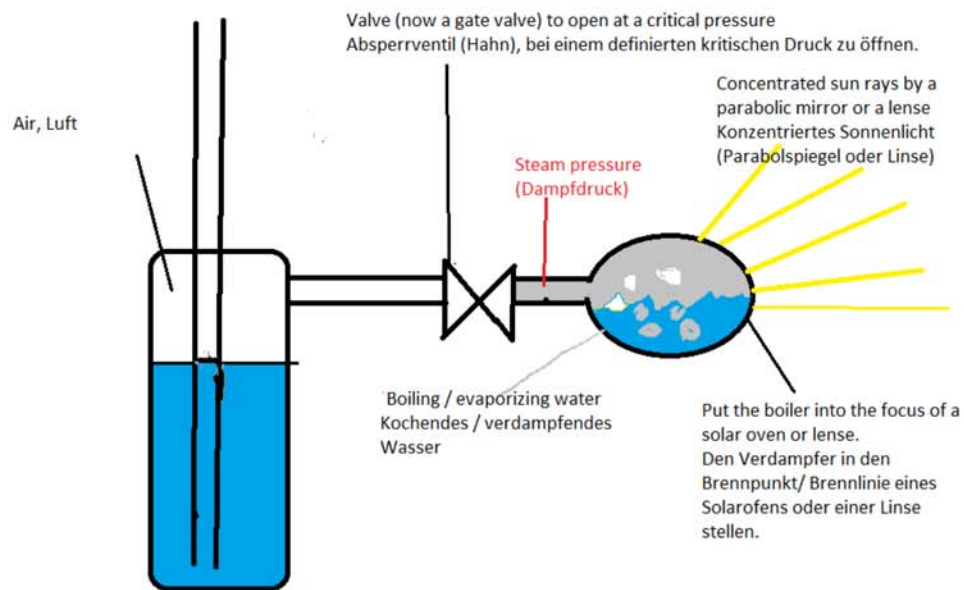
Here the lift tube (vertical length) is shorter than the maximum altitude (the portion of solar radiation energy transformed by work into potential energy)... and we see, the alu foil is required to raise the energy density even at 3000 m above sea level in the Peruvian Andes. The Solimeter is very sensitive on this altitude, due to the low air pressure that means that no many air molecules are available per square centimeter, but they have a high kinetic energy due to the intensive global radiation (clear sky radiation gradient^[3]).

Step 2: Heated gas or evaporized water in a closed vessel means pressure:

What is pressure? The sun expands the air in the solimeter within a given volume. So the water is moved and is pured out. So you have to make a difference between (a) energy cargo (pressure) and (b) fluid as working mass - for instance water - and preassure expanded performs work, lifting for instance rockets as we will see here.

Filmed by [SeppLumper](#)

Technical Application of steam exergy to the Solex pump



This is the basic pattern of the Solex Pump with a fluid mix

[here](#) on the scientific Apparatus.

The following sections are devoted to: What is technical work? The transformability of energy into work and the re-transformation of work into Energy: Energy is not the same as power.

How work is transformed into potential energy by pressure: The water rocket film [🔗](#)

The Solex pump with a "stored pressure" seems as if a rocket has a bag at its nozzles. The work of a rocket is its flight vertical to gravity according to the second law of motion - if the propelling mass can expand totally (that means maximum expansion and no internal temperature difference of its temperature to the environment). Here the propulsion mass cannot expand totally, it produces pressure at the pressure vessel. Anyway, cold water rockets are a good example to show the transformation of work into (stored) Energy.

Source: http://www.youtube.com/watch?v=cm13_t1cOUk

Comments by the teacher when showing the film [🔗](#)

- Minute 0:17: You have to construct your machine according to the energy it shall harness. Otherwise it doesn't work
 - Minute 0:37-38: People are working to compress the air for the rocket. This means
1. Work is to "produce" (that means be converted) into potential energy.
 2. The textbook says: The equivalent between energy (even thermal energy) and work: $1 \text{ kcal} = 4,1868 \text{ Kjoules (thermic)} = 427 \text{ kilogrammeters (vintage work unit)}$: This is the equivalent between thermic energy and work. Pump your water rocket that you feel how much work is required

for 1kJ stored energy.

"Lesson #1 to remember: Work is transformed into potential energy (the compressed air).

- Minute 1:00 Adaptation of the devices for transforming potential energy into work (the repulsion for moving the rocket: The nozzles).
- Minute 1:30: The launch angle: So it's not only force (energy) to make the machine effective, also adaptation of it's flight trajectory. The effect of the ballistic energy efficiency based on the principle of impulse conservation.

Lesson #2: What does this mean for sustainability: Drive your car gliding and you save gasoline: Cars have also a ballistic energy efficiency.

This one is not a thermic energy because hard-working people are producing the pressurized air for the potential energy. Let's go back to the thermodynamics. ^[4] Here heat shall produce compressed air or steam (compressed steam).

Turning the water rocket into a (refillable) water pump



Below the big Solex Pump in Thailand is shown with a 10 liter pressure vessel, 2 liter of water in the absorber tube to be vaporized. The bucket for atmospheric refill contained approx. 100 liter water. The films were taken by Franz Rieger as snapshots. It can be explained a water rocket turned upside down with an external solar-powered water evaporizer to produce the pressure the hard working people had to produce by compressing air in the case of the big-banana water rocket. In the case of the solar-powered water pump with no moving parts (except valves) the steam produces the pressure (Detail work in progress).



The big Thai Solex water pump.

To visualize heat we use solar heat - because it is to be concentrated to reach the required energy density for evaporizing water (standard: 2300-2400 Kilojoule per Kilogram water to be evaporized (depending on external air pressure). So you have the energy but you must concentrate it. Energy per area or cubic unit = energy density. The following picture is a textbook solar concentrator for evaporizing steam in the absorber tube (length: 2 meters) and the pressure gauge to make the steam pressure visible). The solar concentrator was constructed in Thailand by remote advice via the Internet from Vienna.



Here on the pressure gauge you see the produced steam pressure of about two liters of water by solar energy: Concentrated solar rays. This is the pressurized gas which was produced by hand in the case of the water rocket. Here we have a steam-driven upside-down water rocket that doesn't fly itself but shoots the water upwards.

Solex Film documents on the test run in Thailand



The first film taken at the Ramayagala Technological University at Kalasin - Thailand shows the Solex-Pump having been constructed by remote advise (via Internet). On the general level the construction of the solar concentrator etc. proves that the idea of turning tele-education into development by electronic communication devices does work. On a more specific level it shows that too Eurocentric engineering is not viable as it required too much valves and to less hunch grasping of technological processes by visualizing them (the job of the Solimeter). So if you teach, please consider all details. The result of Eurocentrism in engineering(funny) is shown here:

(Film taken by Franz Rieger)

Personal presence is imperative but can be shortened by 4 month when using the digital air lifts (video-bridges etc). So the pump was basically okay, it couldn't refill automatically. The reason was that someone of the original team drew plans, which presented the refill tube fixed to the lift tube and not to the pressure vessel. Needless to say that the valves went broken (thermic expansion of material)^[5].

The fluid mix (a matter with rockets) needs personal experience with the topic due to the adiabatic expansion of the reactive mass (fluid). Personal experience cannot be always verbalized by intellectual discourses.

 <http://www.youtube.com/watch?v=BfiacVyDfg8&feature=youtu.be>

After lecturing and re-design of the pump: The implosion (refilling phase of the pump) seems to work (watch the water column gauge indicating the water table inside the pressure vessel).

Less valves but separated tubes / vacuum tubes: The lift tube, refilling by implosion tube and steam tube has to be separated. The fluid mix is essential (as seen by the water rocket above. Here the steam acts as the compressed air) and please watch exactly my comments on the water column gauge glass ^[6] of the pressure vessel to see the re-fillment process of the pressure vessel.

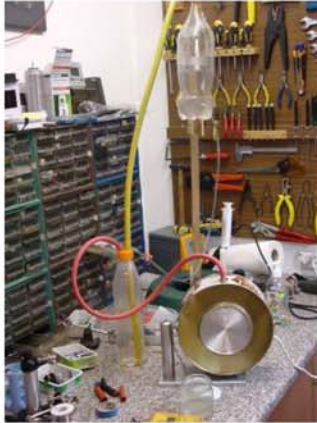
<http://www.youtube.com/watch?v=anbA6zFIJ7w&feature=youtu.be>

(Comments at the German [Lehrerhandbuch](#))

The Nano-Solex 



Nanosolex - Description 

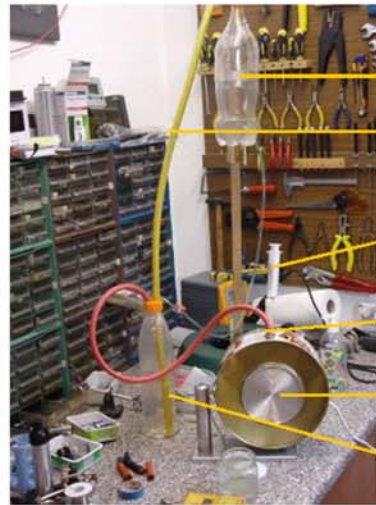


This lab model of the Solex - the Nano-solex - is required for scaling the energy / work performance and the fluid mix, Addendum December 2012: This is a recently developed sophisticated version of the Nano-Solexpump.



Description of the Nano-Solex-Pump taken from the [German-site](#)

Nanosolex-Beschreibung



Original photo in the lab; Source: Sepp Lumper

• Legende

Auffangflasche (storage bottle)

Steigrohr (lift tube)

Wassereinspritzung
Water injection

Dampfschlauch (steam hose)
zur Druckflasche (pressure
bottle)

Heizplatte (mit Wärmespeicher für
schlagartige Verdampfung).
Heat area as flash vaporizer

Druckflasche (pressure bottle)

First start of the pump brought to Vienna - Proof of concept video 1

<http://www.youtube.com/watch?v=2xmuOra0yYE>

(with re-filling by implosion)

Explanation

This video is a proof of concept video such as the following videos. The crew (Uwe C. Plachetka, DI Emmerich Seidelberger) faced severe problems when downloading movies from a small digital camera. Unlike offline video players Youtube made them visible. The solex pump as shown in the youtube flicks is a laboratory device to get the second generation Solex Pumps ready. These S-2 pumps should get automatically refilled and perform their work automatically, whereas the S-1 Thai pump was depending on human control concerning the steam interrupter.

Content of proof of concept videos

- Before circa minute 2:24: The pump works the same way as the Heron's ball (not the Aelopile) with external rapid steam production based on the double fluid theory originally developed for sustainable aviation (known as the "rocket that breath" to British engineers developing the sustainable supersonic aircraft, as it can do with external air supply. The theory is quite easy to be derived from Sängers *Raketenflugtechnik* when having read it - not just having runned one's eyes over the lines).
- After circa minute 2:24: The water to be pumped has left the pressure vessel. The steam inside along with the air is hot enough to keep the internal pressure level, but it is cooling down. There is a threshold value, beyond which the thermodynamic energy cannot cope with the challenges of compensating the lack of mass (the water gone) inside the pressure vessel by the kinetic head of the fluid left inside. This threshold value, once trespassed, leads to an instant breakdown of the pressure and therefore a partial vacuum that allows refilling by implosion.
- The swinging device is a counter to measure the water runoff (quantity per click) from the upper vessel that catches the water pulled up at this laboratory version of the S-2 pump. Along with the manometer and the electronic data logger this laboratory version of the S-2 solex pump is to enable the elaboration of a scale for really working S-2 solex pumps.

Bottleneck by February - March 2012

The Fresnell lense (which is difficult to be obtained) should have a heating performance of 4 KWatt when working with instant evaporation (in contrast to the Thai S-1 pump where the absorber tube served as a boiler).

This sample video is by Green power science to explain the procedure of testing the heat performance of the Fresnell Lenses (unfortunately my mails sent to them were not responded by now).

Original source: <http://www.youtube.com/watch?v=e4iU9kbn1wI>

Due to the Green Power Science demo videos as used during the planning phase of the nano-Solex (the laboratory sample for Solex S-2) the standard test sample is 10 fl oz of water = 0.296 kg of water. Assumed that the starting temperature is 25°C, it requires 92.8 KJ to reach the boiling point, 661 KJ to convert the sample into vapor.

Therefore the solar evaporator should vaporize the 10 fl oz of water by 1.88 seconds.

For improving the energy efficiency (economizing, in physics it is the Greek letter eta written as ê here) the Blackbody energy flux phi (ph, Greek f) indicates the maximum energy input with no reflection of sunlight: 775647W/ square meter. So paint your absorber pot or absorber tube black and close it.

Proof of concept video 2 ☆



Heated by electricity for measuring the efficiency!

For advanced Students: Exergy and related issues ☆



EnergyEnthalpyandExergy

Solar Energy provision ☆



For small pumps we have to increase the energy density ☆



Again, the energy density has to be increased, because small pumps cannot have a solar concentrator of 2.5 m length and 2 m width. Therefore we use lenses. But lenses can be made of a lot of transparent materials, even water

Reference page: German page [here](#) the Solex-Pump shall be miniturized (all rights reserved until authorized further notice).

We need the solex pump in environments with slowly running river. In mountain areas the ram pump is to be recommended (whereas the solex pump was developed out of an inverse water rocket which doesn't fly itself but ejects the water, the ram pump has perhaps no reference to the ramjet). <http://www.youtube.com/watch?v=qWqDurunnK8&feature=related>

Now the students should learn how to use environmental energy in a correct way ☆



Can we use the big parabolic mirror for small machines? No.


Milestone # 2 The Construction step by step ☆



(Documentary of research issues).

Step 1 Using lenses



To avoid the adverse effects of the eclipsis usually Scheffler reflectors are used (see  [here](#)). The problem is that, as we have learned from Thailand, water evaporizers based on reflective material tend to be very large. For the nano-fying process, lenses should be used.

Demonstration of the Fresnell Lens by  [Green-Power-Science](#) (the following videos are citations from there).

Do-it-yourself Fresnell lense device



◦  <http://www.youtube.com/watch?v=p7dvd959wfg&feature=related>

[LenseRepository](#)



Step 2: Developing a feedback heater



Fresnell lenses are considered as expensive, therefore we need some positive energy feedback - by heat traps and heat storage devices to improve the energy density (Kilojoules por cubic centimeter in the evaporation device).

Usually flat solar panels are used. This one claims to heat water to 270°C - see this embedded film:

A black garden hose would do it as well. This is a good explanation in the following video.

<http://www.youtube.com/watch?v=S87KDpEUzFE&feature=related>

Conventional solar cookers

Definition according to [Wikipedia](#)

The idea of the feedback heater is to charge the evaporizer with collected heat. This is not a hybrid cooker, but a heat collecting evaporizer.

The term "hybrid cooker" is defined as follows: *A hybrid solar oven is a solar box cooker equipped with a conventional electrical heating element for cloudy days or nighttime cooking. Developed primarily for use in first world countries where both solar energy and electricity usage is abundant a hybrid solar ovens can be a convenient and reliable cooking appliance. They currently, however, lack the cost advantages of some other types of solar cookers, and so their use in third world countries where electricity or fuel sources simply do not exist has been limited.* (Wikipedia).

All these collecting items have a problem to recycle side-radiation. This needs a kind of concave mirror - or a heat trap as the typical 3rd world self-constructed suitcase solar cookers are (but they are very slow).

The construction of a heat trap

The solar box cooker typically reaches a temperature of 150 °C (300 °F). This is not as hot as a standard oven, but still hot enough to cook food over a somewhat longer period of time. (Wikipedia).

What, if the Solar box is situated in the focus ellipsis of a lense?

This is now an unconventional approach but was used by Peruvians to construct solar cookers for Africa: The use of positive feedbacks. This is what I consider to be responsible for Schauburger's use of Vortices (e.g. in the Vortex Turbine) to enhance energy efficiency: reducing the waste energy by refeeding it into the process. With mechanical fluids in an engine this refers to the "ballistic energy efficiency" based on the conservation of impulses. With solar thermodynamics this refers to recycle reflected rays and heat storages (buffer materia), so the energy feedback efficiency of box cookers is to be optimized:



Some relevant experiments have been done already with the Solimeter in Peru in the course of developing the Solex pump.

This means: Put the heat collector into the focal ellipsis of the Fresnell Lense and isolate it very well (Glass wool). The heat trap must have mirrors inside on the wall, except the glass the light has to go in. Inside the heat trap box is the boiler.

Some turn pizza boxes into solar ovens. The sustainability of pizza boxes is disputed - and the sustainability of industrially prepared pizzas as well. However, turn trash into devices for teaching to get any sense out of it.

<http://www.youtube.com/watch?v=xbwliZJiHe8>

(but if you do that, be careful with the lenses - otherwise you have a pizza flambé.

the construction of an evaporizer that means water boiler

This is a South-American solar cooker to boil water within 3 minutes.

<http://www.youtube.com/watch?v=qg0z8lwXXA8&feature=related>

From Green Power science: A 12 [KW-steam-engine](#)

... and the South-American Solar cooking book...

<http://www.youtube.com/watch?v=OxEaMTPa0s4&feature=related>

Okay, dinner is over and no Caipirinhas after because we are continuing now. In the case of a lense-solar-box combination the heat is to be accumulated and stored, as the disadvantage of the parabolic mirror oven is as follows:



some clouds passing by and the evaporizer ceases to produce. So you have to have a heat storage to make your evaporizer resilient. In the case of constructing the pump in Thailand 2011 the visible and invisible clouds were indicating a third ENSO cold phase, although Thailand was already flooded in 2011 by two consecutive "La Ninas" (ENSO cold phases). Therefore the Monsoon lasted too long. (details: [LaNina](#)).

The steps for constructing the small pump

Step one: Measure the required energy

Photos for the documentation available ... but a lot ... (will be online soon)

The experiments in Mr [SeppLumper's](#) lab in Purgstall

Principle of the Solimeter - the blueprint of the Solex Pump

Exercises and fun for students to practice those lessons

... shanghaiad on the Davos summit <http://www.youtube.com/watch?v=SLmXrFSzmKU>

 Upload: [UweChristianPlachetka/VorlesungsWikiPlan.doc](#)

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[3] The environmental gradients in the Andean mountains and the consequences for indigenous technology of ecological system management are provided by Prof John Earls here: <http://macareo.pucp.edu.pe/~jearls/documentosPDF/theCharacter.PDF>. See especially the clear sky radiation gradient and the air pressure gradient at page 4-5

[4] As a consequence of the [Solex-Pump](#) in Thailand

[5] Total crash of any theories concerning mod-2 "scientists" as somehow advocated by the open source movement - this is the reason for the

strict license

^[6] In German: Wasserstandsglas - indicating the water table of a steam vessel

11 pages:

... .. FolderFolders/AldeasGlobalesPopulares/SustainableAviation
... .. FolderFolders/NanoSolex/CopyRight
... .. FolderFolders/NanoSolex/DidacticalPotential
... .. FolderFolders/NanoSolex/EnergyEnthalpyandExergy
... .. FolderFolders/NanoSolex/LaNina
... .. FolderFolders/NanoSolex/LenseRepository
... .. FolderFolders/NanoSolex/NanosolexLehrerhandbuch
... .. FolderFolders/NanoSolex/NanosolexLehrerhandbuch/NanosolexEmmerich
... .. FolderFolders/NanoSolex/NanosolexLehrerhandbuch/RoterFaden
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