

SAMPLE ANALYSIS REPORT

Sampling location:

HUNGARY

Sampling time:

17.01.2022 - 15:00

(dry, sunny weather, +5 °C)

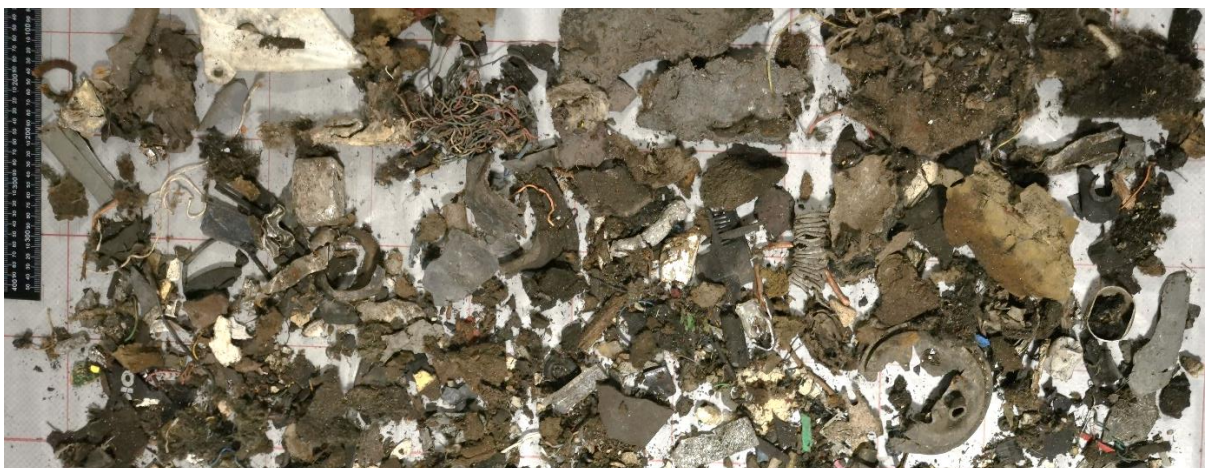
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SAMPLE DESCRIPTION

Automotive shredder light fraction (SLF) pre-processed by a **LINDEMANN Shredder II./PS 2000** unit, collected from open air bulk storage. On-site observation shows an estimated distribution of particle sizes from 0-500 mm. Detail analysis of this report is focusing on particle sizes below ~200 mm, corresponding to the client's initially proposed sieving / separation solution. *A short summary of oversize particles (greater than those captured by the detail manual separation) is provided at the end [p23] of this document.*

SAMPLE PREPARATION FOR DETAIL ANALYSIS

3 x 10l sample, below ~200 mm particle size, from three different pre-mixed locations of the bulk storage, remixed at the facility of reparticle, evenly spread on the separation table. Of this spread about 1/3 of the total mass, 4117,6g was manually analysed by hand picking and sorting 3534 individual particles (corresponding to a weight of 3873,5g) and hand sieving of the bottom dust (4mm mesh sieve) fraction (corresponding to 244,1g of mixed fine particles.)

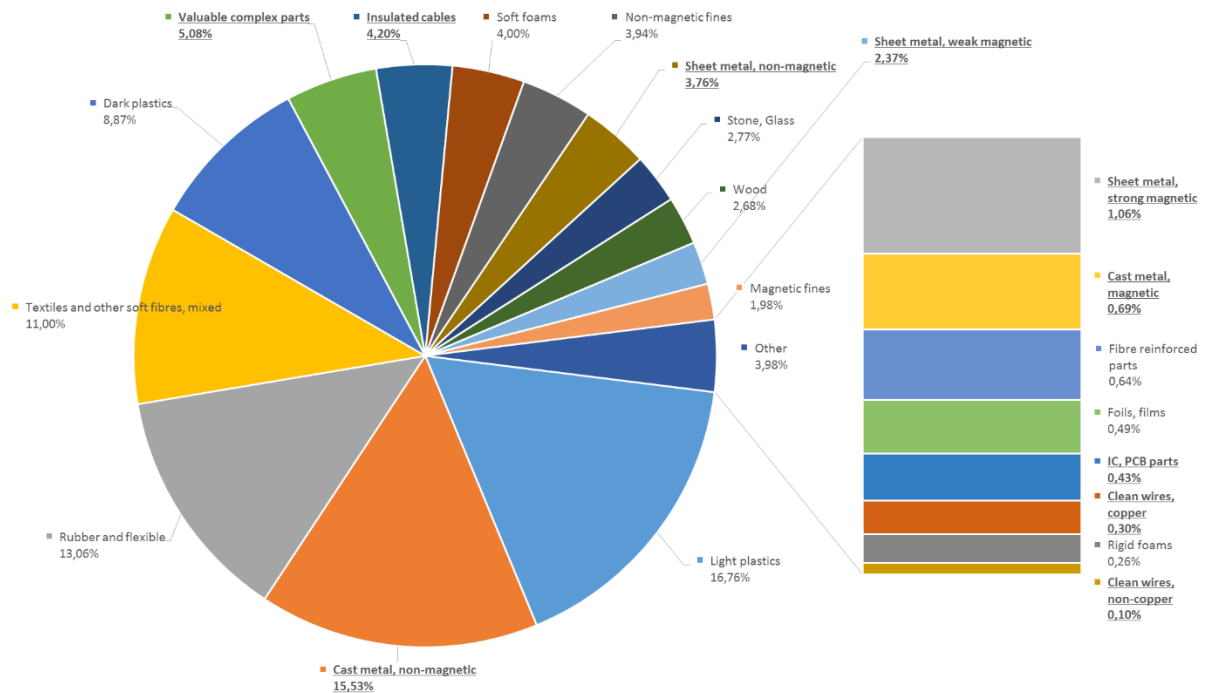


Estimated **bulk density**¹, based on 3 x 10l volume (<200mm): **0,36 g/cm³ – 360 kg/m³**

¹ This density estimate does not include oversize materials [see p23]

SAMPLE COMPISITION – BY WEIGHT

Manually sorted particles (>4mm, <200mm)



Residual fine particles (<4mm, hand sieved)



Total amount of fines <4mm
~ 6%wt



Non-magnetic fines <4
~4%



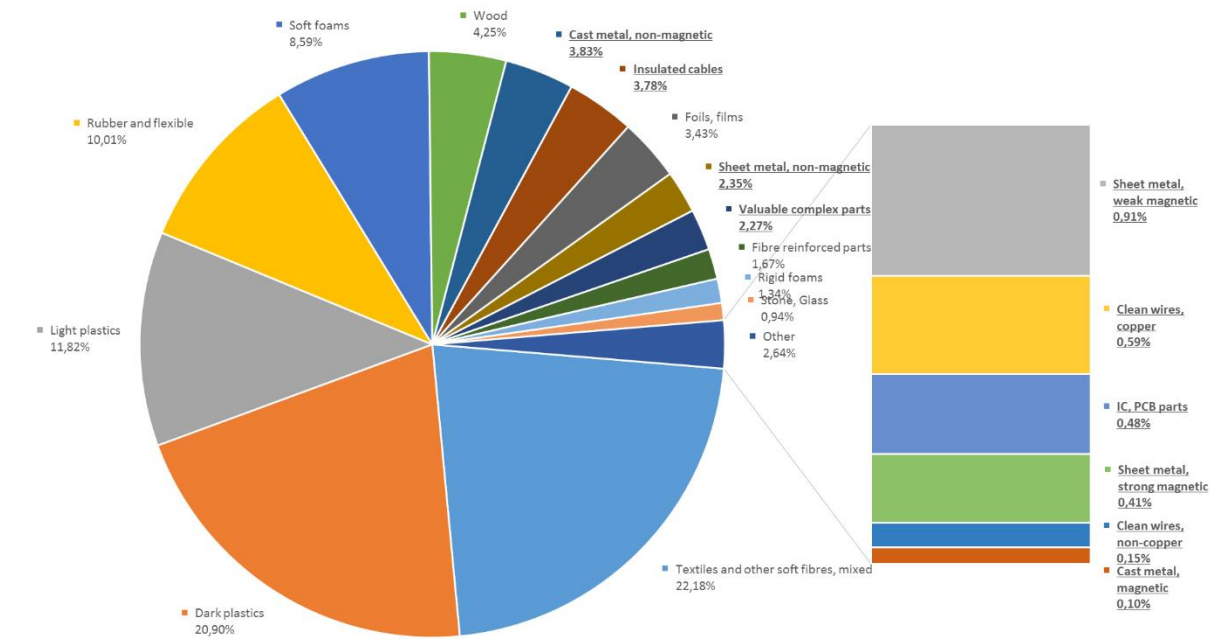
Magnetic fines² <4
~4%

² Separated through track-by-track manual scanning by strong industrial magnet

SAMPLE COMPOSITION – BY 2D PROJECTED SURFACE AREA

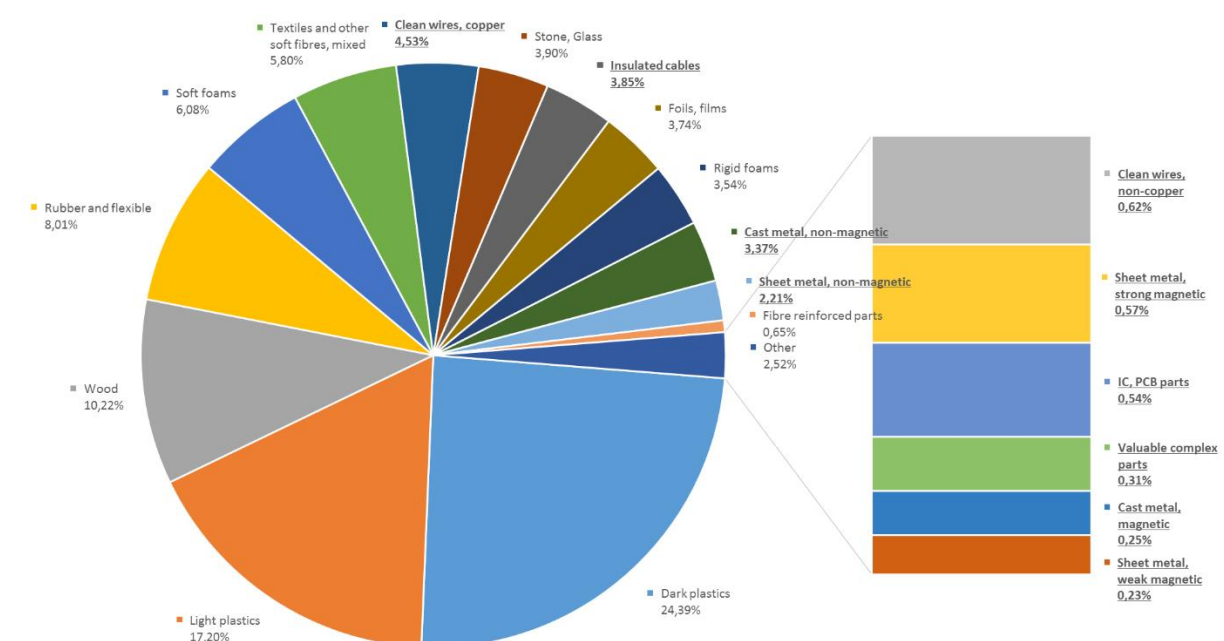
In order to indicate the volumetric distribution of various materials within the sample, digital photography and automated image processing was used to measure and compare the visible surface area of individual particles. While this technology is not able to capture the true 3D shape of materials, since most particles are flat, the diagram provides a good approximation of volume for each material type.

Total 2D area of particles by digital image recognition (>4mm, <200mm)



SAMPLE COMPOSITION – BY NUMBER OF PARTICLES

Manually sorted particles (>4mm, <200mm)



MATERIAL FRACTIONS OF THE DETAIL ANALYSIS

CAST METAL, NON-MAGNETIC

Percentage of Sample (weight)

16,51%

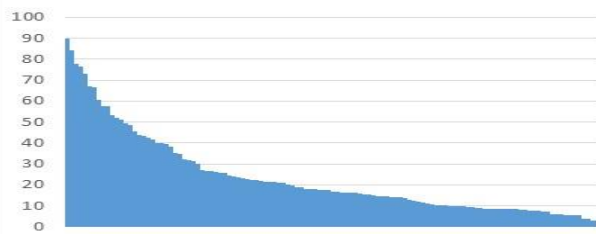
Total Weight

639,6 g

Particle Count

119

Cast metal, non-magnetic -
MaxCaliperSizes of particles (mm)



CAST METAL, MAGNETIC

Percentage of Sample (weight)

0,74%

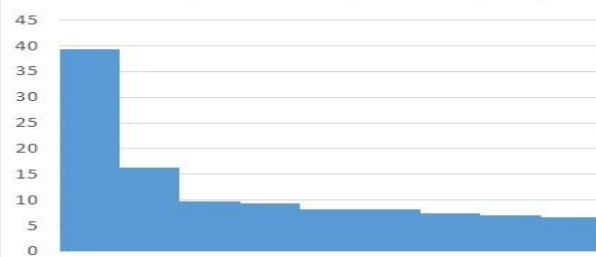
Total Weight

28,5 g

Particle Count

9

Cast metal, magnetic -
MaxCaliperSizes of particles (mm)



SHEET METAL, STRONG MAGNETIC

Percentage of Sample (weight)

1,13%

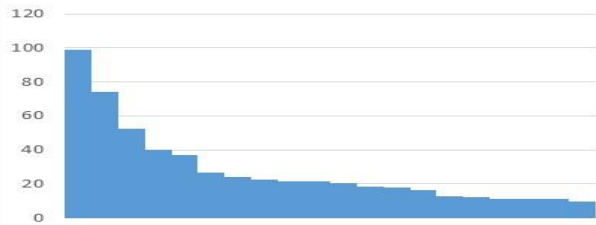
Total Weight

43,8 g

Particle Count

20

Sheet metal, strong magnetic -
MaxCaliperSizes of particles (mm)



SHEET METAL, WEAK MAGNETIC

Percentage of Sample (weight)

2,52%

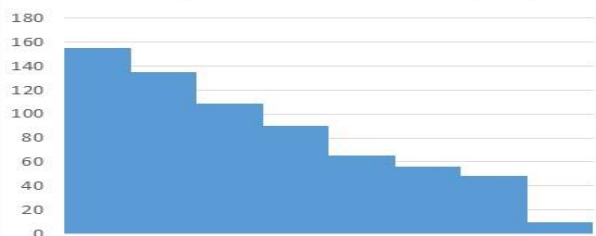
Total Weight

97,5 g

Particle Count

8

Sheet metal, weak magnetic -
MaxCaliperSizes of particles (mm)



SHEET METAL, NON-MAGNETIC

Percentage of Sample (weight)

4,00%

Total Weight

154,8 g

Particle Count

78

Sheet metal, non-magnetic -
MaxCaliperSizes of particles (mm)



CLEAN WIRES, COPPER

Percentage of Sample (weight)

0,32%

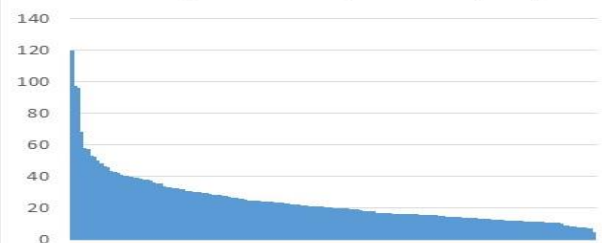
Total Weight

12,5 g

Particle Count

160

Clean wires, copper -
MaxCaliperSizes of particles (mm)



INSULATED CABLES

Percentage of Sample (weight)

4,47%

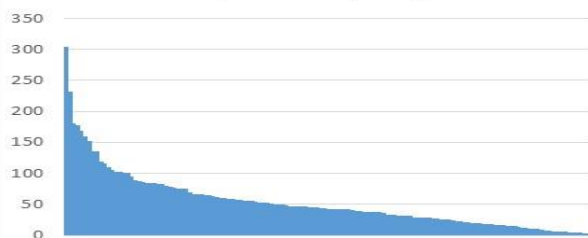
Total Weight

173 g

Particle Count

136

Insulated cables - MaxCaliperSizes
of particles (mm)



CLEAN WIRES, NON-COPPER

Percentage of Sample (weight)

0,11%

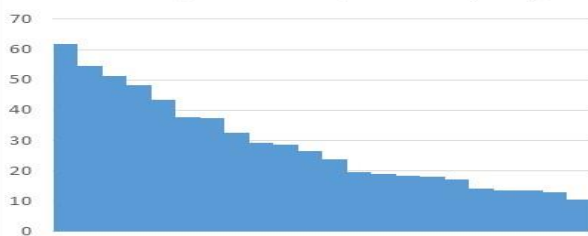
Total Weight

4,26 g

Particle Count

22

Clean wires, non-copper -
MaxCaliperSizes of particles (mm)



IC, PCB PARTS

Percentage of Sample (weight)

0,45%

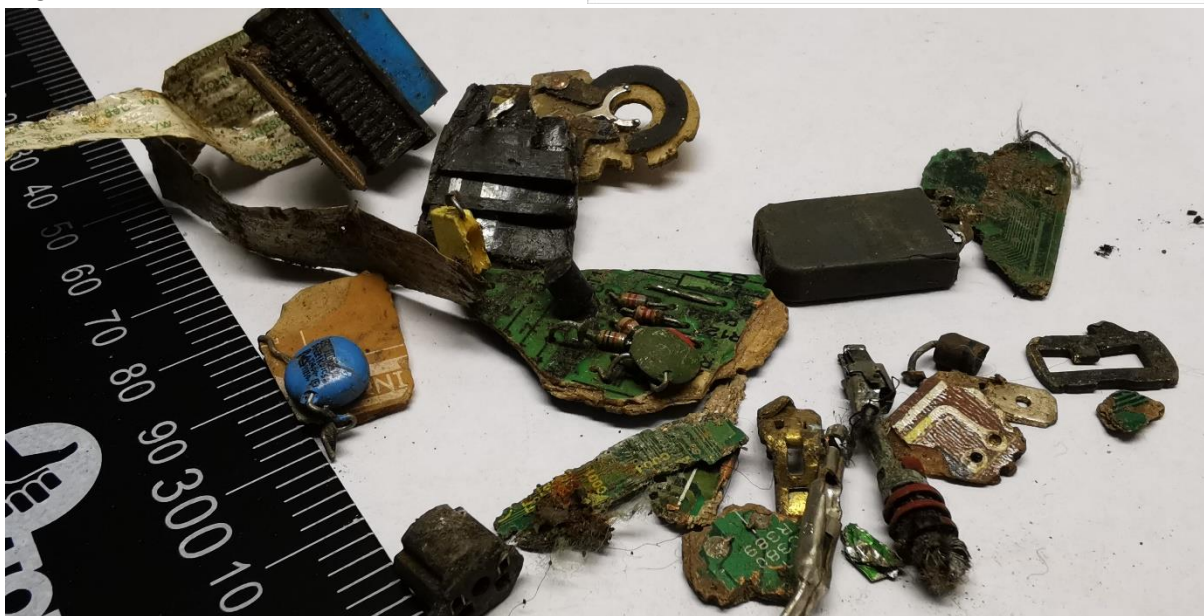
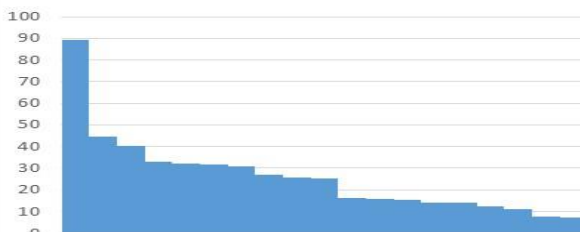
Total Weight

17,61 g

Particle Count

19

IC, PCB parts - MaxCaliperSizes of particles (mm)



VALUABLE COMPLEX PARTS

Percentage of Sample (weight)

5,4%

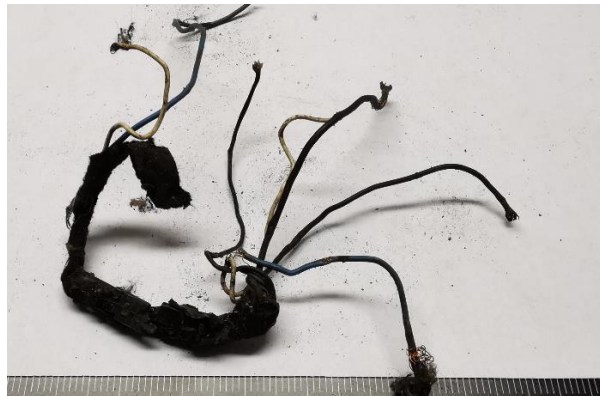
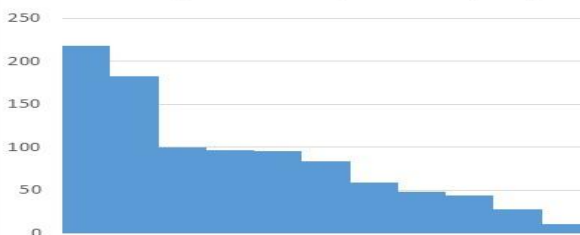
Total Weight

209,2 g

Particle Count

11

Valuable complex parts - MaxCaliperSizes of particles (mm)



LIGHT (NON-BLACK) PLASTICS

Percentage of Sample (weight)

17,82%

Total Weight

690,3 g

Particle Count

608

Light plastics - MaxCaliperSizes of particles (mm)



BLACK (DARK) PLASTICS

Percentage of Sample (weight)

9,43%

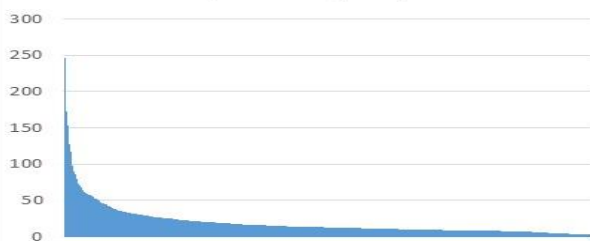
Total Weight

365,1 g

Particle Count

862

Dark plastics - MaxCaliperSizes of particles (mm)



FIBRE REINFORCED PARTS

Percentage of Sample (weight)

0,68%

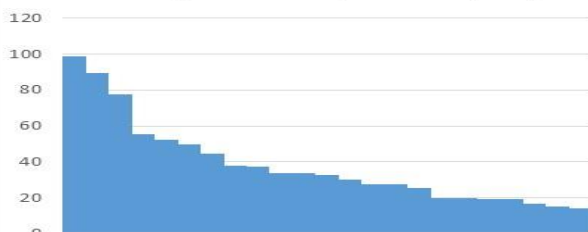
Total Weight

26,34 g

Particle Count

23

Fibre reinforced parts -
MaxCaliperSizes of particles (mm)



RUBBER AND FLEXIBLE PARTS

Percentage of Sample (weight)

13,88%

Total Weight

537,6 g

Particle Count

283

Rubber and flexible -
MaxCaliperSizes of particles (mm)



FOILS AND FILMS

Percentage of Sample (weight)

0,52%

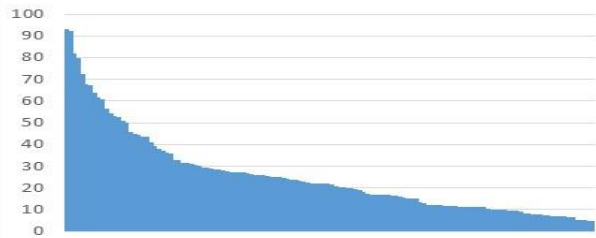
Total Weight

20,13 g

Particle Count

132

Foils, films - MaxCaliperSizes of particles (mm)



RIGID FOAMS

Percentage of Sample (weight)

0,28%

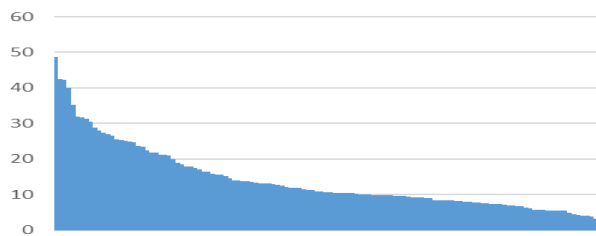
Total Weight

10,86 g

Particle Count

125

Rigid foams - MaxCaliperSizes of particles (mm)



SOFT FOAMS

Percentage of Sample (weight)

4,26%

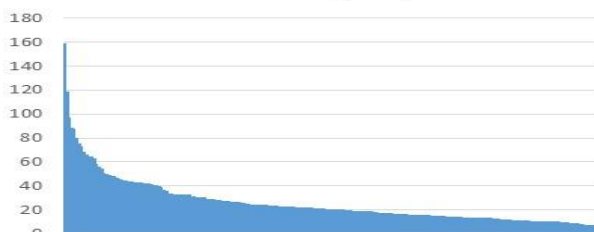
Total Weight

164,9 g

Particle Count

215

Soft foams - MaxCaliperSizes of particles (mm)



TEXTILES AND OTHER SOFT FIBRES, MIXED

Percentage of Sample (weight)

11,7%

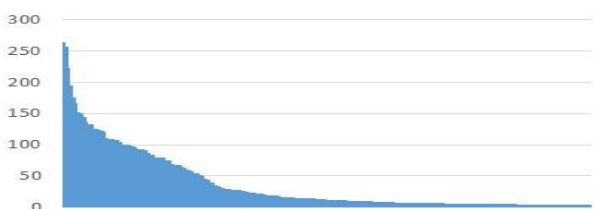
Total Weight

453,1 g

Particle Count

205

Textiles and other soft fibres, mixes - MaxCaliperSizes of particles (mm)



WOOD

Percentage of Sample (weight)

2,85%

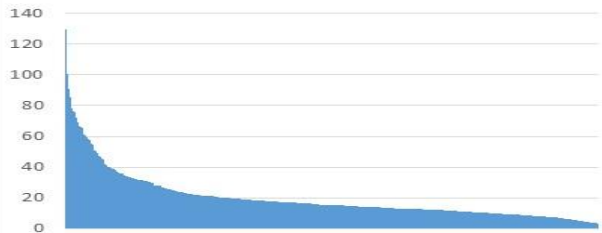
Total Weight

110,5 g

Particle Count

361

Wood - MaxCaliperSizes of particles (mm)



STONE, GLASS

Percentage of Sample (weight)

2,94%

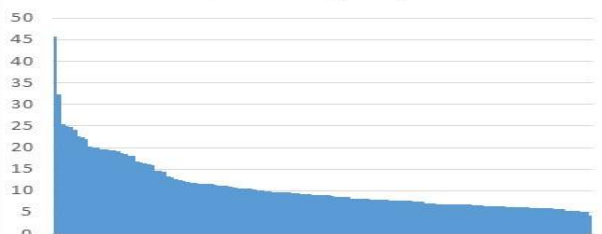
Total Weight

113,9 g

Particle Count

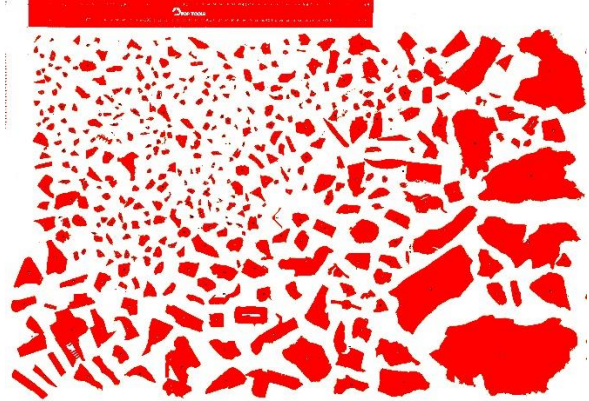
138

Stone, Glass - MaxCaliperSizes of particles (mm)



PARTICLE MASKS FOR DIGITAL IMAGE RECOGNITION

Dark plastics #1



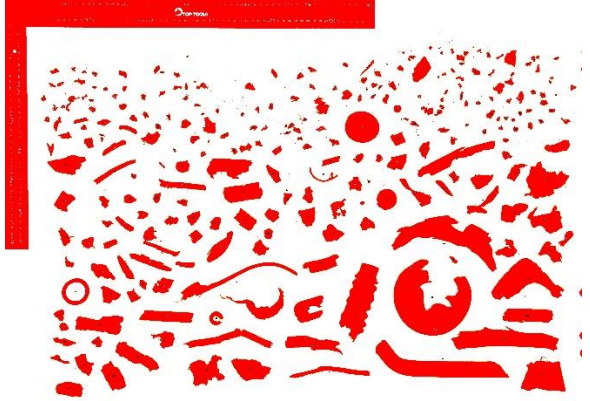
Dark plastics #2



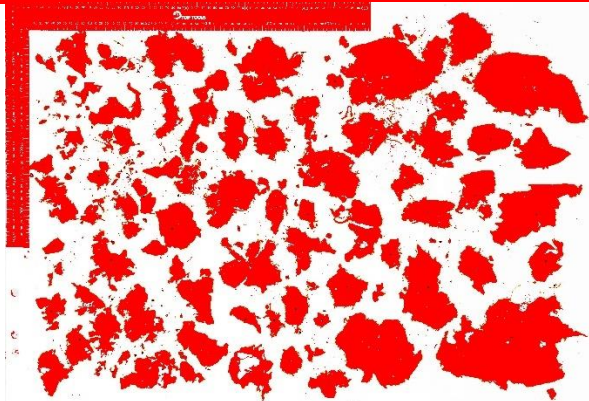
Light plastics



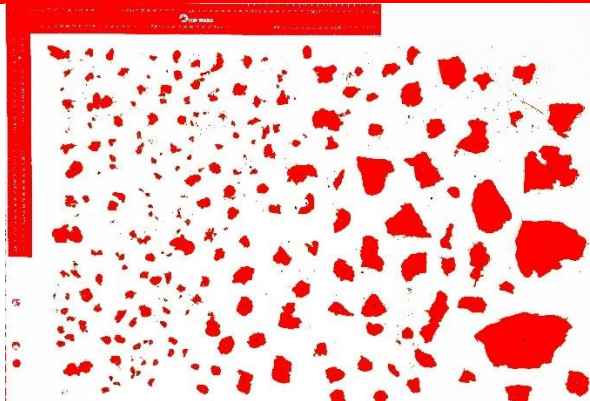
Rubber



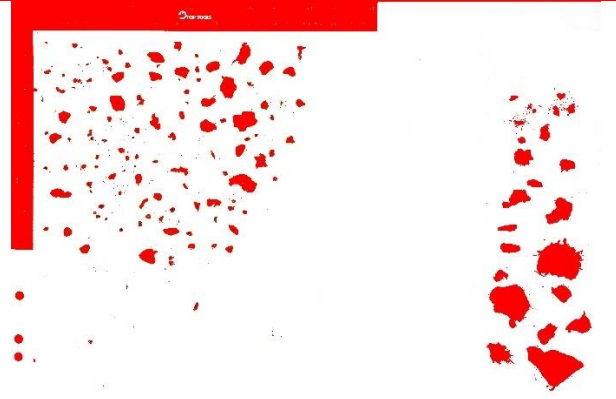
Textiles and soft fibres



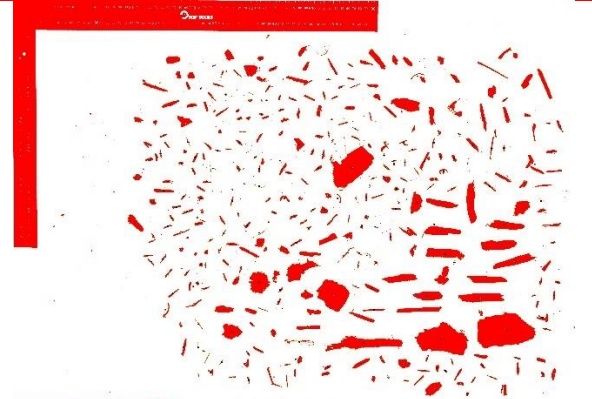
Soft foams



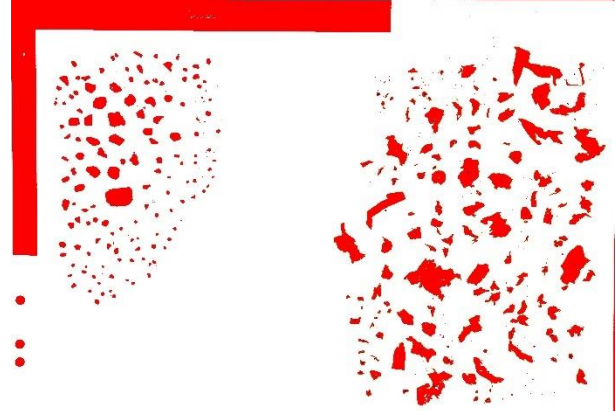
Rigid foams (L), Fibre reinforced (R)



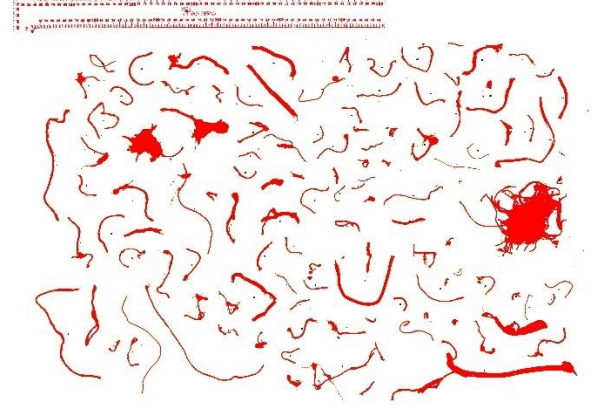
Wood



Stones & Glass (L), Foils & Films(R)



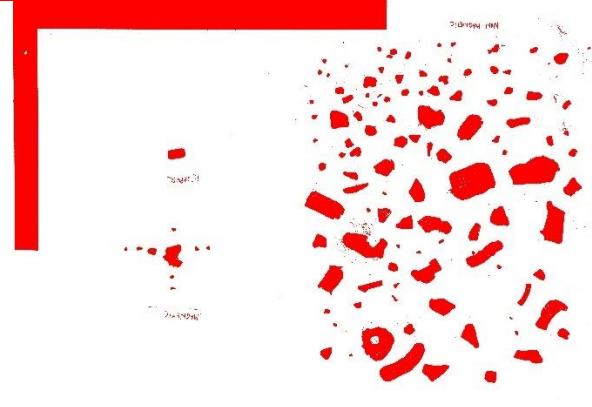
Cables (insulated)



Wires, NC (UL), IC & PCB (LL) Wires, Cu (R)



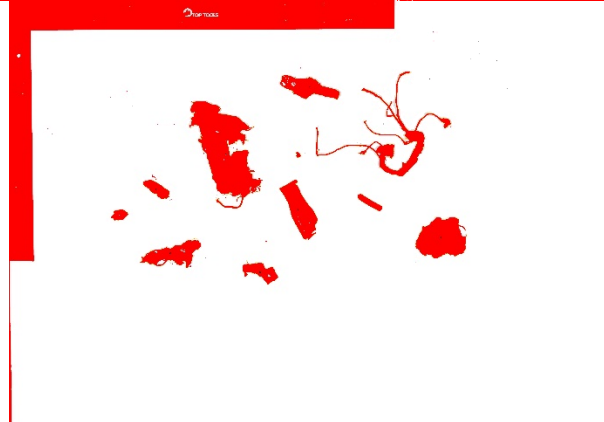
Cast metals magn. (L) non-magn. (R)



Sheet metals, magn. (L) non-magn. (R)



Complex parts



PARTICLE GEOMETRY SUMMARY by IMAGE RECOGNITION (mm, g)

Main type	Minor type	Area	Width	Height	Circ.	Feret	MinFeret	AR	Round
Mineral	Stone, Glass	75,71977536	9,72134058	8,739181159	0,759666667	10,89015217	7,491224638	1,447036232	0,720108696
Plastic	Foils, films	287,8644545	20,53685606	20,35309848	0,473909091	25,32029545	14,25485606	1,951424242	0,57630303
Plastic	Light plastics	215,1859605	15,59002303	14,73971382	0,589978618	18,78040296	10,49922862	1,954478618	0,595037829
Plastic	Dark plastics	268,3337111	15,89488631	14,94667981	0,611687935	19,11388051	10,81065081	1,86587703	0,605074246
Plastic	Fibre reinforced parts	801,48	35,32547826	29,51226087	0,42473913	38,10208696	25,36304348	1,666434783	0,637913043
Plastic	Soft foams	441,911814	22,29767442	21,54684186	0,506348837	26,10312093	17,26701395	1,664232558	0,670748837
Plastic	Rigid foams	118,378912	12,339112	11,115544	0,627352	14,173944	9,140288	1,673976	0,658624
Elastomer	Rubber and flexible	391,5333993	24,46349823	17,86724735	0,537798587	27,27096466	13,65438516	2,141286219	0,581268551
Wood	Wood	130,417097	178,6795277	14,29924238	45,58542105	10,18793075	47,78983518	5,479142659	2,348056787
Complex	Textiles and other soft fibres, mixes	1197,29682	31,04812195	30,01298537	0,363136585	37,04929268	22,70065854	2,006414634	0,584239024
Complex	Valuable complex parts	2288,411636	75,27063636	63,51109091	0,376909091	87,57945455	46,04854545	2,426	0,490181818
Electronic components	IC, PCB parts	279,709	22,51215789	19,21831579	0,555263158	25,96926316	14,86626316	2,047526316	0,586736842
Magnetic	Cast metal, magnetic	125,0864444	11,33233333	10,24166667	0,724333333	12,444	9,278111111	1,407444444	0,739111111
Magnetic	Sheet metal, strong magnetic	227,1518	25,6477	15,68145	0,4443	27,9815	11,74345	2,9511	0,47455
Magnetic	Sheet metal, weak magnetic	1256,775	57,051375	60,948125	0,27175	83,493875	30,697875	3,22225	0,426875
Other metal	Cast metal, non-magnetic	355,7216134	20,74406723	17,94573109	0,610672269	23,32990756	14,19054622	1,736806723	0,651142857
Other metal	Sheet metal, non-magnetic	332,8917436	23,19275641	20,73252564	0,474141026	28,44708974	12,95567949	2,426564103	0,508230769
Wire	Clean wires, copper	40,76789375	19,61281875	16,0058625	0,11744375	24,4389625	8,95441875	3,569025	0,372975
Wire	Clean wires, non-copper	74,307	21,69945455	21,35309091	0,111363636	28,7685	12,32413636	3,118363636	0,369227273
Wire	Insulated cables	307,6352353	41,10711765	37,33041176	0,155926471	53,31869118	20,46026471	3,789301471	0,382169118
Fines <4mm	Magnetic fines	0	0	0	0	0	0	0	0
Fines <4mm	Non-magnetic fines	0	0	0	0	0	0	0	0
	0 MEASURED TOTAL	0	0	0	0	0	0	0	0

Main type	Minor type	Solidity	Total area mm2	Total weight (g)	weight (%)	AVG weight (g) / area mm2	Particle count
Mineral	Stone, Glass	0,93692029	10449,329	113,9	0,027661745	0,010900221	138
Plastic	Foils, films	0,800681818	37998,108	20,13	0,00488877	0,000529763	132
Plastic	Light plastics	0,871064145	130833,064	690,3	0,167646202	0,005276189	608
Plastic	Dark plastics	0,876974478	231303,659	365,1	0,088668156	0,001578445	862
Plastic	Fibre reinforced parts	0,828956522	18434,04	26,34	0,00639693	0,001428858	23
Plastic	Soft foams	0,840404651	95011,04	164,9	0,040047601	0,001735588	215
Plastic	Rigid foams	0,88476	14797,364	10,86	0,002637459	0,000733914	125
Elastomer	Rubber and flexible	0,839632509	110803,952	537,6	0,130561492	0,004851813	283
Wood	Wood	0,574295014	47080,572	110,5	0,026836021	0,00234704	361
Complex	Textiles and other soft fibres, mixes	0,735395122	245445,848	453,1	0,110039829	0,001846028	205
Complex	Valuable complex parts	0,770636364	25172,528	209,2	0,050806295	0,008310647	11
Electronic components	IC, PCB parts	0,840368421	5314,471	17,61	0,004276763	0,003313594	19
Magnetic	Cast metal, magnetic	0,921888889	1125,778	28,5	0,006921508	0,025315826	9
Magnetic	Sheet metal, strong magnetic	0,777	4543,036	43,8	0,010637264	0,00964113	20
Magnetic	Sheet metal, weak magnetic	0,63375	10054,2	97,5	0,023678842	0,00969744	8
Other metal	Cast metal, non-magnetic	0,888260504	42330,872	639,6	0,155333204	0,01510954	119
Other metal	Sheet metal, non-magnetic	0,792833333	25965,556	154,8	0,037594715	0,005961744	78
Wire	Clean wires, copper	0,3068625	6522,863	12,5	0,003035749	0,001916336	160
Wire	Clean wires, non-copper	0,305363636	1634,754	4,26	0,001034583	0,002605897	22
Wire	Insulated cables	0,394647059	41838,392	173	0,042014766	0,004134958	136
Fines <4mm	Magnetic fines	0	0	81,7	0,019841655	0	0
Fines <4mm	Non-magnetic fines	0	0	162,4	0,039440451	0	0
	0 MEASURED TOTAL	0	0	4117,6	1	0	0
			2%				

SIEVING SIMULATION

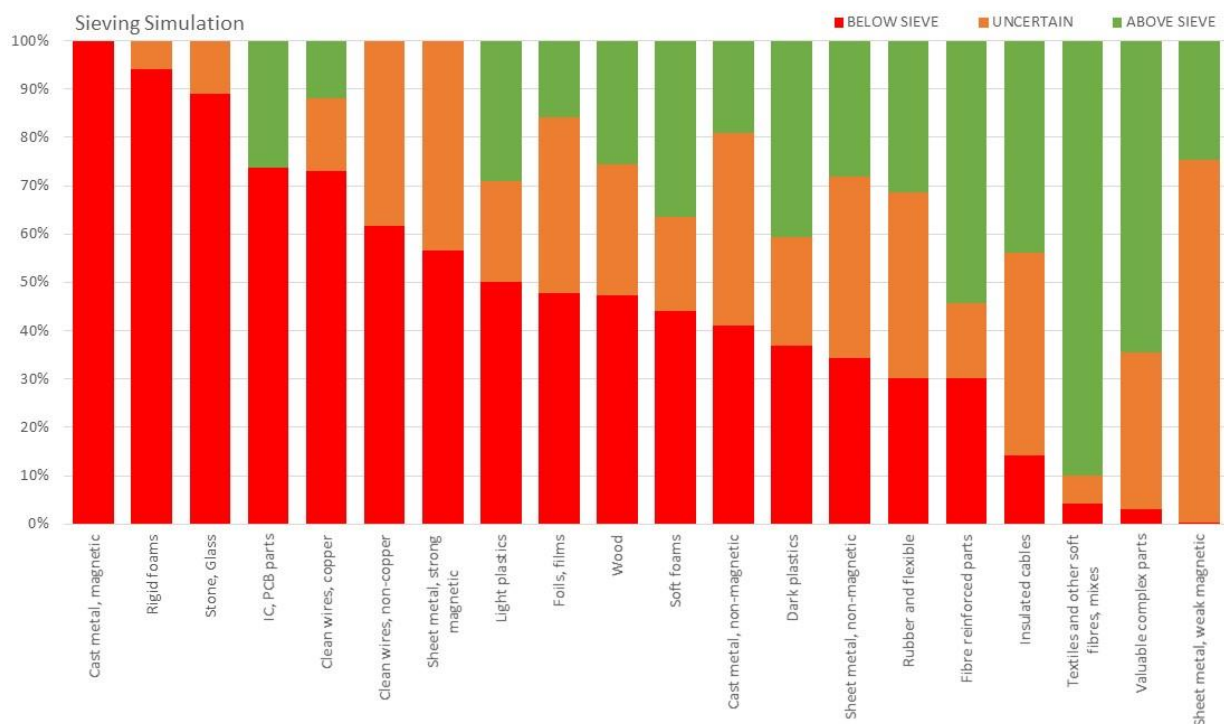
Utilizing the digitalized 2D projection of each particle, it is possible to generate a rough model³ of particle behaviour for mesh sieves. Particles' behaviour is influenced by three simple rules in the model:

FALLS THROUGH: all particles for which the maximum caliper size is smaller than the holes of the sieve. These are expected to fall down in any case.

STAYS ABOVE: all particles for which the smallest possible caliper size (minimum Feret's diameter) is larger than the holes of the sieve. Normally these particles remain above the sieve (unless a strong force is distorting them)

UNCERTAIN: particles between these extremities, which depending on the efficiency or motion of the sieve might rotate into a position enabling their fall.

SIMULATION OF 45mm MESH SIEVING



³ The model does not capture a multitude of real-life challenges, like the overlap of material due to improper feeding, particles attached to each-other due to humidity deformation during processing. Therefore, the simulation does not replace practical processing trials

SIMULATION OF 45mm MESH SIEVING

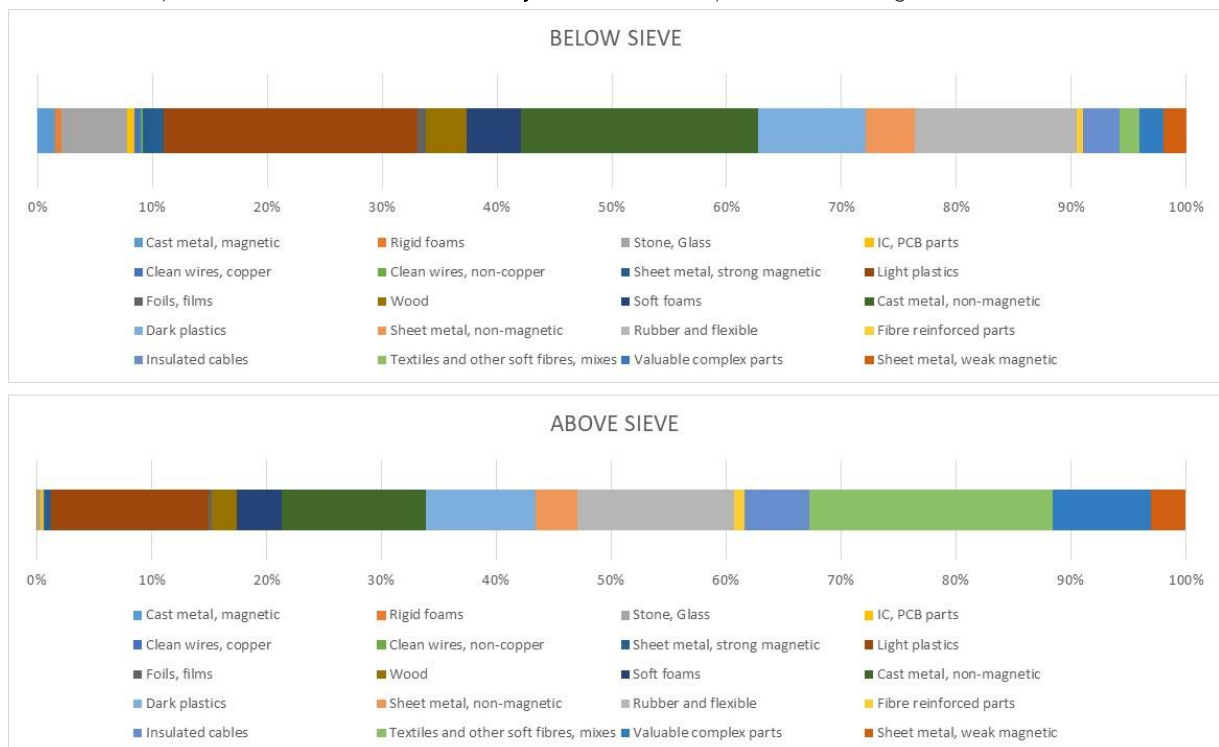
Distribution of particles in case the **sieve effectivity is very low** (only those particles fall through which have no dimension greater than the sieve holes)

	BELOW SIEVE	ABOVE SIEVE
Cast metal, magnetic	2%	0%
Rigid foams	1%	0%
Stone, Glass	8%	0%
IC, PCB parts	1%	0%
Clean wires, copper	1%	0%
Clean wires, non-copper	0%	0%
Sheet metal, strong magnetic	2%	1%
Light plastics	26%	14%
Foils, films	1%	0%
Wood	4%	2%
Soft foams	5%	4%
Cast metal, non-magnetic	20%	15%
Dark plastics	10%	9%
Sheet metal, non-magnetic	4%	4%
Rubber and flexible	12%	15%
Fibre reinforced parts	1%	1%
Insulated cables	2%	6%
Textiles and other soft fibres, mixes	1%	17%
Valuable complex parts	0%	8%
Sheet metal, weak magnetic	0%	4%
TOTAL	100%	100%
<i>Valuables concentration</i>	<i>31%</i>	<i>30%</i>

Distribution of particles in case **the sieve effectivity is very high** (all particles fall through which have any chance of being rotated to a fall-through orientation)

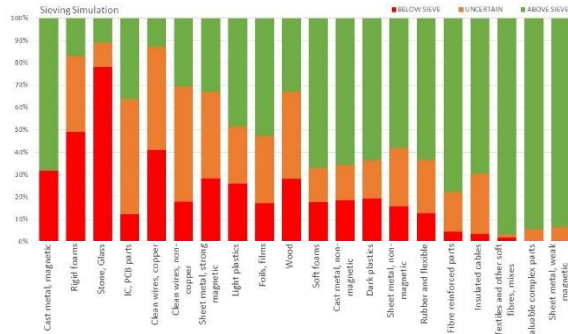
	BELOW SIEVE	ABOVE SIEVE
Cast metal, magnetic	1%	0%
Rigid foams	0%	0%
Stone, Glass	5%	0%
IC, PCB parts	1%	0%
Clean wires, copper	0%	0%
Clean wires, non-copper	0%	0%
Sheet metal, strong magnetic	2%	0%
Light plastics	20%	14%
Foils, films	1%	0%
Wood	3%	2%
Soft foams	4%	4%
Cast metal, non-magnetic	21%	9%
Dark plastics	9%	10%
Sheet metal, non-magnetic	5%	3%
Rubber and flexible	15%	12%
Fibre reinforced parts	0%	1%
Insulated cables	4%	5%
Textiles and other soft fibres, mixes	2%	28%
Valuable complex parts	3%	9%
Sheet metal, weak magnetic	3%	2%
TOTAL	100%	100%
<i>Valuables concentration</i>	<i>37%</i>	<i>19%</i>

Distribution of particles with **medium sieve effectivity** (50% of uncertain particles fall through):

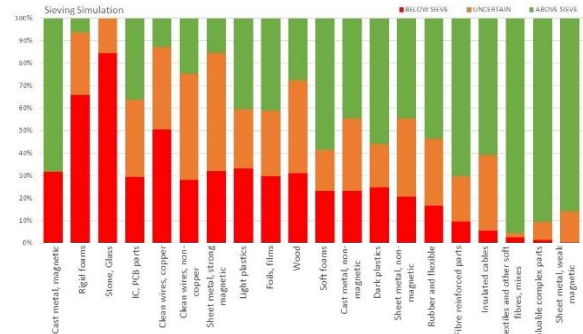


SIEVING ALTERNATIVES

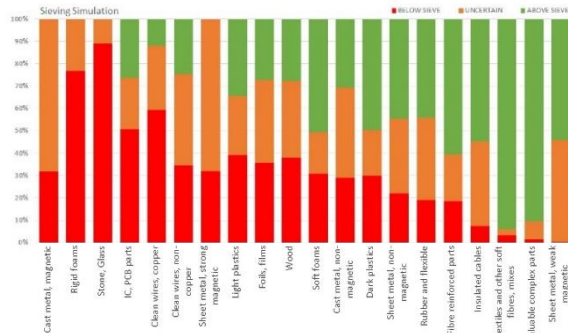
25mm MESH SIEVE



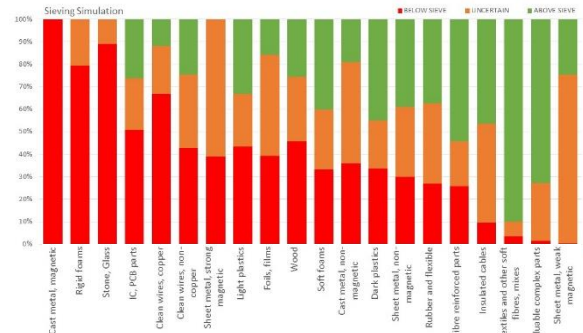
30mm MESH SIEVE



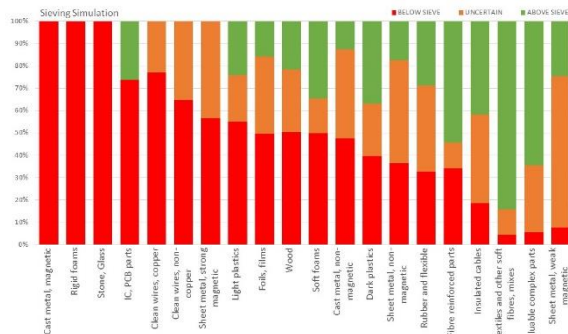
35mm MESH SIEVE



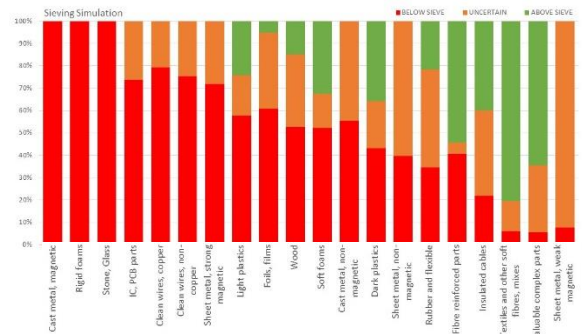
40mm MESH SIEVE



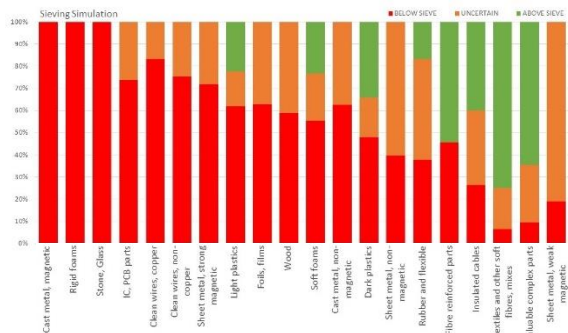
50mm MESH SIEVE



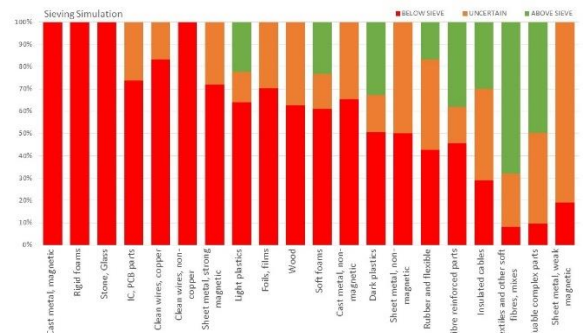
55mm MESH SIEVE



60mm MESH SIEVE



65mm MESH SIEVE



<4MM FINES

Fine particles were removed by hand sieving through a 4mm rectangular mesh before the sorting of particles by image analysis. This residue, (weighing a total of 244,1g) represents **5,93% of the hand-picked sample**.

Using a manually operated magnet, it was possible to further separate the residual particles to a magnetic and non-magnetic sub-fraction. By visual observation it is apparent [see images on p2, bottom] that the non-magnetic part is coarser, containing larger particles. The magnetic sub-fraction remains also inhomogeneous however, with fine fluff and other components in addition to iron/steel powder.

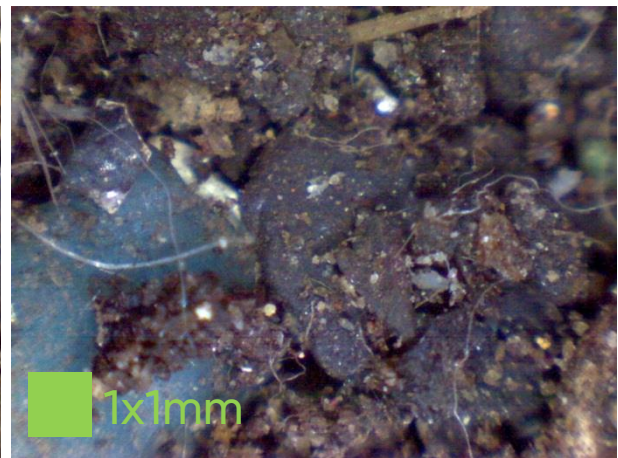
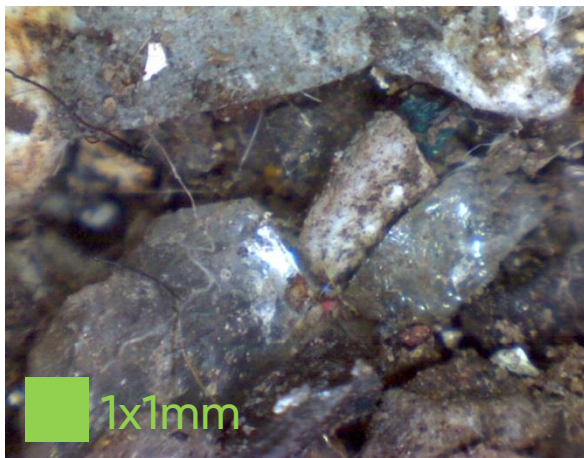
Bulk density estimates are only approximate values, calculated by manual compression of the fine powders in a standard 10ml syringe to remove air before measurement.

Non-magnetic fine particles

162,4g (3,94% of the analysed sample)
1,04 g/cm³

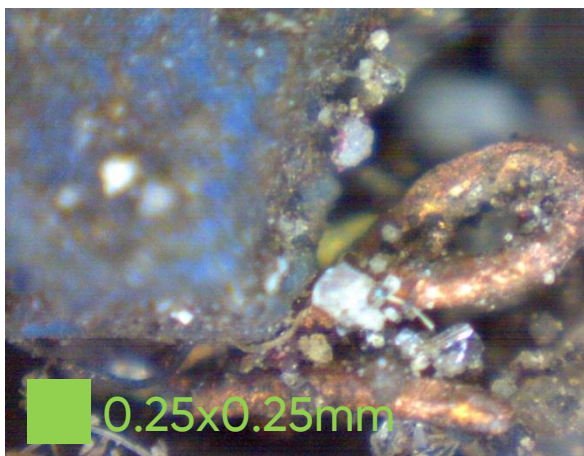
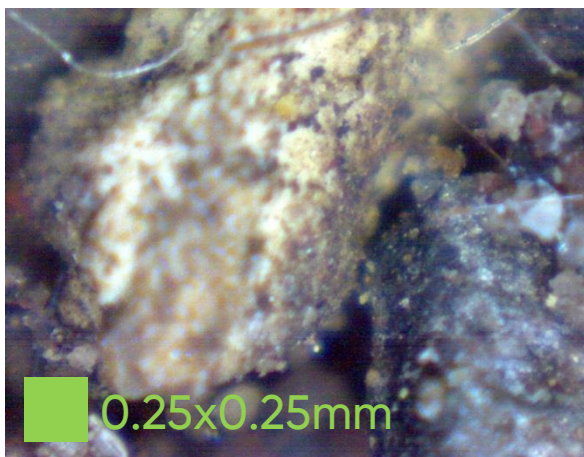
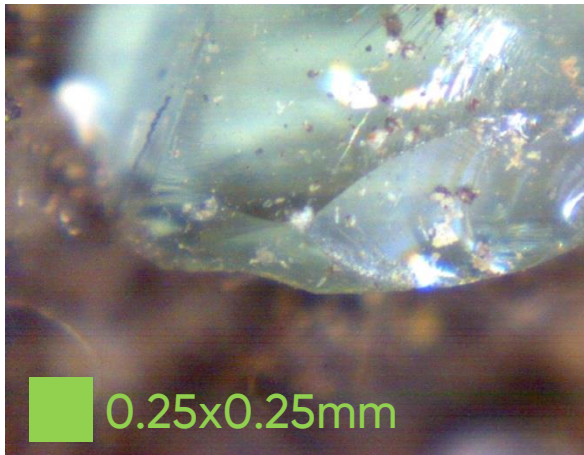
Magnetic fine particles

81,7g (1,98% of the analysed sample)
1,23 g/cm³



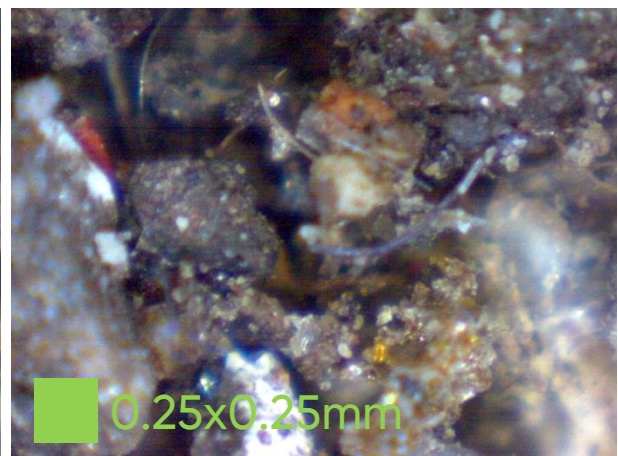
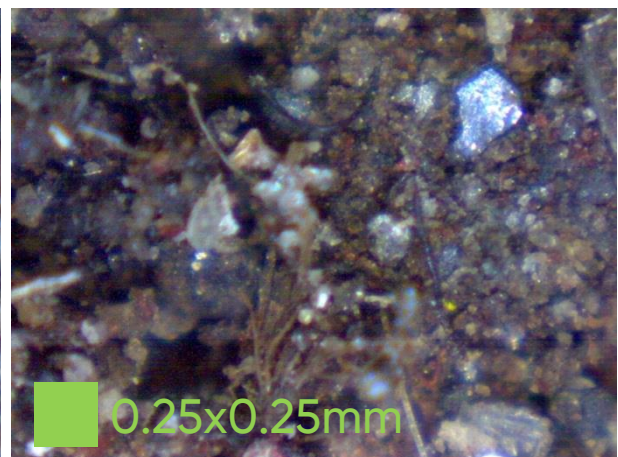
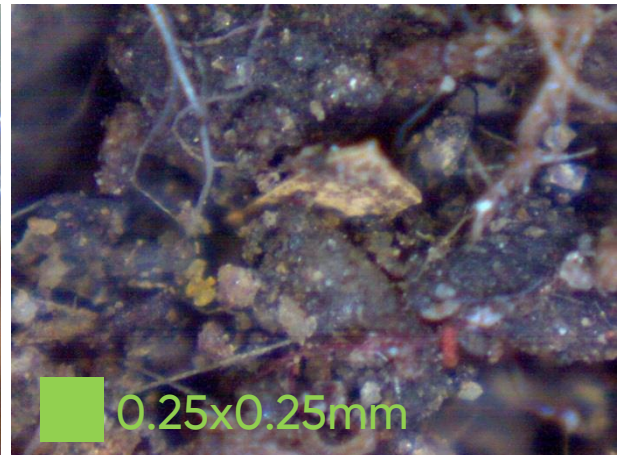
Non-magnetic fine particles

162,4g (3,94% of the analysed sample)
1,04 g/cm³



Magnetic fine particles

81,7g (1,98% of the analysed sample)
1,23 g/cm³



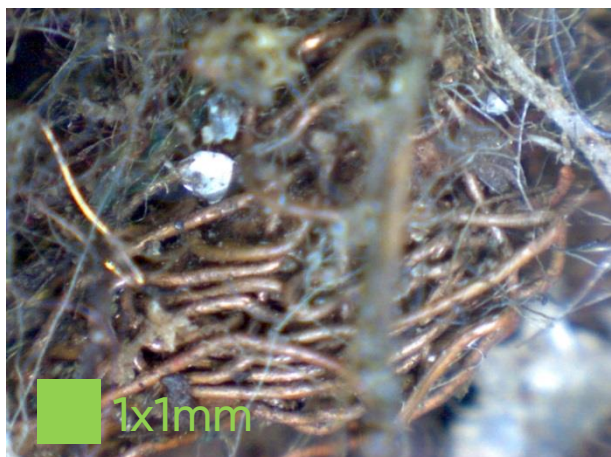
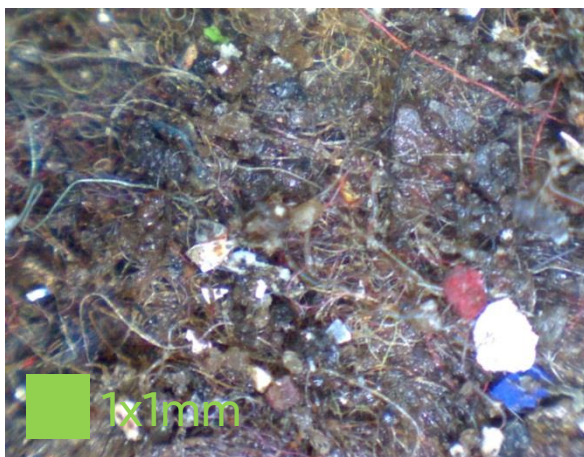
TEXTILE FLUFF

Other than the fine powders, the only output fraction of the analysis significantly contaminated with a diverse assembly of micro particles is the content categorized above as “textiles and other soft fibres, mixed” (453,1g ; 11%).

A limited amount of fine copper wires is present, completely entangled in this fraction. While it is possible to document the presence of such fine wires by microscope photography, these metals constitute much less than a percent of the weight of the textile fraction.

Proper weigh measurement of the photographed copper fibres could be only executed by further laboratory analysis.

Textiles and other soft fibres, mixed
453,1g (11,0% of the analysed sample)



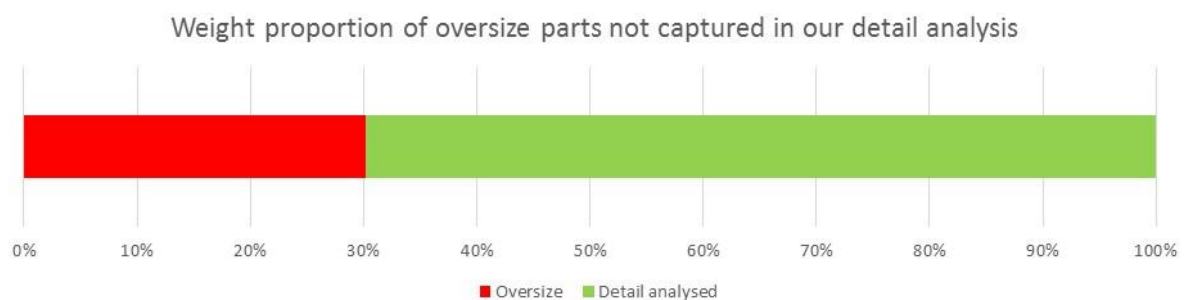
OVERSIZE MATERIALS

A challenge of sampling/analysis was that, in the output of the automotive shredder investigated, several larger particles (up to 500mm) are present. These particles were not part of our detail analysis, since the declared technology aim of the client is to further process and separate the SLF fraction below 95mm size.

Ensuring the presence of >200mm parts in sufficient amount for drawing conclusions about their size and composition would have necessitated a much larger sample size for our detail analysis. Resulting in 10.000-20.000 individual fine particles to be assessed and thus rendering the investigation much more expensive. It is nevertheless still *important to have an overall estimate regarding the proportion of such oversize parts in the input material*. Therefore, we picked an additional, 65l on-site sample for which we did not individually analyse the fine particles. Instead, we manually separated and weighed each part larger than the particles also present in the detail analysis on the previous pages.

Based on this sample:

The expected average density of the initial material to be uploaded to the first sieve of processing is below that of the detail sample. We measured 0,14 g/cm³ (140 kg/m³) for this batch, the actual value however could be much better approximated by weighing big-bags on the site of the client.



Thus calculated, for each ton of material input cca. 300kg of oversize material will be processed / discarded during the initial sieving. (In addition to the material discarded based on our sieving simulation.)

The amount of oversize parts is not sufficient in our sample to provide a reliable composition analysis for these items. Nevertheless, since only 2 out of 32 oversize items were metallic and each oversize item was easily identifiable, hand picking by human operators might be feasible for the removal of valuable oversize content during processing.

OVERSIZE EXAMPLES



SAMPLE EVALUATION METHODOLOGY

Sample was manually separated by visual observation. Separated particles were aligned in a resting (flat side) position by non-touching boundaries on a white background under neutral lighting conditions. Each scene of such particle assemblies was digitally photographed. The photos were size calibrated using a ruler placed alongside the scene during photography. Digital images were post processed to remove trace shadows (where present) and further neutralize background.

Image Analysis was conducted by the Java based open source image analysis suite IMAGEJ by the National Institutes of Health (U.S. Department of Health & Human Services). IMAGEJ and detailed documentation is available for download here: <http://imagej.nih.gov/ij/>

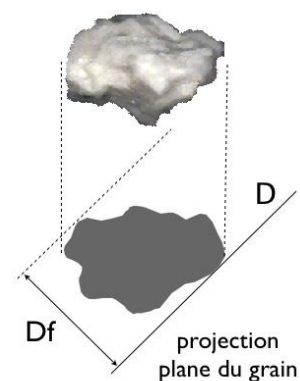
Image Analysis steps:

1. size calibrated images were cropped to remove irrelevant parts (visible ruler, edge of background etc.)
2. images were converted to greyscale images of white background and black particle masks
3. The Adjust->Threshold tool was used to define particle related pixels.
4. Particle Analysis was applied to count and measure the 2D view of particles and their relevant geometrical data.
5. Data was exported and an image overlay of individual particle IDs applied by the software was applied / saved for future reference.

Relevant data collected of each particle photographed (2D Projection Geometry):

- Area
- Perimeter length
- Minimum Fit Ellipse minor and major axis length (not used in current study)
- Maximum and Minimum Feret's diameter (=Caliper length)
- Roundness and Solidity

Feret's diameter is a measure of an object size along a specified direction. In general, it can be defined as *the distance between the two parallel planes restricting the object perpendicular to that direction*. It is therefore also called the caliper diameter, referring to the measurement of the object size with a caliper. This measure is used in the analysis of particle sizes, for example in microscopy, where it is applied to projections of a three-dimensional (3D) object on a 2D plane. In such cases, the Feret's diameter is defined as the distance between two parallel tangential lines rather than planes.



1. Feret's Diameter

Fig. 1. shows one possible Feret's diameter of a 2D projection based on a 3D particle. Such a diameter can be calculated for every angular orientation of the "D" lines. For the purpose of this simplified analysis it is assumed that any investigated particle is going to fall through a sieve / screen hole in case the hole diameter reaches or exceeds that of the Maximum Feret's Diameter. It is also assumed that any particle is going to stuck or remain above the surface of the sieve / screen if the hole size is below the Minimum Feret's Diameter of that particle.

For hole sizes between the Maximum and Minimum Feret's Diameter of a particle an uncertainty exists: *such particles might turn⁴ into a position inside the screening mechanism which allows them to pass the hole.*

Additional Data:

- Weight

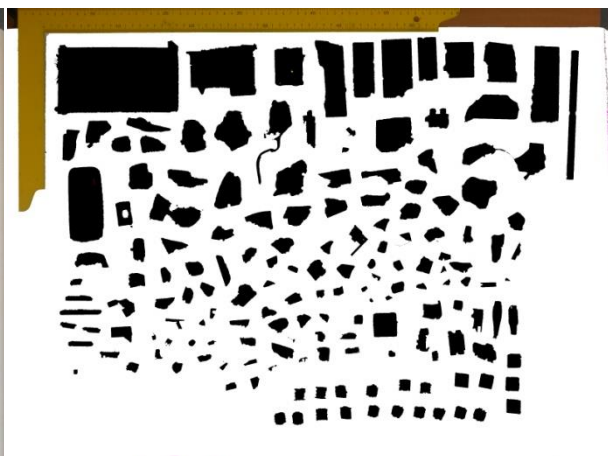
For estimated weight data photographed batches of (pre-sorted) homogenous particles were measured and weight was distributed among particles proportionally to their projected surface area.

- Particle type

Each particle was hand separated and manually identified.



1. Fig. Photograph taken



2. Fig. Enhanced contours for Image Analysis

Limits of the Image Analysis approach:

Image Analysis was chosen as a method for rapid processing of the sample in order to retrieve decisive data. Still, several limits of this approach have to be considered while utilizing the results:

⁴ Each particle was positioned for photography as flat as possible. This means that (except for very complex geometries) the Minimum Feret's Diameter of the projected 2D contour will be greater than the protrusion of the particle into the third dimension. Reaching the threshold of this diameter such a particle can flip/dive.

- Due to the large amount of particles to be digitized resolution of the images was limited to about 7 pixels / mm. This, in combination with the conversion of full colour edges to greyscale contours introduces errors in the detected particle sizes. Angular errors of the camera / lens setup could also influence detection.
- Technology dust was present on the surface of particles which on occasion minimally contaminated the background of the photographed scenes. In order to avoid the detection of these dust particles a filter was applied and each data point below an area of 3 mm² dropped without analysis.
- While most particles were either flat or cubic in appearance, several particles showed complex geometries where behaviour cannot be estimated by 2D projections. A typical example of this is the Wires fraction of the sample. The behaviour of such items during industrial screening is not predictable by our analysis.
- The calculations are based on a theoretical hole size and do not consider effects of friction or crowded screen compartments forcing particles on irregular paths.

OUTPUT DATA

Result of the analysis is available in addition to this document in a Microsoft Excel .XLSX dataset.

The worksheet "Particle database" contains a database of all particles investigated.

Analysis report compiled by:







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