

# MISG 2025

## Sugar centrifuge image classification

1

Dr RC Loubser





# The sugar process

## Preparation

Cane shredded with hammer



2





# The sugar process

## Extraction

Sugar washed out of shredded can in a diffuser



## The sugar process

### Evaporation

Multiple effect evaporator train



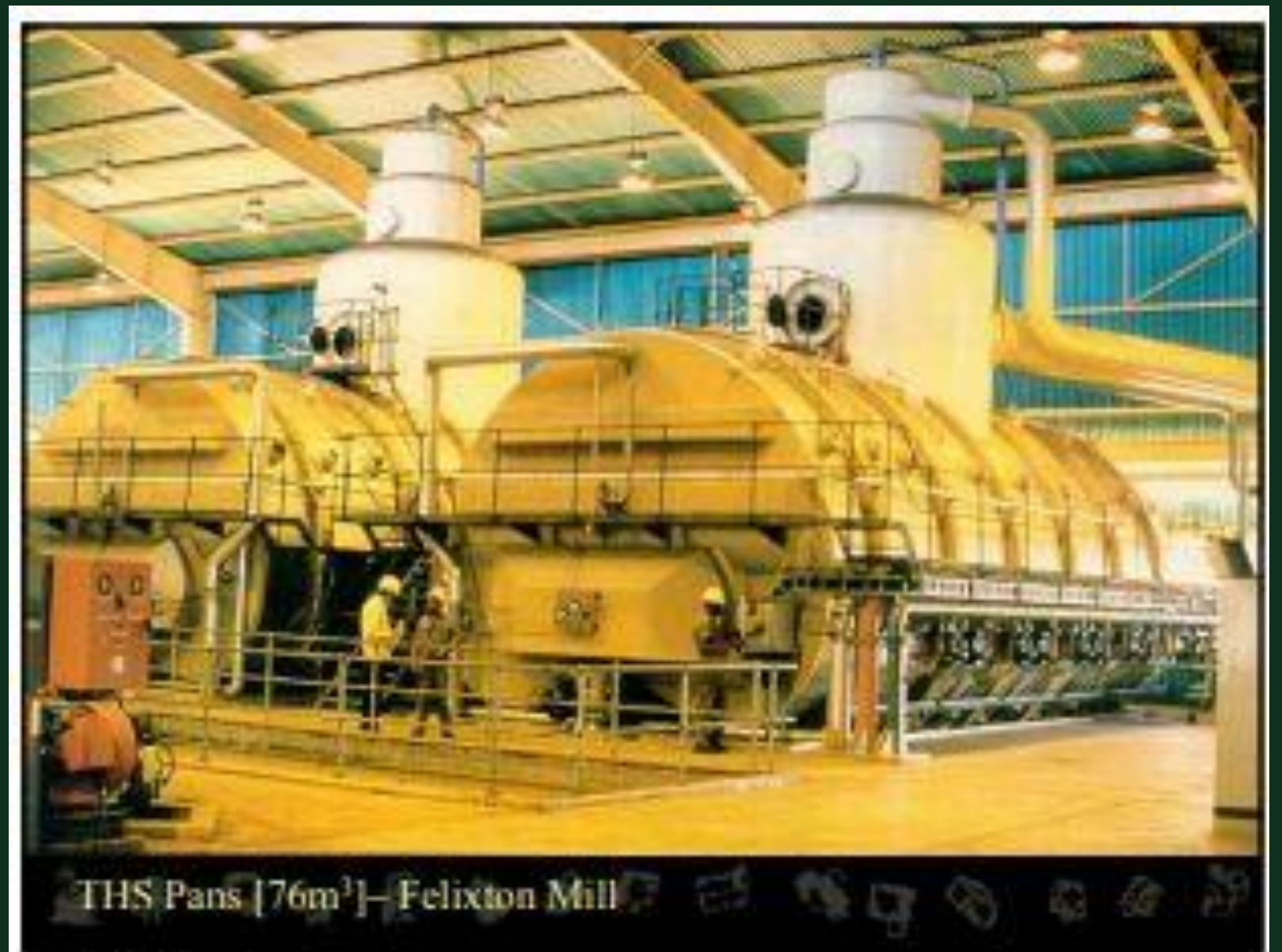


## The sugar process

### Crystallisation

Vacuum pan boiling with seed

5



## The sugar process

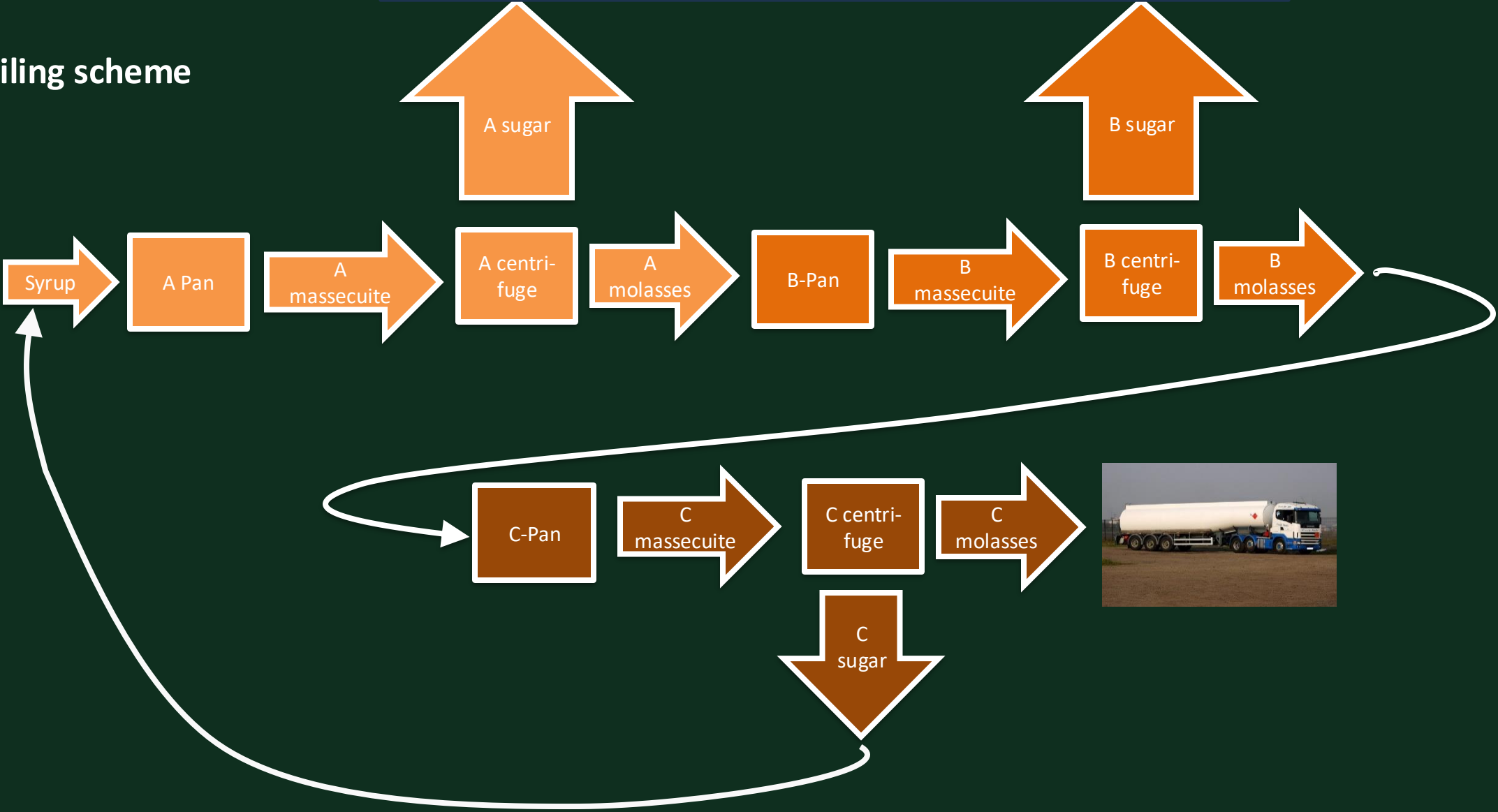
### Separation

Centrifuges separate sugar crystal from molasses



Bagging plant

Boiling scheme

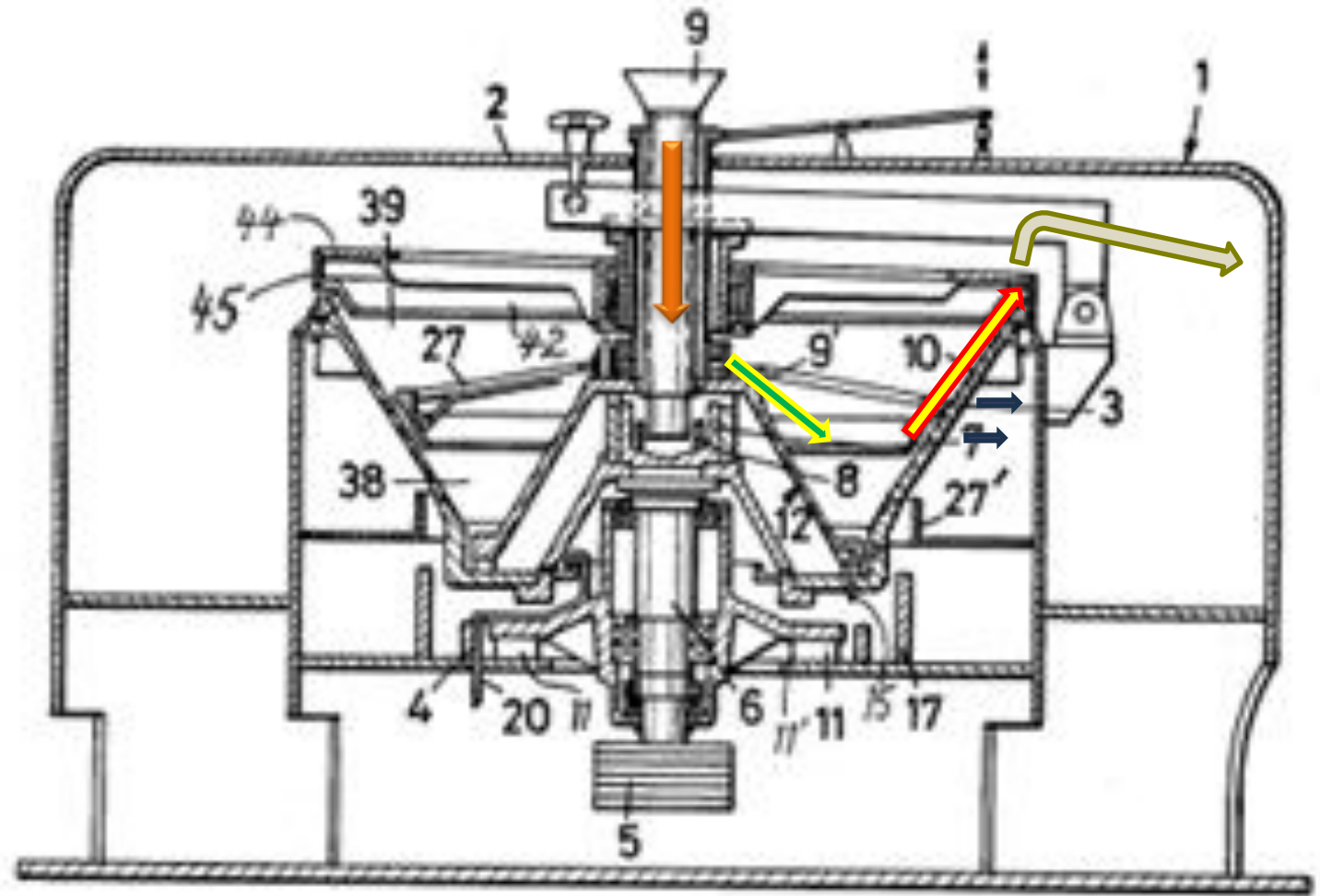




# Continuous centrifuge

8

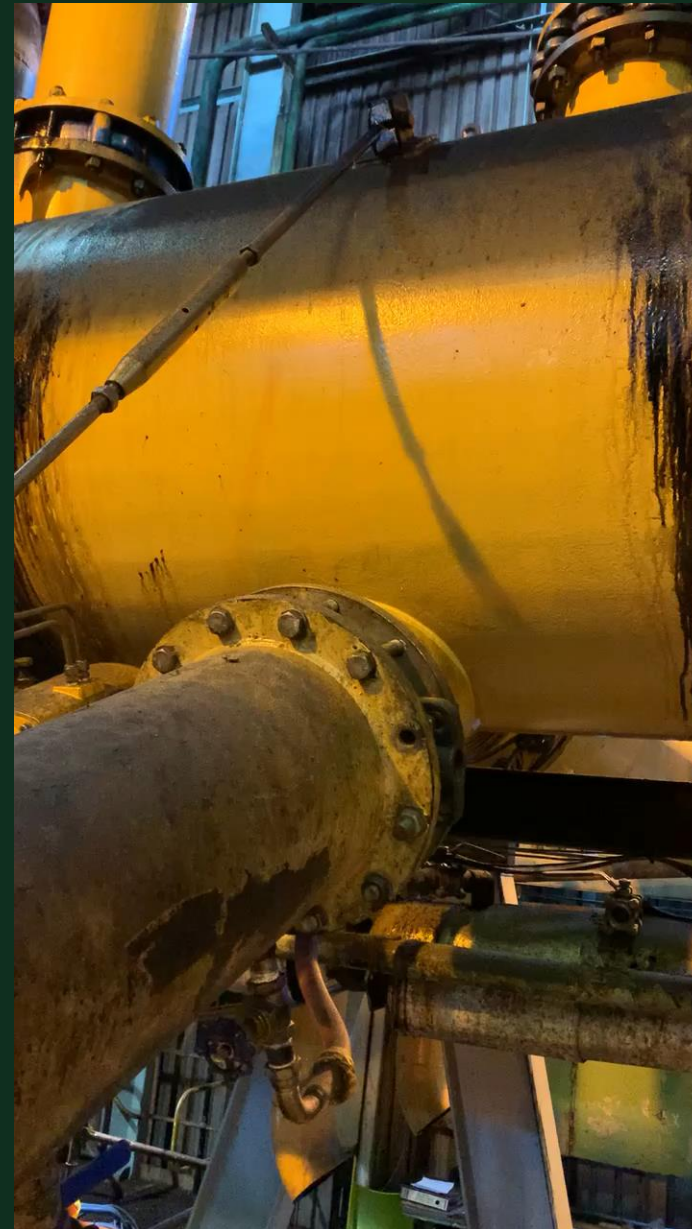
U.S. Patent Dec. 20, 1977 Sheet 1 of 5 4,063,959





## Massecuite feed

9



## Continuous centrifuge basket





## C centrifuge control system

Synchronised flash



## Camera arrangement

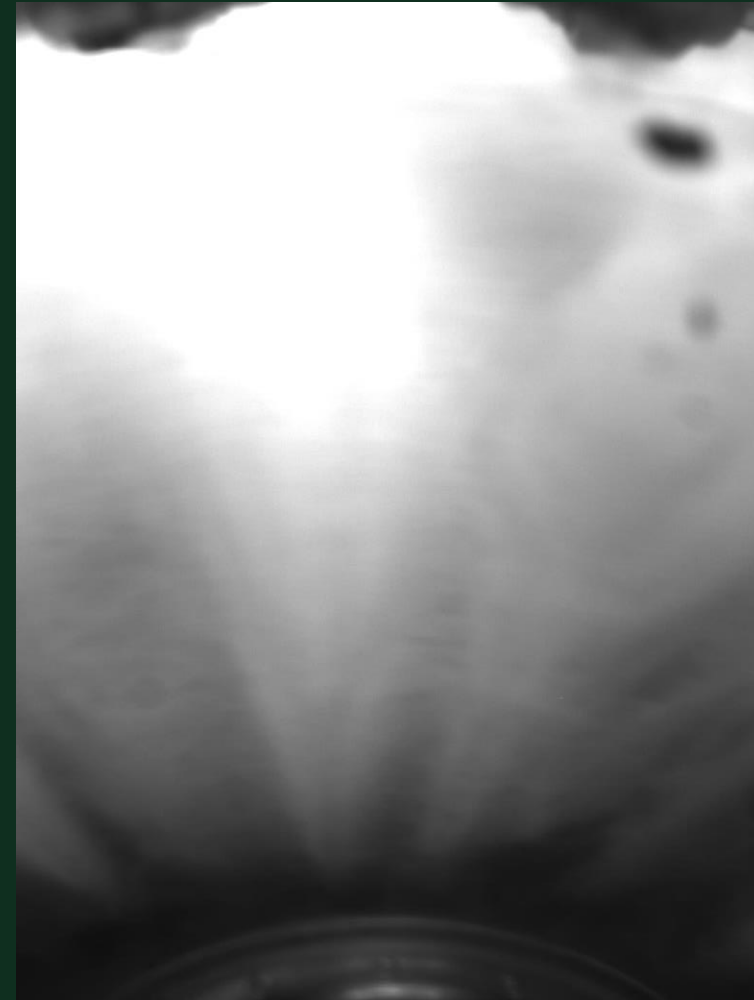
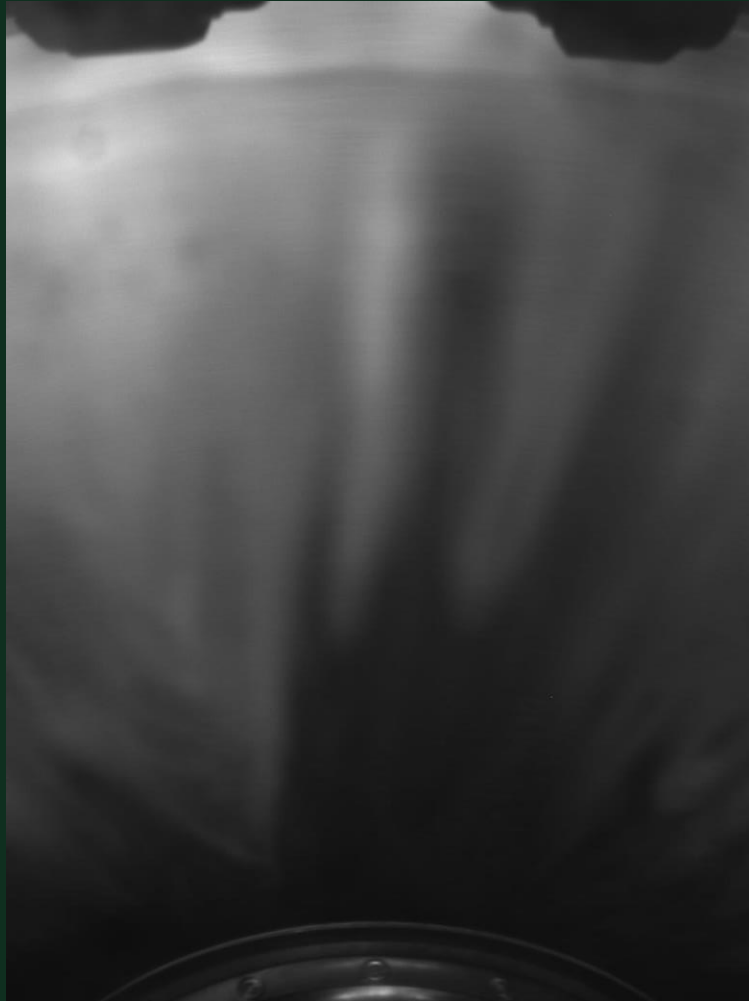


Camera housing

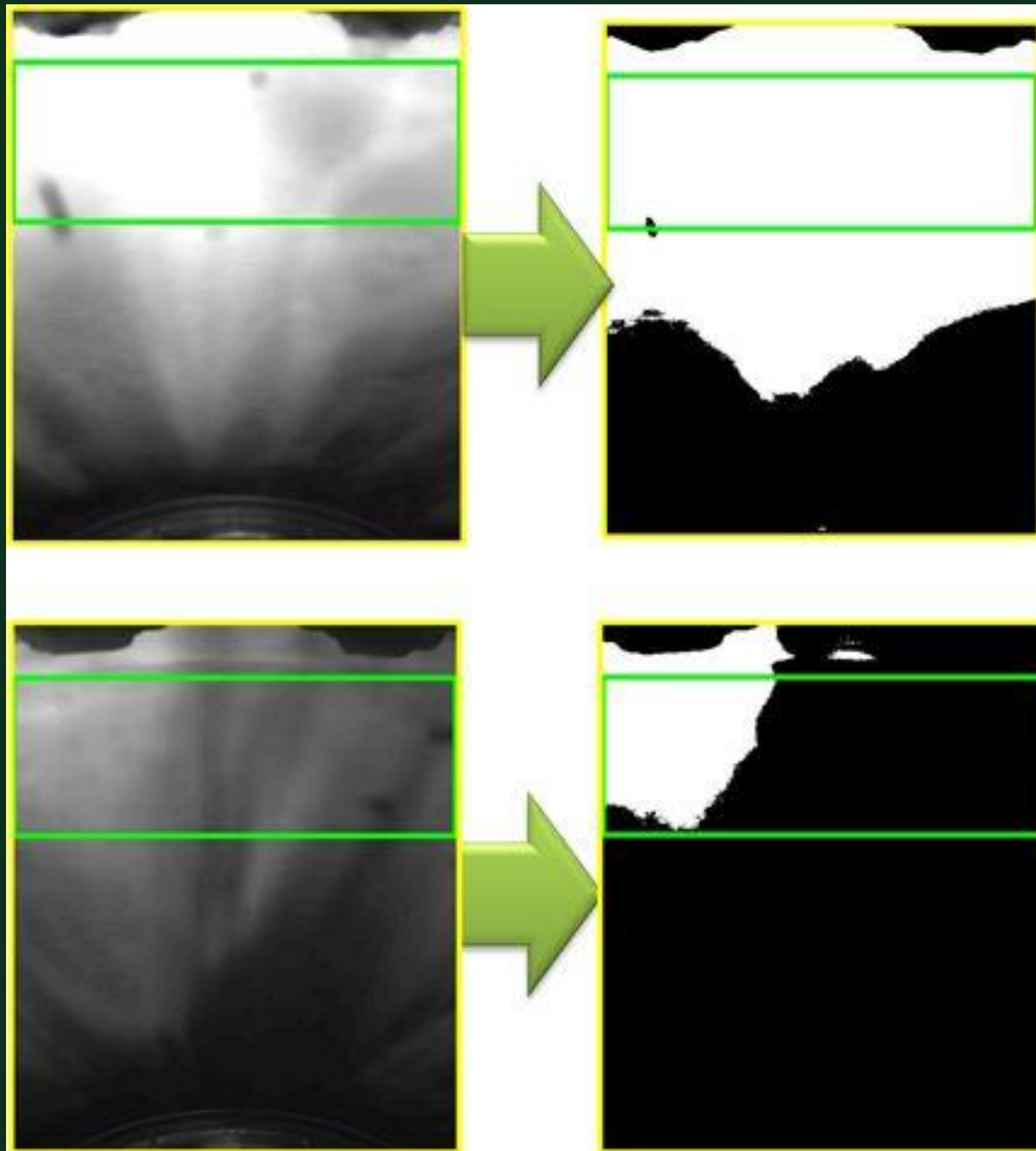
LEDs which flash once per revolution to produce stroboscopic effect in centrifuge



# Images



# Sugar ratio



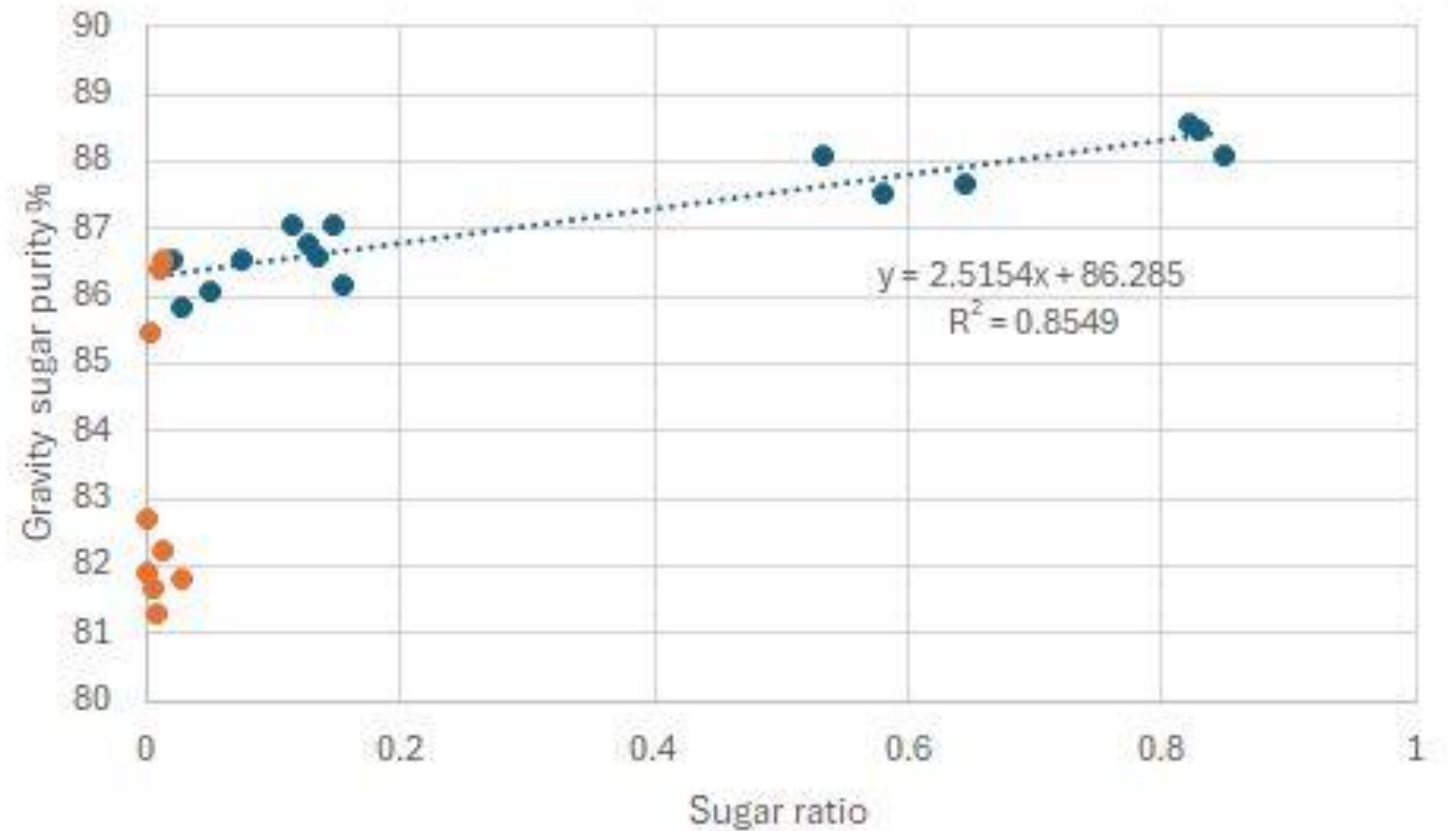


## Added water control valve



## Results

- Purity has a positive relationship to added water
  - Linear within operating range
- Sugar ratio is an indicator of purity
- Actual value of ratio using fixed threshold method depends on:
  - Lighting
  - Camera aperture
  - Flash duration
  - Threshold level



## Control of purity

- Acquire image
- Find clean sugar area
- Use area fraction to calculate valve position
- Adjust valve
- Repeat

CCC.py - C:\Users\rhoubser\OneDrive - Sugar Milling Research Institute\CCC\CCC-python\CCC\CCC.py (3.10.4)

Device: STC\_SBS163POE\_ELP(21D4610)

|          |          |           |                            |               |      |
|----------|----------|-----------|----------------------------|---------------|------|
| COM      | 6        | Set point | 20.0                       | Sugar Ratio   | 0.0  |
| Exposure | 300000.0 | Threshold | 100                        | Valve opening | 76.9 |
| Gain     | 0.0      | Current   | 66.72                      | Flow rate     | 7.6  |
| Delay    | 20       | Comment   |                            |               |      |
| Duration | 100      | Fileroot  | c:\images\ES_26_6_2024\CCC |               |      |

Image file: c:\images\ES\_26\_6\_2024\CCC

Buttons: Start, Stop, Set Flash, Set Camera, Set Image, Set File root, Set Manual data

Code lines (70-113):

```

70 gra
71 gai
72 exp
73 del
74 dur
75 dur
76
77 gai
78 exp
79 del
80 dur
81
82 gai
83 exp
84 del
85 dur
86
87 ser
88 ser
89
90 set
91 thr
92 thr
93 com
94 fil
95
96 val
97 val
98 val
99 val
100
101 flo
102 flo
103
104 dis
105 dis
106 dis
107 dis
108
109 def
110
111
112
113

```



# Summary of problem

- How can massecuite area be separated from sugar?
  - Must not be fooled by uniform shade
  - Must be immune to variations in lighting and camera settings
  - Calculate sufficiently fast for control (2 seconds ?)
  - Images ready every 300 ms
  - Must run unsupervised

# Discussion

