Boiler design considerations for cogeneration

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Australian high pressure cogeneration boilers

- Rocky Point
- 137 t/h MCR, 70 bar, 510°C
- Economiser Y air heater Y air heater
- Vibrating grate, air cooled
- Fuels
  - Bagasse
  - Garden waste – very high ash content
- Wet centrifugal scrubber modules (vertical)

Australian high pressure cogeneration boilers

- Pioneer No. 3
- 130 t/h MCR, 65 bar, 483°C
- Air heater Y economiser
- Water cooled stationary grate
- Fuel
  - Bagasse
- Wet centrifugal scrubber modules (vertical)

Australian high pressure cogeneration boilers

- Condong / Broadwater
- 150 t/h MCR, 72 bar, 520°C
- Air heater Y economiser Y air heater
- Moving grate
- Fuels
  - Bagasse
  - Woodchip
- Wet multi venturi scrubber module (horizontal)

Australian high pressure cogeneration boilers

- Racecourse No. 4 (under construction)
- 150 t/h MCR, 80 bar, 525°C
- Three stage superheater
- Moving grate
- Fuels
  - Bagasse
  - Coal
- Wet centrifugal scrubber modules (vertical)

Australian high pressure cogeneration boilers

- Increased % over fire air
  - Lower position of furnace flame
  - More stable combustion
- Single pass convection bank
  - Reduced tube erosion
- Furnace exit baffle (bull nose)
- Wet scrubbers
  - Tighter emission limits

Australian sugar factories

- ~ 6 month crushing season
- Insufficient bagasse surplus for year round power generation
- Multiple factories per cogeneration plant
  - Transport costs
- Auxiliary fuels
  - Fuel costs

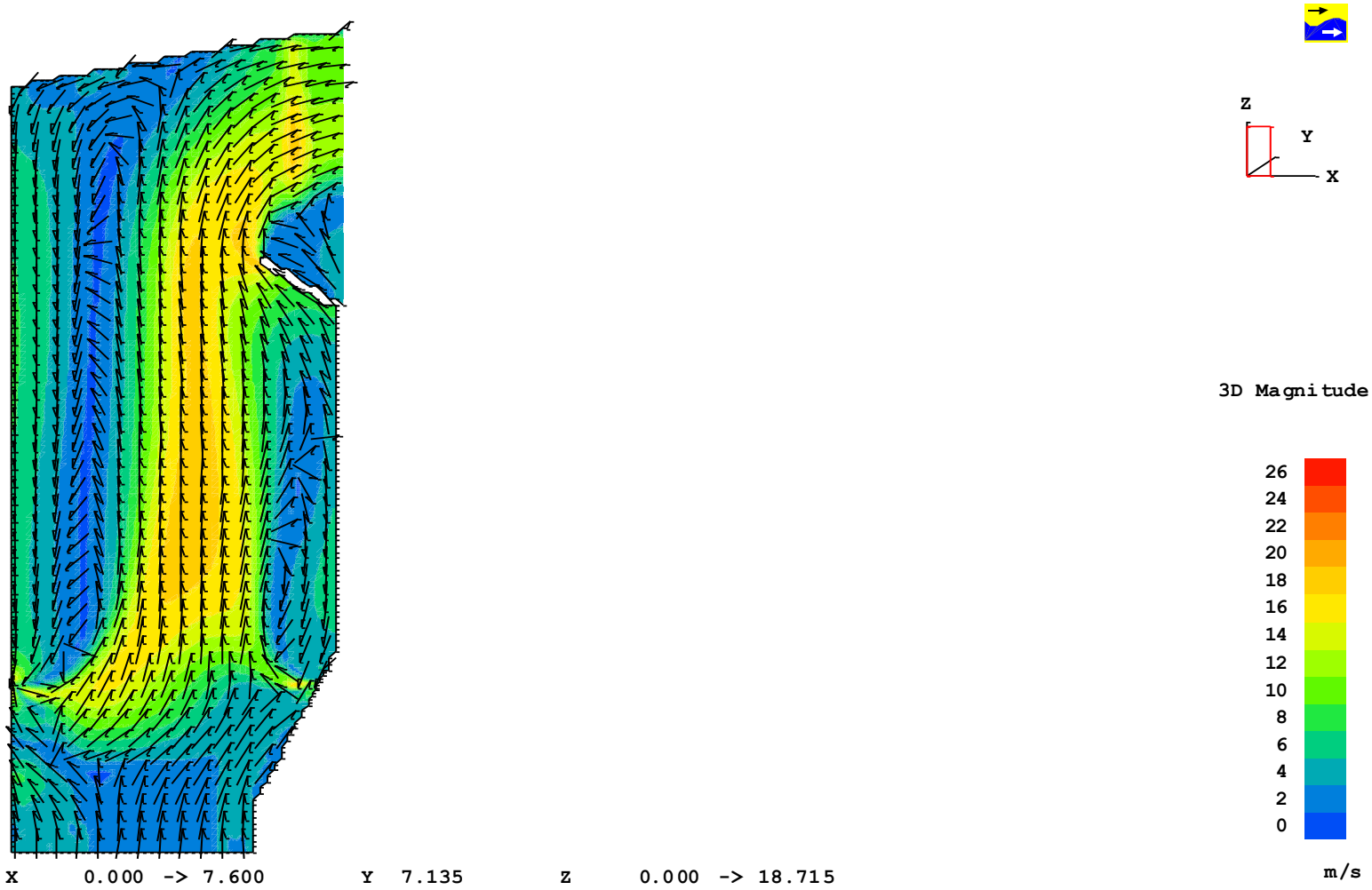
Operational issues

- Fuel supply
- Fuel quality
- Mixing of fuels
  - Heating value
  - Ash mixtures with low fusion temperatures - slagging
- Flow distributions
- High pressure turbines less tolerant of changing steam conditions

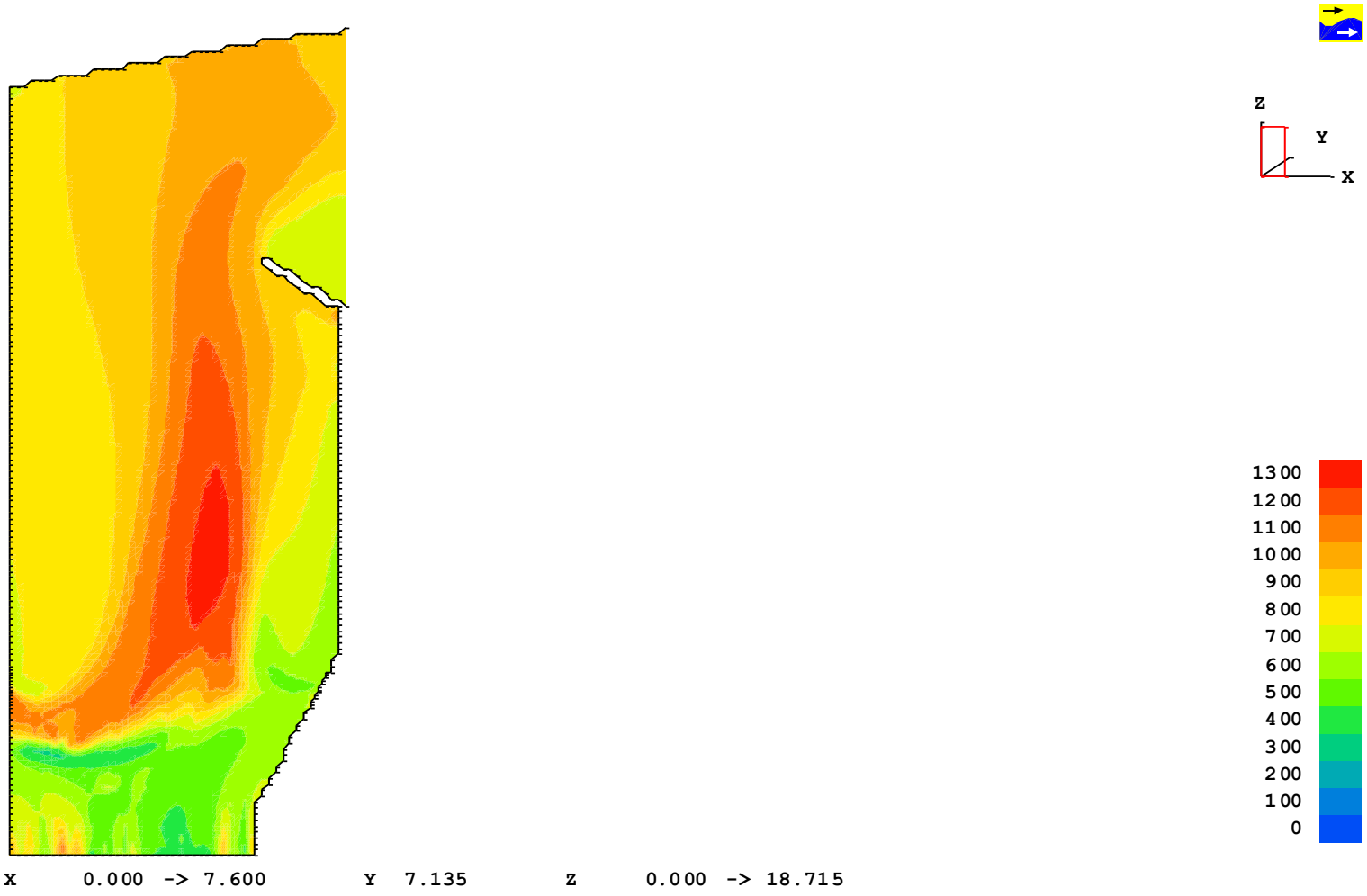
Furnace design limits

- Furnace residence time
  - Unburnt fuel carryover
- Volumetric heat release rate
- Plan area heat release rate
  - Grate build up
  - Combustion cycling
- Sugar factory boilers designed for bagasse
- Lower rating for alternative fuels

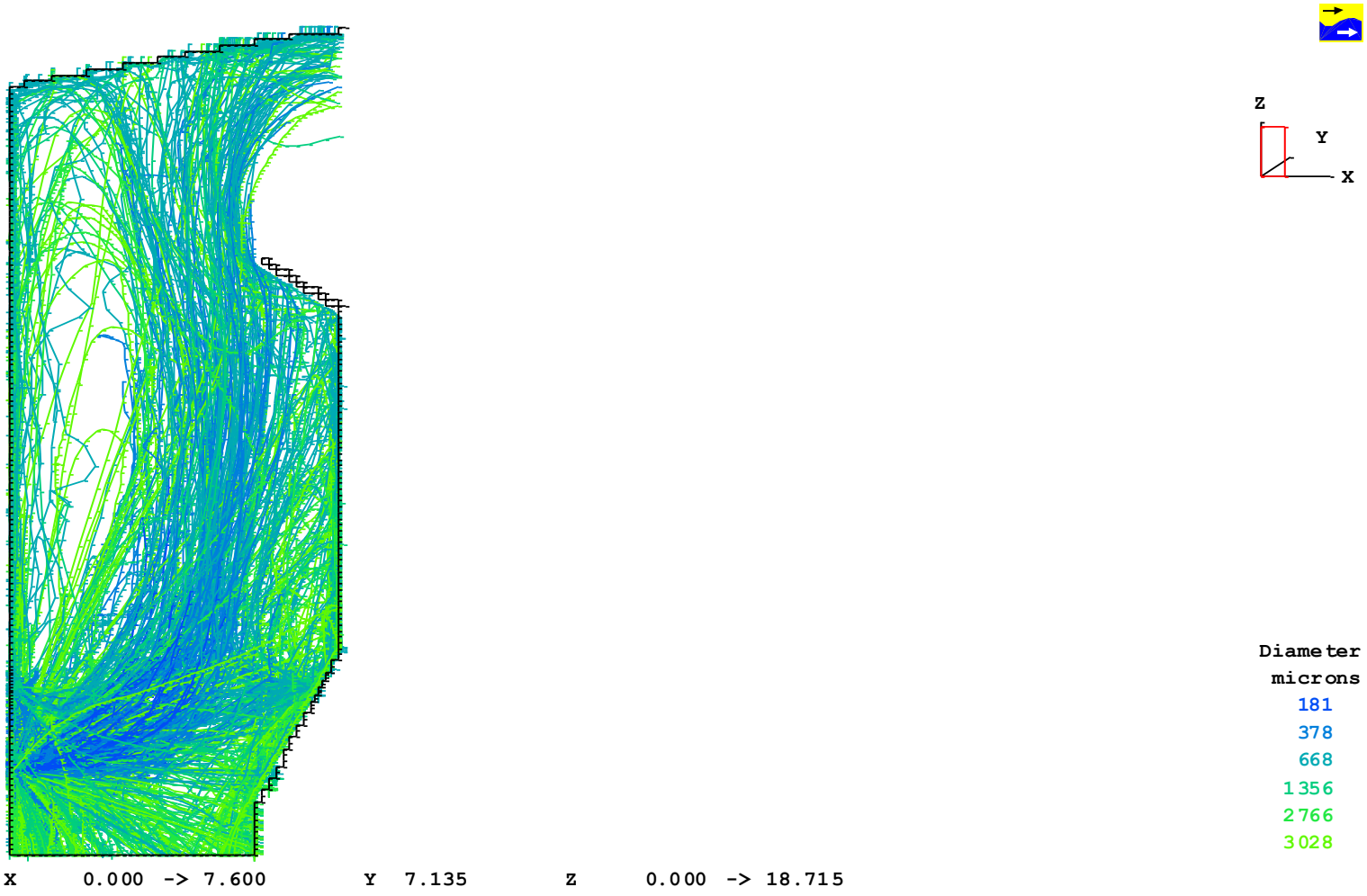
Furnace gas velocity distribution



Furnace gas temperature distribution



Furnace particle trajectory distribution



Furnace combustion

- Most bagasse burns in suspension
- Small amount burns on grate
  - Piloting effect
- Too much bagasse / wet bagasse
  - Grate overloaded
  - Build up
  - Combustion cycling
  - Actual plan area heat release rate limit exceeded
  - Insufficient heat in lower part of furnace for drying

Dual firing

- Grate fired fuel (woodchip etc.) increases heat in lower part of furnace
- May increase actual plan area heat release rate limit
- Possible increase in boiler capacity
- Effect on boiler efficiency

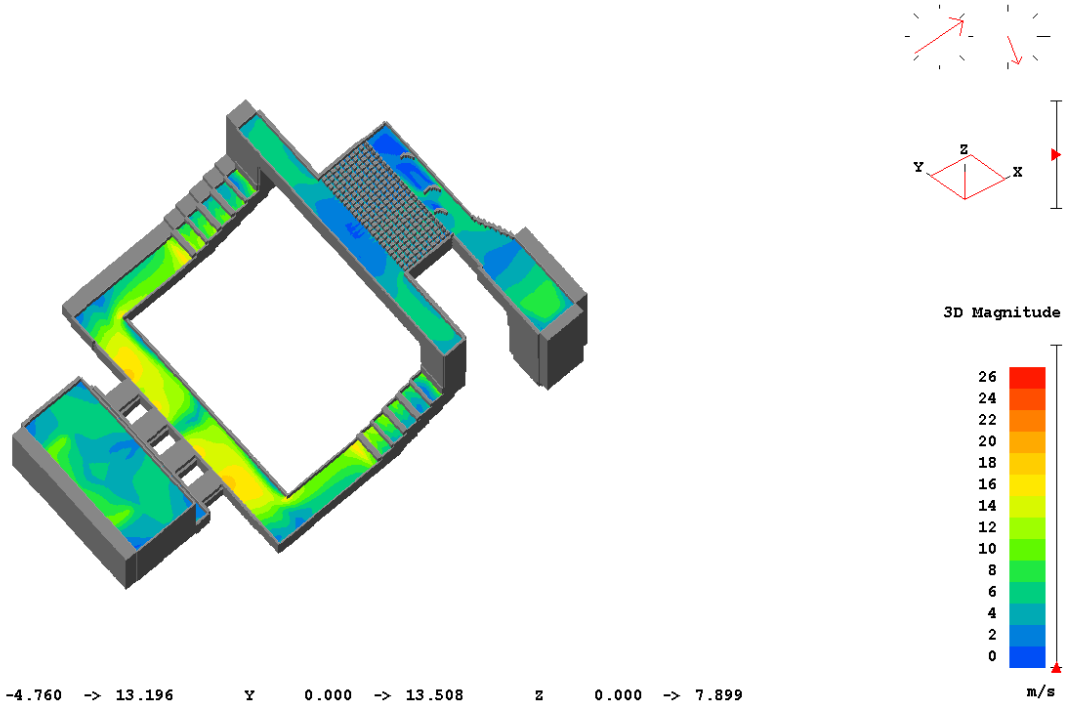
Swirl spreader combustion system

- Increases actual plan area heat release rate limit
- May increase boiler steam output
- Improved tolerance of poor fuel



CFD modelling

- Gas and particle flow distributions
  - Tube wear
  - Drum wear
  - Design modifications
  - Heat transfer
- Air flow distributions
  - Flow biases
  - Heat transfer
  - Combustion performance
- Over 100 consultations



Concluding remarks

- Most Australian sugar factory boilers over 30 years old
- Will not last forever
- Sugar factories need steam
- Increased cogeneration will happen