Quantum Design PPMS VSM user training seminar

part 2: experiment design

June 2015

outline of seminar

- choosing which VSM coil set to use
- sample preparation
- sample mounting rules
- low-T sample holders (1.9 – 400 K)
- oven sample holder (300 – 1000 K)
- installing sample in cryostat
- measurement sequence examples

choosing the coilset

- standard (6 mm bore)
  - 7e-7 emu noise floor (1 sec. avg.)
  - 4 mm+ samples can rub the coilset
    - heating at low T
    - background signal and higher noise in field
- large bore coilset (12 mm bore)
  - 1e-6 emu noise floor
  - larger samples (<1cm), less risk of rubbing the coilset
  - larger uniform detection region
  - more “parasitic” background signal in field

VSM sample preparation

- beware of introducing magnetic impurities
  - no cutting/handling with ferrous tools
  - clean with solvents: dust is ~5% Fe !
- width should be narrower than holder
- length should be <4mm for best accuracy
  - see table in VSM user manual
  - VSMcoilcalc.exe program on Pharos
  - best thermal uniformity for oven samples
- in oven: need thin (<1mm thick) samples
  - high thermal gradient between stick and Cu shield

VSM sample mounting rules

- need low background signal
  - *uniform* and *nonmagnetic* sample holder
- durable attachment to survive large accelerations and extreme temperatures
  - default A=2mm, f=40 Hz
  - accel. = $A*(2\pi f)^2$ = 126 m/sec^2 > 12x “g”
- see VSM app note [1096-306]

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VSM sample holders (1.9 – 400 K)

- 4mm wide quartz paddle (half-rod) 4096-392
  - best for vertical plate-like samples
  - use Duco, GE 7031 varnish, clean tape, etc...

- 3.5mm wide brass trough (half-tube) 4096-391
  - round samples (3 – 4 mm diam.)
  - horizontal flat samples on 3.5mm diam. quartz rods 4096-399
  - powder samples in capsules (4096-388, next page)
  - spring force holds samples, adhesives not needed
  - 5.5mm version used for large bore (12mm) coilset

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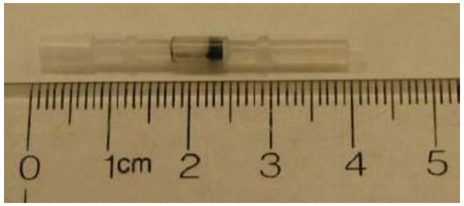
VSM sample holders (1.9 – 400 K)

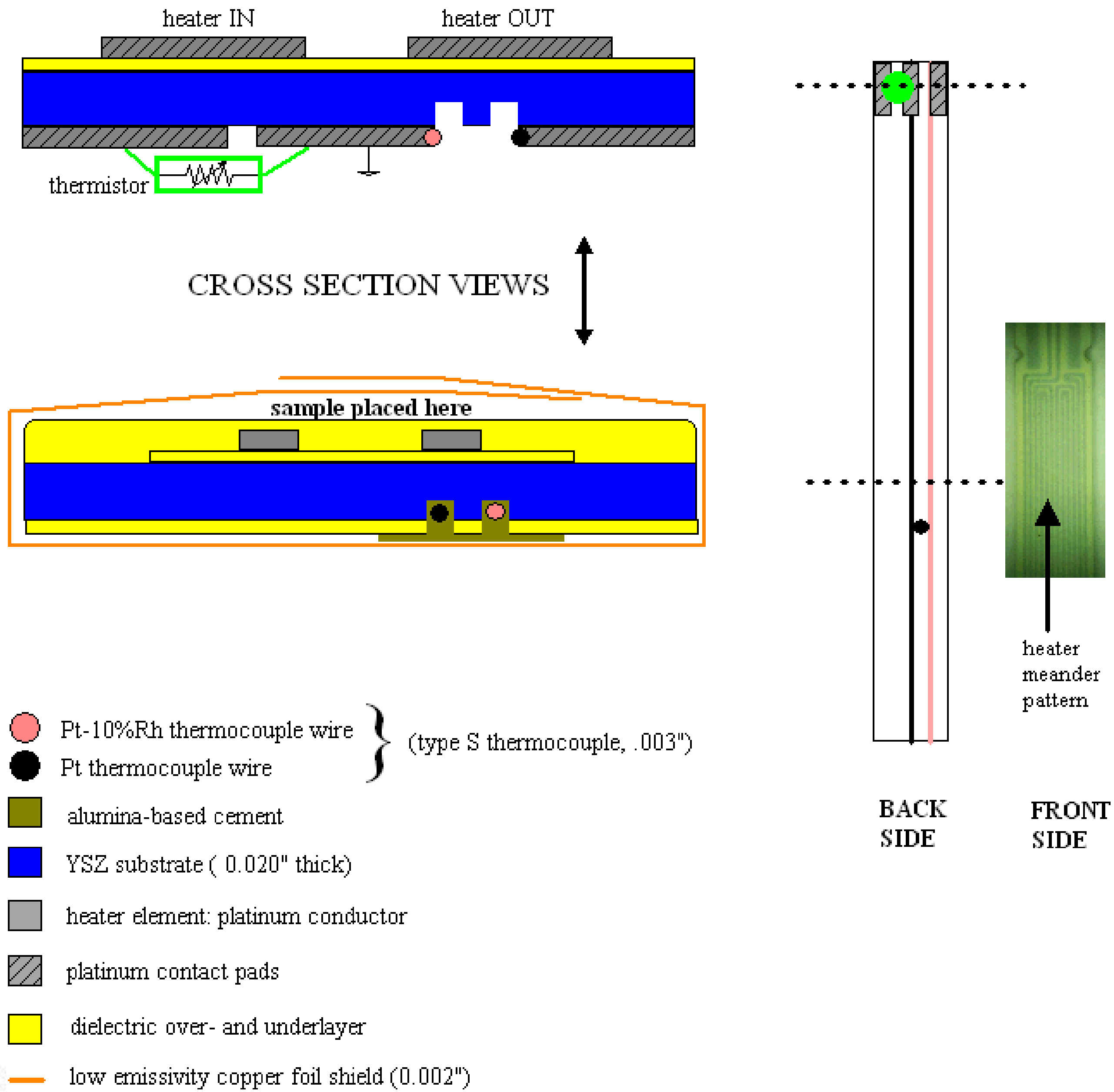


- powder sample capsules
  - each part has male + female side, 2 needed for usage
  - injection molded polypropylene
  - background depends on separation of the two halves
    - can look diamagnetic or paramagnetic (MvH linear)

VSM sample holders (1.9 – 400 K)

- drinking straws (6mm): usable on large bore only!
  - See QD for straws (AGC2-BOX) and new straw adapter (4084-815 is box of 3)
  - Films perpendicular: 4.1x4.1mm
  - Films parallel: 6mm wide
- liquid samples
  - No official QD holder designed yet
  - Must have no air bubbles above liquid!

VSM oven sample holder (300 – 1000 K)



VSM oven sample holder (300 -1000 K)

- heater region: 3.5 mm wide x 25 mm long
  - mount sample on heater, NOT back side (thermocouple wires in grooves can be damaged)
  - Temp. uniformity best over 4mm at center
- sample mounting (training videos on Pharos)
  - DRY (no cement):
    - Sandwich sample between heater and a thin ceramic plate
  - WET (Zircar cement):
    - Should cover the sample; Dry with heat gun

VSM oven sample holder (300 – 1000 K)

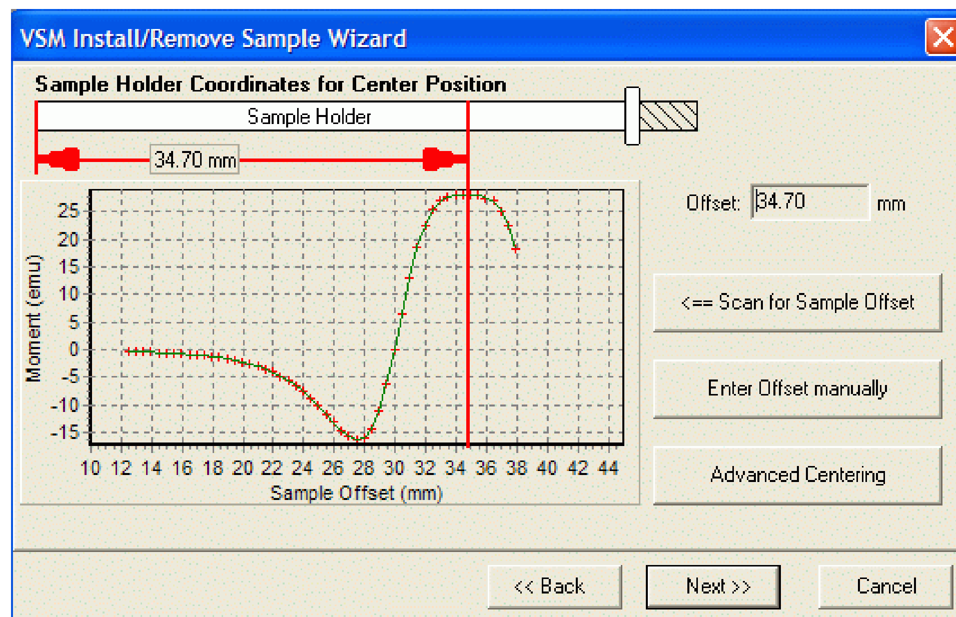
- wrap with provided 50 μm thick copper foil
  - needs to be clean, shiny (low emissivity)
- max. temperature can be raised to 1100 K
  - Fe T_c = 1043 K (standard sample available)
  - contact QD

installing sample in cryostat

- attach holder firmly to sample rod
- inspect for straightness along whole length
  - small deviations can lead to rubbing in coil set
- inspect for breaks in glue joints or glass parts
- use extended purge if going to low T

VSM sample centering: *sample offset*

- user specifies the *sample offset* : distance from bottom end of holder to sample
  - either measured by user or scanned to find signal max
- easy to measure on bench



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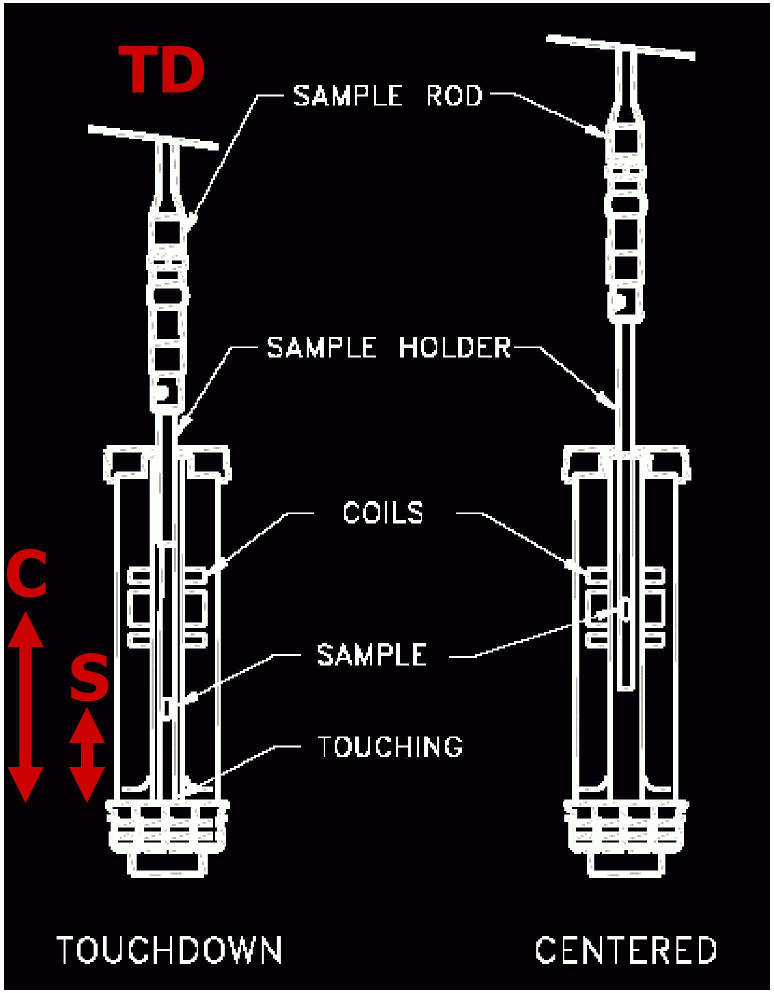
VSM sample offset

- coil height **C** above puck is known
- user supplies sample offset **S** from end of sample holder
- then motor operates at a location:

  z = "Center Position"

  = **TD** + (**C** - **S**)



sequence examples

- **M(H) 5-quadrant SWEEPING.seq**
  - “5-quad”: initial magnetization curve, then +H –H +H
  - continuous measuring while sweeping field, fastest measurement mode
  - no touchdowns: assumes stable at Temp. for > 1 hr
  - *sticky* autorange: change to *fixed* in cases of strong FM with steep M(H)
- **M(H) 5-quadrant STEPPING.seq**
  - uniform field spacing, magnet static and driven at each field
  - no touchdowns
  - sticky autorange: always OK for stepping
- **M(T) 300 to 20 to 300 K SWEEPING.seq**
  - down and up in temp., 1 K/min
  - touchdowns ON!
  - continuous measurement, 10 sec. average (why not? still 1681 points)
  - you will need to add a Set Field command (note magnet remanence)

sequence examples, part 2

- **M(T) 300 to 20 to 300 K STEPPING.seq**
  - stable Temp. at each point, get there fast (5 K/min)
  - Advanced setting: wait 60 sec. at each Temp. before measuring
  - Uniform T spacing of points (T^2, √T, 1/T, logT are possible)
- **remanent moment relaxation.seq**
  - measures M(H) down from saturation (e.g., 3 tesla)
  - goes to “real zero field” (here, +18 Oe) which corrects for magnet remanence (different in each magnet! See app note 1070-207)
  - stays in driven mode to minimize field drift from flux creep
  - measures M(time) using “VSM Adv. Measure” command
  - stops, sets persistent magnet after 1 hr
  - motor amplitude drifts: can be corrected by knowing moment(amplitude) for your sample in situ
    - **moment vs amplitude scan around 2mm.seq**