Chapter

1

LEVELLING

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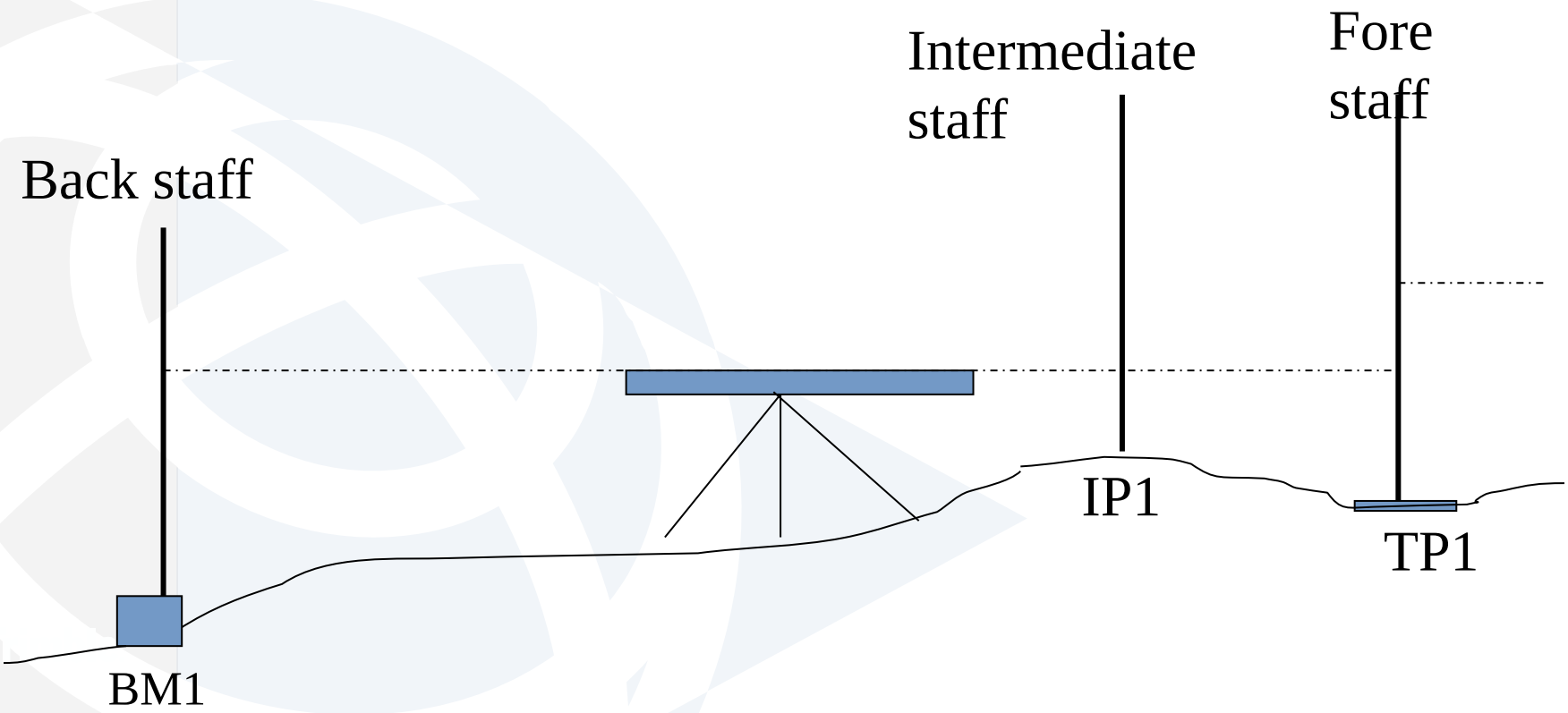
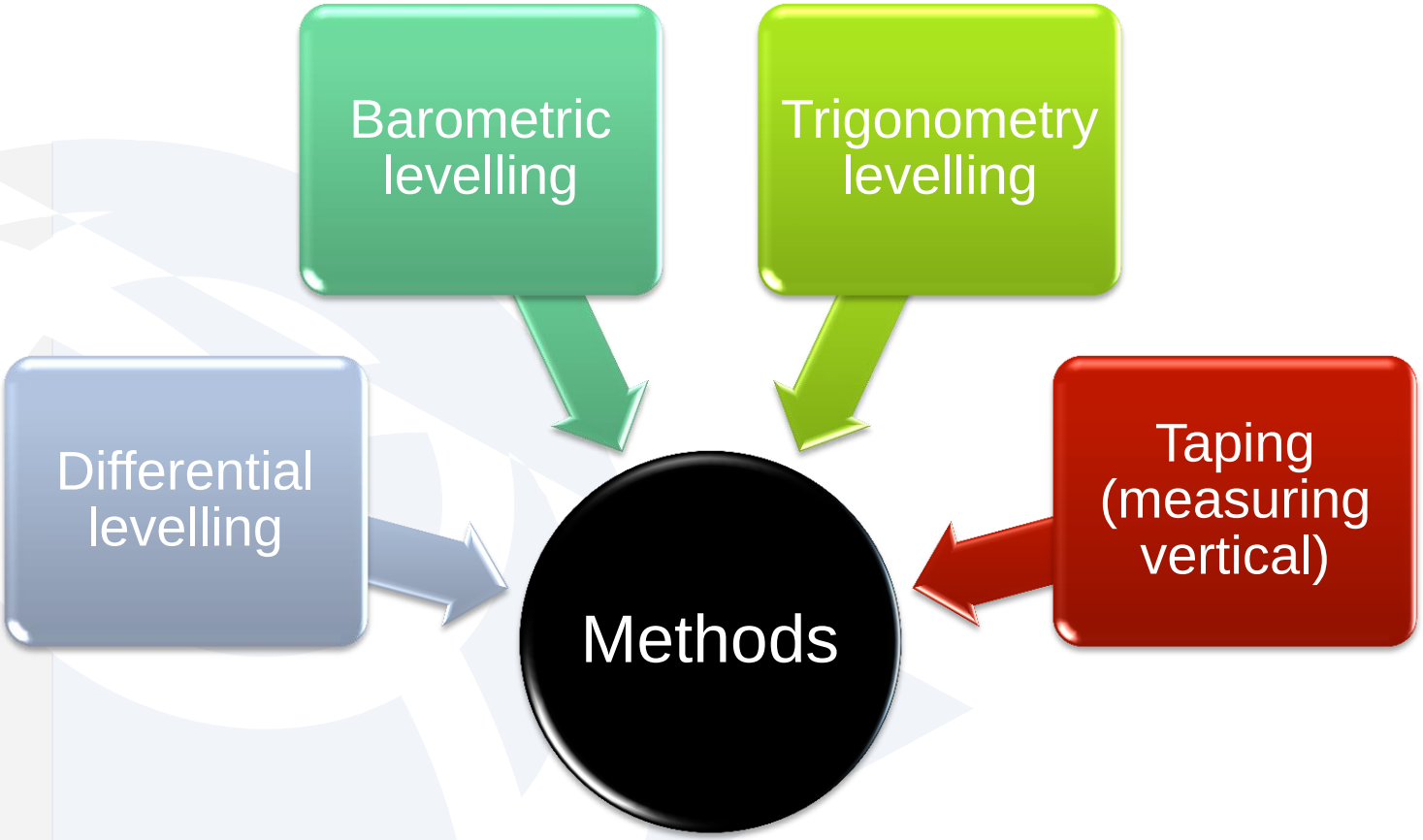
Levelling is a process to determine the heights of points on the surface of the earth



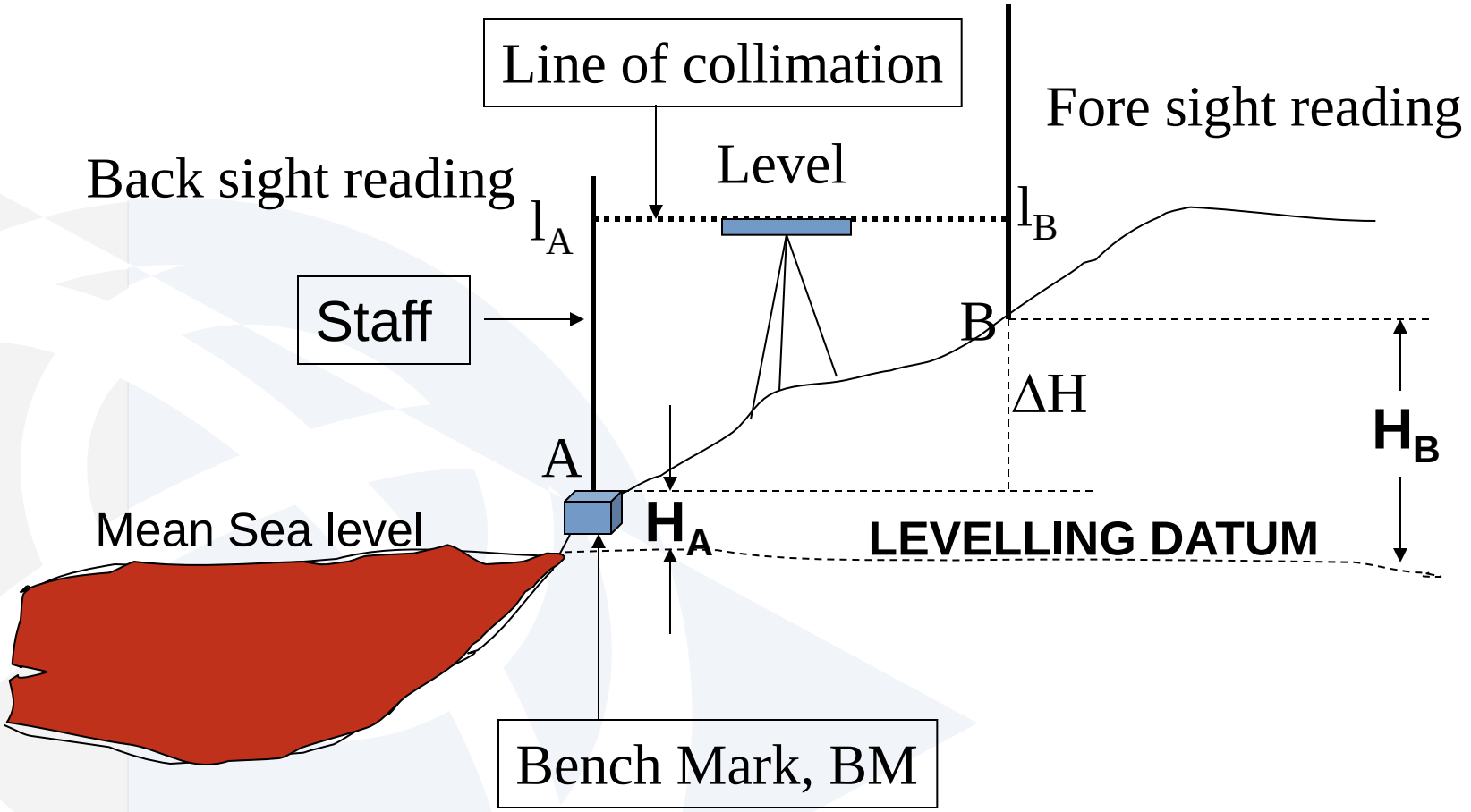
LEVELLING RESULTS ARE USED

1. Design highways, railroads, canals, sewers, water supply systems
2. Layout construction projects according to planned elevations
3. Calculate volumes of earth or other materials
4. Investigate drainage characteristics of an area
5. Develop maps showing general ground configurations
6. Study earth subsidence and crustal motion

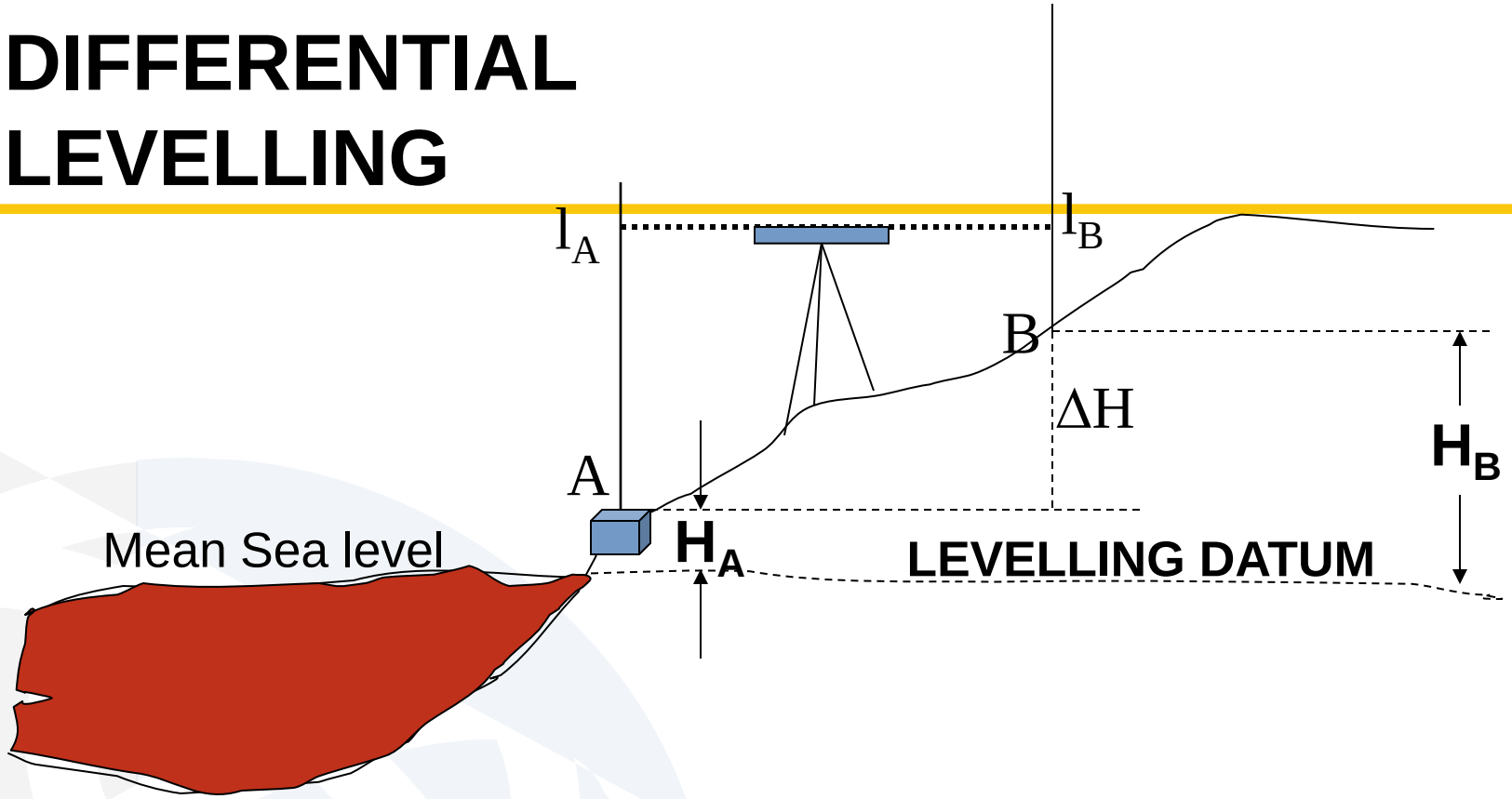
METHODS OF LEVELLING



EQUIPMENTS OF DIFFERENTIAL LEVELLING



DIFFERENTIAL LEVELLING



A= BENCH MARK, KNOWN HEIGHT, H_A

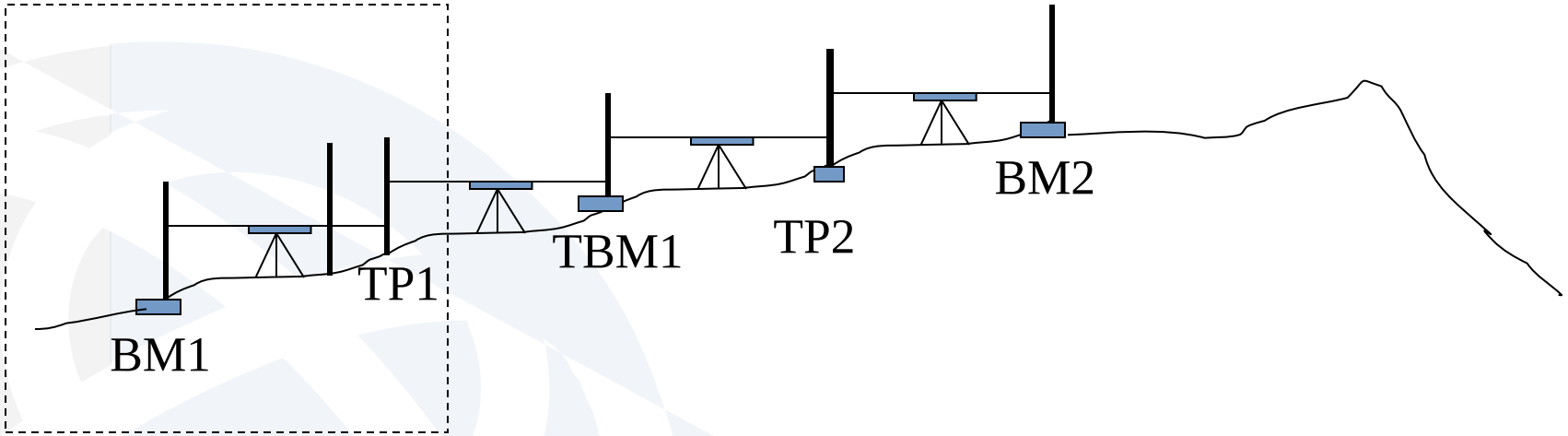
B= ITS HEIGHT TO BE DETERMINED, H_B

ΔH = DIFFERENCE IN ELEVATION BETWEEN A AND B

$$\Delta H = I_A - I_B$$

So $$H_B = H_A + \Delta H$$

LEVELLING FIELD WORK



Booking System

- RISE AND FALL METHOD
- HEIGHT OF COLLIMATION

BOOKING SYSTEM : 1. RISE AND FALL METHOD

BS	IS	FS	RISE (+)	FALL (-)	REDUCED LEVEL	CORR	CORR HT	REMARK
2.700					43.500			BM1= 43.500 m
	1.300		1.400		44.900	0.002	44.902	IP1
2.535		1.790	0.910		44.410	0.002	44.412	TP1
3.450		2.473	0.062		44.472	0.004	44.476	TBM1
3.100		1.650	1.800		46.272	0.006	46.278	TP2
		3.205		0.105	46.167	0.008	46.175	BM2= 46.175 m
11.785		9.118	2.772	0.105				

Note: height of intermediate is determined independently

BOOKING SYSTEM : 1. RISE AND FALL METHOD

BS	IS	FS	RISE (+)	FALL (-)	REDUCED LEVEL	CORR	CORR HT	REMARK
2.700					43.500			BM1= 43.500 m
	1.300		1.400		44.900	0.002	44.902	IP1
2.535		1.790		0.490	44.410	0.002	44.412	TP1
3.450		2.473	0.062		44.472	0.004	44.476	TBM1
3.100		1.650	1.800		46.272	0.006	46.278	TP2
		3.205		0.105	46.167	0.008	46.175	BM2= 46.175 m
11.785		9.118	3.262	0.595				

Note: IS reading is included in the whole ht calculation. . Better system than previous system. Give another checking system.

SELF CHECKING SYSTEM

SUM OF BS – SUM OF FS = LAST BM – FIRST BM

11.785 – 9.118 = 46.175 – 43. 500
2. 667 = 2.667

Diff sum of rise - sum of fall
=3.262 – 0.595 = 2.667

i.e. no booking error.

The measurement is accepted or not depending on the misclosure

MISCLOSURE

- **Any observation must comply with certain level of accuracy.**
- **Accuracy is the degree of closeness of the observed value to the true value.**
- **The observation error need to be small (within allowable limit or tolerance).**

- **True value = observed value + observation error**

MISCLOSURE

Levelling Allowable Misclosure, AM

AM = [20(D)$^{1/2}$] mm, D is measurement distance in kilometer

Ex: D = 500 meter = 0.5 km
AM = 20.(0.707) = 14 mm

Observation Misclosure = Observed ht – Known ht
= 46.167 - 46.175
= - 0.008 = 8 mm(misclosure)

Since OM less than AM, the measurement is acceptable.

CORRECTION TO THE OBSERVATION READINGS

- Correction to the observed data can only be given after we satisfy that our observation are acceptable due to blunderless or gross error free, as evidenced by OM less than AM.

Ex:

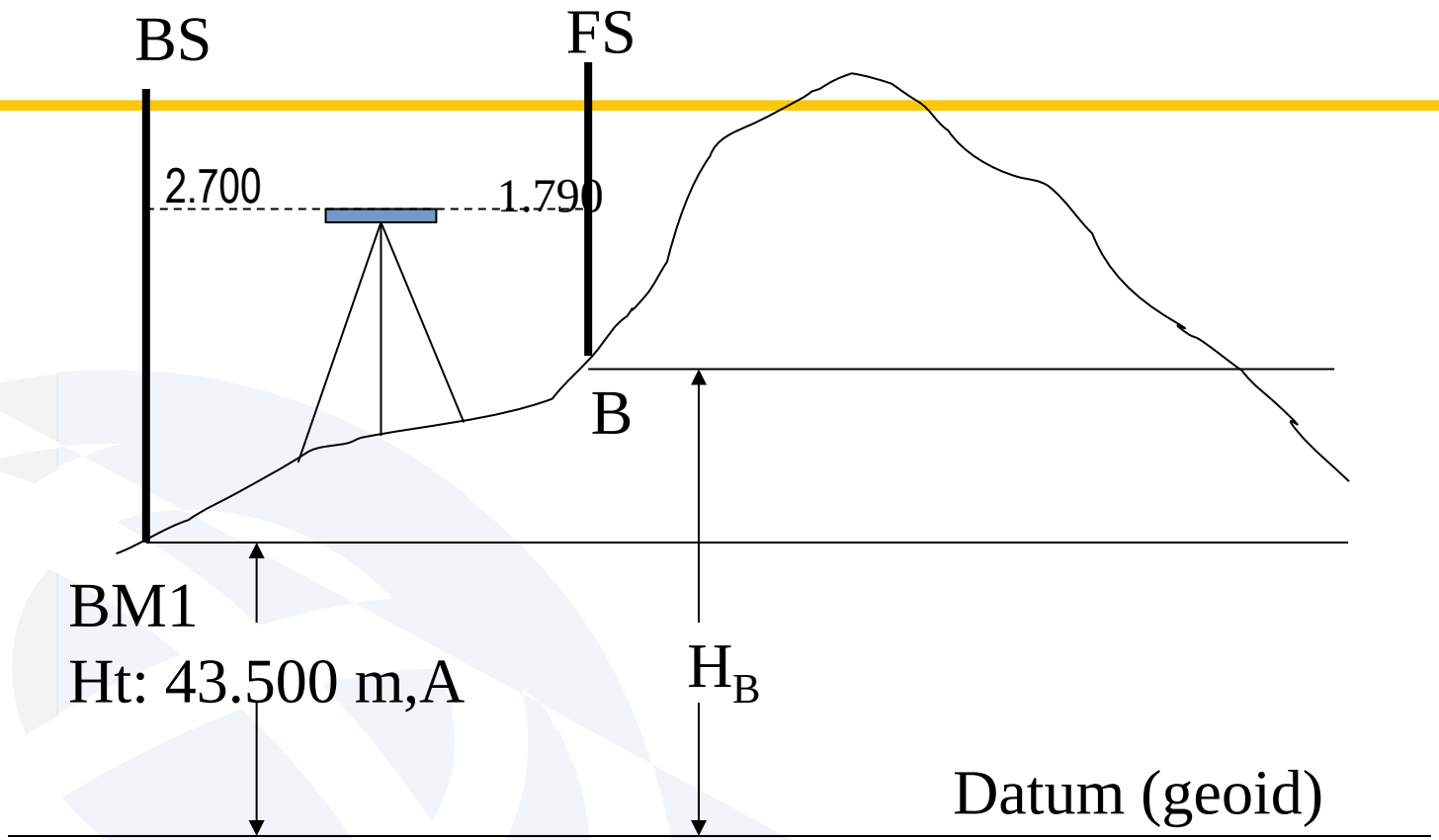
- the correction, c = + 0.008 in 4 setups

  = + 0.002/ setups,

- The magnitude of correction accumulates as the measurement distance increases

BOOKING SYSTEM : 2. HIGH OF COLLIMATION METHOD

BSR	ISR	FSR		HC	REDUCED LEVEL	CORR	CORR HT	REMARK
2.700				46.200	43.500			BM1= 43.500 m
	1.300				44.900	0.002	44.902	IR1
2.535		1.790		46.945	44.410	0.002	44.412	TP1
3.450		2.473		47.922	44.472	0.004	44.476	TBM1
3.100		1.650		49.372	46.272	0.006	46.278	TP2
		3.205			46.167	0.008	46.175	BM2= 46.175 m
11.785		9.118						



Height of Collimation, HC = H_{BM1} + BS = 43.500+2.700= 46.200

H_B = HC – FS = 46.200 – 1.790 = 44.410

Factors affecting accuracy in levelling

- **Reading of staff**
- **Bubble not being central**
- **Instrument not being in adjustment**
- **Differential settlement of the tripod**
- **Tilting and settlement of staff**
- **Sensitivity of bubble or compensator**