Diagnostics is the 'organ of sense' for the beam.

It required for operation and development of accelerators

Three types of demands leads to different installations:

➢ Quick, non-destructive measurements leading to a single number or simple plots.

➢ Instrumentation for daily check, malfunction diagnosis and wanted parameter variation.

➢ Complex instrumentation used for hard malfunction and accelerator development.

A clear interpretation of the results is a important design criterion.

General comments:

➢ Good knowledge of accelerators, general physics and technologies needed.

➢ Quite different technologies are used, based on various physics processes.

➢ Each task and each technology calls for an expert.

➢ Accelerator development goes parallel to diagnostics development.

⇒ Interesting and challenging subject!

LINAC & transport lines: Single pass ↔ **Synchrotron:** multi pass

Electrons: always relativistic ↔ **Protons/Ions:** non-relativistic for E_{kin} < 1 GeV/u

Depending on application: Low current ↔ high current

Overview of the most commonly used systems:

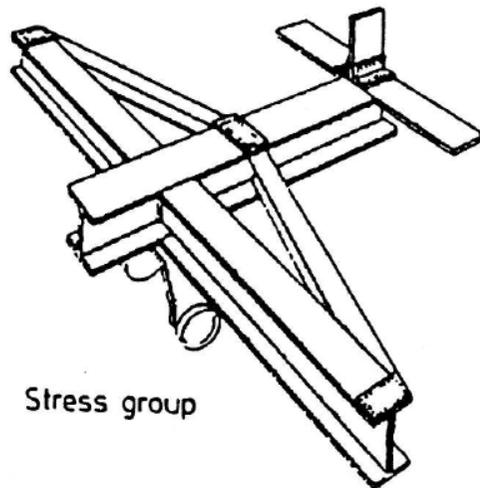| Beam quantity		LINAC & transfer line	Synchrotron
Current I	*General*	Transformer, dc & ac Faraday Cup	Transformer, dc & ac
	Special	Particle Detectors	Pick-up Signal (relative)
Profile x_{width}	*General*	Screens, SEM-Grids Wire Scanners, OTR Screen	Residual Gas Monitor Wire Scanner, Synchrotron Light Monitor
	Special	MWPC, **Fluorescence Light**	
Position x_{cm}	*General*	Pick-up (BPM)	Pick-up (BPM)
	Special	Using position measurement	
Transverse Emittance ε_{tran}	*General*	Slit-grid Quadrupole Variation	Residual Gas Monitor Wire Scanner
	Special	Pepper-Pot	Transverse Schottky

Beam Quantities and their Diagnostics II

Beam quantity		LINAC & transfer line	Synchrotron
Bunch Length $\Delta\varphi$	*General*	Pick-up	Pick-up Wall Current Monitor
	Special	Secondary electrons	Streak Camera, Laser
Momentum p and Momentum Spread $\Delta p/p$	*General*	Pick-ups (Time-of-Flight)	Pick-up (e.g. tomography)
	Special	Magnetic Spectrometer	Schottky Noise Spectrum
Longitudinal Emittance ε_{long}	*General*	Buncher variation	
	Special	Magnetic Spectrometer	Pick-up & tomography
Tune and Chromaticity Q, ξ	*General*	---	Exciter + Pick-up
	Special	---	Transverse Schottky Spectrum
Beam Loss r_{loss}	*General*	Particle Detectors	
Polarization P	*General*	Particle Detectors	
	Special	Laser Scattering (Compton scattering)	
Luminocity L	*General*	Particle Detectors	

➢Destructive and non-destructive devices depending on the beam parameter.
➢Different techniques for the same quantity ↔ Same technique for the different quantities.

Diagnostics

Weight group

Equipment group

Armament group

Power plant group

Stress group

Wing group
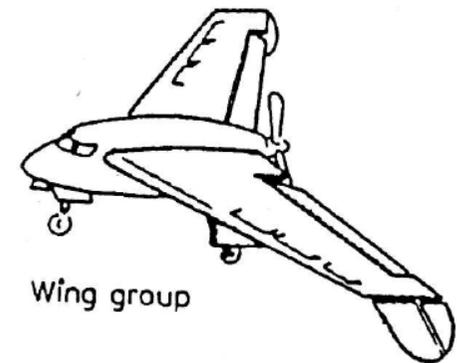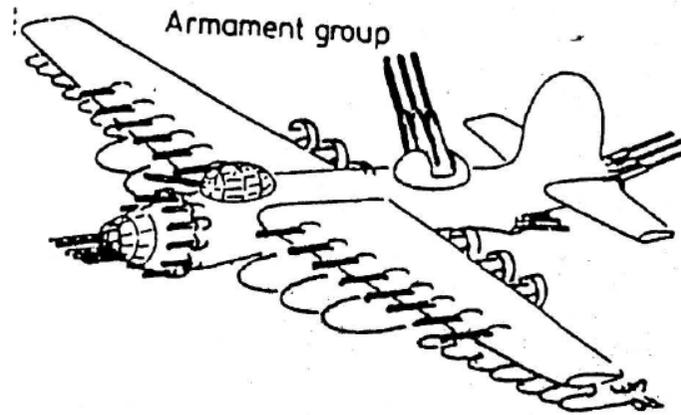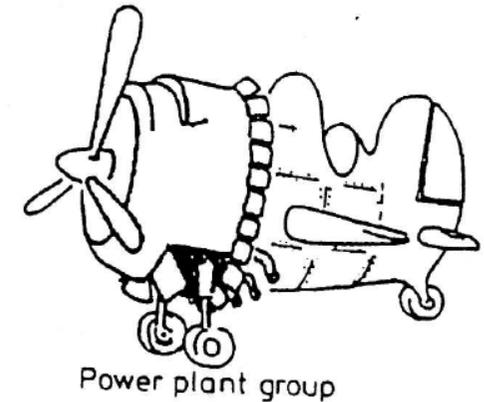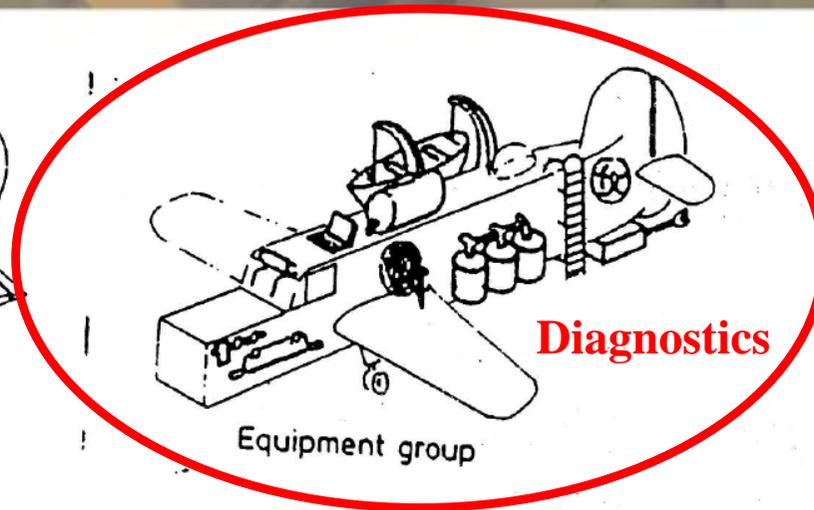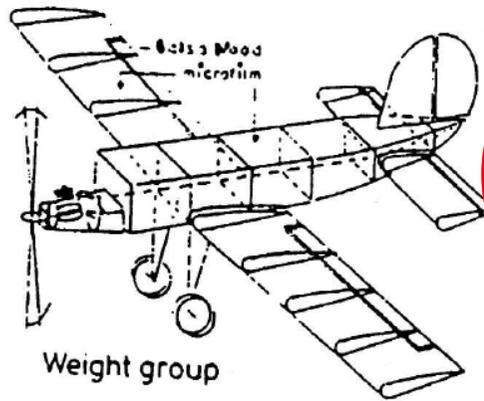
For a successful construction and operation of an accelerator,
the understand and right balance of all disciplines is required!